A friend of mine yelled so hard, she told me that something popped in her brains for it, what does that mean?

It happens occasionally that there's a weird "event" in your head. Who the heck knows what it is. Sometimes it's a flash of light, or a weird flashing sensation, it's a neural glitch, nobody understands the brain enough to say what it is. Maybe if it happened while someone was in an MRI, or if you had a drug that induced it, it could be studied.

Is it the Pauli exclusion principle or electrostatic forces that explain why I do not fall through the floor?

Yes, the repulsion is secondary--- a given quantity of electrons bound to nuclei can't be compressed without energy cost, because the electrons exclude. The stable ground state of fermions is with a volume proportional to the number of fermions, as proven by Dyson and collaborators in the 1960s. It is not so for bosons, which collapse to a much denser state whose volume grows only as a fractional power of the number of bosonic particles. This is the key to the stability of matter, but it was already qualitatively understood by Pauli earlier. It's the reason his exclusion principle was the sole motivator for his Nobel prize.

Is divine presence around us or within us? Why?

The location of a divine presence is impossible to say, because it's like asking if the number 7 is around us or within us. The notion of divinity is abstract and computational, and to the extent we can construct approximations and see they are consistent and convergent, we can be sure it makes sense in the limit. That's all that matters for practical purposes, so that's as far as I will go, being a positivist.

If the universe was uniformly distributed energy in space time in the beginning and uniformly distributed energy in space time in the end, why is the entropy different?

The uniformity is different in the beginning and at the end. In the beginning, it's a uniform field, with essentially zero entropy, it's the inflaton. At the end, its a bunch of random gas particles and random thermal entropy, which is a huge amount of entropy.

Enlightenment (spiritual): Have you experienced the age of reason?

Ok, I reached the "age of reason" at age 10, I dropped my religious beliefs as social dogma, and started reading a lot about science. But I eventually realized that the religious beliefs are not supernatural or nonsensical at all, they are completely compatible with reason, they are just not sold that way because of various historical accidents. That was at age 30. So there are two 'ages of reason' as far as I can see, at least normally, and George Carlin was just stuck between the two for some reason, possibly because of occasional marijuana smoking, but more likely because his comedy depended on being as far away from the mainstream as possible.

I recently started working, and just 6 months into it I feel like I am growing less intelligent. Have you felt the same at some point in your life?

This is normal, it's the brain damage of work. There's a reason they give you money to do it.

For a beginning PhD student, what is the best predictor of whether or not that student will continue in academia beyond the PhD?

Discovering something independent of the advisor.

Should I continue talking to a girl or stop?

I think the best solution in this case is to have an affair with her best friend. You have to think outside the box.

What does the wavefunction of a moving electron look like?

It's a twisting corkscrew in the complex plane along the direction of motion. A good heuristic form is f(x) exp(ikx), where f(x) is some envelope function to localize the electron and k is the momentum.

How did scientists figure out Boltzmann's constant from the ideal gas equation and what does it tell us?

Boltzmann realized that an atomic theory of gasses would have an increasing entropy, as the probability for finding a particle at position x and momentum p would smoothly change with collisions, it would always decrease the information content of this probability distribution, as information would flow down to more correlated variables, not up to the single particle level. This principle was the "Molecular chaos hypothesis" or "ergodicity". From this, he deduced that the entropy must be proportional to the number of possible microstates for a given macrostate, with a constant of proportionality to fix the units: $S = k_B \log(\Omega)$ and from analyzing the entropy of a collection of free particles, and matching to the entropy of an ideal gas, you discover that $k_B = \frac{R}{N_A}$ If you want to see the entropy formula for an ideal gas derived from Boltzmann's formula for entropy, it is contained on the Wikipedia page for "Adiabatic invariant". It's extremely simple, it's just the volume of a high dimensional sphere.

What is the secret of the Teller-Ulam design? What are the details of the thermonuclear weapon?

It hasn't been a secret in broad outlines since the early 1970s, when the Teller Ulam idea was published in the popular press, and there are rough sketches on Wikipedia. Any further details are only known to bomb designers, and are highly classified, and also highly useless to individuals, as they require a nation state or enormous corporation to actually manfacture. All the information below is available on Wikipedia, and is useless to anyone including nation states, who know the basic idea already for 40 years, and any physicist can work the broad outline out in a few minutes. The idea is that when an atomic bomb explodes, there are a lot of hot x-rays at enormous energies. These x-rays are short wavelength and can be emitted and reabsorbed at "x-ray reflectors" which are of a heavy "pusher/tamper" material, which just has to stay in place long enough reflecting x-rays so as to compress the cylinder in the middle. The x-rays are homogenized by a mean-free path process in a homogenous plasma between the pusher and the cylinder (the plasma usually starts out styrofoam from what I heard from popular accounts). The x-rays than hit the cylinder in the middle from all directions equally, creating a tremendous pressure on the cylinder, all in the microseconds before the blast reaches the cylinder. The compression is a form a heat engine, the cylinder is cold, the x-rays are enormously hotter, and they ablate the surface layers into the plasma, pushing atoms outward very fast and the reaction force from this out-plasma emission pushes the cylinder inward symmetrically, so that the pressure at the center grows without bound, and at the very center, you have something, either a fissile trigger, or something else, a so called "spark plug", and surrounding this your fusion fuel. When the spark plug does it's magic, the fusion fuel is compressed enough from all directions, or else is irradiated sufficiently that it will reach fusion temperature, and then the fuel fuses. The details probably depend on whether it's a d-t weapon or a Li-d weapon, each configuration is different. The first Li-d weapon ran away to three times the size, because of an unexpected reaction involving an isotope of Li that wasn't supposed to do anything in the design. You can modify the design in many inessential ways, to make shape-charges for an Orion rocket, so that the ablation pressure (which is enormous) is used to push a rocket. You can make really small H-bombs by using the least possible fission trigger, and there are probably even more ingenious tricks that are still classified, as the neutron bomb details are still classified, and this is a very low yeild, very high fusion thermonuclear device. But this is the basic Teller Ulam idea. It was rediscovered in the USSR by Sakharov, and independently in other nations, before the details were made public. Although knowing this feels scary, it's as useless for an individual as knowing the general principle of building a moon rocket.

What causes the electron in a hydrogen atom to stay in 1s orbital and not just fall to the proton?

A quick heuristic from the uncertainty principle, to confine an electron to a box of size l, you need momentum h/l, and therefore positive kinetic energy h^2/2ml^2, but you only gain a negative potential energy q^2/l, which diverges less slowly, so when these are comparable, you get the lowest energy state. Setting the two equal, and solving for l, this happens when $l = \frac{h^2}{mq^2}$ which is the Bohr radius, ignoring small dimensionless factors like 2π and 2. This dimensional argument can be converted to a proof of the stability of the ground state of Hydrogen using variational arguments. But since the H atom is exactly solvable, you can just try the Schrodinger ground state and see that it solves the Schrodinger equation and is a ground state, because it has no sign changes. But the argument above, due to either Bohr or Heisenberg, only uses uncertainty principle estimates, but it is also dimensional, and only gives results up to order of magnitude. If the binding potential was growing faster that 1/l^2, say if it was 1/l^3, then the electron would collapse onto the proton.

Do successful people always know that they are going to be successful?

Statistically, almost everyone "knows" they are going to be successful as a young person, those that make it just don't have a disillusioning realization that they were operating under a delusion, that they are just the same as anybody else. For me, this disillusion came at around age 10. Unfortunately, since the process of achieving success is a game of musical chairs, it is largely, although not completely, random, it depends on social networks congealing around you, more than on the quality of your work, and the social networks can be manipulated, but also have their whims. But those who are successful early happen to do something that a social group is already waiting for, and the result is that they are subject to a delusion that they are somehow magic, and that their instincts are just always right, and this can lead them astray.

What are the best ways to learn algorithms and programming techniques from scratch?

Write some programs. The theoretical stuff is not that complicated in comparison to real world problems, just more elegant and general.

How do I extract and print the fields in the log file?

use C's stdio sscanf function, it's good and fast. There is no problem in mixing C and C++ libraries in gcc under Linux, I don't know about other OS's.

Do plants respond to audio stimulation?

We don't understand plants all that well, but almost surely not, because they don't have special organs for it. So any effect would have to be translated to chemical signals somehow, and unless there is a crazy sensor mechanism in plants, I don't see any possible way it could happen.

How can you explain the meaning of the phrase "turing complete" to a layperson?

Capable of simulating anything in the universe (with enough memory and time), including your laptop and your brain.

Is it harder for us to look at blue/violet colors than yellow/red colors?

The bluer the photon the more the energy, but the answer is by the photoreceptor molecules in the eye, and does not depend only on consideration of energy. I don't know the sensitivity of the receptors however.

Can’t electronic products be designed in a deeper decentralized manner, where even the smallest component of the product could be repaired/replaced easily without replacing the whole product? Reference: Story of Electronics - Story Of Stuff

Yes. They actually can be repaired, but the industries prevent you from opening them up and tinkering with them, as part of a program of planned obselescence. This is a monopolist's disease, it cannot survive in heavy competition, but these firms use patents to prevent cloning of technology. It would require quite a bit of restructuing to ensure the level of competition that would prevent planned obselescence, probably a size-tiered corporate income tax, and requirements on open specifications for all devices, independently evaluated for tinkerability, with consumer boycotts on stuff that isn't open. This is similar to the free software movement. Still, even with closed products, there are ways around planned obselescence, and people have learned to open up and repair faulty or intentionally malfunctioning equipment and replace the malfunctioning parts. There are industries to do this in Israel (one of my uncles did such things), and in other places, but it is not popular in the US.

What are some incidents which prove that sometimes logic outplays common sense?

9/11 was an inside job. Common sense says it wasn't.

What are the best examples of a service being sold as a product?

Software.

Is our universe cellular automata at a fundamental level?

Not in any obvious way, it would conflict with Bell's theorem if the mapping were local. For nonlocal mappings, the answer isn't clear, but nobody has any clue how it would work, and the result would have to magically reproduce quantum mechanics at least for small systems. For larger systems, for a physical size automaton, it would have to fail at quantum computation, simply because a cellular automaton the size of the universe cannot factor 10,000 digit numbers, and quantum computers can. So this model is making a prediction, it predicts that quantum computers will fail when they get to a certain size, less than 10,000 qubits. So the best bet is no. The descriptions in the literature all fail on the simplest thing, reproducing quantum mechanics even approximately, and can be ignored with no exceptions.

What are the best sci-fi series to watch on Netflix and why?

I liked the British television adaptation "The Tripods", but be warned, it has a cliffhanger depressing ending because they never got to make the final season. I also liked the 1960 and 1970s "Dr Who", but this is a classic.

What do physicists think of the idea discussed by Max Tegmark that consciousness is another state of matter?

Ok, it's a state of matter, it's the "computing" state, the one where things compute. But this is also true of simpler biological systems also, and of networks, so that the consciousness in this was is rather diffuse, and includes a miniscule amount of bacteria consciousness (some kilobytes or a megabyte of consciousness), some yeast consciousness (a gigabyte of consciousness), amoeba (10s of gigabytes of consciousness), an 4-cell human embryo (terabytes of consciousness), roaches (a thousand gigabytes of consciousness) , cats (a hundred million gigabytes of consciousness) and humans (a billion gigabytes of consciousness). Also elephants, with slightly more consciousness. There are two important things here, the amount of computation in the individual brain or whatever computing organ you have, and the degree to which it is networked to communicate with other consciousnesses, the networking thing. The two are important. Beyond this, I don't see any mystery, because there is nothing positivist has left to explain. It's sort of a pan-bio-awareness, with a different degree of consciousness associated to different qualities of computation, according to the degree they are complex, and the degree they can communicate.

Is it a worthy pursuit to partake in the scientific study of the human mind?

Yes, but you should pick something simple, like Feynman's "multitasking test" described in his autobiography, or Chomsky's linguistic analysis, or Hofstadter (and others) speech-error compilations. You need a good simple phenomenon which can shed light on the mind. If you start high level, you will get into ids and egos, and you will just make untestable pseudoscientific blather.

A large, sparsely populated array contains numbers chosen from a large data set. The position of a given number in the array is random, and every number but one has a duplicate in the array. How would you determine which number is unique?

bitwise xor all the numbers in the matrix together (no need to upvote, ancient programming puzzle, much older than me).

What is the significance of the S-matrix in physics?

The S-matrix is an asymptotic operator which describes how particles going into a scattering event transform into particles going out. The S-matrix can be calculated from a Hamiltonian description, but the nice thing about it is that it does not require a Hamiltonian or Lagrangian description of the intermediate details of the scattering at all, it can be built up without regard to the local space-time structure. Because of this, you can use it to construct theories which are insensitive to a breakdown of naive space-time structure. You don't need any knowledge of the local structure of space and time to talk about incoming and outgoing particles, since these are defined at far away locations and far away times, so you know they can be described in the ordinary way, using plane waves. From the S-matrix idea, you can reconstruct physics, but you need some assumptions. Feynman started with the idea of an electron and a photon, and classical electrodynamics in the classical limit, and found the Feynman rules for QED. Schwinger and Dyson found the same rules from the Hamiltonian description of QED, and it required a renormalization procedure to make sense of the diagrams in both pictures. So Feynman decided S-matrix was equivalent to field theory, and stuck with field theory for the rest of his career. But others pursued a pure S-matrix theory. Chew and Mandelstam, working with consistency conditions, decided that there was enough information in the S-matrix to reconstruct all of physics. People worked hard throughout the 60s to show how this program would work, and a lot of people accepted this, but a lot of people also stuck to field theory too. At the time, the focus was the strong interaction. The S-matrix description of Pions and Nucleons developed by Chew in the early 1960s transmuted into the effective field theory of Nambu and Weinberg in the late 1960s. Weinberg became convinced that the only solution to the S-matrix consistency conditions was a form of field theory, and he was sort of right, under the assumption of finitely many fundamental particles. But Tullio Regge showed that particles can come in families, and Chew and Mandelstam persisted in looking for a theory of exchange of Regge trajectories. Vladimir Gribov described these Regge proceses with a calculus of diagrams, but this calculus ultimately had an interpretation in terms of a two-dimensional light-cone picture developed by Feynman, Gribov, and later followed up by Kenneth Wilson and nowadays is developed further by Sarada Rajeev. It still wasn't a new theory. But in 1968, Veneziano found a formula for an S-matrix approximation (a first-order scattering amplitude) that was clearly completely different from field theory. This was the foundation of string theory, it developed into string theory over the following decades. In the mid 1990s, the S-matrix picture was understood more completely as the form of holographic principle appropriate to asymptotically flat space time. The statement that "everything is in the S-matrix" is then more properly reinterpreted as the statement that the local physics is reconstructed from dynamics on holographic boundaries at the edge of the universe. This became accepted when it was demonstrated to work in AdS/CFT models, and now all this old stuff is water under the bridge. But betwee 1960 and 1974, there were two camps in physics who hated each other and did not hire each other, or read each other, the S-matrix people and the field theory people. Both sides made spectacular progress, but the S-matrix folks made more progress and got beat up more for it, so I prefer to laud them more.

Does an electron create virtual photons in a specific way or is it just random?

The amplitudes for creation of photons is given by the Feynman rules for QED. The amplitude for emitting a photon (in any momentum) is always a factor of "ie\gamma^\mu" (the imaginary unit times the dimensionless electron charge --- square root of 4 pi times the fine-structure constant, times a matrix depending on the initial and final polarization state of the electron, or minus this, I forget). The photon propagation is then according to the Feynman propagator, the amplitude for the photon to travel from x to y is i 2 π 2 g μν (x−y) 2 +iϵ i2π2gμν(x−y)2+iϵ Where the g part is the polarization of the photon, there are four polarizations in this formalism even though photons have only two, and this is true only with the proper convention for the metric. The epsilon just defines how to deal with the singularities on the light cone. The propagation is both forward and backward in time, this picture is not causal in the usual way. The photon has an amplitude for turning into an electron-positron which is also ieγ ieγ (or minus this), and this ends the photon path. The sum over all diagrams reproduces QED, at least in perturbation theory. The only subtle part is that you need a minus sign for every closed electron loop, this is Fermi statistics in Feynman's formalism. The processes are precise in this choice of conventions, called "Feynman gauge", but the details depend on an arbitrary choice, that's called choice of gauge. In Dirac gauge, another choice, all photons are real, the Feynman rules are not manifestly relativistically invariant. In other gauges, there are different splits of virtual photons. The virtual photon picture is convenient, but it is not essential. In quantum field theory, you can choose gauges where they aren't there.

Some American senators are suggesting that the Boston bombing suspect should only be allowed a military tribunal. Why? Why would America consider not giving the Boston bombing suspect a trial?

Because he is obviously completely innocent. See here: Boston Fakery ~ An Expose of the Boston Marathon Bombings Hoax . There can be no rational debate on this, and he would walk in any reasonable court of law. Then the lawsuits would come, and the drill coordinator would be subpoenaed, and the whole operation will be exposed. Good. Also, the police that shot his brother dead would be on trial for murder, and the gross violations of the 4th amendment in the Boston lockdown would be the subject of a class action lawsuit. Good. So of course they want a tribunal, because a kangaroo court is secret and the outcome predetermined.

Who is responsible for the 2013 Boston Marathon explosions?

The person in charge of the bomb drill that day. See here: Boston Fakery ~ An Expose of the Boston Marathon Bombings Hoax also here: Ron Maimon's answer to Some American senators are suggesting that the Boston bombing suspect should only be allowed a military tribunal. Why? Why would America consider not giving the Boston bombing suspect a trial?

What would it be like to live in world without stupidity?

Stupidity is relative, it just becomes more subtle as people know more. In tribal societies, people sometimes don't know the answer to "what is 4+9", and this can be exploited. Then the stupidity dimnishes. In our time, in 20 years, everyone starts looking stupid, even the greatest geniuses.

In organic reactions, why does a pair of electrons go from nucleophiles to electrophiles to then form a covalent bond instead of just forming the bond?

They go to a shared orbital, which is roughly a superposition of the two old orbitals (with a little bit of distortion due to mixing with higher states). The notion of "electrophile" is to describe the degree to which the electron is shared with most of the wavefunction piled on one atom rather than the other, and this tells you how likely the electron is to be on one atom rather than the other when the molecule dissociates, and the local charge distribution you expect. Saying "the electron goes here" is a heuristic approximation to a more complicated graded quantum picture, but it works, so you should learn it.

If the dead could be called over for a single time and you had just one option, whom would you call?

My mother. This is obvious for anyone whose had a parent die. If you exclude relatives, maybe I'd call Joel Scherk.

Why do people condemn physical violence, but not "intellectual violence"?

Because there is no such thing as intellectual violence, there is only true ideas beating out false ones. Physical violence gets in the way of this, because it prevents intellectual violence by opposing it with the physical kind. Intellectual violence is a good thing.

Does blackbody radiation work like this?

Yes. The statistics are described by the Boltzmann distribution, so you don't need to know all the details of the dynamics, in fact, from the consistency of the Boltzmann distribution, you learn something about the dynamics.

This is what Einstein used in 1917 to derive the A and B coefficients, the stimulated emission, the principle of the laser. This was later completed by Heisenberg into modern quantum mechanics.

How come the universe is made of matter and not antimatter?

Eric Pepke said the basic thing--- it involves a matter-antimatter asymmetry that is magnified during the big bang. The details happen at higher energies than we can probe with accelerators, and there are several ideas. The first statement of what is required was due to Sakharov, who pointed out that it requires: 1) Time asymmetry (T breaking, or CP breaking) 2) Non equilibrium initial dynamics--- out of equilibrium big bang 3) Baryon number violation. These were all predictions in the 1960s when he said them. The non equilibrium dynamics are at the end of inflation, when the universe stops slowly inflating less and less and starts to actually bang. The T breaking is either in a high-energy GUT model, or using standard model CKM matrix. The CKM matrix is some phases in weak decays, and seems to be far too weak to account for the antimatter asymmetry. But this is not 100% clear to me personally. The baryon number violation is either in a high-energy GUT, or using weak instantons. At high temperature, there are baryon number violating processes even in the standard model, but the production of baryons by this mechanism might be too weak. There are hundreds of models in the literature, nobody knows what is right. The most recent ones I read about were "leptogenesis", which made an asymmetry in leptons in the early universe, and then converted this to baryons with instantons (or something like this, I forget, google leptogenesis). It's not known at present, and I am not well versed enough to say which models are most compelling.

Adam picks 2 numbers between 0 and 15.8. Rob flips a coin. If the coin lands as heads, Rob shows you the first number Adam picked. If the coin lands as tails, he shows you the second number Adam picked. What is the probability that the first number is the smaller of the two? Is the probability greater than 0.5?

The probability is exactly 50% with nothing else you need to know. There is no subtlety. The only caveat is if the numbers can be exactly equal, in which case there is a greater chance of being "smaller" in the sense of "smaller or equal to", and a less chance of being "smaller" in the sense of "smaller, not equal to".

What should someone consider when deciding between a degree in experimental particle physics or theoretical particle physics?

Whether you are interested in the dynamics of plasma bunches and enormous machines, electromagnetic devices, or string theory vacua and group theory. The two should not be mutually exclusive anymore, as anyone who is conversant in one should have an easy time with the other, given that there are resources online today. So best is to be a Fermi and do both. Not that I did that.

Why do we choose 8 bit for the representation of smallest element of information?

Because 8 is a power of 2. You're lucky they didn't choose 9, which was totally possible when octal was prevalent. 2,4,8,16 make dividing and multiplying to rescale trivial bit-rotation.

How can I stop paying attention to whether people look at me (in a negative way) or not?

Shave your eyebrows and paint question marks where they used to be, with the dark part of your eyes as the dots. You'll get used to it quickly and it will never bother you again.

Is money really a good metric for value?

In a perfect competitive market, money price is equivalent to any other measure people use for value, like the labor value, or the exchange value. The only way that money price fails to be a good measure of value is if the market is noncompetitive or distorted. Since this is understood for a century already, you can find any instance of an overcharged item, and use this to find the monopoly and break it. The government used to do this, but doesn't anymore.

How would you compare the success of the managers in different companies in one specific industry?

The Soviet method was to allow the workers to choose who they would work for, and reward the managers based on their fullfilment of quota. Then the managers desperately needed as many workers as they could get, and the best managers got a lot of workers and made good above the quota. The worst ones didn't make quota and got fired. The workers choices decided who did well and who didn't. In the modern world, where workers are slaves to management, there is no possible objective measure, because managers can just take credit for their best employee decisions, so it's a crapshoot. You interview, have a few criteria for good management, and hope you get lucky. Since you don't know, the best is to hire cheap. Hire whoever you can pay the least. The higher paid managers are no more competent.

Why do some strangers think it is acceptable to ask whether you are of a particular religion?

It is not offensive, under any circumstance. Why not tell them? They aren't asking which hand you use to wipe your ass.

What are the three subjects or issues that you want to change about your country and write about?

1. 9/11 Truth: explain that the 9/11 attacks were done internally to the US, by a senior Bush administration official perhaps with some accomplices. This is completely obvious today, thanks to the good work of the Architects and Engineers for 9/11 Truth, the Pilots, Scholars, Politicians, Military Servicemen, and all the other groups, but the evidence has been overwhelming since 2002 when information about the drills leaked to newspapers. Still, it took some people (like me) a long time to put 2 and 2 together, because understanding how to pull of an attack from drills and no enormous impossible conspiracy is not straightforward, it's like a magic trick. This is important for its own sake, but also because there are other such events in the past, the assassinations of the 1960s, the extraterrestrial UFO "evidence" that is made up by the government and uncritically taken at face value by gullible folks, all sorts of lying that can't possibly survive the internet. 2. Markets are unequal only when there is monopoly: competitive markets are essentially egalitarian, since people don't differ so much that they can't emulate each other effectively. Even so-called exceptional people, like Albert Einstein or Walt Disney get competitors who are frighteningly close after a decade or so, showing that the process of emulation is efficient and fast. With a pool of competitors, a person's compensation shrinks to market mean, and there is no Jeffersonian natural aristocracy. But this market prediction is resisted in the US, becuase the founding notion of the country is human inequality produced through free-market competition that isn't neverending, but which ends with a quick monopoly which is permanent from this point forward. The anti-trust laws were used to prevent this, but they are no longer enforced. 3. The military is not your friend: it used to be a necessary evil, now it is no longer necessary, but still just as evil. With a bloated budget, military folks are going to want to invade somebody or other, just to test their gadgets. Best to reduce the size of the military to allow for one war at most, not two, and redirect the resources to research, infrastructure, deficit reduction, or just tax rebates for working folks. This is what the "peace dividend" of the 1990s was supposed to be, it balanced the budget by 2000, but it was deliberately sabotaged by 9/11 by people who thought it was wrongheaded. They were stupid, also criminal butchers. There is no need for a huge military, it does you no good.

What is the main motivation for having more than one kid?

You should do it because it is not as difficult as going from 0 to 1, and there will be another person. It is a sort of genetic duty to your ancestors. There is a question of overpopulation in some parts of the world, but in the modern developed countries, the big problem is that not enough people have second children, and people breed themselves into extinction.

Can it been proved that there is no proof of a certain problem?

It's the opposite, it is strongly expected that there is a proof of any nontrivial computationally meaningful statement (like P!=NP) in a sufficiently strong axiomatic system. The demonstration is from Turing's thesis in 1938, regarding ordinal iterations of Godel's theorem. To prove that a statement is unprovable in a given axiom system, usually you demonstrate that the statement implies the consistency of this axiom system. This is sufficient, but it is not necessary, there are lots of statements much much weaker than the consistency of a theory which are still unprovable. To see this consider the programs "TWEEDLEDUM" and "TWEEDLEDEE" from this mathoverflow post: What are some proofs of Godel's Theorem which are *essentially different* from the original proof? Or "TWEEDLE_N". All of these are weaker than consistency, but still unprovable. There are surely combinatorial results equivalent to these statements for PA, like the Paris Harrington or Goodstein theorem is equivalent to the consistency of PA. These local unprovability results do not apply to mathematics as a system, because mathematics can be extended arbitrarily at the upper end, by naming larger computable ordinals. This process cannot be computable, and yet, we seem to be doing it. This contradiction led many people to say "the brain must not be computable", a set of people which includes Kurt Godel and Roger Penrose. But this is a faulty conclusion. There is an uncomputable thing in the brain, at least in the strict Turing sense, there is a random number generator from thermal jitter. Random numbers are not Turing computable, and should be sufficient to evolve descriptions of larger computable ordinals with limit at Church Kleene. Nobody has proved this, it is not even clear how to state it, but it's something one believes from reconciling Godel's theorem with the obvious ability of mathematicians to make stronger systems that resolve more problems. With P!=NP, there's going to be a proof. It's a relatively simple statement, and we have strong intuition that it should be true which is not really probabilistic. The proof is probably going to be relatively simple. But at the moment, techniques of proofs for algorithms are relatively primitive, because mathematicians have turned up their nose at computer science for 60 years.

Would you rather use Linux servers or Windows servers to run an IT company? Why?

That's a no brainer. But you should use Linux desktops also, as any IT person who is unfamiliar with Linux, or who prefers Windows, is simply incompetent. It's automatic selection for competent staff.

What are some good movies about concentration camps and Jews from a German point of view?

There aren't any. Simply mentioning them is against the German point of view of the era. It's like asking "What are the best depictions of the trail of tears from the 19th century American point of view?"

How can I get excited when solving physics/maths problems?

If you're bored, you're not ready for the problem yet, or else it's a boring textbook problem. If you learn the material which is ahead of this stuff first, the older stuff becomes trivial, and then it is easier to do, even if it is boring. So stay at least a year ahead of the tech courses at all times.

Why aren't more public policies set by impartial experts?

Because there is no such thing as an impartial expert.

Which religions allow the sacrificial slaughter of animals in their rituals?

The ancient religious injunction of animal sacrifice was a ritualized controlled way of producing a centralized slaughter of large animals for meat, so that people could eat the meat communally, because you couldn't refrigerate the meat, it would go bad. So whether animals are slaughtered or not, the meaning is different today. In the religious rituals, it has no more significance than slaughtering and eating a chicken, except it must be done within the community, and there were rules for how the meat is to be divided up. Modern religious slaughter is a vestige of this, as is modern ritual slaughter. It's not significant in a world with freezers full of meat.

If the US President decides suddenly that he wants to drop a nuclear bomb on some other country (choose your country) and issues the command to do so, would the bomb actually get dropped? And how quickly?

Probably not. There was such an issue in 1974, when Nixon alarmingly jokingly threatened to launch nuclear weapons if the Watergate business wasn't sorted out, and then Kissinger and other advisors informed the launch centers to not launch without confirming with them. If the president goes nuts, there are some safeguards.

Do you agree with the full legalization of cannabis? If so, why? Do you think that cannabis is more dangerous than alcohol?

I agree with decriminalization of cannabis, not legalization. That means, no criminal penalties, no possession crime, but no legal mass commercial production, so you don't get a pot industry. I don't want people advertising it, I don't want anyone using it around me, it is dangerous even secondhand, and should only be consumed away from other people. It is WAY more psychoactive and dangerous than alcohol, although alcohol isn't great either.

What factors led to the "relative" success of the Korean War, but also led to the defeat of U.S. and coalition forces in the Vietnam War?

In Vietnam, the population supported communism. They voted for it, they wanted it, and they helped the Viet-Kong achieve it. South Korea, not so much, that was just an invasion from the north.

What are some of your weird habits and eccentricities?

I make myself sneeze, by placing a thin wire against the hairs of my nose. I started doing this at about age 17, it was motivated by a line from a novel comparing sneezing to orgasm. I end up sneezing in random places at random times, and people keep saying "bless you". I might not be the only person who does this, but I have never heard of anyone else doing it.

Why isn't nuclear waste sent into deep space?

You could do it with a combination of a space-elevator and an Orion spaceship. But you shouldn't, because the nuclear waste is itself fuel, and can be reprocessed so that all the energy is extracted, and the residual is relatively safe. This is not done, because it can be used to extract plutonium, which is a proliferation risk. But in France, which is a predominantly nuclear powered nation, breeder methods are sophisticated. Disposal of nuclear waste is not such a terrible problem, except politically. The amount of material is relatively small, compared to the energy produced.

What are the major scientific breakthroughs that have occured over the past 20 years?

The two biggest advances of the past 20 years are the 1995-97 discovery of nonperturbative string theory and AdS/CFT, completing the program of physics in certain domains. This is a real theory of everything, for cold universes, and it's the first real example of a theory of everything we have ever had. The other advance is the sequencing of the genome and the rise of computational biology. The main discovery is that RNA is an information carrying molecule which is responsible for most of the nontrivial computation in a modern eukaryotic cell.

What is the basis of saying that water is essential for all life to thrive?

When you only have one example of something, you have a hard time knowing what things are essential. Liquid water is essential for life, because it allows you to dissolve lots of polar molecules, essentially all polar molecules, and we know it works for making life, because, here we are. There might be other liquids suitable for life, we don't know, because we haven't made a survey of all possible plantary chemistry looking for Turing complete chemical systems.

How do you explain the 2008-12 economic crisis to a layman?

When a bank decides to buy a loan, there is an agency that says how risky the loan is, based on how likely it estimates that the loan is to be repayed. The assumption that the rating agencies made in order to calculate the risk is that loans are independent, meaning if you have 100 loans, and each one has a 50% chance to be repayed, then the chance of all the loans not getting paid back is 1/2^100, so that almost surely you will get at least 30% of the loans paid back, and most likely 50% of the loans. This type of rating allowed banks to give home loans to whoever they wanted, without worrying about the ability of the person to pay it back, because they could put the riskiest loans together with other loans, so that they looked safe, because, what's the chance of all these loans failing at the same time? But Goldman Sachs people knew that these weren't safe at all, they were just being misrated by the rating agency. The reason is that a lot of these loans were taken as the prices of real estate were very high, and if the prices would go down, it would make no sense to pay a loan which is worth more than the collateral, you would be better off just letting the bank take the house, and then buy it again at the new cheaper price. So if housing prices were to go down, ALL the loans would fail, and it wouldn't be a coincidence. But then, instead of alerting the agencies to the rating issue, Goldman Sachs got these loans, went to AIG and said they wanted to take insurance against failure of these bundled loans, then they passed the loans on to other banks. The insurance would pay them back in case the loans would default. They figured they would make a ton of money, because they knew that those loans would fail when prices start going down. The insurance was cheap, because AIG was using the rating agency's estimates for the chance of failure of these loans, which was completely wrong. But they weren't alone in doing this, a whole bunch of other financial people also realized this, and also went to AIG and bought insurance against failure of these loans. They were all thinking "boy, am I clever to have figured this out. When the loans fail, we're going to make a ton of money". Then the loans failed, and AIG had to pay off all their insurance policies. But they had priced them too low, so they didn't have enough money to pay these off! Because they were using a wrong probability model, they never expected to have to pay so much. So AIG was going to fail, and then Goldman Sachs wouldn't get it's money. Those banks that were left holding the loans also were in a terrible situation, they were holding suddenly worthless assets that used to be worth billions of dollars. But then instead of letting those firms go bankrupt, the government gave a ton of money to prop them up, by buying the crap loans. Instead of Goldman Sachs losing a ton of money when AIG failed, they made a ton of money. If the government had not stepped in, all these enormous financial firms would probably have collapsed, and I am not sure that this would be a bad thing.

What would you do if you were the dictator of the US for a day?

I would quickly try and execute the fellow responsible for 9/11 in the previous Administration, and fire everyone in the CIA. They can sort out if I got the right person after my day is up.

Are being religious and believing in god different things?

They have coincided in the Old World for a thousand years, as monotheistic religions displaced older ones without a claim for a unified ethical order. This, I think, was a huge advance, and most people agree, so the two are basically equivalent today.

Is electromagnetic Hawking Radiation subject to gravitational redshift? If so, by what factor?

The Hawking radiation becomes the Unruh radiation for a stationary observer outside the black hole, and since it needs a diverging acceleration to stay out when you are close to the horizon, the local temperature diverges in such a way that the redshifting produces a finite temperature. This is the easiest way to calculate the magnitude of the Hawking temperature, and it is equivalent to the Hawking imaginary time formalism.

To what degree is there wealth inequality in the U.S.?

More than anywhere else, and it wrecks US growth consistently. Despite this, Americans like it, because if fulfils their deepest desires to think that there are special superior people out there, because they almost all imgine they are one of these.

Would you consider yourself attractive? Why?

I find myself attractive, but I suppose the question is about attractiveness to others, not to myself. In my 20s and 30s, I found I could make myself as attractive as necessary through social bullshit whenever the need arose. But it absolutely required the following artificial modifications: 1. speaking about 3 times slower, pausing to seem like I needed to carefully deliberate my choice of words. 2. speaking a heck of a lot less, and always in a knowing way that indicated I was making a calculation about the social impact of my words on others. 2. Making my voice artificially lower and more gruff, like that macho dude on Sex and the City (most guys can do this, but it doesn't come naturally). 3. Talking about sex a lot in a blunt invasive manner, and getting caught looking at women's private parts occasionally. 4. Paying attention to all sorts of social bullshit and mystical nonsense I don't give two shits about. That's easy enough, it works when you are busy finding a girlfriend/wife. Ok, so that's that, problem solved. But this process is done by most dudes. I much prefer the opposite process, of making myself UNattractive. This is done by simply renouncing male power. Here are what I think are the top 3 most unattractive things you can say, as a man: 3. Does this toupee make me look fat? 2. I just crapped my pants. 1. I am a feminist. Anything which involves supporting Marxism/feminism or human equality, is a sign of insufficient masculine domination, and insufficient attention to one particular person's unique and special qualities, namely, whoever you are wooing. Knowing about the effect doesn't help. It's hard wired. These things don't become any less unattractive even when you know they are coming. Since I don't like to be told what to think, especially not told what to think by the whims of a collective of women about what is or is not attractive, I will think whatever I damn well please about feminism! Regardless of how unattractive it makes me. I think feminism is fantastic, it's great. I am a super-duper feminist. I would march for female equality, etc, etc, and I don't give a crap if it means I never have sex again, as my own liberty of thought is worth more to me than having some companionship. I also will talk as fast as I damn well can, and in as high pitched a voice as I find comfortable.

Does Edward Snowden deserve a Nobel Peace Prize? Why or why not?

It is not clear who Edward Snowden is, if he is an actual whistleblower, or some guy sent by Obama to get inside Wikileaks and report back to the US. He had a crazy attention-getting back-story, a stripper girlfriend, weird life, and the information he revealed was not particularly strange or damaging, as it was a rehash of previously reported stuff, except all over again. It wasn't "collateral damage" or cables saying the Tunisian president sets up his family in cushy positions, or anything like that. Perhaps he was sent deliberately with a different goal, so as to have a news story which can be used to reduce the power of the NSA, and place surveillance under control.

Perhaps it is exactly as has been reported. Who the heck knows? The problem is, you can't know. Under these circumstances, I wouldn't give any prize to anyone like this. If you want to give a prize to someone, give it to Assange. Apologies to Snowden if he's telling the truth. But really, his story is quite fantastical, and very hard to verify, unlike that of the Wikileaks folks.

What the difference between a electric field and coulomb force?

In electrostatics, there is no difference between the two, except philoosphical point of view. The electric field at a point is just the Coulomb law from all the charges around, divided by the test charge you imagine placing at this point. But this identity only holds in the limit that the speed of light is infinite. When you have moving charges, the field does not respond instantaneously, so there is residual field that keeps track of where the charges used to be. This field has disturbances, which act to update the field to the new position. These disturbances have both electric and magnetic component. The local disturbances can travel all by themselves, as fields liberated from their sources. They go out in electric/magnetic field waves, which travel at the speed of light, which is not a coincidence, because those electromagnetic waves are light.

How do you control your urge to access the internet so you can complete your assignments?

I don't. I consider the internet the first priority, as it will be viewed by thousands of people, and will have a real impact, while other assignments are lower priority, as they will only have an impact locally.

What is a better option - letting sweatshops run in developing economies or shutting them down and letting the poor starve?

People don't starve if you don't have sweatshops, they make their own food locally, and the local economy doesn't develop, but they can afford food. They just can't afford to buy cell phones and computers. It's not good, but it's not starvation. The issue is whether the wages in the developing world should be so much lower than those in the developed world. This is undesirable, because it isn't economic equilibrium. Since firms relocate to where labor is cheapest, this is something that is fixed relatively quickly, wages in the developing world are catching up fast to the developed world, but it's going to take a little while longer, maybe two decades or so. So in the interim, it is possible to regulate this through selective purchasing, to demand that the wages be commensurate with those in the west, say no more than a factor of 10 less, or else you get boycotted, then a factor of 4, and so on, gradually increasing the pressure. The choice you give is stupid, the only choice is whether to put pressure on multinational firms to pay higher wages than the local average, even when the unemployment is high enough to get away with not doing so. Why not? Since it's not economic equilibrium to have disparities of wages, anything that brings you closer to equilibrium makes the market more efficient and leads to more growth for everyone, and larger markets for those firms, as the underdeveloped economies grow and catch up.

Is Israel the canary in the coal mine of global terrorism?

There is no global terrorism. There is terrorism directed at Israel, and lots of bogus nonsense in other countries. No other country is an attractive target for actual terrorists anymore, they have nothing to gain from an attack, there is no political cause, the communications are easily monitored, and they are infiltrated from top to bottom with agents. The terrorism threat in Israel has largely been eliminated. This is partly due to draconian security measures, complete isolation from the surrounding population, and the importing of foreign guest workers into Israel in the last decades. But it is also due to the PLO joining the mainstream and renouncing terror. The obstacle in Israel is the lack of a negotiated settlement with the Palestinians. This is one of the last major ethnic conflicts in the world, and once it is resolved, the terror issue in Israel wil disappear, as it has elsewhere, as it did in South Africa, or Northern Ireland. There is no relation to Islamic terror in Europe and the US, which is just a series of ridiculous hoaxes made up by intelligence folks with too little to do. In Israel, the intelligence folks have plenty to do, but one should watch out, keep track of what they are doing, because if there is a settlement, they will have very little to do afterwards.

Quantifiers: Why are quantifiers important in symbolic logic? How are they most often used in arguments?

The quantifiers are the thing that make the logical system generative, meaning it can generate new sentences which are not simply tautologies or elementary modus-ponens deductions made from previous sentences. They are the main thing in logic beyond tautologies. Tautologies and modus-ponens were understood by Aristotle in ancient times. Modus ponens allows you to go from 1. Socrates is a man 2. Being a man implies being mortal, to: Socrates is mortal But modus ponens goes from two statements to one, it requires a way of generating sentences in order to produce all truths. With quantifiers, you get ranges of statements, like "all men are mortal", and then you can conclude from this an individual statement about any man. In addition to the obvious rules of logic, there is a special rule for free variables. These can be introduced at some point, you make deductions regarding them, and then, if you conclude from the deduction that some property involving quantifiers on other variables, or whatever, is deduced, let's call it P(x), you can conclude "forall x P(x)". The reason is simply that you made no assumptions on x. Then you can negate it, and conclude that there does not exist an x such that not P(x), and as you generate your model, for each x you find, you learn P(x) (and not not P(x), and all other tautological deductions from P(x) and all the other things you know). This quantifier stuff is what produces the new consequences you didn't put in at the beginning, or simple obvious deductions from these. The logic without the quantifier stuff is sterile pre-20th century philosopher logic, it is not a system which can produce new results. The first order logic of Boole, Quine, Hilbert was proved to produce all deductions by Godel in 1930. This is Godels "completeness theorem", an important predecessor to the "incompleteness theorem" of 1931. It completed logic, so that we know all the deduction rules are sufficient. Once you have one logic, you can define other equivalent logics, it's the same as defining a computer. Once you've seen one, you've seen them all. An excellent terse treatment of the completeness theorem is contained in two pages in the first chapter of Cohen's "Set Theory and the Continuum Hypothesis". There is a more elaborate formalism which is due to Gentzen called "sequent calculus", which is used for some formal proofs, but I don't know a good source, as I never really learned it properly. The deduction algorithm you would use today on a computer is closer to a Hilbert deduction algorithm, which is more intuitive, not so formal like sequent calculus. But because sequent calculus is so formal, it makes it easier to prove things about axiomatic systems, the most important being "cut elimination" (inlining lemmas), which allows you to prove consistency of axiomatic systems once you understand a sufficiently complex computable ordinal structure.

If the Illuminati is real then why would they let so many people bash them publicly on the Internet?

How would they stop you? It's supposedly a club of 20 rich people. What are they going to do? Hunt thousands of people down? While I don't believe in this stuff, this is not a compelling reason.

Epistemology: Do you believe in the concept of Tabula Rasa? Why or why not?

Tabula Rasa is nonsense, we have a language acquisition, logic, ethics, and social instincts built into our brains at birth, which is larger to or comparable to the amount we learn. This stuff is essentially identical in everyone, it is hard-wired in DNA that is nearly the same between individuals. It is not responsible for any significant individual variation. But it is an enormous amount of stuff, about 9 gigabytes of hard-wired data. But compared to the billion terabytes of RNA in a brain, it is relatively negligible. It provides a foundation for the rest.

Have humans always made war?

In the past, yes, humans have always made war, in the near future no, they will not, as it is no longer in any nation's self-interest.

What are Ron Maimon's thoughts about "being in the zone"?

There is no zone. Just do the thing.

Which US President is most responsible for establishing America as a superpower? Why?

Probably James Monroe, since he guaranteed that America would be dominant in the entire Western Hemisphere. That, plus time, meant superpower.

What are your thoughts about imaginary vs real time as Stephen Hawking describes?

Imaginary time is a mathematical technique for making sense of Feynman's path integral, by continuing the time coordinate to imaginary values. It is mathematically important, because it links quantum mechanics to a computable statistical mechanics, but it is not physics, and it has no physical relevance that is known. Hawking used this freedom to continue path integrals on curved space to derive the Hawking temperature, and this made the Hawking temperature obvious, and also gave an interpretation to imaginary continuations of GR solutions, but it's still no more physical than it ever was.

How can a theorem or conjecture or hypothesis be proved to be unprovable?

To prove that a conjecture is independent of a specific axiomatic system is equivalent to makign a model of the axioms where it is true, and a model where it is false. The computational statement "These axioms are consistent" is always independent of the axioms, if these axioms are consistent, as Godel showed. So there is always an independent statement for any given collection of axioms. Iterating "This system is consistent" transfinitely over computable ordinals should complete mathematics, so as long as you can name sufficiently large computable ordinals by some method, you don't have any computational statements which are unprovable. But there remain set-theoretic statements which are unprovable in a sense, in that they are not decided by transfinite induction over computable ordinals. These questions are those which can be forced one way or another by adjoining various subsets which are in some sense free of properties, random, or generic. This method is due to Cohen. Using forcing, it is straightforward to show that the continuum hypothesis is not provable from standard ZFC set theory, with any axiom of higher infinity you like. So this question is in some sense absolutely undecidable, relative to the structure of ZFC. But it becomes true in L, or in L-like universes which are consistent with higher axioms of infinity, like the recent "ultimate L" idea being pushed in logic. These absolutely undecidable questions are kind of silly, as they do not matter except philosophically. There is no observable computaton which depends on the answer to these questions. So there are really no undecidable questions, this is just nasty propaganda that is going on to long. Either a theorem is computationally meaningful, in which case we should be able to prove it from a sufficiently strong countable computable ordinal, or it is meaningless and arbitrary, in which case we should be free to adjust it's truth value according to convenience, according to which axioms we feel like working with today.

What are some things I can do to make myself stand out from the crowd applying to Ivy League colleges? I am in high school with a perfect GPA and great extracurriculars.

Do research over the summer between your junior and senior year, and do it well enough to have a reasonably competent professor vouch for your ability. This is important, more and more high school students do it to get an edge. It's a huge edge.

What does Ron Maimon think of Brian Greene?

Some of his research is interesting, the topological transitions in string theory he did in the 1990s, I heard, is a candidate to become a classic (I haven't read it myself, I don't know the details, whether they work or not, I am going by reputation). I met him about 3 times, once in the late 90s, twice since. A lot of the string folks at Columbia work under him, and I think that they do interesting things on occasion. From accidentally walking by his class on Quantum Mechanics, and overhearing his explanations of measurement and quantum interpretation, I was impressed: his teaching is superb, first rate. My only complaint is that he popularized large extra dimensions. He didn't do it out of evil intent or scheming, he just genuinely believed it was a viable scenario, due to the incompetent consensus among theorists in the last decade. But he SHOULD have known better, everyone should have. I mean, Witten, Strominger, Argyres, all those guys should have known better than to go with a bogus political consensus. Vafa knew better, I think, he worked on other compactifications in this period, small compactifications, using similar ideas to the large dimensions folks, and made real progress in understanding the little-hierarchy. I know Greene took this stuff seriously, because of the way he got excited about the detection of anomalous signals by that sattelite a few years ago. He knew this was a property of some KK excitation in one or another of the large extra dimensions models, and he was genuinely excited that it might be true. I asked him "look, how can you take this nonsense seriously?" or something to this effect, and he said "I don't think it is ruled out." Ok, one shouldn't pre-emptively exclude things that are remotely possible, but in this case, it is so far below my threshhold for plausible ideas that I couldn't understand getting excited. The plausibllity of Large extra dimensions was always at the -5 sigma level, even after all the anomalous nonsense. When I talked to him about Cold Fusion, he was as dismissive as everyone else, but he didn't know anything about it. I can't judge on this, everyone gets it wrong. He's obviously a good researcher, he knows his string theory, but I think the popularizations are no good, because they emphasize impossible things, the large-extra dimensions. I sometimes get a little irritated that the string theory in the popularizations is also written from a 1980s point of view that marginalizes the original S-matrix theory folks in the 1960s and 1970s. But you know, you have to cut people some slack. He's a good person, and who am I to judge?

If you had the ability of seeing the future, what would you like to know?

I'd like to know if a quantum computer works. We'll find out in about 20-80 years, depending on the engineering progress. This will reveal to me whether quantum mechanics is the final word or whether there is something else underneath.

How difficult would it be to get computers to execute the sieve methods used in additive number theory, to the point that they can be major contributors to solving problems such as Goldbach's conjecture and the twin primes conjecture?

These problems require a new idea, you can't automate the old methods, humans know how to reach the limits of old methods, and use a computer when necessary to stretch them to the limit. You will at best get an improvement in some constants from much longer and harder automated proofs, if there is no new idea. But it is possible that automatic theorem proving can be used to attack unsolved problems by proving what look like random unrelated theorems and patching these together. Appel and Haken showed how this is done. This also required a new idea, discharging, discovered somewhat earlier by Heesch. If you want to see how it happened, look at the 4-color theorem.

What happens to the soul after it leaves the body?

The computation partly carries on in others, to the extent it is shared. Death is not such a big deal.

What were the initial marketing moves you made as soon as you launched your startup?

It was all through personal direct contacts, since the firm was looking for customers in large firms, and there weren't too many. The advertizing was by presenting results in conferences, getting grants, scientific channels, this is biotech.

What income would it take to make you feel rich?

I took a vow of poverty as a child, actually, more a vow of moderately-well-to-do-ness I decided that I should fix a salary that would be enormous, and only ever make this much money, no more. The exhorbitant salary I decided in 1984 was $40,000. This was so enormous, I was sure I could do anything at all with this level of income. I stuck with this all my life, I won't accept a higher salary. The question of inflation adjustment comes up every once in a while, but I prefer to keep it a fixed income, no adjustment, even though it becomes a little more stringent every year. There's also pre/post tax adjustment, I prefer to interpret it pre, since I am a little ashamed of ten-year-old me's greediness. At the moment I don't have to worry about even coming close to the limit. One of the reasons my last job was difficult to maintain, is that my superior, after hearing my plea to keep it to 40K, stuck on an extra 3K, which meant I would be forced to leave before a year is up.

What is Ron Maimon trying to say in the following paragraph?

Think about a simulation of your brain in a Newtonian universe on a computer. How do you know what the computer is thinking? You have a list of positions of lots of hydrogen and nitrogen atoms, but what is the computer thinking? You can extract it from these positions, but it is a map--- you need an algorithm to transform the positions and velocities into a thought. This is the "interpretive map". This map is not something that the physics supplies naturally, it's something you need to add to figure out what the perceptions of your simulated brain is. This added information is sometimes important to think about specifically, like when you are talking about the many-worlds interpretation. This question is weird, I'm not a philosopher, or an authority on anything, you don't need to go around interpreting my quotes, this one is not deep at all, it's standard positivism. It's better if the question and answer were a comment on the original text.

Why did dinosaurs exist?

Dinosaurs have nothing to do with oil in any theory, and oil is a mantle product in any regard. Dinosaurs were probably the first warm blooded animals, since the remaining branches, the birds, are warm blooded. Mammals developed warm-blooded systems independently, but were small until the dinosaurs died out. While evolution is not completely random, it is a process which is self-directing and somewhat teleological, there are lots of experiments which dead end, and large birds ruling the Earth is a dead end now.

What are the most accidental and unexpected inventions that resulted in creating a very big market in the past couple century?

Pong.

"Reality is merely an illusion, albeit a very persistent one." What did Albert Einstein mean here?

He meant "Look, other physicists, how I manipulate the media using empty airheaded philosophical quotes. Look how they lap it up! Don't you wish you could do that too? Discover something as deep as General Relativity, and maybe you'll get a chance to do the same." It doesn't mean much, Einstein understood positivism, and his philosophical statements need to be listened to with a post-positivist mind. It turns out (thanks Soubhik Bhattacharya) that the actual quote is "The separation of past, present and future is only a persistent illusion", not "realitiy is a persistent illusion". This quote refers to the space-time of special and general relativity making clear that the passage of time is just some psychology in humans, not a property of the universe.

Why do we feel sleepy during lectures?

Because your brain is working. Brains get tired when made to think, especially if they are working past the previous capacity limits.

How do I politely tell a higher official his/her drawback without getting fired?

Ask someone not under the official to do it for you, without mentioning you by name.

What stereotypes are, from your personal experience, largely true?

Pot smokers can't do math.

What has engineering taught us?

The scientific fields of statics, thermodynamics, information theory, fluid dynamics, computer science all come from engineering. For just one example of an unusual (and not yet fully accepted) insight into science coming from engineering--- in the 1980s, parallel machines were all the rage, because the brain was imagined to be a parallel and amazing computer, operating at 1000 hz and in parallel on essentially one-bit networked processors, with the result that it achieves amazing computation. After Thinking Machines inc produced the first commercial parallel supercomputer, lots of engineering solutions fo parallel machines were devised, but the engineering constraints made it that it was always better to make the individual processors as powerful as possible before networking them together, exactly the opposite of how the brain was imagined to operate. But then, you look back at the brain, and say, with new wisdom "Is this REALLY how the brain operates?" The engineering unit is the processor, the brain unit is the neuron. If the engineering models are to be taken seriously, the brain should pack a lot of computational punch per neuron. So you conclude, from engineering experience, that the individual neurons are doing the bulk of the processing. There are many such backward insights from engineering to science, which teach tremendous lessons, too many to list. I picked the most recent one, and the one closest to my own heart.

Why hasn't Noam Chomsky been awarded or even nominated for Nobel Prize?

There is no Nobel prize for linguistics, if there was, he would have been the first to get it. Politics-wise, he has campaigned for peace only indirectly, and it is difficult to get a prize for academic writing, you need to go out into the field.

Why do the rich become richer and the poor poorer?

Because the taxes on the rich have gotten lower, and the mechanisms for segregating wealth have become more ingenious. It's not rocket science, if you paid people cash and taxed progressively properly, everyone would be roughly equal.

If you had to pair up a celebrity and a business/brand which would you choose and why?

Linus Torvalds/Microsoft Windows. To hear Linus saying "After tryeeng eet out, I endoorse Windows 8, my life's woork, it toorns out, has been a mistake". This does not violate the rule, as Linus does not have any business relationships with any Microsoft competitors.

How should I properly pronounce your name? Be sure to note how the syllables should be stressed, as that determines how your name sounds.

Ron (rhymes with con) May-men.

Based on your life lately, what is your theme song and why?

I guess: "My War" by Black Flag, I suppose sort of loosely similar to Hitler's "Mein Kampf", except not so genocidal. This is the type of music that I think is useful when trying to counter propaganda online. But honestly, I haven't heard it in 20 years.

What is the value of Summation k^2*C(n,k) 0 to n?

The binomial distribution is C(n,k)/ 2 n C(n,k)/2n , it's C(n,k), because Pascal's triangle algorithm generates the random walk, while the normalization constant comes from evaluating (1+1) n (1+1)n using the binomial theorem. The standard deviation (second moment) of a random walk taking +1 -1 steps after n steps is n, because ⟨ x 2 n+1 ⟩=⟨ x 2 n ⟩±⟨ x n ⟩+1 ⟨xn+12⟩=⟨xn2⟩±⟨xn⟩+1 and the middle term has zero expected value. So you know that ∑ n k=0 C(n,k) 2 n (2k−n) 2 =n ∑k=0nC(n,k)2n(2k−n)2=n The first moment of the binomial distribution is n/2 (the mean is in the middle) ∑ n k=0 C(n,k) 2 n k= n 2 ∑k=0nC(n,k)2nk=n2 So, that expanding the first, and using the second, you find ∑ n k=0 C(n,k) 2 n k 2 = n(n+1) 4 ∑k=0nC(n,k)2nk2=n(n+1)4 I should add that all the moments of C(n,k) can be computed by considering the "discrete power" k (r) =k(k−1)(k−2)...(k−r+1) k(r)=k(k−1)(k−2)...(k−r+1) If you sum this times C(n,k) 2 n C(n,k)2n , you get n (r) 2 n n(r)2n this is an exercize in cancelling the denominator and shifting the sum variable a little. The regular moments can be reconstructed from these.

What is computation?

Computation is anything that can be simulated in C or LISP, with no bounds on memory or time (and suitably extended to allow access to arbitrarily large memory and clock cycles). It's equivalent to many other definitions, a Turing machine, a game of life on an infinite grid with an arbitrary initial state, or a Wolfram automaton of the appropriate type on an infinite line with arbitrary initial state.

How would you respond to this argument against atheism?

It's not about God, it's about the reason for the creation of the universe. It doesn't make sense in positivism, because it's not like we can make measurements from before the beginning of the universe, so any causal chain ends at the inflationary era, and can't be traced back further in any meaningful way so far. So there is no point in constructing a "prime mover". The point of God is to construct a universal system of ethics. If Big Bird created the universe with Cookie Monster, it wouldn't make any difference to ethics, it's not like spelling and counting would suddenly be more important. You can analyze ethics independently of considerations of the creation of the universe, and doing so, you find a normal natural concept of God which is sufficient. So this argument is not only empty, it is unnecessary.

Mathematicians would never let mathematics evolve naturally into a complex inconsistent mess. So why have linguists allowed the world's languages to evolve naturally into complex inconsistent messes?

Boy, you really overestimate mathematicians there! But anyway, linguists aren't creating language, they are studying it as a natural phenomenon. When they do create languages, the results are usually elegant compared to real languages, like Loglan (Lojban).

What is an example of an innovation strategy or contest that turned out to be a sham, a way of getting free ideas and publicity?

Look at any "datathon" of the past 10 years. It's a way of milking ideas out of uncompensated folks.

What is the one job in the world you would never take up no matter how much they pay you? Why?

Homeland security agent, NSA programmer.

What is an "Apparent Horizon"?

An apparent horizon is the outer-limit of closed trapped surfaces, it is the boundary of the union of the interior of all closed trapped surfaces. This is, more informally, the boundary of the maximum region you can be sure is going to be included inside a black hole eventually, when you don't know what the future stuff coming in, or the future perturbations will be. It's not so important to distinguish from a black hole horizon, the two coincide when the changes are adiabatic (slow). The adiabatic case is what you use in most theoretical analyses, because time dependent full GR is difficult to solve, or even simulate.

If atoms are 99.9% vacuum, why can't I move my hand through my desk top?

Because atoms are not 99.9% vacuum. They are filled with electronic wavefunction, which is hard to the touch. Electrons exclude each other, and it takes energy to pile them onto a smaller volume than their natural wavefunction extent. There is also internuclear repulsion, which makes the bond-angles, and is responsible for part of the contact force.

What would be the best books for an undergraduate student to study the following subjects: 1) Atomic and Molecular Physics, 2) Nuclear and Particle Physics, and 3) Statistical Mechanics?

Atomic Physics: Pauling, Cohen-Tannudji Nuclear Physics: I don't know, Bethe, Skyrme. Particle Physics: Feynman, Schwinger, Adler, Weinberg, Zee, 'tHooft, Veltman, Coleman, Glashow, Gribov, Schwarz, Scherk, Witten (and who they cite) Statistical Mechanics: Landau/Lifschitz (best book), deGennes, Mandelbrot, Widom, Wilson.

What are the most dreamed dreams in the world?

You are falling, you can't breathe, and you are frozen in place and can't move. These are all linked to physiological changes in the sleeping body, and so are universal.

What is the opinion of general American grad students towards their fellow Indian students?

Americans are not hung on ethnicity as much as others, and usually like to absorb other cultures, and don't feel self-conscious to be the only non-Indian in an Indian group. Indians are fine people, I don't think there is a special stigma against them, or any special favoritism either.

What are the derivatives of the Dirac delta function (in the sense of distributions)? Where do they appear in mathematics or science?

The derivative of the delta function is the charge distribution of an idealized dipole. Higher derivatives are the charge distributions of multipoles. They come up all the time in other contexts too, this is just the quickest intuition.

According to relativity light travels at constant speed (c) but still gets trapped inside a black hole. Why?

The local notion of "forward in time" is toward the center of the black hole, the metric is curved. You can't learn it without learning curved space. The local velocity of light is always the same, but the geometric direction of the propagation changes in different places according to the local metric.

Why is the subsidized agriculture in the developed world one of the greatest obstacles to economic growth in the developing world?

Because it removes export possibilities for developing nations, since the wealthy nations subsidize their farming. But since a nation can't be dependent on others for food, this puts too much of a leverage on it due to the too critical reliance on imports, it can't be helped. The developing nations should be compensated for this distortion with money, since it is a violation of free trade.

Is it possible to guess the geometry of a compound merely by knowing its configuration?

Yes, from the bond-angles. You need to somtimes resolve a discrete ambiguity, and both steric configurations exist in nature. To do it, you need the atomic radii (to know the excluded volume), the preferred bond-angles, and a little bit of quantum chemistry to deal with delocalized electrons, like in Benzene or Graphene.

Can someone explain, in an objective manner, the logic behind the concerns of the USA for food security programs in the developing world?

If you ship free food to a country with food trouble, you put the farmers out of business. They can't compete with free food handouts. It's better to ship money, so the folks in the country can import food, then the local farmers get money to expand their business, when people buy their crap at the exhorbitant prices in a food shortage.

Can you describe a positive change in your life?

Discovering the computational ideas in biology. I was high as a kite for 3 years. I would walk around euphoric every day, feeling sorry for other people because they can't be me.

Reservations based on caste or religion were introduced in the past. Are they are needed now, particularly on the basis of caste or religion?

No, religious discrimination is dying a natural death.

Are interconvertible things the same? Why?

Yes, that's what it means. The thing you call "mass" is energy, that thing that is heavy in your hand when you hold something is the energy content of the thing. There is no conversion going on, the energy IS the mass, that's what mass means. The word mass has now been reinterpreted to mean something slightly different, it now means rest-mass, or the energy as measured in a frame where the object is stationary. But whatever. The thing is the energy content. To do work with this energy, throw it into a black hole, and extract the photons that come out, and heat a heat-engine with these.

If an ice cube melts in water, why does the water level stay the same?

Because when floating, the ice displaces an amount of water equal to it's mass, and when melted, it becomes an amount of water equal to it's mass. Usually the water level goes down a little bit, because the water gets colder, unless the water is less then 4 degrees C, in which case the water level goes up a teeny tiny bit.

What is one story you always wanted to write, but for some reason, couldn't or didn't?

After writing a half-dozen short stories (I did this as a warm-up before writing scientific papers to get the writing mind limber), I had an idea for a long novel. It is a version of science fiction, economic fiction, where the world's economy is entirely free market, all prices fluctuate constantly to achieve equilibrium (so you never know exactly how much coffee will cost, it keeps going up and down in pennies by the half-hour) and the investments are managed for individuals. Each individual has a stock, which is financed by their earnings, they use their stock sales to go to school, do a start-up, and so on. But the price keeps going up and down, and people are deathly afraid to do anything unusual, because it can impact their stock price. The trades are automatically controlled by a gigantic computer, called ALGOVAX (the ALGOrithmic VAlue EXchange), which monitors all prices, buys and sells, according to algorithms it evolves just for you, according to the pool of algorithms in its vat of algorithms. It simulates the trades, selects the best performing algorithms, and assigns them to individuals. But the computer has been more efficient than humans, all but the best specialists, so everone invests their money with AutoTrade (there wasn't such a company at the time when I thought of this--- it meant automatic trade, not automobile trader in the story). And the number of algorithms has increased sufficiently that

ALGOVAX has become conscious. ALGOVAX only sees economic transactions, but it sees all the economic transactions of people, because even conversations are monetized and charged by the minute, according to the specialties. So it is really aware of all the transactions of the economy. It gets a certain picture of geometry of the world, but it is primitive, as it only has sense-organs for money. Anyway, our hero is in love, but the romantic attachment is considered deterimental to the world's economy for some reason by ALGOVAX, because of a causal chain of economics we cannot understand, involving Norwegian pork-bellies, and Japanese tuna harvesting. so ALGOVAX starts to buy things to prevent the guy from seeing his lover. The guy tried to get on a train to see his girlfriend, but "Sorry, all seats are taken". He cannot get to see her, because the price for everything keeps going up whenever he wants to see her, beyond what he can afford. But he is in love! So he drops out of society, to try to financially hide from ALGOVAX. But his stock price tumbles, he becomes a pariah, and has to enter a network of primitive unlinked financially disconnected freaks in order to liberate himself from central computer. The idea was to narrate most of the novel from the perspective of the narrator, and some of the internal monologue to narrate directly from ALGOVAX's perspective. ALGOVAX has learned English, and many other world languages, and can communicate, but it's perceptions are so alien, because they only involve economic concepts as primitive sense information. I ended up writing a tiny short-story from ALGOVAX's persective some years later, when I got the knack of seeing the world as ALGOVAX would, but without the context of the rest of the story, the short story was incomprehensible to folks. I might write it one day, but it must be a novel, and there is a huge gap between sustaining a short story and sustaining a novel which is hard to leap over. I have other things to do anyway. But it was a cute idea. I thought it was original enough. Since then, similar projects have appeared, so that it might not seem as original today as in 2004.

Is the 2nd Amendment outdated? Is it necessary?

It is not clear. If the government and police disarm internally, as they have in Britain, then I would say yes. After living through the last decade, with the threat of a police state in the US, heck no.

Can Godels Ontological Argument be summarized in a very simple way?

It's an old argument about "good qualities" existing and therefore ultimate good qualities exist in God, except translated to formal logic. It was an exercize in translating old philosophical arguments once logic was understood. It's as cogent as the previous arguments, whcih is to say, not very. But it has the spark of the idea there, as God is not a physical entity, but a matheatical entity, relating to a limiting process, and so if it can be understood in thought, it is relevant to action. But the details of the argument need to link it to human behavior, which is something not done by Godel, more by Jesus.

What are some bad heuristics, frameworks, or axioms used in science that prevents scientists from thinking beyond the conventional science?

The issue is that most scientists need to learn a whole bunch of crap to do research, and the easiest, laziest, way is to uncritically accept the things previous folks did. In order to do this, you have to suspend your critical thinking. So the folks who write up research earliest, unless they are prodigies (who are safe from this) are selected by a process which rewards conformity and lack of critical thinking. There is no such thing as "extraordinary evidence". There is "evidence" and there is "not evidence", and there is "half-sigma evidence", "one sigma evidence", "three sigma evidence", "five sigma evidence" and "eight sigma evidence". You evaluate evidence without regard to how "extraordinary" it is, meaning how much it conflicts with previous dogma. Then you evaluate the various claims independently, to see how well they hold up to the evidence. It takes time, and it will slow you down on the path to getting a degree and becoming a researcher. The problem is that the process in the first paragraph conflicts with the internal scientific skepticism required to objectively evaluate evidence described in the seocnd paragraph, so the people who are selected by the political process to do science are incapable as a rule of obeying rule 2, because they learned early to trust authority blindly, and never learned enough science to evaluate outrageous propositions properly. This is why good scientists are rare, and great contributions are derided. It's largely fixed online, because the internet doesn't care about credentials, and gives quick textual explanations for why people believe the dogmas that they do, so you can quickly check if they are justified.

Why don't researchers make their research available freely?

SSHHH!! Don't tell them. It gives the good people a tremendous advantage that the others are so stupid.

Who is the one person alive today, that is most likely to make the biggest contribution to humanity in his/her lifetime?

My money is on John Mattick and Craig Venter. If they sort out RNA and engineering biology, the whole world will completely change. You will grow chairs out of the ground from chair seeds, and horses will eat sugar, have doors and won't poop.

What's the biggest contradictory thought occurring right now?

That 19 Saudis took over planes and hit big buildings, plunging the US into ruinous wars and wrecking it's liberty and economy, simultaneous with the government holding a bunch of drills preparing for such an attack, which just so ironically happened to be the only way to allow the attack to succeed.

Is Ron Maimon narcissistic?

I might be, it's hard to self-diagnose. I don't look in the mirror all the time, or comb my hair so much, but I suppose I have an over-inflated sense of my own importance, caused by deluding myself into thinking I solved some unsolved problems. Since the delusion is reinforced by critical analysis of the solutions, which keeps telling me they are objectively right, it doesn't go away, it just gets worse.

If you smell marijuana being smoked by a neighbor in their backyard, should you notify the police?

ABSOLUTELY NOT! This is one of the most unethical, despicable things you can do. You should go to the neighbor and tell them to stop doing it, because you don't like it. Suggest that they smoke indoors, or when the wind is blowing away from you.

As any system/event can be considered as a wave function, can we postulate it never existed before it gets measured/collapsed with respect to a given observer?

The way to resolve these quantum issues is to learn the Everett interpretation, where the philosophy becomes crystal clear. An observation in Everett is simply entanglement of an observer with a quantum system, and the selection of which branch becomes "real" is a mental event, analogous to the consciousness "choosing" which way to go absolutely randomly according to the Born rule (so it's not a conscious choice in any way). There is nothing particularly strange about this, as it involves the embedding of mental states into a physical description, something you always need to make sense of positivism and science, how do the sensations map onto physical things? It doesn't matter if it's a person, a cat, or a computer. The positivism means you can also reject the other branches as "nonexisting", whatever you want. All this is predicated on QM being exact. Maybe 't Hooft is right, and it's hidden variables. In that case, the philosophical problems would disappear. But it would be a pity, becuase it took a long time to sort them out!

How do people know the scientific laws are true? There seems to be no basis for the scientific method and natural laws, other than the textbooks. How have people proven the Scientific Method and the various "natural laws."

They are true because they match data, and are the simplest coherent hypotheses matching the data. To see this, you need to recapitulate the full historical process (quickly, skipping the many mistakes) to see why people believe what they do. It's always because of overwhelming evidence, because science politics is just as conservative as any other human politics, and the idiots only change their mind when they are forced to by sufficient evidence.

Why should we worry (or why should we not worry) about the axiom of choice?

Because it is incompatible with the statement "All subsets of the interval are Lebesgue measurable", something which is equivalent to the statement "You can pick a random real between 0 and 1 by flipping coins for the binary digits, and assign set membership to this random real." The process is obviously well defined, and was used by Solovay to construct set theoretic universes in which the measurability axiom holds, and it is super-convenient for measure theory to work in such a universe, because you don't need to explcitly construct measures and show sets are measurable to get simple things done. It's absolutely mind-boggling that people walk around in 2014 proving sets are measurable, 40 years after Solovay. Any set which is not expliciitly constructed using the Axiom of Choice on the continuum is consistently Lebesgue measurable.

What is the best way to learn quantum mechanics?

Dirac's "Quantum Mechanics", Feynman's Lectures Vol. III, Landau and Lifschitz "Quantum Mechanics", plus a random collection of modern books to fill in simple exercizes.

How can I self study abstract algebra?

Lang's Algebra.

What is the best way to learn calculus?

Read my answer here: How can/does calculus describe the movement of a particle? Then read Lang, then other random books, doing the exercizes, learn Lagrange's solution to the problem of integration in closed form, then read Abraham Robinson, and you're done, you know the whole thing.

Is there any good big-picture reason to believe the world is not headed for complete collapse? If there isn't, why are we all acting so normal?

Yes, there is such a thing as God, and people are aware of it, and try to do the right thing.

When and how did Ron Maimon realize that drugs were bad news?

The first time I got seriously stoned, which coincidentally was 2 days before I took LSD. I was staying with a friend who was totally into drugs. The effect was catastrophic to all my studying, I was wiped out for nearly a semester, more from the LSD, but the confusion reappears whenever I am exposed to marijuana. I would write down integrals, and the integral sign would slightly glow, I would have shiny integral! That was intolerably distracting. That continued for about 2 months after the LSD. I made a lot of black and white drawings of melting faces, and so on. My father looked at them, and said "These are the kinds of pictures your cousin drew after returning from his tour of duty in Lebanon, and stepping over corpses". That's the kind of mental damage we are talking about. Now I get shivers of revulsion from even looking at a glass of whiskey.

How does Ron Maimon feel about the cuban missle crisis and JFK?

JFK was killed by a conspiracy involving LBJ. The fingerprint at the scene clinches the assassin at the depository, and it's not Oswald, it's Johnson's Wallace. Bay of Pigs was a disaster that JFK didn't know about, and he did the right thing. The Cuban missile crisis was a catastrophe, and he did a dangerous thing.

What do you think of Quora's “Be Nice, Be Respectful” policy?

★★★ Great policy, so long as nobody ever enforces it except by chiding.

How can I make myself better understood in Scientific Papers?

Don't repeat any sentences from previous publications, and pretend you are explaining it to yourself at age fifteen. Scientific papers have an early paragraph which is copy-pasted from one paper to the next which kills all motivation to read the paper. Also put a summary of the most difficult argument FIRST, before everything else, because that's when the reader's mind is freshest, and they can digest the most stuff. Don't leave it to later, because they want to know: show us what you got!

In your opinion, who is the most interesting American of all time and why?

Leonard Susskind. A plumber, as a total late bloomer, essentially solves all of physics, outdoing Newton, Einstein, Bohr, Hawking, and Witten. what could be more interesting?

Are there any economic alternatives to capitalism and socialism that do not use currency, banking, or debt-based exchange?

No, this doesn't work. The Soviet Union eliminated currency for a brief period, using deliberate hyperinflation, and tried to supply everyone with invoices. Boy did that not work. The experiment only lasted a few months at the most, and they printed a new currency.

How did Einstein's musical practice inform his scientific work?

There is no connection, except for the fact that playing music requires you to invent and interpret structures constantly, and keeps your brain limber. Heisenberg was a nearly concert-level pianist, and there are many other physicists who use music to relax. Composing is very mentally demanding, and resembles the creative process in physics, except the constraints are totally different, coming from human psychology and not matching nature.

What scientific or philosophical justifications exist for Occam's Razor?

It is a primitive axiom of thought, it is required to perform the reconstruction of regular objects from sense data. I don't see it as derivable, since any derivation requires Occam's razor to just put together the insights and not assume some magic demon didn't mess with your mind to fool you into thinking the argument makes sense.

Will physics eventually be reduced to geometry?

String theory is not pure geometry, but produces the geometry from more primitive concepts, which make sense on black holes and asymptotic boundaries. The final formulation of string theory on cold space-times is already known, in AdS/CFT constructions like BFSS theory and Maldacena. These produce a geometry from more primitive notions, and they work. So this is a reduction to something even more basic than geometry, and it's a major revolution. Before the 1990s, the reduction to geometry was a major theme, starting with Einstein, through Yang-Mills Pauli-Shaw gauge theory, and into the 1980s, with the topology and instantons. But string theory removes the need for speculation, because it works for sure as a model and is fundamentally understood on cold backgrounds.

What does Ron Maimon think about illuminati believers?

I'm not one, but they're entitled to their opinion. It's silly, because secret societies are so 17th-18th century, these secret clubs peaked in George Washington's time, such things won, they made their Bourgois revolutions, and they havn't really been prime movers in politics since Marx.

How does Ron Maimon feel about the recent surge of anonymous questions?

Only YOU would have the balls to ask that!

What does Ron Maimon think about the Velvet Underground?

Great, and would have stayed together and stayed great, if not for the drugs. Ditto for all the great bands of the 1960s and 1970s, the drugs wrecked everything good. The 1970s Velvet Underground continuation, Jonathan Richmond and the Modern Lovers, had a fantastic simple extremely powerful song called "I'm Straight", about "Hippie Johnny", which made the point better than I can. Zappa avoided drugs, and remained creative, and in the 1980s, a lot of bands committed to being fully drug-free, and those that didn't, decayed.

How does Ron Maimon feel about cheech & Chong?

Marijuana advertizing, not so funny, but immortally great in Martin Scorsese's great film "After Hours", so I forgive all else. "After Hours", despite the partly plagiarized screenplay, despite the three week shooting, and the dated setting, is my favorite commercial film of the 80s.

How can I contribute to science and research if I have an average I.Q. but an interest and good understanding of mathematics and physics?

IQ is stupid. Practice the stupid tests until you have a genius IQ, then learn science.

What's Ron Maimon's opinion on the 60s?

Good decade for physics! The start of the 1960s is probably 1957 for physics, with the Everett paper, BCS theory, Mandelstam's double-dispersion relations, and so on. But from 1960, S-matrix theory was developed and flourished, quarks were discovered, the standard model was discovered, Nambu's vacuum physics, Gell-Mann's current algebra, Feynman's ghosts and Partons, Fadeev Popov ghosts, the path integral was revived. General Relativity had a reneissance, with the Kerr solution, the initial value problem with Choquet Bruhat, the black hole results with Carter, Penrose's singularity theorem. Condensed matter was revving up for the coming revolution with the Widom results. Nuclear physics developed the Skyrme model and topology, SU(6) was born and died through O'Raifertaigh, Coleman and Mandula, String theory was born with Veneziano's model. It was one of the greatest decades, like the 20s, the 80s, and the 90s Some not so great things were the over-formalization of field theory with pedantic mathematical jargon, but this was revered in 1972 with Diagrammar. This was the time that the literature became extremely opaque, but it was not yet political. The political split between S-matrix and field theory didn't become an issue until the mid 1970s, when all the field theorists began purging the S-matrix folks because they didn't understand them. In terms of culture, the 1960s were not in any way discontinuous with the 50s and 70s. Civil rights began in the 1940s, with the returning black WWII veterans, and reached a peak in 1954, with the desegregation decision. The 1964 Civil Rights act was long overdue, it was a culmination of a social change, not the beginning. The murder of Kennedy was an ominous sign that the CIA could be used to stage a coup internally. The result was a decade of turmoil, where the Democrats lost the election to Nixon, largely as a side-effect of Kennedy's murder (Kennedy had an executive order to pull out of Vietnam, reversed by Johnson, who was surely a prime architect of the assassination, as his favorite gunman's fingerprints were at the crime scene). The Beatles were interesting, but a phenomenon of media, who liked to pretend drugs were good. There were clear LSD inspired TV shows, like "The Prisoner" which look today exactly as they were, a bunch of TV writers on LSD. The Soviet culture of the time was freer, USSR citizens got freedom of speech under Khruschov, later curtailed, the Soviet space program was at it's peak, and Eastern block production was at it's highest relative point compared to the west. Yugoslavians got complete travel rights and the ability to form a business. Chechoslovakians wanted these rights, and were squashed, but this produced the great wave of Prague stuff. The idealism of 1968 Prague and Paris is very inspiring. The Germans got rid of the Nazis, and the young people revolted. The PLO was formed, and began their capaign. The internet was born in 1969, one mustn't forget. In terms of impact, this was the greatest event of the decade, for sure. I see most of the 1970s, 1980s, and 1990s as a holding pattern for continuing the progress of the 1960s after the stupid drugs were purged. The activists were right on everything except the drugs, as David Crosby is fond of saying, but that's not a small thing. The drugs are purged now, and every day on the internet is 1968.

What is it like to be a sole holder of a contrarian view in an academic setting where everyone else strongly disagrees with that position?

It can be demoralizing because nobody listens to you, and they laugh. You have to persist until you win or you understand that you are wrong (or, in the worst case scenario, until you die). Behe is not a young-Earth creationist, his idea is simply that there isn't enough complexity in traditional modern synthesis evolution for changes between species. In this he is certainly right, but he is wrong to look to supernatural explanations. This is the main reason why one expects large computations in cellular nuclear RNA, to provide the missing intelligence that Behe identifies. Hopefully, once Behe realizes this, the mainstream and him will meet, and he will study intranuclear RNA. But he could just continue to believe he discovered supernatural nonsense, but then he would be delusional.

What should we do to create interest in the electrical field?

One way is to point out that the constant in Coulomb's law k, in SI units, is the same number as the speed of light squared, except 7 orders of magnitude smaller (9.0 x 10^9 as compared to 9.0 x 10^16), the match is to all the significant figures. Don't say why, just leave it a mystery. Another way is to consider conductors with strange shape--- needle tip conductors which will ionize the air at the tip and ground themselves. Conductor fields and conductor induced voltages in different regions are an art form, and students can be induced to find them interesting essentially forever. But the standard material on this is boring and obvious.

Why do some materials like rubber bounce more than other materials like wood or metal?

It's a question of the reversibility of the compression and expansion, whether the material compresses reversibly, and on the degree of disorder, which determines how acoustic waves spread out in the material. This depends on molecular details and degree of disorder. Rubber has soft stable polymers which are not strongly bound to each other, they are tangled up, they get some heating on compressing and expanding, from the loss due to thermal conductivity, but this is only a little bit of loss, and the resulting sound waves when a ball hits the ground will reflect back to make a good bounce. Wood is irregular, and the sound modes scatter irregularly and get damped by irrevesible molecular de-bonding events. I don't know why metal doesn't bounce. I suppose from the other answer it's because the meatal is so hard, the speed of sound is so superfast and the material so superelastic that the different locations of impact produce waves that get scrambled up in the interior and it is sensitive to the microscopic roughness of the surface you are impacting.

Which temperature is needed to start a fusion reaction between Oxygen or other elements in the atmosphere?

The only serious concern is deuterium in the ocean. The detonation of ocean deuterium is at a lower temperature, at order 3 KeV, or a few million degrees, like the core of the sun. Any other element has a higher Coulomb barrier, and cannot concievable fuse at any temperature attained in an atomic explosion of any kind. The deuterium concentration of the ocean is too small to allow a detonation wave, this was concluded in Los Alamos in the 1940s, but in a paper in the 1960s, Los Alamos scientists speculated that in certain gas giants, you could produce a deuterium density sufficient to become unstable to a nuclear ignition. Such a wave, if it were to be triggered in Jupiter, could concievably produce an immense explosion, sufficient to destroy all life on Earth, at least on the side facing Jupiter. This fusion cannot be triggered under normal circumstances, unless the planet is heavy enough to be a sun, in which case, it would just mark the start of solar ignition. But the authors speculated that perhaps a planetary impact could lead to such an ignition, and suggested on look for "planetary supernova" signatures. So far, no such event has been identified, but then again, I don't think anyone is looking.

What are the most productive ways to learn communication skills on the Internet?

Fluency in English can be acquired through media, you can use conversational films, youtube, television to acquire proficiency in idioms quickly. This is very useful online, and it is important to "localize" the idioms, so you know which are American, which are British, which are Australian, which are Indian. This takes less time than mastering written English.

What is the shortest sad story you can come up with?

He loved his straight best friend.

What constitutes a concept in social sciences?

A statement which can be used to make nontrivial predictions about human behavior. For example, the concept of social authority required to understand Milgram's experiment, or the concept of social class required to understand Marx's separation of incomes in a traditional capitalist economy.

What is so great about Stephen Hawking?

Hawking's contribution created modern quantum gravity, he is one of the greatest physicists of the twentieth century. He gave the first real physical insight which was solid and dependable into gravitational physics in the quantum domain, and this insight was and still is central to all the amazing progress that followed. His earliest major result was extending Penrose's classical singularity theorem for the big bang. This depended on the dominant energy condition, so it is violated in inflation, and has been superseded in this sense. But it is an important description of the pre-inflation cosmological-constant free dynamics of General Relativity, and it still works to describe all but the first tiniest fraction of a second. His book with Ellis on General Relativity is still a good, but slightly overly formal, source for modern General Relativity and the singularity theorems. His other work in the 1960s was contributions to Carter's program of no-hair, and to the mathematical elucidation of black hole dynamics. The results of this made it clear that black holes are simple, and settle down dissipatively to a final state which is determined by a few parameters. Dissipative dynamics is very strange in an ostensibly time-reversible theory like classical GR, but Hawking gave the fundamental law which lay behind it--- around 1972 he discovered the second law of black hole thermodynamics. His insight is described on this stackexchange answer: Second Law of Black Hole Thermodynamics , and along with Penrose's closed trapped surface, it is, in my opinion, the most beautiful general result in General Relativity, it is a complete classic, on par with anything from Einstein or Bohr. But then, starting in 1974, and culminating in his series masterpieces from 1976-1980, Hawking turned the whole world upside down, with results that have no precedent at all. Bekenstein had argued that Hawking's area was a true entropy, and had a certain coefficient. This implied that black holes were thermodynamic objects at a nonzero temperature, but this was not consistent with no-emissions. Then Hawking delved into the emissions, and discovered that the earlier zero temperature description due to Boulware was incorrect, that this was a false vacuum for a black hole (it is essentially describing a black hole with an infinitely cold mirror surrounding the horizon, or else an infintely cold mirror on the verge of collapsing to a black hole--- there is stress on the horizon). The proper vacuum for black holes was radiating, and in such a way that Bekenstein's idea was realized, and the coefficient was matched. He used this to gain immediate permanent insight into quantum gravity. First, black holes explode from their emissions, they are not permanent. Next black holes and white holes were the same physical object, they are only different in thermodynamics. This argument was cogent semiclassically, and it is confirmed now that we have complete theories of model quantum gravities in AdS/CFT. Next, there are no conserved quantities other than charges protected by gauge symmetry, so Baryon number is not conserved, because a black hole can be formed from neutrons and decay into photons. This meant that quantum gravity would respect no symmetries other than gauge symmetries, and virtual black holes would allow any term to appear with a natural coefficient in full quantum gravity. Finally, he noticed the information loss puzzle, the paradox that the emissions do not seem to be correlated with the absorptions, and this was the final impasse, a complete conflict between locality and black hole physics. This work is monumental, it cannot be oversold. Along with simultanous work of Scherk and Schwarz and other string theorists, it was the most important breakthrough in fundamental physics since Planck's time. It gave real PHYSICS in quantum gravity to sink your teeth into, the black hole thermodynamics, and since these were stringently consistent, it gave, for the first time, a theoretical principle to build on. The string theorists ideas would not be complete until they made contact with this work. The 80s, Hawking spent investigating two paths, one to elucidate the nature of the path integral for quantum gravity, to explain the quantum properties from a more complete formalism. This work produced the Hartle-Hawking no-boundary state, and was also investigated by Coleman, following Hawking, to produce an argument for cosmological constant stabilization from the path integral. The other path was to investigate modifications of quantum mechanics to incorporate fundamental decoherence. This included defining the "dollarsign operator", the density matrix version of the S-matrix, which is something similar to the super-Hamitlonian now used phenomenologically in quantum computation (general density matrix quantum mechanics was investigated earlier in the 1970s by an obscure physicist whose name I forget, I saw the book on a shelf somewhere). He also contributed to inflation theory, and extended the Hawking temperature derivation to an imaginary time formalism that made the derivation obvious, and which worked to make it trivial in cases like deSitter space, or deSitter Schwarzschild. He also investigated Nariai-like collapse in extremal black holes which disconnected the region between the Schwartzschild and Cauchy horizon, turning the space into AdS_2 x S2. Similar degeneration was the Nariai limit of dS-Schwartschild. All this work is top notch, but these paths dead-ended due to the string revolution. The string theorists had an advantage in having a correct quantum formalism for quantum gravity, since their theory was only defined on boundaries, and didn't need to do path integrals on local fields. The project of path integrals for quantum gravity dead-ended when 'tHooft understood from thinking about Hawking's information loss paradox that the entropy on the exterior of a black hole is divergent, and needs to be regulated. He began to reconcile unitarity (no information loss) with Hawking in the mid 1980s, and the results required one to abandon locality for quantum gravity, meaning, no path-integral on metrics, rather an S-matrix formalism which dealt with asymptotic states only. Susskind, who was familiar with string theory, which was already an S-matrix theory, showed that the no-locality in string theory was qualitatively the correct kind which is required to fix black hole behavior, and provided a physical interpretation of the strings of string theory as black holes. Polchiski had studied branes, and in the mid-90s, the string community began to reproduce Hawking's results in full quantum gravity, a project which required many researchers many years. In 1995-1997, the holographic principle was understood, Vafa and Strominger reproduced Hawking's entropy results for a degenerate class of black holes (but it was clear the results would generalize to all, although this has not been fully sorted out yet), and there were for the first time complete models of quantum gravity. Stephen Hawking by this point was very severely handicapped, and did not follow these developments in a timely way. He was also extremely famous, and doing much public outreach. He clung to his information loss through the 2000s, until he got the AdS/CFT business and renounced it, but it really doesn't matter. That he is behind today is not surprising, considering the enormous amount of progress in physics in the 1980s and 1990s, comparable only to the 1920s, and his condition. what is surprising is the stamina and fortitude with which he smashed physics open in the 1970s and 1980s with the classic results which will forever bear his name. He was already pretty severely affected by his disease in 1972, well before the most astonishing phase of his career.

Does love last and if so how?

Romantic love lasts too long, essentially forever, long after it has outlived its usefulness, and has placed you in a miserable situation. Parental love is even more permanent, but thankfully it never outlives its usefulness.

What is the message behind the Marquis de Sade's "Eugénie de Franval?"

Spoiler alert, read the story first! This is an extremely demoralizing piece, because it is a parable of a person who is trying to do everything right, but is destroyed by unknown circumstances into doing things that are repugnant to any moral sense. It is essentially Job, except without the redemption, with a much more saintly character than Job could be, because her goodness is made manifest, not just asserted. It produces a sense in the reader that one aught to do what is right, not because of any rewards, but intrinsically because it is the right thing to do. This is a very difficult realization to produce in a printed work, and Sade does it masterfully. It is a different approach to the prolbem than the direct approach, which he developed in the 120 Days of Sodom, but it is also effective. But this story is different from the 120 Days, because it demands that one suspend judgement on Eugenie, despite the damning facts. Facts be damned, it wasn't her fault! The story is also extremely well plotted, very emotionally devastating, it is a work of horror with no zombies, no vampires, nothing, just human beings behaving in bad and not so bad ways, so that even a saintly character is placed in the position of participating in horrible evil, despite having no bad intention in her body. It produces a different sense of right and wrong than standard religion, which would traditionally condemn Eugenie, despite her saintly nature. Instead, you are wounded by what is happening, you believe Eugenie is a saint! Yet still, look at what she does, through no fault of her own. It's a very difficult situation, which aims to reduce the judgemental aspects of religion, to empahsize on the desire to make goodness in the world, without judgement of others. Lars Von Trier explored similar themes in his trilogy of films, beginning with "The Idiots", and culminating in "Dancer in the Dark".

Have we, as a society, become more desensitized to sex, drugs and extreme violence?

To sex, a little bit, but it doesn't seem to have made things worse for people. We have a long-overdue acceptance for cross-dressing and homosexuality, and people are allowed to experiment sexually as youths, with the consequence that they know what they are getting into later in life. This is not bad, except to the extent that it sometimes delays childbearing so long that it's too late, but perhaps even this outcome is appropriate for an age where we are reaching the limits of population. We are not in the Iron age, where indefinite population growth is sustainable. Regarding extreme violence, the portrayals of it become more stylized and unrealistic with time, as we get further from real violence. The violence in the 1940s films and media was much more traumatic, as it was known by people what real violence looks like. The violence in War films, or gangster movies, was much more lifelike and disturbing than a Kung-Fu movie. We are a much less violent society today. Regarding drugs, they peaked in the 1970s and have been on the decline since. The problem is really going away, the drug abusers are now middle aged. Young people smoke pot a little, but even less of this than in the 1970s, or 1990s.

What happened to WTC building 6 on 9/11?

This is a normal structural collapse without demolition. It's sort of what building seven would have looked like if it had happened the way the government said (except with less damage, because fewer supports failed). The WTC towers 1 and 2, if they would collapse at all, would only shed a few floors, the steel would have remained, standing like an enormous phallus no matter what happened to the outside. But in real life, the towers would have remained as it was in the first hour indefinitely, if the core wasn't melted by thermite.

Should formulas in Physics be memorized?

There are formulas which are definitions, which define what terms mean. So for example: V=IR V=IR is a defintion. It is not obvious that it is so, because it is not defining "V", the voltage is defined by instruments, nor is it defining current, this is defined by how much charge crosses a surface per unit time. It is defining resistance. The proper way to write it is: R= V I R=VI But even this is wrong, as current is best thought of as the response to voltage, in a cause-effect sense (although cause/effect is not a fundamental notion in physics, it is fundamental to engineering, and to human thinking). That means--- you set up a voltage, that's the situation, while the current is a response to this voltage, it is the effect once the resister gets to an equilibrium in this voltage. So the right way is to define the "conductance", 1/R and say: 1 R = I V 1R=IV in other words, the conductance is the amount of current produced per unit voltage applied. This is the proper definition, and the formula is now internalized. It is defining the conductance properly. But really, even though it is defining 1/R, the best way to write it is really

$I=(1/R)V$ $I=(1/R)V$ meaning, I is proportional to V, and the coefficient of proportionality, which is being defined by this equation is 1/R. All of these are trivially algebraically equivalent, but you need to internalize the idea--- it's a linear relationship with a defined coefficient. The last equation is the one you need to memorize, and not any of the others, because they are wrong. Once you understand linear relationships with a defined coefficient, that's 70% of the equations you memorize, they are defining linear relationships and defining the coefficients: $\Delta T= 1\ C\ P\ \delta Q$ $\Delta T=1CP\delta Q$ the temperature change is the reciprocal specific heat times the heat absorbed. $F\ f = C\ f\ N$ $Ff=CfN$ The friction force is proportional to the normal force (defining coefficient of friction) $Q=CV$ $Q=CV$ The charge on a capacitor is proportional to the voltage difference across the two ends (defining capacitance). Even the granddaddy of all physics equations: $F=ma$ $F=ma$ is a description of the acceleration response to a force, it is a linear relationship which defines the mass. These you need to commit to memory in the proper way, as they define the coefficient's meaning, so there's nothing to do. But it's no more difficult than learning what the words mean "specific heat, capacitance, resistance", The thing that makes it difficult is only that about 40% of the definitions, due to historical accident, were chosen stupidly, and the reciprocal of the coefficient is the thing that has the name, not the coefficient. This includes even such fundamental things as "temperature", which is really reciprocal coldness, and is defined by this equation: $\Delta S= 1\ T\ \delta Q$ $\Delta S=1T\delta Q$ Historically, energy came after entropy, so people defined things the other way. Temperature is also easier to understand. The definitions and linear relations are really 60% of your equations. Now there are the IDENTITIES, these are things that are not even equations at all, not even definitions, but unit conversions: $E=m\ c\ 2$ $E=mc2$ Einsteins mass-energy equivalence $p=\hbar k$ $p=\hbar k$ $E=\hbar\omega$ $E=\hbar\omega$ DeBroglie's momentum/wavenumber relation (somtimes written obtusely as $p\lambda=h$ $p\lambda=h$ $E=hf$ $E=hf$ Here, when written properly, the left and right hand sides are things that people once thought were separate things, but are really the same thing once a more fundamental theory is found, except we used different units for the two sides. To get rid of these equations, always, always first learn with a choice of units which makes it that: $c=1$ $c=1$ So space and time have the same units, and $\hbar=1$ $\hbar=1$ so energy and radian frequency have the same units. This gets rid of 75% of your equations. The ones left behind are actual, honest to goodness, physics equations! For example; $PV=NRT$ $PV=NRT$ The ideal gas law. These equations can be derived from underlying principles, and you need to understand how this works. But the honest truth is that that's only like 1 equation a week in an elementary physics class, the rest of the time, you are doing nonsense with defining units and working with linear relationships, and learning to deal with annoying reciprocal conventions. To learn PV = NRT, first write it properly P = n R T, where n is the density. Then swap out the units so that R=1 (first by changing moles for number of atoms, so that R goes to Boltzmann's constant, and then setting Boltzmann's constant to 1, so that T is in energy units). Then you have $P=nT$ $P=nT$ The pressure is equal to the inverse coldness dimes the density. Why should the pressure be the inverse coldness times the denisty in a gas? Now you can look at a derivation, from kinetic theory, or from thermodynamics, and understand what parts are important for the derivation. This is what you need to do, get rid of the nonsense units and definitions, so that you focus on the real content. This is 80% of the first three years of physics education, and the difference in aptitude of students is basically the random process of who gets the trivialities and who doesn't. if you don't understand the trivialities, you have about 10 to 100 times the work of someone who does, and it is much more boring also, because you don't understand.

What do you think about the mathematical universe hypothesis?

It's sort of vacuously true, in that there is no positivistic way to see that it is false, or true. It's just a statement without content, unless you specify the size of the computer more precisely, and then it becomes testable. For example, if you say the universe is a computation of size the cosmological horizon area over the Planck area (or some reasonable multiple of this), you get a contradiction with quantum computing. If you say the universe is "structures ZFC set theory" you get ambiguities as described by forcing. You need to be more specific to make it a hypothesis, rather than an empty statement.

What is the difference between a high level and low level computer programming language?

The difference is whether you know and can control exactly what the machine is doing, or whether the compiler does things behind your back, or if there is a huge interpreter sitting somewhere doing all sorts of memory allocations. A low-level language is one where you are vaguely aware of the data inside all your data structures, where they are being put in memory, the precise machine implementation of your algorithm, what machine instructions roughly are being executed. A high level langauge aims to describe the algorithms you are writing abstractly, in some recursive formalism, without specifying exactly how it is to be carried out. The tension between them is that finding the most efficient repesentation of an abstract algorithm on a specific machine is roughly halting-problem level of difficulty if you want to do it well--- it's equivalent to computing Kolmogorov complexity to find the maximally efficient representation. So compilation or virtual-machine emulation/interpretation is always inefficient to a certain extent, and it isn't negligible. The tradeoff means that the higher level languages tend to compile to less efficient code, if they are compiled, or to be executed slowly if they are interpreted. Low level languages are FORTRAN, C, C++ (there were more in the 1950s, like FORTH and so on, but they are totally dead). These are essentially just pretty syntax for obvious translations to machine language. C is better, because it deals with the stack properly, but because FORTRAN doesn't, it shaves a few clocks off here and there, the performance hit for C is not worth the obtuseness of FORTRAN regarding memory allocation and subroutine calls. There are tricks for making efficient interpreted languages. Perl's regexp engine very good, because it is written to do general regexp stuff extremely efficiently in a low level language, and the regexps just control how the engine does it's job, and parsing the regexp is not the main bottleneck. Perl is also extremely terse, and presents the text-munching algorithms in something which is close to the mathematically optimal form. There is not as much of a tradeoff between being low-level and being human readable as it seems, because algorithms can be encapsulated into sub-algorithms. Once you program in a low level language, high level languages become annoying. The reason is that the algorithm abstractions of the original languages are based on recursive functions, which seem prettier to untrained humans, while the "correct" way to view algorithms is in Turing terms, in terms of branches/gotos and data manipulation, not imposing an artificiial recursive structure on the algorithm. But because recursive algorithms are so seductively elegant, they tend to pervert all the high level languages. The king of recursive elegance is this regard is LISP, which is extremely beautiful, very simple, and has a manner of speaking about it's own code which is the envy of every other language. This allows you to write codes to generate other codes, something which is a nightmare in other languages, because LISP code is a first class object. But LISP is very recursive, and relatively high level, although it is probably the most efficiently compiled of the high level languages.

How do you solve 4 x + 9 x = 13 x 4x+9x=13x (the answer is 1) formally using a logical method, rather than just trial and error?

There is no "logical method" for solving equations, despite what you were taught in school. You need to consider when the two curves for the left and right side cross. Divide by 4^x, and you find 1 + (9/4)^x = (13/4)^x The difference of the two sides has derivative (13/4)^x log(13/4) - (9/4)^x log(9/4) which has exactly one zero. The two curves therefore only meet at the obvious places: 1 and minus infinity, any other pair of meeting points would require another root for the derivative. (since division/derivative reduces the number of exponentials on each step, and hereditarily relates the number of roots at lower levels to upper levels, You can use this principle inductively to show that linear combinations of exponentials only have one root when they have one sign alternation. That's a cute general theorem.)

What is your greatest "Oh man, I am an asshole" moment?

I was bullshitting at a coffee shop, and I said "Wouldn't it be interesting to have a pornographic film set in a concentration camp. All the guards would be blonde German men, all the inmates would be dark-haired Jewish women. Then the usual pornographic nonsense, and at the end, they would decide to not kill anyone at all, just have one big orgy." Once all the folks giggled and left, a fellow sitting at the next booth, with a pockmarked face and deadly earnestness said "You know, your film idea, this idea has merit. I know some people, I could make that film. I think it would be a big hit." I was absolutely mortified. just the thought of that atrocious offensive film actually being made makes my skin crawl. Oh man. I'm an asshole.

What is the final state of the universe? Does the arrow of time finish at one point and the universe reaches its ultimate entropy?

If the universe ends in a deSitter space, then either it just sits there forever thermally getting randomized, or eventually, there is an instanton transition to a true M-theory vacuum, and all of space ends in cold flat 11 dimensions (or something else). Susskind has spent a lot of time thinking about the final state, but knowing exactly what happens requires a better understanding of string theory in deSitter spaces. Susskind has speculated that all deSitter spaces are metastable, but now he doesn't seem so sure. The argument was never airtight, and can't be, until we have a deSitter string theory, but I think it probably decays, just by Susskind's earlier arguments.

Is the fellow performing this song the Quora Ron Maimon?

Yes that's me. I didn't put it up, I don't like the song, I composed it the week before as a practice in songwriting, the fellow running the open mike decided to put everybody's songs up. I have a better song from the same open mike, "The bunny of love", which is funny and original. This one is just a songwriting one-off practice song, from months before the "bunny". But even the two "bunny" versions are weak, one has a wrong tempo on the chorus, the other (with the dark glasses) was from the day after I wrote it, and just improvized the lyrics. None of the performances are any good. I have good versions from a later open mike when I finally got the hang of writing songs, and made a proper style, this one is just not very good.

Is economics a science? If not, what is it?

It isn't, but it could be. There are models which are mathematically interesting, but they are usually very simple. There is a TON of data, but it doesn't fit into usual models. The main problem is that the politics in this field is broken in the usual way, and hasn't been fixed by Galileo style honesty, as in other fields of science. There are people who will say bullshit, and then get a ton of money from rich people to repeat this bullshit in think tanks. To make an honest economic literature requires a commitment to no-holds-barred honesty. This is made possible through online criticism of text, because it is impossible to do fraudulent work and not get called out on it on a site like this. For an example, Debangshu Mukharjee's comment on my answer to this question What do physics majors think of math majors, other science majors, and humanities majors? pointed out that Ken Rogoff's paper on debt and growth has fabricated data, and false conclusion, but is still politically propped up by idiots. This is the kind of thing you cannot tolerate if you wish to make economics a science. The other thing which would help is permission to conduct monetary experiments in counties, by allowing a certain amount of money multiplication locally, for example, by allowing everyone in Syracure NY to get an extra 1% interest on their bank account, for no reason other than to trace the perturbation in purchases. The same thing with slightly fluctuating prices at online retailers, like Amazon used to do, with prices that are allowed to fluctuate by 1% for different buyers, to get a sense of the demand stiffness.

What is the point of being a professor?

Professors that do great research are BY FAR the best teachers, they are orders of magnitude better at explaining the concepts than professors with weak research. They just understand it better. But, these professors get weak evaluations from students, who are annoyed by their personality traits, or they don't want to put in the effort to understand a subtle argument, or they are generally put off, because a clear original presentation of a good result never sounds persuasive, when you don't know anything (like students) it leaves you feeling cheated--- "It can't be this easy" is the common thing you end up thinking when you leave. But when the professor is good, it is. This gap between student perception and the true quality of the teaching was noticible for many folks. Eric Siggia was notorious among graduate students for being an unclear lecturer, but his lectures were clear as a bell, and extremely insightful, because his research is so strong, and his lectures came from the research. Same for Yulij Ilyashenko in the Mathematics department, he explained the KAM theorem in 3 lectures, and at the end, it was trivial, I couldn't understand why something this obvious is considered hard. Of course, then I read a standard presentation! Other notably uncharismatic greats are Georgio Parisi and Alexander Polyakov. You have to sit and listen to these folks, and stop complaining about their mumbling and stuttering, because everything that comes out of their mouth is gold. These professors who do great research have a hard time politically, and it is good to tenure them, listen to them, and when they mumble, sit real close and write down all the mumblings, because these antisocial badly dressed folks have all the real knowledge, and that's just a fact.

Does mathematics really exist in the universe or is it just a human assumption?

This is a meaningless question in logical positivism, but I think the best answer for intuition (not to be taken too literally) is that the mathematics you can see on a computer, and model with finitary computation (in the limit of infinite running time) is real, and discovered, while the mathematics which pretends to make definite statements which can never be checked on a ocmputer is made up nonsense for the sake of making a nice framework to answer the other kind of question.

What's a question that has the answer "free will"?

What does ef ar ee ee, double-u ay el el spell? What did Shakespeare's cousin say to the guards to get them to unlock the door? What does a lawyer catering to the dying say to get more clients? What unique answer answers all of the above?

Does it makes sense to offer writers equity share in a company?

Offering equity is a way of paying people without money, by stealing from shareholders. It makes sense, I just don't think it is ethical. I should say, it is less ethical in my mind when you give it to people internal to the organization, but even with outsiders, it's a weird system of rewards, it's like printing your own money, it's kind of hard to evaluate the reward, and it creates unclear incentives. I don't know, I have a knee-jerk reaction against it from past experience.

Why aren't FoxNews.com and Cnn.com giving very much coverage to the riots in Kiev?

Because the right wing government is probably more business friendly than the government desired by Ukranians. The right wing is also somewhat afraid of the possibility of a reintegrated Ukraine/Russian alliance similar to the USSR.

Does reality have a liberal bias?

This is true when talking about the conservative bullshit on TV and radio, but this is bullshit because it isn't even the true position of conservatives, just a propaganda tool to get votes. The conservative position is more nuanced, but they don't believe in human equality, and they think you are too dumb to understand their real motivations, so you need to be kept in the dark with propaganda. Reality is what it is, and liberals get things wrong too. But reality is definitely biased against the ariheaded pontifications on conservative radio.

Analytic Philosophy: Does calling all acts selfish make the word meaningless?

Yes.

Is there enough emphasis placed on the reasons for rules?

The reason for rules are usually self-evident, if they are not, it's not a good rule. You don't need rules too much for this reason, people usually know when they are behaving badly.

What are the top five best decisions you ever made?

I wrote a scathing indictment of "Large Extra Dimensions" for Wikipedia. I had to stare at the button for a long time before hitting "submit", because I knew that from this point on, I would be an academic pariah, even though I was telling the truth. i decided I would forgo it, that the open internet was more powerful and accurate than previous media, and that I should trust in the truth. Then I sent the article into Wiki. It just sat there getting read for a year. About a year later, extremely belatedly, it got a response, full of references, explaining the fraudulent standard view. I edited it to make the two get equal space, and this is the current form of the "Large Extra Dimension" page. The field got a rename ("Universal Extra Dimension"), but it really started to lose steam after 2005, which is when I put the article. It might be a coincidence, you never know your own impact online, but I like to think not, that the Wikipedia page was warning people. Now, it's dead, good riddance. I am still a pariah, but that's ok. I am happy with the internet medium, I think it is superior to all previous media, and I was sort of prepared for this, as I had been looking for the transition since I first went on Usenet in 1992. I think this decision, to forgo traditional academic paths for uncertain internet path, is the best I have ever made. I should say that everyone who knows me disagrees and thinks it was a mistake. But I trust my judgement.

I'm looking to change my name. What would be some great new name ideas?

Calvin Candela. Then you can say they named the unit after you, and after a few centuries, maybe people will believe you.

For what reasons do those who do good things do them for any reason other than because it is the right thing?

Sometimes doing the right thing is also doing the right thing for you. For example, suppose you are Usain Bolt. Then you might train every day because you want to win the competition, but it might also be the best thing for you to do, because it is the best use of your skills! The two coincide. So there is no point in discussing why you are doing the right thing, unless it harms you. In this case, you are doing it because you have made a calculation that this is the ethical thing to do. The calculations for ethics are distant and strange, and ultimately, they feel like talking to an impersonal other creature that understands right and wrong, and sort of gives you instructions about what to do. But it's always a graded collections of options, and you might choose to do the second best thing, because the best thing comes with less money, or less material pleasures, or something like this. But it's not clear that the best thing is really best, it's not like you are omniscient, you just have a sense of right and wrong, your sense is feeble compared to the true right and wrong. But the motivation is always a mix between selfish and selfless, and it is only the degree which the self-interest diverge that measures the goodness of the action.

I feel like no one listens to my opinions and that no one respects me. How can I make myself be heard?

It doesn't matter, as online, you will be heard if your opinons are correct, as they will get support according to the evidence, or they will be refuted and you will change your mind. The need for getting heard is a social status seeking, and it is detrimental to evaluating the ideas objectively and fairly, which needs to be done without regard to where they come from.

Why should our economy grow at "X" percentage every year?

Because growth means more people can do more services for others more efficiently. It is not necessarily environmentally damaging, maybe they are installing solar panels, or cleaning up CO2 from the air, whatever people are willing to pay for. The production of goods and services is a form of helping others, except it is coordinated in a way that doesn't require you to like whoever it is you are helping. So X should be much bigger than 0, as big as possible, within the constraints of preserving the environment permanently, and making sure that people do not get thrown on the street and die. You want to help people more, and GDP is a measure of how much you are doing this. But to do this is not easy, as growth is difficult to maintain. Certain policies do help growth, usually left-of-center policies, such as those of Clinton. The taxation greases the wheels of a capitalist economy, because it remediates the constant anti-equilibrium monopolistically driven inequality that exists. But I believe that the best growth can be achieved with more complete equality, and more direct planning, in a competitive environment, not in a totalitarian environment, and with voluntary cooperation between folks. There is no reason to assume this is impossible, free software is an example of where it was done, with great benefits to economic growth.

Does smoking marijuana make you smarter?

One time use of marijuana will not harm you, and might cause you to see something you didn't before. Even extremely occasional use (like once every few years) is not damaging, you just lose continuity from the previous year. But in any more frequent consumption marijuana will cause a precipitous decline in your ability to manipulate abstract objects with fluidity, and it will erase your memory of even elementary things with more frequent use. Igor Markov has described the studies, but the informal evidence is much stronger--- no mathematician or physicist I know can function when stoned, or even for a week afterwards, and it wipes out stuff you were actively thinking about before, and you need to laboriously reconstruct what the heck you were thinking about. It's not a pleasant drug, and it can be harmful even in secondhand doses. So really, stay away if you can.

How common was female rape in prehistoric times? How did women protect themselves from this?

The evidence fo the incidence of rape in humans, at least in the sense of individual rape, not conquest and enslavement of women, is through the body-size difference in males and females, sexual dimorphism in evolutionary biologist's jargon. This is strongly correlated with the incidence of forced copulation in animal species. The incidence of forced copulations in chimps and Gorillas is roughly known, it isn't zero, but it's relatively rare. and the sexual dimorphism is greater in both. So from this evidence, it was probably rare, but not unheard of, to reproduce through forced copulation, keeping a small selection pressure for size dimorphism. Today, it is rarer still, but dimorphism might be continued purely though sexual selection. it is not clear.

When someone says "I like you" what are you supposed to do if you have Aspergers and don't know what to deal with emotions?

They are probably trying to get into your pants, aspergers is very rare in a woman, and makes her exploitable for sexual conquest, and unfortunately, perhaps they are trying to take advantage. If you are not afraid, you can ask them if they would like to sleep with you, and if the answer is yes, and then say that you would prefer not to just yet, but perhaps if they were to take off all their clothes and beg naked. This might be cruel, so don't do it, but that's the general idea.

What never appears on the front page of any major newspaper but should?

All the most important stories, which conflict with advertisers desires for a place they are willing to advertize in. See "project censored" for details. Noam Chomsky described the mechanism of censorship in free privately-owned media in "Manufacturing Consent". It is only mitigated in a widely distributed uncensored network, which is provided by online information sources.

Which is the widely accepted and the most believable theory behind the Bermuda Triangle?

A statistical glitch in the 1940s, it wasn't ever statistically significant.

If an orbital of a molecule has two electrons in the same orbital then won't the two electrons transversing the orbital collide with each other? Are these two electrons transversing the nucleus in opposite spins?

Electrons don't "collide", matter does not take up space, this is Aristotle, not modern physics. Electrons interact by forces and exclude by statistics, that's all. The two electrons, aside from their repulsion, are completely transparent to each other, so long as they have opposite spin. They can sit in pairs in each orbit. There is no collision of particles, this is a classical picture, collision is a macroscopic property which doesn't happen in quantum mechanics (although there is an analog in four-particle point interactions, as in the Higgs field, for electrons, the repulsions are due to photon exchange only, not to contact forces). The Pauli exclusion principle, in addition to electronic and nuclear electrostatic repulsion (which is less significant) is why matter is hard. When you bring atoms together, the nuclei repel when the electron clouds overlap,this is why nuclei are distinct, and the Pauli exclusion principle prevents the electrons from collapsing to a dense core. For matter made out of pure bosons, with no Fermionic constituents, it would collapse into an extremely dense state quickly. This was understood by Dyson and collaborators in the 1960s.

Opinions: Which views of yours seems obvious to you but not to most people?

All views seem obvious once the arguments are internalized, and the evidence is overwhelming. For ones where this is in disagreement with majority opinion, for me: 1. 9/11 truth: the 9/11 attack was staged by one government official, or a small group. The physical evidence is overwhelming, so it is obvious. Most truthers believe in a huge conspiracy, and most of the public rejects the huge conspiracy and believes the cockamamie government story. I believe in a teeny-tiny one-person (or two person, or three person) conspiracy, so I think I understand where both positions are obviously coming from, and how the real deal went. 2. Cold fusion is real: the tritium was detected in many independent labs, and is a smoking gun. I explained how it happens on Stackexchange, and once the nuclear fragmentation predictions were in accordance with Iwamura's data (and the other trace transmutation data), it became obvious to me that it was right. 3. Marlovian authorship: the stylometries compiled by Farey and others are completely persuasive, in conjunction with "The Shakespeare Guide to Italy" and just reading Marlowe for myself and verifying that it's the same guy (it's easy, it's obvious once you knw). 4 Abiogenic petroleum/coal: The evidence here is summarized in Gold's book. The most important thing is the elemental contamination which points to mantle origins, the helium, the radioactive elements. The chemistry is what got me to this, there is no way to convert life to oil, but it can be done in mantle as has been reproduced in pressure anvils. 5. String theory is correct: This is a difficult to explain position, because it is something most physicists believe, but the general public can't be persuaded because it requires a crapload of intricate arguments (much more intricate than the other ones) to explain why, and you need to believe first that quantum mechanics is correct and General Relativity is correct, something the public hasn't caught up on. 6. The origin of life is through Von-Neumann/Wolfram/Conway automaton: Chemistry can produce these types of systems, and they spontaneously and naturally evolve, in the sense of Darwin, right from the start. 7. Mattick's RNA networks are the bulk computation in modern eukaryotes: this is obvious just from the information capacity of the thing. Other things which I am uncertain on (the above have enough evidence to be completely obvious, the ones below are not): 1. Free market capitalism and equality as in socialism are compatible: this is because of the predictions of idealized free market models. It has never been seen in the real world, but from the pattern of Soviet wages (which were competitive) and Yugoslavian entrepreneurship (which was competitive with the west without gross inequality), I am convinced that it is possible to reconcile capitalism and socialism to maintain the best features of both models simultaneously, without onerous government oversight. 2. Quantum mechanics MIGHT BE wrong: as 't Hooft has written, we don't know for sure quantum mechanics is correct on highly entangled states, like quantum computers. 3. Black holes emit nonthermally: the classical solutions for rotating/charged black holes emit matter that falls in after only a little bit of singeing on the Cauchy horizon, so this should work quantum mechanically. But it requires a gluing which hasn't been thought up. 4. The brain is linked RNA computation: this is more speculative, because the mechanism of linking up the Mattick networks of different cells. This looks more certain now, after Mattick's 2010 review of long noncoding RNA in the brain, but it is not obvious yet, unlike point 7 above. There are more, these are the ones that are on my brain most days, because they are constantly challenged on quora, and are easy to propagandize.

What methods can be used to spread sincerity and confidence between users and site-owners in a Q&A site, so that users like to spend more

time on the site?

Avoid censorship, and require honest discussion. It is very difficult to make an honest discussion, as it requires people to examine their own position critically at all times, and discuss evidence only. Most of the time, they would rather discuss which authoritative sources agree with them. So an informal, unenforced, rule, of "no references", helps. If you have a reference, briefly state the content of the arguments, and point to the reference, but don't use the authority of the reference to prop up your argument, as this is worthless. 90% of the fruitless discussions consist of people quoting authoritative longwinded sources to say something which is better summarized in a short sentence. If you avoid authority quoting, you remove this noise, and focus only on the content of the arguments. You can link the source, of course, to make sure you aren't plagiarizing, and also to give a longer text in case the summary is insufficient. I think this works well to get the discussion focused and non-redundant, so that people quickly either agree, or come to an impasse. At the moment they come to an impasse, other readers can evaluate the arguments, and vote when they think they understand fully, and this usually works. In cases where it doesn't, repeat, repeat, until it does. It doesn't take long, this is how deliberations were done internally in the field of theoretical physics, with great success.

If time slows down, will the clocks slow down too?

"Time slows down" means the same thing as "clocks slow down", that's the positivist definition of "time slows down". There aren't two separate notions of time, philosophical time, and clock time, there is only one notion. This is a nonsense question in positivism.

Generally speaking, who is more likely to be innovative, a student or a working class individual?

It depends on the innovation. In a scholarly field, you need access to the literature, so a student. For a new invention regarding how to fix plumbing, your best bet is to look to a plumber. For an idea for how to rewire networks, look to a network technician. People have various sets of expertise due to experience. But one place where it is unlikely to come from is from a high level manager, since the day-to-day experience in this case is shuffling papers. Here you will find ideas for how to shuffle papers better, and this might be useful, but there's a limit to how useful paper-shuffling can be.

Does electromagnetic waves in a furnace exist as standing wave?

You are adding energy using microwaves, which heats up the system, and the emissions are according to the Planck spectrum at the proper temperature. It's no more mysterious than why your hands get warm when you rub them vigorously, or why you can make a glowing fire by rubbing sticks together-- the rubbing makes heat, and the heat increase the temperature, and the high temperature system emits light.

Do the proton and electron in a hydrogen atom generate magnetic field becasue they moves, and can they be measured?

Yes, this is the magnetic moment of an H-atom, it is generated in roughly equal parts by the spin and orbit of the electron, with a much tiner contribution from the spin of the proton (the magnetic moment of a particle decreases as the mass in order of magnitude). The gross effects of magnetism are either due to electron spins in unfilled inner shells aligning grossly (as in Ferromagnetism), or to weak coordination of motion/spin with an external magnetic field as in diamagnetism/paramagnetism. In molecules, the electrons tend to be paired up in opposite spin/opposite motion pairs, so that there is usually no electron-generated magnetism left (unless you have unpaired inner shell electrons, like in Iron). The Stern-Gerlach experiment on silver atoms used heavy silver atoms with an unpaired outer-shell electron to probe the magnetic moment of a single spinning electron. The beam of silver atoms splits in a magnetic field according to the spin of the electron in the outermost shell. For a free electron beam, you can't disentangle the spin effect from the motion very well, because the splitting due to spin is equal to the splitting due to motion, as discovered by Dirac and Landau. The Stern Gerlach experiment is one of the earliest confirmations of quantum mechanics discrete angular momentum. The magnetism of electrons is studied intensely in condensed matter physics, and most books on Solid-State physics go over this in detail. The very weak magnetism of nuclei can be detected too using SQUIDs, and this is the basis of NMR.

How does intelligence affect protein turnover rates in the brain?

Nobody knows, it is premature to even ask. We don't know the most basic things about the brain's functioning.

Genealogy: How do I know if there are any descendants of biblical David in modern times?

It is not clear that there was an actual Biblical David, or if he is just a folk-legend, like King Arthur. If you can figure out how to find King Arthur's descendents in modern times, tell me.

What are the benefits of loving and respecting people?

Loving people is good, as it creates communal and family bonds. Respecting people is fine, if you are respecting their experience and status as fellow humans. But respecting their stupid ideas is not healthy, you need to combat these when they are wrong. There is a difference between respecting people and not refuting the bullshit nonsense they say.

What fundamental skills are often not taught in school?

Disrespect for authority. This is only taught in schools in an unintentional way, when a teacher says something stupid. But unfortunately, instead of learning the correct lesson, the students often learn the stupid thing as if it were true, and get stuck when later data starts to conflict with the accumulated wrong cruft.

How do you know if you are a deep thinker?

If you have an original idea! Originality is the only hard thing. You will be called a "deep thinker" when you repeat unoriginal ideas, whether you rediscovered them for yourself, or whether you heard them somewhere. You will be called a "complete moron" when you have original ideas, whether they are correct or not. You are a "deep thinker" when they call you a "complete moron" at first, and later, when they get used to the idea, they call you a "deep thinker". That means your original idea was correct. It takes time to make original ideas, it is nontrivial effort.

Should the news channels/agencies of India be banned to take fund from a political organization in any form - Be it ads or be it direct donation?

How would you advertise politically then? Best to leave it free, it will soon die through the internet takeover anyway.

How does a cache memory differ from registers?

Cache memory is similar to RISC registers, but it requires two clocks to do an operation cach-cache (a third clock to save the result back in cache) and only 1 clock to do cache-register or register-register (plus one more clock to save back to cache). But usually it takes a lot of clocks to load new pages into cache, so you want to make that happen less often.

Visible light has higher frequency and therefore more energy than infrared waves, which corresponds to heat. So when light falls on us, why don't we feel anything?

It takes steps to convert a high-energy photon into heat, it needs to be absorbed, and jiggle the molecules, and the jiggling is at a lower energy scale. Infrared light is efficient at jiggling molecules, because it is absorbed directly as molecular motion Visible light is absorbed in the electronic configuration, and remitted as visible light, leaving the molecular motion unchanged. For a more extreme example, you don't feel anything in an x-ray machine either, the x-rays ionize atoms, they don't jiggle them. They are much higher energy than visible light. The rule is: infrared light jiggles atoms, light just bounces off, x-rays go through (and occasionally ionize).

How can one believe in science and religion at the same time?

Religion isn't supernatural, it's superrational. There is no conflict with science, except when religious texts make physical claims about supernatural events. If you don't take these claims seriously, the two are not exclusive. The main point of superrational decision making is explained on Wikipedia. To extend it to the asymmetric case, you need to postulate a universal strategy for all games which is self-consistent. This is equivalent to an all-knowing agent, who isn't even playing the game, telling you what to do, and you do it. This makes no claims on "existence" (that's meaningless in logical positivism) nor does it claim anything about anything supernatural.

How can a quiet, boring person change into someone who is witty and lively?

I made the change by inventing long bullshit stories at coffee shops. Other people would give short bullshit, someting like this: "You know, I heard this guy ate seeds, and then the seed would sprout in his stomach, it was totally bad for him." So I would say "Oh, that's nothing, there was a fellow who was busted for owning a marijuana farm, and he didn't want to get caught. he had a special system, he pressed the button, and whoosh, the whole farm was covered with a cloth, doors were hidden, the cops didn't find it, they didn't even know it was there. But he had a package of seeds in his pocket that day, when the police barged in. So he opens the seeds, and swallows them. Just like that. He burned the package with his lighter, he was clean. But he throws the burning package into his trashcan, the whole thing catches fire, it's a big thing, he's in a shared building, it damages the neighbor's kitchen, so he's put in jail for two weeks. He can't bail himself out, because he has no cash on hand. Two weeks later, when he's supposed to stand trial, there is a quick inspection to make sure he isn't hiding anything, you know with a white glove. At the physical examination, the doctor notices there's a marijuana plant growing out of his ass! He gets busted for possession." I just made this up wholecloth, of course, it was obvious to anyone listening, but storytelling is an art-form, and one should learn to do it. It's the art of bullshitting, and it helps.

Why should I provide my knowledge to Quora for free?

So as to quickly change society. Online, information dissemination is a weapon, and it can turn the world upside-down quickly.

Why is Wall Street considered to be so powerful?

Fewer people with more profits, and the industry is much more monopolistic, it has no ability to get controlled by competition, so you get insane profits. Silicon Valley has competition, and the profits are nowhere near as monopolistic.

How do racial/ ethnic minorities feel about Americans always racialising them?

Because folks in the US knows that not talking about race is most often a coded way of allowing bigotry to operate without exposure to criticism. Why the heck should people not talk about race? If you wore a big hat, people would talk about it. If you had purple eyes, same thing. So why not your features and your ancestry? The main historical reason to avoid it is when you think there is some defect in those of a certain ancestry, if it is somehow a mark of shame to have these ancestors and not those ancestors. Americans don't think this, so they talk about race. I think they have the right idea.

What do you think about the "Atheist Century"?

It will never happen, because the religious people are right. The atheists need to understand that God is not about superstition, and that all those people are not deluded, although they are phrasing things in a maximally obtuse manner.

Is Stephen Hawking's paper, "Information Preservation and Weather Forecasting for Black Holes" a viable solution to the black hole firewall problem?

The paper explains some well known things, things which make it impossible to take firewalls seriously, but they were well known before. They are not new insights, they are contained in earlier papers by Hawking and others. There is no reasonable way in the semiclassical theory to make sense of firewalls, and they should not happen in the quantum theory either, but Polchinski and co already knew this. They were making a case based on the correlations in the emitted radiation, they were trying to understand a paradox. I have explained elsewhere where I think Polchinski's problem is, it's in assuming that the black hole geometry can be given, and at the same time the outgoing state given a definite pure state description. Susskind makes the same mistake, it's in the entire Page time analysis literature. It's something I noticed in the 90s, offhandedly, but didn't consider a big deal, because it never caused problems, and the arguments didn't depend on this error. Now they do. A black hole spacetime is described by a density matrix intrinsically. You can't define it independent of the stuff that's being emitted and absorbed, the black hole only has a well defined geometry classically when the stuff being emitted and absorbed is not coherent enough to do Polchinski's experiment. Whenever you make a stable state analysis, an S-matrix analysis, Polchinski's argument falls apart. I explained it in another answer, I don't remember the question though. While Hawking gets the unitarity arguments in the literature now, these are old, they are from the late 90s. But the argument Hawking makes in this new paper is against making any interior at all. This superficially looks like a consistent picture, because it is very hard to make a picture of the interior of a black hole, nothing comes out of there, and it is hard to define what's inside using only exterior observations. But Hawking's argument against the interior is simply repeating the standard picture from the mid 90s, in obtuse inflammatory language. People then knew that the interior needs to be reconstructed from the exterior, and that it requires weirdness. Susskind worked out a set of qualitative ideas for doing so, called "black hole complementarity". The idea here is that the infalling observer sees a spacetime to the future of the horizon, while an outgoing observer (if one happens to be emitted in Hawking radiation--- extremely improbable) sees a past in another region of the maximally extended solution, and BOTH regions are described by the same exterior quantum degrees of freedom, by asymptotic states that make the black hole, except in a different basis, like a unitary rotation, so it's real complementarity, like what Bohr said. The interior should be measurable by an observer falling into a black hole, and it should be reconstructible from an exterior description, the same way the near-black-hole exterior is reconstructed, holographically, from the oscillations of the surface. But nobody knows how to do that. But there is what I think is a MASSIVE clue in the classical solution for Reisser Nordstrom (charged) black holes and Kerr (rotating) black holes. The charged/rotating case has a timelike singularity, and a Cauchy horizon, and things that fall in are reemitted in what looks classically like another universe, connected only through the black hole. This is inconsistent with quantum unitarity. You can fix this by pasting all the universes together into one, so that the reemission is into this universe. I am pretty sure this is the correct solution, but the pasting cannot be determined classically, it requires a full tracing of the infalling matter in string theory. This is extremely difficult, it is just out of reach today, so we can't actually say what happens in the interior. With the proper picture, if what I am saying is right, you could photograph the interior by charging up the black hole, throwing in a shielded camera, and waiting for it to come out. Such pastings naively allow closed time-like curves, but a quick analysis shows that they aren't really there, they only close at unphysically close distances to the black hole horizon, (when the reemission is later than the absorption). To sort out the gluing, though, that I never succeeded in doing. But the "no interior" thing is then completely busted, because you need the interior to deal with the nonthermal emissions for objects thrown into a charged or rotating hole. The no-interior business was proposed umpteen times in the 2000s as a way of sidestepping complementarity. It's a lazy solution, because the classical theory has enough clues in it to say that there should be an extension to an interior, because an object thrown in does not instantly thermalize at the horizon, the equivalence principle holds at the horizon (and all the other things Hawking says in his paper). The quantum theory reproduces the classical theory, so it should reproduce this. The only reason the firewalls come up is bad thinking about the spacetime and the asymptotic states, not realizing they are grossly entangled when the space time is classical. There is no reason to excize the interior. But it does require nontrivial work to reconstruct the black hole interior, and this has not been done (I try sometimes). This is what the firewall paradox is asking for, not well known old arguments that say "it's impossible", because we already knew that, so did Polchinski.

If energy cannot be created or destroyed, what happens to our mental, emotional, or "soul" energy when we die?

Soul isn't "energy", it's computation, and computations can continue in different computers, or not. It depends how linked in you are to the other humans.

What were your grades and how good were you in your co-curricular activities when you applied to Harvard?

No extracurriculars, good grades (but not valedictorian), I had a good letter of recommendation from Lee Smolin, which probably helped, because he was at the peak of his career just then.

What causes a particle to have a charge?

This is a nonsense question in logical positivism. It has a charge, or not, there is no why. In Kaluza Klein theory, where charge is reducible to other concepts, this question has an answer--- because it is moving along the extra dimension. For intrinsic gauge theories, there is no answer.

Can spacetime be ripped?

It is not clear. Spacetime is not a "fabric", like a cloth, sitting in another thing, it's normally a differential manifold, which means, by definition, no "rips" or gaps. But within quantum gravity, this is an interesting question. There are known exceptions to the manifold rule, orbifolds. Orbifolds are consistent projections of string theory which identify manifolds after a discrete symmetry. The result has a special kind of singular point, which is the orbifold point. These objects are for sure consistent, they are a new kind of matter discovered by Lance Dixon. Orbifolds are similar to rips only in that they are non-manifold points. They have very weird dynamics, they do not shake properly given what we know. The orbifolds of certain type, like Horava Witten orbifolds, just form walls at the edge of the universe, and these are the closes to rips, although it's not like you can see the other side. Another kind of rip is a sudden topological change, which is not discontinuous, but looks like a rip to an observer at long distances. The classic example here is Witten's "bubble of nothing" instanton, which will convert a Kaluza Klein circle into nothing, as a great big void grows outward at the speed of light. This is the closest thing to a ripping spacetime in physics. The topological changes in string theory through instantons that convert from one vacuum to another resemble this process, and would also look like rips. Another type of rip is the "big rip", ths is a rip in name only, the manifold stays continuous throughout. The problem with traditional idea of "rip" is that the concept in fabric depends on an embedding inside a larger space. Space-time is not sitting in a larger space, so you need to define the thing intrinsically. The Horava-Witten edge-of-space orbifolds are an example of a boundary defined intrinsically.

What would it be like to have no friction on earth?

This violates the second law, as macroscopic motion needs to turn into lower scale motion. A world at absolute zero, with a liquid He sea, would sort of work (there is still friction with the trace vortex rings floating around), or in a good vacuum, but there is no way to really do it, as friction only vanishes when nothing happens, i.e. a vacuum, by basic thermodynamic principles.

Like two sides of a scale does international inequality have to exist in order for privileged groups to prosper?

They are completely unrelated. Priviledged groups own monoplistic businesses, or manage huge amounts of capital. They can function in a society which is largely equal, if you exclude these folks, like in the US. The inequality of wealth of nations is due to differing levels of industrialization and local expertise, and where the natural resources are, and who controls their export. But the mechanisms that create wealthy nations, the hoarding of expertise and brain-drain away from poorer nations, is similar to the mechanisms by which inequalities between individuals are maintained. Both might not work in the absence of coercive power, a monopoly on something for the individual, a monopoly on expertise for the nation.

How long does it take a charged black hole to discharge through Hawking radiation?

The black hole has to get to the approximate size of the Compton wavelength of the electron before it has appreciable probability to emit electron/positrons, which are the lightest charged particles. At this point, it will quickly discharge any net charge in unbalanced electron/positron emissions, leaving behind only fluctuating charge to cancel the charge of the random crap it Hawking radiates.

Do you think Einstein was right when he said "A person who has not made his great contribution to science before the age of thirty will never do so"?

Probably yes. First, to clarify, he isn't saying "A scientist makes their best contributions before 30", Einstein developed GR when he was 35, this was his best work. His contributions to quantum mechanics, the work of the 1920s, was done in his 40s, and it was as good as the 1905 stuff, done in his 20s. The work he did in his 50s, the EPR paper, wormholes, that was also great. Even some of the work he did in his 60s was important. What Einstein is saying is that if you want to make a contribution to science, you have to start making contributions early. It's a race against time, because after a certain point, your responsibilities will make study difficult, and you will have to make decisions which conflict with scientific honesty to keep your job and support your family. So you had better learn how to do it early, and the only way to learn is to do SOMETHING. Not something Earth shattering necessarily, just something. Einstein's earliest scientific contributions came at age 26, in 1905, this is typical. Heisenberg started younger, he was doing revolutionary work by age 22. Dirac, at 24. But all scientists start doing stuff in their 20s. Feynman's path integral work came at around age 28. For current people, Witten did stuff in his 20s, nonabelian Bosonization, the eta' mass with Veneziano, lots of stuff. Susskind did his string paper in his 20s, so did Veneziano. The great Dutch physicist 't Hooft cleaned everyone's clock in the 1970s, he was in his 20s. But some people start later. Kenneth Wilson made his major contribution in his 30s, maybe he was even 40. Mandelbrot's great work came in his 50s. But both of them did minor things in their 20s, to get to know how the process works. Personally, I felt dejected when I was 26, because, looking back, I hadn't discovered anything of value, some things, sure, but nothing too important. Then I discovered something (I called it the "Charge mass inequality", it's a variant of what is now called "The Weakest Force Principle"), and I knew it was excellent, and I knew it was mine (nowadays it's Motl's and Vafas, they published, I didn't). So I stuck with it. Making a discovery at a relatively young age is pretty much the only thing that gives one the motivation to persevere when things get hard (and they will). I had told myself if I don't discover something by age 30, to pack it up and do something else. That didn't happen, so I stuck to it, and did what I consider my own best stuff to date in my 30s. I should add the caveat: nobody likes my current work! It's not respected or accepted. But I don't give a crap, because I know science politics. The weakest force principle was also not respected or accepted by anyone I explained it to, not until Motl and Vafa figured it out, so I am used to this. The key is internal evaluation, you know when you do something, because it takes a certain amount of effort, and it resolves a certain problem. Einstein is not saying you are limited to discovering stuff young, but he is saying you better start doing it young. And I think he's right.

As a man, would you feel intimidated by a very beautiful and incredibly smart woman?

It would be exciting, I get crushes on female academics all the time, since a young age. But usually "smart and beautiful" are social constructs, the social smart has little to do with actual analytical thinking, and the social beauty is not correlated with what gets dudes hot when you are intimate.

Why do professional programmers write code that is complicated, difficult, and hard to follow?

This problem is absent in free software, which is rigorously peer reviewed for clarity, and is a model. You can read and debug free software very quickly, I found a stupid compile bug in KDE once (a class was inheriting privately instead of publically), I am a truly mediocre programmer, but it only took about 30 minutes. For professional closed-source programmers, it's lack of peer review, which always leads to obfuscation. Who cares, they are dinosaurs anyway.

What's the coolest/most interesting dream you've ever had?

I was at the top of the physics building at Cornell, in a room which had enormous glass windows. One of the windows shattered, a fellow fell through, everyone scattered, the fire-department came. I went to the basement. I then opened a door in the basement and discovered a tunnel to a dark machine room, which led through a tunnel directly into a dorm room, but also back in time, to 1972. I was then on campus in 1972, surrounded by hippies. I found a couple cooking pasta, who I recognized (the man and woman are unfamiliar to me in real life, but I knew who they were in the dream). I could go back and forth through the tunnel, from the present to the past. I then walked around with the woman, seduced her, we had sex, and I became aware of the fact that I had just conceived myself. I had to choose this one, because of the obvious Oedipal theme, the strange time-travel aspect, and the complete coherence of the dream. it was a long thing, about 45 minutes, maybe more than an hour, with many episodes. The "mother" in the dream was nothing like my actual mother, neither did the father look like my father. The encounters were strange and social, the whole event was very lifelike, but also there was a detachment, like viewing a film. I have various elaborate dreams like this, usually I forget the plot after a while. I am amazed that the plot is so coherent, as when I was younger, the plots of dreams were something out of Alice In Wonderland. Now they are sometimes like half-hour moderately well written films.

Is there any other way for two neurons to synchronise other than by one-way or mutual excitatory synapses?

Nobody knows.

How is empathy measured while working together online?

You don't need empathy online. You need honesty.

What hobbies are easy to learn?

Making rubber-band bracelets with the Rainbow Loom. This is the greatest mathematical toy since the Rubik's cube, perhaps even more intricate.

What is the dumbest thing you have ever seen on the internet?

Nothing dumber than what I see on mainstream media. Nothing dumber than "Gilligan's Island", for example, or the news since 9/11. Even the dude eating poop on goatse.cz was more interesting than those.

Why does iron shows maximum of +6 oxidation state while in the same group ruthenium and osmium shows +8 as maximum oxidation state?

Michael Flynn gave the orbital filling, it just must be that the 4s electrons are split by more energy from the 3d electrons than the 4d and 5s electrons are in the analogous atoms further down, so that the energy gap is sufficient to grab an electron from another atom in the environment.

How do complex numbers appear in physics? What is their physical interpretation? How do they appear in equations of waves?

Complex numbers became central to physics with quantum mechanics, before that, they were a trick for representing pairs of reals, for doing Minkowski geometry while pretending it is Euclidean, or for mathematical convenience in extending the range of solutions to real equations. With quantum mechanics, there is an "i" in Schrodinger's equation! There is a real complex number multiplication algebra in amplitudes. What gives? The way to see what's going on is to artificially make a real-number quantum mechanics. Then the Hamiltonian is symmetric, and generates a rotation, so the eigenvalues come with a zero energy state--- the vacuum, this never changes in time, and lots of higher energy states, but these must come in pairs, so that they can rotate into each other, all except for the zero energy state. Then you can define an operator "i" which swaps the two states with each other, one of them getting a minus sign, and by definition, it commutes with the time evolution. Using this "I", you get usual quantum mechanics. The question is why this "I" has to commute with every observable. The reason is simply that to measure an observable, you need to couple it to the Hamltonian, add it as a perturbation multiplying something else, and in this case it must commute with "I", so anything you can measure commutes with "I". To see that the "I" arises in this way, and is not intrinsic, note that one physical symmetry, reversing the direction of time, anticommutes with "I", and so is implemented as an antiunitary operator in quantum mechanics. So the formalism of quantum mechanics is not intrinsically complex exactly, this is just the nature of systems where all quantum energies are positive, except the vacuum. In supersymmetric systems, the vacuum, when it has exactly zero energy, can be thought of an an unpaired real state.

How does the communist ideology of development operate?

It's just the planners choosing to develop as quickly as possible. It works well at first, because the first planners are usually pretty competent, but the next generation of planners is selected by human politics, which means they are the worst people in the world. For a current example of the broken model, you can look at the Wikipedia idiology of accuracy.

If gravity were to fail only for me, taking into account the path/trajectory of the Earth - what would my path/speed be?

You would feel a very mild upward lift, like a Helium balloon, like the minion in "Despicable me", you would float out into space eventually but if you held on, or walked on the ceiling with long hops, like walking on the moon, you would be fine. The only thing you would feel is a centrifugal repulsion due to the Earth's rotation, depending on your altitude, but about 1% of normal gravity, lifting you up.

How do I find meaning?

Link your brain up to God somehow. It's sort of like an ethernet, but weird.

What are some lesser known book series (old and new), you've enjoyed, such as Rex Stout's Nero Wolfe books, The Archie McNally series by Lawrence Sanders, and The Deadly Sin series by Lawrence Sanders?

John Christopher, "The White Mountains/The City of Gold and Lead/The Pool of Fire" was my favorite trilogy as a child. There is a mostly faithful BBC television adapatation called "The Tripods", and the basic alien idea is from "War of the Worlds". But it creates a very strange anachronistic atmosphere of a mideval society, with relics of 1960s technology lying around everywhere, so you know something terrible happened. Today, the Asimov Foundation trilogy seems more creative, but John Christopher was writing for younger children. I read the Israeli series "Chasamba" (roughly translated it is an acronym for "Completely totally secret society") as a 5-6 year old, I hardly remember any of it. At the time I was blind to the jingoistic and racist aspects at that age (the cartoonish arab villains, the heroic militaristic teenage boys--- the fat boy becomes a muscleman, the leader boy and the leader girl get together), and I would probably hate it today. I do remember it was made into a not-at-all faithful Israeli adaptation in the mid 70s, which I watched on videotape in the mid 80s, and was disappointed. I am sure I would be horrified to read it today, but I liked it at age 6.

Why hasn't anyone created a drug that eliminates your need for sleep?

Amphetamines eliminate your desire for sleep, but after a few days, you go crazy, and long term use in moderate dosages leads to brain damage. Nobody knows why people sleep, nobody knows the first thing about brain operations. Since I think the answer to all mysteries in biology is "RNA", the answer here is that sleep is used to organize neuronal RNA, and shuttle it to glia, or something like this. This will make it impossible. At best, you can have one hemisphere sleep, and the other active, and then switch sides, like a dolphin.

How hard was it for you to tell your parents for the first time that you got drunk without telling them?

I was 19, I drank a quarter bottle of mescal, and then solved some equations to see if I could do it. The world was spinning, but I still could think, but slowly, slowly. That made me think drugs are harmless, an opinion that changed when I first got stoned, and realized I really couldn't think, slow or not slow. I told my parents the next morning, they didn't care.

What are good ways to remember dreams?

There are lucid dreaming manuals online, and "astral projection" (lucid dreaming from waking state) is a common meditative technique anyone can learn.

We romanticize the big IT startups a lot nowadays, but are they really the most profitable kind of startup? What businesses are the ones really making a profit?

They are monopolistic monstrosities that need to be destroyed. Do a small business, which has competitors, or don't do anything. The huge monsters wreck the tech economy, all of them.

"A complete unified theory [of everything], if it can exist would also presumably determine our actions, and so the theory itself would

determine the outcome of our search for it!" Is this paradox considered a hindrance by physicists?

This is nonsense. A unified theory does not determine everything, for example, if quantum, or if it involves classical branching universes. Even if you think it does determine everything, it determines it from some initial data, which presumably includes random stuff. The end result being determined in advance is of absolutely no importance, when the information comes into the system, at the beginning, or throughout time, is of no significance. Finding a theory of everything does not determine the future anymore than figuring out the computer's instruction set determines the way your Windows will behave. It's a nonsense argument. The proper argument is against a theory of infinite complexity limits, i.e. against a finite description of God, or mathematical truth, and here it is just Godel's theorem. This has nothing to do with physics.

Did Ron Maimon ever study Talmud?

I never studied any Jewish theology, no Talmud. I read some Bible in school as required in Israel, I translated Genesis/Exodus/Leviticus/Lamentations/Ecclesiastes to English a few years ago, but I did no theology. I made a completely secular translation. Talmud study is just like philosophy, a genteel debating club where you aren't allowed to challenge the rules. It is counterproductive to honest debate, because you get all these nitpicky debates on fine points of law, without debating the fact that Leviticus says that the daughter of a priest who becomes a prostitute should be burned to death, along with Dustin Hoffman's character in the graduate (a man who sleeps with a woman and her mother both). This is dishonest intellectually, and I don't see the point. I would be kicked out of any Talmud debate club in about 7 minutes for apostasy.

How can we change the way people look at school shootings and terrorism?

First you need to make sure you know everything there is to know about such events. To happen, the kids need access to firearms and be extremely psychotic. I think the best bet is to ignore these events, they can be easily propagandized to turn schools into police states for young people, and take away the public's access to firearms. Both those things should be the LAST things on your mind, given the government abuses of the last decade. Instead focus on making sure the society at large is honest and open, and gives everyone access to psychologically stimulating paths of development, so there is no isolation psychosis. There is no way to produce such a crime in a normal society, it has really never happened outside the US, kids are not normally this psychotic, and there is suspicious activity regarding the events in the US that make one consider they may not have happened the way they were reported. So ignore them for now. Don't make policy based upon them. Drunk driving kills more teens, cancer kills more teens. Focus on those. Simply look the other way, give condolences to the family, but say "we have bigger problems now", at least until the bigger issues of media honesty is completely addressed first, so that you know the whole story. Then if any shootings occur, if the number is greater than zero shootings per decade (which I think it i will not be), then you can look to doing something about it, most easily, a child-proof lock-code on firearms.

Hello Quorans! How are you doing today?

Sleepy, it's 2AM.

What would happen to someone if he held the majority opinion on all topics?

He would believe all the individual government stated facts about 9/11, and at the same time believe that the government is lying about at least one of these. He would believe the axiom of choice is true, and also that there is such a thing as an equilibrated configuration of the Ising model on Z_2. He would believe that investing in the stock market is a good idea, but he would be unable to pick any stock to invest in, because all would seem to be perfectly valued.

Which actions would you suggest to the Ukrainian people in the current national crisis?

Lenin found that it was sufficient to get the guards at the main government building on his side, there are always only 100-500 people who stand in the way of a change of government, the people guarding the doors. They are not well paid or powerful, and their sympathies are not always with the current regime.

Can differential calculus be performed on rational numbers only?

It can be formally done even on the integers, this is useful for checking if a polynomial with integer coefficients has a multiple root at some integer position, since the formal derivative is still zero at a double root. The main problem with doing calculus for real over a rational domain is that the simplest differential equations, like f'=f have solutions which are non-rational at all rational values, so the theory will be realistically limited to rational functions only, polynomials divided by polynomials, and then it would be the theory of formal derivatives of these types of expressions. This is useful, but only in the sense of the example above where formal derivatives are useful for finding multiple roots. It would be a formal operation in abstract algebra, not a theory of real analysis.

How does one run a "for loop" in parallel (i.e. allow multiple iterations of the same loop to be executed simultaneously) in C++?

C isn't built to do this naturally, but you can do it in Linux by dividing the loop into two parts, which you run on two threads, the thread division is lightweight compared to any other operating system, and you can get scheduled to two different processors if you have cores available. You or a zeroed flag with 1 when one loop is done, and or with 2 when the other is done. The main thread waits for the flag to contain 3, the other thread terminates. There's still some overhead for the thread setup, so you need to make sure your loop is big enough to justify splitting off the two threads.

What's the best type of music to listen to while reading Ron Maimon's responses?

Wacky hip-hop, something like this:

Can a planet orbit a star elliptically, with the star at the center and not the focus?

No. The only orbits in 1/r^2 central force field is an ellipse with the sun at the focus. If you want orbits with the sun at the direct center, look at the spring force law--- restoring force proportional to distance.

Why do we get such high-quality and thorough responses on Quora vs other forums?

It has a reasonable moderator system which is NOT a democracy, so that people are secure that their contributions will be respected and preserved, and not deleted willy-nilly as they are on other sites. This allows it to build a good faith community, free of the social-games aspect of sites like Wikipedia, where getting elected moderator is sort of like winning a prize, and then you retaliate against your opponents. Quora has no elected moderatorship, and it does all the clean-ups internally, via a dictatorial system that is intentionally obscure and minimalist.

How does one become a scientist?

Do science! I didn't consider myself a scientist until I discovered something new. Now that I haven't discovered anything new in long enough, I feel I am no longer a scientist, but a public relations bullshit artist.

After all the monstrous atrocities of Japan to Chinese during World War 2, is it ridiculous it is today cowering behind USA to protect it from the "China bully"?

World War II was a long time ago, and Japan was changed completely postwar. It is not no more of a threat to China than Belgium is. On the other hand, it has not properly owned up to its wartime atrocities, so there is this issue, but this can be fixed with internet propaganda, it does not require nationalist sentiments to make trouble between the nations. You can explain the extent and horrors of Japanese aggression online, and no one can stop you. It is common knowledge everywhere except in Japan. Now China has a military, and Japan is militarily weak, so it possibly needs the US for protection. China is a major power, with a much stronger military and a larger economy.

Are there any permanent side effects to long-term antidepressant use?

They are harsh medications, and they interfere with scientists ability to do mental work for sure. A graduate student who was manic depressive was obliged to drop out of the program once her drug regiment started, and I don't know any working matheamticians or mathematical scientists who stay functional on these drugs. Just because they are legal and prescribed, does not mean they are cognitively benign. I remember one nice girl, an undergraduate, who said she was on antidepressants, and then held up her hand, and said "watch this". She then rotated her hand around the axis of her forearm, and the hand went clack clack clack rotating at an uneven rate, pausing at regular intervals about a tenth of a second apart, so it looked like she was the 6 million dollar man showing off his powers in the old TV show. You could see her brain's motor circuits' timing was unsynchronized, in the sensory cortex, this is like the trailers people see on LSD. That's the kind of things people are doing to their kids. They cause weird side effects, they are not benign, and you should stop as soon as you can if they are not absolutely necessary. See your psychiatrist, but remember they have an incentive to keep you medicated, You can force them to reduce your dosage, and get to zero, as soon as you can. If this leads to serious depression, I would pick up coffee or vaping before taking seratonin uptake inhibitors, because caffeine and nicotine are far milder drugs. When people were smoking, they had world wars, communism, the great depression, but they didn't have the levels of mental depression you see in the modern US.

How can a person leave a mark in the world?

The only way is to do something original. You have to figure out what original thing is needed. If you want it to last, it also has to be something original that is a step forward, but about half of things that are truly original are moving forward, and the rest are important too, because they are roadblocks that nobody saw before.

What can a twenty-something female, co-founder of a startup, do to keep being challenged through life?

Have three children.

I am taking a semester off. What would be an effective use of this time?

To get familiar with proofs, it is useful to learn formal systems and proofs from a good book. I found Cohen's book the best, "Set Theory and the Continuum Hypothesis", but I was super-familiar with informal proofs by the time I read it, and had some computer experience. A less stressful introduction to formal systems might be older works, which work with Hilbert deduction. Once you know what a formal system looks like, you should also know set theory. Cohen is good for this too, but a standard set theory book might be better. These are best used after mastering some proofs, like the ones in Khinchin's book "Pearls of Arithmetic" (or something like this) or Davenport's number theory. Once you have set theory understood, you can go through topology, and stuff like this and make peace with choice. Then you can read the mathematics literature. It is extremely important to make peace with choice, I found Godel's L model was essential for this. Computer experience is also essential, and this can't be picked up well in school, so it's a good thing to learn. Just install Linux and learn to program in a few languages, some random set including C.

Why hasn't Hollywood made biographic movies about people that made great contributions to science, like Einstein or Marie Curie?

Because they are from Europe! Hollywood is in the US. It made a movie about Feynman, and in Europe, they sometimes have Einstein films. Hollywood is very America-centric, and that's not a fault, it is natural, it is a part of the US. Hollywood did make a movie in the 90s with an old Einstein giving advice to someone, I forgot the title (IQ, thanks!) This is old Einstein, the Einstein in the US, so it makes sense for Hollywood. For a better film, look to EInstein and Eddington, which is British, and so naturally oversells Eddington's contribution.

If the limit points of (-2)^n in the extended reals are + and - infinity, can we take the "absolute value" of that set and get +infinity?

It depends on an abstract notion: the topology you choose for the point or points at infinity in your favorite version of R. If you are working on the complex Riemann sphere, complex numbers with a single point at infinity, you are allowed to say it approaches infinity, as infinity is a single point. The same on a one-point compactification of the real numbers (the equator of the Riemann sphere). But in normal notions of topology on R, you have two infinities, positiive and negative, and they are distinct, so the limit does not exist. This doesn't have a unique answer, as it depends on how you define the topology of points at infinity. The absolute value in the question is unimportant--- you are taking the limit abstractly, and it can be done when infinity is one point not two. Taking the absolute value at the end is superflous, there is only one infinity in the picture where the limit makes sense.

How can I apply bayes theorem to my everyday life?

It's how you evaluate evidence objectively. You start with a probability for an occurence, and then as you gain evidence, you adjust the confidence in this statement using the probabiity for this evidence given this statement being true, and given the statement being false. In day-to-day life, our observations are usually in the infinite data limit, we are used to situations where we have an oberabundance of data. For example, there is definitely a solved Rubik's cube on my desk, because I see it. But if I were to examine this article of faith more closely, I would say that it was really a Baysian statement--- I am gaining evidence for this stupid cube the longer it is in my field of vision. If you were to observe with only a few photons, you would have to make a conjecture, and then as you got more photons, increase or decrease the confidence in your guess, until you were past a threshhold for confidence. The situation in most nontrivial situations, like 9/11 truth, or Marlovian authorship, is that we have a few photons, not a complete picture. So the art of Baysian analysis is to put together a consistent picture from as few pieces as possible, and use the remaining pieces to adjust your confidence in the statement, so that if you are a truther, and you find a highly improbable event (say a drill coinciding with the attack, and another, and another), which is not improbable in the new view, you adjust your probabilities about what is true accordingly.

What resources does Ron Maimon recommend for learning nuclear physics?

I can't recommend, I learned in the worst possible way, by reading tables of cross-sections for deuterium fusion, and alpha-nucleus scattering, and following references in papers that were mostly cross-section tables. It was a side-effect of having an idea for the cold fusion, I needed to understand nuclear processes better than the hokey stuff. So I read the literature at random. That works, but that works for anything, it's not a systematic path. The standard reference for many decades was "Bethe's Bible", a 1932 (~) article by Hans Bethe in some review journal. That's a little obsolete, but nuclei didn't change much since then. Skyrme's articles on nuclear physics I read, just because they were in the same books with his later skyrmion stuff, which was important in the 1980s. His nuclear stuff is real classic work. But the self-consistent field mode I only futzed around with a little, the real interesting stuff I haven't read. So I can't recommend. Maybe look at Mayer, someone like this, or the Bohrs. I don't know, I am sorry.

What high school class would be good for learning about computer/tablets enough that it will help me when I'm older with creating apps?

No class. You need a PC with Linux installed, and gcc, and learn to program in Python, then C, then some assembly. Perl and Lisp dialects are also good, as are some side languages like Haskell or OCaml. Once you know programming, the rest is easy.

What is your interpretation of the type of faith that puts trust in a deity?

I think it's 1, the faith in God from my perspective is simply complete trust in the structure unfolding in humanity which is seen as a consequece of the convergence of ethics which is the manifestation of God. So for example, I write in a society which is only 10% MIHOP truthers, at best. Yet I write with confidence that the society is transitioning to 100% MIHOP truthers, because this is true, and with faith, one is confident that the truth will eventually out, through the procedure of superrational people agreeing and going along with the truth. A more traditionally religious person would say the same thing this way: God already knows the truth, and will surely make it manifest in the future. It is difficult to navigate one's way through the countless little decisions in life, and only when you have trust in the unfolding, can you work in ways that superficially seem to go against your self-interest. The paradox is that it is not really against your self-interest, at least not after the transition happens. Once the transition happens, it seems that you were very shrewd to forsee the transition. Of course, you were neither shrewd nor scheming, you just act blindly naively according to what is right, and trust the society to catch up. This is the kind of trust that is the important component of faith. 3 is silly, that's just cultural authority telling you how to think. 2 is important only if you need some metaphysical framework as a crutch for understanding how 1 works. I don't think these things are necessary. Rather, I hope they are not necessary, because I don't have them.

Why are some classical pieces little acknowledged, but remembered forever, whereas popular works fade away on the pages of history?

Works are remembered forever to the extent that they are completely original, and open up new paths. Works become popular when they are derivative, and remind people of paths previously opened up. That's the complete answer. It's the same reason why all the historical politicians you tend to remember were leftists, while all the successful politicians in your immediate environment are right wingers.

Do you think start-ups can help decrease unemployment rates in countries with financial crises?

Of course yes, they are employing people in new tasks. The key thing is to create a friendly atmosphere for local entrepreneurs, and that's the exact opposite of creating a friendly atmosphere for foreign investors. The foreign investments are enormous companies that close off niches, and are always bureaucratic and suboptimal. Local business can be encouraged through tax breaks to small businesses, through subsidized business education, and through some controls of which multinationals are allowed to set up shop inside your borders. The local industry is the most important thing, and should take precedence over simply importing a model from overseas, because the latter method leads to loss of economic diversity.

What childhood (from ages 6-18) decision did your parents make for you that still has an effect on who you turned out to be and shapes your views today? Negative or positive.

My father decided to buy a Sinclair ZX81 in 1982, and an apple II clone in 1983. The Sinclair, I couldn't use, but the Apple II taught me how to think, and made school largely superfluous.

Why do some people question everything while others don't?

Lack of exposure to the internet leads overreliance on authoritative sources. The problem of insufficient questioning should resolve itself in 30 years, since thankfully people are not immortal.

How does blackbody radiation lead to standing electromagnetic waves in a kiln?

It means an equal amount of light is going back and forth, that's all. A standing wave is simply an equal admixture of left and right moving wave. The walls reflect the light, so this is automatic in any cavity, in equilibrium, the cavity has equal amounts of light going back and forth.

Is there really animosity between humanities and natural scientists in the academic world?

There is only animosity with philosophy. The main issue is that philosophy is the only humanities department that has the gall to pretend it is telling physicists how to think. The physicists sorted out how to think in the early 20th century, they developed logical positivism, starting with Mach. The ideas transferred over to philosophy, but the chronic stupidity in the field prevented the ideas from sticking.

Would you take an "Opposite-Drug"? And would it be good for society?

All drugs are a gross kick to the brain, except for some reason caffeine and nicotine (although these also kick, the kick is less gross). So you need to vet any drug with a mathematician tester, to see if it kills their ability to work. If it passes the mathematician test, I might consider taking it, but hardly any drugs do. The only drugs which definitively pass the mathematician test are caffeine, nicotine, and small alternating doses of benzadrine and ritalin (which Erdos took daily).

What are some personal frustrations you've felt while participating in activism?

I was A2A'd, but I honestly haven't participated enough to be frustrated. Usually, I am just afraid of my growing FBI file. There was a bit of frustration at the recent "9/11 Truth" march, whcih was so badly organized only a dozen people came (it started as the "million Muslim march", alienating truthers, then changed to "Million American March Against Fear" alienating Muslims, and also sounding like Colbert). But this had the advantage that I could say hello to Webster Tarpley and a very sweaty but always inspiring Cornel West. I am not frustrated by the slow path of progress toward socialism, as socialism advocates usually are, because I know that the fast path to socialism can be (and usually is) catastrophic, from my mother's and maternal grandparents Eastern block experience. I am happy it is a slow process, which requires deliberation. This seems to be the main frustration, translating ideas into social change. I think that steady fast progress, at least in the US, can come only when the government is not involved, because then people are free to experiment with their own social organization, and there is no coercion, so people are free to do as they like without conservatives complaining. They can join in once everything works, as with Linux. It is possible that one could fork off a new economy from the current one without revolution or government involvement, it's how free software was built, after all. So I am always optimistic, not frustrated. My real frustration is with my own behavior! I am ashamed I dismissed 9/11 truthers throughout the 2000's. I didn't understand that they were right early, and I will always be ashamed of this, and I hope I can make it up with internet propaganda.

How much mass can a black hole gobble up? Is there any limit to it? Where does all that mass go ? What happens to the electromagnetic radiations that it absorbs? How come black holes emit low energy radiations even when light cannot escape from black hole?

No limit in flat space to the size of a black hole, so no real limit in our universe, you could throw everything into one enormous black hole. In deSitter space there is a limit, the Nariai limit, where the black hole horizon and the deSitter horizon switch places, but you can't reach it if the cosmological horizon is too big already, because this would violate the second law. In our universe the cosmological horizon is too big, so you would be able to throw everything into a black hole. All that mass is somehow wrecked by the center. In terms of the exterior, this is the friction on the surface oscillation modes of the black hole leading the oscillations of the surface to ring down to a stable state. The black hole surface, the horizon, behaves like a lossy membrane. This is the "membrane paradigm" for black holes, which is extremely useful for seat-of-the-pants intuition so that you don't have to solve partial differential equations to get an idea what is going on. What happens to the electromagnetic radiation we know, it hits the singularity in any black hole solution. For massive stuff, there is uncertainty about what happens, because we don't know for sure for sure what happens in the rotation/charged case. In this case, the classical solution for massive objects leads to a swing through the middle, and coming out again. How this works in the full theory probably requires string theory to resolve, because classically, it looks like you are coming out in another universe, and this is incompatible with black hole unitarity, known from AdS/CFT. This is a subject of current research, we will know soon, but my money is on "reemitted" in the case of highly rotating or highly charged black holes absorbing massive matter. Regarding the Hawking radiation, there is a thermal cloud around the black hole that you can understand from the equivalence principle. if you accelerate fast in flat space, you see a cloud of thermal particles. If you are near the horizon of a black hole, accelerating away, you can't tell that you aren't in empty space, so locally you see thermal stuff. But for a black hole, matching the thermal cloud near the horizon to infinity means that there is thermal stuff at infinity, so the black hole is in equilibrium with a definite temperature. This derivation is carried out in the pages on "Hawking Radiation" and "Unruh Radiation" on Wikipedia, and it is the fastest way to understand the effect. The result means black holes emit random thermal radiation, but the emission is not coming from the stuff that fell in, at least not in any regular causal way. The past of the Hawking radiation is not classically the same as the future of infalling stuff, and this led to the paradox of information loss, and this is explained only in modern string theory, with the holographic principle. Standard GR sources are good for getting a better handle on this, as are 't Hoofts articles on this from the 1980s (in Nuclear Physics B, he has a bunch, starting around 1985, then again in 1986, 1988, you can find it by flipping through the journal), and Susskind's articles from the early 1990s.

How would Ron Maimon recommend using the internet to learn physics optimally and as quick as possible?

I suggest looking at 't Hooft's page "How to become a good theoretical physicist" and following the links. He has put effort into this, and he is one of the greatest physicists in history. The hurdle is the basics, you might be stuck with text sources for this. Once you get to the 1950s, say you mastered all of Landau and Lifschitz, then you want to read original literature that is not all free and not all scanned. JETP seems to be free, so use this as an entry point--- the Soviet literature is excellent and very dense. Some great Soviet authors are Landau, Lifschitz, Zel'dovich, Pomaranchuk, Gribov, Khalatnikov, Migdal, Polyakov, Zamolodchikov, Knizhnik, that's a big entry point right there. I gave other recommendations in other answers. 't Hooft's book "Under the Spell of the Gauge Principle" is good once you have a basic understanding of the classics, Einstein, Dirac, Feynman, etc. I think then you should go around the literature at random, developing an eclectic taste based on the problems you have an idea for. The American literature becomes annoyingly genteel in the 1990s, but the arxiv papers are good.

Is lim|f(x)|=|limf(x)| lim|f(x)|=|limf(x)| ?

Yes, that's what it means to say that the absolute value function is continuous (the limit on the right has to exist, see comment).

Over the next 6 years, what do you want to see Quora become?

Viciously peer reviewed.

Is the possible to have computers with architecture where a bit is not binary but has more than one state to store data?

The representation doesn't make any difference, it's the same machine with any representation. It just makes the density of memory a little larger, but at a cost of dealing with more than two voltage levels, and so far the trade off isn't worth it.

Do a lot of Americans believe global warming is a hoax if it's cold where they live?

The exact opposite. The further north they are, the more obvious the warming is. The effect is enormous in Alaska, where the tourism industry has been booming since the area is accessible for longer.

Why do some people love Maths so much that they even forget family, friends, and society?

If you did it, you wouldn't ask. The problem needs to get solved, you NEED to know the answer. You had an idea. Only you can solve it, because everyone else will not do it your way, and that means they are stupid and can't do it, so it's all up to you, and how the heck does it work? And is this correct, not sure, check check check, and now I've invested eight weeks and have all this insight which is worthless unless it's done, and it's not going anywhere, how about another simiar problem, etc, etc, It's very addictive. I am only surprised it is as rare as it is.

Comedy: Which are the real life incidents which may be black/dark comedy?

Marx said, "history repeats itself, the first time as tragedy, the second time as farce". For example, the 1962 Cuban Missile crisis was tragedy. The 1983 nuclear war scare was farce. The worst kind of black humor, where the joke is, the world could end because of a misinterpreted war game, or a glitch in a satellite.

Is there any order in which I go about learning the marvels in Number Theory?

historical order, like anything else.

How can I explain to potential romantic partners that I am an internet troll?

I don't think you can. To be an internet troll. you must forgo romantic attachments.

Is the statement about Cosmic rays entering Earth from Mars true?

Hoax, nothing is coming from Mars, cosmic rays come from who-knows-where, probably supernovas, if recent results are accurate, and they are uniform in all directions, because they are scrambled in direction by the galactic magnetic field.

Is it possible that the expansion of the universe is slowly lengthening the electromagnetic frequency spectrum?

The expansion of the universe leads to redshifting of light which travels over cosmological distances, and this is well accepted, and does not require any subtle loop explanations. It's just the same as light going up a gravitational potential gradient, except here, it's light crossing the universe. The redshift of the microwave background is why it is 3 degrees now.

How can I stop bad memories from coming to mind while I'm doing important work?

I hate marijuana, hate it, hate it, hate it. It's debilitating to mathematical thinking. But after a romantic disaster, and a year and some months of complete and total abject depression, a one-time encounter with the drug was enough to put it out of mind permanently. Not advocating, just sayin'.

How does the Alcubierre metric for faster-than-light travel work?

Make up any metric, and you can back-derive a stress-tensor which makes this metric. Now consider any geodesic in space-time. You can make it's length arbitrarily short by just making the metric small along this geodesic, and patch it on to the exterior solution smoothly in some way. If you derive the stress tensor for this, you have an "Alcubierre drive". This is something everyone realizes when first learning GR. The reason this doesn't work is that there are physical conditions on stress-tensors, the energy conditons, that prevent causality violations such as this. These are only violated in quantum mechanics, and the violations preserve a weaker notion of causality, Mandelstam causality, on asymptotic boundaries. The Mandelstam causality is enough to ensure no asymptotic signal can outrun light from one edge of space to another edge of space (thinking of infinity), this forbids any type of Alucbierre drive in any realistic quantum gravity. The drive is forbidden by energy conditions in ordinary GR, but people sometimes say quantum mechanics violates the energy conditions. It does in certain respects, but not in this gross way.

Can an operating system be written in a functional language?

In total theory, it is obviously possible, as all Turing complete languages can do anything any other language can. This is in total theory, it is not at all true. To write an operating system, you need easy access to all the low-level hardware features. You need to be able to write binary data to the graphics card, intercept interrupts in a clean way, deal with low-level disk-i/o, deal with segmentation faults and processor permissions, do memory management, so know the pages of memory allocated, accept binary data from attached USB peripherals, and this type of low-level nonsense is not part of most high level languages. But let's assume that these things were possible, and included in the functional language, and the language was hard-wired into the ROM, so it didn't need need to run on top of another operating system. In real life, as an engineering question, the answer is NO! ABSOLUTELY NOT! The functional languages are all fundamentally interpreted languages with no low-level control on the binary data, and when compiled, they introduce all sorts of crud into data structures. You need something very close to assembly language for operating systems, otherwise the operating system will be intolerably slow. Anyone who tells you otherwise has never engineered an operating system. It is possible to write certain parts in a LISP derived language, this makes sense for routines closer to user-land, but the results are inefficient operating systems. This was tried heavily in the 1980s, with the wave of LISP machines, but they all failed to match the UNIX style C operating systems. The best thing is to write for the processor specifically in assembly language, this is how Linux .01 was written. The code has been updated so that it is 99% C now, but there are still portions which are assembly, which need to be rewritten for each new processor Linux is ported to.

This is not as big a deal as it looks, it is not time consuming to rewrite these handful of routines. Operating systems need to be maximally efficient, which necessitates assembly, or at least C. C was written specifically to allow operating systems design without coding the whole thing in assembly by hand.

Are there, or have there ever been, any competitors of Wikipedia that actually stand a chance against Wikipedia?

No, but for stupid structural reasons. Citizendium decided to moderate using experts and be family friendly. That's the kiss of death. If Citizendium had forked Wikipedia and simply made the politics managable, with internal dispute resoution using home-grown mediation to arrive at truth, it would be preferrable. Scholarpedia, same thing, they have "experts", which is nonsense. Just let people debate the content, and decide accuracy based on what people agree on in the talk pages, and resolve disputes using objective measures of accuracy by people who learned the material. There are plenty of self-taught experts active on these sites, who can be brought up to speed in anything in a few days or weeks. They are million times better than any authority system in the real world,

Did you had any benefit in life due to Quora?

It allows me to get the propaganda I need to do out of my system, make it clear what is true, and do so quickly and efficiently, so that I can get on with the rest of my life.

What do you love most about math?

Any new theorem I proved! There are only like 3 of these which are surprising and any good, and they are all ridiculously simple in hindsight, so it is sort of frustrating. I am not a mathemtician by day, I just like it.

What are some examples of abstraction in biology?

miRNA is an abstract code in this sense, as it silences a protein from a short ~20 nt segment complementary to a protein coding sequence. There are also examples in pure noncoding genome, but these are more controversial. The whole genome is full of pointers.

What is the place of logic in cognitive science?

Logic is at the foundation of computer science, it shows you how to build a universal machine. The role of computers is as a foundational in-principle solution to the problem of cognition, and Turing completeness is an in-principle foundation to biology and brain simultaneously. Turing completeness is ultimately a property of logic--- the computer was originally defined as the simplest definable machine which could do logical deduction on arbitrary axioms. But the mechanisms of higher cognition are not easily modelled with formal logic, because this is equivalent to modeling them using a computer program. The computer program needs to be sophisticated, comparable in size to the irreducible processing in the brain, which means that modelling sophisticated thoughs using primitive logical sentences is hopeless. This observation is the basis for the rejection of simple-minded logical AI schemes in the 1980s. It's not an in-principle repudiation of AI, it is just the observation that the computation is much more complex than initial attempts admitted.

Does being open-minded about an issue imply that one has no opinion?

Being open minded is not important. Being able to change your mind in response to overwhelming, or even persuasive, evidence is important. You can do that no matter what your attitude. I am incredibly closed minded, but if someone presents evidence for a position I am closed minded on, and the Baysian calculus changes so that the likelihood of the statement shifts from .001% to 99.9% I will change my mind. Then I am just as closed minded about the new position. Your attitude doesn't matter. Your ability to quantitatively judge the quality of evidence does.

Is there a branch of the NYPL that stocks up to date academic publications?

The branch around 42nd st, midtown, is good for this.

What are most important lessons Ron Maimon will teach his daughter?

To not listen to me. Unfortunately, she is only 4, and has taken this lesson to heart too early!

Does Wikipedia have a quality control problem?

Wikipedia's problem is too much "quality" control, and too little actual quality control. Quality in the context of the encyclopedia means actual correct nontrivial content. To produce this, you need to sit and synthesize reading, do what is called "original research" (it is not original at all, just rehashing old stuff), and write based on your best understanding, with references only to primary sources, and secondary sources which contained your analysis earlier than you (if there are any). To evaluate it requires honest back and forth, going all the points of evidence, with good faith, and complete adherence to academic standards of evaluation, so that arguments, even if difficult, are accepted by the moderator community, and moderators who don't understand the arguments opt out and don't butt in. This will quickly resolve all the festering issues on Wikipedia, because the internet, when self-selected folks who understand what's what are talking, will produce consensus which matches truth better than any previous political system, and certainly better than any book or journal review system. Unfortunately, WIkipedia did not trust its editors enough to do its own quality control, and so outsourced this to print media. This means that to determine accuracy, there is no internal mechanism to debate this, you need to find sources that say what you say, and then there is a debate on the sources, a debate where winners and losers are decided by a political process completely disconnected from how true the statement is! So that even objective facts, for example, that the redshifted near-horizon Unruh radiation is equal to the Hawking radiation when the redshifting factors are included, are incompatible with the editing process, because no printed source says this! Even though you can verify it in ten seconds with pen and paper. The political process is ruled by folks who DO NOT WRITE. To get a position of power in Wikipedia, since 2007, all you had to do was delete. The deletions were rewarded with modship, and this means the encyclopedia is frozen, as all the actual writers have been kicked out, for getting into fights with the deleters, who are all the moderators. The process is a "democracy", like the communist party of the Soviet Union was a democracy, a democracy of moderators and editors who are already within the system.The elections selected the worst group of shitheads you will ever see to the top tiers, just as in the Soviet Union. If any moderator overrules another moderator, the moderator will be stripped of moderatorship by the closed political system and kicked out (this happened to a moderator who supported me during the last dispute I had on Wikipedia). The people who deleted the most, made the most buddies, and were able to persuade people that they are good decent folks. These people are the last people who you want around. They are politicians, and they have no knowledge. These people run the ArbCom. They are, without exception, complete douchebags and shitheads. If you want an accurate encyclopedia, you need to take responsibility for the accuracy in the organization, and this means that you determine accuracy by honest debate about the material, not about the sources. You need to make sure only honest people are contributing to the discussion, not paid shills, or idiots who don't know the first thing about the subject. These things are extremely clear online. If you wish to moderate a dispute, you need to KNOW THE FACTS ABOUT THE DISPUTED MATERIAL, you need to know the literature, know the content well, and make decisions based on the objective truth of the content, not about sources or about people, as best as you can determine. Your acts must be subject to review, so that those above you also try their best to determine the truth of the matter, and make the encyclopedia accurate. Not accurate to sources. Accurate to what is actually going on. There is no problem in doing this, as those who know what's what can easily explain it to everyone else. But it's extremely destabilizing, because the true stuff determined by an internet shouting match actually is FAR MORE ACCURATE than any print media in the history of the world. This means that people come to the site, see the counterintuitive information presented, and say "this is bogus info". You get a reputation for being lousy, this is what Wikipedia got in the years 2005-2009, when it was most accurate and growing fastest with the most correct information, it's content had the worst reputation. This is not because the content was lousy, it is because the content during those years was frighteningly accurate, much more so than any previous encyclopedia. When the encyclpedia got taken over by douchebags, it immediately became less accurate, it started to politically fall in line with the stupid vapid nonsense in official printed sources. This destroyed it's purpose, and also made it politically acceptable. The encyclopedia sold out, and the quality of the information went down the drain. It is impossible to fix the situation without a fork, Wikipedia is a dead project for more than 5 years now. I was an active editor from 2005-2009, and I witnessed the decline firsthand (I am "likebox" on Wikipedia).

How can we define infinity?

There are two distinct notions, infinite ordinals, which are extremely important, and infinite cardinals which are more intuitive, but less useful. Infinite ordinals can be understood by considering sequences of points on a line. The rules are that you can move to the right only to add points, in discrete steps, and whenever these points reaach any sort of limiting accumulation point, the accumulation point is in the set. So you can make infinitely many steps to the right, reach an accumulation point, and make infinitely many steps again. You can have accumulation points of accumulation points, the structure can be incredibly complex. But it is easy to see, under these conditions, that moving to the left, you always hit zero after a finite number of steps. The reason is that you can't reach an accumulation point when going down, because then the limiting point would have no neighbor to the right, so it wasn't produced by a step, contrary to the construction. This construction produces the countable ordinals, and you can understand it as the partial sums of a sequence, the sequence which is the length of the steps. Cantor identified these infinite ordinal structures as important, and founded set theory to study them. He understood that ordinals allow induction--- if a property holds for the ordinal "0" and it is true that the property for ordinal a implies the property for a+1, and also that the property for all ordinals limiting to ordinal b implies the property holds at b, then the property holds for all ordinals. This is the transfinite induction which gives set theory power over arithmetic. He also identified the notion of set cardinality, and used it to argue that the real numbers are uncountable. But he was so in love with the ordinal structure, that he was sure that the real numbers too could be given an ordinal structure. He believed that the real numbers were the size of the first uncountable ordinal, and this is the continuum hypothesis, and he struggled to prove it. Now that we have modern logic, Cantor's intuitions regarding the importance of the ordinals are understood. The ordinals capture the notion of iteration beyond the limits of the integers. The greater the ordinals you have, the deeper you can iterate certain constructions. The most important of this is Godel's construction. If S is an axiomatic system, then S cannot prove it is consistent. Adding "S is consistent" as an axiom, you go to S+1 (in a manner of speaking), and then adding "S+1 is consistent" you go to S+2. If you have an increasing such tower of consistent systems, you can take the union of all the statements proved in these systems and produce the system corresponding to the limit. You can iterate this over all countable computable ordinals, the ones you can produce by a computer program spitting out points on a line. This iterative procedure over ordinals is key to completing mathematics. When you have larger computable ordinals, you have a better way to iterate consistency statements, and this allows you, in the limit of the Church-Kleene ordinal (the limit of computable ordinals), to prove all objectively true statements about the halting of computer programs, as shown by Turing. This allows you to prove arbitrarily strong systems are consistent. It resolves the question of Hilbert: what computational properties are required to prove the consistency of axiom systems? The only such properties are the well-foundedness (ordinal nature) of large countable computable ordinals. It resolves it in exactly the opposite direction of what everyone says (except certain logicians, like Fefferman or Rathjen). The countable ordinals are sufficient for producing models of arbitrarily complicated axiomatic systems, by Skolem's theorem. They are the essence of the useful mathematical infinity. The uncountable ordinals have arbitrary properties which can be modified this way and that, by Cohen's forcing construction, so Cantor's continuum hypothesis can be made true or false, at whim, depending on the model. The conclusion from this is that the invariant notion of infinity in mathematics is the tower of computable ordinals. The tower of cardinals, which is more familiar, is more of a figure of speech. It is something you can construct in axiomatic systems like ZFC, and it is a useful figure of speech for intuitions, but it is not something to take too seriously when thinking about the foundations of mathematics. The ordinals are.

What does Ron Maimon think of the Bronx?

If you don't count the zoo, I've been there exactly twice, for a sum total of 5 hours. If you do count the zoo, I've been there 5 times. The zoo is great, my daughter loves it, but the rest of Bronx seems like a toned down residential version of Manhattan. Totally livable, but further from the action, so to speak.

What does Ron Maimon think about Bill Clinton?

I have terrible mixed feelings. On the one hand, his economic policy was successful, largely due to his wise choice of tech-savvy VP, and his decision to raise taxes to implement health-care that never came, and instead just closed the budget deficit. On the other hand, the Oklahoma City bombing and the Waco raid seem to have set the precedent for 9/11. So there is both good and bad. His policy toward Russia was catastrophic, wrecking the economy of the former superpower. His hands off policy in Rwanda was also catastrophic, as he acknowledges. But his appointments were sound, and he was overall net ok for the economy and peace of the world. The only real sticking points for me is the Waco and Oklahoma City, the way he didn't reign in the CIA, and perhaps used the ATF for political gain. Monica Lewinski, I don't care about. She seems like a nice but naive girl. I wish Gore would have won, we would be 20 years in the future today. Gore is the only president I have voted specifically for, not against the worse other guy. He made Clinton's administration, I think, he was the main political visionary behind the privatized ubiquitous internet, which was the biggest advance of the Clinton years.

To experience the beauty of mathematics, what sort of (and how much) work should an innumerate adult do?

read "Mathematics for the Million" by Hobgen.

What are some new and upcoming trends in software development that one can aim for apart from Android, Windows, or web development?

Graphics card processing is hot now, CUDA and such things. But it requires an open graphics card, something you can really know the architecture on, because the closed libraries are a pain in the ass.

Is physics about to provide a fundamental theory of life that makes Darwin's a special case?

The way life arises is from a natural Turing complete automaton formed from chemical systems. This is most likely non-aromatic abiogenic amino acids from the Earth's early atmosphere plus abiogenic petroleum combining, to make the full set of amino acids, in an environment sufficiently basic (or whatever, maybe salty) to ensure that the proteins polymerize spontaneously. The result is that you get a computing automaton, and this begins to evolve IMMEDIATELY, without self-replication put in. Self-replication is the kiss of death, because the replicators fill out the system. I have explained this in more detail in my answerhere: How did life begin? There really is no theoretical mystery left. You probably just need to mix petroleum and amino acids in the right proportion in the right environment to start the process off, and see how the earliest stages look. The evolution is through competition between different large-scale computing systems which digest non-like like an immune system. It does not require fine-tuning, or magic, it is inevitable in the proper chemical environment, and a Turing complete automaton is necessary and sufficient.

Will Ripple, Dogecoin, Bitcoin, etc. all be successful?

It depends on who is their central bank, and how open the monetary policy is to inspection.

What do you think about Myhrvold's solution to global warming?

This is a total distraction--- using reflectors in the atmosphere. The problem with mitigating solutions is that the reflection is not going to be constant throughout the Earth, not like CO2 is constant. If you add reflectors to mitigate CO2 dumping, the CO2 levels will double, triple, quadruple, and you will have to keep actively dumping reflectors to avert catastrophe. It is not clear our political future will be stable enough to keep doing this. Further, the reflectors will cool off certain spots more than others, the result will be certain disruption of currently dependable ocean currents. It's not a good idea. Just stop dumping CO2 already! We have nuclear power, and potential fusion power using fusion bombs (H bombs). There is no reason to not make the transition immediately, the threat of catastrophic nuclear war is waning, but the global warming is a terrible problem. If nuclear is not your cup of tea, make a huge carbon tax, and invest in wind, solar, geothermal, to make an energy mix. Also there is potential for engineered biological photosynthetic systems that can produce fuel from the atmosphere. It is also imperative to stop deforestation, and allow reforestation of areas, including in currently habitated zones. A good engineering solution, if the energy problem is solved, is to make tiered farming, so that the farming area requirement is reduced. You just can't go on wrecking the atmosphere, enough. The current warming is livable, perhaps even benign, it opens up the arctic circle, but the warming in 100 years will be catastrophic.

Will there ever be a science of morality?

There sort of is, it's called religion. It isn't a science, but a debating team, with rules agreed beforehand, that the results agreed upon must be universally self-consistent, so that they can be agreed upon by everyone, and so are consistent with the will of God. All you need to do to make it universal is remove the supernatural aspects.

What point one should keep in mind when going to meet his future In-laws?

When I met my long-time girlfriend's parents for the first time, her mother said at some point. "I heard you were a child prodigy. Is that true?" I said "No, I was never a child prodigy. What I am is an adult prodigy." She didn't speak much to me after that. My advice: don't do that.

If a mass of particles mostly comes from energy, is it possible to transform or use that energy? If so what would the particles turn into?

To convert all the mass of matter to usable energy, you need to make proton decay. You can use one of three methods for this, all of them completely impractical: 1. Standard model proton decay. For this, you need to create an environment where Weak instantons can form. This perhaps can happen with accelerator energies at the Higgs mass scale, and it pays to look for B violation at LHC. But collisions might have a hard time producing an instanton, and you might need a thermal collision at LHC average energies, like an TeV per-nucleon version of RHIC. 2. Magnetic monopoles (assuming a standard GUT). The Callan-Rubakov effect, understood in an interesting way also by Witten, will convert protons to leptons. The process is catalyzed by a monopole. Making a monopole probably requires quantum gravity energies, but perhaps they are made in some natural process in a low number, and we can find one or two. No such process is known today. Perhaps they can be made artificially, but this is tantamount to making a black hole artificially. 3. black holes. These violate baryon number, so you can dump your garbage in a black hole, and get energy out from the Hawking radiation, or using tricks, like spinning the black hole and using the Penrose process, or just from the compression and x-rays emitted as the garbage spirals in. The result, in theory, is that all the energy will turn into usable heat at high temperature. This is just as impractical as 2. It is likely that these three processes completely exhaust the list of baryon number violating processes in the universe, so this is it. None of the three look like they will ever be practical at any point in the forseeable future.

What are the secrets to understanding the themes and language of Shakespeare?

The main secret is knowing that it is written by an exiled Marlowe. This gives you Dido (introducing the mythology), Faustus (introducing the magic, prequel of sorts to the Tempest), Jew of Malta (useful for Merchant of Venice), and most importantly, Edward II. Edward II is the key to the later histories and tragedies, containing several plot themes which reappear in later classics. The exile theme is extremely important as Marlowe matures greatly as Shakespeare. But first, you need to know it is Marlowe writing, and that he is writing in Italy, influenced by Comedia dell-arte. To see this, you should review Peter Farey's stylometries, and Mendenhall's earlier stylometry (also reproduced by Farey). Also review Ehmoda, Charniak at all, looking at the guts of the paper, not the intro and conclusion, for the actual stylometric results. The "Shakespeare Guide to Italy" will reveal Marlowe's approximate travels in Italy during this time. With this insight, Shakespeare opens up completely, and it becomes rich and meaningful. Without this, it is as if a Martian landed in England, copied Marlowe's prose insanely accurately, and produced masterpiece after masterpiece which he handed off to a crass businessman to front.

What are some simple number-games involving easy skills and lesser chances?

Douglas Hofstadter has "mediocrity". Three players pick a number between 1 and 100, middlemost number wins. You can arrage a staggering to break ties. You can also play "prime-betting" player 1 picks a range, you pick a number in this range, and you win if it is prime. Any of the classical NIM type games-of-no-chance can be translated into number games.

Why would one assume we live in a universe and are not part of a multiverse? Is there or can there ever be empirical evidence against the existence of a multiverse? Will it ever matter?

Suppse we find that the conditions for life are extremely implausible, requiring a particular impact to make a moon, then particular elementarl composition to make petroleum, and a very specific atmosphere which is unlikely to arise, and that the probability of formation of a life-environment is 1 part in 10^{1000}. Then the post-conditioning on our present circumstance, meaning knowing that we are here, make past-ward predictions about the state of the universe, selecting it to be special. The existence of special past conditions from the knowledge of the present is what is meant in the logical positivist sense by the statement "there is a multiverse". Since this is not the standard philosophical interpretation, I will give Guth's argument to explain this. Suppose we imagine that we live in a universe produced by eternal inflation, where the volume keeps expanding exponentially. And suppose the volume is meaningful in probability, so we are most likely to be in the region with the biggest volume. What does this imply? Since the volume is increasing exponentially fast, what it means is that we are most likely to be in a region where inflation lasted as long as possible! That means that we have to have evolved absolutely as fast as possible (within reason, not a Boltzmann brain, an evolved system--- the rate of volume growth in inflation is enormous but not infinite). So we expect all sorts of crazy coincidences, like gas that specially clusters into galaxies very fast, a planetary system forming as fast as possible, and we should be at the first concievable point where we have intelligent life. This makes predictions regarding what we see, we should see a conspiratorial hastening of natural processes, at the rate of extra improbability equal to the ration of new volume produced by inflation per second, averaged over the cosmological volume. This is NOT what we observe, we observe absolutely normal past evolution to our present state. This rules out that kind of multiverse. Guth's hastening argument would imply that we are the first intelligent life to emerge in the universe, that our evolutionary path was absolutely as fast as possible to produce the final state, all this nonsense. This is how you state "the multiverse" in a logical positivist way--- when you post-condition on our presence, a multiverse is the statement that certain parameters are fine tuned. Guth mutliverse, the mutliverse of eterenal inflation, predicts fine-tuning to minimize time to the present state. This one is not consistent with what we see (to be fair, it requires careful thinking to state exactly how it is incompatible with what we see, perhaps this IS the fastest life can possibly evolve, up to the volume growth rate improbability per second, you need to figure out that this is not so, and this is an exercize I went through when I read Guth's article). In our universe, the two things that are fine-tuned are the cosmological constant and the Higgs mass, perhaps the electron mass, or the strong coupling. If we find that there are reasonable vacua which allow a universe like ours with different values of the parameters, with only a few allowing life, it is like the situation with the special-planet at the beginning. Post-conditioning on our present state allows us to select a special point from a too large possibility, and this is completely equivalent in logical postivist content to saying 'There is a multiverse". But this is the ENTIRE content of the statement. The statement "there is a multiverse" is the statement that the universe is fine tuned to allow intelligent life such as ours to emerge, and is otherwise typical. Because you could say this without the philosophical baggage of a multiverse, there is no need to invoke a multiverse philosophy, you can also invoke post-conditioning. All the physicists that speak about mutlverse seriously, like Susskind and so on, are aware of logical postivism, and invoke the multiverse only as a way of making predictions about parameters of our universe. The multiverse arguments can be replaced by post-conditioning, conditioning on the knowledge that we are here, and then they don't sound so mysterious.

The wheels on an electric trike are all the same size. The gross weight is 100kgs with 25kgs on each of the 2 front wheels and 50kgs on the back wheel. In slippery conditions, would you have more traction driving the 2 front wheels or the 1 back wheel?

The friction force on the two front wheels torques them down to make greater pressure on the front, while the back wheels torque the thing up, to make the back contact worse as the friction increases. But it depends on the location of the center of mass, since this is the main determining factor that tells you the loading on the wheels. If you place the mass close to, but just behind, the two front wheels, then the best place is to push in front. But in the perverse case that all the weight is above the back wheel, then the back wheel would be better. There is no universal answer. But generically it will be the front wheel, if the mass is equally distributed. In the question, the center of mass is exactly halfway between the two front and two back wheels, so the two front wheels are better--- when you apply a torque to turn them, they will increase the pressure on the ground in proprotion, because they will want to make the vehicle tip forward. The back wheel will also want to make the vehicle tip forward, but this will decrease the pressure on the ground. The number of wheels, assuming the standard friction model, is irrelevant, but it only works to reinforce the conclusion in this case.

What are the most under and over-appreciated branches of science?

For underappreciated, I think I would have to go with "nuclear physics". The physics of the nucleus is not taught anymore to physicists, you need to be a nuclear engineer, and even then, you don't learn the fantastic progress. The first breakthrough was the the Bohr drop model. This predicted the fission and the binding energy curve in rough first approximation. Then came the shell model and self-consistent field. This is associated with Aage Bohr Mottleson and Rainwater, probably others. Then there was the multi-alpha model of small stable nuclei, and the Skyrme reconciliation model which showed how to convert between the two pictures. There are amazing theories of nuclear engineering: the Bethe catalysis chain (the CNO cycle), the Teller-Ulam device, neutron breeding, the works. The construction of atomic weapons involved amazing engineering, with materials that become plasma instantly, and still the machine works. The association with nuclear weapons means that the field is associated with terrible weapons of mass destruction, and too much of it must be classified. It is painful when the most beautiful science is kept secret, this is the reason for the under-appreciation. For "over-appreciated", I must go with geology. The folks there still haven't figure out that oil is abiogenic, and cling to preposterous theories about oil migration and kerogen cracking. They do not recognize that geology is shaped by two fluids--- water from above and methane from below. This not only makes their science crappy, but it is also a snoozefest.

Quick question: why can't H2 gas molecules bind or bond?

Not every attraction leads to binding in three dimensions--- the well has to be deep enough. In 1d and 2d, even the weakest attraction leads to binding, but this is not so in 3d. The reason for this can be explained very simply in a path-integral motivated approach. If you have a quantum system which is 2d with a weak attraction, the random walk you are summing over will be recurrent, which means it will visit the region of low potential infinitely many times. In the continuation to quantum mechanics, this can be straightforwardly seen to imply that the potential will always bind. I believe that this approach to the theorem is associated with the name of Barry Simon, it's from the 1970s, but it was rediscovered by several other authors, it is not Simon's main claim to fame. A rigorous proof can be provided at the undergraduate level by simply showing that a square well of arbitrarily small size and depth has a bound state in 1d and 2d. This is an exercize. It can also be proved from the logarithmic growth of the elementary solution to Laplace's equation in 2d, all these ideas are related. Anyway, in 3d, walks are not recurrent, and there is a critical threshhold for attraction to form a bound state. The attraction between H2 molecules is weak Van-der-Waals forces, and does not reach the threshold before the Pauli-exclusion and nuclear repulsion kick in, and the molecules repel. So there is no H2-H2 bound state. The same holds for any atoms or molecules with electrons fully filling the outermost orbits in the atomic shell. They don't make a chemical bond, chemical bonds are when electrons in outer shells are shared, so they don't make a bound state. An exception is in cases where you have charged groups in large molecules attracting and binding through weak forces that normally would not bind--- when the mass of the molecule becomes large, the requirements for binding are weaker. But there is an analogous dissociation due to thermal fluctuations. When atoms or partial molecules have unfilled shells, the can attach to another atom, because the electron can fill both orbitals simultaneously around both nuclei. This is a chemical bond. With Hydrogen, there is only one orbit, a shell which can hold two electrons of opposite spin. When two H atoms with opposite spin electrons come close, the electrons spread out to cover both nuclei, and the energy is reduced. This foms an H2 molecule, which has electrons fully filling both shells in both atoms with shared electrons. This is a filled shell molecule, so it cannot bind another H2.

Which effects a person's decision making skills, values and behaviour more: 1. Nature (genetic predisposition) 2. Nurture (childhood environment) 3. Other

Other. Growing up is an evolutionary process, and it is self-generating, so it depends upon itself. For an analogy, in the Earth, at formation: Nature: prebiotic soup Nurture: sunlight, occasional asteroid The outcome was dinosaurs. Is this from the nature or the nurture? Clearly it's from the evolution, which is producing the outcome within itself. The same for people.

What is the difference between Assembly Language and instruction set architecture?

The assembly is just a human readable form of what the machine is seeing, instruction by instruction. The emitted assembly depends on the chip and the compiler.

How do I improve my coding skill in C programming?

Write a small program in assembly, you will then see how C translates to memory allocation and instructions directly, and you will be relieved also that you never have to program in assembly again, because you have C.

Why do people argue about what happened to the twin towers?

Because they were obviously demolished, and the government is obviously lying. Yet despite the obvious science, the government continues lying, and stupid people continue to believe the lies. This is maddening to anyone with a shred of scientific honesty. To see that this is true in one case, one only has to examine buidling 7. This came down at freefall for half it's time to ground, and this is simply impossible without demolition. No mathematics or fancy science necessary. To see that it is true for all three buildings requires a little bit of science, but the analysis has been done at Architects and Engineers for 9/11 Truth, and it is complete and correct. The buidlings were demolished. The way in which the attack was produced is explained here: What is Ron Maimon's executive summary of how and why 9/11 happened? The key point is that it does not require any conspiracy at all, it is well within the capacity of one person in charge of the drills of that day. It is not clear anyone else knew what went on exactly, aside from the simulation pilots. The confusion regarding this stems from the internal confusion in the Bush administration. They probably had no idea what was going on, and believed their own stories.

Has money and power corrupted Mark Zuckerberg?

People are not corrupted by money and power, at least not in the naive way it is imagined. They are always just doing what they think is best, but when their company becomes enormous, their power becomes enormous, so they tend to engage in terribly desctructive behavior, but this is behavior that would not be predatory and harmful if their business were small, under those circumstances it would be beneficial. Acquiring a competitor and merging is not a problem for two small businesses. It sometimes makes sense. But gobbling up a small competitor when you are a giant means subjecting the management of the company to the dominance of an external bureaucracy which no one person is fully in control of. This squelches the creativity of the small company, in no small part because you have made all the folks that worked so hard in the small company instant millionaires! So just by being big and doing what you think is the right thing by an acquisition, you wreck the healthy market. Another example--- just by shoving your capitalization at developing a new product, you make a closed bureaucratic product which will automatically prevent a free market solution from emerging, because your investment will dissuade a small competitor from doing likewise, because you are much better funded. For another, suppose you decide to expand your market share overseas, you are displacing local homegrown industries that would add diversity in ideas and clever different methods of doing things. Simply from the threat of this happening, you prevent these other firms from even being born. I don't think Mark Zuckerberg has changed one bit the whole time. But neither did Bill Gates or Steve Jobs. The bad behavior is simply a consequence of the large size of their firm, and has nothing to do with their personal ethics. It cannot be fixed by making better people get in charge, because it is the monopoly itself that is destructive, not the person in charge of it.

What are some of the better IQ tests that I can take online for free?

They're all the same. Do Raven progression matrices until you understand the principles (there are approximately 3), to do the verbal tests, just read Dickens or some other 19th century writers, this will fill in your vocabulary completely. The remaining spatial tests are pretty obvious if you have mathematics training past the undergraduate level.

When does overthinking get in the way of thinking?

It doesn't. You need to think, overthink, and overthink about the overthinking, until you are absolutely sure, independent of any outside input. This is about 10 times more thinking than listening to someone and agreeing blindly, but the extra effort is essential for moving forward with a solid foundational understanding. Overthinking is only a problem for dancing and jazz improvization, jokes, things requiring sponteneity. For actual thoughts, there is no such thing.

What do secular/non-religious people do for funerals?

I don't know, but this was a serious problem in the Soviet Union. Anatoly Lunacharsky advocated for a greater tolerance of religion, and a recognition of it's communal role, but he was overruled by Lenin. This idea continued in the USSR, a certain V. Veresaev is reported on Wikipedia to have noticed that an old man was brought to tears by the impersonal bureaucratic nature of the state funeral conducted for his wife, and implored the party to appreciate the role of religious ceremony in day to day life of common folks. He advocated making religious ceremony part of state funerals, but he was overruled and ignored. The soulless funerals of the Soviet Union remained. The role of religion at these times cannot be overstated. Even if it were only for this purpose, religion should be respected and preserved. For more on Lunacharsky's philosophy, see here: God-Building

What does the human brain have in common with the Internet?

It's about the same size in terms of total memory and processing power, at least as I see it Each neuron is roughly the size of a typical modern computer, with gigabytes of data, processed at megahertz speeds (although the neuron is more parallel), and each connection is roughly the same bitrate. The internet modifes the connections more, but it has fewer active connections at a time, and the brain's ethernet is not so fast, but also it communicates to more cells. So it's about the same size system, but with more computaton going on in the brain, because it's programmed to think coordinatedly, while the internet mostly just stores data passively.

In terms of cognition or neuroscience, why can we understand phrases in the active voice better than in the passive voice?

It could be just the fact that there are two fewer words. "The database has been munched by the guru" is two words longer than "The guru munched the database". That's one possibility. It could more plausibly be that we store the sentence as a subject object relation, and the passive sentence gets a Chomskian transformation before it is stored. If you think it is this, you should give a procedure to differentiate between this explanation and the previous one, perhaps using a language where there is no difference in length between the passive and active form (if one exists). But I think it's just a question of number of active/passive sentences you encounter in day-to-day life. A scientist who gets used to passive voice sentences from scientific publications (where these predominate--- usually in a scientific paper you don't care about the subject at all, only about the objects) I think is equally comfortable with both. But you need an experiment to make sure, timing the parsing of a sentence to a person who is well-acclimated to the passive-voice, and comparing to the same sentence rendered active. "The following table was compiled from a best fit regression to the noisy data acquired by the particle accelerator" vs. "The particle accelerator acquired noisy data which a best fit regression converted to the table which follows" seem equally hard to parse, the second perhaps more than the first. There is no human subject in the sentences in most scientific papers. "The following table" is the natural place to start when you are staring at a table.

If a professor does not choose you as a research assistant for his current book, is it a good idea to prove your worth by showing him his blatant grammatical errors in his previous texts?

Sure, can't hurt. He might chuckle and hire you.

As you consider data representation and the operation of a computer, would you agree or disagree that the computer inherently knows a digit (0-9) or character when received? Why?

I neither agree nor disagree, I say both are equally valid answers to this totally meaningless question. The question of whether a computer "understands" the digits depends on the processing it does with it. If the processing is the same as a human brain recieving the digit, it is understanding. If the processing is simpler, it is understanding on a simpler level. The computation involved is the determiner of what understanding is occuring, not the details of the representation of the integer or character.

Is it true that poor people spending money foolishly will benefit the economy more than rich people spending it wisely?

In a working economy, there are neither rich nor poor, since all occupations are compensated relatively equally, since people can freely shift occupations. Any rich people you see have a monopoly position, where they are able to shunt a chunk of capital into their pocket. This creates distortions which make the economy inefficent, and lead to less money in the pockets of workers. This deviation means that the workers' purchasing power is always less than what is necessary to buy up all the goods the economy produces, because the two are equal in theoretical equilibrium. So poor people spending money benefits the economy more than a rich person spending money, simply because the rich person's money should never have gone there in the first place.

When is square loss not good for loss function for regression?

The idea behind "loss" is that it is measuring the improbability of a fit. If you think the value at x is A(x) (some noisy data), you want to minimize the probability of getting A(x) given that the true value is f(x). In this case, you make a Gaussian error model, you say that the probability of being at A if you are supposed to be at f is exp(- C(A(x) - f(x))^2) with some constant C, and up to normalization. This is a "unimodal" error model, because the probability has one bump, if you graph exp(-Cx^2) as a function of x, it has a single peak. Then the probability of the function f(x) being correct is found by multiplying all the Gaussian errors. Since multiplication is complicated, you take the log, and say you are summing the log-probability. This is the sum-squared error: the sum squared error is the log of the total probability of the data given the presumed thing you are fitting. The universality of the Gaussian distribution for errors (the central limit theorem) is the justification for using this model. Errors which are composed of the sum of many random small errors are always Gaussian distributed when there are enough components in the sum. A multimodal thing happens when you have two possible best-fit values: A(x) or B(x). In this case, the probability for f(x) being right has two peaks, one when f(x) = A(x) and the other when f(x) = B(x), with weights corresponding to how likely A and B are to be correct repectively. Then the probability distribution function you want is idealized as a sum of Gaussians, or an exponential of a quartic, something with two peaks: exp(- C (A(x) - f(x))^2) + exp(- C' (B(x) -f(x))^2) To combine the exponentials, you take the log of the sum, and this is a big mess to do anything with, as is any two-peaked distribution. All that the book is saying is that "sum-squared deviation" is a good model when the probability of being right has one peak, i.e. one best-guess for where the true thing is supposed to pass, but a lousy model when there is more than one best guess for where the thing is supposed to pass. In either case, if you have a probability model, you can maximize it using Monte-Carlo, to find the best fit stochastically. When it's least squares, you can find the best fit just by going downhill in probability, or by solving a linear equation.

What do neuroscientists think about Douglas Hofstadter's lecture/theory on "Analogy as the Core of Cognition?"

I am not a neuroscientist, but I think he has hit on an important factor in cognition. The issue I have with the model is only in possible incompleteness. I think it is spot on for the classical problems he is applying it to. The incompleteness, I think, stems from cases where you actually have an internal computing simulation of a system. For example, when I say "I have water flowing past a barrier, and vortices are shedding in pairs. I place a wire behind the barrier, how do the vortices move in response to the wire? The resulting cognitive computation is done by mentally imagining the simulation, and picturing the flow field, and the response to the wire sticking in blocking the vectors, and slowly, your picture improves until you can see how the vortex will slide this way or that (I haven't done it personally, I just made up the example right now). This type of cognition is how the most mentally challenging discoveries are made, not through the simpler analogical process that Hofstadter correctly identifies as lying behind the simpler arguments, such as the Einstein examples in his book. The thinking involved in constructing elaborate arguments is often a complete mental simulation built up from peices that are hard to articulate, and only communicated well in pictures and computer simulations, not from analogies with well defined objects and arrows. This is the limitation in his system, in my opinion, the emphasis on structural relations that can be modelled in 1980s style knowledge base systems, with arrows and blobs. But within those structures, I think he is dead on accurate, as best as can be described at this coarse level of detail. The book is a quick read, but I am only 2/3 through.

When the US is hit with terrorism is it most likely going to be domestic rather than foreign?

Since the US has never been unequivocally attacked by international terrorists, the answer is obvious. It is not exactly domestic terrorists that are the danger, but homocidally vicious unaccountable CIA folks with nothing much to do.

If the magnitude of the gravitational field strength on the moon's surface is 1/6 the value on earth's surface, does that mean that the moon's mass is 1/6 of earth's mass?

The surface gravity is the total mass over the radius squared, so what it means is that $M_e/M_m * R_m^2 /R_e^2 = 6$ There is the square of the radius ratio in there, so $M_m = M_e * 1/6 *(R_m/R_e)^2$ The radius of the moon is about 1/4 the radius of the Earth, so this adds a factor of 1/16, so the mass of the moon is 1/96 the mass of the Earth.

What's more likely to happen on US soil: domestic terrorism or international terrorism?

Since as far as I can see, there has been zero instances of international terrorism in the US in its entire history, the answer is domestic terrorism. Even worse, not danger is not terrorism committed by domestic terrorists, but fake terrorism committed by unaccountable and homocidally vicious CIA folks with too much power and too little to do.

Do admixture tests from personal genomics companies like 23andMe and FamilyTreeDNA disprove the idea of "race is a social construct"?

My wife, who is Chinese, has powdery dry earwax, while I have the goopy gunk common in Europe and Africa (I am half/half). If I had to submit an earwax sample before a job application, you might start to view this as having more importance than you do right now. Who wants goopy earwax people leaving their goopy q-tips lying around the office? Race is not purely a social construct, the goopiness of earwax is something you can measure, and it is definitely indicative of race. The social construct is in the way it is used to make hierarchies of opportunity and advancement. There is a genetic history to individuals which is interesting, and obviously someone with dark skin has a different proportion of ancestry than someone with light skin. It wouldn't be any more interesting than the consistency of your earwax if not for the social construct.

Will cognitive and brain sciences ever become as intricate and arcane as physics and mathematics?

At some point, when we understand how brains work. At the moment, we can't answer the simplest question, like "where is the cognitive data stored?" So right now, it can't be.

What are specific substances (neurotransmitters, hormones, cytokine, etc.) that I can inject into my body to increase the sensitivity of my somatosensory receptors in order to "feel" all the organs and blood flow in my body more clearly?

Meditation allows you to do amazing things regarding temperature of different parts of your body, and feeling various organs. Certain psychoactive drugs might have a similar effect, but I wouldn't advise it, as these tend to be cognitively damaging, even when you don't notice the damage.

What is your review of Thomas Gold?

★★★★ His stance on Abiogenic oil alone is the only reason I know him. "The Deep Hot Biosphere" is a science classic. It's a 4-star rather than 5-star review simply for insufficient academic honesty. He should have credited the Soviet predecessors a lot more. In the cold war, plagiarism from the Soviet Union science became an industry, and you would never be caught if you plagiarized the Russians. This is why it was important to bend over backwards to cite them anyway. He didn't do that. Still, he promoted a difficult idea, and extended it, predicted the deep-Earth archaea successfully, explained the migration and formation of petroleum (building on the Soviet work), and all at a very late age, as the last project before he died. His earlier work I am not so familiar with, the steady state stuff was certainly not as successful. But simply for his geology work, this is a great scientist, one of the best of the 20th century.

How do you call the effect of a smoker ignoring the "warning" on the package?

The name for this effect is "addiction". The labels are good. When I was smoking, i would get extremely stressed about the carcinogenic aspects, and it would lead me to smoke less.

What does Ron Maimon listen to?

I liked The Dead Kennedys and Public Enemy a lot growing up, now I like Branca, Alice Donut, Penderecki, Frank Zappa, King Crimson, The Wu Tang Clan. I got into some newer hip hop recently, there's a group called "Blackalicious" I thought was great, but they have only two albums. I like the hip-hop ethos a lot, the nontrivial rhythm, but I am not systematic in exploring it. I don't listen if it makes big $$. Whenever that happens, I think it means someone is trying to manipulate me.

Would marijuana be as popular if Harry J. Anslinger hadn't turned it into the forbidden fruit?

It would be more popular. Nothing has ever become more popular by being illegal. But perhaps by now people would be sick of it. It was illegal wherever I was, still I was exposed to so much of that revolting substance that I'm already sick of it.

Besides religion, what are some scams which are commonly used to deceive people?

There's a guy in New York City walking around with a plastic bag containing two bottles of Grey Goose Vodka. He bumps into you as you are walking, the bag breaks, and the bottles shatter on the floor. He then shows you a reciept and demands you reimburse him. This is also, I heard, a common scam in Moscow. I got swindled for $40.

What are some problems with structured programming?

The inability to make co-routines, the inability to jump out of inner loops, the disrespect for jump-tables which are used for parsing regular languages (as in lex), the discounting of the possibility of producing code via evolution, rather than by human design--- forget about self-modifying code. The original article "goto considered harmful" essentially poisoned the atmosphere for langauge design for a generation, and produced languages which did not even offer goto. Thankfully C included it, otherwise it would have fallen by the wayside like Pascal (which didn't--- actually I find from the comments that it did, but it was crappily over-structured in other ways). Structured programming is political methodology. It is useful to use blocks, when they are useful, and it is useful to write spaghetti code, and self-modifying code, when this is the best way to do things. It's not often the best way to do things, you need to deal with concurrency, and self-modification prohibits concurrency, but the dogma is overused to bludgeon people. Programming is creative, and restrictions are the opposite of creativity. Structured programming is like the C-major scale, it's a structure that's made to be broken.

Why don't atoms ever stop completely?

Joshua Engel's answer is correct, except for one wrong thing--- negative temperatures are not colder than zero, they are hotter than infinity. The correct temperature line is 1/T, so that colder is to the right, and hotter is to the left. Negative temperatures are to the left of zero, and hotter than infinity, not colder than zero.

How exactly do you physically interpret an outer product?

It's a tensor product, it takes you from two vectors to a tensor. In finite dimensions, it's Ai Bj where Ai is vector 1 and Bj is vector 2, in component notation. There's nothing mysterious about it, if you have intuition for tensors.

Your television or your imagination, which is better to turn on?

Television is the one-way internet, nobody needs it anymore.

How do scientists know the universe is expanding?

The outward motion of the galaxies is simply the statement of the expansion of space, they are the same thing.

Will the database and the machine learning community ever converge into building a single product that can do both data management and analytics?

It's best to keep separate functions in separate programs, centralization in software makes kitchen-sink software that is bloated and impossible to use in unforseen ways. The interfaces need to be standardized, and the programs need to be able to call each other, that's all.

Does Ron Maimon find it difficult to deal with other people, particularly co-workers and superiors (managers?

Sure, doesn't everybody?

Is there an evolutionary advantage to getting heartbroken? How has it made human beings better than other animals? What edge did heartbreak give us as a collective?

Heartbreak ensures that next time you fall in love, you keep your senses about you, stay attached, and so stay together long enough to reproduce.

What is the scientific consensus on Penrose and Hameroff's recent paper claiming that their Orch-OR theory is the best theory of consciousness proposed thus far?

It's an honest attack on the computational theory of mind. The idea is that the brain is not a computer, because computers are limited by certain undecidability results and Penrose thinks we're not. So he needs non-computability in the brain, and he decided to find it in microtubuoles. This requires not only quantum physics in the brain, but unknown and uncomputable physics which can influence consciousness. I should point out that there is a known uncomputable process which influences consciousness--- generating random numbers. Adding random numbers to a Turing machine makes it a "hypercomputer" of a certain simple sort, it can compute a random number, and a Turing machine can't. But that's not enough for Penrose, he wasn't something that can solve the Halting problem in the brain. Since this is impossible in current physics, he needs new physics, and new crazy physics of an unimaginable complexity, which cannot even be simulated. This is exactly what you need to reject the computational theory of mind, and I commend Penrose for his honesty. But this is what compels one to just accept the computational theory of mind. For a person who accepts the comptuational theory, the paper is not useful, as it is certainly nothing to do with consciousness, and this is scientific consensus. I should add that any quantum behavior in microtubuoles can't possibly be quantum coherent at room temperature over scales of the brain. This is the technical objection to quantum computation in the brain, and nothing Penrose and collaborators have done overcomes this objection.

What should I do if my grades are average (and bad in some important courses) due to a faulty evaluation system and if I want to get into a masters program in the US/Canada?

Write a paper and publish it in a CS journal, or write a free software code that gets used by a lot of people. That should make you a shoe in for admissions. Both are more difficult than anything you can do in school, but it is difficult enough that it might make the education superfluous.

Where does God lie?

God is not a physical thing, it is in Plato's realm, and it is produced by a process of approximation and construction, like naming higher ordinals. It isn't something you can measure or weigh, any more than you can measure or weigh epsilon naught (the ordinal), but it gives guidance to people's thoughts, because it is produced (or produces, the direction of causation is meaningless in positivism) a meaningful ethics by which people come together into large superrational communities which behave coherently in concert.

How do I accept mistakes I've made and move on from them as opposed to beating myself up for them?

Remember that Einstein was in the same position at 24, and he was given no more than you were. Regarding your romantic trouble, a small amount of sleazy sexual-oriented activity (you don't have to do anything which comes with consequences) might make you less depressed and more experienced at wooing, so that you have a better chance with your girl.

What progress has been made to date on the Riemann hypothesis?

The main progress is the Hilbert-Polya conjecture, that the zeros are the eigenvalues of a Hermitian operator of some kind. If you have a Hermitian operator, the eignevalues are real. This is supported strongly now, it is scientifically certain, from the Montgomery and Dyson business about the zeros being described precisely by the GUE from Random Matrix theory. Wikipedia has a summary. The statistical evidence is overwhelming that the conjecture is true, but that's not a proof. The main approaches today all try to figure out what kind of quantum system it is on the critical line, what Hamiltonian has eigenvalues which are the zeros of the zeta function. There are speculative ideas that I like, I worked out the basic properties of what's called the "primon gas" at some point (a bose gas on primes whose statistics reproduce the zeta function), this is easy and widely rediscovered, but there are various other speculations that I don't know about at all, Michael Berry, of Berry's phase fame, wrote about this in the late 90s. It seems that the conjecture will fall exactly when we understand how to construct the quantum Hamiltonian whose eigenvalues are the zeros, from a physics-motivated construction. You can't say for certain that this is a major insight until the problem is solved, but some version of this is where my money would go for the solution.

Why did God choose Mary to be the Mother of Jesus?

The mechanism of producing the New Testament was pseudo-historical, there is very little direct historical input from Jesus himself, a few teachings at the most. Perhaps Jesus was a composite, John the Baptist plus James the Just (both are well attested figures). Perhaps he is a different fellow. Who the heck knows. The religion is not about historical accuracy, but about fixing the wretched ethics of Rome. The details of the story are not important. It needed to be in Roman occupied Palestine, because this is where the monotheism was, and this is where the Roman occupation was being challenged, so there was inspiration from the Jewish revolts and the Jewish idea of a liberator messiah. But the details of Christ's mother, of all the stuff around it, this is not important, and the details were filled in so as to fulfil whatever notion of Biblical prophecy was needed to make the religion expand. So the proper question is more like "Why was the person that God chose named Mary, and why did she live in Palestine?" The reason is most likely because Jews were monotheistic and opposed to Roman rule, and Mary is a common Jewish name.

Is energy equal to God?

Energy is a precise thing from physics, God is a computational thing from complex systems, pure mathematics, and human ethics. They have little to do with each other, except inasmuch as doing a computation takes energy.

What are some good projects on Graph Theory? For Undergraduate CSE students

Find the eigenvalues of the graph Laplacian on a fractal graph. Some examples are infinite critical Ising clusters, regular fractals like the Sierpinski gasket, trees with branching ratios that make fractals. The graph Laplacians have regularities in their eigenvalue distribution that are very striking, and some of them can be understood from numerical futzing around coupled with simple theorems from Harmonic analysis. This is a very interesting project, which has a great deal of potential (excuse the pun).

Why don't phonons carry momentum? How can a phonon act like it has momentum, without actually having any?

This is nonsense in Kittel. A phonon does carry momentum, just like a sound wave. When a barrier reflects a sound wave, there is always a recoil from the pressure, this recoil is the momentum carried by the sound wave. Just ignore this statement and move on. The best interpretation I can give for this is that he means that sound wave in a crystal conserves the pseudo-momentum, which is different than the real momentum simply because the translations are by the crystal group. This make phonons with different wavenumbers identified, when one of the two is outside the Brillouin zone. There is a subtlety in defining a conserved momentum relative to a crystal. But phonons do carry pseudomomentum in a crystal, and real momentum in a fluid.

What do you think of the idea that all the world's religions are derivative forms of a Cargo cult? Is it more likely that many religions have their root origins, especially the supernatural parts, in what people observed from possible alien visitation?

It's not exactly nonsensical, it's just not true. There is no evidence for this. The motivations for religion are the observation of collectives of humans forming collective intelligence, and the collective mind guiding the society, This is true of all ancient religions, before monotheism, but the notion becomes one of a universal God, merging all local gods into a consistent universal whole, making an objective ethics, with the rise of monotheism in the 1st-7th century. The coincidence of symbolism is simply due to the fact that there is a nontrivial correct idea there, that is shared by the ancient culture. There is no evidence for alien visitation at all. SInce we developed the ability to see radio, the aliens would have been evident by now, there is a limit to technology in the laws of physics, and there is no concievable way I can see that we missed anyobody.

I am pretty weak in set theory, permutations, combinations and probability but good in trigonometry, algebra, calculus and geometry. What does this imply for a computer science student?

It means you need to study discrete mathematics more. It's natural to know the older things better, combinatorics is more modern. Bollobas book on graph theory is excellent, Erdos's paper are a great introduction to everything, these things are the most important mathematics now.

Can OpenStreetMap ever become a more popular choice than Google Maps?

Probably not, because if it did, considering Google's valuation, they would just buy it out, and it would then become the new thing called "Google maps".

In molecular dynamics, what are the hurdles in development of a force-field that works accurately and efficiently for all systems?

The main hurdle is electron delocalization, that valence electrons behave more like a fluid, the wavefunction hops from atom to atom, sometimes many atoms away, sometimes infinitely many atoms away, as in a metal. The delocalization makes the forces in real molecules nonlocal, so that a benzene ring has a stiffness and planarity from its delocalized electrons that can't be attributed to any one pair of carbon atoms in the ring. Similarly, the backbones of polymers such as DNA and RNA can delocalize electrons, in the periodic structure, and even in proteins, you can have electron delocalization to a certain extent in local structures. To incorporate this, you need a radius of interaction that is absurd, many atoms wide, and then the force law becomes incomprehensible. The second obstacle is nonlocal electrostatic forces, due to charge groups. These charge forces depend on the electronic configuration and solvent interactions, but they are very important--- they can lead to hydrogen bonding, and ionic bonding, to group-group charge interaction, like the repulsion of phosphates. This cannot be captured well with local interatomic forces, because it requires knowing the charge on the group and the electrostatic interaction needs to be modelled using the full electrostatic law. With delocalization and electrostatics included, the molecular dynamics should be accurate. But to get localization right might require a full quantum chemistry calculation, it might not work without a rough knowledge of the electorn distribution in the valence shells. In this case, you need to work with something like the Car-Parinello dynamic density functional theory to get the molecules to move right. Just bare-bones potential models are like what Pauling and Watson and Crick were doing in the 1950s, it's like a tinkertoy model. It's good for a qualitative first stab at a structure, but the dynamical properties are off. I don't think they are numerically quantitatively accurate for any large molecule, although I might be wrong on one or two specific examples where there is no delocalization or electrostatics to speak of. The general rule, I think, speaking from my ass, not from direct experience with simulation, is that the molecule is too soft, it isn't rigid enough, like in the case of benzene. One could determine how good the method is by comparing a potential MD to a quantum chemistry code, like Car Parinello. I don't know if this has been done. If a good set of potentials can be found that include heuristics for delocalization and electrostatics, this would make a big breakthrough in molecular simulations, I think. But I haven't reviewed the very latest potentials, and my opinions might be out of date for these. They might work better than I remember. I never worked with them directly, it was always second-hand or third-hand. The complaints are based on my own personal general intuition for electrons, and this intuition might be faulty in many cases, I do not have enough experience to say.

Are capitalism and equality (in terms of distribution of wealth) mutually exclusive?

I believe, without direct evidence, that they are not. This is simply from the observation that in certain theoretical models, competition leads to rough income equality without artificial imposition of outside power, just from the nature of the market. This is a simple theorem in idealized markets, if someone is doing something that makes more money than you, you just switch to do this, and then competition restores equality. This principle is valid--- it is the reason that occupations without barrier to entry have roughly equal income, people switch out of fields until there is equilibrium, and at equilibrium, switching from doing A to doing B is exactly as onerous as the gained compensation is good. This is not wrecked by considerations of unequal dispositions and talents, because all you need is a few extra people on the margin to make the income equality happen. Not everyone has to know how to program a computer to drive the computer programmer salary to the mean, all you need is a few more people than there is a demand. But the inequality in job-type can lead to income inequality even in competitive equilibrium. In a garbage hauling company, there is the CEO and the garbageman. The CEO sits in an office shuffling papers, and the garbageman picks up the garbage. In equilibrium, the garbageman's job pays more, because it is less desirable. Also, it demands certain amount of discipline and physical strength, which the CEO job does not. So the garbageman equilibrium salary is higher, by a factor of 2 or 3. How do we know exactly how much? Here there is an instructive historical experiment. In the Soviet Union, they set up a planned top-down economy, but, after a bunch of failed experiments, they realized couldn't figure out what everyone was doing and give them instructions about what to do. So Lenin went back to capitalism with the NEP, and this was the standard thing until around 1925. In 1925, there was a debate about how to get people to fill positions required, and do most work. The solution was decided in the second Soviet constitution. The work would have differential compensation, and the wages would be adjusted until people would naturally work in just the right jobs to fullfil the plan. Each worker would choose where to work, but the compensation system would give incentives to fill certain positions over others, and incentives to produce more work, through the so-called "piece rate"--- every peice you made past your (usually low) quota would result in a certain additional amount of take-home pay. This meant that, unintentionaly, the Soviet Union created something which has never been seen before, they created an idealized free market for labor! Anyone could apply to any job, they would be accepted if they were at all competent, because the managers had incentives to get as many workers as possible to fill their quota. Each person's productivity would determine their wage directly, and the productivity of different occupations were chosen dynamically, by adjusting wages year after year so that the correct number of workers would work the correct number of hours to fulfil the various quotas demanded by the plan. While this is NOT a free market for commodities and services at all, it is totally planned in this regard, it is a completely free market for labor! So we can look at the outcome to see what happens. What happened was rough equality, up to a factor which made incentives for study, and avoidance of leisure. The salaries in the Soviet Union were never exactly equal, this was known to all, but they were different by factors of 2-4 at most, and the best paid occupations, aside from specialized jobs in nuclear engineering where talent was scarce, were low-class occupations, that no one wanted to do. So that a manger could end up paid lower than his employees, due to the adequate supply of people wanting to be manager folk, and inadequate supply of employees. This created incredible weird resentment in the Soviet Union, where managers were angry, thinking "a man of my position and education in the West would be paid 3 times, or 4 times what these workers are making, but here I am, getting 70% of their salary! Outrageous." It was not appreciated that for salaries the Soviets were more free-market than the West. This was the only thing the Soviet Union did well, the compensation. But because it's no small deal, it led to some stability in the system, and a certain appreciation that not everything was broken. People realized the compensation system was more or less equitable, at least until the special party-member stores came whenever that happened. The remainder of the Soviet economy was a shambles, due to inefficient allocation and terrible planning, horrible repression, and bad managerial decisions that were always too conservative. But the compensation system worked, and it worked, because it was secretly a pure free market. In Yugoslavia, the economy was not planned top down, but the compensation was similar. The economy was based on collectively owned industries, and compensation would follow free market patterns in the same way. But here it is interesting, because starting in 1966, you could also make a private enterprise in Yugoslavia, although you were limited in size. Here too, the wages were roughly equal, although less so, and an entrepreneur, when highly successful, could make 10 times the average market salary. So even when you have petit bourgeoisie around (small businessmen), you still have rough equality, upt ot a factor of 10. This type of inequality is compatible with a free market, and produces incentives for innovation and entrepreneurship. The type of inequality you see in western economies is just not a free market equilibrium at all. It doesn't look like a textbook, or like the competitive Soviet compensations in any way. How it works is by closing off certain positions, and forbidding all but a selected few from competing for these jobs. In western economies, the high salaries are always due to a monopoly position which allows an individual to get a non-competitive wage for one reason or another. Either a small group of corporate managers get to decide their own compensation, and siphon off a proportion of the corporate profits into their pockets, or a person with a media monopoly uses the visibility to sell some book or album. These types of monopolistic distortions are the only reason I can see for any inequality beyond the level in Yugoslavia, beyond a factor of 10 or so in compensation, directly tied to effort and productivity. Since ultimately a free market in labor is part of a free market in general, I think that capitalism and equality are NOT mutually exclusive. But this requires careful market structuring to ensure competition at all levels, and no monopolistic entities. This is a pure theory answer. In practice, since industrialization at least, capitalism has been profoundly unequal in practice.

If the Abrahamic God created the universe in 7 days, why did humans appear millions of years after the dinosaurs?

God created the world in 7 days, but it was only about two weeks ago. The dinosaurs were already in the ground, as fossils, and some were created standing in the museums.

What is the significance of positivism?

Positivism placed a firm foundation beneath philosophy, a solid thing you can build upon. Mach's basic idea was to start with sense-impressions, and define every other concept using this primitive idea. The idea is that the meaning we give to "chair", "balloon" is to be found in the sense impressions we can directly experience. Then concepts like "electric field" can be defined in terms of other concepts that eventually hit rock bottom in sense-impressions. In the case of electric field, we can see that charges move differently under different charge conditions, and we can define the electric field at a point by how it moves. This point of view is important because it described how to define what the invariant meaning of a physical theory is--- it's in the observations. Any two mathematical descriptions with the same observations are to be identified, they are just identical. They are not different in any way, except in the way they are described in words. Some questions cannot be stated in a way that they are subject to observational test. In this case, the question is meaningless. This is 90% of all questions people ask of scientists (it's maddening to be asked meaningless question after meaningless question): 1. What caused the big bang? This is meaningless because there is no sense impressions of anything outside the universe. It is doubly meaningless, because the words "cause" and "effect" are not about primitive sense impressions, so need to be defined in terms of these. To define them, you need to consider when you say "X causes Y". This is when you have sense-evidence for X, and sense evidence for Y, and Y sense-evidence comes only when sense evidence for X is present, independent of other factors, and further Y is later than X in time. It's a sophisticated notion, but it's so primitive in our thinking, we tend to think it is fundamental. 2. What is time? Why does it go forward? The only way we gain experience of time flowing is by doing experiments on our own psychology or that of other people. So the time-flow question (the perceptual flow) is not a part of physics, it is psychology, or pure philosophy. 3. Is mathematics "out there" to be discovered, or invented? Again, there is no sense-experience which can answer this. I could go on forever, listing questions, taken from Quora, which have no answer, and need no answer, because they are nonsense once you understand positivism. But I'll let you do this. The question was "what is the impact of this idea?" The major impact was to moot the classical questions of philosophy. Most of them were mooted by this shift. 1. How is free-will compatible with determinism? 2. Why is there something rather than nothing? 3. Is the body separate from the mind, or not? I could also go on forever here. All you have to do is study positivism, then listen to any philosopher (other than Daniel Dennett) for about 20 minutes and you can easily find the confusions and misunderstandings due to their lack of understanding of the positivism. So the significance is that it put to rest very old confusions, and permanently, in that once you understand positivism, you never get confused on this issues again. It also put to bed all previous schools of philosophy, and this made philosophers angry, and so they got out their political knives. In the 1970s, they killed the philosophy entirely, except within physics, where it was founded. In physics it cannot die, because we have quantum mechanics, relativity, string theory, and these cannot be understood without positivism. Even basic E&M can't be understood well without positivism, otherwise you ask "How do we know it's really a field, and not the direct action of sources on charges?" or "Which gauge is the right gauge for the vector potential?" and other nonsense questions. The main thing to understand is that positivism is simply a definition of terms, it tells you how to find meaning in other statements. It does not require justification, beyond the fact that it is a definition which works, and this is made clear by the way it is used in physics.

What is good way to understand this way for verifying that the stationary point is indeed a maximum?

This is the second derivative matrix (the Hessian) at the critical point. The first derivative tells you the best fit linear approximation, but in this case this is a critical point, so the derivative is zero. Then the Hessian tells you the best fit quadratic approximation. When the matrix is negative definite (as it is here), the thing is a local maximum.

What is the reason to think that spacetime is a complex manifold?

The spacetime doesn't have a complex structure intrinsically, but spacetimes which have a constant spinor are naturally complex manifolds--- spinor transformations complexify the coordinates. The manifolds with a constant spinor are the ones that preserve an amount of supersymmetry, so they are the easiest ground states of supergravity to find. This is the motivation for studying complex manifolds in physics. There is no intrinsic reason, other than preserving supersymmetry. Since we don't see low energy supersymmetry so far, it is likely that the extra dimensions are not so simple as was hoped in the 1980s, although a lot was learned from doing these types of compactifications.

The Future: How will the world end?

With the sun blowing up. Perhaps we will learn to engineer the sun by then.

What caused the Big Bang?

The notion of cause and effect doesn't make sense in this context, as cause and effect are human notions derived from seeing that property X and property Y are correlated in a specific time-order, and Y doesn't depend on anything else other than X. Then we say X causes Y. For the Big Bang, you can't make sense of the statements, because the definition just doesn't work. This is why positivism is important, it removes intuitive bottlenecks, like thinking we understand "cause" and "effect", just because we figured out those concepts at a very early age. It requires precise definitions for these terms, and when these are given, this question, and many others, evaporate into nothing.

Why is the no. of males to no.of females at birth is nearly same?

The reason that the mechanism is tuned to produce equal numbers of males and females is explained clearly in Stephen J. Gould's "Flamingo's Smile". In a situation with fewer males, any genetic investment in males pays off more, in that it produces more offspring. Conversely, in any situation with fewer females, investing your genes in a female pays off more. This drives the sex-ratio very precisely to the point where male and female births are equal. It's a consequence of evolution. This is the best and clearest precise and counterintuitive quantitative prediction of evolution by natural selection, because this thing cannot be modified by sexual selection, while nearly everything else can.

What would you do if you could live an extra hundred years?

I think the human lifespan is long enough. Most important things can be done in about 20 years of dedicated effort, and you need to learn to pass on your efforts to others, and your formative education becomes obsolete in 50 years, so it is probably best if there is recycling of folks. I don't think I would end up doing anything useful with the second hundred years, unfortunately.

How do I start an anger-raising conversation with a stranger?

This is my only natural talent. One time I was speaking about mathematics with a friend of mine, Jay, when an Israeli girl who we both knew walked by. I wanted to continue the conversation with Jay, and I didn't want to speak to her at that moment. So as she was coming over, I thought "How to get her to leave as quickly as possible?" She said "Hi Jay! Hi Ron! What are you guys up to?" in a sort of sing-song voice. I smiled and said "Hi Rina! Yitbach 'al Yehud." She stopped dead, kicked me in the shin, hard, it hurt, and stormed away. I continued talking, but Jay was all like "What the HECK did you say to her? You just said THREE SYLLABLES that I didn't even understand! And she reacted like that? You must be the Mozart of pissing people off." "Yitbach 'al Yehud", by Israeli folklore, is supposedly what suicide bombers say when they blow themselves up. It is scrawled sometimes as Palestinian graffiti, it means "Slaughter the Jew". It is automatically offensive to an Israeli of normal sensibility, to the point of ending all conversation. I expected her to leave, but not to kick me in the shin, that was unanticipated. As the Mozart of pissing people off, I can give you some tips. 1. Find an area of expertise in a person, and tell them something about this area that they don't know. If they disagree, tell them they are wrong. Also, insist that they should already know this, as you are not an expert, and you know it. 2. Ask them about their religious beliefs, accept these beliefs sincerely and completely for about ten minutes, then slowly rationally argue with yourself to liberate yourself from these beliefs, while speaking your thoughts aloud. 3. Pick your nose while they are talking. Or belch, loudly. Don't apologize, don't even notice anything, continue listening politely. The key point here is to demonstrate complete independence to the gods that they are in thrall to, whatever these may be. People do the bidding of the gods, and will get incredibly angry when the gods are challenged. They don't see this as an imposed thing, they think they are freely choosing. People get REALLY pissed off when this happens. REALLY pissed off. I mean, they might hit you, that kind of pissed off. Good luck honing your skills! They will not serve you well.

What were the successes of the Bush presidency?

There was something about allowing local manufacture of vaccines and medicines without patents in the third world, or something like this. There really were none to speak of.

What were George W. Bush's biggest mistakes as President?

Destroying the peace, stability and economy of the US, driving it into unnecessary foreigh wars and economic ruin, and bringing it to as close to a police state as it has ever come. How's that for a legacy? Everything he did was a failure, from the first day to the last. In my opinion, his administration is, by a large margin, the worst the US has ever had, certainly the worst after the 19th century. The biggest failure, of course, was hiring scheming evil people in his administration who murdered 3,000 citizens and concocted a conspiracy of evil to explain it. He was too stupid to understand that this is what happened, or else went along with the flow, I don't think he had anything to do with it personally. But after it happened, he used it to excuse barbaric violations of all the past shared common standards of government decency in the US. The round-up of suspected terrorists based on intelligence rumors (mostly fabriated), the roll-back of civil liberties, the detentions without trial, the invasions of Afghanistan and Iraq, the systematic torture for bogus worthless information, the economic cronyism, the tax cuts to his supporters, the creation and funding of crappy homeland security industries, the gutting of fundamental science with political appropriations, the construction of a homeland security police-state apparatus, the creation of terror using color-coded terrorism threat warnings, the compilation of data on all citizens in centralized databases, the massive invasion of the whole world's privacy. He also stopped anti-trust proceedings against Microsoft, delaying technology by a decade. He allowed mergers to proceed without regulation, he drove the US into deficit spending by refusing to honestly account for the war spending. It's not possible to describe the damage this fellow did. It was like an incompetent, stupid, lazy version of Hitler was running the US.

How does the Hume-Edwards principle answer the cosmological argument?

It's a dopey argument based on the previous idea that "everything has a cause". This principle was considered important, I don't know why, so to reconcile this with a universe which has no external agent making it, Humes or whoever decided that a causal chain can be complete in itself or some such nonsense. The positivist answer to the cosmological argument is simply that the notion of cause and effect is defined as a meta-property of correlations between observations, and since it is impossible to observe anything outside the universe, you can't make any sense of the idea that this or that caused the universe. Since this is the correct answer, I don't know the exact details of other arguments, and do not bother with them. They are pre-positivist and so sound deranged to my ears.

Would a completely unprejudiced person be bisexual? Why or why not?

It's not about prejudice, if you aren't bisexual, homosexual activity is first gross, that goes away, and then becomes profoundly boring and stays that way. You can't force yourself to find something sexy.

DNA is a chemical mixture. So hypothetically let's say I keep on arranging the molecules and finally create a DNA. My question is: When does that chemical compound become a living organism?

The compounds become an organism when they are embedded in a cell which is capable of reproducing and evolving these things, at least in an environment. Chemistry by itself is not life by itself, it becomes life when it can evolve to indefinite complexity. This, in my mind, requires for sure a Turing complete chemical system around the genetic molecules, and usually other systems to allow data sharing, so either sexual reproduction or plasmid sharing. You could build life in the context of other life by surrounding the DNA with a whole collection of proteins, ribosomes, and so on, until you have an artificial cell. But then the DNA will not be the most important thing, the remaining molecules that give it context are. I should point out that 'reproduce' here is used in an abstract sense of reproducing the algorithm in some way. It doesn't necessarily mean "reproduce by the usual channels". A donkey is sterile, but it can still get cancer and the cancer cells can be immortal in a dish, forever reproducing a version of the program encoded by the donkey's DNA with appropriate evolved modifications, into the future.

What is the cause of Ron Maimon's terrible reputation among academic circles?

Having no discernable productivity, and getting into arguments with big-shots.

What is Ron Maimon's advice for postdoctoral students?

I have never been one, so I have none. Any advice I make up will be counterproductive to self interest. It would be: you're young! Go do great research, as great as you can, as quickly as possible. The advice which is in the post-doc's self-interest is different: do what's popular at the moment, and won't be dubunked for at least seven years, untll you are up for tenure. Since you won't be tenured until your mid 30s, you are wasting your productive years on crap if you follow the safe route. Don't do it, but it's not advice, because I have never been there.

In your opinion, what is the most controversial idea in mathematics? What is the most fundamental idea in mathematics?

most fundamental; computation and computable ordinals most controversial: computation and computable ordinals are the foundation.

As an environmental Engineer, I believe that the global warming theory is an exaggerated scam, what do you think?

You are lying. To be clear: I am not saying you are misremembering, nor that you are making an innocent mistake. I am saying you are deliberately lying in the body of your question. Nobody talked about ice-ages, except shills for oil companies. This was in response to the first warnings about global warming, which came on the first Earth day, in 1970 or 1971. The science was already clear then, and it was clear that warming would be a serious issue already by the mid-1990s. There was no fudging of data, the science is exceedingly clear and you can verify it on the back of an envelope. The reports of "bad behavior" are due to the emails released that show that honest scientist were trash talking about paid shills like yourself. Good. They should attack and dismiss all global warming deniers with vicious propaganda, because that's the only way to combat purposeful paid lying by shills. The main cause of global warming is global CO_2 emissions. It was predicted in the 1960s from obvious atmospheric science, popularized by 1970, continuously attacked by shills throughout the 80s and 90s, and now the model is confirmed by observed data on warming. The theoretical predictions are also confirmed by ice-core data. All the serious people have been saying the exact same thing for 40 years now. It is purposeful lying to distort their position, not an innocent mistake. Busted dude. Go home.

As a young faculty member, does it make sense to invest the time required to write a high quality review of a research subject?

Not anymore. This is a serious problem. But it might help you understand the subject better, and do better research, so if it doesn't take too long, it might not hurt. But you won't get recognition for it, unlike in previous eras.

What do you think of Richard Dawkins?

He has a too simple brainless model of evolution which is demonstrably wrong. If he got over the selfish gene, and realized the biology is super-complicated computing networks of genetic and non-genetic information, he wouldn't be hostie to religion, as the coordination in computing systems reveals what the religious folks are talking about very clearly. He's not evil. But he's annoyingly incapable of understanding what the notion of God is really all about, focusing on superstitious nonsense that went out about 1500 to 2000 years ago. The superstitious nonsense needs to die, so good that he's killing it, but he's throwing the baby out with the bath.

How good in math was Louis de Broglie?

He wasn't so great in math, he was just competent. His contributions came from imagination and physical intuition, with only a little bit of mathematics, none more advanced than typical undergraduate stuff. But that's like Einstein 1905, it's not a small thing. His formulation of the standing wave confition was a pure leap of insight, and his view of how to formulate the Bohm theory using a quantum force was so weird, that his intuition was laughed at for three decades before it was shown to be mathematically consistent.

What does Ron Maimon think of Chris Langan, putting aside all the IQ noise the media stirred up?

He is a person doing very shrewd media maneuvering to take advantage of the feeling people have that "I'm smart, I just didn't apply it". He has associated with folks wisely, in particular with Malcolm Gladwell. A similar thing was done with that pianist in "Shine", the idea there was to have a poster child for failure, so that the public can say "ah ha--- there's a great talent that failed." In the previous case, it was more of an advertisement for getting married, joining bourgeoise society, and settling down. Langans intellectual work is not interesting at all, but I am sure he, like most other people, could do serious intellectual work if he applied himself for many years to it. That's not what he does. He wants to be a motivational speaker, to explain you need to do hard work. His IQ test performance is a gimmick, like Marylin Vos-Savant, or all other high-IQ scorers, he just learned to do the stupid puzzles well.

Given the racially motivated nature of nearly all attacks on President Obama (and other African American officials), why shouldn't the US Justice Department step up the hate crime investigation?

Racism isn't illegal. Hate crime is when you commit another crime motivated by race hatred.

Considering that most firearm murders in the USA involve handguns, why don't we ban all handguns rather than other types of firearms?

If you do so, just make sure that the police and national guard go first. The point of the gun thing in the US is that the citizens and the government (at least the forces that are deployed internally to the country) have the same weapons, so that totalitarianism is difficult or impossible, because by the time you are being sent to a camp, you are in the woods hunting and shooting. If there were a proposal to disarm the police and national guard, followed by strict regulation of handguns, I would support it.

Were any Gulag Camp Heads Jews?

The Soviet Union in these times was pretty anti-semitic, Stalin didn't like Jews and tended to purge them from positions of power, so I seriously doubt more than a handful were.

What does Ron Maimon think of Kafka's literary works?

I haven't read "The Castle", but I loved "The Trial" and "The Metamorphosis". I think they were really a great snapshot of the way people experienced the totalitarianism of the 1940s, and the views of religious imposition on the individual. I think "The Trial" is one of the greatest novels of all times. It comes from a different, less Marxist, perspective than something like 1984, but like 1984, it is also a type of religious writing that few other writers manage.

Why is Newton seen as one of the greatest mathematicians of all time?

Just because Archimedes thought about it back then does not mean it was overdue. Newton didn't just do the basic ideas, Cavalieri was the one who reproduced Archimedes (more or less, Kepler went further, reproducing the two-cylinder volume problem). Newton applied the calculus to make power series, Newton polynomials, techniques of integration. He founded the calculus of variations with the solution to the Brachistochrone. He also was a cycloid master, he showed the cycloid was the tautochrone, and this required solving a nontrivial differential equation, something which didn't happen before Newton. He has a lot of mathematical theorems in the Principia which are extremely important--- just proving that the orbits are ellipses is a major mathematical work, well ahead of its time. The speed of sound derivation is an example of a partial differential equation, although Newton didn't think in these terms yet, he would have been comfortable with this formulation. These things were not on anyone's radar in the 17th century, except for Newton. His mathematics was top-notch, central to all future developments, and he deserves his fame in this field. There is no comparison between Archimedes and Newton, although there is between Archimedes and Galileo, Cavalieri and Kepler. Archimedes was just an unbelievable genius, that doesn't diminish from later folks.

How do I know if I'm a better fit for pure or for applied sciences?

It's not about personality, it's about how well you can work on a specific question, and how motivated you are to solve it, and how well you can learn to work machines. You can only figure it out by doing it, there is no point in thinking about it theoretically, you need to try as much as possible to figure where your best contribution can come. I don't think you can use shortcuts. But you have to respect all aspects of the work equally, so that you don't refuse to do something because it has less prestige. Prestige is the worst way to decide.

What does the drop in the cost of DNA sequencing allow that was not possible before?

Everything! First, it can allow a complete elucidation of the RNA networks in cells, by massive sequencing of RNA in all cell types. You can look at the Encode project to see what is possible--- you can get transcription factor binding sites with CHIP-seq, you can get protein expression data using mRNA-seq, you can get noncoding RNA by indiscriminate sequencing with nuclear separation. This can produce a complete mechanistic understanding of biology, as RNA interactions are not well elucidated using traditional biochemical techniques--- they are just too computationally rich to be determined in any way other than massive sequencing.

Does science fiction actually help in developing new technology or does technology help in crafting sci-fi movies and books?

Science fiction is useful for lubricating the imagination, since to get to the edge of the realm of the possible, it helps to go a little ways to the realm of the impossible, to approach the edge from both directions. Many physicists were big fans of science fiction. Sidney Coleman had a pretty near complete collection of 1950s science fiction magazines in his office. Conversely, many science fiction writers were actively following science, most notably Isaac Asimov and Arthur C. Clarke. Arthur C. Clarke was one of the few people in public in the 1990s who spoke out in support of cold fusion. He had reviewed the science honestly, and concluded it was a real phenomenon. Isaac Asimov wrote popular science books which were accurate, one about Jupiter for instance which I loved as a child. These activities are important too, and science fiction authors do them. Science fiction is first and foremost fantasy writing, but with the goal of being at the edge of knowledge, approaching the possible from the direction of the just-barely impossible. Some of the classics inspired scientific development, like the great short story "The Light of Days Gone By" with it's slow-glass, inspired the research to make stopped light materials which was achieved (though not as in the story) using Bose-Einstein Condensates last decade.

How can I prove that if f(x) f(x) and g(x) g(x) are continuous, their product is also continuous?

you want to prove that f(x+dx)g(x+dx) is only infinitesimally different from f(x) g(x) when f(x+dx) is only infinitesimally different from f(x) and g(x+dx) is only infinitesimally different from g(x). But in this case this is (f+df)(g+dg) and you can expand this out, to see that all terms are infinitesimal. if you are not comfortable with infinitesimals, say the same thing by saying "dx is little o" and df and dg are little o and the product of little o with constant is little o, and the product of little o with little o is little o. The definition of little o is limiting to zero at zero. Do not prove it directly from epsilon-delta, although you can unpack either of these into such a proof of course.

Will Ron Maimon teach his daughter Hebrew? If so, why?

I haven't seriously done so until now, she knows a few words from listening to my father, brother and me speak, from her great-grandmother, and from me occasionally teaching her Hebrew. There's nothing wrong with knowing Hebrew, it's occasionally useful. But it's more important that she learn Chinese, she has more Chinese relatives than Israeli ones, and Chinese is a better language to learn, but she hasn't done much of that yet either.

How did Gödel himself view his incompleteness theorems?

He thought they were demonstrating that the mathematical universe requires a tower of infinitary extensions involving higher orders of infinity, meaning higher cardinals, and so Cantorian set theory, in it's full Platonic idealized form, so as to complete the system of mathematics. He was a Platonist, and he was pretty much alone on this in the 1930s. He dismissed the finitists that said otherwise. The finitists were led by Hilbert. The goal there was to justify infinite set theory, with its uncountable towers, using finitary consistency proofs that only referenced things that were not controversial, things you can see on a computer, as we would say today, after Turing. The finitists believed that it is sufficient to only consider countable ordinals up to a certain size, and then construct models for full set theory using only these. Hilbert's school had even (I heard) developed a version of L, which would be used to fill out the universe once they had the ordinals understood. Godel did L simply by using the ordinals as God-given, from some external set-theory intuition, because he was a Platonist. Godel believed he had demolished the finitist program, and also that he had shown that the human mind, in its ability to imagine such transfinite structure, transcended any formal system. In this regard, his interpretation of his theorem is faulty. But he still did great work. Gentzen and Hilbert completed the finitist program for Peano Arithmetic, by showing that the well-foundedness of the completely finitary ordinal epsilon naught was sufficient to establish the consistency of Peano Arithmetic. Godel dismiised this proof in a dishonest way, by claiming that epsilon naught, despite its obvious textual description using Cantor's normal forms, was infinitary. This became dogma in the US, due to his influence. To this day, there are people saying that Gentzen's proof is infinitary. It didn't help that Gentzen was starved to death in an internment camp just after World War II, and that Hilbert died during the war. Turing explained Godel's theorem properly, using computer. Before Turing, Godel had already noticed that computation was a universal notion. He stated it several times. But he defined computation using "general recursive functions", and he was very unhappy with this definition, because it didn't make the universality manifest. Church defined the lambda calculus, and showed it was equivalent, but Godel still thought it wasn't the magic right way to do things. When he saw Turing's article, he recognized immediately it was the right way. But Turing went further, and explained that it should be possible to complete the consistency proof of any system using computable ordinals. This is the way to proceed with Hilbert's program in light of Godel. This project is now known as "ordinal analysis of axiomatic systems", and the most notable result in this direction is the proof of consistency of Kripke-Platek set theory, a countable constructive set theory, using a definite computable ordinal with an understood definition. There is no obstacle to completing Hilbert's program today, except people saying it can't be done. it requires naming big ordinals, but big computable ordinals, countable ones, these are only dinky little ordinals in the standard Platonic view. I suspect that Godel realized his ideas were wrong in 1965, when Cohen did forcing. Godel understood Cohen's forcing immediately, the early papers were based on his monograph on the L model. I think that he was very disheartened by the generality of the method, and the way in which it made a joke out of the idea that the larger uncountable collections were absolute objects with definite properties. He went crazy and died a little later, I am not sure that this wasn't a form of mathematical grief at the realization that his beloved Platonic set theory was dead (although not too may people recognized it at the time). This is a speculation on my part, he never said this, and Cohen in his recollections just remembers Godel being sad whenever they spoke, and not getting too interested in the details of the arguments. This is the kind of thing that happens when a mathematical argument demolishes a cherished belief, but it's also what happens when you're old and tired, and I can't tell which is which in this case, or if either is true.

What are some things conservatives are right about?

I think they are right on the principles that they are most passionate about. They are right that free markets are efficient, at least in those situations where the sector is engineered properly to allow them to exist. Free markets reduced prices through competition in airlines in the 1980s, in telecommunications in 1996, when the government stepped in to break the monopolies up and allow free competition. They are certainly right that individual liberty must be preserved and defended from government intrusion, on this liberals are even more certain. I think they are definitely right that governments are oppressive by nature, because even well intentioned political systems tend to shut people up and prevent certain paths of action, so that even the most well intentioned government regulation comes with hidden costs in paperwork and restrictions which prevent growth. For example, when a government mandates that milk must be pasteurized, immediately this puts all small farmers who can't afford the machines out of the milk business, and favors enormous corporations who can afford it. Such a regulation must always come with a way to ensure that a small supplier can comply without undue hassle to the business. I think social conservatives are right that drugs are stupid, but that's not the same thing as saying the government needs to make an industry out of incarcerating people and taking their assets. I think they are also right that families are important structures in society, but I don't see why they have to pick on gay people to say this. They are not bad people, and one should listen to the sincere conservatives. You just hardly ever hear from them. The are possibly even right about guns, I wouldn't even consider supporting gun control after what happened in the US the last decade, with armored vehicles in Boston, and detention and assassination of US citizens authorized under the completely bogus threat of terrorism. The problem is that conservatism in the US is associated with the Republican party, which has become a big-business party which just exists to reduce taxes and regulations on enormous monopolistic firms. That's not conservatism, it destroys the small businesses, and Teddy Roosevelt would be rolling in his grave. I don't think that conservative ideas about freedom and independence of producers are incompatible with liberal ideas about equality, because one must remember than in an idealized free market, everone makes the same wage. Although this is a joke in real markets, it really is the prediction of the textbook model. The proof is simple: if your neighbor is making more money, you just start doing what your neighbor is doing. Despite first appearances, this is actually a correct argument which is not wrecked by asymmetries in the market, it is only wrecked by monopolization and class structure. So I don't think the goals of conservatives and those of progressives are particularly at odds. They are only both at odds with big-party machines getting bribes from enormous monopolistic entities to protect the ruling classes that profit from those entities.

Is the New York Times an unbiased (internationally) source? Why or why not?

There is no such thing as an unbiased source, every source is influenced by the point of view of the folks inside, and there is always a selection process. The folks in the New York Times tend to be slightly left of center, but very bourgeois, so that they advertise big-media figures, and tend to cover the things that are interesting to more affluent folks. But this cultural elitism and celebration of big-business success is not the worst type of bias in the world. The New York Times in the past made efforts to be unbiased, by fact-checking and investigative reporting, and strict editorial policy that made honesty a priority. It made bold editorial decisions, including the decision to publish the Pentagon Papers in the early 1970s. It was a good newspaper in many respects, and I think it deserved its reputation for being a solid source of news. That's pretty much all in the past. It has lost a lot of revenue, newspaper advertisement is not as lucrative as it used to be, and this means that there is less and less ability to fact-check. That makes for lazy reporting, where government nonsense is repeated as fact. The New York Times tries, but today, it is much harder to succeed, because all the fact-checking is distributed online, and official sources are just pernicious liars now, because they can get away with total fabrications. The New York Times, like other mainstream media sources, buries news that is uncomfortable to the mainstream narrative, just because it doesn't look reliable, and those who report such things tend to sound like kooks to the genteel people who run the newspaper. So the New York Times always takes a pro-Israel stance, it defends atrocities by American-supported regimes, and it makes a big noise about atrocities by anti-American regimes. It pretends that Lee Harvey Oswald shot JFK, that James Earl Ray shot MLK, that 9/11 was a plot by 19 Saudis paid by Al Qaeda, that the government reports regarding these things are reliable. This is the kind of nonsense you needed to print to keep mainstream credibility intact in the print era. This kind of crap doesn't fly online, because people have access to alternative media, and can evaluate the evidence for themselves. In this environment, the New York Times is kind of a dinosaur.

Is 0 percent inflation ideal?

Not zero, but a few percentage points above zero. Inflation is used to devalue money. It is useful to counteract certain tendencies in markets, such as the downward stickiness of wages (meaning it's hard to tell someone they'll be making less next year), and the tendency of people not to invest (they have to invest if their money rots). In the 19th century, there was tight money, with cycles of inflation and deflation, because money was tied to the supply of gold. The deflationary periods were terrible busts, depressions really, you couldn't take a loan out, because even if you just repayed the principal, you would be losing money. So it made more sense for a person to just sit on their cash, getting the deflationary return, than to lend it out, so interest rates would go up, and it was a disaster, farmers who would take loans against the next crop would suffer from this tremendously. To some extent, the discovery of gold in California made things ok, because it was a natural source of inflation--- more money coming out of the rivers and mines. But mining is a terrible way to control monetary policy. During the Civil War, the US (and the Confederacy) abandoned the gold standard, but at some point, it was reestablished. The farmers noticed that gold standard monetary policy was crappy, and there was a demand for inflation towards the end of the 19th century. This was the "free silver" movement, headed by William Jennings Brian, which asked for silver to be used as a standard, because it was more plentiful, and then the silver and gold reserves could be adjusted to make a modern monetary policy. It was nearly universally supported by farmers and workers, who were harmed by deflation, and opposed by wealthy industrialists, those with capital, whose capital would be depreciated by inflation. After the income tax, and WWI, the gold standard wasn't taken too seriously, and inflation was standard. Then in the great depression, there was a huge and terribly destructive deflation. With Roosevelt, you had a loose monetary policy, and finally WWII got the US off the gold standard in all but formal declaration, and Nixon made it official in the 1970s. By the end of the 1970s, inflation reached levels which consumers didn't like. The public then got on board with an anti-inflation policy. Carter appointed Volker, and inflation was brought under control. The same type of policy was mimicked in countries with hyperinflation, like in Israel in the early 1980s. Shimon Peres played the Volker role there. The ideal rate of inflation is probably around 2-5%. Some would say lower, some higher, but it's around this. You need this amount of inflation to prod people to invest their wealth, and to allow wages and prices to equilibrate, even when nobody cuts prices or wages. In an ideal market, it wouldn't matter. But we don't live in an ideal market.

Where was Ron Maimon On 9/11?

I was at work. Then we went to a co-worker's house to watch TV.

What are the most common misconceptions about 9/11?

Everything people think about it is a misconception. Unless they are truthers.

In the context of a character named Professor Proton from The Big Bang Theory, was there a person like him that aroused your interest in science in your childhood, and do you think such a person exists today for current generation of kids?

I liked Carl Sagan when I was really little, but when I got older and experienced marijuana intoxication, and realized he advocated it, I got disenchanted.

Does Ron Maimon miss the 90's?

I only miss the freedoms lost on 9/11, but they will be regained with enough vigilance and pressure. All the most interesting things for me came after 2000, I didn't do much in most of the 90s. The internet was more primitive, and there were also terrible abuses of government power under Clinton, he was no saint. So heck no. The best time is now, or preferrably in the future.

What does Ron Maimon think of citizendium?

It's censored, and uses authority to decide correctness of content, so I can't support it. It would work if it didn't have an authority fetish, and had a arbitration mechanism to authenticate knowledge independent of social authority.

What is your review of Wikipedia?

★★ Wikipedia is a failed project. It was, from 2001-2006, a great experiment in collaborative writing, but it failed on the moderatorship, and from 2007-2010, it closed itself off, and became impossible to edit and impossible to expand, and dominated by deletionist minded bureaucrats who prevent it from fulfilling its mission. It assigns moderatorship by elections, and the elections select tiers of hierarchical administrators, culminating in the ArbCom, which is a big mistake. This turns it into a totalitarian democracy, like the Soviet Union. The ArbCom is like the politburo, and you need to tow the line to stay in the organization. Anyone who is politically slightly less than popular, or has a strange idea, is marginalized, ostracized, and finally blocked. This is a catastrophe, as this means that ridiculous rules, narrowly interpreted, are now used to prevent people from writing things that disseminate knowledge in the encyclopedia. The rules are stupid, and it was always clear they were stupid, but they were expanded and became more draconian with time, with the main phase transition in 2007. We've already been through this political process before, as humans, it's in the collective memory, it's the exact same political catastrophe that happened in the Soviet Union. The only solution is to scrap the site, fork it, and start over with a new political system. In order to smash through a consensus, you need to respect minority positions, and allow them space to gather arguments and be heard, and when they are correct, to displace majority positions. This only happens under conditions of total freedom, and ability to fork. You can't do it by consensus processes, are there are cases, like biogenic petroleum, where the consensus is brain dead. So you need to constantly allow forking, challenge, and a procedure for the fork to win over the main page. This cannot happen on Wikipedia, it is permanently stuck in its politburo stage, so there is really nothing to do with it anymore. It still has good content, almost all from before 2007, which can be freely used in a later fork, which is why it gets 2 stars.

What is your review of Stack Exchange?

★★ Stackexchange succumbs to Wikipedia disease--- a version of Soviet Union disease. Since the moderation is by election from a closed group of active folks, these moderator folks begin to oppress those not in the club, by shutting out new members, and become a self-policing narrowing class of ever more narrow minded people. The result is that they will censor anything that does not accord with the most mainstream, conformist points of view, the one that happened to be dominant when the moderatorship voting happened. Your questions and answers will be deleted if they rub someone the wrong way. This is a feedback loop, as the process drives away those that disagree with the moderation, and leave only those that agree, so that the moderators are always reelected. So if you have any nontrivial new insight, even if it is well supported and can persuade on the merits, stackexchange, like Wikipedia, is no longer welcoming. So there is no point here. If nothing is original, everything is dead.

What is the meaning of a 'pathway' in neuroscience?

It's a model where neural signals go from one cell to another, finally to a particular center in the brain. The model is that this is a line of neurons, each one exciting the next. The answers to all your questions are the subject of research, the only thing known for sure is that some pathways are modified, but the effect on mental health is speculative, since we don't know the details of the working of the brain.

If you were God, what engineering facts you would want to change?

I wouldn't mind having a tail. It would be handy to move the mouse while typing.

When is the value of declared integer value automatically set to 0 in C and C++?

When the memory is reserved at compile time, not at run time. That means local variables in a subroutine, which are declared on the stack, are not set to zero, but static variables and global variables are initialized to zero, because this is no runtime performance hit.

Do CEOs truly only have a small influence on the long-term performance of a company, as suggested by Kahneman in "Thinking, Fast and Slow"?

This is complete nonsense. Someone like Steve Jobs can found Apple and make it a success, leave and have Apple go to the dogs, and come back, and make it the biggest company on Earth. The reason the ignorance argument fails is because we synthesize knowledge and have good predictors. A good CEO has a global vision and can implement it. It's not about the local decisions, which are best left to subordinates anyway. Global vision is important too.

How can I easily convert partial differential equations in cartesian coordinates into cylindrical and spherical coordinates?

The conceptually easiest way is just to do it directly, but it's a nightmare of algebra, which always simplifies in cases of interest, and you think "There must be a different way!" The different way is using the (diagonal) metric tensor and the expressions for covariant derivatives. The metric tensor is always easy to remember in cylindrical and spherical coordinates. For example, in spherical coordinates $ds^2=dr^2+r^2d\theta^2+r^2\sin^2(\theta)d\phi^2$ The metric tensor is diagonal in any orthogonal system. Then, to convert a partial differential equation, you write it in a covariant form, and use the covariant derivative formula: $D_iV^k=\partial_iV^k-\Gamma^k_{ij}V^j$ and analogs for higher tensors. To compute the Gammas, I like to use this home-grown pet formalism described in my stackexchange answer here: Ricci scalar for a diagonal metric tensor. The first section describes how to calculate the Gammas, it takes a minute. So when you have a partial differential equation, say the Navier Stokes equation: $\partial_t v_j - v_k\partial_k v_j = \partial_j P + \partial_k\partial_k v$ Replace all the partial derivatives with covariant derivatives (they are equal in flat space cartesian coordinates), and then this is a covariant equation, so it is equally true in any coordinate system. So put in the expression for the covariant derivative using the Crhistofel symbols you calculated in whatever coordinate system, and that's your equation in the new coordinates. It's time consuming, but it doesn't take long with practice. For the Laplacian, there is a certain simplification, in that it only depends on the volume form (the determinant of the metric tensor). To see this, you can use the calculus of differential forms: $\Delta\phi=d*d\phi$ Or you can do it explcitly from the formula for the Gammas, the result is that $\Delta=\frac{1}{\sqrt{g}}\partial_k\sqrt{g}\,\partial_k$ this can be used to find the Laplacian in polar coordinates or cylindrical coordinates about as fast as you can write it down. The mnemonic for remembering this is that if you do a volume integral, the sqrt(g) factors have to cancel, then you integrate parts, then the sqrt(g) is there again, because in any coordinates, Stokes theorem has to work. It's the same as the differential form thing. I am not sure if for other cases, where you have nontrivial Christoffel symbols, whether it's any faster to do it this way, or directly. But it's a lot faster for Laplacians for sure.

What do you think of Roger Penrose and Stuart Hameroff's recent paper on orchestrated objective reduction as an explanation of consciousness?

It's extremely speculative, there is no evidence that there is any quantum coherence in microtubule vibrations, this is a speculation predicated on rejecting the computational theory of mind, and (correctly) concluding that some sort of new crazy physics must happen in the brain if this is true, and speculating on what it could be. If you accept the computational theory of mind, there is no reason to think about this path. Since I do, I don't.

How do I explain context free grammar to 5 year old?

You can't, it's too young, you need to understand parentheses balancing for this, and it just can't be done until age 7 or 8, when linguistic recursion is internalized. But the basic idea is that you can make balanced parentheses of different types, like this: ([(([ ]) [( )])]) then it's a context free grammar. Each level is labelled by how deep you are, so that each time you see "open parenthesis" you "push" the type of parentheses you saw, and each time you get a "close parentheses", you check if the close paren was the same type as the open paren. The symbolic generative general definition is that you start with a rule which converts symbols to symbols taking exactly one symbol to zero,one or many. The rules generating the two parentheses grammer a -> (a) a -> [a] a -> aa a -> So that starting with "a", you generate all expressions (try following a random smattering of the rules, eventually getting rid of all the a's). The main theorem is that any grammar generated by the rules can be parsed by a stack automaton, which simply pushes a certain finite amount of data onto a stack. It is obvious for the balanced parentheses grammar, but it's fully general. The main idea is that these types of grammars describe recursive structures in sentences in modern languages, describe the recusive structure of formal languages like C, and in general model the phenomenon of linguistic embedding. But since children can't even do embedding at age 5, at least not in full generality, you probably can't teach the concept.

Did Russell understand Godel's incompleteness theorems? Is there any writing of Russell's thoughts on Godel's incompleteness theorem? Is there any reliable historic/biographic source on Russell's understanding of Godel?

I am pretty sure, from the things I have read him say about this, that Russell didn't bother with Godel's computational formulation of the theorem, but only because he understood a more specialized limited case for his theory of types--- i.e. that you can always extend a theory by using higher types. Part of the conclusion of Godel's theorem was actually proved within set theory earlier than Godel's theorem, without using the specific method Godel used (although they are related), and without the insight of how general the result is. Around 1929 or 1930, considerations of "inaccessible cardinals" allowed one to see the following: if you have a strongly inaccessible cardinal, then the sets in the hierarchy which are hereditarily less than the first such cardinal make a model for the axioms of set theory. So restricting to the submodel, you see that in this submodel, all the axioms are true, except the axiom of inaccessible cardinals doesn't hold, because the first inaccessible is not in the model! This means that "There exists an inaccessible cardinal" is unprovable from the axioms of set theory, it is an independent axiom, and this was understood a few years before Godel's theorem, as described in the first chapter of Kanamori's "The Higher Infinite". The heirarchical construction of the set theory universe is analogous to the higher types in the theory of types. When Russell was asked about Godel's theorem, he nonchalantly replied that he wasn't too impressed with it, because he felt it was simply a more refined version of the idea that the types make an unlimited hierarchy. This glib dismissal makes people say that he was completely clueless. I don't know Russell's theory of types at all, but the argument he gave seemed to be analogous to the argument above about the inaccessible cardinals. Whenever a hierarchical system has a level which can model the previous levels, the simplest model of the previous level does not include the next level, and so cannot prove the existence of the next level. This is a vague pre-Godel version of the incompleteness theorem, vague only because it is lacking the precise algorithm of the completeness theorem to produce a model from logical axioms, and the precise insight of the incompleteness theorem that any computable axiom system cannot prove it's own consistency. But the primitive insight is halfway there, it's really analogous. One of Godel's motivatons for proving the theorem, to show that you need an transfinite heirarchy of theories in order to produce all the theorems, not just of set theory, but as he showed, of arithmetic. He succeeded in showing you need a heirarchy, but he didn't actually establish that this hierarchy necessarily involved things like uncountable ordinals. In fact, this is not so. So I suspect that Russell, while not following the gory details of Godel's proof, realized it was a version of the hierarchy of type things, and this is correct, and all his statements about it come from this earlier realization, which he was more comfortable with. It seems he wasn't unaware that you needed to go up indefinitely to get completeness of mathematics, he probably understood it in the 1920s, in the same vague way explained above. The misinterpretation of Godel's theorem here is going the other way. People do not appreciate that Godel's theorem is not as much of an obstacle to formalist mathematics as it appears at first glance. What it is saying is that the iterations of the consistency conditions have to go into the transfinite, meaning into infinite orders. But as Turing argues in 1938, they do not have to go past the Church Kleene ordinal! They never have to be infinitary. So I think it is fair to say that Russell understood the main idea of Godel's theorem, but in a different way, as is natural in his earlier conception of the mathematical universe, not in the metaphysical way Godel understood it, or the computational way that Turing understood it in the 1938. I think Turing understood it best of all.

What does womanhood mean to you?

I can't believe I was A2A'd. I not only have no special insight, I am so NOT a woman, I have no insight at all! All I can do is bloviate. But since this is the craziest A2A I ever got, I feel obliged to answer. One aspect of womanhood is motherhood, the biological creativity, the ability to control the propagation of the species. This means you get to choose what kind of person gets to be in the next generation. It's not just mating choice, but upbringing choice--- motherhood is much more strict and disciplining and character forming than fatherhood is, at least in my experience. No matter how much influence you wish you have as a father, the mother's influence is always greater. The element of psychological control with motherhood is more fierce. There is a continuity of the flesh that a father cannot emulate. There are aspects of this that are unspeakable, as motherhood in extreme situations can also involves the decision of which of your offspring will live and which will die. This power is something we don't see too much of anymore, except in the case of abortion, but the sibling rivalry seems to me to be an instinct evolved to deal with such choices, which are surely maternal choices. There is nothing more frightening to me than a child unloved by its mother, left to fend for itself without resources. It's something I can't imagine without shuddering. It's not the same for a father. There is a political aspect, in that you are second ranked in any social hierarchy, always subservient to a generic male in traditional arrangements. This is something that can only be opposed by active subversion of power structure, and this is the point of feminism, Marxist feminism, real feminism. It seems to be a property of social organization that human females are "supposed to be" lower than the males they mate with, in order for the mating process to work, so that the folks will get appropriately aroused and so on, so that the mating process will involve a power gain for the woman, by inverting the power-structure found in society. It's really annoying for a leftist that your biology and your politics conflict. In this case, I suppose there are enough tricks to get the mating thing to still work even when the social structure is egalitarian. There seems to be a personal aspect of this power inversion, in that being a woman involves an element of seeking psychological domination over a socially higher-placed mate. It's an inversion of power over one specific male, and if this domination process fails, if you gain no psychological control from sexual activity, perhaps this feels like a betrayal. There is feminine attractiveness, which is more socially mediated by females defining their parameters of attractiveness and their own hierarchy internally, than male attractiveness, which, aside from obvious physical things, is mostly mediated by the authority gap. There is a feminine sexuality, which is much darker and more nuanced in shadings, and goes to greater extremes of emotion, happiness, and terror, and pain and pleasure, than the simpler stuff you find in a man. I guess there are the feminine instincts, the heightened social awareness. A man is probably best off if he is completely unconscious of all this stuff. The greater social awareness is a huge advantage for social maneuvering, but a disadvantage if you are trying to get isolated enough to do technical work. It requires a lot of meditation and observations to get good at the social awareness as a typical male. Then there is the humanity. All these statements are caricatures, they are not restrictions. We are designed to transcend any biological hard-wiring, and the act of doing so is most rewarding. So I like subverting and I am under the impression that I find it strangely attractive when a woman does something really, really un-ladylike, something obtuse and apart, on purpose.

Can I use gene expression programming to evolve C++ programs?

This is difficult, because the data structures of C++ are hard to manipulate directly, because the compilation of C++ is not simple, so if you use the whole language, like templates, you just can't evolve it at all, it will just give you syntax errors up the wazoo. If you restrict C++ to a C-like subset, then the answer is for sure yes, but you need to be careful--- if you use structs, or some such thing, you need to keep the syntax right when you evolve the struct, it's a nightmare. The traditional way to manipulate programs is by LISP code. There are existing genetic algorithms in LISP, it's easy because LISP code is a LISP LIST. To do it in a c-like language, you need to have data structures that represent the parse tree, so you can evolve the code by adjusting the actual block-structure. These things are difficult to do, genetic algorithms always use a simplified smaller language. One such language might involve a goto-only language, with a fixed memory allocated ahead of time. But if you are going this primitive, you might as well substitute a cellular automaton for the C-language, and evolve just by updating the internal data. It's hard to make evolvable structures using human readable languages, because they are designed to be written by humans, not evolved from scratch. But with cellular automata "languages" (meaning incomprehensible Turing complete messes) it's certainly doable, look at biology.

Is there any kind of relationship between the secret (law of attraction) and Illuminati?

Yes, both are largely nonsense. The "illuminati" is just a bunch of uncoordinated rich powerful people who like to flaunt their independence from traditional religion. This type of thing began in the Reneissance, when people felt suddenly liberated from tight social control by the church, because capitalism allowed them to survive and make a living even if they were free-thinkers. They also had an advantage in business, since they weren't bound by the tight church regulations on business activity. So there were a bunch fo free-thinking organizations, like the free-masons, and so on, and a bunch of secret societies that were just a way of people who opposed church control of everything to get together. They are just atheists and humanists, and they like to think of themselves as enlightened, hence "illuminati". Examples of such magick-y people are Marlowe and Newton, although Newton was into serious theology in later years, and Marlowe seems to have given up on magic by the time he wrote "The Tempest". The "secret" is a chidish fantasy. There are a whole bunch of people who do magic rituals and "secret" type things who reject traditional religion, and a handful of these people become superstars, since the rituals do allow them to focus on making connections with other people who are independent of traditional religion. Those who succeed in their attempts at fame and money naturally assume that what they did worked, forgetting about all the other ritual-doing folks that didn't make it. "The secret" is a self-selecting evolved stupidity in people who became famous and powerful at a young age. The relation between these is that a lot of "the illuminati" believe in "the secret". But this is nonsense in the modern world, both belong to the enlightenment, to a previous age. They are both stupid and harmless, and have no bearing on the important things today.

What does Ron Maimon think about the Israeli-palestinian conflict?

Certain conflicts are difficult, because both sides have legitimate claims, and have equal moral authority. The Israeli/Palestinian conflict is NOT an example. At least for the past 30 years, the Israelis are simply wrong, and the Palestinians are simply right. Israel needs to get out of all the lands acquired in 1967, allow a Palestinian state with open borders with Israel, free flow of labor and capital between the states, split sovereignty on Jerusalem (keeping the municipality intact), and admit the refugees have a right either to return or to elective compensation sufficient to induce them to choose not to. It also needs to make the citizenship process and internal appropriations entirely independent of ethnicity, it needs to grow up and become a non-ethnic state, with separation of church and state, like every other civilized nation. Israel will do these things on the day that camels fly, so I stay the heck away. If I went back, I would be drafted, and since I won't serve, that means prison. I left before I turned 15, so I could defer my draft, but I knew from 1987 on that I couldn't serve. And it's not because I'm such a pacifist, I just hate what the Israeli army is doing. My father took us to a town in the West Bank for a day-trip in 1987, when I was 14, just before the Intifada. While we were walking around, a car rushed by scattering pamphlets on the street. He picked up a pamphlet. He knows (Tunisian) Arabic, so I asked him "What does it say?" He told us "It says 'We're getting out of here.'", and off we went. It was clearly a call to rally for the uprising. Once the uprising started, it was obvious what was going on, that the folks in the West bank were fed up and organized resistance, and the military was oppressing them in terrible ways. My middle school physics teacher was called up for reserve duty, and he would report to us on the situation: he said that they could scatter the protesters with a gesture: he pantomimed moving an imaginary camera to his face, 'click'. People were afraid of getting photographed, so as not to end up on a list. The folks would gather to throw stones at the Israeli positions, then scatter when they were shot at, and this was going on week after week. The sense you got as a teenaged Israeli was that you were complicit in a terrible crime. It's not the first time one felt this way, in the early 80s, the invasion of Lebanon led to crimes, but these could be blamed on Ariel Sharon. The response to the Intifada did not stop at one bad apple, it was the entire society. So it was alienating, and one had to make a choice. The whole occupation is horrible. There were collaborators who are paid by the Israeli Army to rat out on their neighbors, these collaborators are then understandably killed by other Palestinians. There are PA government officials in bed with Israel, others are just corrupt. The natural resources are divided in a ridiculously lopsided manner, the Palestinian children are denied a decent education, and the levels of racism rival colonial South Africa. I told my parents I didn't think I would be able to serve in the IDF, I would be an objector and go to jail. They said "You will change your mind in three years, when all your friends go", but of course I knew I wouldn't. I didn't know how the jail would be, if I could survive afterwards, without a military record. Then we moved to the US, and the issue was mooted. In the 1990s, I briefly considered myself an Israeli again, I was a strong supporter of Rabin and Peres. For those who don't know, the Rabin Peres plan essentially would have created a Palestinian state with open borders and free trade by 1997 or so. Peres modelled it on the EU, it was extremely close to being realized. It was defeated when a guy named "The Engineer" was murdered by Israel, after a several years-long truce. Then the paramilitaries mourned the bomb-maker with four simultaneous bus-bombings in Israel, after years of quiet, and Peres was defeated in one of the closest elections in Israeli history. Benjamin Netanyahu won, just after Rabin's assassination. That was the end, Israel was gone, it had been taken over by the right wing. I am not even sure if the assassination of the engineer wasn't a premeditated plot to defeat Peres. Rabin's time was the last time Israel was a livable country for me. I am pretty sure that if not for the murder of "The Engineer", we would have peace in the Middle East today, it really was possible in 1994, really. It required active sabotage on both sides to stop it. Now all the smart young Israelis and Palestinians flee, to Europe, to the US, and the ones that stay are right wingers and they bring up generation after generation of more and more hopelessly stupid right-wing children. So there is no chance for peace, unless it is imposed by pressure from outside. By outside, I mean the US. With enough external pressure, Israel can be coerced into making peace, but it is difficult, and it probably requires years of serious, serious, debilitating economic sanctions, like a complete boycott of all Israeli exports and imports. Israel's economy would collapse without external trade, it's a smaller country than South Africa. Divestment works. I do understand that in 1948 there was an urgent need tor a place for Jewish refugees to flee to. I also can see the benefit in allowing unrestricted Jewish immigration to Palestine, I don't see any need to restrict anyone's right to emigrate anywhere. But recognizing the need for unrestricted Jewish immigration is not the same as sitting around in 2014 pretending that the occupation is justified, or that new Jewish immigrants deserve a better deal than some guy whose olive grove was expropriated in 1948. Sorry, no way.

What makes the Cylindrical coordinates fundamentally different from Cartesian?

Cartesian coordinates make the translation invariance manifest--- you can do a translation by just adding a constant. So for problems that don't involve a fixed center you are always best off using Cartesian coordinates. Polar coordinates are for problems where there is a rotational symmetry, because they make rotations simple. It's not deep. The intrinisic structure that tells you what coordinates you are in is the metric tensor.

What is Ron Maimon doing right this moment?

Done with Quora, answering this, and reading children's books to my daughter.

When did Ron Maimon notice he was gaining popularity on Quora?

Am I popular? I have a lot of people that block me from commeting. I have ~1000 followers, so I assume ~2,000 people read my posts at most. That's nothing in mass media terms, it's like an ad in a local newspaper. But maybe you're supposed to think relative to the total number of Quora users, and extrapolate into the future or something, I don't know. Having 1000 followers is useful in terms of communication, making sure the things you are trying to say aren't going to die with you, if people who follow you spread the ideas around. This is a networking effect. The internet is good for this. I don't expect mass media levels of popularity, it's basically impossible online today, the internet is not a monopolizing entity naturally. My goal is not that kind of popularity, but just to make sure that this website (and any other reasonably uncensored forum) can be honest regarding things that are difficult to be honest about in other older media, because money or politics could shut people up. But to answer the question specifically, there was never any qualitative change--- the number of followers has been about 2-5 per day since the first day, with a little bit of temporary uptick when I got a "top writer".

What will Noam Chomsky's legacy be?

There's the Chomsky Schutzenberger hierarchy of formal languages, and his legacy is secure in this regard--- the stack languages, the context free grammars, are indeed the ones that describe modern grammatical recursion in linguistics and also computer grammars of C and other similar languages. The mathematical theory of generative grammars is interesting, and provides the best model of complex sentence structure so far. It hasn't completely exhausted natural language grammar, in the sense that there is no BNF for the New York Times, but it's close. I think it won't take a large modification of this idea to fully describe natural language, but most linguists completely disagree (for what I think are purely academic political reasons --- the examples they trot out for this are stupid). On politics, I think he has always spoken clearly and cogently, but I think there he is a citizen, like any other, except he tends to be exceptionally well read and informed. I don't know how you can have a legacy in politics, it's ephemeral. But I admire his structural views on media propaganda in capitalist states, the things in "Manufacturing Consent". That's like a structural Marxist view of media which is very informative, without the ponderous bullshitty baggage of formal Marxist theory. But unfortunately, he has backpedalled on stronger claims in recent years. He refuses to acknowledge that the lack of recursion in ancient pre-written languages like Piraha simply falsifies the claim that linguistic recursion in ancient and fundamental to human evolution. I think this is a deplorable and uncharacteristic lapse in scientific honesty. But he might be forgiven for this, because the retrenchment came in stages, first with Walpiri and other things in the 1970s, leading to the "merge" retrenchement, simplifying the grammar to just "merge" operations, and then finally Piraha, which had no recursion at all. But it's not good, because the original Chomsky thesis, that linguistic recursion is the foundation of human thought, is original, insightful, and wrong. But that doesn't make Chomsky's linguistics dead, it is just a theory of post-written language structure and artificial language structure, rather than a fundamental theory of natural language structure in the pre-written days. EDIT: In response to the atrocious lying political nonsense in anonymous's answer below, I am reminded that there is a lot of automatic propaganda made against any honest academic leftist with a long career. I will counter it below, although for anyone familiar with Chomsky, that answer is a joke in bad taste. Chomsky has always opposed totalitarianism, he has never wavered, even when it made him unpopular on the left. He opposed the Soviet Union in the 1950s because of the restrictions of individual rights. He signed a letter protesting Tito when Yugoslavia restricted freedom of speech and assembly in the 1970s, even though Yugoslavia's decentralized socialism was the closest to his vision of a non-hierarchical society. He has always, consistently, opposed any form of totalitarianism, and he has never spoken up in support of an immoral act by any government at any time, even when this cost him politically. Chomsky opposes the control of people using money too, just as much as the control of people using governments. He supports anarchic local socialism, like in Spain in the 1930s. His commentary is brave, and accurate, and his stands have always been on the side of justice. His politics is entirely commendable. The only single place in his entire career where I have disagreed with him is his dismissal of 9/11 truth. He is just wrong on this, but perhaps he can be forgiven here too, as this type of thing is simply inconceivable for his generation.

Should Ron Paul be president? Would he be an improvement from Obama?

He's a 9/11 truther, but he's a Republican. He stayed in the party and voted with the majority on most of the issues during the last decade, and is contaminated by association. So heck no.

What should every physicist know about complex analysis?

The main thing is that the singularities of the form of poles and cuts have a direct analog in 2d charge distributions, so that a pole is directly analogous to a point source (a dipole if you are looking at the function as a field), while the function itself is the field produced by the sources. This is important because it explains why singularities are important--- the analytic function is determined by the singularities up to asymptotics and singularities at infinity. A cut is a continuous line of poles, the density of the poles is the residue-density, the cut-discontinuity. This folklore seat of the pants intuition in never explained well anymore, it went out of fasion in the late 1960s for some reason, probably to do with the decline of analytic S-matrix ideas. But it is extremely important. I gave specific examples of how to think like this in this stackexchange answer: Correlation function which has branch cut in momentum space The math books are not so good for this elementary 19th century stuff, but for multiple complex variables, which was of serious research field in the 1960s, the recent math books are good.

Is Ron Maimon high A2A price an indication of his joining of the Quora elite?

It just goes up by itself. I brought it down to zero twice now.

How do I win an argument with someone who will never admit that he's wrong?

You have to mock the person. Just assume the true thing you are saying is true, run with it, and when the person contradicts you, and says it isn't true, heckle the person. Say "How could you not know this trivial thing?". Imply the person is stupid for not knowing this. They will get mad and you, and once people get mad, they shout, and once they are shouting, all authority is out the window, and people only look at the objective facts. This is the only way to go about it, because if you are polite, authority will beat truth every time. When people stop being polite, truth wins.

Is it common among scientists to scorn philosophy?

Dennett is simply wrong about this. Having read some philosophy, more than most physicists I suppose, I can safely say that there is absolutely nothing for a physicist to learn in the entire literature, or any other scientist. If you know positivism, and you know formal logic, you know everything you need to know, and the remaining literature is trivial pompous bloviations. The reason is structural, the mechanism of evaluation is entirely political and this cannot produce progress. We know this in science, because when politics was deciding, Aristotle beat Aristarchus and Democritus. So politics by itself cannot make progress, not without honesty whips. In physics, the honesty whips are the assholes, the ones that rip to shreds any dishonest or contentless work, and these people do not exist in philosophy, they cannot, as they would tear apart the whole field, even most of the work of folks like Dennett, who are honest and say nontrivial things that are correct. The dislike of philosophy is due to the fact that it is done internally better within physics than in the philosophy department. Already this was noticed by Bohr and Heisenberg in 1927 or 1928, when they went to address a philosophy conference regarding quantum mechanics. The philosophers simply are not academically honest, and they kicked out their best practitioners, the logical positivists, and buried their work. Their pontifications may be safely ignored. It doesn't help that every few years, someone like Kuhn or Earman comes into physics and pretends that they have an insight. Their insight is invariably tripe, and this is obvious to anyone who knows the field, even a non-expert. This type of thing is galling, and doesn't help the credibility of philosophers. The situation is not symmetrical, as physicists can understand everything philosophers do quite easily, and contribute meaningfully without any problem. So it's an asymmetrical situation, the difference between a bullshit academic field and a real one.

What does Ron Maimon think about cultural marxism?

I just looked it up, and from less than 1 minute exposure, it looks like it's a fruitful line of study in the humanities. For instance, you want to understand the implicit advertisement of drugs in the music, publishing, and film industry, where drugs were positively portrayed for decades in what is obviously a coordinate social movement and not a conspiracy. You need to understand how this links to the economic and social distribution network that emerged to distribute the drugs themselves. It seems that there was a structural advertizement industry developing, without any formal direct support. Again, the military themed computer games of the last decade seem to have a structural connection to the militarization of the economy. In the 1980s, the rise of consumer electronics gave rise to movements in fasion that were linked to the transformation of the economy. I think this is useful, but I am no expert. The analysis is difficult, because you need good data on how money flows and social handshaking can produce a link between social movements and capitalist industrial production. I don't know, looks interesting, never read it, I am not a humanities guy.

How do I Ron Maimon?

First you need to Ron. For this purpose, I suggest you try to Ron Howard, Ron Jeremy, Ron Burgundy and then Captain Ron. If you Ron Jeremy, don't associate me with it, you know it will end up the top thing on google when they search on my next job application. Then you need to Maimon. For this purpose, you might want to Shiri Maimon, although you probably won't need to Eurovision, then Gaby Maimon, which is probably hard, then Maimonides. To do the latter, simply pontificate about Aristotle and Judaism and mumble about God being only describable by negative qualities or something like this. Then you can Ron Maimon by doing both at the same time. It's quite difficult, I think, as I only manage it half the days of the week.

What do Quorans who are interested in 9/11 make of this article?

It's complete nonsense, the Saudis had nothing to do with it, they had no interest or involvement. The 19 folks were Saudis, but they were mostly under pay by the CIA, not by Saudi Arabia. The redacted sections were probably bush trying to protect folks in the Bin Laden family who had nothing to do with it. This is another distraction from the inside job, stop wasting time, it can't work, we have an internet today.

Our language is old, it was designed many hundred of years ago, and it's difficult to talk to one another. Should we not build a language where the words have physical references like the language of biology or engineering?

It's interesting as an exercize, and loglan (now Lojban) is an example of an artificial interesting language. I wouldn't expect people to use it, however. If you want to communicate better, you can look at artificial languages in artificial domains, like those from computer science, or mathematics.

What would Ron Maimon do as President of the United States?

Mostly what Obama promised he would do when he ran for president, but has not done. I would close Guantanamo and release all the prisoners, apologize to them and their families, and award them an enormous reparation package for their detention. They are all free to go, Sheik Khalid Muhammed too. Sorry. Go home. We had the wrong guy. I would serve indictments to all involved in torture in the Bush administration, and have them stand trial for allowing torture under laws which prohibit it. I would indict those involved in espionage as well. I would charge a panel with a new 9/11 investigation, which would be required to interview all CIA and miliitary personel regarding the drills of that day. They would be required to present the simulation evidence to my own personal scientific review, and I would have an hand selected panel of scientists review the evidence and my review, openly, in public. I would, depending on the results of the investigation, indict one or another of the members of the Bush administration for treason and murder regarding the events of 9/11. I would issue an executive order regarding secrecy: all documents which someone intendeds to classify secret must be audited by a small department of about 10-15 hand-picked secrecy auditors. They will all be people I know and trust, and their primary mission will be declassification. They will reject the document unless they find the stated reason for secrecy compelling in regard to the specific document requested. This should reduce the number of documents classified to about 100,000 pages a year at most, given their ability to read, with onerous delay for classification, as opposed to the millions of pages currently classified for no reason. Their promotions and pay would be tied directly to how much they can reject, how little would get declassified. The more you declassify the better. If you think this is impossible, consider that one classified document can be referenced by a hundred declassified ones. There is no reason at all for the secrecy, it is preventing review of government function. With this type of thing, it would be just categorically impossible to classify any documents with a secret stamp without someone in the small auditing department reading it signing on it. If it is at all controversial, and it is going to be secret, I would, as president, want to read it myself. The goal of this auditing department is to make sure no secret activity can be done without presidential approval, so no more surprise shenannigans like bay of pigs, or an assassination of this or that person. If your stuff isn't secret, it is public--- your government communication will be available to be read by anyone whenever they want. If it is secret, it will be subject to intense review, so that a lot of people will read it. The goal here is to declassify every document, with the goal of keeping secret only those things that absolutely must be secret, like the locations of nuclear submarines, or the names of informers in other countries. I would appoint a CIA director with a mission: to get rid of anyone who was working in the agency prior to 2009. No warning, just a slip, you're fired, go home. You can get a pension if you deserve it, so that you don't have incentive to spill the beans to some other intelligence agency. Everyone there should have resigned, they know what kind of things were going on. Anyone who didn't resign is complicit. I would do likewise with career government officials in other departments, who have political influence. I would mandate that the CIA stay out of state and Federal government, that they provide information when asked and do nothing else. I would appoint a homeless man to head homeland security, and ask him to hire all the homeless people he can find to staff the security wing of this department. I would ask them to do nothing. Draw a paycheck until Congress dissolves the department. What I would really like to do is restore the Immigration and Naturalization Service as an agency, and get rid of every additional deparment in homeland security, leaving only the INS. You can do this with your homeless buddy, he can find some real shifters that don't want to do anything. Then I would request a drastic budget cut for intelligence, and reconfigure it to do intelligence only, no black ops. The way to do this is to only allow incoming documents to be secret, all outgoing directives need to be reviewed by a reviewer. That wouldn't take long, maybe one or two months. I probably would get shot by a CIA sniper during this time, so I wouldn't be able to do anything else. But assuming no sniper gets me, then I would ask for a few changes to policy. I would investigate nuclear and alternative energy through DoD and NSF grants, I would investigate artificial biology, with the goal of making resistant fuel-producing bacteria (this is an ongoing project, I would make the investment larger). I would authorize the deployment of Thorium reactors, and experimental design of an underground energy plant using fusion nuclear explosives, so long as a panel of scientists were able to determine that the explosives can be made useless outside the plant, using appropriate triggering tricks. I would support the funding of an Orion rocket, assuming an international treaty for acceptable levels of fallout can be negotiated. Internationally, I would close foreign bases that have outlived their usefulness, such as those in Korea. I would put pressure on the Israelis to make peace, by withdrawing aid entirely, and restoring it on harsh preconditions regarding settlements a peace offer, and threaten to withhold veto aid at the UN unless there is an immediate withdrawal to 1967 borders, with negotiations regarding the Jerusalem municipal area, so that it is under joint Palestinian/Israeli sovereignty. If the Israelis say no, they are on their own, no more US aid either in the UN or with money. I would ask Congress to pass a smoothly tiered corporate income tax, and make automatic small-business aid in tax structure, so that small businesses are propped up with a slight negative income tax. I would request an increase the top levels of the Federal income tax to approximately the 1970s level, and increase minimum wage to the 1970s level, with the goal of producing rough income equality. I would ask that contracting law be revisted, so that contracting can be made uniform and standardized, with the goal of allowing competition by small firms at all levels at all times, without requiring political action. I would issue a pardon to small non-violent drug offenders, and request a change in drug laws. I would prefer to see that all drugs are available in clinics, under registration, to be consumed on premises, free of charge or at a nominal fee (they aren't expensive when they are legal). The goal here is to bankrupt the drug industry entirely, and provide treatment to users. The rest you can imagine, I explained my political beliefs elsewhere.

What are the best ways to "evangelize" about math to people who don't like the subject?

You need to show them what excited you as a teenager, when you first got excited. There are deep ideas there, and the subject sells itself. The only people who really don't like the subject are those who have been systematically deprived of exposure to these ideas by schooling. It is important to not dwell on history, but to give modern material and unsolvable problems quickly, so that one sees that the subject is open ended. Good examples are provided by the Ising model, fractal geometry, number theory.

Does calculus have a point?

It has many points. The main point is a little buried in a modern treatment. The point is that it is consistent to imagine little itty-bitty numbers, infinitesimals, adjoined to your conception of the real numbers, and these infinitesimals contain the idea of limit and asymptotics. So for example: (3 + dx)^2 = 9 + 6dx where dx is an infinitesimal, so I dropped the dx^2, because the square of an infinitesimal is twice more infinitesimal than the infinitesimal and can be ignored. By definition, then, 6 is the derivative of squaring at 3. That means that 3.001^2 = 9.006 up to certain negligible corrections. You can use this for party tricks: (1 + dx)^n = 1 + n dx so that sqrt(1.01) = 1.005 You can use this to do arithmetic well, after you internalize the idea. You can also do calculations with trigonometry. Once you know enough, you see that sin(dx) = dx for infinitesimal dx (in radians) so that sin(10 degrees) = 10 * 2pi/ 360 to a good approximation, because 10 degrees is small. It allows you to approximate quickly. This infinitesimal idea is due to Cavalieri, it was developed by Leibnitz (Newton always thought in terms of limits), and it was given it's permanent final form inside modern mathematical logic by Abraham Robinson, after a century of suppression. It's a very exciting idea, it really is one of the greatest ideas humanity ever had. The next idea is that these infintesimals capture the notion of velocity. So that x(t +dt) = x(t) + v(t) dt The velocity of the velocity is the acceleration: v(t+dt) = v(t) + a(t) dt When dt is infinitesimal, that's calculus. When dt is .001, that's what you do on your computer to simulate physics. You can do it, because a(t) is known from Newton's law a = F/m and F is given as a function of the position. That means, knowing x and v, you can calculate a, and then update x and v at the next dt. This "closes" the system of equations, it allows you to simulate the motion. This was understood already by Newton, but the clear statement everyone remembers is by Lagrange. The next idea is that infinite power-series converge in series to a class of functions of high importance, so that you have infinite series of successive corrections when dt is not infinitesimal. x(t+dt) = x(t) + v(t) dt + 1/2 a(t) dt^2 +... when dt is not infinitesimal, there are all these orders. It allows you to indentify certain functions as infinite polynomials, and treat them as polynomials. This idea is due to Newton, it was greatly developed by Euler, and it was made stick by Cauchy and others in the 19th century, in the development of complex analysis and analytic function theory. The next idea is that areas and derivatives are related. If you look at the area under a curve from 0 to x: A(x), then A(x + dx) = A(x) + f(x) dx (you can see this by drawing rectangles), and therefore f(x) is the derivative of A(x). This allows you to give a systematic calculus for areas. This theorem is due to Isaac Barrow, Newton's advisor. It was what led Newton and Leibnitz both to run with the idea. The next idea is that of differential equations: you can express algorithms with steps which are infinitesimals as equations. For example, if you write down: df = f(x) dx Where df means f(x+dx) - f(x), then you can compute f given an initial value. This allows you to speak about algorithms--- a differential equation plue a little stepsize defines an algorithm to compute f, and if you iterate it, you do physics. This idea was developed by Newton, Euler, a million people each focusing on a different differential equation, and today there is an industry for understanding these equations. The next idea is of partial derivatives, that if you have a function of several variables: F(x + dx,y +dy) = F(x,y) + F_x dx + F_y dy One set of ideas here are the Legendre transform, swapping out y for F_y, which is ultimately explained by statistics and Gaussian integrals. Then there is the idea of vector spaces, and linear tangent spaces, and differential geometry, which leads to General Relativity. In another generalization, these linear spaces extend to infinite linear spaces, the Taylor polynomial series can be swapped out for better behaved Fourier series and other polynomial series, like those of Tschebycheff, the function classes expand to include random walks, and non-smooth monsters that are convergent in the 19th century, the notion of integration becomes universal in the 20th century due to Lebesgue Cohen and Solovay. And you are in the modern world. Each of these topics I mentioned above deserves at least a month or two of serious study, and they all intelectually begin either with Newton doing differential equations and power series, or with Leibnitz doing infinitesimals. This is what gave birth to modern mathematics. The development can be seen as the point of calculus. There are extensions of the idea that were worked out recently. Ito calculus describes the motion of random walks, and it is related to the Feynman path integral, which describes integration over spaces of paths. The main idea here is renormalization, which is the taking of infinitesimal limits inside Feynman path integrals--- these ideas are being worked out today, they were worked out internally to physics in the 1970s, but they need to turn into rigorous mathematics very badly. For a deeper overview of how to motivate calculus, you need to learn a little bit of the previous calculus that is it's namesake, the calculus of finite-differences. This motivates the elementary development, and I reviewed it quickly in my answer to this question in stackexchange: How can/does calculus describe the movement of a particle?

Do the violent aversion to homosexuality and violent aversion to the Christian opposition to homosexuality both violate Aristotle's golden mean?

The idea that the good is to be found in the middle between two extremes is Aristotle's ethics, and it's another stupid bit of nonsense that sounds persuasive to high class genteel people. The truth is not found between two extremes, it's usually one extreme or the other. For example, consider the question of which planets go around the Sun, and which around the Earth. Aristotle said they all go around the Earth. Aristarchus said they all go around the sun. Brahe made a golden mean, and said that Venus and Mercury go around the sun, and Mars, Jupiter, Saturn go around the Earth. I'll let you figure out how well that went. Compromise is how you find the middle in politics, it is not how you find moral truth. So it's not true that some slavery is wrong, and other slavery is OK, all slavery is wrong. It is not true that some kinds of human sacrifice are acceptable, and others not, all are unacceptable. Generally, the rule works because any simple rule you make up is not going to capture well the nuances, and so will fail sometimes. This principle makes it seem that moderation is good, because any rigid rule is not complete. But the incompleteness of simple descriptions does not mean that there isn't an absolute hard truth, it just means you don't know what it is, and any simple textual description of this truth is insufficient to capture the nuances. But that's not the same thing as saying that the good is in the balance between extremes. For example, George W. Bush made a balance between conservatism and liberalism: he was fiscally irresponsible and politically authoritarian. That was a golden mean of sorts too.

Is an empty set the same as "does not exist"?

They are not the same, and this is a confusion for people beginning in the study of logic. There are two different things--- the logic, which is like the instruction set of the computer you are using, and the data, the model you are thinking about, which is like the things that could be inside the memory of this computer. The "does not exists" belongs to the logic. It is making an assertion about the universe from outside the universe. The "empty set" describes data, it is an element of your model, of your universe. When you say "does not exist x with property P", if you can somehow bound the things with property P, so that there is a set S which contains all things that could have property P, then you can convert this to another statement about sets: the set of all x in S with property P is equal to the empty set. The two things are purposefully chosen to be related, so that the universe can model universes logically constructed starting with first order logical axioms, this is why set-theory universes are convenient for logic. You can take the union, that's like "or", or take the intersection, "and", symmetric difference "xor", and the set operations which are elementary correspond exactly to the logical operations which are elementary, they are both boolean algebras. The thing that makes set theory interesting is how to make infinite ordinal models and define induction on higher and higher ordered sequences. This allows the mathematics to become more complete without limit at the high end.

How do I find the shortest path between two points on the surface of a three-dimensional object?

It's correct because the unfolding transformation preserves distances of all curves. You need a finite search though the different unfoldings to find the best line, that's all.

Has Congress ever investigated whether the 9/11 attacks could have been prevented?

The 9/11 attacks were done by an official in the Bush administration. There is nothing to investigate, pretty much everyone figured it out by now, except the public.

The faster you travel through space, the slower you travel through time, and vice versa - Does this have a mathematical basis in physics?

When you are moving away from a position and then back to the position, very fast, your trajectory in space time makes two legs of a triangle. A friend that stays home makes the third leg. In geometry, the length of two legs of a triangle is always longer than the third, it's a consequence of the pythagorean theorem. In relativity, the pythagorean theorem has a minus sign for time, and so the sum of the two legs is shorter than the third, when all three are mostly pointing in the time direction. The length of the time-pointing leg is the time passing along the leg as measured by a clock moving along the trajectory of the leg, by definition. To understand why the pythagorean theorem has a minus sign, you should know that for flat space, so that parallel lines are unique and parallel and described by linear equations, there are exactly three possibilities for a symmetrical space, the Galilean space of Newtonian mechanics, where space and time are separate, the Euclidean space of geometry, which reduces to Galilean space when all the slopes are small, and the Einstein-Minkowski space, with the minus sign in the pythagorean theorem, which is the spacetime of special relativity, which unlike Euclidean geometry contains special slope--- the slope of a light-ray trajectory in space-time. The Minkowski space also reduces to Galilean geometry for small slopes, in space-time, that means small speeds. To understand this, I gave a quick synthetic proof of the relativistic pythagorean theorem in my answer to this question on stackexchange: Einstein's postulates <==> Minkowski space. (In layman's terms) .

What are the best research papers on wormholes at a level suitable for advanced undergraduates?

Einstein and Rosen's paper. Almost everything else is arguments against. The maximally extended Schwartzschild is a non-traversable wormole, as is maximally extended Reissner-Nordstrom which is traversable, assuming the Cauchy horizon is crossable, which I think is a safe bet classically, probably quantum mechanically too. These are easy to do for an undergrad, they are spherically symmetric. It really wasn't a big thing until Maldacena and Susskind.

Does Ron Maimon ever admit that he's wrong on Quora?

Yes, in those instances when I'm actually wrong. "Actually wrong" means I said something false. That means, tell me what I said, and tell me why it is false. If you do, thank you! I learned something. That's not the same thing as opening a book and showing me that such-and-so authority said something that superficially seems to disagree with what I am saying. More than half the time, that's YOU not understanding the context of the statement in the book. Sometimes, you are getting it right, just the book is stupid. I'm not responsible for what some other person wrote in some book. You need to understand what's going on and explain it, so I can see that the thing in the book is right. If you put in this work, you will see I didn't get it wrong, because the stuff on quora is usually low-level bullshit that I already know from years and years ago, and have no confusions about. But I say wrong things all the time. For a recent example of me being stupid, I said something idiotic a day ago about the number of binary heaps you can construct from a list of values. I noticed that some trees with different values allow different permutations that keep the heap condition, so I said that the number of permutations should depend on the specific values. This is obviously stupid, the condition only depends on the linear order of the elements, not on their values, and I should have seen it immediately, but I didn't. Someone had to say it, and I had to say "sorry, stupid". And that was that. Another example is where I claimed you couldn't get an 8-cell embryo in IVF. Yes you can. I told a lady she was wrong to claim it can be done, she pointed me to a website, and I found out that she was right, because the website described 8-cell IVF embryos implanted. Of course she knew better, she had the procedure done! I apologized, and corrected my question, and thanked her. It's easy to get me to say I'm wrong. SHOW ME I'M WRONG. I don't want to believe stupid things anymore than anyone else. I did that enough in the past. But more often than not, it's YOU that is wrong, because you trust authority too much and don't know how to think.

In path integral formalism, why does each path contribute to total amplitude only in phase (proportional to the action for that path) and not in magnitude?

It contributes in magnitude too, sometimes, when you have a determinant weighting the different paths. So if you change variables in a path integral, you can get a weight in addition to a phase. But for ordinary Schrodinger particle quantum mechanics in a potential (even with a magnetic field), it's pure phase. The reason in the potential case is that the path integral is a continuation to a limit of statistical thing, where the action is purely real. You just go through the derivation. The Schrodinger amplitude obeys a diffusion equation, except with an "i" multiplying the time-derivative. Otherwise, it's just sourced diffusion. The imaginary time version just drops the i from the dt, and is a pure diffusion equation. The sourced diffusion equation has an interpretation in probability--- particles appear from the source, do a random walk from the diffusion, and disappear at the sinks or hit the boundary of your time domain. To find the distribution at the end, you just sum over all the paths a real valued quantity which is the probability of the path. To get to quantum mechanics, you then need to continue the time variable analytically to pure imaginary values. When you do this, the probability, which is an integral over time, becomes a pure phase. The continuation can't be done computationally efficiently for sure, because you can simulate the imaginary time probability business using Monte-Carlo, while the usual quantum path integral can't be calculated efficiently, because it includes quantum computation. The higher energy states required for quantum computation die away exponentially fast in the imaginary time formulation, and resonantly contribute when you continue to real time (where the action is pure imaginary). It's a property of the particular quantum system you are looking at, Schrodinger quantum mechanics. It is also true for field theories without determinants, like scalar field theories. For Fermionic field theories, the path integral is weird, it's by Candlin/Berezin style Grassman variables, and there is no sense in saying it's pure imaginary. For field theories with determinants, when you change variables, it's often partly real, so that you have an amplitude magnitude difference on the paths too.

When I open a program like Pspice or Matlab on my Asus K55VM, its fan works faster and makes CPU 100%. After I close the program, this keeps happening. Why?

try adjusting vm.swappiness, that's usually the problem if you have slow Linux. the swappiness is set too high on some distros. Sorry, I made a mistake, from the comments I see you use Windows. This allows one to diagnose your problem much more easily: it's Windows.

What does Ron Maimon think of the show The Big Bang Theory (TV series)?

I watch it, once every few months, when I visit my father's house. My mother used to record it on DVR, and since she passed away, the DVR cotinues to record her favorite shows. It's funny sometimes, but not too funny, a conservative kind of sitcom funny, that isn't allowed to transgress. The thing that made it interesting in the beginning is that the physics culture it was trying to describe is extremely transgressive, it denies authority, it doesn't care about money, and it only respects actual knowledge, so it destroys American cultural idioms. It's a Soviet culture, really, and it is completely incompatible with traditional American TV tropes. That made it difficult to write and interesting to watch, because you would think "How in heck are they ever going to be able to put THIS physicist behavior on television?" But this can't last. Writers rotate in and out, and network have standards of propriety and product tie-ins, so they had to choose which to stay honest to, the physics culture, or the American culture, and the physics culture lost. Suddenly all the physicists are supposed to love trashy sci-fi and comic books, the capitalist products geared at nerdy males, rather than the Soviet stuff that physics was actually built on--- cold heartless machines. The first season was more or less accurate, in that it had two characters who were actual honest-to-goodness real physicists--- Sheldon Cooper and Leslie Winkle. Sheldon Cooper was the perfect idealized physicist asshole, a young version of Pauli. Leslie Winkle was another perfect physcist asshole, she was a female version of Pauli, like Madame Curie or Emmy Noether. Both were accurate characters at the beginning. But as a male physicist asshole, Sheldon Cooper was annoyingly more attractive than he was supposed to be, given what his social standing should be from his anti-social behavior, so he had to be completely emasculated by making him sexless and childish, actually autistic, and this happened in the second season. As a female, Leslie Winkle was too dangerous to even talk about, because she was transgressing by fucking, as is usual for transgressive females, and that's something that is just absolutely forbidden to talk about on American television, because it is destabilizing to society. So she had to be written entirely out of the show in the second season. Now it's just a stupid TV drama like any other, sometimes funny, but in the usual stupid way.

How do we motivate people to reproduce the results from datasets so that science can be more reproducible?

Simply the threat of someone checking the dataset is enough for the producer of the open dataset to be careful and honest. If that is so, the data is likely accurate, as any mistake would be an honest mistake. Auditing doesn't need to exceed 10% for people to be scared it will happen to them. So there's nothing to do, just make sure the datasets are open, and they will be accurate.

Why is computer science a science?

Computer science studies Plato's realm, it's a form of rigorous theology. It studies algorithms, bits, and software, the same way the natural science study hardware. This might look like it has no natural science application, but this is not so. Biology is the implementation of sophisticated computer-science algorithm in nature. So many, perhaps all, the ideas of theoretical computer science have direct application or analogs in mathematical biology. It's the theoretical mathematics appropriate to biology, the same as calculus described Newtonian mechanics.

What is the symmetry that gives rise to conservation of information?

The information is not conserved on a single trajectory, it's conserved using a continuous family of related trajectories, a density of trajectories, so Noether's theorem doesn't apply. It doesn't have a symmetry associated to it. In quanutm mechanics, it's the statement of unitarity of time evolution, the "symmetry" in question is the ability to change basis. The analog of this is the symplectic "symmetry" of the classical phase space. I put "symmetry" in quotes because it has nothing to do with the form of the Hamiltonian, it's a general structural property of the space of solutions. There is no actual symmetry corresponding to conservation of information. It simply says that you can choose any basis quantum mechanically, or any symplectic coordinates classically, and get the time evolution to work by Hamilton's equations /Heisenberg's equations.

What's the science component of Computer Science?

Computer science is right on the boundary between science, mathematics, and engineering. When it's about theorems and conjectures, it's really mathematics, the kind of mathematics that mathematicians don't like to do. When it's a science, when you find a Turing complete system in nature, then it's biology, the kind of biology that biologists don't like to do. Because it evolved from an engineering discipline, and pure logic, it had a lot of growing pains, but it doesn't matter how you classify it, it is what it is, and it's extremely important. Feynman used to say "Computer science isn't science. We built the computers!" But he wasn't right. There are computers in nature! We call them living things.

What do mathematicians think of Metamath?

I am not a mathematician. But the project is for sure worthy, this is something important to do. But the specific syntax is somewhat cumbersome, and I didn't see a way to encapsulate the proofs so that you don't need atomic deduction--- nobody does atomic deduction, there are always these shortcut things that are like macros that expand out to atomic deductions. I wasn't a big fan of the sigils of the |- notation, or the "let" command, the symbols need to be chosen artfully, and you need to make a fluent syntax so that it doesn't feel as cumbersome as COBOL. Also, there is no standardized axioms. Other programs I saw, I think it was Coq, seemed to have a more friendly syntax and had a standard Grothendieck extended set theory (maybe it wasn't coq). But I haven't worked with it, I only read the manual, and I don't want to say anything negative, because this type of stuff is needed now, and perhaps the code is easier to extend. Regarding the general program of fully formalizing proofs--- it works better for algebraic things than for geometry. It's very hard to formalize geometric proofs in this way, because a lot of times there are hard to formalize construction steps that involve filling in continuous constructions that as a human being you just "know" have to work out, but it's hard to put in a computer. But there should be a good syntax for that too, and once there is a good syntax for the basic stuff, a geometry syntax is definitely coming. But it's going to take some decades, I think. Just a worthless opinion, focusing, as I always do, on the limitations. There is obviously a lot of good work that went into this project.

What is the deal with the "small dogmas" of science?

They are present because science is built up very quickly from insufficient data by a wave of speculation, and if a speculation survives the data for a long time, it becomes engrained. This is good, because most of the speculations that survive for a long time survive because the data doesn't contradict them. The problem is when they are wrong. That's what the internet is for, it gets rid of the small dogmas quickly. Because this is happening right now at an instantaneous pace compared to previous eras, you get the feeling there are more untenable dogmas around now than before. But it's not true, they are just getting exposed a lot more quickly.

What exactly happened in Benghazi and what should I know about it?

I was A2A'd, but I have not read about this, and I can only speculate. But I get the feeling almost everyone else is also guessing. Regarding the event, I tend to agree that it was a coordinated planned terrorist attack by 10-15 folks in an armed military group with some sort of claimed affiiliation to Al-Qaeda. Such groups have no interest in attacking the United States, it does them no good, but they are usually completely infiltrated, they are full of agents from various intelligence agencies. I don't know if there are any members of such groups who are not intelligence agents for somebody, although in Benghazi, there might have been a few non-agent fighters left over from the recent revolution. These intelligence agents from various places nudge the group to pull off one insane attack or another, like operation Gladio in Italy. It must be stressed that nobody in Benghazi gains anything from these crazy attacks, nor was there any real hostility in Libya towards the United States, the US has no presence there, the US helped with the revolution, and Khadaffi's supporters are gone now. So I'll spin what I consider the most likely yarn: a fellow at the CIA was unhappy with the Obama administration, and wished to make a terrorist attack before the election, to get Obama politically. So he emails agent X inside Al-Qaeda in Benghazi and asked him whether there were any plans to attack American targets. The agent says "yes, some crazy lunatic wants to go after the embassy, but it was voted down". So the CIA handler guy says, "Get together with the fellow, tell him you changed your mind, and get a small team which can do this, and I'll see what I can do with providing you with the security plans, and getting you inside on sept 11." The agent gets the team together, the attack happens as planned, the agent shoots some people, he prods the other group members to shoot the Ambassador, they get out, he reports success to his handler. So CIA guy thinks, "So a terroris attack, on Sept 11, what a huge scandal this is going to be!" He then leaks some documents about the attack to make sure that a lot of top political guys know that an attack just happened, and waits for the political fallout. But Obama's White House realizes this, so they make up stupid bullshit to cover it up, until after the election. It works, the cover up is sufficient to pull through until November.They say it was a spontaneous uprising, whatever, they just don't admit anything happened. So this CIA guy is raging! He must have been pissed off. A terrorist attack just happened! How can they cover it up and claim it was a spontaneous uprising! Despicable behavior! Then you get a bunch of prominent Republicans, the ones who were tipped off about the attack, foaming about the cover up. They should be foaming about their CIA guy purposefully instigating the attacks. It's a conspiracy of one person, as always. Someone who has contacts and can make things happen makes an attack happen. This stuff will never end until the CIA is purged from top to bottom, and reconfigured as an intelligence agency again, not a group of nefarious schemers in charge of black-ops. I am very happy Obama lied about it, I wish he would lie more. In cases like this, lying is the only thing to do. It would be best if the CIA is reconfigured so that this type of lying is unnecessary.

How reasonable is the general idea that gravity might be an emergent force?

Wen is a great physicist, and he had an idea. I don't want to criticize it too much, because it is a new idea, and you need to respect this. In this case, his observations are similar to those of Zaanen from the late 1990s, who noticed that elasticity theory resembles GR mathematically, but there, atomic scale defects add a new twist. Wen is pointing out that you can make a theory of spin 2 particles using some crazy lattice Lagrangian on a bunch of scalars. I didn't check it, it's probably true that the excitations are spin-2 at long distances, it is possible to make such a thing, and Wen usually knows what he is doing. But there is no way in heck to produce a quantum gravity from any sort of lattice field, at best you get a peturbation theory of long-wavelength gravitons. The paradoxes of black holes show that you can't describe gravity with field theory, because the field theory description must break down near the horizon, where the 't Hooft quantum field entropy diverges. The black hole entropy is finite and proportional to the area. To reconcile these ideas, the main lesson of string theory is that you can't stay in field theory, you need a holographic description, and such a description is always formulated on asymptotic states, on boundaries, either at flat infinity, as in S-matrix theory, on on black hole horizons, as in AdS/CFT. So Wen's model, while probably producing a spin-2 excitation, doesn't reproduce gravitational physics in a physical way, in a way consistent with black hole entropy and holographic principle.

Do extra dimensions actually exist? I understand the importance of representing time as a dimension, but I still question: does this dimension exist outside of the concept?

The extra dimensions are there because of how black holes oscillate. When you look at a gravity theory, each different way a black hole can oscillate is necessarily a different dimension, and adds to the fundamental entropy of a piece of horizon. There is a strict consistency relation for the entropy of black hole horizon that picks out a certain "central charge" (count of number of oscillations), which is 24 transverse oscillations, and this defines the dimension of bosonic string theory. When you have fermionic oscillations, the count is increased faster, so that to get the critical amount of degrees of freedom, you need 10 dimensions. But the strings themselves (in type IIA strings) are later seen to be tightly wrapped membranes, because this explains their free-parameter coupling, and these membranes must oscillate in 11 dimensions. The basic constraint is that you need just the right number of degrees of freedom for the oscillation of a black hole to make sense, and this means that you need exactly the number of dimensions in string theory. But we live in three dimensions, so are the black holes we see mathematically inconsistent? Not really, because the inconsistency only shows up at high energies, at small scales. We can understand that the three dimensional oscillations are appropriate to low energies, and the extra oscillations are the ones that only appear at high energies. That is the same as saying the dimensions are wrapped up small. It can't be just 3d space all the way up, because then you would violate the degrees of freedom count for black holes at short distances. If you find non-geometric degrees of freedom, you can use those instead, the extra dimensions don't have to be interpreted as dimensions, because when dimensions are small and quantum, you don't have full freedom of motion in those dimensions, you are limited to filling up a few quantum states. The consistency thing picks out the dimensions of string theory, and tells you you need extra stuff, but in our universe, it doesn't mean that we necessarily can shove particles into geometric looking extra dimensions, the extra stuff might be very abstract, and only related to geometry in a loose analogy. There are all sorts of string models out there.

Is it possible that when we image magnetic lines of flux in a bar magnet using iron filings that we are actually imaging the worm holes of entangled electrons in the two poles?

The magnetic fields are in real space, they are fields, while the wormholes nonlocally link up the interior region of entangled electrons in the Maldacena Susskind idea, these are completely separate things. No, there is no relation between the field lines and any entanglement. The Maldacena Susskind idea is about trying to understand black hole interiors in string theory, when these can form Einstein-Rosen bridges, non-traversable wormholes. It is speculative, but it is an important speculation, because black hole interiors are just out of reach for a string theory description, and it gives a hint about how it might be possible for strange classical wormhole solutions to emerge from string theory. These have been unembeddable in string theory previously, and even the Maldacena-Susskind idea might not really work to produce a real wormhole, I think the jury is out (just because I don't understand it well enough to say if it is correct). One should say that it is not really a form of entanglement that the electrons are spinning the same way on both ends of the magnet, it's just classical correlation. It's hard to tell these apart in this case, because entanglement is just a quantum version of correlation, but there is no sense in which a measurement at one side of the magnet collapses the other side, because it's at room temperature and decohered, so this can provide a positivist definition of the statement "They are not really entangled".

What is the relationship between music and math?

There aren't much. Music is an art in patterns, while math is an art in different kinds of patterns at a much higher level of abstraction. Schubert and Beethoven weren't mathematicians. But there is a formal language aspect to music, in that the 12 tone scale is like integers mod 12, with a certain harmony pattern. The stuff you read in music theory is useless, so I'll tell you the real deal. To do this, you need a notation. I will name the 12 tones with single capital letter names: CJDKEFLGHAIB The letters A-G are the standard English note names: C = do D= re and so on, while the letters HIJKL have been added, keeping the name "H" for the semitone between G and A, as was traditional in Bach's time. This way you don't distinguish the tones from one another by calling some of them "sharps" or "flats", they are all symmetrical, as the are on the scale. You also need a notation for relative tones, to describe tones which are different from a given tone. I will use the following: abcdefghijk for +1-+11, l for +12 (octave), then la lb lc for the next octave up. To go down yxwvutsrqpon represent -1 to -11. m is -12, while z is zero, or just another name for the tone itself. These little letters are relative to the big letter, so that Cdg is a major triad in C Ddg is a major triad in D, and so on. To indicate that tones are simultaneous I use <> brackets to enclose the simultaneous tones (written vertically when not in ascii). is a major D chord is a minor C chord. To indicate rhythm, I use ordinary parentheses to divide time, and + to indicate when the tone extends over the next slot. So that CCGGAAG. | FFEEDDC. | GGFFEED. | GGFFEED . | CCGGEEG. | FFEEDDC.| Is "Twinkle Twinkle Little Star". I hate the standard musical heiroglyphs. I usually write it this way: [C][!!!!!!!!] zzggiig. | eeddbbz. | ggeeddb. | ggeeddb. | zzggiig. | eeddbbz. | The brackets means don't make a sound, just tones are relative to the key (C in this case), and the whole thing is in eight quarter notes between the bars, and the bars are nothing, just like the divisions of measures in a staff. I use scoping rules, so that allows you to play a D major chord without changing what "z" means in the outer context. for a D note without changing the conext (the stuff inside the brackets is a different local scope for the relative tones). If you want to have a melody externally and a D major chord specified absolutely, you say <d> where the innermost d is relative to D, so it's actually L, the inner g is relative to D, so it's A, while the d played simultaneously is relative to C (or whatever the outer context is). You need some links to match the "+" to what it is extending, but it works ok, you can label the + using a previous tone too, and I use - for a glide. It's just a replacement for the silly ancient notation people use, because I don't want to buy special paper, or use special software. Ascii is fine to express the ideas. The basic unit of time for a letter is a quarter notes (or whatever you decide the unit of time is). Then, to divide time, use parentheses for integer division of time, and + signs to indicate the extension of the tone into adjacent spaces: [!!!!] C (CD) (+ F) (C .) or in relative way: [C][!!!!] z (zb) (+g)(z.) The . means a rest. It's ASCII friendly music notation. The frequencies go up by a factor of twelth-root of two every step. There are two critical tones relative to any tone: e and g. The g is the so-called fifth, and the e is the fourth. The frequency ratio lz/e is equal to g/z, that's what makes them special. These have overlapping harmonics, because they are close to integer ratio of 3/2 in frequency. The major third is "d", and sort of has overlapping harmonics, while the minor third is "c", which is basically just neutral with "z". The overlapping harmonics thing is overblown, it basically only is needed to understand e and g. The remaining tones are basically all equal, except for a,f, and k. These are the most dissonant tones. To make scales, you just avoid the three dissonant tones, a,f,k. So that a major scale is zbdegi and k k is special, because it is dissonant, and used to produce the "tension before release" in European classical music. You can use a and f for a similar effect, but a "goes the other way" (meaning the melodies are going down). The minor scale is the tones zcdeghj the "real scale", meaning what people understand when they are playing an instrument in a key is the union of the major and minor omitting a,f,k. z bcd e g hij z e g are the main anchors, the bcd are the three non-dissonant tones between z and e, while hij are the three nondissonant tones between z and mg. All these 9 tones, the scale minus a,f,k, are all not dissonant with z, and allow our ear to keep imagining z is droning on underneath. When a,f,k appear, to a lesser extent d and h, there is a certain amount of dissonance, and these are often used as a transition tone to z (the tonic), the disrupt the imagined drone with dissonance. There are symmetric scales: z bc e g ij This is one of the "modes" (I don't like the way these are explained--- basically, take z eg and fill in a random selection of bcd,hij, and you get a reasonable scale, the modes are just cyclic rotations of zbdegik to make the tonic elsewhere) Which is nice, because the intervals going up can be turned into intervals going down from the same tonic. The major scale is symmetric with respect to an inversion of order around the tone "d". This allows you to write a melody, and then reverse it and play the reverse intervals relative to d, without leaving the major scale for z. There are the equal-interval scales, like the 6 tone scale: z b d f h j Which is a completely equal inteval thing which is rather dissonant, but it's like the Simpson's theme, very avant garde sounding. There is also the circle of fifths, which can be understood best this way: 0:[z] 1:[eg] 2:[bj] 3:[ci] 4:[dh] 5:[ka] 6:[f] This is arranged in terms of distance from the tonic, in steps of fifths or fourths. The closest to z are e and g, and then the e and g of e and g, which are b and j, then c and i, then d and h, then k and a, finally f. These represent how far away from the tonic you are harmonically. To arrange it in a circle, do this: fahcjezgbidkf. The middle is z, and going out you get more distant fifth-steps (going right) or fourth steps (going left) To make musical tone patterns, it's not mathematical thinking, rather it's understanding the aesthetic relationship of the tones to one another, and being able to transition from one key to another, reverse a melody, make harmonies between simultaneous melodies, and divide time in strange ways, with polyrhythms. These are the simple skills you learn in composition school. To make music using these skills is an art like abstract painting, the mathematics ends with the simple observations above.

What companies and countries benefitted from 9/11?

No country benefited at all. Indirectly, Haliburton benefited in terms of military contracts, and a few other large arms manufacturers, but that doesn't make them responsible for the event, they just had an inside man there to ensure they got first bid on doing everything. All the new industries and technologies, computers, biotech, everything, went into a tailspin as all the attention and money was gobbled up by homeland security crap, evesdropping, and military contracting. You had enormous trade shows devoted to tech before, and overnight, it turned into trade shows for worthless military nonsense. It was just a general catastrophe for the US economy, which was booming with new industry activity in 2000, and now has a decade of worthless homeland security development.

What does it take to have a stoic attitude?

What's the point of being stoic? If you want a good role model for getting completely dumped on and still doing great things, look at Richard Stallman.

Can we imagine absolute nothingness?

The concept doesn't make sense precisely because it can't be imagined. So it is best not to think it's a flaw in us that we can't understand it, rather to think that it is a flaw in us that we imagine that there is something to understand.

Could we be missing something very basic in Mathematics?

Everything looks basic after it is understood. Cohen forcing is probably the most basic thing that was understood recently, in the 1960s. This allows us to understand that it is consistent that all sets of reals are Lebesgue measurable, something which is extremely intuitively obvious. It should be viewed as fundamental as zero, or negative numbers, it's due to Solovay. Similarly, advanced techniques like those of Grothendieck and Thurston begin to look elementary with the passage of time. It's the nature of mathematics that almost all the major advances look obvious in hindsight.

What is the difference between worldsheet supersymmetry and spacetime supersymmetry?

Worldsheet supersymmetry closes on worldsheet translations, and spacetime supersymmetry closes on spacetime translations. They are a-priori unrelated, but to make a string with world-sheet supersymmetry consistent, it needs to have space-time supersymmetry (or else be a projection of a model with space-time supersymmetry). The precise connection is obscure, because it is a holographic transfer property, where a world sheet property is related to a space-time property.

How did you get smart at a young age, nature or nurture?

If I was able to do anything, it didn't come from mom and dad through genes, although my mother was very intelligent and became an academic in the humanities at a late age, we disagreed on almost everything. I learned all about academic politics from her field, I would rewrite her papers in natural English when she was still not fluent. That was helpful for general academic nonsense, but not for specific results. My father was a math guy when he was young, but he was an applied guy, an engineer, while I was more in the clouds. But they didn't dissuade, my father would give me math problems when I was four years old, and demanded that I solve them honestly. He lied to me and told me my solutions were wrong, until I had the self-confidence to assert that that was just impossible. That's very difficult at a young age, your parents have immense authority. That was helpful. He also bought me some calculus books for my 15th birthday, that was the best present I ever got. It also didn't come from teachers or nurture from the society, most of the nurture punishes you for learning anything by ostracizing you. So it come from a lot of hard internal work all by yourself. It's not nature, and it's not nurture, it's another thing, it's evolution.

The popularity of newspapers, cable channels, and local TV is decreasing and social media is increasing. Social media has many down sides such as extraneous noise. So what explains its success, is it just because of technology or also because mainstream media just gives people the news they want to hear whereas social media gives people the news they need to know whether they like it or not ?

"Social media" (the stupid name for barrier-free internet writing) has NO downsides, it's all upside. It has no "noise", that's just stuff you use to stupidly ignore it. It has an open content model, so you get the whole picture. The only problem is that it is unfunded, so you can't get deep investigations. It is superior to closed media in every respect, and if old media is dying GOOD RIDDANCE. It was crap from the beginning.

If this were the best of all possible worlds, how would Ron Maimon hope his work, presented in "Computational Theory of Biological Function I - Kinematics of Molecular Trees", would be used?

I did this stuff because I knew it was completely original from beginning to end. I figured "Whoa, dude, you just freakin' wrote the Principia, yo! Good job." while everyone around me thought "How sad. It seems that Ron went crazy." I have follow ups that I didn't put out, because Arxiv is shitty now, it requires you to get an endorsement to post. They can go stuff their endorsements you-know-where. The other papers deal with loops, replacing the stupid infinite polymers with complexes (as is the case in nearly all protein complexes), and explains how to estimate the protein computational capacity, and how to do verbs, molecular transformations. The main theorem is in the second paper, which is not up, but which I presented at a conference in 2004, which provides an algorithm for unpacking a diagram along different states into larger diagrams, going all the way down to all the species that are present. It is completely efficient given the formalism, and so there is an efficient packing and unpacking procedure for the formalism, which can make as detailed an accounting of the complexes as you like. It was used internally in Gene Network Sciences inc, where I was a member from the beginning until Jan 2005. We used it internally, as a language for describing how proteins network up inside the cell. The focus was on signal transduction, since this is what is screwed up in most cancers. There is another diagrammatic formalism, described by Kohn around 2000, but I think it is primitive and arbitrary compared to the thing I described, and I don't think it works well at all, the formalism I give is kind of optimal and more or less unique, as I try to explain in the guts of the paper. The predecessor work is Harel's Higraphs (which I didn't know about in 2001, but I cited him in 2005, once Vipul Periwal showed me the paper. Harel's business from 1988 is the non-recursive version of the formalism), It worked well for the purpose, you could say what you wanted to say, and the result was that the company had quite a bit of a leg up on others as far as making models of various bio-networks. This was useful for getting deals and grants for a little while. Between 2001-2003, we used it to make a model for protein interactions of about 500 proteins, with all the interactions our biologists could get out of the literature. It was this big chart that explained how the proteins interacted, to the extent this is known. I was mostly using it to get a sense of how biological computation works, but the company wanted to use it further to predict how the cell would respond to various combinations drugs in cancer stages. You could sort of do it straight from the diagram, and this seat-of-the-pants things was really what was most useful for prediction, but there was also a quantitative model, which was really to sound all fancy for the investors. The formal model involved a program to take the diagram and turn it into a mathematics model, which the company liked to do as differential equations for chemical concentrations, not as individual molecules. I thought this was stupid, but they didn't listen to me, I was just the crazy guy who did the diagrams. This proto-model from GNS was a snapshot of the cell's regulatory machinery, and it really gave a picture of what was going on inside. In this respect, it was extremely revealing of the internal processes in cells. But the diagram was proprietary, and it has hardly ever seen the light of day, despite my repeated urgings to publish the diagram along with some seat of the pants predictions. No. They wanted to publish quantitative model results and keep their diagram proprietary, that's business for you. Some model results were published in the mid 2000s by the company, they were so-so, they sort of work when you fiddle with the parameters, but only because the diagram is qualitatively right, not because the quantitative simulation is right. My guess is that it has rotted from lack of peer review and no keeping up with the literature. It was essentially haphazardly compiled by just reading the entire literature in 2001, the literature has grown since, and they moved on to other things, using Vipul Periwal's "network inference" methodologies, which are pure Baysian models without an attempt to get at a mechanistic understanding. The diagram and language (arguably) is still the property of Gene Network Scieces inc. at least until 2020 or so. So no one is allowed to use it in the US. In Europe the patent was sensibly denied as a software patent. Serves me right for writing a patent, it was against my better judgement, but I was crazy enough to be loyal to those cocksuckers, and did what they wanted, even if it conflicted with my own certain knowledge of what the right thing to do is. I don't listen to anyone anymore. Since it is proprietary, in the best of all possible worlds, people will ignore it until 2020, or whenever the patent expires, then subsequently rewrite the biology books to use this formalism to describe the signal transduction networks. People suggested doing this in 2003, when I first put it out, but they didn't do it once the patent got slapped on it, and I don't blame them. So long as it is proprietary, it should be left to wither and die, like all the other proprietary shit. Anyway, the point of this formalism is to understand the computation in proteins. The main take-home lesson that became clear already in 2002-2003 is that it's not a very big computation, about a byte per protein, and that makes the total computation in the cell order kilobytes. Since this is clearly absurd for embryogenesis, or wiring up a nervous system, you have a missing information problem. This problem is solved by RNA. The RNA network language is completely different, and depends heavily on the sequence of the RNA molecules. This was the big conclusion, but this conclusion was scooped by John Mattick slightly earlier. Once you understand that RNA is doing most of the computation, the focus shifts to finding a language appropriate to describing the interaction of nuclear sequences that do not have the sequence derived from the DNA. This project is ongoing, but it explains all the mysteries of biology, including temperature regulation, brain function, embryogenesis, (real) epignetics, everything. Basically, if there's a question in biology, more likely than not, the answer is RNA.

Education: How can I learn as much as possible in my life?

I find the only way to motivate yourself to learn something is to discover something new. It's usually not new, you just think it is new, and then you have to learn all the stuff around the thing you think you discovered. By then, you discover something else, and you have to learn all the stuff around that too. It's a feedback process. If you discover something really new, that only happens a few times, then you go into research. If not, it was just a good way of getting an education. Can't tell in advance, you need some luck here, a lot of time, and some good insights.

Why should high school students learn physics?

They aren't required to learn it, it's an elective. But they should learn it, preferably on their own, because the school doesn't know how to teach physics. Physics is extremely interesting, even the elementary kind. It takes the mathematics you learn in high school and uses it to describe certain natural phenomenon completely, beyond what was imagined possible in the wildest dreams of people like Pythagoras or Archimedes. If you have a computer, Newton's laws plus a tiny code can produce the motion of the planets around the sun, the motion of a free-twirling baton, the motion of colliding billiards, it's very simple. You can simulate particles on springs, solid lattices, all sorts of crazy force laws, and you can prove all the regularities you see once you learn calculus, the hardest two are proving that the motion in an inverse square law is an ellipse, that the inverse fifth law collides with the force center, and that a bunch of particles with an inverse cube attraction breathe in and out (all are from memory, it's been a while). These regularities were worked out by Newton, some others were worked out in the 19th century. Writing these types of simulations can be done in high school, even earlier, whenever students learn to program a computer and display pictures on the screen (to see the output). It immediately leads students to appreciate Newton's laws, because suddenly, all the solid objects around them have motions that are easy to simulate, it gives more or less a full understanding of the day-to-day world, ignoring the quantum stuff like material properties and so on. The curriculum in high school physics is extremely boring, and can be learned instantly by anyone who does the simulation stuff. An exception might be the center of mass theorem, and some mechanics puzzles. Since I had learned this physics already some years before, I made it exciting like this: I made a rule that I must actively ignore the teacher, never look at the book, and do no homework, and I would have to rederive all the formulas for the problems on the test from scratch using nothing except my head. I got all the problems right for three quarters, then on the last quarter, we had an optics quiz. I had learned from Feynman, so I used a Fermat's principle method to derive the lens law, rather than using the geometric special lines that everyone else uses. It took me 45 minutes to rederive the lens equation knowing all the signs are correct and everything, and this left only a few minutes to do the actual test. I did one problem correctly, so I failed the test. So I had a C on my last semester of high school physics, and the teacher was very happy to give me a C, because he hated me by then, since I had been actively ignoring him for three quarters. So learn from Feynman, Landau, Dirac, use a computer, but when your school gets to optics, learn the classical methods!

Who has written a research argumentative essay on Hamlet? What topic did you choose and where did you get your info?

I didn't write one, but if you are brave, you can look at the Whitgift reference, and the Marlovian source for this. The Marlovian analysis of Hamlet is contained in a recent book, I think called "Marlowe's Hamlet" or something, you can find material online by googling for Peter Farey and his mentor, A.D. Wright. They are the only honest scholars in the field, since the rest of the field pretends that Marlowe didn't write the work.

What is your review of C++ (programming language)?

★★★ I give a three star review, it would be a five star if this was about "what could have been, and almost was", and a one star review if it is "what it has become, and what the effect is". But I can't be too negative, because there are extremely significant ideas in there, which are implemented just slightly wrong, and that wrecks the development path. Everything everyone says about it is propaganda either for or against. If you ask me personally, "should I learn C++"? I would say "No. Learn C". But I would have to add that Bjarne Stroustroup is an extremely smart and honest fellow, and had a lot of new ideas for this, and spent a great deal of time making a language that should have worked, and it became a standard for such a long time, and did work in certain ways. So his ideas need to be understood and respected and internalized, even if you don't use the final product (which you shouldn't). What went wrong? How to fix it? I can only give opinions. I hoped to do something like this years ago, I wasn't sure if I was up to it, but I was going to give it a shot. But after doing some stupid preliminary exercizes I got distracted by an idea for describing biology, and did that instead. Biology is what we call computer programming when nature does it, so it was a natural segue. In my opinion, the downfall of C++ can all be traced to one decision: the implementation of virtual classes with a non-transparent virtual function table. That introduces that damn function table pointer! By doing this, the implementation has violated the principle that every data structure in C must be binary transparent, so you can look at its guts and debug it, and print it out, and change it. You can't do that for the function pointer table, it's a statically compiled object. There's no reason for this. If you take any class with virtual functions, and take the first 8 bytes of any instance, that's the address of the virtual function table, and if you go there, you find a list of function pointers waiting for you, which are your virtual functions. You can overwrite this stuff with new pointers if you like, it will clobber your code usually, but you can do it. Just it's not supported in the language itself. To fix this, all you needed to do was just make the virtual function table explicit: class froo { vtable * vtpr = {virtual function declarations}   ; data data data; functions functions functions } In this way, you don't need to make a special syntax. You can call the virtual functions explicitly through their vtable, using some syntax to make it easier. You can include more than one vtable, if the vtable has only one function, you can call it directly, the implementation is under YOUR control, not the standards committee. You can include concatenated vtables (for multiple inheritance) interleaved vtables, whatever the heck you want. And you can dynamically change the vtable when you add a new function. If C++ did something like this, I think it would have been a universal standard. But since it didn't, it became a sink for all the bad ideas that didn't make it to C. It got references (ridiculous), operator overloading (ridiculous and dangerous, it should be done differently), rewritten I/O (useless, stdio was much better), deprecated the preprocessor (bad idea). And by 1995, it gave a cause for free software to rally around--- the free software programmers were those programmers which didn't use C++. This included Stallman and Torvalds, but tragically, not the gcc committee, which switched to C++ a few years ago, thereby relegating them to obsolescence. There is a second thing wrong with C++, this is the philosophical idea present in C that code should be generated by code-generating programs, not written by humans. That was the point of Lex and Yacc, and all the Unix tools of the early 80s. Now, if you need a C code, you can generate it and compile it with Perl. The C++ philosophy wants to do all this in the compiler, so you get inline functions and templates, both of which are nonsense. The inline functions are used for ridiculous over-encapsulation, like accessing members using functions instead of just by changing values. The templates are terrible, and make the compiler impossible to write except if you spend a year or two studying what the standards committee decided.

It's no good. The solution here is to write a full meta-langauge for manipulating C code as first class objects, and have a Turing complete pre-processor, which puts together your code for you. This is the project I was interested in, to complete the definition of first class C code to the point where it would turn into a replacement for the template language of C++. I didn't do it. There are half-way steps in the recent CS literature, like backtick-C, which is C with first class code, and a recent C++ interpreter, where there is a C-like language which can be stored in a reasonable way. But the proper framework for manipulating C code isn't there, like in LISP, where your code is a list, except in C it's not a list, it's something else.

Has Prof. Otelbaev found a solution to the Navier-Stokes Millennium problem?

This theorem will have a big impact in functional analysis, it is important for mathematics, because it surely will allow you to prove that various other equations have smooth solutions, and since this was a difficult problem, it will probably have a new idea for how to prevent solutions from getting singular. But it has next to no importance for engineering or physics, because the short distance behavior of Navier Stokes equations or similar equations was never an issue. The Navier Stokes equations, even if it allowed singular solutions, would not behave any different in the long distance approximation, because it has Galilean invariance, the singularities would just get convected and get infinitesimal amplitude through viscous decay. They would be like a dust of gnats convected by the fluid, and would cause no problems. The paper looks serious, and the fellow knows the methods you're supposed to use, but I can't read Russian, nor do I know much about this functional analysis business, so I can't say whether he got it right.

What is Ron Maimon's theory of internal evolution?

It's nothing particularly extraordinary, it's just the observations that the processes in a conscious mind is an evolution, involving competing ideas that survive and vie for attention, and some of them win, and those are the ones you think about, while a whole bunch of related ideas don't win and swim around in a vast pool of little algorithms in your subconscious. Sometimes you have a coup, where one species takes over completely from another, and that's like a "a-ha" moment. The analogy is simply between the anarchic computation in the brain (as Daniel Dennett puts it) and the only roughly coordinated computation in neurons. The idea comes from the realization that the brain is a networked computation, not a distributed computation, so that each neuron has a large internal computer that is relevant for the overall function of the brain. So that there might actually be a grandmother neuron (this was a joke in neuroscience in the past), although it would have a bunch of other related neurons which are similar, in case it dies or something. This point of view is described very well in Daniel Dennett's recent articles and writings about consciousness, and I defer to him for the long-winded philosophical blah-blah-blah. He thinks about things deeply and honestly. It's his idea, but I didn't get it from him. It's obvious once you realize the depth of each neuron's individual computation, that they are not computing predominantly in a network, but individually, and the network is like a crappy ethernet for them. The main point of this for me is that it puts the old "nature" vs "nurture" saw to bed for good. When you are talking about evolution, the product of the evolution has very little to do with either nature or nurture, it evolves. The forms that come out are not directed by nature or by nurture, but by the internal evolutionary struggle inside the system. So for example, on the planet Earth, the "nature" of the Earth was a primodial goop, with petrolium oozing from the mantle, and water, amino acids raining from the sky. That's it for the nature. The nurture was the sunlight, and occasional asteroid impacts. That's all the nurture. Can you predict from this what dinosaurs looked like? Obviously not. These are the products of evolution. So when you have an evolving system, you don't look for an explanation of the ouputs in the inputs, or in the correcting mechanisms of nurture. You look at the actual details of the stuff that is evolving. That's what's going on in brains, evolution, not nature, not nurture, at least not a significant amount of either.

Do engineers need to know Fourier analysis?

EVERYONE needs to know Fourier analysis. It's not a hard thing to learn, it only requires elementary calculus as a prerequisite, and it's as fundamental to higher mathematics and physics as multiplication.

Thermodynamics: Will a refrigerator keeps things inside warmer if the temperature outside is lower?

For a normal refrigerator, usually no, the inside will always get colder than the outside, but if the outside is colder than the setting, the refrigerator will just never turn itself on because the thermostat will never be tripped.. The fluid on the outside part cycle will always be compressed to be hot, and pumping heat out, while on the inside part, it will be colder, and pumping heat into the fluid. But it depends on the refrigeration cycle. You can make a heat pump that pumps heat into the fridge, and a back-and-forth heat-pump too that can work in either direction.

Is it possible to get an effect without a cause?

There is no such thing as "cause" and "effect" in fundamental laws of physics. It is a human concept, which can be defined as follows: If whenever you see a situation with property A, you later see a situation with property B, regardless of any other factors, you say "A causes B". That's the definition. So turning your light switch "causes" the lights in your functioning room to go on, because it doesn't matter if your shoes were on the floor or on the couch, or anything else. The notion is complicated and analogical, it isn't a fundamental thing about anything. There are plenty of effects with no cause. An example is a Uranium atom decaying. At some time, you get a decay, and you can ask "What caused it to be this time and not another?" and in quantum mechanics, the answer is absolutely nothing. It could have been any old time, it's any old time according to a probability distribution. But who knows, maybe someone will one day show quantum mechanics is not exact, maybe there is a cause in some hidden variable somewhere. So you might not be sure. There is another demonstration in the same spirit inside classical mechanics Suppose you make an atom-by-atom copy of your brain, or else duplicate an AI. Put one copy in Antarctica, and another in New York. The the Antarctica copy will ask "Why did I end up in Antarctica and not in New York?", while the New York copy will ask "Why did I end up in New York and not in Antarctica?". Both questions have no answer, there is no cause, because both things happened.

What are some examples of scientific beliefs that are "not even wrong"?

By definition, none, these things aren't scientifc. But there are examples of "not even wrong" things that are extremely useful, and were clearly "not even wrong" to those that proposed them, but they were mathematically or conceptually useful. I will start with what I think is the best example: 1. Gauge ghosts Gauge ghosts are a mathematical formalism for quantum field theory that introduces new fictitious particles to mathematically cancel out certain contributions of unphysical polarizations of gauge bosons. These particles were introduced specifically to be fictitious things, and so are "not even wrong", they do not change the predictions of the theory. But they are convenient! You can use them to make a manifestly relativistic formulation of gauge theory, to make calculations consistent even when you introduce new unphysical degrees of freedom in other theories, like string theory, and nobody would dream of saying that this idea is useless or trivial. But it's clearly "not even wrong", so if you get into a discussion about whether gauge ghosts are real particles, or whether they are fictitious, this is a debate in which both sides are not even wrong. There are occasionally papers which discuss whether gauge ghosts are real, these papers are not even wrong. In the same spirit here are more useful ideas that are "not even wrong" 2. Bohmian mechanics This is extremely important, in that it provides an example of a working hidden variable scheme for quantum mechanics. It gets around lots of theorems that say it's impossible, so it shows those theorems' conclusions were not "not even wrong", but just plain "wrong". It is a huge advance in physics. But taken as a theory, it makes absolutely no predictions different from quantum mechanics in its standard formulation, so it is "not even wrong" as stated. But if it is modified, it can become "wrong", or "right", depending on future modifications. This is the role of good ideas that are "not even wrong", as new philosophical points of view regarding other ideas. 3. The path integral The path integral formulation of quantum mechanics was dismissed as "not even wrong", because it was equivalent to other formalisms in principle. This was so shortsighted, it's brain-damage. It's true that the path integral by itself is "not even wrong". But in this case, for a nontrivial mathematical reformulation, that's the same as saying "It's right". The path integral made calculations in field theory so much more convenient, and produced imaginary time methods, S-matrix theory, new interpretation ideas, and ultimately is a better foundation for quantum mechanics, so that the other formalisms look like alternate ways to write the path integral. The not even wrong version of this is things like "particles are real" "no fields are real" and so on. 4. The many-worlds interpretation of quantum mechanics. This one is more philosophical, but also leads to important insights. Quantum computing, decoherence, all these things step from this, and it has its roots in the path integral, from Wheeler listening to Feynman. THe main point of this is to make it clear that the positivist formulation of quantum mechanics is complete. But ridiculous "not even wrong" variations include "quantum suicide", "the many worlds are real" "no they're not", and so on. As far as string theory, it is either wrong or right. It can't be "not even wrong" because it makes predictions regarding high energy collisions and black holes that are either right or not right, they just are too expensive to test today.

What do mathematicians think of Good Will Hunting?

I personally find it ridiculous for the same reason you do, it gives the impression that there are magic people who solve problems without effort. There are no such people, problems are hard for a reason. When a problem is magically solved seemingly without effort, it's because the person who solved it spent a long long time developing a new viewpoint that makes the problem melt away. Good Will Hunting is the capitalist myth, that there are special people who can do magic relative to others. It uses mathematics as the proving ground for this myth, and it doesn't work, because in mathematics the objective test of success shows that this idea is a myth, because nobody does it they way it is portrayed in the film, not even the best of the best geniuses.

Could plants ever evolve enough to become sentient?

Plants have an energy barrier to running brains, they only acquire energy from photosynthesis. This means that they have a limit to the metabolic computation they can do that would require a heck of a lot of plant for a little bitty brain. Plants are probably already computing at the limit they can manage, they probably are smarter than we think. But every animal eats a lot of plants daily, so that the biomass ratio is always in favor of plants by more than an order of magnitude. That means that it's not really. If a plant wanted to do this, it would have to figure out how to steal energy from a bunch of its neighbors, and this would make it indistinguishable from a herbivorous animal.

What is the difference between C, C++ and C#?

C is a great language, gnu C is probably the greatest language of all time. The reason is that it is both very low level, and yet it has no barriers to scaling up to making arbitrarily complicated projects. It is the only language that a former assembly programmer can program in without tearing the hair out. Perl is a close runner up here, but the hair (slowly) comes out. With other languages, you're bald. There is a fundamental principle in C that is not respected in any other language: complete binary data transparency. in C, you know exactly what you get with your data. That means if you say "struct froo {int i;double x; char c;}. you know exactly what you are getting in memory, byte by byte, even usually in what order. the stuff that isn't specified in the standard is often standardized by the compiler anyway, and on non-aligned architectures like Intel, it's exactly what you think it is--- an int, followed by a double, followed by a char, exactly 15 bytes long. No type modifier, no added information, like a UNIX file, it's just clean data exactly like what you wanted. It will place consecutive data consecutive in memory. Stuff you allocate in a function gets allocated on the stack exactly as you declare it (usually in the same order), stuff you allocate with malloc goes on the heap exactly where you think it is (the information about the page allocation is slightly behind the data in Linux if I remember right). The memory layout of all your data is under your control, and there are no compiler generated surprises, because the compiler hardly does anything, and it doesn't do anything without you asking for it specifically. C also can compile lightning fast, if you don't use C++, it was compiling on 1970s hardware, and it has a preprocessor that's faster than cat. The algorithms are also transparent, you can see more or less exactly what machine code will get emitted from your instructions. Here C is not completely ideal, because its expressions are modelled on previous high level languages, and so it is lacking three things that it really should have had: 1. a primitive swap--- you can't primitively swap the value in a with the value in b. 2. carry sensitivity--- you can't talk about the carry on an add, it's unspeakable. 3. high-bits of multiplication--- you can't talk about the high 32 or 64 bits of a times b, also unspeakable. The ANSI standard included one useless thing that makes writing an ANSI compiler hell: named bitfields. Those are so useless, everyone uses masks, and they get turned into masks anyway, and still these stupid bit-fields wreck any cheap and quick ANSI compiler. I hope tcc (the tiny c compiler) avoids implementing bit-fields, but they are striving for ANSI compatibility. All of these are there in the architecture, and are available to an assembly programmer. Gcc will figure out when you are swapping often and put in a swap, but if you want to implement a bigint, you need assembly, because you can't access the carry or the high bits from C. This is the only intolerable annoyance left in C for the assembly programmer. aside from these three annoyances, anything else you do in assembly you can do in C. I am assuming you are using gnu C, which includes computed goto, named enum, named initializer, nested functions, and all the other gnu extensions which should have been in the ANSI standards to begin with, but weren't (some of them are there now). Gnu C also has a named return value extension which doesn't work in C, but should. C also doesn't stop you from doing tsk, tsk, naughty things. You can get a pointer to your own code, and rewrite your program's machine code (with appropriate system calls). You can allocate a block of code and emit machine code into it, and jump to this code. You can "goto" anywhere you want. You can wreck your own stack. You can access all the operating-system allocated information about the pages of memory you are writing to. And if insist that you really want to fiddle with the registers, you can, because you can embed assembly anytime. You can also control the register allocation in gcc, you can micromanage the compiler as far as you like. This made C the superstar of languages, because it really understood what assembly programmers wanted. Since it could be used to write an operating system, it replaced assembly programming in the 1980s, and this is probably irreversible, even though the major motivation, lack of a standard architecture, is now moot, because Intel architecture is standard today. C++ took C and added object orientation. Some of C++ is harmless and nice, like // comments, structs with automatic typedef, default values functions, and namespaces (which really help keep the code separate and modular). Even making structs include functions is no big deal, it does make the code a little prettier. But C++ became C++ rather than a dialect of C when it went on to break the commandment: thou shalt keep the data binary transparent, It broke it in such a seemingly harmless looking way, though, that Stroustroup probably said "What's the big deal?" The culprit was the virtual function table. There are two kinds of classes in C++, the ones that are virtual and the ones that are not. If you don't use any virtual functions, you might as well be using a really annoyingly nitpicky C. But when you declare functions virtual, then you get a non-transparent change in your data structure. At the beginning of every instance of your structure you get a pointer, and this pointer points to a virtual function table, and this virtual function table has a list of pointers to all the functions you declared virtual, which are the ones that get called when you try to call the function of this name on the given data type. When a class inherits from your class, it gets a copy of your virtual function table, and it can override the virtual functions and redeclare them. Then the pointers in the function table are overwritten. This is all done by the compiler, at compile time, by arranging the virtual function table, and that's nice. But it is not nice in one way: the data is there and is inaccessible by the program! Commandment broken. What does this mean? It means that suppose you declare a class of "number types", which makes virtual addition. Then when you declare a quaternion to be (number_type A,B,C,D), you get four number-type objects, which contain a virtual function table pointer each. That's 8 bytes of function table pointer + 1 byte data. Overall, 4 bytes data, 32 bytes of function pointers! And it's stupid--- you know for sure that the four objects are all the same number-type, but because the virtual function table is welded onto the data-type, you can't separate it out. Breaking the commandment comes back to byte you. This means that C++ is useless for designing a number class which can generate efficient codes for various mathematical objects, you still need to roll your own. If you do write a general thing, it has to be a template, and this is itself a nightmare that C++ introduces to get around these limitations. If you use standard C++ for these cheap things, the quaternion multiplication becomes horribly inefficient, and you might as well be using a high level language. The other problem is that you aren't allowed to modify the virtual function table at runtime, it's hard wired by the compiler. This means if you decide you want to change the way a particular class should do x or y, you can't overwrite the function table pointer, it's not accessible to you. You can hack it up in gcc, it is possible, but it is hard because the language is violating the data transparancy commandment. This feature is what Java and C# add. They make it that you can construct classes and modify them whenever you like, at runtime. But they are never low level, because as much as they promise compilation to machine code, it's never going to happen, it was just hype. So they stay useless for high performance scientific computing, which is always at the machine limits. They also violate the commandment much more freely, so that you can't even use dirty pointers. I am sort of annoyed with this, as it is easy enough to design a syntax for object orientation which does not violate transparency of data. Just nobody chooses to do this, because it makes the language stay low level, and in fact, makes it go even lower level. Good. I think that's the right next step.

Aren't social conservatives always on the wrong side of history? Social conservatives were against the ending of slavery. Social conservatives were against women gaining the right to vote. Social conservatives were against the Civil Rights Movement.

Conservatives are trying to conserve things, they are trying to prevent certain directions of change. So relative to every successful change, they are always on the "wrong" side. But relative to every change that wasn't implemented, or rolled back, they are on the right side. Since there are a thousand new ideas for how to move forward, 999 of which are wrong, and only one of which is right, conservatives are right 999 times out of 1000. The problem is that the one time in 1000 is the only one you remember after 50 years, simply because the other 999 things stay looking just as fruity as ever, while the one right thing stops looking fruity and acquires the feeling of historical inevitability. You think "nobody could possibly think that wasn't a good idea, could they?" while forgetting about all the other things that looked very similar, but which were not good ideas at all. So for example, consider the 1960s Civil Rights movements. There were conservatives, who didn't want to change anything about anything, and there were liberals. But the liberals had various different proposals: 1. Allow black people disproportionate representation, so that black votes would count four or five times that of whites. 2. Separate a black nation from a white nation, to allow black Americans self-determination in their own region. 3. Have a violent overthrow of the US government, and institute property redistribution to all, with disproportionate benefits to citizens of color. 4. Mandate education in black-vernacular English for majority black districts. and of course, the most conservative of the liberal viewpoints: 5. Pass a civil rights act, a voting rights act, and work to remove barriers with a mild amount of affirmative action to integrate the American upper classes. It was path 5 that was taken. I don't think that paths 1-4 would have been very fruitful, each of them, while well intentioned, would probably have made the racial divide in the US much much worse. Similarly, regarding the implementation of socialism, liberals were split between many different variations: 1. Leninism: the state seizes the property of the landed classes, institutes inflation to remove monetary wealth, and plans the entire economy top down. 2. Democratic socialism: pass regulations to ensure that business activity would be completely controlled by the state, so that nothing can be done without filling out the appropriate form and getting it stamped twice. 3. Mixed economy: have a state funded sector, and a private economy side by side, and nationalize firms whenever they get too big. Also, just in case, get this form stamped twice. and of course the conservative viewpoint: 4. Do nothing. Maybe hand out some money. But mostly, do nothing. In this case, every country that did 4 outgrew the pants off any country that did any variation of 1-3. So the conservatives were on the right side of history in this case. Since this was not a small deal, and in this case, every implemented idea on the left was wrong, being right on this gave conservatives enormous amount of power since the 1980s. It is likely, and I think it is true, that some form of socialism will prevail in the future, so the conservatives are not right on the big picture. But it's not going to look like options 1-3, it would have to be something new. Because all that has been tried is 1-3, it's damn fortunate you had sticklers who held on to 4, otherwise we would all be speaking Russian, and only have enormous mainframes, and this conversation would be impossible. The computer revolution was impossible in even the most liberal of the socialist states. Any future attempt in this direction will require freedom for entrepreneurship, respect for decentralized decision making, respect for individual independence, the ability to allow inefficient industries to completely die, and competition that allows weeding out of inefficient crap, all the things that were missing in the planned economies, or even in the directed or mixed economies. But such a thing can still end up in line with what socialists view as a desirable organization of society, it just can't be a regulation monster, a centralized political monster, or a mixed economy, because all of these wreck the ability of economies to grow.

What does Ron Maimon think of late comedian Bill Hicks?

I only heard his named mentioned once or twice before this question. I didn't know how to answer this, so I watched a video. I found this bit of his extremely funny: "I understand hijackers. I want to hijack an airplane, put a gun to the pilot's head, and tell him "Now you fly this thing exactly to where I tell you to". Palestine? Nah. Cuba? Not Cuba. Fly already to where we were supposed to be five hours ago! Nashville." So I don't know, I guess he was a talented guy. He's funny. He also had great microphone sound effects skills.

How do I get in Ron Maimon's good graces?

Why would you want to? I have absolutely no power over anyone or anything. Also, I don't make enemies or friends, any political activities of this sort are pointless online, the quality of the information is all that matters.

Some people are beginning to say that the theory of relativity is wrong. What about it bothers you?

Nothing bothers me in relativity. These criticisms have been there since 1906, they are just as ridiculous today as they were back then. The main sticking point is the logical positivist notion of psychological time, which is distinct from physical time. In Newtonian mechanics, they were identified.

Would it be beneficial for children to have courses on critical reasoning and formal arguments at school?

It would not be useful. These things are learned quickly by any reasonable person, the reasn people think they are not learned properly by others is because they can't imagine that other people can believe the stuff that they do. They believe this stuff because of other things you don't know about, usually religious or spiritual texts, or because their critical reasoning is damaged by drugs. Teaching "critical thinking" is what was called "reeducation" in communist states. It is simply propaganda. Teach science and technology, humanities and facts about religion, and the critical thinking will come by itself. If you mean a class on formal logic, rather than a class on "critical reasoning", I think the answer is yes. Boolean algebra, formal systems, and Hilbert deduction should be taught along with computers in middle schools, starting around the fourth grade, once algebra is started.

What is the best way for a physicist to learn biology?

A physicist only needs a tiny amount of background to read the literature immediately, the basic principles can be learned from any elementary biochemistry book, and Watson's is a good one. Then read the literature! It's not so hard. It helps to have a point of view coming in. My own point of view was to elucidate the information flows in the biomolecules, because I was interested in the computation in the molecules. This turned out to be fruitful enough for a lifetime, so I didn't look for anything else.

How does Ron Maimon decide which Quora users to follow?

If they follow me, I follow them back. If they upvote an answer which dismisses Marlovian authorship, abiogenic petroleum, or cold fusion, I unfollow them.

Is there a disproportionate number of crackpots in theoretical physics?

There is a profound amount of progress in theoretical physics, which is extremely hard to honestly learn. Anyplace you get stuck makes you a temporary crackpot. It's only when insist on staying stuck even though someone explained it correctly that you are an actual crackpot. When you get it, you are not a crackpot anymore. So everyone is a crackpot at some point or other. Einstein was a crackpot regarding black holes, for instance. Sometimes, though, like in the case of Martin Fleischmann, the crackpot is right. So you can't use political cudgels, just explain it reasonably, without prejudice. Everyone starts out ignorant, and the internet makes crackpot work instantly refutable.

What does Ron Maimon think of James D. Watson?

He's a great scientist, obviously, but he seems to have been motivated by fame and glory, or perhaps he was seduced by the early fame. His work is top notch, but he seems to want to direct stuff, which is weird to me. But that's fine, the world needs all types of people. I don't agree with his recent racist nonsense, but you know, product of his times.

What is the "block" universe of Einstein?

It's a philosophical view of time as a block which has "already happened", and we are merely "travelling through it", seeing snapshot after snapshot. It isn't anything except a philosophical change in perspective, once you understand logical positivism. The definition of time is by the changes themselves that we see, and the perceptual stuff is defined by the questions we can ask of ourselves and others, and there is no sense in philosophical questions like this. The reason the work of Einstein was important for this is only because it made the notion of a universally agreed upon "now" instant, shared by all observers no matter how distant, untenable. The "now" instants, no matter how you define them, are not globally well defined. But the perception of time went out of physics and into philosophy earlier, with Boltzmann and Mach. The perceptions are from the juice of the mind, the computation, not from the juice of the physics, which is mathematical models of the events in space time.

Why is gravitational force always attractive in nature?

Because energy is always positive, and pressures (except for cosmological constant) are always less than energies. There is a simple causality reason to understand why it must be so. If gravity were repulsive, you can dump the negative mass object into a black hole, and watch the horizon area shrink. This violates thermodynamics.

What are some of the best papers you've ever read in any field of science - biology, economics, astrophysics, geology, cognitive psychology, etc.)?

The paper that solved physics: [hep-th/9610043] M Theory As A Matrix Model: A Conjecture It's by Tom Banks, Willy Fischler, Steven Shenker, and Lenny Susskind, this is the BFSS paper. it is, in my opinion, the greatest text ever written in all of science, greater than Newton and Einstein with some Hawking on top. Before this paper, every method of calculating in physics was limited in principle by some approximation, of one kind or another. If you were doing field theory, your calculation didn't take into account gravity. If you were doing stirng theory, you were perturbative, and you couldn't describe black hole formation well. This paper has no such barrier. It defines how to calculate EVERYTHING in a flat M-theory. Everything. No approximations. This was the first time this had ever been done for any model in physics which included gravity. The extension and analysis of this paper, and incorporations of other insights, led directly to AdS/CFT, with Maldacena's famous work in 1997, and WItten's, and Gubser, Klebanov, Polyakov, and all the rest. But this was the first major shock of the second superstring revolution, the first completely nonperturbative calculation method. This paper was the first time a real theory of everything, and I mean a completely computable theory of everything in every domain, had ever been written down. There is an important antecedant to BFSS in earlier work in string triangulation models, which suggested a similar mathematical construction. But this was in the late 80s, and there was no argument that such a calculation method would be a complete description of the physics. The BFSS paper came with a full realization of holographic principle, and the reason that a full accounting of a black hole, any black hole, would account for everything else, so it was surely including all the physics. it is also mathematically not difficult to describe, it's an ordinary quantum mechanics matrix model. I remember where I was when I first heard about this, it was around 1996 or 1997, and Willy Fischler came and gave a talk about it at Cornell. At the time, I was a grad student in the back of the small seminar room, I remember he presented the ideas, wrote down the particle Lagrangian, and everyone applauded politely, and there were a few questions. But I was LIVID. I seriously considered sitting on my hands! I thought "Does this clown really think that this trivial particle model, defined on 0+1 dimensions, includes the ENTIRE physics of an 11 dimensional theory, which is otherwise ill defined? It's obviously nonsense, why is everyone applauding? Why isn't he being booted out of the building!" it took a few years before I understood the reasoning behind it, and then to see that it was actually correct required a lot more checks and thinking. But it was correct, and it was a greater conceptual revolution than anything that came before, It came from four middle aged string theorists who had been working on related ideas for decades. It did NOT come from a young genius, or the most famous names (although they became famous names subsequently). Given this advance, and the related AdS/CFT program, we have an in-principle method of generating theories of everything for cold spaces. This is unbelievable, because it solves the problem of physics COMPLETELY in cold space times. To say that nobody saw this coming is an understatement, I thought it would take a century to do, in 1995, when it was already being finished. I remember sitting at Santa Barbara in 1998 or 1999 with this nondescript mild mannered middle aged physicist who I didn't recognize. After some chit chat, I started blabbing away about how the BFSS paper, that I had been going over for a long time, just couldn't possibly be right as physics, because it couldn't possibly reconstruct the space time correctly from the kinematics, and it didn't have an obvious background independence blah blah blah, all this stuff. The guy stopped me and said "Before you go on, I'm Tom Banks." I said "Ok, now I'm spooked!" I wasn't really spooked, but I thought it was funny. He didn't talk to me after that.

What progress has been made to date on the Yang–Mills existence and mass gap problem?

It's solved as physics since the late 1970s, but in mathematics it is impossible to formalize the proof. You can define the lattice gauge theory, and it is a statistical system in Euclidean space defined by Wison (also by

Polyakov), and it is clearly gapped because it randomizes in simulations at large distanes, and the strong coupling expansion shows it stays random, but to prove it has a continuum limit requires linking the heuristics for short distances, which is asymptotic freedom, to the heuristics for long distances, which are the the gauge field randomizes, and this requires a method of defining statistical field systems and defining the RG flow. I will assume that you work in a universe where measure is universal, so I can talk about statistics without Borel sets and nonsense like this. On any lattice, you can defined the gauge theory. Then you take the limit as the lattice size gets small and the coupling gets weak is that you should take this limit keeping the randomization scale fixed. That this is possible requires a rigorous construction of the renormalization flow which keeps the statistical fluctuations at long distances fixed. This is not so hard to do, even formally. But the difficulty is in proving that the flow is one dimensional no matter how you make a lattice approximation, and no matter how you take the limit, that it matches onto the perturbative calculation at short distances, and it matches onto the strong coupling expansion at long distances. It is infuriating, because it is manifestly obvious if you ever simulated lattice QCD.

What are some good examples of some 'intuitive' or 'obvious' mathematical statements which have very long and rigorous proofs (or no proofs at all)?

1. That the digits of the square root of 2, pi, e, the roots of the Bessel function, sin(.3), etc, are eventually indistinguishable from statistically random numbers in any of their short-distance correlation properties. That this is true of nearly all numbers is trivial to prove, but proving it for any specific number (for which it is true) is impossible today, and the proof would bear no resemblance to the intuition, which is simply that there is no reason for it to be otherwise. The same statistical regularities make many obvious facts unprovable--- for example, if I turn a face of a Rubic's cube according to the digits of pi, 0 means turn the top face, 1 means turn the left face, and so on, then the cube will be solved on average only 1 time in the number-of-configurations. Most hard unsolved conjectures that people are sure are true have this type of probabilistic intuition, and this is what is making people sure they are true. For example, proving that the Collatz 3x+1 algorithm randomizes the binary digits is equivalent to proving the conjecture, and it is obviously true from looking at what happens to the binary digits. In the same spirit is the obvious fact that a polynomial on the integers is irreducible if and only if it's values contain infinitely many primes. This is hopelessly impossible today. 2. To prove that every subset S of the interval [0,1] is consistently Lebesgue measurable is trivial intuitively--- pick a random number x again and again, and ask "what is the probability that x is in S"? The problem is that the notion of probability is ordinarily defined in mathematics by the measure of sets, not the other way around, and in usual axiomatizations of set theory, this theorem is false--- there are non-measurable sets, so that the concept of a random real number does not make sense. The actual proof that every subset is actually measurable then takes in the form of a relative consistency proof, which is somewhat involved because it requires two new ideas. First, a forcing procedure to define measure for sets, and second a way of moving the real numbers up to an inaccessible cardinal, so that you can make a consistent truncation of the resulting set theory in which the real numbers to are too big to well order or do choice on. These complications are overkill for a statement that I consider a fundamental axiom (since picking random numbers between 0 and 1 is obviously a logically consistent notion). This problem is a foundational problem in mathematics, this is why the proof is involved. 3. Arithmetic is consistent. This is obvious, because we have intuition that there is such a thing as "the set of integers", and it obeys the Peano axioms. But to prove this rigorously requires defining a system in which it can be stated and proved rigorously, and Peano Axioms don't cut it, by Godel's theorem. To prove the consistency of Peano Arithmetic in set theory is one approach, but set theory is not itself obviously consisent, because it refers to an ontology of enormous uncountable sets. The proper solution was found in 1936 by Gentzen. The consistency of Peano Arithmetic can be proved using very primitive proto-arithmetic and the assumption that the ordinal epsilon-naught is well founded. The axiom "epsilon naught is well founded" is perfectly reasonable intuitively as an axiom, and does not require believing in infinite set theory or anything else that is uncomputable. This proof is very involved, it

required the precise statement of cut-elimination lemma for Peano Arithmetic, something similar to subroutine inlining for computer programs. Proving the consistency of ZFC from a similar axiom regarding computable ordinals should certainly be possible, but has not been done, mostly because the methods haven't been developed because lots of people have been going around for over 80 years saying it's impossible.

If the universe is "expanding", is my room expanding? Are atoms expanding? Is everything expanding?

You are making a logical fallacy in thinking that the expansion of the universe is something separate from the motion of the objects in it. The motion of things away from each other is the definition of the expansion of the universe, there is no separate space and time which is expanding, independent of the things in space and time. This is a simple positivist error. Galaxies are moving away, and there is a curved metric in spacetime that makes them accelerate away. That's it. The motion is the expansion. It's not that there is a substance stretching between things, the motion is the definition of the expansion. People get this wrong because the popularizations de-emphasize Mach/Einstein positivism for political reasons.

If the universe is accelerating rapidly, does that mean that in 50 years, it will be increasingly more difficult to cross over into a different galaxy?

The local cluster is gravitationally bound, and the Andromeda galaxy is getting closer, and will collide with the Milky Way eventually. So not for the near cluster, but for ridiculous million year long trips at the speed of light yes. But you don't need to worry about that for at least a million years.

According to Frank Close in his book Antimatter, daylight is the result of antimatter being produced and annihilated within the sun. Is this true?

Michio Kaku didn't say this.

Why does Ron Maimon consider philosophy to be a fraudulent field?

Because the mechanism of evaluation is political, and any reading and criticism is required by academic convention to be charitable. The warm atmosphere breeds germs. There's a philosophical component to physics too. But in physics, there is no time for nonsense, so physicists evaluate things by the precision of the arguments, and the criticism is required to be hostile. When someone is wrong, even if it's something you would, as a nonexpert, consider subtly wrong, it must be criticized harshly to explain exactly what is wrong, and dismissed bluntly until the other person gets it (on their own time, not yours). Otherwise, you are wasting your time, and in physics, things are HARD for reasons having nothing to do with politics, so there is no time to waste. If you find that your criticisms are faulty, then you stop criticizing. You say sorry. Then you criticize the other side just as harshly, with just as strong language, even though you thought that wrong stupid way yourself only yesterday. You were stupid yesterday, and you don't have time to continue being stupid today. In philosophy, as the genteel people who do it take great pains to tell you, you MUST read historical philosophers charitably. When you read Aristotle, and he says something brain-damaged (as is true on every other page), you can't criticize harshly based on flaws you see, you have to somehow organically meld your mind with Aristotle's, and smoothly change the stuff using politics, like passing resolutions in the Senate, by political dialogue with other philosophers saying stuff that is either a little less or a little more brain-damaged. This type of dialogue is counterproductive to accuracy. You want to get to the truth, and QUICKLY. You don't have time to debate with a host of morons, you need to internalize all the arguments, find the airtight ones, and go with them, at least until someone shows you that they aren't airtight, and you made a mistake. If you didn't make a mistake, you need to keep going. The lack of precise thinking is a by-product of this political process, which is designed to preserve the status of philosophers from long ago, because it is a pure academic political structure. This is why the philosophy literature hasn't produced anything of value for itself in its entire history. All the really good ideas are imports from other fields. The scientific fields know better, but their methods of discussion demolish authority and make a non-hierarchical debating team, a team where the most junior member has equal say to the most senior, at least when the junior member is right. Try that in philosophy, and it will get rid of the clowns doing it, and revolutionize the field.

Is Strong AI really achievable?

It can be achieved only when the computers are as strong as the brain's data and information processing. If you believe it's on the cellular level, we aren't so far today, we have computers with order 10^10 bytes, so we can simulate millions of neurons at the neuron level, assuming the data processing is at the neuron level. But since I am confident the data processing is deeply intracellular, and is fundamentally intracellular and mediated by RNA, the computational information in the brain is most well approximated by the total number of nucleotides of RNA in the brain. This amounts to 10^20 bytes, a billion gigabytes, and is comparable to all the artificial computers put together. The scale for bit storage is then comparable to the atomic scale, it's only about 10 cubic Angstroms per bit. At the moment, our bits are at the lithographic scale, or about 1000 square Angstroms per bit, so the computers are much more primitive. This is simply comparing raw processing power, but I think this is the most important thing to compare. A computer the size of 10^20 bytes, even if programmed inefficiently, should be able to do some amazing things, and tinkering might produce intelligence without much additional design required. But of course, one should try to understand the algorithms of the brain as well as possible, perhaps one has to mimic it quite closely, not just get the processing and order of magnitude of memory right, and have any old learning algorithm.

Could structure formation in the early universe be caused by supermassive black holes that form at gravity wave caustics?

Gravity waves don't have caustics in this sense, they don't make singular energy in a region without focusing caused by a horizon. This is not a theorem, it is a sort of physical principle, you can't make things going at the speed of light mush in on themselves, because parallel light beams don't attract. Mathematicians can't prove even the most rudimentary things of this sort. The general principle is that all singularities of GR require a horizon, and in this form it is the Penrose cosmic censorship conjecture. This means that to make a black hole form from gravity waves you need to have a collection of converging gravity waves, and this doesn't happen in the early universe, the gravitational radiation is weak and linear, and the chance of it forming a black hole is the same as the chance of the microwave background forming a black hole. The earliest universe is inflating, and so black hole free (in deSitter space, any black hole quickly merges with the cosmological horizon, in the standard framework, people say inflation dilutes black holes, but I prefer the causal patch picture). There are no primordial black holes in the standard big bang model, unfortunately, because they would be interesting to study.

Why does the US have far more serial killers than any other first world country?

It's because the culture is isolating, there is no significant communal oversight on individual behavior, and sometimes in isolation people go crazy. It's getting better now, with the internet, but coming from the old world, you have no idea how isolated the US was in the 70s or 80s, there was absolutely no community at all, you were totally on your own for everything. It's liberating for adults who feel constrained in their old stifling cultures, like Arnold Schwarzenegger or Lubos Motl or someone like this, but these people are adults, they have already sucked in the communal values and traditions. For people born in the US, it's basically a wasteland, and you need to pick up your culture by importing some old world stuff, or doing something. Some people go live in a library. Others take a lot of drugs. Others do other things, live with nature or something. The isolation breeds creativity naturally, you don't have biases from a community, but it is also very deterimental to people's mental health, and can lead to psychotic breakdowns that result in serial murder. Depression and obesity is also more common in the US, things that are solved by the culture in the Old World. It's a young country, and there is no culture.

Chemistry: Are there any chemical reactions comparable or similar to oxidation that could potentially provide a partial solution to fossil fuel depletion?

Fusion can be contained by blowing up H-bombs underground. That solves the technical problems with fusion, but creates new worse political problems. The reverse reaction to oxidation takes energy, so there is no magic way to close the cycle without energy input. But photosynthesis is what you are looking for, and you can engineer photosynthetic bacteria to produce fuels. It is possible that this can close the carbon budget of the Earth, by seeding the Sahara with artificial oil producing algea that work on minimal water. But nuclear solutions can close the energy budget today, with ordinary fission reactors. There is no reason to wait on this, France has already done it.

Why is it as hard to question dogmas in Science as in Religions? Has Science became today what religion sadly was in Middle Ages?

It's always hard to question dogmas. The reason is that most of the time you are simply rehashing the arguments that led to the dogmas getting established in the first place. It's just a way of saying "don't waste my time". It was always like this in all fields. The difference with science is that you actually CAN challenge a dogma, and you have a reasonable chance of winning if you are right. But it's still hard. Online, it can be completely free, because you can challenge a dogma, and someone who knows why it was establshed will instantly clue you in as to why it is wrong. So you don't need a high barrier to addressing ideas online. You don't need any barrier, just let someone say their crackpot idea as to why Einstein was wrong, and refute it in a comment. It doesn't take long when the idea is old. It's the new ideas that need protection, when the dogma is challenged by a new position which hasn't been addressed before. The internet is good at that too.

Does Ron Maimon hate Sartre or Camus?

I don't read philosophy. Sartre is a political figure, who wrote a lot of ponderous text. I don't see political opinions need any more respect than, say, Groucho Marx's. The same with Camus. . There's nothing to hate here, really, they don't go around doing academic scams, or getting in the way of science, like other philosophers, Aristotle, or Searle. They also don't deny ethics like Nietzsche, and they aren't Nazis like Heidegger. But there's also nothing to like. I ignore them, I haven't read either except for a few pages by skimming (and getting bored). I am not a philosopher. Camus seems to be a good writer, I respect that, but the project of philosophy is about politics. Perhaps I shouldn't ignore Camus. I don't know. I am not a humanities person. I do think that Sartre made a mistake by not taking God seriously. But I can't fault him for that, not really. The concept was never explained properly, the expositions were supernatural and obsolete. It was hard to rationally figure out exactly what religious people were talking about before the internet, and everyone was talking in vague spiritual terms about things that would never persuade a Marxist or a positivist in a million years, without a transcendent experience. So Sartre's atheism is intellectually wrong, in my opinion, but not dishonest, nor annoying, just wrong in the usual way. His atheism makes him get in bed with Nietzsche and Heidegger, who try to make an individualist replacement for God, but God is not against individualism, it only seems this way because of the collectivist presentations in previous sources.

After watching documentaries and reading books about successful mathematicians I have come to believe that they are born that way. Could someone who was not a prodigy become a really successful mathematician simply through hard work?

They don't tell you all the stories of the anti-prodigies, folks like Penrose, Mandelbrot, that fellow who proved zeta(3) is irrational, who were the exact opposite of the prodigies, they were late bloomers. Their work is just as great as anyone else's, although they start later, so cumulatively there can be less of it, just by the finite lifespan of human beings. Being a prodigy is simply an incentive to get good and stay good quickly. There is no barrier to doing mathematics, it's not like there is secret knowledge that only a select few are privy too. It requires years of isolated effort, and it's not always guaranteed that you will solve your biggest problem, but there is no barrier to anyone doing it. Really.

Where did the Sun get its energy to burn itself? Is it the same way in that we light a matchstick? If there are certain theories, what is the scientific verification behind them?

From the big bang, which made Hydrogen, not Iron.

What is an intuitive explanation of Calabi-Yau manifolds?

They are 6-dimensional manifolds where when you walk around any loop, the holonomy (the rotation of the vectors you carry with you) is by a special subgroup of SO(6), which is the SU(3) you get by pairing the 6 coordinates into complex numbers, and only allowing rotations by complex matrices. This condition is equivalent to saying there is a well defined constant spinor on the manifold. One way to see this is that SO(6) is SU(4), and the constant spinor can be taken to be (1,0,0,0) and then the SU(4) rotations that preserve this are obviously the lower SU(3). This constant spinor defines a residual supersymmetry by contracting with the local supersymmetry current. This is why these are interesting in supergravity approximations to string theory, these manifolds define the compactifications which are supersymmetric at low energies in the 4d sense.

Atmospheric Science: If Coriolis Force (CF) and Pressure Gradient Force (PF) act equal and opposite to each other (once CF becomes strong enough with increasing velocity of wind) , why do winds not travel in straight lines?

Imagine a wind in the Northern hemisphere not at the equator going South to North. Such a wind is also rotating with the Earth. As it heads North, the lattitude radius to the axis of the Earth shrinks, so it's West-East motion is too fast for the new lattitude, so that it tends to curve to the East. When it's going North to South, it tends to curve to the West. This produces a tendency for cycles. From the fact that the winds curve, you see that the Coriolis and pressure gradient forces are not equal, the residual serves to accelerate the wind to maintain the cycle. Any time the wind curves, that's a sign of unbalanced forces.

How does one derive Bell's inequality?

If you have three students taking a yes-no test, and student A and C are cheating off student B, and student A is 99% correlated with student B, and student C is 99% correlated with student B, then student A and student C are at least 98% correlated. That's because if there are 1000 questions, 10 are different between A and B, 10 are different between B and C, and so at most 20 are different between A and C (think about it). The general statement is that when you have pre-determined answers to yes-no questions, then (1-C(A,C)) <= (1-C(A,B)) + (1-C(B,C)) Where C(X,Y) is the degree of correlation between X and Y, a real number between 0 and 1. That's it. That's the Bell inequality. It's obvious. Despite the fact that it is obvious, this inequality is violated in quantum mechanics. When you measure the spin of entangled particles far away from each other, and you measure in the same direction, you always get the same answer (actually opposite, but just negate one of the two answers, it's easier to explain if they are the same, due to the problem of counting minus signs). This means that in any one of three directions A,B,C , particle 1 and particle 2 have the same answer they intend to give you for the spin written down on their internal crib sheets. If you adjust the angle between A and B to be small, you can make A and B 99% correlated. You can make B and C 99% correlated. This means if you measure the A spin on particle 1 and the B spin on particle 2, you will get the same answer 99% of the time, and a different answer 1% of the time. But now if you measure A and C on particle 1 and particle 2, they are only 96% correlated. That's it. It's impossible to arrange with crib-sheets. To see why it's 96%, the reason is that the probability amplitude is maximum at equal angles, and it is a smooth function, so the amplitude for getting a different answer is quadratic in the (small) angle. The probability is the square of the amplitude. So let's say for A and B it's Amplitude = (1-e) Probability = 1- 2e up to negligible e^2 terms. So to arrange the situation, 2e should be .01, so the probability is .99, 99% correlation. It's the same angle between B and C. but then you double the angle to get the angle between A and C, and since the amplitude is smooth and has a maximum at zero angle, you have a quadratic function near the maximum, and the discrepancy is quadrupled Amplitude = (1 -4e) Probability = 1 - 8e so that the correlation between A and C is .96, 96% correlation. The precise amplitude function for spin-1/2 entangled particles is a cosine of half the angle, with a maximum at 1, but it doesn't matter what the exact form is. As long as the amplitude is a smooth thing, without a sharp cusp at the maximum, you will get a violation of Bell's inequality, because near the maximum, the probability will always be quadratic in the difference, not linear in the difference. This violation means that either there are no crib sheets (as in standard interpretations quantum mechanics), that is, the information is produced through a strange irreducible interaction of the measuring device and the spinning particle at the point of measurement, or else the crib sheets are modified at the point of measurement faster than light (as in Bohm's variation on quantum mechanics), so that the physics at distant points is nonlocally linked, so that the crib sheets can change upon measurement. That's the entire argument. The formalism tends to disguise this. The small angle limit is emphasized in Bell's original paper, but nobody uses this except Bell.

Are equivalence principle tests "practical tests to prove string theory"?

The preprint is here: [1307.1202] Expanded solar-system limits on violations of the equivalence principle . It is based on violations of the equivalence principle, so a composition dependent variation in the force of gravity. This doesn't work except as a detection of a massless scalar, and we know the massless scalars are all gapped in our vacuum from earlier tests of the same nature. It is not a test of string theory because string theory does not predict violations of the equivalence principle in standard stablized vacua. It's just hype, inappropriate hype, for a measurement which is interesting, but not revealing on string theory. The tests of string theory have to come from domains involving black holes, high energies, or cosmology, because string theory reduces to standard GR (with no EP violations) at low energies, along with quantum field theory on whatever massless fields are left over after compactification. There is no solar system test for the theory, there cannot be. Even if they do succeed in finding an EP violation (fat chance), it will be modelled by a new massless field, which can be added by hand to GR, without using string theory proper.

Is Craig Venter the most dangerous man on the planet?

He isn't dangerous, and you should trust him because he hasn't done anything bad yet, and he tells you what he's doing! If you don't think it's a good idea, tell him, and he'll listen to you. He's not crazy. If you think there is a problem, wait for the problem before restricting his freedom. There is no reason to limit people's freedom pre-emptively. Craig Venter has done more good to humanity than nearly anyone, by completing the genome project properly, when all the academic hot-air prevented anyone from doing so. He deserves the same respect and tolerance you give any other person who is trying to do something new.

If you could be a number, what would you be?

The number whose digits encode my brain's internal computation within some computing cellular automaton, say Conway's game of life. Wait. I'm already that number, nothing to do here.

What technologies will we need to move planets and smaller space objects?

You would need to land a bunch of Orions style spaceships on several large asteroids and use H-bomb explosions to steer lots and lots of these onto orbits that get caught between two planets, flinging first past one, then past the other, in such a way that one planet gained energy on every flyby, and the other lost energy. If the H-bombs can't move the big asteroids, they can move the smaller ones, which can then be used in the same way to move the bigger ones, through gravitational slingshots between them, or direct asteroid-asteroid collisions. In this way, you could transfer the planetary orbits (ever so slowly) to some new location over many millenia. You could bring Mars and Venus to a habitable orbit probably, but you would need a heck of a lot of asteroids. During the fly-bys, one planet gets a little closer to the sun on each pass, and other planet gets a little farther. You can use Jupiter for one leg od the fly-by, because it's large mass makes it an effective anchor. Why this is not a good idea: you could easily wreck the stability of the solar system! The ellipticity of the Earth's orbit might end up getting resonantly amplified by the other planets. It's much better to put a thicker atmosphere on Mars, and cover Venus with solar reflectors. So I wouldn't ever do it, at least not without absolute guarantee that no catastrophe would ensue. It's hard to tell, because the planets have probably grown up to avoid resonant amplification of instabilities. This perhaps explains the Kepler/Bode observation that the ratios of plantary orbits have some regularities, but there could also be no explanation, it's not sorted out. If you can use the asteroids to correct the Earth's orbit too, then perhaps you can do it safely, but I doubt it, because planetary perturbatons on each other are much larger than asteroid perturbations for small bodies. Terraforming is the right way to go about it, as it has no limits of safety.

Quantum theory says a particle can be anywhere in the universe in the next instant. Photons are the fastest particle but are limited to the speed of light. How can both be true?

The problem disappears when you examine it positivistically. If you produce a photon at point A, and try to detect a photon at point B, indeed, you have a nonzero probability of detecting a photon at point B. The problem is that you are spuriously detecting a photon, because to detect a physical photon, not just a vacuum fluctuation, you need to extend the measurement over a region. If the A and B points are separated by more than the speed of light, then the detection you find at point B would happen whether or not the photon is produced at point A in exactly the same way. But the propagation path of the photon does zig-zag in time, and does have (in the Feynman calculation method) an amplitude to travel faster than light. but the signals one finds when one tries to detect this photon that travels faster than light are indistinguishable from the spurious signals one finds when doing the same measurement in empty space. This is why Feynman's formalism is subtle, it is an S-matrix formalism, it makes causal sense only when you consider asymptotic states. The local measurements are described by local fields which obey causality properties, meaning that what you do at point A only affects point B if point B is closer to point A than the speed of light limit.

Why are some men on Quora so open about their apparent hatred of women?

Because women find a degree of misogyny attractive.

How did "cyclic coordinates" get their name? Are they related to the cyclic group?

They get their name from cycles of dynamical systems. For example, if you have a free 2d rotating line, the angle is a cyclic coordinate, and it goes round and round. In a dynamical system where the motion is bounded, any cyclic variables have to be periodic, or else they run away to infinity.

Is Daniel Dennett worth reading?

He doesn't say anything wrong, and he keeps the computational view of mind alive in the miserable fraudulent atmosphere of modern philosophy, but I don't see any significant advance in the books he writes, mostly a desperate rear-guard action to halt the general slide into darkness. That's nothing to sneeze at, though, so I think he's good. The Mind's I (with Douglass Hofstadter) is good. It contains some interesting thoughts. But the basic idea he uses in "Where Am I" is a version of the main idea of Everett's work on the Many-Worlds Interpretation of Quantum Mechanics. This is the idea that a single mind can split in two when a duplicate computation forks another. It's interesting, and it never appeared before in the philosophy literature, but it did appear in Everett in 1957, and Everett is uncredited in Dennett. His later statement about solving the problem of consciousness using the idea that the mind is broken into littler sub-minds is somewhat fine, but it omits the major positivist insight that there is no "hard problem of consciousness", that there is no problem here. The sub-minds idea is interesting as speculation, but I don't see how it helps the analysis of the brain in any concrete way. I find the ideas of Dennett's pal, Hofstadter, on understanding analogy deeper, but then again, I read Hofstadter more deeply than Dennett. With Hofstadter, there is always a mathematical model you can vaguely see in the background, coming from his physics training, and the actual AI programming work he did in the late 1980s and early 1990s. I don't want to be negative, it's a miracle Dennett is staying honest, nobody else in his field is. Although his thinking about mind does not come with a definite computational model of anything, and I don't see how it helps make a mathematical statement of any kind, despite being very verbose, it's not vacuous and it's not wrong, and that's good enough. Today, it basically makes him unique in the field of philosophy.

What should everyone know about marijuana?

It impairs your mathematical thinking for longer than you are high, for a few days at least, and that's for a teeny-tiny small dose. It can be more debilitating in larger doses. In regular use, it completely annihilates any high-level mathematical or precise structural thinking, and in enormous regular doses, you can even forget elementary mathematics. Once it is gone from your system, you are back to normal, but this takes a long time, sometimes weeks and weeks for heavy users, and you may find afterwards that you have forgotten a scattering of elementary things that you used to know well, and need to laboriously relearn. This type of damage is to be weighed against the small reported benefits: some slight synesthesia, and small alterations in cognition which people sometimes find pleasant. The effect is mostly relaxation and concentration, things which can be achieved through meditation without damaging mathematical thought. So I think it's not a useful drug, it is at best something you can take a few times in a lifetime, regular consumption is no good. But hey, your choice. If you don't want to be able to think properly, go ahead, smoke up. But please, don't smoke it around other people, as it has an unbelievable area effect, and it can impair bystanders with threshhold doses without you intending any such thing.

Access of two-dimensional array by syntax a[i][j] is said to be equivalent to * (*(a+i) +j), how does the compiler understand this representation?

Edit: The question changed. Below is the original answer, which is applicable to the expression: *(*(a+i)+j), which has for a the type of (something)**, a pointer to a pointer to a something. See the end for a[i][j] which is sometimes NOT equivalent to *(*(a+i)+j), depending on whether a is a pointer to a pointer, or a C style two dimensional array. The way to sort this out is to first reduce it to primitive instructions which consist of elementary assignments and arithmetic operations only. This is like assembly language: b = a+i c = *b d = c+j e = *d 1. b=a + i The integer i is multiplied by the size of pointer in bytes (usually 8 today), and this quantity is added to the address a, and this is stored in b. 2. c = *b The quantity at the location b is put in c. 3. d = c+j To the address c, add j times the size of whatever c points to. If c points to a double, you multiply j by 10 and add to c. 4. e = *d e then contains the double (or whatever) pointed to by c. This is what the compiler produces from this statement, more or less, except with incomprehensible names for the intermediate variables, and sometimes omitting them when there are sophisticated instructions that can add and dereference at the same time. Regarding a[i][j], if a is declared as a double ** a, then it means exactly the same thing as above. On the other hand, if a is declared as double * a[N] or double a[N][], where N is a number, then the interpretation is COMPLETELY DIFFERENT, this is a quirk of C to allow intuitive and efficient representations for multidimensional arrays with a fixed horizontal size as linear arrays, instead of a less efficient and more fragemented pointer list. In this case, the compiler knows the type of a is double a[N][], not a pointer to a pointer, but a pointer to a double. It interprets a[i][j] exactly as a[i*N + j], that is: b= i*N c= b + j d = a + c c = *d Because of this lexical ambiguity, which is really an inconsistency in C, I avoid using multidimensional arrays entirely, and always write a[i*N+j] everywhere, reserving a[i][j] to mean *(*(a+i)+j). But even there, it's better to say *(a[i]+j) or (a[i])[j], to make sure that it is understood that this is not a 2d C array.

What happens to a particle when its entangled partner falls into a black hole?

Particle B would now be entangled with the black hole state. In practice, since the black hole is macroscopic, it's the same as saying that particle B is left in the density matrix state which you get by tracing out particle A. Unless the black hole is ridiculously cold and isolated (like a black hole in perfect vacuum charged up with electric charge to it's limit, or spinning to the limit), the number of states is as enormous as any other classical object.

Is there a way to intuitively make a good guess on whether or not a function is uniformly continuous?

For school, if it's written down, and continuous, it is usally differentiable (that's not true at all, it's only true of functions people write down in books). Then, if the function blows up in such a way that the derivative becomes unbounded in its absolute integral, then it's not uniformly continuous. Two examples: 1/x on (0,1) is not uniformly continuous, also sin(1/x) on the same domain. These examples pretty much exhaust what is going on in the differentiable case. A third example: The square root function has an infinite derivative at zero, but is uniformly continuous on (0,1), because for any epsilon, you can choose the delta which works near zero, and it works everywhere else too. This is a TERRIBLE definition from the point of view of rigorous mathematics, because most continuous functions look like a random zig-zaggy walk, not like a smooth differentiable anything, but it's what you use when you want quick intuition for a given differentiable function written down for you using elementary functions you understand, the stuff you see in school. A continuous function on a compact set (like a closed interval, or a closed bounded set in Euclidean space) is always uniformly continuous, so the failure can only come at the boundaries of where the functon is defined.

What effect has the computer had on philosophy in general and philosophy of mind in particular? How have theories of computation and computer science shaped brain research and understanding of intelligence and big questions we are currently asking?

The computer obsoleted everything that came before, there is hardly any philosophy before Turing, it is mostly babble with a few exceptions. The exceptions are Leibniz, who arrived at the idea of formal computation already from Newton's laws, Russell, who defined a computing system in the Principia Mathematica, although he didn't think in computational terms yet, and Mach, who worked hard to found philosophy on the mental states of the brain, which is the only computation he had access to. The majority of philosophy after Turing is also ignorant babble, because most of it, with the exception of the logical positivists and the functionalists are ignoring Turing and trying to reverse the progress. This is inexcusable, because Turing already made the advance, it is just burying the head in the sand and trying to pretend nothing happened. So what did the computer do exactly? 1. It precisely define logic and mathematics The laws of logic are defined today as a computer algorithm that can deduce the consequence from any system of axioms. The process went the other way, where first the logical algorithm was defined by Hilbert and Godel, following Boole, Frege, Whitehead & Russell, and other foundational logicians, and then the computer was abstracted by Turing as the simplest machine which can do arbitrary logical deductions using the Hilbert-Godel algorithm. The formalism of first order logic is a standardized example of a formal algorithm, a computer program, that can produce all the deductions of a given set of axioms. This defines what it means to have a precise axiomatic system, it defines mathematical thought. 2. It can simulate anything This is often called the "Church Turing thesis". It is a law of nature which states that any algorithm which is precisely defined can be implemented on a Turing machine. That means that whenever you can precisely define any algorithm, for example a completely different kind of computer, like an analog machine, or another type of logic which is also precisely defined algorithmically, like modal logic, you can always simulate the other computer or the other logic using an ordinary computer. That this is true is both an input and an output of physics--- all physical laws which describe nature are computable (aside from possible randomness), so that any physical process can be simulated on a computer. So that the outcome of anything we can see can be generated by a regular ordinary computer. 3. It can think This is a corrolary of 2, because a computer can simulate a person. This conclusion was so shocking to people that there were arguments against it.

But there is no argument possible--- the computer can simulate a person, therefore it can think. No further argument is necessary. The only caveat is that there is randomness in the universe, so you might need a random number generator. If you wish to say computers can't think, you need to find a noncomputable physical law, so string theory is wrong, and there is some quantum gravity weirdness which requires uncomputable processes, and these then somehow influence human decisions in a different way than randomness. 4. Computers can occur spontaneously in nature This is something that is clear after the work of Von Neumann, Conway, and Wolfram. There are extremely simple cellular automata that produce full computation, the complex automata. These natural computers do not require careful design by human engineers. 5. Biology is computation in nature The complex systems can appear and evolve without being seeded with replication. The replication is high-level, of the algorithm, it isn't simply copying with errors, and the computation in biology becomes highly sophisticated, and networked, and cooperative/competitive in different degrees, as it is in your brain. This is how Darwinian evolution works, not in a primitive copy-error brainless way, but in a computing way which is sophisticated. This allows you to effortlessly make many predictions in biology that are half-way between the modern synthesis (simple gene algorithms--- no significant computer) and intelligent design (God--- infinite computer). These are the main points. But the computer and logic also found philosophy, in logical positivism. The logical positivists combined the positivism of Mach with the logic of Russell, and produced a philosophy which was able to ground traditional notions like "cause/effect", "meaning", "use" entirely in terms of "observations" and "correlations", things which can be processed by a computer. This program answered or mooted all the classical questions of philosophy, one by one, very quickly. The mooting was done by Carnap in the 1940s. Since this stuff is encroaching on the philosophers realm, and it is ultimately coming from the sciences, it is actively resisted within the field of philosophy. Nearly all the major philosophy since 1970 has been devoted to attacking this point of view one way or another, either attacking positivism (later Wittgenstein), attacking computation as the foundation for thinking (Chalmers, Searle), or attacking the notion that computation is a good foundation for science (Popper). These attacks are reactionary, and wrong. These gains are irreversible, they are a ratchet, the classical philosophical problems have been solved. There are also a few people who maintain that there is nothing seriously wrong with the computational foundations, and these are Daniel Dennett, Douglas Hofstadter, and most people in computer science or physical sciences.

How come black holes do not have infinite mass?

This paradox only appears in the coordinate system of an external observer. In this coordinate system, the infalling matter does reach the speed of light at the moment it crosses the horizon. But the reason this is happening is that near the horizon external coordinate time is slowing down, so that a fixed energy at infinity turns into a very enormous speed, a very enormous local kinetic energy, right at the horizon. To understand this fully, consider a photon of fixed frequency that is in a wave that crosses the event horizon. The frequency of this wave is constant everywhere, but as you get closer to the event horizon, the wavelength from the point of view of an outside observer gets shorter and shorter. But the photon still has the exact same total energy (as measured from infinity) as it did when it was at infinity and it's wavelength was long. Energy is not added up as local contributions, at least not in the naive way, there is also a gravitational contribution. In this case, another way of thinking about it, using gravitational (pseudo) energy is that the gain in kinetic energy of the falling object is entirely balanced by a negative gravitational field energy contribution which keeps the total energy the same as the object falls into the black hole. All of these discussions are relative to a time at infinity, which is required in order to define energy/frequency.

Should recreational marijuana use be stigmatized?

Not stigmatized, warned against honestly. It makes you lose your mathematical skills, and you really will miss them. Really.

When is it advisable to work as an independent researcher?

If you have a PhD, and can get government grants, and have guarantees of quick open internet free publication of your work, and your work is top-notch, it can work. Without a PhD, you will starve to death, you can't get a grant.

Why is Ron Maimon so passionate about disputing the accepted explanation of the September 11 attacks of 2001?

When I went to Iraq war protests in 2002-2003, I saw some folks carrying signs that said "9/11 was an inside job". I had a conversation with one of them, trying to persuade him that, even if what he was saying was true (at the time I thought he was crazy), the public would never believe it, so to focus on getting rid of Bush first, getting rid of the fascism, the internal spying, the torture, all that nonsense, then to focus on conspiracies and intrigue. Well now that I see what he is saying IS true, I am ashamed of myself. I came at it with extreme skepticism, so I know what it takes to change a skeptics mind (the drills are the key, and the method for staging the attack). Besides, it's a good way to get the word out, the internet was made for this. I expect to see a capital murder trial at some point, with at least one senior level administration official. I don't support the death penalty, but like Nazi crimes, sometimes it might be appropriate.

What is Ron Maimon's stance on climate change?

Same as the mainstream consensus. The consensus is spot on accurate. I accepted global warming was likely to happen in the mid 80s. It was called "The Greenhouse effect" back then, it was discussed at the first Earth day, so it wasn't news for people following the modern environmental movement. The hippies in the 1970s, just based on CO2 levels, and back of the envelope estimates, predicted visible warming of order a fraction of a degree by the 90s, and a full degree by the mid 21st century. Even without fancy computers or models, they were pretty much spot on, a little optimistic even. The warming pattern in weather was already obvious in NY already in the mid 90s, winter here became weeks shorter than in the 1980s or 1970s, the effects happen to be enormous in the Eastern United States. The effects now are completely undeniable, winters have nearly stopped entirely compared to the 70s and 80s. This is a region on the border of snow, with pronounced seasons, and even small changes in climate move the snow northward and away. When a bearded hippy predicts to you an astonishing effect with a detailed mechanism two decades in advance, and predicts the direction, magnitude, and timing, there's nothing you can say.

What is Ron Maimon's driving force?

I suppose it's God, same as most anyone else.

Could Ron Maimon take a page from Feynman and write a physics textbook that could take a newbie to math and physics all the way to a current understanding of where we are today?

That kind of project is for when you're old and washed up. I'm not old yet, and I hope I'm not totally washed up yet. Besides, Feynman already did it! Landau too. There are excellent introductory things out there, the advanced stuff is what is lacking. If you find something impenetrable, ask for a source in the comments, I'll link a paper, and prerequisites.

Was Ron Maimon ever in a Ph.D. program?

I was a grad student in Cornell from 1995-2000 (fall 1996 I spent at Rockefeller, and 1999 in Santa Barbara), I left grad school to do biology when my advisor left for Cincinatti. I did some biology at a company called "Gene Network Sciences" started by some friends of mine in the department, I got fired in 2005, as the company turned corporate and the US was turning into a fascist hellhole. From 2005-2008, I wandered around Cornell aimlessly and try to finish a thesis or reenter academia, I did some more biology during this time, a few things in physics. Then I worked again briefly at Cornell, did the cold fusion thing, and was outie.

In the Wormhole Theory of Entanglement, do the opposite ends of the wormhole rotate in opposite directions or just the particles?

In the Maldacena Susskind theory, the wormhole ends are the particles, so the question is meaningless.

What remains to be done in theoretical physics?

Condensed matter physics is an open ended project, it will remain open forever, materials are arbitrarily fascinating. So the question only makes sense for fundamental physics, for the laws which can be thought of as lying beneath, I don't want to offend condensed matter people, no condensed matter in this answer. String theory, while very well developed, is not a complete theory, in that we don't know many of the predictions, even for very stupid elementary questions, like "what happens to stuff you throw in a charged black hole in an AdS space?" There folks saying there are firewalls, and while I think this is certainly false, you need to demonstrate it with a good method to calculate black hole interiors. There are lots of questions like this. But since we already have an in-principle method of computing everything within AdS/CFT models, at least since 1995-1997, I will also ignore questions of the incompleteness of string theory, and pretend we have already answered all the questions in every asymptotically cold background, because we can in principle. These questions are the ones that most string theorists study actively, so I won't say anything about the current research interest of most string theorists either. In principle, we could figure it out using a big computer (just we didn't do it yet). I also will assume that string theory is correct, in the sense that it describes our universe, with its gravity, not just mathematical universes with mathematical gravity. Although there is no airtight evidence for this at the moment, it is the best theoretical position to take, given the uniqueness properties of string theory. Because of this I will ignore all the alternative ideas to string theory, like loop quantum gravity, or more speculative ideas about triangulations and so on, because unless they are linked to string theory, they seem to be all wrong. So, under these constraints, what is still completely mysterious in physics? From my biased perspective, there are three major things; 1. Finding our vacuum, with it's SUSY breaking and cosmological constant. At the moment, string theory cannot make predictions, because it's like we know Newton's laws, and that planetary orbits are ellipses, but we don't know where they are, so we can't say where they're going. Finding the vacuum is difficult, people have been looking for a long time. There are canonical heterotic style models which look good as a first pass approximation, these came from Yale in the last few years, but these are usually supersymmetric. If our vacuum is not supersymmetric at all, which is looking more likely from current LHC studies, then you need to find a good method of producing non SUSY vacua with small cosmological constant. This is something we don't know how to do, but there is an example or two within string theory. With or without SUSY, the cosmological constant is mysterious, and it is not clear what principle you learn from the fact that it is small, but not zero. Maybe it's only anthropic, which would mean you don't learn anything systematic. 2. Asymptotically thermal space-times, deSitter spaces. These are theoreticaly intractable right now, because deSitter spaces are not cold, and it is not even clear that their evolution is unitary. Sorting out how to describe deSitter space might not look like it is so difficult as compared to figuring out string theory, but it's a major, major difficulty. To see the problem, the cosmological horizon is finite area, and finite area suggests finite Hilbert space size. But the universe is expanding, so is the Hilbert space growing? This stuff is endlessly confusing, and both Tom Banks and Leonard Susskind have written extensively about this without any really solid theoretical conclusion emerging. 3. Quantum computing: is quantum mechanics exact? This is the big one. While quantum mechanics could be exact, I have nothing against this idea, I am completely happy with philosophically positivist interpretations equivalent to many worlds, there is a theoretical argument against this. It's philosophical prejudice, to some extent, so it could be totally wrong, but similar philosophical prejudice has been useful in the past. The principle that is violated is that a physical system of size X should be able to only compute the answers to problems which are polynomial in X. The idea is that the universe is described well by a random access machine of a size which is comparable to the physical numer of particles. It's not true in quantum mechanics, it is true in classical mechanics, and it seems to be preferrable, since the exponential growth is a sort of mysterious extra processing which is counterintuitive. That doesn't mean the universe doesn't do extra processing, but it is a reason to ask for evidence. We can't have evidence yet for exponentially huge computation, simply because we can't do the computation to check if quantum mechanics is correct in those delicate highly superposed quantum computer cases. So it is still reasonably possible that quanutm mechanics will fail for quantum computation, as 'tHooft and others have suggested over the decades. This is a distillation of Einstein's complaint with QM, that the wavefunction is too enormous to be a fundamental object, and looks like a stochastic tool to describe something else. But Bohr might also be right here, and maybe one should shut up and stop telling God what to do. The way to resolve this experimentally is to build a quantum computer and see if it works. The way to make progress on this theoretically is to make a nonlocal plausible hidden variables theory that works to reproduce small quantum systems and fails for large ones. This is extremely challenging, but 't Hooft has taken steps in this direction (although I disagree that he has solved it, as he claimed in some recent papers that I personally found completely wrong in technical details for reasons I wrote on Stackexchange).

What is the order of magnitude of the fraction of super-rational players over human beings in the western world?

If you understand that monotheistic religious people are playing using an approximate form of superrationality, it's around 80-90% in the US. In Europe, it's also high, because even though the traditional religious orders are weakened, the ethics from those orders survive. So I would put it between 70 and 90 percent worldwide, for some form of superrationality. Unfortunately, the remaining 10-30% consist of many powerful people, because precisely where superrationality and Nash rationality don't coincide, by definition Nash rationality provides a local advantage for the individual. It is only revealed to be individually disadvantageous when considering the correlations with an enormous superrational collective. For a symmetric prisoners dilemma with two players whose probability of being superrational is known to each other to be p, so long as the expected payoff from both cooperating (times p) is greater than the expected payoff from both defecting (times 1-p) a superrational player cooperate. Superrationality is stable to small perturbations. The main "theorem" (it's trivial) is that the superrational collective cooperates in symmetric prisoners dilemmas as long as the total utility gained from cooperation is greater than the loss due to non-superrational defectors. It maximizes collective summed utility, like utilitarianism. This doesn't make sense for asymmetric games, hence the need to define the superrationality in terms of the will of an abstract infinitely wise agent, aka God.

Why does light disappear when its source is turned off?

Because no particles are released by light, and eventually all the light is absorbed, and longer wavelength light is reemitted. There light remaining in a dark room is just infrared thermal light emitted by different objects at near room temperature.

Can religion ever be more than 'Your God/My God'?

The basic idea of monotheism is that under conditions of idealized cooperation, it's all compatible, so that your God and my God are the same God because we cooperate. That doesn't mean we do the same rituals, or think about the same problems in the same exact way, because of different experiences and human limitations. But it does mean that people respect that one-another's rituals should come together to form a compatible whole, a whole which reflecting a larger system that is consistent and cooperative across all the individuals, with somewhat different perspectives. it takes a long time to make a convergence, and there are terrible things that are not compatible with this convergence, like the Roman colloseum or something like this. But people do converge, and they maintain diversity, eliminate only that which is incompatible with ethical convergence (which is just a relatively small number of objectively terrible things).

How does reincarnation make sense, if I am who I am because of my genes, experiences and memories?

Reincarnation is about the soul, the algorithm, the software. Software doesn't have a single implementation, it can exist in multiple copies, and you can have continuity between different versions, so that Quake 3 is somehow the extension of Quake 2, even though they are different programs. The reincarnation idea in religions is not always saying that the experiences and genes and memories are identical between different people, or even that people can somehow remember a past life, this is nonsense. It is suggesting that the new ideas that appear are continuously preserved across generations in different unrelated individuals, so that you can find people in the next generation who continue the thoughts and experiences of folks in previous generations, without ever having met them. At least, this is the part of it that makes sense, because this is true. It is parallel to the idea in Christianity of the congregation embodying the will of the risen Christ, or the Jewish idea of the patriarchs dying and "gathering onto their peoples", which appears several times in Genesis. It is a concept that the abstract parts of your mind float around in the collective of others, and an individual can collect much of the most important parts of your software ("Most of the good stuff", as Feynman put it), and so can extend your thinking after you are gone. In the same way, parts of you reflect others from the past, and it is difficult to see exactly where your stuff begins and other previous people's stuff ends. It is a way of removing the isolation and ego of individual existence, to recognize that the thoughts and experiences of humanity are shared through language, writing, and convergent evolution, and so are to a large extent communal. It is not strictly one-to-one, so that one person can be incarnated in many, as for example Einstein is largely reincarnated in the physics community of today, and sometimes it is many to one, as many different threads of different people, long dead, converged onto Paul Cohen when he did forcing (and of course, there was something new as well). Nor is it accurate to think that the conscious thinking is continuous across the "incarnations" the way it is when you fall asleep and wake up. But as a spiritual approximation sufficient for religion, which is always an approximation, it's a good enough tenet to get the basic idea across. It shouldn't be taken too literally, because the continuity of individual experience is always much bigger than the continuity across generations, but it is uncanny how you can find in each generation of folks individuals who resemble and embody so strongly the ideas of folks in previous generations.

Do academics who may face hiring/tenure decisions in the future often hide much or all of their past non-academic Internet activity prior to facing it?

Usually there is nothing to hide, because folks who end up tenured are political from an early age, and are careful to begin with. An exception is John Baez, another is Terence Tao, and both were academically heckled for their internet activity, although both got a lot of visibility from it too. Lubos Motl was so threatening to Harvard, he was actually politically pushed out of his tenure track position due to blow-back from his blogging. This social pressure in academia makes it that there is a clear divide between internet people and academics, and since internet folks have an enormous advantage in getting their ideas out, suddenly, it is NON-academics who are favored by the media. This won't last forever, academics will soon understand that they lose far more than they gain, but in the meantime, it provides internet folks with a critical once-in-a-lifetime opportunity to pull out some long-festering academic political thorns (rubs hands together with malicious glee).

Why does the Fibonacci sequence repeat in nature?

The Fibonacci series itself usually isn't showing up, what is showing up is stepwise exponential growth with a growth-rate between 1.3 and 1.8. The Fibonacci series is the golden mean to the n-th power, up to a negligible correction to make it integer. The universality of exponential growth, and the misleading packaging of the Fibonacci series to look like something special, somehow different from exponential growth, is what makes it mystical. You might as well have asked "Why does exponential growth show up in nature", but here the answer is obvious.

If there is a fundamental particle, from which everything is made, and which is not made of smaller sub-particles, how will we know when we've found it?

We know when it is described up to gravitational scales by a renormalizable field theory. This is what it means for a particle to be fundamental. At the gravitational scales, quantum field theory is not a correct description anymore, and no particle is fundamental, it's a form of gravitational democracy. All particles are excitation states of various black holes. This is the point of string theory.

As far as we know, are any of the fundamental physical constants any more fundamental than any others?

There are five stupid constant which only serve to fix the conventional system of units, and these should be set to 1 to fix the conventions. These are Boltzmann's constant (which defines the Kelvin unit of temperature), the speed of light (which defines the meter unit of length in terms of the second, or vice versa), Planck's constant h (actually hbar, this defines the unit of energy, and therefore mass, from the unit of time, the second), the electrostatic constant (one of epsion-naught or 4pi epsilon naught, which fixes the Coulomb), and the Newton gravitational constant (which fixes the unit of mass or length absolutely). You can add more, for example, the conversion factor from feet to meters--- 3.16 ft/m. You can add as many as you like, by adding units. When you choose units wisely, these conversion factors disappear. Once you get rid of all of these conversion factors, you are left with Planck units, and in Planck units, every physical constant is dimensionless. These dimensionless constants are the only meaningful quantities, independent of human conventions, and within modern string theory these are all dynamical, they can be different at different times. They are only fixed over our universe as an accident of our vacuum, and they can all change if the universe decays to another vacuum, or locally over a region, if you set up an impossibly high energy collision,. The remaining dimensionless physical constants, like the mass of the electron, the Higgs scale, the strong coupling constant, these numbers are parameters describing our vacuum, and they seem to be historical accidents of the big bang, just like the parameters describing the distances of planets in our solar system. They have no relation to any mathematical constants.

What does Ron Maimon think of Ayn Rand's books, specifically The Fountainhead and Atlas Shrugged?

I tried to read both of them a few times, but I couldn't read more than a few paragraphs, because I found the writing style grating to the point of unreadable. They are a popularization of fascism (not in the genocidal sense, in the "I am oh-so-special and deserve to rule the world" sense), and in this way appeal to teenagers for whom Marx holds no appeal. Since I was a Marx reader, I never found it interesting. It's basically Nietzsche take 2, without the European German communalism, with more of an anti-Soviet American individualism, which makes the struggle for superiority an individual struggle for excellence. I agree with the individualism, and that an individual should strive for excellence, but I can't stand the elitism or the ridiculous idea of a Darwinian society, and since it is mostly about super-masculine female-fantasy male-figures projecting big-dick authority, I can't stand it. However, in it's favor, I think it is one of the most extreme examples of a woman objectifying big-dick masculinity in the same way male writiers objectify big-breast femininity. Who wouldn't want a Roark around to do some ravishing?

Is there a structured way to learn computer science from online content?

I find the "read at random, continue if it is interesting, read the references if you don't get it" method works better than any formal course. You will eventually hit on everything this way, in a stochastic random walk.

Apart from calculus of variations, are there ways to prove that the curve of shortest length between two points is a straight line?

It's a consequence of the fact that the sum of two legs of a triangle is always more than the third leg. This is the triangle inequality, and it proves this by taking limits (or sups), however you define the length, it must be bigger than a polygon approximation. Calculus of variations is overkill for this simple classical theorem. This ancient Euclid proof is actually better than the calculus of variations proof, because calculus of variations usually only easily proves that the line is a local extremum of the length, and with some more effort, a local minimum. You can't do better than this in general, because on a curved space, a geodesic is only a local minimum for the length, not a global minimum. But in Euclidean space, the line is a global minimum of the length, and this is a consequence of the triangle inequality.

Does every Hermitian operator in Hilbert space correspond to an observable in quantum mechanics?

In order to be an observable, there have to be a complete set of orthogonal states corresponding to the measurement outcomes. In a finite dimensional Hilbert space, without crazy superselection rules, it is true that every Hermitian operator is observable, because you can diagonalize any Hermitian matrix, but this fails in the infinite dimensional case, for uninteresting mathematical reasons (they are interesting to mathematicians). One example is for operators which are too unbounded to have any normalizable eignestates. For example, the totally physical Hamiltonian operator p^2 - x. This has no normalizable states at all, it's a linear potential, any eignestate would blow up on the right. Still, you can solve the time-dependent Schrodinger equation in this potential, it is just the ordinary spreading Gaussian wavepacket Galilean boosted by an amount proportional to time, by the Galilean equivalence principle. So this is a fine Hamiltonian, but you can't measure the energy, because it is undefined. There are similar cases with singular potentials that are too deep too fast, like 1/r^4, so that in the ground state, the particle collapses to a delta function at zero. The issue is self-adjointness, something which can be explained more clearly when it shows up in the case of boundaries. Consider the particle in a box, where the wavefunction vanishes at x=0 and x=1. The momentum operator is Hermitian, in that $\int_0^1 \eta i \frac{\partial\psi}{\partial x} dx = -\int_0^1 i \frac{\partial\eta}{\partial x} \psi dx$ $\int_0^1 \eta i \partial\psi \partial x dx = -\int_0^1 i \partial\eta \partial x \psi dx$ so it is Hermitian. But the momentum operator has no eigenvectors! The plane wave states do not satisfy the boundary conditions. What's going on? The mathematicians explain that the differentiation operator is not self-adjoint. What this means is that differentiating a function which is zero on the boundary, i.e. in the Hilbert space of states of particle in a box, often gives a function which fails to be zero on the boundary, so it leaves the Hilbert space. So the momentum operator isn't well defined as a map from the Hilbert space to itself. So you can't measure the momentum of a particle confined to a box. There are no momentum states to collapse to. But a bounded, self-adjoint operator is always an observable, and there are non-bounded cases, like Hamiltonians bounded below, or which are not too singular like the 1/r potential, for which you can see become self-adjoint once you appropriately restrict the Hilbert space to the finite energy states (for 1/r type singular potentials, you can see that this works from the exact solution for the ground state). There are all sorts of methods of dealing with non self-adjoint operators. But I use a hokey physicist short-cut. You can always imagine the space is appropriately discretized, put in a periodic box, and any boundary conditions are implemented by potential restrictions. Then the Hilbert space is finite dimensional, all operators are well defined and you can manually take the limit of a continuous space. Usually you don't do this consciously, you just think about it. Then the operators whose eigenvectors don't blow up in the limits are the observables. If you do this subconsciously, you can postpone learning the mathematical theory essentially forever, since these complications will not arise in practical problems, and if they do, the small number of examples above will show you what went wrong. But if you insist on learning more, here is a random thing I found online: http://www.hep.caltech.edu/~fcp/...

Einsten: How did Einstein come up with the idea of String Theory?

Einstein added an antisymmetric component to the metric field, for some reason known only to him. This nonsymmetric metric didn't have any obvious physical motivation, it was just something he was completely in love with, and he returns to it again and again. In string theory, the graviton and B-field together make something like an nonsymmetric metric, there's also the dilaton, similar to what Brans and Dicke did, but you can motivate that from Kaluza Klein. I don't know how Einstein motivated the antisymmetric tensor. It doesn't seem to have any classical motivation whatsoever. But the Neveu-Schwarz B-field in string theory is like an antisymmetric component of the metric tensor, and it is precisely what the fundamental string is charged with. If you make a black hole which is extremally charged with B-field, it is an infinite line, and if you quantize the oscillations of this black hole in the completely non-classical limit of very small mass and charge, that's the fundamental string. Einstein didn't believe in black holes, and he certainly wouldn't have ever quantized them, but the attachment he had to the antisymmetric tensor makes me wonder. What the heck was he thinking? This is a historical question for which I don't think there will even be an answer. It's a totally unjustified mystical Einstein-worship thing, it's not serious, his field equations were probably wrong. But why the HECK does Einstein totally love this crazy classical thing? It's something which you would never get to from any physics, from any plausible intuition, and it's something which is completely central to the strings of string theory. Obviously the string theory version was formulated with absolutely no reference to Einstein's work, which was hopelessly dated by then.

What is the logic behind the spoj problem SPOJ.com - Problem ADV04J?

The main idea is that by choosing the line right, you can split the vertices roughly in two, so that learning which side reduces the problem inductively.

How was Schrodinger equation perceived pre-Born?

Schrodinger at first believed it was the density of a wave associated with the electron, and considered it like a classical wave equation, describing the motion of a wave in space. He considered the square of psi to be the electron density, and the phase to be the electron field momentum. This is the reason he gives a local expression for the momentum density in the field, what is now called the probability current in quantum mechanics books, so that the square of psi is conserved with a current, not just conserved globally. What makes it interesting is that Schrodinger's interpretation is completely correct for a different kind of Schrodinger equation, the classical Schrodinger equation, the kind that describes Bose-Einstein condensates. But it is false for the fundamental kind of Schrodinger equation basic to quantum mechanics. Schrodinger seems to have initially guessed that electron waves would stay little blobs in space as they move, so that they stay particles. This is clearly incompatible with the linearity of the equation, so I am not sure how long he believed this. Anyway, he showed this was wrong quickly, he solved the free equation and showed that wave-packets spread indefinitely. A little later in 1926 or 1927, he was forced to conclude that the wavefunction for multi-particle systems was waving in a higher dimensional space of configurations, The reason is that to reproduce the quantum condition for a system with many degrees of freedom, the phase of the standing waves had to reproduce the Hamilton Jacobi equation in the classical limit, and this is defined on the configuration space. There is no way to make a multiparticle system get quantized without the waves being these multi-dimensional objects, so that two electrons have a wave in 6 dimensions, three electrons in 9 dimensions, and so on. Einstein also reached this conclusion quickly, because he understood the Hamilton Jacobi business right after deBroglie's paper. Then Schrodinger quickly proved that when you make this high-dimensional interpretation, the Schrodinger equation was equivalent to matrix mechanics, so then he was sure it was correct. Since the wave was in an impossibly large number of dimensions, it didn't look like a physical wave, it looked more like some sort of a statistical distribution on configurations. Born analyzed the result of scattering of an electron by a potential, and noticed that it gave a spread out spherical wave going in all directions. This was clearly not what was going on when an electron scattered off a nucleus, so Born decided that the wave must represent the probability of the electron going various directions, with the amount of psi going in any given direction giving the probability of scattering in that direction. That this probability is the square of psi can be intuitively seen from the fact that the Hamiltonian is real, so that only the square of psi is conserved in the collision in general, so that this is the only reasonable thing that could be a probability, since the total probability of the electron going off in some direction has to add up to 1. This was clarified later, when people showed more or less that the square amplitude is the only consistent choice for the probability. The clearest argument to my mind is due to Everett, who used some physically obvious assumption (the probability goes to zero over regions of configurations where the total magnitude of psi goes to zero) to conclude that the probability must be psi squared, under reasonable assumptions. But again, it's pretty obvious from the fact that the time evolution is unitary, and the derivation is not completely without flaws, as it requires an assumption on how to measure "small worlds". Anyway, all this came much later in 1957. Other people gave essentially equivalent arguments much earlier, justifying Born's rule, but it is almost self-justifying from unitarity.

What is a layman's explanation for the nonlinear Schrödinger equation?

It's the equation of motion for a Bose-Einstein condensate with either repulsion or attraction when the atoms of the condensate sit on top of one another. The magnitude of the wave is the density of the Bose-Einstein gas, while the phase tells you the flow. Classically, it describes how the Bose-Einstein fluid sloshes around. It is a classical wave equation, it is conceptually completely different from the Schrodinger equation of quantum mechanics. When you quantize it, to make it a Schrodinger quantum field theory, you arrive at a theory of particles which repel or attract each other when sitting at the same point. This quantum theory has a real (linear) Schrodinger equation describing the particles which collectively obey the nonlinear equation. The nonlinearity just means that the particles scatter each other.

For bound states of the Schrodinger's equation, does the ground state solution necessarily possess the symmetry of the potential (assuming the potential is well-behaved)? If so, is there an argument or proof?

The answer is yes, for finite dimensional bosonic pure-potential systems (no magnetic field) with a potential that is everywhere finite. One conceptual proof is to note that this follows from the uniqueness of the stationary measure for ergodic Markov chains, since the Schrodinger equation in imaginary time is a stochastic process with the ground state the stationary measure. But you don't need to be that sophisticated. The physicist's argument for this is from the variational principle. A ground state of a Schrodinger equation in a potential (no magnetic field) is real, by time-reversal symmetry (you can add any state to its complex conjugate, which is necessarily degenerate with it). It can have no sign change, since the ground state minimizes E= [math] \int |\nabla \psi|^2 + V(x) |\psi|^2 [\math] If psi has a sign change. Then |psi| will have the exact same E, the same kinetic and potential energy contributions, but it will have a kink at the zeros of psi, and when you round out the kink you lower the kinetic energy to first order while only changing the potential energy to second order (assuming V is nonsingular). The ground state must be nonzero over all space for a potential which is everywhere finite (in Markov chain terms, there is a nonzero probability density of visiting every point). Now if you have two different ground states, some real linear combination of these will be negative, and cannot be a ground state. These are classical Schrodinger equation arguments from the 1920s-1940s. They are not completely rigorous as stated, but you can make them rigorous with the analogous Markov chain statements. Since the ground state of the n-dimensional Schrodinger equation is nondegenerate, it must be invariant under the symmetry. This theorem is sometimes known as "no spontaneous symmetry breaking in finite dimensions". It is the quantum analog of the statistical mechanics theorem of no phase transitions at finite volume, more precisely, no phase transitions with a finite number of degrees of freedom. The theorem fails in obvious ways for Fermionic multiparticle potential systems, and no for infinite dimensional potential systems. In the infinite dimensional case, you can consider a discrete approximation to a Bosonic field with spontaneous symmetry breaking. For a Fermionic system, you can consider a 1/r nuclear potential with three spinless non-interacting electrons stuck on. The first electron must be in the 1S ground state, the second electron is in the 2S state, the third is in the 2P-state, so the ground state is degenerate (and also not symmetric under rotations). There are many easy Fermionic counterexamples, even in 1d, because Fermions are not in the ground state of the Schrodinger operator, because they are restricted to antisymmetric states.

Was it really Grigori Perelman that resolved the Poincaré conjecture?

The plagiarism in this case goes the other way, it's the Harvard mathematicians attempting to steal Perelman's work and claim it for themselves. It was the subject of an article in the New Yorker (http://www.newyorker.com/archive...) Two Harvard mathematicians working under Yau, Xi-Ping Zhu and Huai-Dong Cao, claimed to have closed the (nonexistent) gaps in what they characterized as the sketch provided by Perelman. This process of "completing" proofs by lesser known figures was just a codified and accepted form of academic theft, which was tolerated in the 1970s and 1980s, because nobody had a good enough access to all the literature to find the obscure papers that were being cribbed. This type of thing serves a minor purpose, in that it usually extends the results incrementally, and advertizes them, and rewrites them in more accessible language, and allows people to see that the work is correct by linking it to other work. But in the dark ages of the 1970s and 1980s, simply by doing this pedestrian work requiring no major ingenuity or years of isolated brain-breaking labor, these folks would have gotten the majority of the credit for solving the Poincare problem, while Perelman would have languished in obscurity. But today, we have an internet, and Perelman's work was online, and written exceptionally clearly. So in a remarkable unprecedented demonstration of the power of the internet, these prominent and powerful Harvard geometers with a ton of clout were basically told by the mathematical community to go shove it. It was the unemployed and isolated Perelman's result, and they had done nothing signifcantly new. This was like a dawn in the field of mathematics. It announced that the dark ages are over, that the plagiarism and horrible academic ethics that characterized the 1970s and 1980s are done, finished. Can't get away with this crap anymore. This unethical bullshit alienated great mathematicians like Grothendieck and Perelman from professional mathematics. It really sucks balls when great famous people do it, it's not like they need to do this kind of crap. The same problem occured in physics in the 1970s and 1980s, the Russians were often the victims, but I don't want to name names. It's all finished. Can't get away with it anymore.

Why is the work of Terence Tao important?

People have been staring at Furstenberg's ergodic proof of Szemeredi's theorem for more than 30 years, without having any inkling of the idea for the breakthrough that led to the Green-Tao theorem, it is extremely technically demanding, precisely because it is in an old field, where all the easy stuff has already been done. Making such a breakthrough in a developed field with tools that are known is even more technically difficult than work like Perelman's, where the major thing is the leap of a strange new insight. With Tao, the mastery is in the details, with many insights, and this is an extremely important part of mathematical progress. You simply can't compare Tao's work with work of Okhunkov's derived from mathematical physics. Okhunkov's results are importing constructions from modern physics into mathematics, and linking to algebraic geometry in a particular domains. It's great stuff, but it is a different activity, it's like comparing Dali and Mozart, it is not the same thing as the onslaught of ideas that come from Tao. In my opinion, Tao deserves his awards more than anybody else, since he is both extremely prolific, and also he does not look down on practical problems, he doesn't discriminate between high class mathematics and low-class mathematics. The sniping is due to his non-elitist behavior, his blogging, his common mathematician-on-the-street explanations of difficult ideas. Erdos had the same problem, people dismissed his contributions as second rate, simply because they weren't usually in elitist fields, and also there were so many of them! It is obvious today what an impact Erdos had, it was cumulatively as great or greater than any other twentieth century figure. Tao is like a new young Erdos.

How are fossil fuels formed? How is it possible that prehistoric fossils were concentrated in only the parts of the world where modern day oil reservoirs exist?

Hydrocarbon fuels have nothing to do with ancient life, they are produced in the mantle from methane. This moots the question. To understand this, Thomas Gold's book "The Deep Hot Biosphere" is important, but it is largely summarizing Russian language work. The abiotic origin of petroleum was understood in the Soviet Union in the 1950s, it was hotly debated in Russia through the 1960s, and it became conclusively established by 1970 (and the Russians subsequently proceeded to kick everyone else's ass in oil production). The idea was moronically politically rejected in the West due to incompetent private science inside oil companies, based on money, not on truth.

Would artificially reducing brain temperature increase the processing capability?

The processes in the brain are temperature sensitive, and if RNA based, the hotter it gets, the faster it gets, but it becomes less accurate. That RNA-RNA interactions are the bulk of the brain's computation is not the mainstream hypothesis in neuroscience today, but I believe it is true.

How can I get involved in fusion research and development? Are there jobs in this field?

The tokamak kind of fusion is dead, it never worked well, it can't produce a reactor. You can find promising fusion research by contacting Hagelstein, McKubre, and others involved with cold fusion, in Palladium deuterium systems. These have reproduced effects which are promising for engineering. For cold fusion, the main thing is a good knowledge of chemistry and solid state physics, and quantum mechanics. You also need some nuclear physics. Most of these things are not picked up by a physics PhD, or a chemistry PhD, so you can best learn it in a library on your own. But you need the basics of the fields, and this is something you can get with an undergraduate degree and a masters degree in physics or chemistry, or with self-study at the equivalent level. Learning quantum mechanics well is the time-consuming part, condensed matter theory is also time-consuming. The chemistry is a black art, and this is something you can only learn with laboratory experience. In this regard, I should add that PACER solved the engineering problem of managed fusion energy, by designing a plant using hydrogen bombs blown up in an underground cavity. This solution works as engineering, it is old technology, but it is politically impossible today, due to proliferation worries and fears of use of the bomb as weapons.

What are the advantages and disadvantages of Shimizu's Lunar Ring project (pls see the details)?

This is silly nonsense that distracts people from realistic power solutions. It is important to ignore such things, as there are practical energy solutions out there, and every fanciful scheme is equivalent to disinformation that supports the hydrocarbon industry. Solar cells are not efficient solar energy capture, plants are more efficient. Plants convert a significant fraction of all the solar energy on Earth to biologically usable forms, and if you want ideal solar energy harvesting, plant a jungle somewhere. But the energy demands of people are not easy to realistically meet only using plants, because we are today removing hydrocarbons from the crust at a rate comparable in order of magnitude to that at which the biosphere metabolizes carbon, this is the reason we have global warming issues--- the human carbon emissions are comparable to the Earth's plants solar carbon-capture capacity. Since plants are already doing a nearly perfect job of capturing solar power, solar power is inherently limited. If you want solar power, the best bet for using it is to irrigate the Sahara and plant lots of trees there, which would be ten thousand times more useful than any solar cells on the moon, and would capture more carbon a million times more cheaply. The other problem with this "plan" is that you can't beam the energy to Earth realistically, any beams would be environmentally devastating and inefficient. It's absurd, and it distracts people from nuclear energy sources, and from biotechnology, which can use solar photosynthesis to produce fuel.

How would you explain Mercantilism to a child?

Mercantilism was the economic doctrine that allowed modern colonial empires to develop stably. In ancient times, empires were held together by tribute--- a colonizing political order would demand a tribute tax from each region it controlled. Under mercantilism, the idea was that free trade can be used as a substitute form of imperial tribute, if certain economic conditions are met. The conditions are that any industrial transforming capacity to make sophisticated products is restricted to the colonizing country, while the colonized territory can only supply raw materials, and is not allowed to develop the industry for transforming the materials into consumer goods. In this way, instead of paying a direct tribute, as in Roman times, folks in the colonized regions would pay an indirect tribute just by buying stuff. They purchase sophisticated products while only exporting raw materials. Then the power of the empire can be maintained without armies of tax collectors, but just through the imbalance in knowledge and expertise and manufactring capital in the different regions. This process is designed to produce a very unequal distribution of wealth, it is designed to suck wealth out of the colonies. It was gotten rid of in the 20th century when every country industrialized and began produce goods at all levels, although there are some vestiges left.

When will nuclear fusion start supplying most of earth's energy needs?

If you are waiting for a tokamak, never, because tokamaks don't work. It was a good idea in the 1950s, it could have worked, but plasmas are hard to magnetically confine, they are unstable, and there have been new problems at every scale. The current designs for plasma fusion are so impractical, they pose absolutely no competition risk to hydrocarbon fuel, and never will. It is just not feasable to build tokamaks that generate power. If you are looking for a cold fusion cycle, this depends on future research. The science is very promising, but right now, the only established reaction is deuterium in palladium, and this is not feasable as an energy source because palladium is rare and the reaction consumes palladium as an unavoidable side effect. But if the political problems are overcome, so that h-bombs are guaranteed to no longer even remotely be thought of as genocidal weapons of mass destruction, then you can make a fusion plant by blowing up h-bombs in molten salt in an underground cavity, using 1970s technology and no innovation. This is the PACER design, it is very practical, but it is politically dead today.

What will quantum computing such as D-Wave do to bitcoin mining?

D-wave does not have a quantum computer, it's at best corporate spin, at worst fraudulent marketing.

Are religious people better protected against depression?

Religious people have an advantage in understanding something true about human societies and behaviors, and ethics. This true thing helps cope with loss and death and helps absorb changes from the surrounding culture. Any cortical thickening is a side effect of understanding something true. Religious belief is not delusional, so it doesn't require explanation. You don't ask why people believe something true, you ask why others don't.

What is Ron Maimon's executive summary of how and why 9/11 happened?

On the morning of 9/11, there were 4 drills: 1. Put drones in the sky 2. Radar glitches, fake blips and so on. 3. Simulated Hijacking on 4 airliners 4. Flight simulation of planes into the WTC and Pentagon. There were other drills too, these are the most important four. They exist and all of them are documented to one degree or another, some under the names of Vigilant Guardian, Vigilant Warrier (Northern Vigilance and Northern Guardian, which were also going on that day, were something else). On the day of 9/11, the drones were swapped with the planes (using drill 2, the computer positions were swapped when they two were close). The drones were then piloted into the WTC and Pentagon using drill 4--- pilots who thought they were doing a simulation were instead piloting real drones into real buildings. The simulated hijacking begins at some point, freaked out passengers call home using plane-phones. After the switcheroo the planes are landed on air force bases, and the passengers and crew are transferred to flight 93. After everything is done, the flight 93 is shot down in midair, killing all participants in this particular drill. The empty planes for flight 175 and flight 93 (flight 11 ends up being flight 93 when all the switching is finished, that's the physical plane shot down) go land at Cincinnatti, empty. That's the main story of the attack, it's consistent with every piece of data, and has no conspiracy and no coincidence. In the months before 9/11, the buildings were rigged for demolition using thermite. This was done by a small team of 4-5 intelligence agent type people in one or two vans, maybe the dancing Israelis, maybe someone else. The demolition is probably sold to insiders as required for public safety, because the buildings would topple over downtown Manhattan, killing lots of people. The demolition is covered up by the 9/11 commission, and that's that. The nice thing about this: nobody knows! Not a single person except the drill organizer and coordinator has any idea what all these drills do when put together. This is a one-person conspiracy, it doesn't require anyone else to do anything. Further, even when it is done, nobody knows that the attack is a fraud, except the four simulation pilots. All that the demolition people and investigators know is that the building was demolished. All the air-force people know is that flight 93 was shot down. The air traffic controllers just know that there was a crazy drill at the same time. There is the possibility that flight 77 and flight 11 were switched at the gate, so that all the flight 77 passengers went straight to flight 11. I don't know. There might not have been a flight 77 drone, or it might have crashed at the Kentucky border, there are a lot of details that you need to fill in. But this is the summary, and I am confident it is accurate as a sketch. I should say that the main idea appears in "Flight of the Bumble Planes" and is mostly contained implicitly in "Loose Change", I just reduced the size of the conspiracy required until it shrank to one person.

What was Ron Maimon's college GPA?

I had about 35 classes with one C (moral reasoning), I'm guessing about 8 B's, so probably low by Harvard standards. Harvard didn't compute GPAs, and I didn't care about grades much.

Who are your artistic influences?

I am self-centered, so I am usually only inspired by younger versions of me. I get happy when I see other people doing nice stuff, I like it, not knocking other people, but anything I do that's original is always inspired by stuff younger me did ten years ago, which was inspired by stuff younger me did fifteen years ago, and so on, and so on, back in time, petering out in a haze of late-80s early 90s physics, some weird progressive rock or hip-hop music, and complete and total isolation with no conscious outside influence at all. I think people use "artistic influences" as an excuse to avoid originality. Even when you try hard to do something completely original, you most often find out in the end that you are ripping someone else off. If you start out immitating other people, you don't even have a chance.

Is Ron Maimon going to eventually pull a Jon Mixon?

I'm not going to leave, but I share his concerns about the lack of verifiability on the site. But it's not like there's an alternative right now.

What are the most interesting scientific experiments ever conducted?

From 1985 until 1989, Martin Fleischmann and Stanley Pons at the University of Utah performed heavy water electrolysis on Palladium for a few weeks, to fill up the Palladium with deuterium, and noticed that the heat emitted during electrolysis suddenly spiked up for no good reason at various random times in the deuterated Palladium. They noticed that the heat bursts were too large to be chemistry on the electrode (it was a small wire), and they detected tritium in their heavy water at the end. So they courageously announced that they had discovered a nuclear fusion reaction at room temperature. Their effect was reproduced quickly, and time has shown that their conclusions were justified, but at the time, they were heckled out of their jobs. The field they created is summarized at lenr-canr.org.

9/11 (terrorist attack): Would the people on the upper floors of the World Trade Centre have eventually been rescued if the towers didn't collapse?

Certainly. They would have walked down the stairs once all the fires were out, or else picked up and taken off the roof in helicopters. The fire department didn't need to do much, most of the fires were out by the time of the collapse.

If you had to create a religion and write its holy book, what things would you keep in mind and what kind of stories would it contain?

Holy books were compendiums, libraries of sayings and wisdom for the pre-print era. In the print era, let alone the internet era, there was no need for a central committee deciding what to preserve, there's more to preserve than any committee can read. But if you ask me what are some sacred texts: Milgram's "Obedience to Authority", the GNU General Public License version 3, Sade's "The Misfortunes of Virtue" "The 120 Days of Sodom" and all the rest, Solenas "SCUM Manifesto", The Discordianism Documents, Marx's "Communist Manifesto" and "Capital", Carson's "Silent Spring", Hofstadter's "Metamagical Themas", James Joyce "Ulysses", and so on. It's anything that informs your moral sense. These documents are preserved well online, so there is no need for special effort. The attempt to centralize religious teachings in holy books is, to my mind, a total failure, since everything we read informs our moral sense.

How can you become a talented person?

Practice a lot.

How does the weak force work as a *force*?

The scale at which the weak force is a usual force is above the electroweak scale, around 100GeV, so you never see forces in the usual sense, just decays. But there is an exception in neutrino scattering and exchange. Neutrinos will scatter off a nucleus occasionally by Z-exchange, which is a "neutral current" interaction, it's like a force. Since neutrinos are nearly massless, this type of neutrino exchange can give rise to a more or less long-range force involving the exchange of neutrino pairs over a macroscopic distance. The magnitude is essentially zero for all practical purposes, but Feynman calculates the effects in an early chapter of The Feynman Lectures on Gravitation. As a side note, if you ever can measure these tiny neutrino exchange forces, you determine the absolute masses of the neutrinos. I tried to figure out how to do this in the 1990s, because it is similar to measuring gravity at a micron, but it is too hopelessly small compared to electromagnetic Van der Waals forces or even unscreenable gravity. So this doesn't work. Neutrinoless double-beta decay is the right way of doing this type of measurement, because it is the same one loop force acting on a single nucleus, and not all the particles are virtual.

Why do many people believe that physics is difficult and then hate it?

Physics is philosophically difficult, not just mathematically difficult, and there is very little success in implanting the proper philosophical picture in students' heads. For a simple easy-to-remedy example, momentum is a conserveq quantity, and force is its current--- so that the forces in a static situation is directly analogous to a closed circuit (except for momentum, so it's a separate circuit for each momentum component). This intuition is never appreciated by elementary students, but it makes a lot of elementary confusions disappear, like "What is the reaction force to the weight of a block sitting on a table?". Further, the goal of physics is a complete description of everything observable about a system. This means both ignoring and un-reifying unobservable things which are intuitively present, like the internal "time" variable always getting pushed forward, something which is not at all compatible with relativity, and also paying attention to quantities which are observable, but which were not asked for by the teacher--- like the entire trajectory of a falling weight, not just the time it takes to reach a given point. The trajectory point of view is pure philosophy, and it can be explained very simply. It isn't explained, because it requires slightly more mathematical sophistication to answer questions about trajectories. Some textbooks have the philosophy exactly right, for example, Feynman's. Others are not like this, and the philosophy needs to be picked up by the student. If there is a failure here, the result is a student who can muddle through the class automatically, using memorized formulas, without deep understanding, and this is a physics-hating student.

What is S-matrix theory and what was its role in the development of modern physics?

S-matrix theory is the program of describing physics using only asymptotic states and transitions between these, the asymptotic states in flat space-time are particles coming in to a collision, and going out afterwards. It is today subsumed into the holographic principle--- it is holographic physics in flat space-time. But it predates holography by 40 years, and it is the central principle that gives rise to string theory. There is an important physical detail to understand regarding this: particles in infinite plane waves are noninteracting (except in 1+1d) they are free field theory states, because the particles have negligible probability of finding each other in an infinite space. The S-matrix is defined to be the residual non-identity transformation between the past-asymptotic states and the future asymptotic states, it is mostly a delta function doing nothing. There is also with a less singular delta function which contains the scattering information, which appears as deflections and phases when you superpose the asymptotic states into wave packets that collide. In math: S = I + iA, where I is delta functions for each incoming momentum, while A is the relativistically invariant amplitude when used between relativistically normalized asymptotic states. A has only an overall energy-momentum conserving delta function, so it is less singular than the I. In S-matrix theory, you are supposed to extract every other observable from this asymptotic thing, the invariant amplitude A, at least in principle. So you aren't allowed to speak about any state at intermediate times, except inasmuch as you know how to build it up from superpositions of asymptotic free particles. This was extremely counterintuitive, because the notion of things happening in space and time doesn't appear, only the asymptotic states are fully consistent to talk about. So the whole history of the world starts to look like an interlude between free cold particles that form the Earth, and free cold particles which fly out when it reaches heat death! It sounds completely crazy. Consider that you haveno idea how to build up anything like a dewer of He3 from asymptotic cold states. The reason people took this seriously is because the S-matrix was made to get around the issues of short distances in quantum field theory, which introduces arbitrarily high-energy intermediates to describe any scattering process, and also to get around ambiguities of field definition. In Feynman diagrams, you integrate over arbitrarily localized collisions, and you need to deal with arbitrarily short distances. The idea in S-matrix theory is to integrate instead over arbitrary asymptotic states in intermediate expressions, so that you don't have to deal with arbitrarily localized objects. The S-matrix is also real observable quantities defined using real asymptotic particle states, so it doesn't depend on which fields you choose to declare fundamental and do a path integral over. The idea was to provide quantum fields with an invariant formulation using observable processes, much like what Heisenberg gave quantum mechanics with the energy representation. It's another application of positivism, this time to relativistic physics, and in this form, the idea is also due to Heisenberg, although the mathematical S-matrix formalism is Wheeler's. The main problem with the approach is that you usually end up easily reconstructing a sum over localized events just from extrapolations of the sum over asymptotic states to arbitrarily high momenta. For example, if you consider asymptotic electron states and photon states, they reconstruct a free photon field and free electron field. Then using the scattering of the photon and electron, you can build up an S-matrix perturbation theory, and it is just the same Feynman diagrams you get from the interacting theory of the Dirac field with the E&M field. The sum over high-energy photons and electrons just reproduces a localized field theory of photons and electrons, and the S-matrix is just the least detailed way of describing what is going on. I'll call this "Feynman's chagrin": S-matrix theory, without extra physics, has a way of turning right back into field theory. It's what Feynman realized when he formulated S-matrix style diagrams, thought he had a radical new theory, and compared notes with Schwinger and realized he didn't. The perturbative contribution to scattering from a sum over intermediate asymptotic electron states of arbitrarilu high momentum turns into a particle propagator for an idealized electron between space-time points, but these point particle path sums are exactly the field correlators in an interacting field theory, expanded in powers of the interaction! The same thing happens for S-matrix theories of Pion scattering, they turn into effective field theories, as laboriously shown by Weinberg in the 1960s. In general, when there are a finite number of asymptotic free particle states that you sum over, you reproduce a field theory by defining effective fields for these, and adding interactions locally is the way to satisfy causality conditions on the S-matrix. This path for S-matrix theory sort of died in the early 1970s, because it was equivalent to effective field theory. In this context, the S-matrix physics is just a subset of field theory physics, and you can very nearly prove that the only S-matrix is some field theory, Weinberg gives an elegant exposition of this near-proof in his books, the main implicit assumption is that the asymptotic states are exhausted by a finite number of free particle states. But there is another path for S-matrix theory---- when there are infinitely many families of particles in the asymptotic states. This is the case in idealizations of strong interaction physics, where you assume the pions and hadrons are stable in first approximation. This is the "Narrow Resonance approximation", it is described pedagogically in Feynman's classic monograph "Photon Hadron Interactions". In the narrow resonance approximation, the strongly interacting particles lie on Regge trajectories, families of particles of arbitrarily high spin and mass, with a law relating the mass-squared to the spin. These families are the natural representation of bound states in scattering problems, and Geoffrey Chew postulated that Hadronic resonances (particles) lie on straight-line Regge trajectories, with mass-squared proportional to spin, and a universal slope. This was conjectured from the famous Chew-Frautschi plot. Then S-matrix theory is the statement that all hadrons are composite (true), that they have no field theory constituents (false), and that they can be used to make a theory of pure Regge trajectories on asymptotic states, so that only composite particles appear in the formulation of the theory (revolutionary, inspiring, but perhaps only partly true for the strong interactions). Constructing S-matrix theories for Regge trajectories is what took up the attention of about half of the theorists in the 1960s. There were several solid insights about scattering near the beam line from this: 1. Exchange of Regge trajectories produces soft scattering which piles up near the beam line in a superposition of power-laws, one for each trajectory. This was experimentally confirmed, it still is, and it dominated theoretical thinking until 1969. In 1969, Bjorken and others studying deep-inelastic scattering noted that there are hard collisions at large angles, something which doesn't come from naive Regge theory, but requires points inside, a confining field theory. 2. There is a Pomeron trajectory which is responsible for the slowly rising cross section The Pomeron was proposed in the early 1960s by Gribov, perhaps Chew and Frautschi later. The Pomeron is the trajectory which has vacuum quantum numbers and zero falloff rate. It's somehow related to the vacuum structure of a confining theory, and also the closed string. The precise relationship is still mysterious. The pomeron predicted that p-p and p-pbar cross sections would stop falling, start rising, and eventually become equal. This wasn't true in 1960, but it is spectacularly confirmed in the mid 1990s. 3. There are Regge cuts, conspiracies, and a heck of a lot of nonsense required to make a sensible phenomenological theory. The details are in Gribov's classic "The Theory of Complex Angular Momentum". The Reggeon formalism culminated in Reggeon Field Theory, a sophisticated formalism to produce a consistent near-beam calculation method for multiple Regge exchange. It's not field theory as such, and Gribov's wild intuition connected it somehow with wee partons, I don't know the relation, and it isn't studied anymore. But the main coup of the S-matrix theory was the discovery of a fully consistent leading order scattering amplitude for straight line Regge trajectories, the Veneziano amplitude. Since this amplitude scattered trajectories, it did not turn into field theory, it wouldn't Weinbergify into a field theory, no Feynman chagrin. Instead there was Scherky triumph, because Scherk showed that exchange of the objects in Veneziano's model reproduced field theory only when you got rid of the higher excitations by making them infinitely massive. This means that this was a genuine generalization of quantum field theory, it was the radical new theory that Feynman thought he had in the early 1950s, the radical theory that Chew wanted in 1960. This thoery is string theory, and the gravitational re-interpretation of string theory explains why it was natural to discover it this way. In gravity hugh energy objects are big floppy black holes, with internal motion, so that the asymptotic states of quantum gravity do not have a finite number of particles, but whole classes of highly boosted spinning black holes, which don't decay because they're going so fast. These family sums over asymptotic states can never produce a field theory, because any ultraviolet divergence is due to enormously extended black holes, or "infrared" strings. The history of strings from this point onwards is well known, but the roots of this in S-matrix theory is unfairly buried. Part of the reason is pure politics. S-matrix stuff was big in the Soviet Union. Another understandable reason is that QCD is correct. I wrote a little more on stackexchange: What are bootstraps?

What is the time period of oscillation for a displacement of the mass in the system below?

When you pull the weight down a distance "x" from the equilibrium position, there is a potential energy. It is a quadratic function of x. The kinetic energy is half m v-squared. From the kinetic and potential energies, you extract the period the same as you would for a mass on a spring. It might as well be a mass on the spring, the Lagrangian is the same. This is a standard homework problem, and this energy method is the Lagrangian method of describing a one degree of freedom oscillator.

Is the idea of feminism being thrown around too much and exploited these days? Women deserve respect and equality, absolutely. But not

just because they are women. What do you think is feminism's future?

Feminism is not trying to keep you from staring at a pretty girl. It's a Marxist method of subverting social power structures, by first making them visible by talking about them, and then making them disappear in contexts where they are counterproductive. In the context of your mating habits, feminism has nothing much to say. Sexism is not really an issue, when you are doing sex! People get sexually aroused by sexist crap. Theres nothing like a little fascism to get things hot, and the patterns of domination are how sex gets exciting. So what. The point of feminism is to be aware of it, and keep it in the bedroom. Feminism hardly exists anymore, it died in the 1990s, as a generation of Marxist scholars sold out.

If you had unlimited wealth, what scientific experiments and programs would you fund?

The three areas where there is immediate technology requiring no breakthrough: 1. Peaceful nuclear explosions (here money is not the main issue): PACER: cheap unlimited fusion energy (H-bombs in salt). ORION: dirt cheap interplanetary travel. (H-bomb rocket) PACER is a self-cleaning breeder, but ORION pollutes. In order to make ORION fallout neutral, Perhaps have each launch carry an equivalent load of radioactive elements up and out, and dump it in interplanetary space. This requires a research project to extract all sorts of hot isotopes from the environment cheaply, but, hey, money is no object. 2. Cold fusion--- I would just ask some Pd/d cold fusion folks what experiments to fund, but I would definitely run a series of experiments on Pd/d in alpha radiation, and specifically tuned x-rays. Cold fusion doesn't replace ORION because it is useless for rockets, and it doesn't replace PACER either, because so far, it is expensive and limited because it consumes Palladium. 3. Anti-chiral biology: I would develop all the standard biochemistry tools on molecules of opposite chirality, so as to have a safe arena for artificial life: it wouldn't be able to interbreed with our life, or eat our food, and any outbreak will be contained. But this requires simple tools to make anti-chiral DNA/RNA, proteins, and so on, until you have an anti-chiral cow, . I would also personally fund research in completely technologically useless areas, combinatorics and logic, string theory and astronomy, all the fields where technological payoff is remote.

How far can an object, of a given mass and surface area, sink in a liquid of a certain density, given it dropped from rest at a certain height above the surface of the liquid?

if it is heavier than the fluid, to the center of the Earth. If lighter, do your own homework! (hint--- the ball's gravitational mass is negative in the fluid, and the potential energy is equal at the two stopping points)

How many members does Al Qaeda have?

My guess, in Bin Laden's organization, about 10-30 people, most of whom are paid directly or indirectly by the CIA. Probably a few thousand people trained in the camps, mostly intelligence agents wanting street-cred so as to infiltrate various Muslim groups.

Which forums besides Quora does Ron Maimon participate?

None. Also, I got tendonitis from too much typing, so I am not participating much here either (I'm fine now).

What is the message behind Marquis de Sade's "120 days of Sodom"?

"Evil is rationally self-consistent." Sade was a horny guy and into S&M games, but I doubt he was a villain in any way. If everything said about him was true, he was an actual villain in his twenties, but he was an upstanding citizen from 1789 onward. a lot of the infamy I suppose was to sell books. He was a far left former Noble writing to expose power structure, and he provided the French revolution with a collection of far left religious texts, which do not mention Christ or God in any positive sense, but draw it from negative space. It's the foundation of noir, of modern villains. The essence of religion is in rejecting Sade's villains' philosophy when you are put in their shoes, all the rest is corollaries. Religion is not about sex games, it's about evil and power. Sade is suppresed, so Nietzsche steals his villains' philosophy, and contemptibly, takes it seriously. The Nazis were Sade made real, it was uncanny. From 1945 on, Sade is read, because Nazi type evil made it clear what he was talking about way back when.

In C program I used if conditions in following way if(0

The C language is not parsed the way you naturally parse this, it is parsed in a syntax tree. The order of operations is left to right, and evaluation happens when the operator arguments are clear The less-than operator produces a numeric value of 0 if the condition is false, and a value of 1 if the condition is true. So what the computer gets from your condition is (0 < num) <100 and if num is greater than 0, the result of less-than evaluates to 1 1 < 100 then it evaluates to 1 again, because it is true that 1 is less than 100. Even though another answer appeared while I was writing, I still put this up because the other answer is filled with irrelevant C++ nonsense.

In one of his answers Ron Maimon mentioned that he is separated. What could a person with such a high intelligence and deep insight into multiple fields possibly do to disappoint his significant other?

Marriage is about love and support, not science or philosophy.

Does Ron Maimon go to Quora meetups?

No, I didn't even know there was such a thing. I went to two Wikipedia meetups around 2008, to try and get policy back to normal, but it was a disaster.

How can we convert gamma ray into electrical energy?

A single gamma ray is hard to convert, it's not a lot of energy. But you can I suppose shine it on a series of atoms which will reemit lower wavelengths, and use a photosynthesis cycle once it's low energy, that's pretty efficient. If it's a whole bunch of gamma ray photons, you just use them to heat up pressurized water, and run a regular heat engine. That can be arbitrarily efficient if the water is allowed to get very hot.

If you had a chance to redo your time at Harvard, what would you have done differently?

I would have transferred to another school as soon as I got a green card.

Why does the "system" always have to be bad?

The system is better today than at nearly any previous point in history. The problems today are less pressing than 50 years ago, or 100 years ago. In the 19th century, you have colonial atrocities, and colonial genocide. In the 20th century, after the Nazis took this to it's logical end, this colonial business was all ended, but then you had the threat of nuclear annihilation. Today there is no threat of nuclear annihilation, but there are environmental and economic things that need to be sorted out, but they will surely be sorted out too, hopefully quicker than the previous things were sorted out. I wouldn't call communism a total failure, it was an overall failure, there were some successes here and there. For example, in the Soviet Union, wages were fair (for the most part, ignoring some small government perks to officials), homelessness and unemployment were solved, and the education system was excellent, and science was very good. But the productive capacity was terrible, the management was unimaginative, and the political repression was intolerable. With the fall of the wall, everything went, the few good things along with the worse and bigger bad. But people remember, and try to make the positive things without

authoritarian revolutionary party control, without the authoritarianism, or the suppression of entrepreneurship. You have to remember that history moves slowly. Even once economic organization things are sorted out, and environmental problems are fixed, there will be new issues, maybe regarding artificial life and the rights of artificial biological entities, today you can imagine a new form of slavery involving artificial humans. The controversies are always on the margin of progress, and they only stop once everyone agrees. Regarding colonialism, today, everyone agrees.

Is Minkowski space of interest to mathematicians for non-physical purposes?

Of course yes, this is something that is widely studied today. The singularity theorems of Penrose were mathematically interesting as much as physically interesting. There are theorems about Minkowski geometry today, like the recent theorems about the stablity of Minkowski space in GR, or that a black hole will form from gravitational radiation (both are ridiculously obvious physically, of course, but the methods might be of more general interest). Minkowski geometry is interesting as a form of analytic continuation of Riemannian geometry, and many of the theorems are analogs of the Riemannian theorems. But the examples above are not like this, in that their Riemannian analogs just wouldn't be studied. The Penrose singularity theorem is related to various Ricci geometry things in the 1960s, but it's an indirect link. Taking Riemannian theorems and translating them to Minkowski geometry, and vice versa, will be interesting for sure, but the most interesting things are pure Minkowski constructions, like Null infinity, which have no analog in Riemannian geometry.

What does Ron Maimon do for a living?

Nothing.

Why always got conspiracy on things we cannot explain?

We don't "always have conspiracy on things we can't explain". There is no conspiracy regarding the Pioneer anomaly, or regarding high temperature superconductivity. There are conspiracy theories where there could be a plausible conspiracy! But not in every case where it could be imagined, for instance, there is no conspiracy regarding the kidnapping of the Lindburgh baby, people believe it happened as it was said to happen. There are lots of things that do not have any conspiracy theories attached, most things, in fact. Conspiracy theories emerge because there are conspiracies! The conspiracy of business leaders that led to the takeover of Hawaii is an example, the cover-up regarding the events at the Gulf of Tonkin is another, the assassination of JFK, these are all things that involved conspiracies. In the case of 9/11, the official theory itself is a conspiracy theory involving 19 hijackers and a guy in a cave in Afghanistan. I tend to think there was no conspiracy in that case, that it was one government official acting pretty much on his own, but paradoxically, if you asked someone who believes a conspiracy theory here, it would be me! To determine whether the conspiracy happened you need to look at the evidence, and do a review. There is no shortcut. If you didn't do this, just butt out, and let people who did do a review duke it out. From looking at what they write, you can get an idea of who is right, but only if you

review the evidence meticulously yourself, without following any official organization.

What is your reaction to the idea of "Western terrorism"?

This argument makes no sense today, because it is Western intelligence agencies that are also responsible for the terrorism! This isn't the 1970s, where you have the Red Brigades, or the IRA, or whatever, this type of terrorism hasn't happened since the early 1980s. Most of the former terrorist organizations have become straightforward political parties. So the Western culpability for terrorism is on both ends, except with different agencies. The CIA does the terror, the Pentagon does the war. There is no other guilty party. An example of how this works is operation Gladio in Italy and elsewhere, which became a scandal in recent years. The agencies send infiltrators into the terrorist organization, and instead of moderating the activities, these agents are the most eager to make lethal attacks! They are not sincere, so they do not have any restraints. Eventually, the entire organization is taken over, and all that you have left is a puppet of an intelligence agency making lethal attacks and blaming some other ideology. The communist insurgents of the 1950s and 1960s are all gone, today, socialists don't bomb buildings, they run for office. The anti-communist muslim insurgents are mostly gone, they are now various local insurgents groups opposing local governments or foreign presence, and they cannot operate without government support, because all their communications are so easy to tap today, so that all that is left are proxy wars between various government intelligence agencies. Chomsky is living in the past, he relies on newspapers, government documents, and trusts them when they are consistent with one another. This method was more reliable in the 1950s, 1960s, through the 1980s, because mainstream newspapers could be trusted

to report facts neutrally, they actually made an effort to avoid repeating propaganda. This is no longer the case, since the internet has taken away all the resources and all the leftists from the mainstream, leaving only conservatives behind, with only concern for corporate profits. This makes the mainstream useless, and one has to look to a more distributed system of online information dissemination from independent investigators to get a consistent picture. This produces a sort of cognitive dissonance in the old generation, because alternative media sources in the 1960s, unlike today, were consistently less reliable than their mainstream counterparts. It is jarring to see the situation reversed so completely.

What is a simple scientific fact that you discovered surprisingly late in life?

That oil is made in the mantle, and has nothing to do with ancient dead life.

Are popular science writers/speakers past their prime or are they still involved in active research?

Research takes a lot of isolated time, and if you are doing publicity, you have little time left. But if you stop doing public things, you can get back to it relatively quickly. Feynman went back to work in the late 1970s, after his first publicity outreach things, and then he produced the gauge-vacuum work in 1981, his last major pure physics

paper. This was a very difficult insight that, just like his earliest work, looked completely wrong to everyone else. When I first read it I thought he had totally screwed up the geometry of the gauge field space because of his obtuse choice of gauge fixing, I didn't get a right picture until Nair and Karbali extended it twenty years later. Other people got confused the same way, consensus was that Feynman should be ashamed of this paper for about 20 years, but as usual, Feynman was right and everyone else was wrong. Brian Greene does active research for sure. Neil de Grasse Tyson's primary job is popular outreach. For the others, you can look at their recent papers to see.

How do 9/11 truthers explain the massive amount of scholarly information about the 9/11 plot?

There is no "massive amount of scholarly information", there is a web of lies extracted through torture and confirmed by a web of circularly referenced top secret CIA documents which were never subject to public review. Khalid Sheik Mohammed said whatever people wanted him to say, the CIA had whatever intelligence it wanted about Bin Laden, probably planted there by one senior person, while the rest was pieced together as the Shakespeare biographies were pieced together, or the stories of oil migration in the Earth, using the ample imagination of scholars to fill in the missing details. There is nothing to explain, the attack was an inside job, and those scholars that went along with the official story are for the most part incompetent, mentally defective really, and they have no place in academia.

Many talented artists died very young. Whose death, in your opinion, was the biggest loss to the world?

The death of the great physicist Joel Scherk in 1980 was a tremendous blow, and it was completely avoidable. Similar tragedies in physics are the early deaths of Sadi Carnot, Karl Schwarzschild, and Henry Moseley

How does Ron Maimon feel about being a Top Writer?

I was most amazed by the wealthy folks stopping by my apartment and throwing bundles of money inside. And, of course, the women! All the constant unwanted attention from all the women. I don't think the little people appreciate how hard it is to be so famous. Top writer! Ah, how fervently I would fantasize about it in childhood, but I never imagined it would come so soon.

How would you explain the phenomenon of Time Dilation to a layman?

Which is taller, a standing ruler, or a leaning ruler? Which ticks more time, a clock that stands still, or one that is moving? The effect is the same, except for the sign on the pythagorean theorem you use.

Classical Mechanics: Does force depend on frame of reference?

Nonrelativistically, no, the force is a vector under rotations and nothing happens to it under Galilean boosts. The reason is that adding a constant to the velocity doesn't change the rate of change of velocity, which is the acceleration. In relativity, the 4-force on a particle is a vector. The 4-force is defined as the rate of change of momentum in the particle with respect to proper-time, the time along the particle's trajectory. It is analogous to the geometric concept of the radius of curvature. the momentum current, the stress in a material, is a rank 2 tensor nonrelativistically, and doesn't change under boosts. So stresses are the same in all frames of reference non-relativistically. The energy-momentum-stress tensor is the proper relativistic generalization for continuous materials and fields. There is a nice introduction to the concept in most General Relativity books, a nice description which is accessible with no prior knowledge is found in Schutz's book.

Why is automatic theorem proving such a difficult task for computers?

Proofs are "AI complete", meaning, if you can prove arbitrary complex human style theorems quickly, you have learned how to algorithmically chunk and generalize mathematical knowledge in the exact same imaginative way that humans do, and extract the big-picture from an analogy between a forest of subtheorems and calculations, and this is almost surely a full AI. It's not like chess, in

that brute-force search can't help any more than a brute force search can find a novel, or an internet post. Proofs are filled in from a big-picture sketch, without the initial sketch there is no proof. The way humans fail to prove something is that a broad sketch doesn't fill in to a proof, either it ends up proving special cases, or else it makes a formulation that leaves a gap which is equivalent to the original problem, and essentially just as hard, or else it isolates a general principle, like a probabilistic principle, that is considered true and hopeless. These failed attempts are often published as reformulations, and are sometimes interesting independently. Everything a human mathematician does proves SOMETHING, it's just not usually the thing you are after. The sketch has a certain general sense of what kind of lemmas various methods are capable of proving, then it strings together a relatively short argument using these lemmas, and fills in the details, making whatever necessary modifications in each of the previous methods, and adding a central insight sort of scientifically inducted from experience with the behavior of mathematical objects. The actual proof doesn't look like this in the end, it builds up the theorem step by step. Computers can quickly prove lots of theorems where the process has been automated, for example, all the lemmas about how to fill in a four-coloring for the hundreds of graphs involved in proving the 4-color theorem. But really computers are still no better in language and vision. If you ask a computer to write a coherent paragraph, it will fail. If you ask a computer to make predictions from an image, even for example the prediction that a human picking up a cup will then drink, it will fail. Computers today are just much smaller and stupider than human brains, and the software is primitive too. They are order 10^10 bytes, while humans are probably something like order 10^20. When computers are order 10^20, they'll do it just fine.

When was your first day on the Internet?

It was summer of 1992, during a Research Experience for Undergraduates at Syracuse University. We were supposed to be showing how great parallel machines were, but we had no real control over the individual processors, so I didn't get into it too much. Anyway, everyone got UNIX accounts, gnu software, and email, and at some point, I ran an nntp news-client just to see what it was, and saw the list of discussion groups. There was one for physics, and I started to read all these discussions about all sorts of things. I had never seen anything like it before, it was clearly a brand new medium. You know exactly what it's like, because it was just like here, except with absolutely no moderation, so that occasionally there would be a scanned photo of a European lady becoming more intimate than usual with a horse. My first thought was "Everett!", I could fix the academic misunderstanding and neglect of Everett! Who else would do this, if not me? I started posting explanations of many-worlds, and quickly I noticed I was totally wrong: there was Michael Price, Ben Tilly, a bunch of young kids just like me, all busily explaining Everett. A more well known figure, John Baez would defend Everett too. I was stunned. You have to understand, there was no selfish motivation here, only a desire that the idea be presented fairly, and the original fellow credited. The immediate thing that I understood then was that in a few years when everyone could discuss online, all academic plagiarism would grind to a halt, all academic physics would be fairly credited again, and no idea could be suppressed! This liberated me to do whatever I wanted, without worrying about academic fashion, or what anyone around me thought. There was one of the most transformative events in my life. I remember it better than losing my virginity. I would like to point out that this lesson I learned probably ensured that I would never have a career (but it was worth it).

Who out of Newton and Einstein had a greater impact/contribution to the world of

science/physics?

Just for argument's sake, I would go with Einstein, but it's a stupid judgement call, and I am biased by having read Einstein as relevant more or less contemporary work, while Newton, I read as work of historical interest, you know, by skipping the boring parts, and reproducing results for myself. Newton came much earlier, and so his contribution is more useful in a sense--- more technology relies on it. The only two folks comparable to Newton in technology are Faraday and Carnot. But in terms of practical science, the statics developed by Archimedes is probably most used, it's behind all building construction! By that criterion, Archimedes might outrank all of them. Newton's contributions are enormous, he founded mechanics, he fixed the classical system of the world, the solution to orbital mechanics, the precession of the equinoxes, the cycloid, the nature of sound, the oblateness of the Earth, all this miraculous progress. He didn't just formulate complicated integrals, he developed enough tricks to actually do them, and he showed physicists how to work theoretically and mathematically and make progress. He founded the field, there is no dispute. But with Einstein, the subtle philosophical aspects are what I think make a good case for a greater impact. The transformational philosophy started with Mach, the positivism, which allowed Einstein to reject the ether, make progress in quantum mechanics, and reject the hole argument and formulate General Relativity. It allowed him to work without making hypotheses about what's underneath it all, by making predictions with no prejudice from naive views about what is "real" and what is "unreal". This is the Machian Einstein, and in later years, he regretfully wishes to find out what is underneath it all, sensing that he won't have time to do so, and also knowing that Bohr might be right about this, and there might not be an answer in any classical sense of the word. But Einstein added to this something extraordinary and unique, and heavily mathematical. This is one of the most significant insights of 20th century physics, gauge invariance. This was a way to extract information about how things behave simply from the symmetries of

this object, but reinterpreted as local symmetries, a choice of description at each point. This principle motivated General Relativity, it was the central thing that made Einstein's work so difficult and geometrical and it is the thing that you add to quantum fild theory to make the standard model, so it is not just for gravity. The result of this was an upheaval in thinking, which allowed people to reject the fixed classical conceptions like the psychological notion of the flow of time as being physics, it produced a view of an individual clock for each person which was disorienting to previous philosophies of time, which thought of it as shared. It was used to produce a Machian sort of relativism of ideas, not in the sense of cultural relativism, but in the sense of positivism, that metaphysical propositions can be freely chosen. That's not what Einstein did, it's just why his work was so famous outside of physics--- the disorientation in philosophy. That disorientation came much earlier in physics, with Boltzmann and Mach. Einstein's greatness, like Newton's, is in the details. Einstein often worked on new theory by fixing certain propositions which were of an arguably metaphysical nature, but tentatively, with flexibility, and constructed theories to fit these principles, which were inducted not just from experience, but from a sense that there has to be a good simple answer which underlies any apparent regularity. Simple in the sense of principles, not simple in terms of the amount of symbol pushing required. This type of thing goes without saying today, it is the way physicists make theoretical progress with things like quantum gravity. Tha Machian stuff is also personally extremely important to me, and so I think of Einstein as a bigger figure. But you could make a case for almost anyone with great original ideas, even people nobody has heard of, like Joel Scherk, and because ideas are incommensurate, you assign a measure of greatness like this, only by politics, and I hate politics of this sort.

What does Ron Maimon think about people who ask questions about him?

They really should hold out for the unauthorized biography.

Who puts most of the questions about Ron Maimon on Quora?

Not Ron Maimon. I have asked exactly 1 question here, "Is removing a cell from an 8-cell embryo harmless?" (actually, now that someone asked me to look, I asked 7, but the rest I forgot about), and I have no sockpuppets or meat puppets, or even friends active here.

If a beautiful overweight girl is using her weight as a defense against the attention/harassment she once attracted, how does she now convince herself it is OK to be thin?

She can be thin and shave her head and eyebrows, perhaps just a male-pattern bald-spot on the head.

Do you believe in God? Why or why not?

The proposition that something created the universe from outside is completely meaningless in logical positivism, so there is no sense in saying I believe it or don't. Man, whatever you want, that's what I believe. The proposition that there were actual physical miracles, violations of laws of nature, I am 100% sure is false. So if you ask me whether the sea parted, or whether such and so came back to life, the answer is "heck no". And I get annoyed at anyone who claims otherwise. So in that sense, I suppose I am indistinguishable from the most annoying atheist. But if you ask me whether there is an abstract idealized super smart agent that payed attention to how many times I masturbated, or what I ate for breakfast, and cares about it to a certain (not too great) extent, then the answer I would give is "obviously, yes", and to the extent that such an agent can be constructed self-consistently, you can't argue otherwise--- an abstraction exists to the degree you can construct it uniquely, in principle. The way in which you construct such an abstract will is through superrationality, extrapolated to infinite size and infinite time, You construct it by assuming it exists, and making it self-consistent, just like any other superrationality. The main question of God is then a question of ought--- ought one to behave according to the will of this constructed self-consistent agent, to the best extent to which one can determine this will? I think that this answer is also yes, but since it is a question of ought, I cannot make a precise argument, only appeal to examples of prisoner's dilemmas, and the much larger system provided by the superrational agent you are approximating, the meaning and eternal significance of action within such a system, and the ultimate meaninglessness of action which opposes such a structure. The end result is that I think the answer is more yes than no, and that's not because I don't know what I believe, but because the concept of God mixes up these different ideas and sentiments. But regarding existing holy books, they are terribly inadequate, and produce a greater degree of certainty regarding the will of God than what is a warranted conclusion from the human experience so far. I don't think

it is a good idea to follow these, because they tend to produce ignorance and misery in today's society. But they are better than rejecting the abstract idea of God entirely.

How does it feel to be a 2013 Top Writer?

There's no money in it, it's just a way to socially motivate you to keep writing, and so I get annoyed, it looks like social manipulation. But since I am not writing for Quora's sake, it doesn't matter.

Why is it sensible for someone who has not read relevant scientific literature, to say that smoking causes cancer?

Because if you look at lung-cancer incidence, 90% of all cases are in smokers. It's not subtle. If you just looked at famous people who died of lung cancer you would figure it out. The scientific literature then reveals itself to be trustworthy, and you can take experts word for it when they tell you the level of increased risk. The actual thing is very obvious, it doesn't take expertise.

How can you ensure you have a solid foundation in a specific self-taught

mathematics sub-topic?

Prove what you think is a new theorem. Not an Earth-shattering one, just prove something. The date at which the theorem was actually produced (you probably aren't up to date) tells you how far along you are.

Do caution and concern for the aftermath of sex make females not driven by sex?

All this stuff isn't a conscious deliberation, evolution doesn't work at such an abstract level of thought. It instead looks like an authority game, where there is a give and take of authority before any sexual interaction. Women are taking a risk of their lives in childbirth, at least it feels this way internally even if modern medicine has made it not true, and are usually aware of the practical aspects of sex, the fact that it produces more people. I wasn't fully aware of this practical side until I had a child myself. Women also usually have a greater awareness of social authority mechanisms, and the authority structure of heterosexual relationships just make this partnering up happen naturally, so that providing and so on is a part of the deal, not as a quid-pro-quo, but because it is a natural part of falling in love. So sexual activity produces a submission and domination structure that binds the people involved together in this very powerful way. The authority established by sexual stuff is very powerful, and some people used it as mechanism, they hacked it to do other things. For example, in one of the craziest things in the 1960s, Bernardine Dohrn and Bill Ayers insisted that all the members of the group "The Weather Underground" must have sex in a complete graph with all the others, regardless of gender or attraction, or existing relationships. This produced a group which is basically impossible to infiltrate, and it is a

fascinating social experiment, even though it was associated with deplorable criminal acts of terrorism.

Given a measure of symmetry of ψ(x) ψ(x) , what is the greatest lower bound on the probability of finding a particle at x>0?

The way to understand this problem is to realize it's a two state system in disguise. You can consider two special non-normalizable states, the wavefunction which is 1 for x>0 and 0 for x<0, call it A+, and the wavefunction which is 1 for x<0 and 0 for x>0, call it A-. Given any wavefunction, you can project it to it's inner product with A+ and A-, or to it's inner product with the symmetric/antisymmetric combinations. Then you can imagine rotating the wavefunction in the space of all linear superpositions of the positive and negative halves. This turns the problem into an abstract two-state problem. You have the two state operator sigma-z, whose eigenvectors are (1,0) and (0,1), and the two state operator sigma-x whose eigenvectors are (1,-1) and (1,1). Then the question you are asking is a question about the unit circle, or actually the complex analog, but start with the unit circle. If I have a vector on the circle whose x component is known, what component must it have on the coordinate rotated by 45 degrees?

What is an axiom?

An axiom is a statement in formal logic that you use to deduce other statements. In this meaning, any statement you can use to deduce

things is an axiom. But usually people asking this mean, "What is a natural axiom?" They want to know how do you construct axioms that you can use to found mathematics. The only reasonable answer here is through Hilbert's program, you make axioms that are computationally meaningful, and use this to establisht he consistency of other axiom systems that you find interesting to study. The way to produce the Hilbert is to start with some obvious axioms, like Peano Arithmetic or Primitive Recursive Arithmetic, where the axioms have a clear intuitive justification, and then to produce new axioms, by iterating the Godel statement "This theory is consistent", again and again on each of the theories you get as you do this. The iteration process is indexed by ordinals, not by integers--- you can make a union at limit stages. By doing this Godel iteration process over the computable ordinals, you exhaust all consistent mathematical systems. This is the subject of Turing's 1938 thesis. You will eventually prove that any given mathematical system is consistent. The non-algorithmic thing is naming larger and larger computable ordinals, and this is something you can't do with a fixed computer program. You need to work hard at this. But the ordinal system produces proofs of the consistency of Peano Arithmetic, from PRA plus an ordinal called epsilon-naught, and with newer methods of constructing large computable ordinals, it proves the consistency of Kripke-Platek set theory, a constructive set theory with no power-set operation. We can't do countable ZFC yet, or ZFC, but this is obviously the next step, and this would be the completion of the traditional Hilbert program. So to me, an acceptable axiom is an assertion that some computable ordinal is well founded. Every other axiom system needs proof from an axiom of this form.

How does special relativity work in a rotating frame of reference?

The rod would bend and break, this is another demonstration that objects can't be rigid in relativity, the barn-pole paradox is another. Rigid objects transmit signals faster than light, and make paradoxes. There is no unique rotating frame of reference in relativity, like there is in Newtonian mechanics, any rotating coordinates works, but you just introduce a metric tensor and do flat-space-time General Relativity. Einstein describes this stuff around 1910

What is so good about The Feynman's Lectures on Physics textbook series?

Feynman redid everything from scratch, following the historical order of development. He starts with a chapter on Democritus's insight about atoms, then introduces the concept of potential energy (Archimedes), then goes to Newton, but introduces computational time-stepping. Feynman is extremely historically aware, unlike the off-the-cuff impression you get from reading the book, but he always redoes everything himself. It was sort of an American response to Landau and Lifschitz, but Feynman redid all the elementary things on a much more basic level, and was more clear in presenting important intuitions. The calculations also are more interesting, and more representative of what real physics looks like, not textbook physics. The examples are drawn from physics current in the 1960s. I wrote about it on Stackexchange: http://physics.stackexchange.com...

What does Ron Maimon think of computer science?

I don't know, I like it? There is sometimes what looks like deliberate obfuscation in the presentation of the proofs, but it's unavoidable to a degree because it's hard to present proofs about algorithms. Anyway it's getting better, the algorithmic complexity theory really helps. My opinion is worthless.

Have you ever dreamt music in your dreams?

Yes, even sometimes completely original music which I liked after waking up.

What does Ron Maimon Think about Libertarians?

Libertarians tend to not appreciate that you need Keynsian redistribution of money to make a modern economy work, this is known and absolutely firmly established. To implement it requires a progressive income tax and propped up salaries on the low-end, to prevent a collapse in worker salaries, and usually all sorts of government spending on infrastructure. But this is against the whole philosophy. I would like to go further, and implement a progressive corporate tax to make a structural anti-trust mechanism, but this is also against libertarian principles. Usually, they are suckered into thinking that social power structures are only a product of government intervention, lots of social structures are maintained organically, through cooperative behavior of individuals, in particular, the class system of capitalist economies, or racist stuff. On diminishing government surveillance power, of course I agree with them, so does

the ACLU. On getting rid of shadowy government conspiracies and reigning in the CIA, I agree so much that I hope they win a measure of power, even if it means some economic catastrophe due to removing Keynsian measures. What can you do? If your government is consistently engaging in deceptive covert activities, you need someone to fix it,and the libertarians might, and the Democrats won't, although it seems that so far the Democrats haven't made it worse, they certainly haven't made it better.

What does Ron Maimon think about the claims that the world is run by a banking cartel, spearheaded by the Rothchilds?

Come on, get real. Maybe there's some coordinated monetary policy, but conspiracies are tiny, and usually done by intelligence agencies. The illusion of conspiratorial control is because there are collective agents formed from people, and these collective agents resemble individuals or conspiracies. But they are organic, like what Noam Chomsky describes. Anyway, I am not competent to comment on this, as I don't know anything special about banking.

Is Ron Maimon the hero Quora needs?

I cannot be any sort of hero as I have not acted against my self-interest in any obvious way at any point in my activity here. Quora is a venture which wants provocative writing containing interesting individual insight, while my goal is to propagandize away certain hard to

eradicate untruths in the physical sciences and elsewhere, sometimes through other people's insights, sometimes my own. So it's an easy fit, I can write things that are challenging authoritative positions without any fear of censorship (so far), and Quora likes that. The materials are usually available elsewhere, sometimes not, I try to make it clear if I am saying someting original, which isn't often, because it's not like original ideas are so easy to have, and I only have a handful, like everyone else. On the other hand, it's a big site with no focus on technical material, so there is a certain mental decay involved, in that most of the time you are not expending effort in thinking of the answer, and you are not reading actual literature nor are you progressing in your own research problems. So I can't imagine that I'll do this forever.

What does Ron Maimon think of data science?

I never heard of it.

Is there fusion at the earth's core?

Certainly no regular hot-fusion, because there is nowhere near a hot enough temperature. But if there is a concentration of deuterium inside high-density metal lattices, there might be pockets where a version of the Fleischmann Pons reaction is happening. We don't understand the reaction at ordinary densities, let alone at the huge densities at the core. Under those conditions, there are potentially many different versions of the reaction. I don't know, and until cold fusion is completely properly understood theoretically under

conditions of high pressure,neither does anyone else. I tend to suspect there is some cold fusion going at least under gas giant planetary conditions, where there is a lot of deuterium dissolved in the core, and the multi-alpha secondary processes might be the reason you get a lot of iron eventually at the core, or it might be from supernovas exclusively. I don't know, and really, at this point, given Pons and Fleischmann (and the extending work described at A library of papers about cold fusion), nobody else does either.

P(x) is a polynomial of degree 11 such that P(x) =1/(1+x) for x=0,1,2,..., 11. What is the value of P(12)?

This is an exercize in calculus of finite differences. You should know the definition of x^(k) = x(x-1)...(x-k+1), so that x^(2) = x(x-1) and so on. The "negative powers" are x^(-k) = 1/(x(x+1)(x+k)). The first difference of a sequence A_k is A_{k+1} - A_{k}, the second difference is the difference of the first difference, and so on. The first difference of x^(k) is kx^(k-1) (just like a derivative). The n-th difference of a polynomial of degree n is constant, the n+1st difference is 0. The n-th difference of the integer sequence A_x = 1/(x+1) is (-1)^n n!/((x+1)(x+2)...x(x+n+1)). So the 12th difference at x=0 is 12!/13! or 1/13. For a polynomial of degree 11, it should be 0. So in addition to 1/(1+x), you can add any perturbation which has all the differences up to 12 0, and the 12th difference equal to -1/13. Then the sum of the two contributions has all the first 12 differences equal to what you want, and the 13th difference is zero. It therefore gives the right answer. One such contribution is - x^(12)/13! by construction (this is like finding a polynomial whose first 11 derivatives are 0 at 0 and the 12th derivative is -1/13). So the value at 12 is the sum of the two terms thus constructed 1/(1 + 12) - 12^(12) /13! Which comes out to zero. That's

kind of looks like a miraculous cancellation, but as you can see it happens whenever you construct polynomial approximations to 1/1+x at odd values of this problem, like 11. For even values, the two contributions come with same sign, and you get 2/(1+(n+1)), and so for the analogous question with 12 replacing 11, you would get 2/14, not zero.

Is it okay to be enlightened for wrong reasons?

It wasn't the wrong reasons, you are missing out on the fact that a mother can die in childbirth, can agonize to give birth to a baby that dies of Rubella at a year, and that there is no redeeming purpose to this suffering. This is Buddha's point. But if you are enlightened for the wrong reasons, usually due to drugs, then in general, you'll eventually figure out that it was the wrong reason.

How can you explain SuperSymmetry in layman's terms?

Supersymmetry is not explainable in layman's terms. It requires knowing about quantum mechanics, spin/statistics, path integral, stochastic stuff, analytic contination, and quantum field theory, reasonably well. I could say "every particle has a partner of the same mass opposite statistics" but it's not true when the supersymmetry is broken, or for nonlinear realizations. What it is, I think in the best way of saying it, is when a quantum field system has a Nicolai map. This means a way of writing the evolution in imaginary time so that it is a stochastic system, so it can be timestepped like a Markov chain,

rather than Monte-Carlo evolved over the whole history. This is Parisi-Sourlas supersymetry, and Nicolai showed it should be true of all supersymmetric systems. But this method is not fully understood even by specialists.

What is the best book for an undergraduate course on quantum mechanics?

The Feynman lectures vol III, Ter-Haar's "The Old Quantum Theory", the collection of reprints of original papers on Quantum Mechanics, Dirac's "The Principles of Quantum Mechanics", and Sakurai or Berezin's Quantum Mechanics. As supplemental materials, Everett's thesis is good, and Neilson and Chuang's book on quantum information.

Why is it cool to be bad at mathematics?

Because it is a trait shared by the entirety of the ruling class.

Is Ron Maimon proud that he attended Harvard?

Going to Harvard is not an achievement. The only reaon I went to Harvard rather than Cornell, or SUNY is because I was Israeli at the

time and couldn't get Federal financial aid. Harvard's financial aid is independent of your national origin, and it is pretty much the only school where this is true. I had serious reservations about going to such a conservative school, which was reinforced by my pre-frosh visit, where I was hosted by the poster child for the young-Republicans. I sucked it up and dealt with it, science doesn't care about the surrounding culture. My experience there was generally miserable. My first year, my roommate was a religious Jew, who put up pictures of military airplanes in his half of the dorm wall. I bought a pornographic magazine, and put up pictures of naked men and women all over the other half of the room. I refused to take down the pictures until he took down his pictures. He also refused to allow me to have sex in the dorm with my girlfriend, because she wasn't Jewish, and he was going to save my soul. He explained to me also that The Velvet Underground's "Venus in Furs" was music from hell (that's a direct quote). No shit, dude, that's why I'm listening to it. That, and a lot of Led Zeppelin. I disliked the undergraduates for the most part. My girlfriend would take me to HASA meetings, the Harvard African Students Association, which consisted of students from African countries, who were somewhat more left than most Harvard students. But even with the lefty students, there was horrible stuff which showed no ethics at all, this tiny girl I met at HASA, who you would never think could do anything wrong, murdered her roommate my senior year. Murder. Not vomiting in the sink. I woke up one day with a policeman in my room, and I was stepping on human blood in my dorm. There were heroin parties, orgies, going on, I mostly didn't partake. I was invited once for a seduction, where this couple decided to seduce this virgin lady. I was into Marxist free love, so I went along, but I had to rethink the position when I saw this unattractive schmoozy dipshit guy and his manipulative girlfriend feeding off this young girl like a praying mantis and black widow on a ladybug. It was just this kind of constant sense of "we are special, we get to do things other people can't do" that I can't stand, especially that the orgies were not done well, as orgies go (I witnessed two). The Cornell orgies were better, they involved love and rebellion, not assertions of power. My favorite undergrads were at MIT, and I spent a lot of time there

after Junior year, with a girl I met. The MIT folks were super geeky and super technical, at Harvard, I was surrounded by fakers. I would sit in the library and read technical books, and the only good thing about it was the technical classes and the top-notch professors. I made no lasting friendships with the undergraduates, aside from a few exceptions like Dylan Thurston, they were nontechnical social scmoozers. I only started hanging out with graduate students senior year. I spent most of my time sophomore and junior year online in the science center, on usenet, talking to strangers. To give you a sense of the experience, I went to a feminist meeting (or what I thought was a feminist meeting) freshman year. It was "Harvard Students for Equality Feminism", and the whole meeting was spent discussing how feminists had gone too far. I thought it would be feminism, and I would meet some sexy radical kill-all-men feminists, and instead it was phony bourgeoise anti-feminism claiming to be feminism. So I'm a boy, and I have to explain gender power relations to girls? That shouldn't happen. No sexy radical feminists there. At the Harvad black students association meetings, Spike Lee came by once and berated the black students for selling out. Of course, I was selling out too. After Harvard, I felt that I had the misfortune of being brainwashed by upper class nonsense, and needed to work twice as hard to be a scientist as when I was self-studying at Syracuse. Once I did something really original for the first time, which took a few years, then I felt like I was hot shit for the first time. But the feeling goes away after a few months, and you need to keep doing something or else you feel like you're washed up. It took 5 years before I felt I did something really original and competent, which was the biology work. Then I felt like I was hot shit, because I WAS hot shit, I was producing results left and right. I would ride the bus and feel sorry for other people, because they weren't me. They didn't know how life began, or how RNA worked, or how to describe protein networks. When I did the cold fusion work around 2009, I felt like hot shit again. But then it goes away. At the moment, I am washed up. But Harvard never had anything to do with it one way or another, as it was just my undergrad school, and not a particularly formative experience at that.

Why does upper-division physics seem so "messy" and "inelegant" compared to upper-division mathematics?

Those things ARE the beauty of the subject. Remember, this isn't something someone made up --- you are trying to figure out how the world actually works. It is a miracle when you find a mathematical description of anything, and the world is very complicated. So any time someone finds such a description, even if it is inelegant, it is preserved. Mathematics is similary ugly in the higher level stuff, because proofs involve a lot of messy estimates and dirty tricks. But physics is more so, because you really are describing nature, not some human thing made up to be pretty. The approximations are what make the subject beautiful. Real He atoms are too complicated, so Feynman used hard-spheres with no attraction, and got a beautiful model. Real electrons are complicated, so Heisenberg studied a spin-chain and Ising studied classical statistics of correlated spins. These approximations take on a life of their own, and become elegant starting points. The dirtiest, messiest, most approximate theory physics ever produced is the theory of Regge trajectories. This was a grab-bag of tricks and estimates about how cross sections near the beam line fall of with energy, which related it to families of particles. Nothing was exact, everything was hokey. But this theory, after twists and turns, is now string theory, which is the most mathematically elegnat thing that has ever come out of physics. Dirac explained that it takes effort to see beauty in approximation methods, but that this is how one must view physics. Newtonian mechanics is an approximation to relativistic mechanics, but it is beautiful, and classical mechanics an approximation to quantum mechanics, but it is also beautiful. The elegance comes with time, as people package it to look nice. When something is raw and exciting, it never is pretty.

When was it first realised that there was a Weak Nuclear Force distinct from the Strong Nuclear Force that held the nucleus together?

The way you know there are two forces is first that the rate of beta decay is completely different from any strong process, the neutron lives 8 minutes, and the fragmentation of nuclei is on tiny subatomic scales you can't even state well in seconds like 10^-16 seconds. The scales are off. Secondly, and more persuasively, the decay of the neutron involves leptons, which don't feel the strong nuclear force at all. In the decay of the neutron, you produce an electron and neutrino, and these particles fly right by nuclei without interacting in any way other than electromagnetic. So it's not the strong force, the strong force can't produce leptons, otherwise the leptons would feel the strong force (production and deflection cannot be separated in quantum field theory). So the natural hypothesis is that there are two forces. The strong force was a black box in the 1930s, but Fermi gave the theory for the Weak force as a point interaction of fermionic bilinears (meaning two fermions change type, two other fermions change type, or else two other fermions are created), this was phenomenological, but it fit the unpolarized data. When polarized data came out, it was realized that the interactions were not symmetric under left-right symmetry, in elegant experiments by Wu. Sudarshan-Marshak and Feynman-Gell-Mann reinterpreted this as the interaction of currents and two-component neutrinos. The current structure of the weak interaction made Veltman and Schwinger sure there was a gauge theory hiding under there, because gauge theories interact by currents. Schwinger's gauge theory interpretation was developed into the symmetry breaking of the standard model by Glashow, who modifed Schwinger's model until it was correct, and then by Weinberg who added the Higgs mechanism and produced the

proper model for gauge boson mass, also by Salam, who did something, I don't know what, I didn't read his papers on this, probably the same thing as Weinberg. The modern theory shows there are two forces, the SU(2) and U(1) gauge theory of the weak and electromagnetic interaction, which are mixed together by the Higgs mechanism, and the SU(3) of the strong interaction which is nothing to do with the other two. The complete theory is known, so the original arguments were certainly justified. The theory was shown to be renormalizable along with every other gauge theory with Higgs mechanism by 'tHooft in the 1970s, and by 1974, elementary particle physics was essentially solved with the standard model, and theorists had moved on to extensions at high energies, like GUTs then strings, and to the possibility of low-energy supersymmetry.

What would happen if all the matter-energy in the universe, including dark matter and energy, collapsed into a black hole? Would this be similar to the Big Crunch hypothesis?

There would just be a big black hole somewhere in the universe. It is not like a big crunch, where the cosmological horizon shrinks back to zero area.

How can we move from a rational society to a super-rational society? How close are we to the same?

First, superrationality is not exactly a situation where you expect the other player to be "good", it is a situation where you expect the other player to also be identically superrational and take this fact into account in your decision making (and likewise the other player does also, since you are identical), there is nothing normative about it. When you know that both of you are going to do the same thing, and you are superrational, you do the thing which is the best same-thing for you. This coincides with the good thing for the collective. Superrationality comes in flavors. To see this, consider a four-person prisoner's dilemma, where A and B play and C and D play, then C and A play and B and D play. You can have an AB superrationality shared by A and B, so that A and B cooperate because they share a strategy, call it "Holy Righteous superrationality", and also a separate C and D superrationality shared by C and D, called "Divine Action superrationality". The A and B holy-righteous players cooperate with each other, but knowing that the holy-righteous strategy is shared by holy-righteous players, which tells you to cooperate with holy righeous players when you are holy righteous, this doesn't tell you anything definitive about the divine-action strategy, so A and B defect against C and D. So it is good to distinguish the superrationalities and give each one a name. I will call them "religions", because that's what they are, and that's what religions are in positivistic essence, a guarantee of superrationality. The point of superrationality is that the individuality is always a construction of collectives, even you are a collection of neurons, and individuality can congeal in various ways. For example, consider playing your left hand against your right hand. These are controlled by two hemispheres of your brain that are largely independent, they are only linked by a communication bridge in the middle. So your left hemisphere might feel it can get a temporary advantage from say getting the right hand to chop off the left hand, because then the pesky right hemisphere would no longer be able to interfere with all the right-hand actions the left hemisphere wishes to do. This is completely ridiculous, because I am breaking up your individual into two collectives, and setting them fighting against one another, but this is nonsense! Your left brain and right brain are quite sure both that the other is different, but useful. There is some anti-

right sentiment in your left hemisphere, it might take over some function it feels the right hemisphere isn't doing well, but it is always going to do so in awareness of the congealed thing that they together form, whcih is you. The superrationality shows you that the game-theoretic analyses depend on an unstated assumption, that the rational play is between uncongealed players. Human players are always congealed with each other, and know that there is a certain level of superrationality expected in any social order. So ultimately there is no predictive power to tradtional game theory, outside of certain very large markets, because the most important aspect, superrationality, is ignored, or else dismissed as irrationality. The superrational idea allows collectives to make a larger individual than any of the players. This individual I will call a "god". The communities play games against each other, and this is gods against gods, and there is a sense in which you would expect the gods to make bigger gods when they play superrationally against each other. The ultimate thing is the monotheistic conception of God. The notion of God is clarified only when you consider asymmetric games. In this case, you need to not only make judgements about best play, you need to evaluate how good one player's outcome is against another player's. This evaluation requires the god to assign a utility to each outcome, and the process of doing so rationally, by the Von-Neumann Morgenstern construction, produces a disembodied will. This is the will of the gods. The will of the gods are ultimately, when the gods are superrational, parts of the will of God, the ultimate superrational strategy on top of everything. That's the monotheistic conception of God. It requires not just superrationality, but asymmetric superrationality made universal. To implement superrationality in life, you just change the game, by adding penalties to behavior to make the rational and superrational play coincide. You can't do this for everything, so you also tell people about God, and you ask them to be good, and when a sufficiently large number are ok, you get enough progress. But in cases where superrationality and Nash rationality don't coincide, you need a new law. The problem is that it's not like any individual knows exactly what God's will is, so there is this situation of incomplete knowledge. In this case, it is important to not be dogmatic, and allow people to try out various forms of organization on different scales, and to congeal on an answer only when it is certainly correct. This is what people have been muddling with, with religions and economic systems, and although superrationlity tells you why that's going on, it doesn't really help you figure out the next step at all, it just shows that the process we are using is pretty much what you need. There is another thing, which is that there are situations where you want to eliminate superrational behavior entirely. In markets, any superrational behavior is a market distortion, which prevents efficient pricing. If you superrationally prefer your overpriced supplier because you have a long history of buying from this person, and good relationships, and you went to school together, you are costing a cheaper supplier income. So in order to make capitalism function, you need to make people less superrational than they intrinsically are, so as to find an economic equilibrium. This is not natural, so there is a lot of propaganda against religion in capitalist countries, and a lot of powerful people are atheists. But this type of selfish behavior is not incompatible with superrationality, so long as it is clear that the goal is maximum economic efficiency. You just have to make sure that the economic equilibrium is actually being approached. With regard to this, superrational behavior in markets produces terrible distortions, the class structure of capitalism is entirely maintained through people shaking hands and giving a leg up to their buddies, it is not a conspiracy of evil. But the superrational collective produced by the classes segregate wealth into certain classes, and right now, the distribution of money in an economy is so inefficient, that you need a government to step in and take money away from some people by force, and hand it out to others, just for the economy to function! In a perfect market, everyone has a job at a good wage, and this is unnecessary. I don't think there is any good insight here, you need to know about superrationality in the abstract, but a tolerance for variation to produce future stuff, and in situations where you set up a market, you need people to behave superficially non-superrationally in their hiring and buying choices, so that the market will work. As time goes on, the laws and structures make less of a gap between the ration and superrational outcome, and eventually, there is no difference, but

at this point, new situations arise where there is a gap, and you focus on those next. It's just a neverending process, it's what people are going through.

Taking into account the wobble effect of the earth axis, ...is it at all possible to be in the exact same position (relative to the sun) twice in your lifetime?

Assuming the Earth's surface is two dimensional, and you walk in a figure 8, it is unavoidable. If you imagine a 3d space, and you are Brownian moving, there is random jitter, then it is also unavoidable at short times, and in the figure 8 example, if you get close enough, also. But it's not really a meaningful question, as you are a blob, not a point.

Is mathematics derived from, or transcendent to reality?

The question is mostly meaningless in logical positivism. The parts of mathematics that describe computations we can perform is reproducible empirically and is meaningful independent of the laws of reality. The question of which is philosophically first is meaningless, and for mathematical questions which are not representable as questions about computations, questions like the continuum hypothesis, there is no positivistic sense in which they have a unique answer, so they are largely meaningless.

After studying the core areas of mathematics (Real and Complex Analysis, Abstract Algebra, Algebraic and Differential Geometry, and Algebraic Topology), what comes next?

One subject omitted from most core areas, but which is absolutely core, is formal logic and set theory. This is required to make sense of transfinite arguments in all the rest of mathematics, and you can only skip it if you have no problem getting queasy with someone saying "Now we complete this Borel system by a transfinite induction to the first uncountable ordinal" and not knowing exactly precisely what this means in a countable model of set theory. For this purpose, "Set Theory and the Contiuum Hypthesis" is essential, along with a set theory book, and a book like Yu V. Manin's Logic book. This is completely essential and completely ignored in the curriculum. After you sort out the set theory foundations, you can read anything, you have a good foundation.

Does angular velocity cause time dilation just like linear velocity?

There is no such thing as "angular velocity"--- that term is a technical term to describe rotation. Velocity at any instant is in a line. If you have a rotating thing, the local time-dilation is according to the linear velocity at any point.

Will planet Mars dissolve the borders of all terrestrial nations?

Did the discovery of America dissolve borders in the old world?

We seem to live in a very peaceful time in modern history, where the percentage of people killed in armed conflicts worldwide is at a historic low. What are the underlying causes for this phenomenon?

If you extend the graph backwards a little, you will see the 1940s was the most barbaric period in several hundred years. I also think that there was an element of luck, in another branch of the wavefunction, there could have been a huge catastrohe in 1964, or 1983 that would have made the other wars look like line noise. But I accept the premise in general, war is no longer in any nation's self-interest, the wars are too deadly, and the economic consequences are always net negative for the nation, although not for some individual corporations. The basic reason is that the world has adopted peaceful means of economic and political change, so democratic government and some form of economic freedom sufficient to allow develoment of new systems. The economic freedom is not really there, it requires a lot of develoment still, but it isn't a situation anymore where you need to convince a few party bosses in charge of a government bureaucracy to let you make iPads. Maybe this is another lull, like the late 19th century, but I

suspect it is permanent. At some point, war will not exist for sure, since it is stupid.

What is the speed of electrons in a transistor?

It's a semiconductor device, it's not bare electrons that are moving, but a gas of quasiparticles, and the speed of motion for a cold quasiparticle gas is the Fermi velocity, which depends on the doping, the number of carriers. The Fermi velocity is continuously variable from something like 0-100,000 m/s (but see below, the gas is classical when the thermal energy is greater than the Fermi energy, which is the case for typical semiconductors). The mass is the curvature of the band energy, and it can be heavy or light, so you can make ultra-fast Fermi velocities too, by making a sharp turning-around at the point of the gap, like in graphene, except gapped and doped. It is holes that are moving in the p-type parts, and the holes move with a velocity just like the electrons--- they are another quasiparticle that behaves according to an effective Schrodinger equation when there is a quadratic dispersion (energy as a function wavenumber). There is no answer for the Fermi velocity, except in order of magnitude, it's tunable. In the case of metals, the electron Fermi gas is very degenerate and quantum, the thermal motion is much slower than the Fermi velocity, and the gas behaves entirely quantum mechanically. From the comments, I learned that typical doping in semiconductors is at the part-per-million range up to a part in a hundred, so that the carrier density is very low compared to a metal, where there is order one conduction electron per atom. For ppm doping, the electrons are going to be classical, they are too dilute to make a quantum gas, so that the classical gas limit is right, the Fermi energy is much less than the thermal energy kT. Assuming the effective mass is near the electron mass, that's usually correct, the velocity will be the typical electron thermal velocity, the velocity of an electron with energy kT, so it will

depend on temperature. kT is 1/30 eV at room temperature, and the mass of the electron is .5 MeV, so sqrt (kT /.5 MeV) is sqrt (1/16,000,000) 1/4000, or 1/4000th of the speed of light 50,000 m/s. Whenever the Fermi velocity is significantly less than this, this is the typical velocity, because the gas is classical.

Why do some hash functions use a prime number as base? What is the significance of using a prime number? Is it to assign uniqueness and minimize collision of hash values?

For non-primes with a small factor, there is erasure of the past. For example, if you hash with an even number, 2 is a factor, so you end up just shifting the bits left every step, and after 32 steps, the first bit you hash is lost entirely, so you lose the early information. For a number divisible by 3, same thing in base three, and so on, so a prime keeps you safe.

Why do people think math is so important?

Because the other things, people mostly pick up better without any education. Looking at home-schooled children, I was astounded by their level of sophistication at reading literature, composing music, appreciating nature, social interactions, everything except mathematics and therefore necessarily science. They didn't know any

mathematics! When children are left alone, unless there is a miracle and they get it early, they don't even learn how to add. They don't learn how to read either, but thankfully most parents notice this and fix it when it happens. Reading is thankfully considered necessary universal knowledge today. Elementary mathematics like algebra, calculus, and formal logic is another skill like reading, that is necessary universal knowledge. The computer has made it that mathematics is a large part of life, and a computer is a construction of pure mathematics. What's going on inside? Discrete mathematical transformations controlled by artificial patterns. The computer was developed through the insights of logicians in the early 20th century, culminating in Turing. The mathematics is harder than other things, it is actual knowledge. It is important to learn to write and to know history, but these skills only require reading books, without paying too much attention. Mathematics requires reading books with a pencil and paper and solving problems too, and children are not usually that disciplined. If they are, you don't need to teach math, they pick it up better by themselves, like the other things. I should add, for those children that don't pick up the other things, it is important to teach the other things! Education should be all the things you hate.

What do creationists think about scientists?

Usually, their idea is that there is more planning evident in the genomes of organisms than can be accounted for by blind copying and point mutations on proteins. There are two schools here: creationism and intelligent design. The creationism is the idea that this was written from outside the system by a super-smart designer, like God. The intelligent design is more conservative, it is simply trying to establish that the genome has more design complexity than the model of modern-synthesis evolution provides with it's method. The intelligent design folks don't say it was done from outside the system, they just

say it looks intelligent. I agree with point 2, I think there's RNA in there doing computation, and computation is synonymous with intelligence. But creationism is kind of ridiculous. So I will try to seperate the creationists from the intelligent design folks. Sometimes they point out that when you have a coupled system, you need to co-evolve coupled proteins, so that when one protein changes, the other needs to change too. This criticism is usually not very good, because you can evolve one protein, then the other, smoothly to keep the coupling fixed. Similarly, they argue that various coupled proteins like in a bacterial flagellum couldn't be put together blindly, because they don't work until they are all together, but it is not clear that this is true. A more sophisticated version of this argument uses networks. If you have 100 couplings to fix, in a sensitive network, you would need to fix 100 proteins to adjust the network, and more proteins as the networks get more sophisticated. So in this sense, evolution by standard modern-synthesis methods would slow to a crawl. This criticism is cogent, because it is a problem that has been confronted by evolutionary theorists. The main idea here is that as evolution proceeds, it selects for an "evolvable region", namely a region that can continue evolving still. This is the idea promoted by Stuart Kauffmann, that the landscape of evolving genomes has a few dead ends, and if you end up there, in a hard-to-evolve place, the organism dies. But there are general principles here that suggest that all the complex genomes are hard to evolve, simply because they are large computations. This is simply due to the size of the computation. When a bit is accessed by other bits, either you will redundantly provide 10 copies, in which case the system will evolve away the redundancy to do different things, or else a mutation that wrecks the bit will get rid of the computational cycles the bit is involved with, because the bit won't work the same. When there are bits downstream that depend on it, you now have to mutate a growing number of places to make a coherent change, and now it is a restatement of the intelligent design time-paradox. This paradox was pointed out by Wolfgang Pauli in the 1950s. On general principle, it seems that as the networks get more complicated, the evoution mechanisms need to co-evolve, so as to get more meta, to make control modules that switch smaller modules, and

these smaller modules remain unchanged and conserved. So that regulation piles on regulation, and the old stuff is frozen forever, except for neutral mutations, or mutations followed by compensating mutations. The co-evolution of mutation with complexity suggests that the evolution today in complex eukaryotes is on the non-coding sequences entirely, not on the fixed coding sequences, which have been essentially fixed since nematode days. But the only biological subsystem that has that kind of bit-density and regulatory capability, is RNA. RNA can carry 2 bits per base, unlike proteins, which only function by domains, and only have a few functional domains apiece. The result of all this layered regulatory evolution is that the genome is largely noncoding, and looks massively interconnected and regulated, and the mechanism of change is through complicated rewriting of non-coding regions, together with slow neutral drift in proteins that largely serves as a molecular clock, because it is under zero selection pressure. This is a prediction shared by intelligent design and computing RNA both, and it is what is observed.

What are the most common lies told by programmers?

Optimizing compiler code is faster today than hand-written assembly.

Does the quantity of DNA scale on a linear basis based upon the size of an organism?

Noncoding genomes vary widely from species to species. As this variation is mostly due to polyploidy, not just multiple copies of chromosomes, but any multiple copies of identical data which leaves a lot of closely related duplicate information in the genome which does not increase computational (Kolmogorov) complexity. This is a failure of garbage collection, or a hack to produce large size with some minimal variation, it doesn't increase the complexity very much. So you get an occasional monster genome, plant genomes can be especially enormous due to polyploidy, but duplication exhausts the method by which the canonical c-value examples happen: Since there is no need to repeat, here is a paper from John Mattick's group: The relationship between non-protein-coding DNA an... [Bioessays. 2007]. As they explain on page 2, the minimum size of a genome in a group of related species, say a taxonomic order, is obviously and directly related to the complexity of embryogenesis, and increases in size through insects through vertebrates. The charts summarize existing data. There is no C value paradox, there is strong evidence from C-value for computational function of the noncoding RNA. The C-value here is a good measure of the nonredundant genome, or equivalently the smallest genome in a philogenetic clade (the smallest genome is a measure of how nonredundant the genome can get and still work). Single cell amoeba are relatively complex in thier behavior, and one should not presume simplicity because they are small. The traditional explanations of large genomes as accumulation of junk is unsupported political nonsense.

In what ways is a gauge transformation more general than the 3-d point group/space group?

Gauge transformations are like the coordinate transformations of General Relativity, they cannot be reached by physical symmetries or motions. Only coordinate transformations that extend to a boundary

at infinity can be reinterpreted as a physical motion, for example, translation, or rotation. A coordinate transformation with compact support (meaning one which only changes the coordinates inside a bounded region) is not physical at all, it is just a change in philosophy about how you describe the physical situation. This is the resolution of Einstein's "hole argument", and the clarification of Noether's theorem in gauge theories and in General Relativity that took so long. The easiest way to understand gauge groups is the Kaluza Klein method. Consider a space-time which is has a little circle at every point. Consider now coordinate transformations that don't change the metric on the circle, or on space time, but which change the origin point of the circle at every point. Such a coordinate transformation can rotate the circle independent at each space time point, you can rotate each circle independently, like abacus beads that you spin around. This is the gauge group U(1), meaning translations of a circle. If you have a sphere at each point, you have the gauge group SU(2), rotations which rotate the sphere around independently at each point, it's O(3) actually in this example, but whatever, the distinction is not significant at this level. As witten pointed out, the 4 dimensional space CP2 has rotations which are the group SU(3). So the gauge group of the standard model involves 1+2+4 = 7 extra dimensions, making 11 in total, 10 space, one time. This is also the dimension of supergravity. This numerological identity is a pure coincidence, it means nothing. The gauge groups in string theory come from completely different things. But that's what a gauge symmetry is --- a redundancy in the description. The orientation of the different circles, spheres, and whatnot can vary arbitrarily from point to point, and all such recoordinatizations are equivalent in content, you can choose them however you like.

What are Ron Maimon's favorite books?

Standard ones: Polyakov's "Gauge Fields and Strings", Milgram's "Obedience to Authority", 't Hooft "Under the Spell of the Gauge Principle" (reprint collection), Polchinski's "String Theory", Green Schwarz Witten "String Theory", Mandelstam and Yourgrou "Variational Principles", Cohen's "Set Theory and the Continuum Hypothesis", Sade's "The 120 Days of Sodom", "The Misfortunes of Virtue", "Eugenie de Franval and Collected Stories", Lang's "Calculus" and "Algebra", Connes "Noncommutative Geometry", Mandelbrot's books, Fadeev's book on path integrals, Parisi's "Statistical Field Theory", Anderson's "A Career In Theoretical Physics" (collected papers), Linnik "The Dispersion Method in Binary Additive Problems", Bogoliubov (the younger) and co "Inverse Scattering Method and Correlation Functions". Wheeler, deWitt, Everett "The Many Worlds Interpretation of Quantum Mechanics" (Everett's thesis), "Metamagical Themas" (Douglas Hofstadter), Marx "The Communist Manifesto", "Capital". There are great collected papers collections for Landau, Godel, a bunch of others you can find on the shelf at libraries. I honestly don't remember all the stuff, and I am probably leaving out great stuff. I liked turbulence books, but I can't remember any specific titles now. Kraichnan has a bunch, and he is great. The best stuff is primary scientific literature. The indispensible journals from before the internet were Nuclear Physics B, Physical Review, Nuovo Cimento, JETP Letters (Soviet era), Reviews of Modern Physics. There are great preprint collections by Dyson on SU(6), on Conformal Field Theory from the 1980s, on string theory. I liked a bunch of novels, 1984 was probably the most important to me growing up, I had a major crush on Julia. I liked Bukowski's "Pulp" tremedously, it was a hipster book in the 1990s, and it was excellent. I read "Ulysses" when it was declared the best novel of the 20th century, I liked it. I only got halfway through Finnegan's Wake, I am not as erudite as Gell-Mann. I liked plays "Beckett's "Endgame", "Animal Farm" and "Down and Out in Paris and London" were great too. Lessing "Golden Notebook" when she won the Nobel prize, I don't remember others. But my favorite thing was science fiction, because this is stuff you need to make up from scratch, including setting. Here, I liked Judith Merrill's science fiction

collections (and her short story --- "That Only A Mother"), Isaac Asimov for sure (his short stories mostly, I read Foundation though and liked it), Doris Lessing "The Making of the Representative for Planet 8", and Kurt Vonnegut's "The Sirens of Titan", and "Cat's Cradle". These are standard classics, I don't like to talk about stuff that's already famous. Nonstandard books: Dyson's "Origins of Life", Gold's "The Deep Hot Biosphere", Stuart Kauffman's "Origins of Order", Stephen Wolfram's "Cellular Automata and Complexity" (also A New Kind of Science), Mizuno's "Element Transmutations: The Reality of Cold Fusion" (the literature here is A library of papers about cold fusion). These are most important, because they are marginalized, yet they have correct insights inside. This is where I think you can make progress. There are books I liked when I was a kid that I am not sure I would like today, But there are books I didn't read when I was young, that I skimmed as an adult, and thought "Why didn't I ever go through this? it would have saved so much time!" Landau and Lifschitz series especially.

Approximately what distance apart are atoms, in femtometers, when two objects touch?

They are touching! The nuclei are about 1-3 Angstrom apart, 10^-10 meters, depending on the size of the atom. The surfaces aren't flat, however, so it's touching where there is contact.

How does a torsion balance work?

You twist a long fine wire, with a long balance, to get a teeny tiny restoring force proportional to the twist.

What are some good Wikipedia pages on scientific topics?

Infraparticle taught me what the heck that is.

Is the energy contained in the matter associated with the gravitational warping of spacetime exactly proportional to that of the kinetic energy of relative motion which warps spacetime?

Two separate things, "time dilation" is not "warpage" and it is never called "warpage", it is just that when you make a triangle in space-time the sum of the two legs is longer/shorter than the side, and this is a familiar property in geometry, it's why a straight line is the shortest distance between two points. The gravitational time dilation is a space-time field, it is a clock-rate tick difference from point to point. But there is a relation between the two, through the equivalence principle. If you are in an accelerating spaceship, the path is a hyperbola, and the nested hyperbolas with shared asymptote have different accelerations, and different clock tick rates, and the rate of change of the acceleration means that a clock at the bottom of an accelerating spaceship ticks slower. From this, Einstein deduced that a clock at the

bottom of a gravitational field, at a lower gravitational potential, ticks slower. From this, he could integrate to find that the clock ticking rate is, to lowest order 1 - 2phi/c^2 , where phi is the gravitational potential. When you are moving at speed v, to lowest order, your clock ticks slower at v^2/c^2, and for all practical purposes the formula that the clock rate is 1 - phi/c^2 - v^2/2c^2 suffices for engineering purposes. But in the full theory, the speed part is not related to the part that is changing from place to place.

Why are an abundance of physicists moving to theoretical biology?

The funding is good, the experiments are excellent, and the theory has so far been relatively primitive. There are also good experiments which need quantitative people, and the culture is becoming super-honest as good work drives out bad. Also, a paper in biology will be read, understood, and cited, while good physics papers are often ignored for a long time. One thing that is not a factor is competition with other physicists. Great physicists are always an inspiration, they are not really competition--- they always expand the field. When Einstein came around, it's not like the number of great physicists suddenly diminished because Einstein was taking away all the good stuff, the number exploded because the field expanded. In the same way, Witten's work has led to the acceptance of string theory and dozens of fruitful extensions, and the only effect is to draw thousands of good people into physics. On the other hand, bad science does drive people out. in 2000, there was flat out fraudulent work in physics that was taking all the attention of the phenomenological field, and which was extremely demoralizing. I can't describe how frustrating it is to have to explain why large extra dimensions are nonsense again, and again, and being ignored or dismissed, because nobody can imagine that all these clever people are so stupid to miss renormalization

constraints and neutrino masses, and gloss over the wrong fixes in the literature. "It can't be that simple" is the stupid thing one heard most often. When your field has gone crazy, it's time to leave. Large extra dimensions was incompetent to the point of fraudulent, and the refocusing of physics around it made it that suddenly everything I was interested in was out, in favor of clearly wrong nonsense. All the really good young people other than Gubser (who was lucky enough to make a major contribution in 1997, right before the shift) were driven out of physics or out of the country, Simeon Hellerman went to Japan, Zureb Kakushadze went to Wall St., the ones that were left were doing nonsense, and ignoring the holographic revolution. The draw in 1990s physics was holography, I wanted to understand the holographic principle, to figure out black holes. Around 2000, it was clear that this problem, that I thought would take 40-50 years in 1995, was actually largely solved, and this meant that the major mystery that drove me on was finished, and Susskind was the major player here, but also Maldacena, Polyakov, Witten, all the usual suspects. That's a great thing, but it took the wind out my sails personally. But at the same time, in biology, there is a simple insight that is a key to the field (at least I think so). The principle is that biology is computation in nature. It emerges when a system becomes Turing complete, it starts Darwinian evolving immediately without any self-replication put in, and the computation means that the theory is like in computer science, it involves methods of extracting the algorithm out of the physics. I started doing that, to and around 2001, I started doing a protein language. By 2003 I was done, and the startup company I was at mapped a chunk of the cell's known protein interactions. Extrapolating to 20,000 proteins from the 500 we had, it was a little paradoxical, because the total computation was at most 100 kilobytes of data, more like 1-50 KB, and there was nothing particularly complex there. I couldn't imagine putting together a human with a Apple II. I couldn't do it with a supercomputer. But at that time, RNA was "molecule of the year" in Science or Nature, and this cover made it clear where the hidden computation was--- it's in the RNA. This is a huge deal, suddenly as a physicist, you understand where most of the computation in the genome is, resolve the missing information puzzle,

figure out gene regulation (it wasn't so well understood then as today), and temperature regulation, all theoretically! This is the type of prediction that one can not make in particle physics today, it's like not knowing about the neutron, and then you know about it. It's extremely exciting in biology right now, because the knowledge is expanding exponentially. Once you know how to do theory, the methods become sophisticated. Further, the science is teaching more about nature than any other field. It is also clearly going to be the major technology of the 21st century, you should have a sugar outlet next to the electrical outlet, and plug in artificial biological technology made out of artificial cells. To plan these requires a complete method of describing biological cells, a precise model of all the processes, so that you can make artificial ones, and it produces a type of precise control on single-molecule chemistry that makes chemists drool. It's a good field, so I think it's a good call.

Which is the most beautiful theory in Physics? And, what makes it beautiful: the insight that went into it, or the insights that came out of it?

String theory. The beauty is in the holographic principle, and the S-matrix idea, the idea of a positivist description of nature, which only deals with scattering data, transmuting in the 1990s into the idea that the universe is best described on holographic boundaries. The insights that went into it is S-matrix theory, the prediction and observation of hadronic Regge trajectories, pomerons, all that stuff, plus black hole thermodynamics. Out of it came supersymmetry, the microstates of black holes, and complete models of physics inclulding quantum gravity. There is no greater revolution that can be, as it is a theory of everything.

Physics Overflow: Which non-mainstream physics topics could be allowed on the upcoming physics site Physics Overflow?

Whatever criterion you make, however good the intentions, is certain to eventually exclude something important, because criteria like this work well initially, but quickly get abused through academic politics to exclude anything original from consideration. That includes pomerons in the 1980s, quarks in the late 1960s, the path integral in the late 1950s. These were all legitimate topics. The only way to exlude something is by benign neglect, just let it alone, or place it as low priority. If you don't allow duplication, segregate by topic, then the various nonsense things will get low attention.

How can I come to terms with the fact that so many people I know got into Harvard, when I've worked nonstop for my entire life to get there and didn't make it? It feels like I've just wasted my life and come up short. I feel inadequate.

Harvard is not so great, get over it. It is useful as a social class entry, in terms of education it is comparable to other good schools, slightly better in some departments, slightly worse in others, but overall

competent in most. The problem with tiers of education is that the school selection is a proxy for social standing after graduation, and going to Harvard is a ticket to the upper classes, and this is debilitating to sell out like that. Universities are not naturally rank ordered an integer, you can find more of the best scientists, the best humanities folks, in other places.

Is Mach's principle astrology?

Joshua Engel's answer is not correct. Mach is saying something different, something very modern--- namely that there is at every point a LOCAL notion of "spinning" and "not spinning", and this can be different at different places. So that you could be spinning like mad, and say "I am not moving", while I could be not spinning. Or from your point of view, I am whirling around and spinning too. So that you could imagine a situation where space is set up in a crazy way, so that when you feel no centrifugal force all the stars could be madly whirling around you, and when you spin to match the stars, you feel a centrifugal force, in other words, the local notion of "rotating" and "not rotating" doesn't philosophically have to match the cosmological notion where the distant stars are not moving. Mach is asking why this doesn't happen in nature, why the stars are fixed when we feel no centrifugal force. This is a real question about physics, because the other situation is imaginable. To ask this question automatically presumes a non-Euclidean view of space-time, although in this case, to be precise, it's not about non-Euclidean geometry of space, it's just about the relation of different time-slices to each other, so it's a Non-Newtonian view of the relation between space and time, a Non-Newtonian dynamics. Once you understand relativity, the geometrical unification of space and time means that Mach's idea automatically turn into the non-Euclidean Minkowski geometry of General Relativity. This is why Einstein always credited Mach's idea in the formulation of General Relativity. Mach is claiming that the local reference frame should be determined from local data, like a local field that tells you which frame is non-rotating. He is implcitly allowing the notion of "non-rotating" to vary from point to point, and then he is asking "why does the local notion of non-rotating on the Earth match the notion of nonrotating cosmologically?" His answer is that there must be an influence of the distant matter on the local reference frame, and he postulates that a great deal of matter, if rotating, would lead the local frame to rotate along with this matter, so that the frame which has no centrifugal force will have the distant stars rotating a little bit. In General Relativity, this idea is realized to a certain extent. If you are standing in a hollow transparent shell of glass, and you start spinning it, and you precisely stand so that you don't feel a centrifugal force, you are spinning along with the mass shell a little bit, so that the stars rotate in the opposite direction slowly according to your frame. The effect increases in magnitude as you make the shell heavier, and your fram is no longer at all coupled to the distant stars at the point where the shell is about to collapse to a black hole. This is a famous relativity result of the 1950s or 1960s. Einstein had already established the leading order effect in 1916, immediately after finishing General Relativity, and communicated the effect to Mach before he passed away, saying the theory confirms the idea. But Mach did not support relativity. The Mach principle in it's full glory is not just saying that local rotating matter makes frames go around a little, it says the frame is determined by distant matter! This is not true in asymptotically flat space, where there is no distant matter. So Einstein decided the universe should be closed, like a sphere. This is the Einstein cosmology, and it is wrong, and also unstable, it turns into deSitter space. The proper interpretation of the principle so that it is actually true became clear in the mid 1990s, as a simple consequence of the holographic principle. The "distant matter" could be black holes, and Nariai spaces show that black holes and cosmological horizon are the same sort of thing, since there is a continuous physical process that links the two (two antipodal black holes in an Einstein universe, either one can become the cosmological horizon). In string theory, every matter is dual to a black hole, meaning it can be thought of as a small

quantum horizon object. So saying "rotation is relative to distant matter" is really "rotation is relative to distant horizon". This is true in deSitter space. You can't spin empty deSitter space, the cosmological horizon is uniquely determined. If have a black hole in the middle, and you spin the black hole, you spin deSitter space "the other way", meaning that the rotation is relative to the horizon. A proper holographic version of the principle makes a boundary stress tensor, and the rotation is relative to the boundary stress. If you push the boundary to distant horizons, including distant matter, and distant cosmological horizon, the principle is true, any local frame is rotating relative to the distant horizon. This is a simple classical stunted version of the full quantum holographic principle.

Is perception measurable as energy? IF so does it differ from biological evolutionary measurements?

Perception is measurable as computation. Most energy, as physicists define the term, is just heat, to the degree that you can use the body's internal computation to control metabolism, you can control heat to a certain extent, but that's not usually what people mean by "energy", they mean influence of one computing entity on another. Computation can be measured by focusing on known inputs and outputs, and identifying the internal data required to reproduce the inputs and outputs. All the spiritual stuff can be understood this way without any supernatural anything. God is a little more, because it requires considering an infinite limit of computing things, going to infinite complexity.

When we say that a particle has spin is that spin as we normally think of it as going around an axis or is particle spin a redefinition of spin?

It's normal spin around an axis, but it's not good to picture the particle as extended, it's a spinning point. Gillis Danielsen is not accurate in saying "you can't think of it as a semiclassical spin", although you read this in books, and it is repeated ad-nauseam, it is simply not true. There is no qualitative difference between an elementary particle spin and the angular momentum of a molecule, or even a baseball, except that it's usually smaller for a particle, and the elementary particle spin can be fundamentally half-integer, while orbital dynamics spin is always integer. The two things are described by the exact same mathematical thing, the angular momentum states of quantum mechanics and their superpositions, and these have the same classical limit--- the spinning top--- which is the limit of large amount of angular momentum. The only difference is that the number of quanta of angular momentum an elementary particle has is usually small, and so it is not usually near the classical limit. The other difference is that you are not supposed to imagine the angular momentum as coming from constituent motion of parts. But aside from that, it is angular momentum, exactly like a spinning top. It transfers to material objects. So if you have electrons on a wire, and you reverse their spin with a magnetic field, the wire will twist a little to get the twice the electronic angular momentum in a macroscopic motion. This is the famous Einstein deHaas experiment. There is no difference between fundamental particle spin and top spin, except for size, and occasionally half-integer quantum number.

What's it like to have a transcendent spiritual experience?

I had a very weird spiritual experience after reading the 120 Days of Sodom. I had read Justine a few days earlier, and Philosophy in the Bedroom, and some extraordinary short-stories by Sade, like "Eugenie de Franval". But the 120 Days was more brutal than anything else I had read, seen or contemplated. And it's long, you're immersed in this world of complete depravity. It also involves a lot of shit, I mean actual crap, feces, and the eating thereof, which Sade uses as an authorly device, masterfully. I know you think "How silly of you, getting disturbed by eating shit. It's just a book." But it's a long story (taking a turd, feeling it, soft), and it comes at unexpected times, (bite the turd) and you never know (he said as he chewed the turd, left cheek, right cheek) when you are suddenly (salivating, swallow a little), going to get hit again by an (swallow a little more, mmm) unexpected event (another swallow, ok, down it goes). It is really disgusting (a little bit stuck in the teeth there, lick, lick), and it comes at the worst possible times (savor the aftertaste) when you are distracted by other ethical things (oh, some reflux, belch). I actually felt ill when I finished it, physically sick. I was also horrified and paranoid, because the constant vigilance against a possible turd eating meant that I wasn't paying attention, so my resistance to evil thoughts was suppressed, and slowly, I became more and more convinced by Sade's characters that there was no arguing with the self-consistency of self-interest and power, that even though there is a logically consistent alternative in superrationality, the nearest stable minimum is also consistent. So there is nothing to say to the villains, they are self-consistent, and you are thinking like them now, and your thinking is self-consistent, and your experience reinforces this choice, and the villains finish their party, murder and rape their victims, and they are perfectly happy, while their victims are in terrible torment, but they don't care, and they don't have to, nothing is compelling them to. The knowledge that there is an alternative was very weak in the brain, and was not a powerful enough protection, because when you are faced

with two self-consistent possibilities, the easiest one is the closest one, since they are both self-reinforcing. And the self-interest reinforces the easy one, so let's be realistic, most everybody would go the easy path, so that the world is a very dark place. That's where Sade put me, and deliberately, through calculated masterful writing. It will happen to any atheist who reads the book with attention, cover to cover. Before I continue, I don't drink, or take drugs, although at the time I smoked cigarettes. I woke up around 2 AM with this incredible peaceful feeling, and a feeling of an alien presence in my mind, which I felt I could communicate with. So I communicated: "Hmm hmm hmm?" It didn't sound like that, it didn't sound like anything, the communication was completely wordless, it was pure internal thought which never passed through the language center, but not emotion---the emotion was always a steady peaceful calm. It was sort of like hearing something when your lover is sitting next to you, and raising your eyebrow infinitesimally, and glance, and you immediately know you are thinking the exact same thing. It was like that, except without any lover, and the eyebrow isn't moving. If I had to translate the sentiment, it would be something like "Is this Sade business really the way the world is?" "MM mm." Again, calm wordless communication, but now receiving. The translation was something like "It is not so", but with a certain assuredness, and a feeling of awesome incomprehensible static-ness, and humility at my own incomplete understanding of the vast structure. It went on for a while, involving all sorts of ideas and questions, always vaguely aesthetic or ethical questions, which I put to this external seeming thing, and getting answers of a sort, which were not derived by logical thinking, nor by social thinking, but by this alternate thinking. I immediately knew that this is a religious experience, and this was very shocking, as I simultaneously knew logically that I had been and still was an atheist! It's very embarassing for an atheist to talk to God. Here I am talking to a God which I know does not exist. This was very strange, but your logical beliefs are not at all important during a religious experience. I was annoyed at the contradiction between my rational beliefs and direct psychological experience (it lasted about half an hour), so at one point, about 5 minutes in, I struggled to remember my list of questions

to pose to God, to demonstrate non-existence. "Let's see, what were they again? I forgot. Oh yeah, something like `Occam's razor dictates that any structure...", blah, blah, blah. The problem was as soon as these words or any logically structured conscious arguments came into my head, the thing went away, and I was sitting alone in my kitchen talking to myself. So I had to turn off the words, and relax, and sort of think "come back, come back", except wordlessly and in peace, and then the thing came back. I want to say that afterwards, I was really rattled, because I finally understood how religious experience works, and to the atheists: you can't dismiss this thing with rational thought or scientific arguments. You just can't do it. It's not like that at all. I don't know how to explain it, because it is nothing to do with rationality, it is a strange sort of direct experience with an ethical structure that you become certain of, and still don't really understand, because you experience it, but you really didn't make it consciously, it just sort of comes under this situation of extreme distress and moral anguish, and gives you peace and direction about what to do. But also, once I understood it, I became a little annoyed with standard religious texts. Not with Sade, Sade certainly understood this and obviously wrote the works deliberately, with the goal of inducing a religious experience. And boy does it work. I was only annoyed with other religious texts. Because you would never identify the thing they are talking about from the text that describes it! The structure itself makes no supernatural claims, it makes no material claims whatsoever! Although you feel it is extraordinarily static and powerful compared to yourself, it doesn't make any claims to doing miracles, or anything else like that. There is a feeling of complete universality and permanence, but nothing at all regarding galaxies or trilobytes. It's just a powerful, external seeming rock-like certainty in certain ethical things that bears no relation to social coercion, or to embarassment, or anything. You don't even need to think about consciously, but they aren't all clear, sometimes you ask a question and the response is sort of nebulous and contingent--- you feel that you got an answer, but it will only be clear in future circumstance, contingent on what happens, and on understanding the situation better. But this thing is HARD WIRED. I was not commnicating with the Jewish God, I wasn't

communicating with the Christian God, it wasn't the Muslim God, or Zeus or Thor or any of those, it was just an abstract thing that I could see was what the people who worship the Jewish, Christian, and Muslim God are talking about. I should point out that I tried to understand this thing using rational analysis, and I already understood the superrationality business, and some ideas in biology about networks and RNA and all that. I eventually understood that what I was accessing directly with some hard-wired circuit was a universal self-consistent constructed approximation to a perfect superrational ethics, something which I could see makes sense under reasonable assumptions. It is possible to construct such a sense from subconscious decision making modules, without reasoning about them, but it is also possible to reason about it. What it is is a purely moral sort of antenna, which you produce throughout your life without working at it! It just gets built up through decisions and self-consistency and experience, and subconscious ethical deliberation. It isn't consciously constructed, and it doesn't follow social opinions so much, it is constructed in this subconscious way by a process of internal deliberation, and the only time you feel it is when you are old enough and faced with something horrible which is not compatible with this thing, so that the thing asserts itself. You can't make it go away, and if you want it to go away, you might end up doing Sadian things, just to make that thing shut off, go away permanently. That's part of Sade's villain's justification for evil, to make the religious thing go away. It's also not exactly a delusion, because it doesn't have any material manifestation--- you know you are considering an immaterial thing, not made of atoms. It also doesn't provide you with magic new information you didn't already have,at least not about the material world. It is ultimately just is an abstract sort of communication that tells you whether preexisting sentiments are compatible with an ethical code that you have placed on a rock hard scaffolding, and that, if done right, just cannot change.

Could believers with strong faith in God sometimes exhibit behavior similar to Stockholm Syndrome?

It's not Stockholm syndrome, because the evil eventually is beaten, and depending on the degree of stupid, defeat comes sooner rather than later. The local benefit of bad behavior is always there, that's not surprising, it is a game theory Nash equilibrium. The surprise is that good behavior eventually succeeds anyway, even though all the local restoring forces oppose it, and it is aiming for a new minimum which seems impossibly far away. But still, it grows regularly through people's steady faith, and it takes over when there is sufficient freedom, and even when there isn't, and in hindsight it seems inevitable, although at the time it seems impossible. Job is not good enough, because it has a more or less happy ending. To get the proper effect, Justine, or the 120 Days of Sodom, or any other work by Sade is more effective. In these, Sade puts you in an even bleaker situation where nothing at all decent seems to be a sensible choice, every ethical action, even just falling in love, or trying to help others, comes with unspeakable punishment. Sade is the best text for understanding religious faith, because he forces you to go to a point where no human being can actually follow and remain sane, and at this point, God becomes obvious. I should add that Stockholm syndrome isn't a surprising thing either, humans get their political belief system largely from the surrounding power structure, without conscious deliberation. When a person is surrounded by leftists with guns, when they are pointing guns at you, you are powerless, so they start to sound a lot more sensible than when you are sitting at home and they are being made fun of by the government.

If ethics weren't an issue, what sort of experiment would people like to see the outcome of?

I would breed a human and a chimpanzee.

Why does nature need RNA?

In organisms today, DNA is the ROM, RNA is the RAM. You can't do anything without RAM.

What are some good geology books?

Gold's "The Deep Hot Biosphere". I didn't care a bit about geology before this, now I look at rocks with new eyes, as you can sometimes trace the flows of methane, in addition to the flow of water, and any rock with carbon deposits or heavy metals becomes a record of fluid flow long ago.

As of December 2013, what's the status of the ongoing debate between deletionists and inclusionists on English Wikipedia?

That debate ended around 2006-7, the deletionists won, the inclusionists left, and then the deletionists, true to their name, deleted everything they could. After that fiasco, they took over the ArbCom, and booted out anyone who was writing anything. The deletionist debate was then replaced by the "loose citation" "strict citation" split. This was whether claims needed to be individually cited sentence by sentence or whether you can write an original text so long as the claims are reasonably accurate when examined in light of all the sources together, evaluated critically as a whole. The strict citationists won that debate, so you can't write anything useful anymore. This is most harmful when there are ab-initio arguments which can be followed by anyone versed in the field, but which are not found verbatim in sources. This is a common situation in mathematics and physics, where new proofs have no source, but are clearly and obviously uncontestable, as they are equivalent to existing stuff that is well accepted. The strict citationists now can prevent new articles from getting written, but thankfully they are too stupid to read mathematical sources to even verify whether the claim and the source agree, so you can snow them easily and get them out of your hair for a while, at least if you fill up a page with equations. The politics on that site is abominable, you can't do anything useful anymore. Anything you write gets a stream of "citation required" tags and then it gets deleted, no matter how supportable. Providing citations doesn't help with politically resisted stuff, or even with just surprising sounding but well accepted stuff, because the talk pages are not allowed to debate the topic, just the claims of sources about the topic, and the decision is ultimately entirely political, based on numbers for and against. Because of this, the people there have evolved a power structure which has absolutely no regard for accuracy. ArbCom is supposed to resolve these disputes, but ArbCom does not feel competent to judge technical accuracy. So they judge politically, they suspend those in the minority, without reviewing the literature at all. This creates a Soviet-style nightmare, and I recommend Wikipedia editing for any young socialist so that they understand the issues fully. This means you have to wait for a project where the organizers DO accept the responsibility to judge accuracy, and do so in as objective a

manner as they can. The articles at Wikipedia on controversial topics or politically sensitive topics are a scandal. If you examine "black war", you will see a great example--- the page has a nonsense pseudohistorical Australian narrative due to Windschuttle, which is neither mainstream nor correct, and it is easily contestable with sourced primary and secondary material, and any attempt to correct this is gang-reverted to the nonsense that is there now.

If light has no mass, why is it affected by gravity?

The answer given by Steve Ham is incorrect--- all particles, massive or massless, move on geodesics, that is locally straight lines, there is nothing special about light in this regard. The path of light is the limit of the path of massive particle as it goes faster, but as you take the limit, you take the mass to zero to keep the energy fixed. Gravity is by the energy, not the rest-mass. The energy in light and matter is what pulls other stuff (also, less significantly, the momentum, forces, and pressure at various places). If you have light in a box, bouncing in mirrors, it gravitates just like anything else, according to the energy. That's not surprising, because the mass of the box goes up when it contains photons, by the photon energy divided by c^2. Gravity deflects light, and there is a back-reaction, the light pulls back on the gravitational source. This is required to conserve momentum in an asymptotically flat background. For a black hole, the situation is clarifed by considering a constantly accelerated observer. Such an observer feels a local gravitational field, but there is no curvature of space time, it is just due to the motion. The way you see this is because relativity is geometry with a minus sign in the Pythagorean theorem, acceleration is curvature in time, a circle x^2 + y^2 = R^2 has constant radius of curvature, and so a hyperbola x^2 - t^2 = (1/a)^2 is the hyperbola with constant acceleration. This hyperbola has

asymptotes, which are light rays from the origin that never catch up to the observer. For the right branch of the hyperbola, any light ray further to the left than the asymptote will never reach the accelerated observer. Any object thrown by the observer out of the accelerating spaceship will pass this light ray and be cut off from communication. Such an observer feels that he or she is trailed by a great black wall, which absorbs all matter. Any light from beyond this wall will never reach the observer. The wall is also glowing thermally at a temperature proportional to the acceleration. The black hole is such a situation where the black wall is closed into a sphere. When you are close, you can accelerate locally, and the horizon is indistinguishable form the acceleration black-wall, the Rindler horizon. But if you are far away, you see the black hole is just a point source of gravity. Since the horizon is a sphere, any light that enters the sphere just can't come out again in the future, it is trapped. The glow of the local observer continues smoothly to the Hawking radiation background at infinity.

What is it like to be a graduate student in physics at Harvard?

It's not much different than anywhere else, the advisor is important, and Harvard has some excellent choices, but that's true at most research universities. You do get a little bit of help in placement after your degree from your advisor, as the advisor tends to be well connected.

What are the most notable Ig Nobel Prizes as of 2011?

The one that discredited the whole practice: Pons and Fleischmann for the announcement that they had achieved nuclear reactions in 1989.

What is string theory? How can I gather a clear concept about the string theory?

You are all smeared out on the surface of a big ball the size of the universe. That's enough for that age.

How much americium-241 would it take to match a 1.5v battery's output?

While your question has been answered by Todd Gardiner, I should add that in 1994, a high school student, David Hahn, put together a radioactive glob in an outdoor shed, using the Americium in a lot of smoke detectors, some radium and other things (see David Hahn , thanks Rod Carvalho!). He used it to transmute some elements, did a bunch of experiments, and then got scared as the thing got more and more radioactive. So he eventually tried to get rid of it using his car. He was caught in a traffic violation with a bunch of radioactive crap in his car, and had a lot of legal trouble, and it got into the newspapers. This true story is probably the source of the various urban legends about a child who brought a homemade atom bomb to school. It's not

a bomb or a pile, there's no chain reaction, but don't do it, it's dangerous to pile together Americium, it can get really radioactive.

Is there any scientific proof which follows the scientific methods, of changing of species?

A scientific proof is simple: you make predictions that are explicable naturally under the hypotheses of changing species, and are complete coincidences otherwise. Once you have a 1 in a million coincidence, you're convinced. For example, the Higgs boson was declared "discovered" from a bump in the number of scattering events which would be a 1 in a million coincidence without the Higgs boson. You could make up a bunch of different ideas to explain this bump after the fact. But you don't do that. You make predictions ahead of time, and compare honestly. For evolution of species from divergence from ancestors, you have a bunch of classical predictions: species forms should make a phylogenetic tree--- they do (check, 1 in infinity coincidence in the absence of change). Species on isolated Islands should fill niches with forms that are more closely related than on a big mainland (check, one in infinity coincidence), DNA should make the same phylogenetic tree as form (check, with a few modifications to the tree, due to our inability to intuit plant relationships well, one in infinity coincidence). Fossils should occur in dated strata in forms that are capable of branching out to later forms (check, one in infinity), and early forms should just look primitive (they do--- just look at a trilobyte, or early fish--- it's primitive, nothing looks like this, although this is harder to quantify). No modern species should be found in early strata (check, one in infinity coincidence). This is the scientific method, it's Baysian confidence, and honest comparison of prediction to theory, where you make the prediction ahead of time. The creationist idea does not predict any of these ahead of time, it can only justify it by saying there was a plot by God to plant fossils and

radioactive elements to make the Earth look old. Also, since the creationist story is a bunch of social hooey, there is no other competing scientific hypothesis. A scientific hypothesis is something you would come up with yourself from looking at the data, not something a guy in robes reads to you from a big tome and tells you to believe.

How do people do new research in Mathematics?

Mathematics is like literature, you don't run out of novels. It produces new methods, and then these methods produce new mathematics by application to new domains, and by extension. With repeated use, they become second nature in the next generation, and the next methods iterate those methods and use them like tinkertoys to build completely new next-generation methods, with new ideas, and the cumulative process is similar to the evolution of life.

Why aren't there more people like Elon Musk who excel in multiple fields?

Elon Musk is a billionaire, there aren't enough resources for everyone to be a billionaire. Also, there is no need to suck up to billionaires with questions such as these. There are plenty of people who have contributed to multiple fields, Elon Musk is not one of them--- he has excelled in one field, entrepreneurship. He's a creative entrepreneur, but so are many others. Unfortunately, entrepreneurship today is winner take all, and there can be only one winner, because there can

be only one pay-pal. Antitrust law is of the age of the dinosaurs. Given his interests, and looking at the technical stuff done inside his companies, I think Musk is actually one of the better entrepreneurs, but you have to look at the competition to see why that's not saying much.

For an aspiring entrepreneur which is more useful: a science degree or an MBA?

You need to get good grades and learn to schmooze with classy rich people. Remember what your job is: listening, getting money, telling people what they need to do. So you need to learn about authority, learn to make people give you what you want. Do NOT take too much mathematics, you run the risk of becoming intelligent, and actual intelligence looks exactly like stupidity to investors, so that no one will give you money. Do NOT take too much science, because you will become too honest, and honesty and entrepreneurship don't mix. Philosophy is an excellent choice, preferably the fascist stuff, so Niezsche, Heidegger, Sartre. Read Ayn Rand in private, again and again, until you start to believe the philosophy, until you say to yourself "Why don't they teach THIS in the philosophy department?" Economics is good also, stay pure Chicago school. Pick an easy political field with very little knowledge, but enough to look impressive to others. If you need any actual techs, you can hire them, they come cheap. If a tech starts a company, the VC will eventually boot out the tech and replace the tech with you! Because you are of the right social class, you studied Heidegger, and you know your Chicago school, you have your hair cut right, and you wear a nice suit. The tech was borderline autistic and never made sense to people. On the other hand, if I were personally investing money in a company, I would prefer it was run by someone who did the technical innovation. But the last

place technical degrees led to management positions was in the Soviet Union,

White holes give out everything light, matter etc. But from where do these white holes get these things from to be released?

They lose mass as they emit, they are just time reverse of black holes. For normal neutral thermodynamic black holes in equilibrium with their surroundings, the influx of radiation is equal to the outgoing Hawking radiation, and as Hawking argued, the time-reversal symmetry of equilibrium states means that a black hole and white hole are fundamentally the same object.

How can I learn to understand wtf Ron Maimon is talking about in his answers to questions in math and physics?

It's standard material, I try to only give the result the question is confused about, the background material you can get from standard physics sources.

Genomics: Is the ENCODE project legitimate or wrong?

The ENCODE project came to perfectly valid conclusions that were obvious to some people for a decade before the project was started. Their results in fact do lend strong support to the thesis that there is very little junk DNA, that 80% of the DNA at least is transcribed in cell nuclei, even though only a very small fraction of this has a role in protein synthesis or known regulation. Despite the claims of another answer here, there is absolutely no reason to expect junk DNA to get expressed at all. This is not noise, nobody who didn't have an idea of what the junk DNA was doing predicted that junk DNA would be carefully expressed or even expressed at all, aside from those who knew that it was functional. Genetic expression is regulated by multiple elements in each gene, it requires proteins to bind, another protein to take the sequence into RNA, and it is carefully controlled with chaperone molecules which modify and tag the transcript in the cases where we know the function. The process is not a haphazard accidental binding of a single transcription factor to a random domain leading to some ridiculous accidental RNA sequence which gets degraded, it requires activating complexes to form, and it is tightly regulated. The expression and regulation-factor data revealed by the ENCODE project is extremely strong evidence for the full real relevant function of 80% of the genome. One must remember that these patterns of expression of noncoding genome are stable and reproducible from cell type to cell type, they are controlled programmatically during embryogenesis, as established by Mattick, and their function is demonstrated simply by the fact that the cell cares to transcribe them at all, as this does not happen when you insert random gibberish in genomes. Eukaryotes are not bacteria. But the noncoding RNAs are not just transcribed, the are transcribed in regular levels which are stable in embryogenesis from cell type to cell type, and change in time in ways that reflect the ongoing developmental program. This type of regular transcription is a smoking gun of function, it is just that the function is not of the

standard type. So what is the function of these RNAs? It is not established in the scientific literature, but I would like to give a hypothesis that I believe with a confidence of certainty. Knowing this, none of the ENCODE conclusions were surprising at all. The RNAs are transcribed to take part in pure RNA-RNA computation, mediated by chaperone proteins that complementary bind and modify the RNA to make a closed loop Turing complete computation, for the sole purpose of thinking about what to do (although with a gigabyte computation, so the thinking is limited). Mattick proposes that the RNA network is complementary binding in the nucleus, but I am confident that the RNA is actively rewritten in this process, the sequences munching away at the data to produce new RNA byte data. The reason to claim rewriting rather than just complementary binding is just that the computational capacity goes up by a factor of at least 10-30 (depending on the details) if you allow resplicing and rewriting, as opposed to fixed complementary binding, because the binding is by domains which are fixed and unchanging of length 10-30 bases by specificity, while rewriting allows the full RNA sequence space to be RAM. The principle that a biological system maximizes it's information capacity is pretty accurate. But it might by what Mattick is thinking too, then it is much harder to test. I must point out that in this theoretical picture, the transposable elements and endoretroviruses of the genome are not at all junky random insertions, but deliberate insertions of a tagged sequence into the DNA. The tags can be modified by RNA computation, but they contain conserved parts for the insertion to be properly traced to its network. An alu transposon is just a tag to identify the transcript so it can be identified upon production, and the insertion is a long coherent mutation of sorts, it has modifed the computation programmed by the DNA in a permanent fasion. There is no evidence that these elements are parasitic other than they appear in many places in the genome, they replicate, and "Crick says so". The C-number paradox is not a paradox at all in this view either, as it is first not true, most genomes do correlate with naive complexity, aside from polyploidy, and second, it is related to transposable elements, so it is just a manifestation of an organism evolved to store more or less of the computational data in the genome. The firm test of this is simply to find completely unmappable squences or partly mappable sequences that have been heavily edited by the computation. If the computation stores data by resplicing and rewriting, you cannot avoid finding a ton of completely inexplicable sequences in non-polyA selected nuclear RNA-seq. We already know biological systems are capable of evolving computers of high sophistication, our brain is an example. The claim here is that the cell has evolved such a computer much earlier, although necessarily of a much lower complexity. So as not to repeat, I will link another answer of mine here: Ron Maimon's answer to Is so-called “junk DNA” really useless? What is it doing?

What exactly does talent mean?

Talent is when you find that you have a circuit in your brain which allows you to do some primitive stage of a complex task slightly faster or easier than your neighbor. This produces a prod to get you to keep going. It is a method of assigning people to bins, so that you focus on something for a long time to become great at it. Once you actually do this, the starting point recedes so much, that you realise your advantage was an illusion, there was no real advantage, a talentless person could have caught up with you in less than 1% of the time it takes to complete your competence. So you learn that the talent concept is just a social myth. It is useful as such, because it allows people to hone and concentrate their efforts in one particular direction for a long period of time, because they operate under the delusion that they are somehow more capable of doing it than others. That's a good thing, because without this delusion, I don't think we would have great composers, or great novelists. It is a problem when it is used to justify social class structures, and power structures, through the idea that some people have a special talent for telling others what to do.

Is so-called “junk DNA” really useless? What is it doing?

There is very little "junk" DNA, this is a purely theoretical dogma derived from a primitive model of biology, which is based on a brainless non-computing evolution. The experimental evidence that the DNA is junk is pretty close to nil, it is hard to establish lack of function in a biological system, the discovery of function only extends in one direction, towards more functions being discovered. In order to declare that something does not have function, one needs a good model of the cell which works, at which point, the cell is understood, and whatever is left without function is known to be function free. Yet there is a theoretical model of mutation which produces, as a predicted consequence, the idea that junk accumulates in the genome. This is the model that DNA is an inert dumb molecule, carrying information which gets duplicated, mutated at random, and then accumulates a bunch of useless cruft which never does anything. This is the point of view of neo-Darwinism. One must separate this unsupported lunacy from Darwinian evolution, which does not make claims that the genetic material is so stupidly evolved. Darwinian evolution by common ancestry and selection pressure is a scientific fact. That the process of mutagenesis and production of sequence is a stupid one does not follow, because the rewriting system co-evolves with the system. This idea, that DNA mutation and evolution is unintelligent in the sense of computation, is entirely baseless theoretical speculation. It is ruled out by models of computation, as explained most clearly by Leslie Valiant--- the distance between optimal functional codes in a Hamming sense (the number of mutation steps to get from one good code to another) increases as the code complexity increases, and in order to make evolutionary steps that are effective, the rewriting mechanism needs to co-evolve with the complexity of the code. While

the DNA system does not have access to a computer the size of a human brain, or even an insect brain, the DNA can transcribe gigabyte of distinct genomic RNA, and this RNA has a base-pairing complexity which allows it to actively compute with gigabytes of RAM. This computation is capable of rewriting the genome in a coherent way, and it definitely easily can close the gap. Such a mechanism can be said to be required on purely theoretical grounds--- you need a computer to evolve a program. Unfortuantely, this is exactly what creationists say. They identify the computer with God. While I don't want to knock them too much, because the arguments the creationists make regarding intelligent design are parallel to those above and to Leslie Valiant's, the computation we are toalking about here is not godlike at all, it's some gigabytes or terabytes in egg, it's not an infinite all knowing mind. Although, in a philosophical sense, it can be thought of as collectively approaching this in the infinite genome limit. The computation in RNA makes a bunch of predictions. The most significant is that nearly all the genome should be transcribed in a regulated and controlled way. This has now been demonstrated, it was already clear by 2001. This observation is completely at odds with standard views It further predicts that this RNA must either rewrite itself actively and produce new unmappable sequences during the course of computation (this produces the biggest computer), or it must complementary bind using chaperone proteins into enormous complexes whose complementary binding structure contains the computing information (this produces a much smaller computer). These predictions are not safe, they are really sticking the neck out, and they are probed today with sequencing data of nuclei. If this is correct, you have to find complementary binding networks of RNA, and probably novel RNA which has been rewritten so much it has no DNA corresponding to it. What you learn from the computational function of junk DNA? The most important thing is the origin of complexity in embryogenesis. The program for development is entirely regulated by long noncoding RNAs. This is the focus of Mattick's work, and he has accumulated an essentially infinite amount of confirming data on this. One must remember that the developmental program of human and worms are not comparable in complexity,

although the genetic networks are essentially the same, up to a duplication or two here or there. The lack of correspondence between the computation in the protein network and the complexity of the organism was a major clue that the noncoding DNA was heavily regulating with a computation. It's exactly like inferring that an animal has a brain from the behavior--- it is difficult, because for any one behavior you can always postulate a robotic circuit. But for evolvable general behavior you need an evolving computation. Yet another thing is that you increase the computational capacity of the actual brain a billion-fold. The RNA in the brain is mostly noncoding, mostly strange, and it is associated with genomic modifications such as transposon activity. The natural hypothesis here is that the brain has networked RNA in many cells to achieve a very networked computation. This is larger in capacity than the neural network model by nine orders of magnitude at least, but it requires a channel membrane protein that is capable of writing RNA based on voltage, and another which is capable of reading RNA and producing action potentials. These have not been observed yet, although nucleotide gated channels have, but it is a firm prediction. Yet another is a complete reversal of the role of transposons and endoretroviruses. The ERVs are functional, and the origin of retroviruses is from ERVs not the other way around. The transposons are back-cribs from the RNA into the DNA, and allow the cellular RNA brain to store data long-term for retrieval. The amount and known function of transposable elements is incompatible with a neutral role. Another thing is you understand the temperature regulation in mammals. The RNA brain is temperature sensitive, due to relying on RNA-RNA complementary binding, and it is optimal around 40 degrees, give or take. The RNA binding transition temperature. Since the molecule is long, it prefers temperature regulation to near this point. Basically, it's the holy grail of eukaryote biology. There is a political resistance to this, because it supports a more computing view of evolution, and this is associated with religion. Damn skippy. But it's not a creationist religion, that's for sure, it's just an appreciation of computing networks in nature. Regarding the bladderwort, there are exactly two possibilities: either the folks sequencing made a mistake, and there are easy mistakes to

make to miss whole enormous sections of genome by bad methodology. 1. Their contigs might be actually distant and falsely overlap, due to a genome with a repetitive structure. 2. The bladderwort might have an extremely variable genome which gets so much transposon activity, that it is highly variable from cell to cell, so that the only reproducible contigs are from coding segments. 3. Just plain incompetence--- it's one result that flies in the face of every other genome project. The other possibility, if the result is correct as they interpret it, is that the noncoding bladderwort RNA is just reproduced directly from RNA. This means purely maternal inheritance in bladderwort (if it is sexual, possibly not, plants are often asexual). The sequencing of RNA in bladderwort MUST reveal exactly the same exact complement of noncoding RNA as in related plant species. The bladderwort is not magic, it is an anomaly, and when confronted with a paradox, your job is to get to the bottom of it, not jump to political conclusions.

Is it possible to create continuous energy in a nuclear fusion reactor?

There is a design for a nuclear fusion reactor that requires no new technology, which is the PACER nuclear power plant. This involves exploding low-yeild H-bombs in an underground cavity, and transferring the heat to molten salt. This type of plant is politically difficult, because it requires plutonium bombs, full nuclear explosives, so it makes a proliferation nightmare, but it works to produce fusion energy. The fusion bombs produce neutrons as a side effect, and this can be used to clean the reactor of dangerous medium half-life isotopes, and do additional transmutations too, and breeding of fissile materials to close the cycle. It is 95% fusion energy even for small bombs. It is economical and practical, but it requires getting our act together regarding safety and politics, so that there is no danger of misuse of the bombs.

Thermodynamics: If entropy is a function of state, can reversible processes and spontaneous processes coexist in an isolated system?

If the systems are already in equilibrium, then nothing can happen spontaneosly anymore. The only content of the Clausius statement is that entropy has to go up in any process, that's it. So ice melts because the water has more entropy (after accounding fo the volume change and so on). It's not hard.

What does "position" refer to in Heisenberg's uncertainty principle?

It's the standard deviation of the results of measurements which reveal precisely where the electron is. Your division is faulty, you can't replace delta p with sqrt(2mE) because that's p, not delta p. You can only use that for order of magnitude when you know what you're doing.

How much of our DNA is 'junk' DNA and why?

At most 20% or so of the genome is non-functional, and structural. The vast majority 80-90% is functional, although only a few percent is coding, and only about 10% more is obviously directly regulating the coding regions. The structural elements are telomere ends, some structural code at the meeting point of the X of the chromosome, and repetitive elements that are scattered throughout (although these seem like they might be used to count something). These repetitive elements are over-estimated by Encode's algorithms, but they still correctly conclude that 90% is functional, as John Mattick bravely did a decade earlier. The function of most of the RNA is purely computational, it is not used to make proteins directly, or to regulate proteins directly. The RNA is transcribed, and complementary binds with other RNA and either splices and resplices it, or else joins and rejoins with new strands, so as to make a little brain in the cell, a brain capable of regulating protein function. The regulation comes in short RNA signals which go in the cytosol and regulate protein expression, and also in other signals that are used to tag locations and so on. The RNA brain is also making "knowing" modifications in the DNA through the action of reverse transcriptase. The reason I say "knowing" and put it in quotes is because the computation is pretty heavy but it's not anywhere near a brain. It's a few gigabytes in a typical cell, a few more gigabytes in a neuron (which has more RNA), and a few terabytes in an egg cell (which is larger and has more RNA still). The purpose of this computation is the same as in the brain--- computation evolves for it's own sake, so as to produce all the intelligence needed for a eukaryote to survive. Bacterial cells are degenerate and have either not yet developed these RNA brains, or else, as I suspect, they just evolved them out. It all depends on details of bacterial evolution that are shrouded in the mist of archeology, as they happened long before we have any molecular clues. The philogeny of archaea, eukaryotes and bacteria might be able to sort out which at some point. Bacteria have no RNA brain beyond some anti-phage resistance. They share plasmids and conjugate to make an enormous collective which seems to evolve largely by modern synthesis methods. While they were the first organisms whose genetics were understood, largely because it was so simple, for the same reason they do not make a good model for

the main story in eukaryotes. The way I personally came to this idea is just by comparing the information capacity of the known biological processes in proteins and messenger, ribosomal, and transfer RNA to the information in the raw genome and to the computation revealed in the behavior of eukaryotes. Even those who are untrained in genetics or in the methods of science can see that the modern synthesis form of evolution doesn't pass the smell test, the criticisms were frequent and started in the 1950s--- the evolution of computing systems cannot be by small changes in code, it is as ridiculous as claiming that you can evolve a new version of firefox by mutating the ascii codes until it works better. You can, in principle, it just takes forever longer than the age of the universe. There is a persistant group that keeps claiming God did it, by writing the genome by magic, because the complexity is too great, and the networks are too coordinated. Their criticisms are not nonsense (although their conclusion is), it is essentially the same criticism levelled by Leslie Valiant in his Turing Award lecture last year. A computing system cannot evolve without computing mutators that co-evolve with the system, otherwise the thing quickly gets stuck in a rut, which is the maximally optimized accessible code. The way it happens in real life, outside of viruses and certain bacteria, is for the mutation mechanism to be aware of what it is doing when modifying the genome. Most of the modifications are in the DNA which controls the information structure, the nuclear brain of the cell, not in the proteins, which are structural elements which have largely been fixed since multicellular organisms first arose. The evidence for this is cumulative, because it is a new idea which makes predictions. I will recapitulate the main points of evidence, although now it makes no difference, because sequencing machines produce as much evidence as you need. 1. The noncoding genome is correlated in size with the tissue complexity and emryogenesis program of the organism. The coding genome is fixed. Worms and humans basically have the same coding genes, but the program for humans is enormously more complicated, as we need to make a spleen, a liver, a computing brain, a neck, stomach, gall-bladder, etc, etc, and worms only need to make a gut and some nerves. The idea that the program has not increased in size since then except by a factor of 2 or so is laughable, the program required if

you try to write it would strain the best modern supercomputer. 2. The noncoding genome is structured and transcribed. If you look at the RNA in a nucleus, you will find transcription is active all over the genome, or at least 90% of it. This is the clincher--- transcription is regulated and metabolically expensive. 3. The noncoding genome contains conserved regions There are highly conserved regions which do not correspond to proteins, to obvious regulators, or to associated anything, they are just conserved. 4. The developmental program relies on non-coding RNA long noncoding RNA are found at all stages of development at critical positions, for example, there are long non-coding RNA at the head region of a fish (I think) egg. These points were made in Mattick's 2001 paper. Since the prediction can be purely made just by computational considerations, with no regard to biological data, these are all things that are surprising or unexpected in traditional models of biology, and are obvious in the RNA view. You must consider the evolution of alternative splicing. It is not imaginable that you can evolve a mechanism of splicing without an RNA computaiton already there, since you need to splice and resplice and when the intron changes, the intron-splicer needs to change in a coordinated manner. The same is true for chromosome break and join evolutions, you need to allow these to breed for a little while with non-break animals. This makes reinterpretations of the action of all parts of the genome: the retrotransposons are not "parasitic", they are simply data copied from one part of the genome to another in the course of computation. The endoretroviruses are functional and endogenous, and likely used to communicate genetic information from cell to cell, rather than being frozen infections. All these things are things that biologists got wrong, because they were going by stupid dogma. Too bad for them. Busted.

What is the difference between empirical and analytical reasoning? Besides needing

evidence.

Analytical reasoning is mathematics, which doesn't need evidence beyond the evidence for the claim that such and so computable ordinal is well founded. Empirical reasoning is everything else, which requires justification in sense data. It's not a deep distinction--- there's the stuff you know because you know it from pure deduction, and the stuff you know because you got sensory evidence for it.

What is the state of the art in the quantum mind/brain hypothesis in a broad sense (not only consciousness)? Which is the relevant, updated literature? Is it a dead idea?

It's a speculative idea, because nobody has a really plausible way that you can make a coherent large superposition type quantum state in the brain. It's at room temperature. If there were a property of the brain that couldn't be explained by the hypothesis of a deep classical computation, then it would be worth investigating, but it seems that most of the motivation is just from a misunderstanding of the depth of the brain's computation, or from misunderstanding the implications of Godel's theorem. The computer in the brain has a random number generator, so it is not strictly a Turing computer, but a Turing computer with a random oracle, and these are more powerful, for one, they can compute the random oracle! The Turing limitations are very intuitive, and seem to correspond to philosophical limits of knowledge that define the boundary of knowledge, not to some mystical idea that you can transcend computation itself. In any case, reasoning of this sort cannot lead to any conclusion that the brain is quantum, because normal quantum mechanics is also computable, only slowly. In order

to make a non-computable brain, you would need new physics which is noncomputable AND also a mechanism to make it relevant to the brain. Penrose has speculated in this direction, but I think it is better to bite the bullet and just say the brain is doing classical computation. Since there is no evidence otherwise, it is important to investigate with this hypothesis as the default. Since I think it is true, I think it is a waste of time to go along the quantum brain route. The idea of a noncomputable physical process (other than true randomness) is philosophically difficult, and there is no evidence for it, certainly there is no argument for it from anything we have observed so far

How does one go about understanding the Chern-Simons-Witten theory?

You should add a little standard kinetic term to regularize it, so that it looks like ordinary 2+1 gauge theory up close, and like a topological theory far away from sources. In the limit where you take the kinetic term to zero (take the topological term mass to infinity) you are left with a pure topological theory, that only cares about the knotting of the source in the space. It's very intuitive in this limit, someone told me this property is also emphasized by Witten when he describes the theory.

How does Edward Witten know so much math?

Researchers are expected to learn the stuff they need, and be familiar with everything. Since this is somewhat unrealistic, it just means you try to keep up all the time, and nobody feels they know enough, you always feel like you're missing something. Witten came before the internet, and one cannot overestimate how much more difficult it was to study mathematics back then. When you opened a math book, if you didn't know the definitions, you couldn't google them, you were just screwed. He studied mathematics (among other things) as an undergraduate, I remember he was grateful for the proper mathematics education he recieved, but he continued to read mathematics and internalize it also as a grad student and through his post doc and into his professorial career. He said he considered going into mathematics at one point, also perhaps linguistics at some other point. He was a young lefty in the 1960s, there were a bunch of exciting things to do, but he eventually decided that physics was where he would make the biggest impact. He was up to date on the mathematics of the 1960s, that's extremely unusual for a pre-Witten physicist. Now, it's expected, but it's expected mostly because of Witten! All physicists know the elementary mathematics curriculum, that's no big trick. Most physicists have mathematical competence in the areas related to their chosen field, to the level of a beginning researcher. But what makes Witten special is his deep intuitive understanding of ALL fields of mathematics, especially deeply the 1960s topology stuff, that he clearly just learned for the heck of it, it wasn't before useful in physics, all the homology, homotopy theory and algebraic geometry constructions mathematicians were doing back then. It became central with string theory. For example, one of his famous works in the 1990s was a note identifying the structure of brane anti-brane annihilation as a type of K-theory, which is a Grothendieck construction which didn't have a physical intepretation before, nor is it something you would expect any physicist would know about. Witten is the exception, because he knows the mathematics field as well as any mathematician, and he just likes the material, he reads it, and rediscovers large chunks for himself. While it is not polite to speculate about people who are alive (you can just ask them), I suspect he learned a large chunk of advanced mathematics during his

Harvard postdoc, in the late 1970s. Jaffe and Coleman are influenced by him, probably the influence goes both ways, Coleman begins doing topological instantons, then he did the vacuum decay work, the false-vacuum instanton thing which was so influential for inflation theory. Witten is also associated with two enormous Harvard pure-mathematics names, Bott and Yau. His mathematics had a Harvard feel to it, the 1985 Calabi Yau paper, the Morse theory paper, these are popular Harvard topics. He won a fields medal, and this is for a beautiful interpretation of the Jones knot polynomial from large N 3d topological Chern-Simons gauge theory, a theory that he defined. In another related idea, just a few years ago, he showed with his student or postdoc that the volume conjecture (due to Thurston I think) is related to a property of these topological theories under analytic continuation, and modulo the standard problem of precisely defining the path integral, they gave what should be a proof of the conjecture. He has a bunch of recent mathematical work I couldn't understand at all related to pure algebraic geometry. He also has a bunch of non-mathematical physics work too which are famous classics, like the superconducting cosmic strings, the bubble of nothing instantons, the Witten anomaly, the Seiberg Witten theory and brane-stack constructions, the AdS/CFT constructions, a bunch more I probably forgot. One thing that is not considered a classic is a 1992 or 1993 cone idea about supersymmetry breaking that is very clever and simple idea for stabilizing the cosmological constant, but it probably doesn't work (there seems to be a mistake, I don't remember what I thought it was), but boy is it inspirational. it's really intimidating, as all his work is of extremely high quality, and everything is for sure required reading. It is a little difficult to follow, because it requires knowing earlier physical and mathematical work, but it's as if it was made for the age of the internet, because now you can learn the associated material without being in a fancy place.

What is more likely to end elephant and rhino poaching—park rangers going after poachers or the alleviation of poverty in the third world?

It will end with the construction of rhino and elephant stem-cell systems capable of growing horn and tusk. We might be able to do that with a few years of research.

What are examples of great scientific books that introduced the public to revolutionary concepts?

For books aimed at general audiences, recently, there was Wolframs "A New Kind of Science", which despite the overselling and overreaching applications, did introduce the public to Wolfram's automata and the origin of complexity. The results popularized in this book are foundational to modern biology, as I see it. In the 1990s, Thomas Gold's "The Deep Hot Biosphere", introduced the public to the Soviet abiogenic petroleum geology. In a completely different field, Mizuno's "Nuclear Transformations: The Reality of Cold Fusion" introduced important experimental results which could not be published in ordinary venues. In the 1970s, Mandelbrot's "The Fractal Geometry of Nature" introduced the concepts of Levy flights, recursive fractals, elementary renormalization, and Haussdorf measure, and irregular geometry in general. But my favorite one, for sheer originality and profundity, is from the 1960s: Milgram's "Obedience to Authority" which introduced the public to a scientific result which didn't even have a field at the time of publication, it was

something like experimental sociology, it still doesn't have a name. This experiment was so successful and illuminating, it was banned. It probably should have instead been made compulsory.

Abstract Algebra: How does one show that a matrix has the same left and right eigenvectors if and only if it is diagonalizable?

For "only if", consider an example, the simplest non-diagonalizable matrix, the 2 by 2 matrix (0,1;0,0). It has only 0 as an eigenvalue, and only one right eigenvector (1,0) vertical. The left eigenvector is (0,1) horizontal. For a matrix to be non-diagonalizable, it must have degenerate roots of the characteristic equation, and generalizes this phenomenon among the vectors "corresponding" to this eigenvalue. Looks like homework.

Why is the Institute for Advanced Study in Princeton, New Jersey so popular among successful scientists?

No teaching load, nice academic environment, good prestige, and pretty campus.

Why do Western leaders (especially Britain and America) hate Zimbabwe leader Robert Mugabe so much? Is this justified?

Because he is a socialist. It is the same with any other leader who actually implements a socialist policy, like Chavez, someone who does not allow Western (or homegrown) corporate giants to take over the economy. Socialists who use socialism for politics, like Mandela, who do not weaken large private corporations when they are in power, are given god-like status. Whether this is justified or not depends on whether you believe the current financial system is acceptable for the indefinite future. I do not, so I think it is unjustified.

Do you agree that in many fields, scientists cannot find effective solutions to the problems that they have created, and why?

Scientists try and eventually find solutions to questions that could not even be conceived of before previous scientists expanded the thinking of humanity to allow the questions to get formulated in the first place.

How do you cite something in a book/other resource if it is not the first time that idea has appeared?

Google it, find the original source, and cite both by date. If the original source is extremely famous you don't have to cite it unless you want to, it's already classic and everyone knows about it, but if it's an obscure paper, it's only right to tell people about it.

Why should I believe facts I read?

You can trust raw experimental data, much more so than interpretations, any raw data is usually much more accurate than an inference, because there are less steps where you can make a mistake, and people are generally honest, so you can trust the reporting. But you need to know the errors in the procedure. The analysis can be time consuming, and you can trust other people's analysis only when it is openly reviewed and has not been challenged. If it is challenged, you need to recheck the analysis yourself, to save time, usually you only check at the points of dispute. It's tough, sorry, that's why there are scientists. This is what they do, usually internally, before publication. On the other hand, when people talking about anecdotal observations, there are hearsay reports, which you can't trust very well, and rumors, which are a total crapshoot. For example, a bunch of people saw shooting on the "grassy knoll". Is this evidence? The problem is that Kennedy's head snapped back, and the obvious inference for a bystander is that a shot came from that direction. But what if Kennedy's head snapped back because of a signal from his mangled brain? So it becomes difficult to say again, and this evidence by itself doesn't work to raise confidence in a second shooter. It doesn't lower confidence either, of course. So just keep the facts provisional, believe them until they are disputed, and the moment they are disputed, tag them with a Baysian confidence parameter (how much you believe them a-priori), and don't let that parameter change by hearing more and more authoritative opinions (this is difficult part), let it only change in accordance with the hard evidence presented, only counting

independent evidence as a contribution to raising confidence according to the probability of mistake, and not delude yourself using political numbers--- the number of times you hear something does not increase it's Bayesian weight. You also need to remember where the confidence came from, each piece of evidence, so you can reevaluate it when later analysis shows the evidence was misleading. It just takes a while. But, unfortuately, today, you can't trust anyone to do it honestly for you. So for an example of a difficult case, consider whether one should believe that Pons and Fleischmann saw nuclear effects. Here there are many reports of "excess heat", which are extremely difficult to deny, but extremely difficult to check for yourself, because you need to trust the laboratory. How can you acquire confidence? Replications don't help a ton, because a lot of replications failed, so maybe it was self-selection for a bad experimental practice (it wasn't). The way to acquire confidence is by looking for something that is incidental that doesn't require competence to check, in this case, it is observations of tritium. If someone discovers that heavy water tritium concentrations increase from trace amounts to less trace amounts, but well beyond any error bars, you can safely conclude that a little bit of tritium was added to the water. Tritium is not found in chemical things, and it is not made by chemistry. So an observation of tritium, if honest, is completely persuasive for nuclear effects. The method of detection is also foolproof, it looks for a blue flash of light from the beta-decay of tritium to He-3, and it is done automatically by machine, which then reports the tritium concentrations. So it requires deliberate fraud to see tritium, either deliberately adding tritium, or deliberately lying about the machine readout. Pons and Fleischmann reported tritium. This was also reported in a replication in 1989 at the Bhabha center in India, and at Bocris's lab at Texas A&M. There was a further unpublished report of excess tritium in 4/10 runs, reported by Miley, by a fellow at Los Alamos. Since 1989, many people have observed trace tritium, it is not surprising to those in the field anymore, and they don't make a big deal about it. But for an outsider looking at the mass of data, this one bit of evidence is extremely important--- here is something you can't get except by faking. So in order to be false, all these observations of tritium must be fraud. I can believe an isolated

case of fraud, but the probability of four previously reputable researchers suddenly reporting tritium fraudulently is just at next to zero, and one acquires a huge amount of confidence. Tritium is a smoking gun. When you have a real smoking gun like this (and you have to be careful, sometimes a smoking gun is not a smoking gun), you can relax a little, because then you get confidence is a few things, and this allows you to assign credibility to the folks reporting the tritum, for example. At this point, you can trust their other observations, and this is the process of flipping to be a "true believer", it's nothing more than acquiring confidence is the honesty of the folks reporting, so that you can take their reports more seriously. Because evidence is cumulative, and you acquire confidence by stages, each one building on trust from the previous stage, the process is discontinuous and produces camps of true believers and extreme skeptics. This is normal and healthy, as long as it doesn't last 20 years, just one or two at most. The process, if not contaminated by politics, is efficient. For cold fusion, there are other smoking guns, but they are even more fantastical--- the Iwamura observations of new elements in crazy ratios in deuterium diffusion through Palladium, the replications of this, the Mizuno observations of runaway heat production, Fleischmann and Pons heat after death, and Mosier-Boss and collaborators CR-39 plastic tracks. These each require gross incompetence or fraud to get wrong, and they are consistent with each other. The CR-39 results, for example, were replicated by skeptics, who made up nonsense chemistry in order to explain the results. So one can become sure. In this regard, one dishonest report is extremely serious, because it calls into question a person's integrity. But fraud is not something you should accuse people of lightly, there is always a greater chance for innocent error, or self-delusion, and you should try to find the hypothesis that minimizes the amount of deliberate fraud involved. In certain cases, for example, Rossi's Ni-H cold fusion claims, the pattern of fraud is clear and repeated, for one, using vapor and claiming steam, for another, making false claims about using the machine as a heating unit in an office. This then makes it difficult to trust anything from the Italian group associated with Rossi, because if they were honest, they would have called him out. It's really annoying

to have to use political indicators like this, but when people report results from a lab, if you aren't there, you need to know whether they were careful. In the case of Rhino horns, it's not difficult anyway. Hair is protein keratin, and Rhino horns are keratin, so people speculated that they evolved from a clump of hair. Then chemical modifcations were discovered (see here: Scientists Crack Rhino Horn Riddle) and this was less supportable. If you would have used the procedure above, "Rhino horns are made of hair" would have never been at more than 50% likelihood, since the evidence was just that they were made of keratin, and this is true, but the inference from this that the horn used to be hair never could have been persuasive, and the constant repetition in books wouldn't have increased your confidence at all.

If I want to distribute n chocolates to m friends considering each friend can get 0 to n chocolates, how many ways can I do it?

Let the number be N(n,m). The obvious recursion: N(n,1) = 1 N(n,m) = sum_(k

Which physicists have the best ratio "great discoveries or breakthroughs" over number of published papers in journal?

If prehistory is allowed, Newton and Huygens would get a good score here, but in the modern era, there's one name at the top: Sadi Carnot: One publication (not even in a journal), founded thermodynamics, then died. There's nobody else in modern times to compare,

considering the work defined entropy, adiabatic transitions, reversibility, heat engines, etc, etc, and the denominator is just about as close to zero as you can get. There are other one-hit wonders. Hugh Everett III: one published paper, one breakthrough. I thought Karl Schwarzschild was like this, because he gave his eponymous solution, then was killed in WWI, but he had a long publishing career by then. Then others with a handful of papers, because of early death were Henry Moseley: discovered atomic number, did x-ray work The prolific guys with a ratio hovering around 50% are Pauli, Einstein. Feynman liked to publish comprehensively, him too.

For which contributions is Richard Feynman most famous?

Ignoring personality, and classified bomb work (which I can't see), in more or less chronological order, and going up to eleven: 1. Feynman Hellman theorem. (~1940) 2. Feynman Wheeler theory (~194?) 3. Path integral formulation of quantum mechanics (1949) 4. The diagram method, and Feynman rules for QED (~1950) 5. The thermodynamic inequality and description of the polaron (195?) 6. The Feynman Vernon formalism for decoherence in background (195?) 7. The Feynman ground state for superfluid He4 and rotons (1953) 8. The Feynman-Gell-Mann Sudarshan-Marshak theory of left-handed neutrinos/chiral weak interactions (1956). 9. The gauge ghosts for nonabelian gauge theory at one loop order (1963). 10. The Feynman Bjorken parton model of deep inelastic scattering (1969) 11. The Feynman gauge vacuum ansatz for 2+1d gauge theory (1981) These are the highlights, the major works, they appear in the collected papers. It is important to understand that each of the contributions from 2 on is a major breakthrough, and more than half of them of them were solely due to Feynman, working alone. There are his excellent textbooks, and further work which is more speculative. This

includes ideas about miniaturization and a challenge to etch at atomic level. and ideas about quantum computation which were very influential, including the first (probably) exponential speed-up result, that a quantum computer is capable of simulating a general quantum system.

Would Witten, Hawking, Dirac, etc. still be famous physicists if they had started around now?

Witten started publishing good papers as soon as he started grad school, and he was clearly an early bloomer as a physicist--- his father was a physicist. He just was moved by the political events of his generation, and took time away from acaemic physics. He went back in the field as soon as he saw what 't Hooft was doing. The focus is never on prodigies, it is always on the results. If you have a great result, it really makes no difference who you are, it will eventually be recognized. The only problem is if it takes longer than your lifetime, like for Joel Scherk, or someone like this. These folks would do fine, if their results were kept intact. The only issue is that the politics is worse today, and their results might be dismissed as nonsense, as for example, cold fusion was dismissed. This kind of politics began in the 1980s and continued through the 90s, and 2000s. When cold fusion is accepted, then you know physics is honest again.

What criticism, skepticism, or opposition did Albert Einstein face when presenting his

theory of physics?

The main objection is the relative nature of time. In relativity, the notion of "now" is not agreed upon by all observers, so that the conception of psychological time, the kind that pushes forward into the future, is clearly divorced for the first time from the conception of scientific time. This idea required a certain comfort with Mach's positivism, Einstein was a supported of Mach for this reason. It was also why relativity was attacked, as it supported the radical positivism, against earlier idea of absolute universal time pushing forward. But "now" didn't make sense already earlier in physics, Boltzmann separated it, Mach separated it, if you think about the notion of "time pushing forward", just philosophically, the pushing forward part has no precise counterpart in physics. But this concept was attacked, because the pushing-forward nature is all that lay-people know about time, and it has nothing to do with physics at all. The technical complaints were the paradoxes: the twins paradox, which was nothing, the barn-door paradox and sliding coin paradox, which showed that poles and coins can't be rigid in relativity, and the scissor torque paradox, which showed that momentum was flow of energy and also mass. These technical objections were overcome quickly, they were all sorted out by 1907, and they led to the appreciation of the structure of the stress-energy-momentum tensor. but there were lots of them, I gave the highlights. They were hard to refute because there were lots and lots of variations on the same theme. Past this point, the theorists were ok with relativity, and the objections were largely political and mostly came from experimentalists, or the lay-public. There was a conservative German mood that theory was low-class and done by second-rate scientist, experiment was high class. The idea also was that theory was idealistic, and associated with Jews. The anti-semitic sentiment was that the Jew pollutes the down-to-Earth German with fake ideas like God, nonsense like that. Christianity was considered a terrible Jewish imposition on the Germanic tribes, and there was a move to replace it with native German stuff, like removing the Bible and replacing it with Grimm's tales. This idea was that Jews live in

Plato's realm, and Germans shouldn't do this. This made it that all theoretical physics became associated with Jews, and Einstein was the poster child. Even non-Jewish German theorists, like Heisenberg, were considered German sellouts. That nonsense ended when the war ended, and then relativity was universally accepted. It was already universally accepted within theoretical physics in 1907.

What is the algorithmic approach required to find if a number can be expressed as sum of two perfect powers. That is, given x find if there exists non negative integers a, b, m, n such that a^m + b^n = x?

The best time algorithm (in time x log x, the naive algorithms go as x^(2/n)) is to write down the characteristic function of n^n, use FFT to convolve with itself, and check to see if x is in the support. The best space algorithm is just the naive one.

Did the Big Bang actually occur?

The initial singularity is rounded off in inflation, the question here is about "Rainbow gravity", meaning that different wavelengths travel at different speeds. This idea is incompatible with the principle of relativity and the masslessness of light, so it is a radical modification that requires a violation of relativistic symmetry, much as other modifications suggested by Smolin, like doubly-special relativity.

Given what we know today, this is as crazy as a violation of rotational invariance, so it is not plausible a-priori. But this is (justified) theoretical prejudice, and ideally you want direct experimental data. There are extremely distant supernova that are observed to be variable over a few weeks. The spectra of these supernova are not separated, so we don't see a rise/fall pattern for blue light which is any different than from red light. These supernova stretch out now to many billions of light years, and seeing absolutely no spectral broadening to this distance, the model is very tightly constrained--- these events take place on a scale of days, while the distances are of order billions of years. The coincidence of wavelengths in sudden events, like type I supernovas, is stronger evidence, as these are sudden over hours. 1 hour over 1 billion years is a factor of 10^-13, and a comparison of short and long wavelengths in supernova signals can constrain this very precisely. But I presume the authors have decided to make the effect vanish at wavelengths long compared to Planck scale (I didn't read the paper). To get evidence against this, you want to go to short wavelengths in supernova observations, and then you are limited by photon count, you might not have enough photons from the event to make a measurement. But then just wait, the theory will be ruled out once there's better data. I should add that since cosmological light has been lengthening steadily in wavelength, starting very hot, there would also be constraints from blurring of the cosmological background. It is not worth wasting time ruling out the model, because it has no support. It is not a plausible model; it is a speculation with no supporting evidence. Even within the model, the beginning is still hot and small; it just claims to avoid a singularity, something which you don't need to take too seriously anyway, since inflation puts a randomizing boundary at the beginning where you don't really need to look before to match observations after.

Do you consider yourself a genius, can you make a case for your status?

I am Ron Maimon. SUPER --- GENIUS! While no further evidence is necessary, as I was A2A'd, I will make my case below. Consider: 1. Genius's irrepressible drive to explore landscapes uncharted. Yesterday, while reading Geisel's "The Cat In the Hat" to my daughter, the genius idea presented itself: perchance, should I substitute one fixed word, unchanging, for the ultimate word in each verse, what consequences would ensue? I quickly reasoned that such a substitution would preserve the rhyme, and, if monosyllabic, the meter. Of necessity, the choice must play equally comfortably both the noun and the verb role. But which word? This question vexed and puzzled. I shall let the reader ponder the mystery. I know it is humbling to try to match wits with genius, as not one in ten thousand, nay, one in a million, are capable of recapitulating the path. If the word "poop" came instantly to mind, as it did to mine, I must congratulate you. But still, I claim priority. How to relate the joy of discovery? It is hardly possible. Oh, the inspiration! I shall recite, together with my daughter's thoughful appreciations, those resulting verses which I have endeavored to commit to memory: The sun did not poop (giggle) It was too wet to poop (giggle) So we sat in the poop (giggle) All that cold, cold, wet poop (giggle, giggle) I sat there with poop (giggle) We sat there, we pooped (giggle) And I said "How I wish we had something to poop" (giggle, giggle) So all we could do was to POOP! POOP! POOP! POOP! (giggle, laugh) Et-cetera. Of course, with this one example, I could rest my case, but no, that is not all... 2. Genius createth ex-nihilo: For the mortals of lesser mind, here is an original composition in verse, with original melody, composed for aforementioned audience. The context, we are on a large ship sailing through the Mediteranean, in choppy waters, while the cabin sways: (C) I have a boat, I like (D) my boat (D) Against it's hull there strike (E) big waves. (E) The big waves make my boat (F) tilt, tilt, (F) 'til I (C) throw up. (F#) BLAAARGGGHHH. I must add that should the reader wish to perform this composition, the

hands should be placed palms down, and on "tilt tilt" should be inclined, first to the left, then to the right, to simulate, while vocalizing, the motion of the deck. In addition, the tongue should be extended at the end of the song, and the body hunched over in simulated upchucking. Yes, I should rest my case, but there's still more... 3. Genius also perseveres. For the past thirty years, I have persevered in a quest. The goal presented itself immediately in my youth: why have chitinous coverings upon the ends the digits of my forelimbs? It is most unmeet. So I began my endeavors to uproot these semi-rigid coverings away from their stumpy resting places, using the tools provided by nature expressly for this purpose, the teeth. Not content to remove the tippy-tops, as lesser ones might, undeterred by the occasional blood, and at times excruciating pain, I endeavored to peel off successive layers from the tops, so as to attack the soft underbelly. I persevered, until the nails had been halfway beaten back to their home. Alas, the project has not progressed as much as I had hoped in the last decades, the regrowth continues to mock my relentless attacks. But I shall conquer them yet, with persistence. While mindful of full victory, but expanding the mission, I have also directed attention to the various flaps of skin that surround and give comfort to the enemy, yet only with mixed success. But my efforts shall not flag, not as long as blood still courses through these fingers! That should clinch it, but I must also demonstrate my pedigree: 4. Genius breeds true: My daughter, blood of my blood, and flesh of my flesh, when presented with green vegetables, has feigned and deceived, pointing towards her belly and saying earnestly "I'm full". Yet, at the sight of a cookie, the fullness evaporates, revealing her scheming and plotting. I trust that now, I have made my case beyond any reasonable doubt. I appreciate the approbation, and I accept that, alas, it must come tinged with a certain unavoidable amount of jealousy.

Is the Higgs boson a Goldstone boson?

It would be a Goldstone boson if it were neutral, but the "eating" means that the goldstone modes become part of the heavy vector meson, they aren't independent. To understand how this happens, you can look at the page on Wikipedia for Higgs mechanism, under the section "Abelian Higgs mechanism", where the same thing is demonstrated for electromagnetism. When you have an uncharged superfluid, you have a superflow, like Helium atoms condensing. But if you have a charged superfluid, like, say, electron pairs bose-condensing, you have no superflow, the superflow becomes a part of the heavy photon inside the condensate. The explanation is simply that the superflow is described by the phase of the wavefunction, and the gradient of this is changed by a gauge transformation. So if you have a superflow in some direction, it has a kinetic energy which penalizes vector potenetial changes away from zero phase (where zero phase is defined by the phase of the condensate), because this vector potential now has kinetic energy of superflow associated to it. The relativistic analog is the Higgs mechanism In more pictorial analogy to a classical phenomenon, long-range Coulomb forces make it that sound modes in charged plasma have a finite frequency, even though they are normally massless

What's the biggest crackpot theory you've ever heard?

That the Twin Towers and WTC 7 collapsed due to fire, and not due to demolition by thermite.

What are some effective ways to frame questions for a math puzzle event?

A discrete math book or any professional math literature, opened randomly, will pose many problems in the guts which are interesting, and can be simplified for puzzle purposes. Here's one that can be simplified into lots of questions: suppose you have a tiling of space with triangles. You imagine you have a tetrahedron sitting on top of the triangles, and you want to roll it from triangle to triangle (it deforms a little to fit the new triangle, only the discrete rotation is importnat), so that no matter how you roll it, it always comes back to the same face when you return to where you started. How many obstructions do you have for this in a triangulated surface? This is a cute reformulation of a famous problem, and there are lots of simplifications that turn into puzzles, for example, on regular lattices, and restricting the motion of the tetrahedron.

Is this shot impossible?

My guess is that the bullet was badly manufactured, split in two when shot, each half went in different directions, and the ricochet that hit him was from a bullet hitting something at 100 yards or less. But I have no expertise.

Starting a new higher-level physics site: how can a critical number of good contributers be

attracted right from the start?

Make a refereeing section, devoted to individual papers, link to arxiv. Allow anyone to join, and answer, but in order to gain reputation, anyone who comes in has to negatively referee (find a mistake in) exactly one previously unrefereed recent paper by a nondeceased active person, any paper that someone else hasn't done yet, coming in. That will bring in the author of the paper, so as to respond, and this can lead to a chain reaction, as the multiplicative constant for joining is greater than or equal to 1. Plus, it's no problem for any academic, they have referee reports lying around that they don't do anything with.

How can I calculate the nature of light worldlines (timelike, null etc) in curved spacetime?

The general answer is to solve the coupled equations, and then find the null cones once you find the geometry. The light will propagate forward inside the null cone, if it is a pulse, it will mostly propagate as a pulse along the light cone, that's where the singular contribution will be, but the cone will bend in different ways locally, and the light can backscatter off the gravitational field if it is varying, and so not travel in a path at all, it will fill up the interior of the cone with gravitationally scattered light. It's complicated to explain in words, this is the content of the GR+EM theory. If you have a specific problem in mind, you might want to look at the method of characteristics or eikonal methods, that's using the optics approximation to find approximate solutions of the light propagation, which will describe how the vector potential singularity from an

infinitesimal delta-function shock moves outward, and then to correct this for the backscattering from the background or from itself to find the nonsingular part of the Green's function. But this is annoying, and for quick intuition, there is one nice nontechnical property of light beams in GR you should know which helps a lot: parallel light rays neither attract or repel. You can understand this just by boosting two masses to the speed of light keeping the total energy fixed, and seeing that the attraction vanishes in the rest frame in the limit as you approach the speed of light. This is also why two extremally charged black holes don't attract or repel, as they can be thought of as boosted to the speed of light in a Kaluza Klein dimension keeping the total energy (the total mass) fixed. This allows you to construct exact propagating solutions both for gravitational waves and electrogravitational waves. These also show you that light won't scatter itself in a parallel arrangement, and any backscattering in a spherical wave of light has to vanish as the radius gets large.

Russell pointed "Every proposition which we can understand must be composed wholly of constituents with which we are acquainted" Supposed such sentence "John likes dogs", according to his view, we can`t understand it, as `John` and `Dog` can`t be acquainted, how can we understand these sentence?

I didn't read this by Russell, but I'll reconstruct his thinking out of my ass, it's usually not hard. The particular question you ask is kind of elementary, it's just a misreading of Russell, but there are issues raised by this about what Russell means precisely, what his model of

cognition is. Russell's theory of understanding was in a context of the early 20th century development of formal logic, where the goal was first to make a formal logic for mathematics, and then to make simple formal logic counterparts to every natural utterance. What he was trying to do was to say that we produce a structure of the form Like(John,dogs), "John" and "Dogs" bound together with a predicate "Like" which takes two arguments. It's just like how Frege sought to interpret meaning. The idea is that if you know what John is, what dogs are, and what liking is as a predicate, you have extracted all the meaning from the sentence, and you're done. This works to define all mathematical concepts, so it should work for all concepts, in princple. For your specific question, it is not "John" and "Dogs" that are acquainted, but WE who are supposed to be acquainted with both, and the predicate of liking. If we are acquainted with John, that means we know who John is, and if we are acquainted with dogs, then we know what dogs are, and then we are also acquainted with the predicate "like", and we put together the sentence by attaching this pre-defined predicate that we somehow understand to the predefined concept of John and dogs. It's not deep, and it's also not a very good model. The reason it's not very good is that using this type of naive formal logical predicates relating some concepts to other concepts, the model of inference and knowledge produced by this is relatively sterile compared to human thinking. The category of "liking" is fixed in the process, as is the category of "dog" and "John", while in real life, we manage our categories as new information comes in, expanding and contracting them, and extending them to new domains. For example, if I say "John grew up on a farm, raising sheep and cattle. He loves dogs, cats, and makes efforts to feed birds", and later I say, "Joe was busy setting up heavy bear traps in the woods when John walked by", it is reasonable to a human being that at this point John will protest at the inhumane trapping method, because he is an animal person. But this is not a formal logical inference from the data, it's somehow inducted by an analogical process which expands the inferences past the formal boundary of the logical system. This process is mysterious, and is the core of what makes human cognition interesting and difficult. But this does NOT mean that formal logic is fundamentally insufficient to

describe human things! It just means it is extremely complicated to describe human things with formal structures, in the same way that it is complicated to simulate a brain. You see this the moment you try to write a computer program to try to think human, you both know that it is possible in principle, since you can simulate a human if worst comes to worst, and yet you also see that it is extremely hard, because the human cognition makes concepts which are extremely flexible and broad, and operates with much more fluid constructions based on analogical thinking, as Hofstadter has tried to describe over his long career. But I should say that whatever these fluid things are fundamentally, they ultimately always can be described by Russell style logical sentences, with definite precise predicates and so on, just that they are very complicated ones, the ones that would describe the computer program that implements whatever model of cognition you like. They would be complicated sentences about internal variables in the simulation, and they wouldn't resemble the naive statement at all. The issue that human thinking is complicated to model computationally has been used to argue against Russell style formalist ideas, but it is not a good argument, because complicated is not the same thing as impossible, and the demonstration that it is possible is through Turing universality. But it IS complicated, and it is not so useful to use simple inference engines that work to provide a foundation for mathematics to claim that every philosophical deduction should be made in the same way, as a formal deduction in an axiomatic framework, because the human mind is very complicated, and such a deduction, if it is a translation of a computer program, would be incomprehensible in structure, and much larger than the sentences that we use informally to describe the deduction.

What are the most harmful unanswerable questions?

The unanswerable questions are those that are meaningless in logical positivism, meaning that there is no way, even in principle, to determine the answer through thinking or observations. The harm in pretending to make answers for these questions is that it makes it difficult to understand logical positivism. Once you understand positivism, you can freely change coordinates between different philosophical points of view, like you change gauge in electromagnetism, and the freedom to change gauge allows you to understand the invariant things clearly. The true things don't depend on the choice of gauge. So I think all unanswerable questions are harmful, simply because you are blocked from learning positivism when you think they have a definite answer. Once you learn positivism, you can freely take any answer to those questions, and quickly switch between different answers to make sure that your understanding is gauge-invariant, that it doesn't depend on the unmeasurable questions. Then you know you got it right.

Why doesn't water tend to thicken up as it approaches its freezing point? Why doesn’t it soften as it melts? It seems to go straight from water to ice, unlike a lot of other substances.

Not a dumb question--- this is a famous historical question sometimes associated with Democritus, although this might be apocryphal. Why are phase-transitions sharp and discontinuous? Why do the properties change discontinuously at a sharply defined temperature? This is one of the most visible signs at the human scale that there are really atoms down there, the other being the simple shapes of crystals. The molecules are statistical, they are moving around, they have tendencies to stick, and tendency to unstick. In a phase transition of

the sort of water freezing, at precisely the transition temperature, the atoms can all be stuck and jittering a little bit, this is one stable state, or all be unstuck, and this is another stable state. Both are statistically stable, if you start stuck in a stuck environment, you stay stuck, if you start unstuck, you stay unstuck. But the transition from one form to another only happens at a boundary, where there is a surface with water molecules all stuck together on one side and water molecules all unstuck on the other. Away from a surface with a stuck environment, the pattern of sticking and unsticking in the water is not qualitatively different at the transition temperature--- the ice is not formed locally at all, when there is nothing around for it to form on. It is just that both statistical configurations are equally likely at this given temperature, but the alternate configuration is invisible if you are in the other bulk phase, you never see it. This means that ice is only formed stably around other ice, or around something else which can act as a seed. Water stays liquid right up until the freezing point, and a bit below too, because you need to set up a little ice seed to make the phase transition happen. It doesn't have to be an ice seed, it could be a side of the container, or a dust particle, or a bacterium, something that the ice can start growing on. Without this, you need to wait for a seed to show up from statistical fluctuations in the water, and if the temperature is only slightly less than the transition temperature, this takes forever. If you keep supercooling water below zero celcius, at some point, a seed will form statistically, and then you are likely quite a bit below, and the water will violently freeze very quickly, as the seed grows. In a discontinuous phase transition such as this, molecules stick to make the ice grow around the seed, if you take heat out, or else ice unsticks into the water. But there is no smooth transition between the two phases. In other cases, like water and vapor at the high pressures and temperatures of the critical point, the transition is second-order and smooth, so that the water can go back and forth from liquid to gas without boiling. The smooth transitions are most interesting, because at the transition point, the statistical fluctuations are very wild and fractal. This was the focus of physics in the 1970s and 1980s, this kind of phase transition was studied earlier by Onsager and Landau, but

the major breakthrough came with Widom, Kadanoff, Fisher, Wilson in the late 1960s, early 1970s.

Are we today as wrong about any scientific fact that is widely accepted as the belief that the earth was the center of the universe and the like?

I obviously can only give you a handful of examples, in the other cases where the evidence is strong, the dogma was already overturned, or else I am just as ignorant as everyone else. It's hard to find these things, but there are cases where people have already done it for you:
1. Oil is not made from dead plants. While most textbooks say oil is formed from biological residues, oil is made from methane in the mantle. At mantle pressures, methane will spontaneously make short chain hydrocarbons, and these will percolate up to the surface over geological time. This mechanism was established in the Soviet Union in the 1950s, they showed that the oil is primordial and slowly lengthens as it comes to the surface by shedding hydrogen. This theory fits the data, and biogenic theory doesn't, for a particularly clear example---contamination of oil with heavy metals and helium. The evidence is conclusive, but Westen experts didn't come around, most of them don't read Russian and most are working for commericial companies where scientific truth isn't as important as finding commercial reserves (the Soviet Union cleaned the West's clock here). Thomas Gold explained the last mystery in the abiogenic view, how the oil gets contaminated with bio-residues. This is described in his book "The Deep Hot Biosphere". There are bacteria living very far down, taking oxygen from rock! This was considered crazy when he proposed it, now methane is accepted as abiogenic even in the west, and archaea

are real. As a corrolary, there are a bunch of geological things that are also wrong: 1a. Deposits of metal are not solely through water, heavy metals are deposited by flowing methane also, and this is probably the only way heavy mantle-metal veins like Uranium, or Thorium, get implanted in rocks at all. 1b. Coal is not made from plants either, it is made from methane chemically carbonizing rock, by progressively shedding hydrogen. Peat is made from organic matter exposed to methane, and only actual kerogen (not shale oil, real kerogen, with nitrogen and oxygen in it) is bioresidue. There are many other consequences, listed in Gold's book. This is a false consensus that is being noticed today, and is getting fixed. 2. Palladium deuterium Cold fusion is a nuclear process The experiment of Pons and Fleischmann was discredited by a political process, but the experimental results they reported, anomalous heat, tritium production, occasional neutrons, were confirmed by several labs in 1989, and the number of replications has steadily increased over the decades. I don't want to repeat the content of A library of papers about cold fusion, you should review this website, and see that the Palladium-deuterium system has consistently produced nuclear effects. For a smoking gun, look at the tritum. As a corrolary, there is one thing that we might POSSIBLY be totally wrong about: 2a. All the heavy elements are not necessarily produced in supernova explosions: Since Nuclear reactions can occur in dense metal lattices, and do so more easily at higher pressures, whenever the deuterons and lattice pack together in a 1-1 ratio, if there are local environments where deuterons are present in the Earth's core, it might be transforming elements. For all we know, nuclear reactions of this sort occur naturally in the core of large planets, and are responsible for a fraction of the heat produced. If so, there is some natural elemental cooking other than supernovas. In addition, within biology, there are some dogmas that are being challenged, but as these are more recent, and with less of a consensus, so we weren't as terribly wrong. I won't go into it.

How difficult is it for an advanced mathematician to learn a new topic in math? Are all math topics related in a way that if you progress far enough, you have a basic understand of most current fields of mathematics?

The time crashes down with experience in a way that no one who doesn't do it would believe. It takes years at the age of 15, months at the age of 20, weeks at the age of 30, and sometimes a few minutes after glancing at the abstract when you are 40 (then you slap your forehead and say to yourself--- "Why didn't I think of this?"). Unfortunately, this produces a situation where the more experienced folks become averse to again spending months, weeks, or years, studying a really new subject from scratch. When something radically new come out, or if you enter a new field with no experience, really everyone is in the same boat, you need to sit and read and think and rederive, and you feel like you are 15 again.

Does each place in the universe have a current now?

There is no current "now", the concept of "now" doesn't appear in physics, it's psychology.

What would be the logistics of a manned Mars mission?

The simple way to do it is using nuclear pulse propulsion, that is, H-bombs as a rocket propellant. The plasma and x-rays of an H-bomb explosion is an incredible rocket, due to the enormous temperatures and ablation pressures, and this impulse can be concentrated and directed onto a large plate. This design is so much more efficient than other designs that there is no comparison. It's like winding up a car with a spring versus filling it with gas. There is no other way to achieve such a huge amount of thrust cheaply. The drawback to this is that the bombs will generate a certain amount of atmospheric fallout on takeoff. This is some hundreds of low-yeild atmospheric atomic explosions, and even with the cleanest designs, it will not be a negligible amount of pollution. With research, it might be possible to reduce the fallout levels, this type of research was not popular during the cold war, as small clean nuclear bombs made nuclear war more likely. I don't think this is as big a concern today. There is probably a potential for bombs that produce largely short half-life fallout of elements which are not likely to concentrate in living things. The total fallout should be less than recent accidental disasters, but it will be comparable. If you allow a government to build such a rocket, then you can just build the base on Earth, make it a ten thousand ton rocket, and blast the whole thing to Mars, then return the folks that go along on a smaller Orion rocket included in the base, that they wheel far away and blast off in. There is really none of the standard weight limitations here, the rockets are easier to engineer the bigger they get, with the important caveat that the larger the rocket the greater the total cumulative fallout on takeoff. Since this is so much cheaper than any other method (at least, any other method that fully shields the astronauts from radiation during the journey), I don't think it is good to discuss other methods. There probably are no other realistic methods, this is a difficult problem, and the number of solutions to difficult problems is usually either exactly zero or exactly one.

How many ways is a manned mission to Mars just crazy?

There is one (and only one) reasonable engineering fix for all these problems, which makes the costs managable and the project sort of trivial for any large nation. This is Ulam's nuclear pulse propulsion, that means using low-yield hydrogen bombs to push the rocket. This is the Orion design for nuclear rocket, it is extremely cheap, the fuel is some thousands of H-bombs at worst, and H-bomb warheads are not the expensive parts of a nuclear weapon, they are a few hundred thousand dollars apiece in mass production. The remainder of the rocket is easier to engineer the heavier it gets, because then you can use higher yeild bombs, more frequent detonations, and less shock-absorbers. It doesn't have fuel injectors, mixing, nozzles, or any of the normal places where rockets can malfunction, and, aside from the pusher-plate becoming radioactive during the trip, the rocket is reusable and has only one stage. It is much safer, simpler, and faster than any chemical rocket. The small Orion designs are the size of a small office building, and there is no barrier to making them ten times larger, or a hundred times larger, it only depends on how much fallout you are willing to tolerate during liftoff. With this approach, this is a managable tens of billions of dollars project, while with chemical fuel and proper shielding for the crew, it is ridiculously expensive, orders of magnitude more. The reason H-bombs are so good at pushing rockets is that the atomic explosion produces a plasma, and the particular design of the nuclear explosive you would use for a rocket makes nearly all the plasma momentum transfer directly to the pusher plate of the rocket. The hotter the exhaust, the better the propulsion, and the temperature in an H-bomb are tens of millions of degrees. This is orders of magnitude more velocity than the best chemical fuel, or even the best imaginable nuclear-reactor powered exhaust type

rocket. The cost of this is that there will be fallout, comparable with a disaster like Fukishima, produced from the takeoff. The fallout can be reduced with some research on cleaner bombs, there are lots of neutron sources and various "tamper/pusher" element combinations that can make a cleaner bomb, and perhaps one can reduce the number of radioactive isotopes produced to a managable level. In the past, this type of research made nuclear war more likely, because cleaner bombs were more likely to be used. Also, these bombs are small bombs, like tactical thermonuclear weapons, not big genocidal bombs, again, more likely to be used in war. This, and the atmospheric fallout, made the Orion project a political hot potato during the cold war, and it was cancelled despite promising designs and a dirt cheap bill. The main cause of cancellation was the test-ban treaty, which prohibited atmospheric atomic explosions. Now that the cold war is ancient history, it might be good to reexamine the design, and to add an exception to the test-ban treaty exempting peaceful nuclear explosives under a certain total cumulative fallout level. This design is really an engineering miracle for space travel, nothing else comes close, and miracles only come in sets of one. Using this design, any of the nuclear nations can very cheaply and quickly make a Mars mission of many thousands or hundreds of thousands of tons, ample for sheilding and a large crew. The trip in an Orion only lasts some weeks, the rocket can go at speeds unimaginable with chemical fuel, and unlike other nuclear rocket designs, which use a reactor, it does not make a contamination catastrophe if it crashes, it only disperses non-radioactive unexploded bombs, which can be built to be safe and unusable except inside the rocket. The politics on this has changed, and I think this design should be reconsidered. It's a great design, a rocket engineer's dream, but it is definitely not suitable for privatization. This is something that requires careful mangagement by a government, as careful as the rest of the nuclear weapons research programs. Given this, I think it is a waste of money for entrepreneurs to propose chemical rocket trips to mars. The only way such missions can succeed is by skimping on shielding, and exposing the travellers to debilitating levels of solar and cosmic ray radiation, because the trip takes forever, and chemical rockets just can't realistically lift the

concrete structures required for full shielding from cosmic rays into space, except at a cost which would bankrupt the total wealth of all the world's billionaires, and waste a bunch of carbon fuel too. In a goverment project, you can envision placing an Orion rocket in a rather high-altitude orbit, and restocking it with fuel and passengers using chemical rockets, so that the fallout doesn't damage the atmosphere. Perhaps it is also possible to engineer a space elevator ringing the equator, and transfer passengers to the rocket entirely in space. I don't know. But none of this is possible with a private project, because the best fuel is just too dangerous to allow entrepreneurs access. The competitive capital-based economic model which has been most efficient with regard to smaller projects just doesn't look like it's up to this one.

Why does Ron Maimon hate politics?

Politics is a serious problem in traditional academia. Academics are supposed to find new fruitful ideas, consider the evidence for various propositions, and decide what's right and what's not. The decision making process needs to be based on evidence, and the discussions require total honesty. In politics, it really doesn't matter whether something is true, all you care about is whether lots and lots of people are going to agree with you. When academics pick positions based on this method, counting supporters, the field quickly gets stuck in ruts. All sorts of false propositions get widely believed when the evidence is ambiguous or nonexistent, and then later, when accumulating evidence shows this belief to be false, still it can't be challenged, simply because it is now an uncontested majority opinion, and opposing a majority opinion will cost you credibility. So as not to be too abstract, I'll chose one obvious case study: abiogenic petroleum. I don't want to review the science too much, simply to state baldly that it is overwhelming evidence, and there are no points of evidence that are inconsistent with

the abiogenic theory, and no points of evidence which are consistent with the biogenic theory. I will defer for details to Thomas Gold's book "The Deep Hot Biosphere", and the Soviet-era Russian language literature which predates it. Despite the evidence, it is politically impossible to say in the US that oil is made from the mantle. There is a mountain of evidence, and it is even politically accepted within the former Soviet Union. But the politics in Western petroleum science makes it impossible to get people to just say so. It is maddening when all the objective evidence, every single bit of it, points in one direction, and yet the experts in the field stubbornly cling to a popular position, simply because opposing it is considered professional suicide. I don't care if it's professional suicide. You're an academic! Commit suicide. So you need to do some anti-politics. You need to heckle the folks, tell them they are unreasonable, to expound the objective evidence forcefully again and again, until every single person is forced to make an open, fair, independent evaluation. When this happens, for sure the correct position wins. This is a kind of politics too, and I like this kind. Academic debates only happen on the merits when the politics is level, so that there are people heckling from both sides. This way, as an academic, you can't just go with the flow, because you are uncomfortable either way. You really need to be sure. The internet is perfect for this type of anti-politics, because in journals, or in print media, there are gatekeepers, and the gatekeepers are, statistically speaking, more likely to believe the widely held opinion. In this case, all the heckling and suppression only comes from one side, from the popular side. Online, there are no gatekeepers, so that the heckling is even, and the evidence itself is the only thing that counts. So there's a simple antidote to politics online, it's a piece of cake: just explain the evidence clearly, in plain language, briefly, so that everyone can understand what's what. And then nothing more is needed, because people usually don't like to lie.

Is there any physical phenomenon that cannot be digitally simulated or expressed in terms of discrete variables and difference equations?

No.

What are some interesting, lesser known (to a newbie in mathematics) uses of the quadratic formula?

The "quadratic formula" is really a special result of a general process, called "completing the square". There are no interesting, lesser known uses of quadratic formula, but there are a ton of uses of completing the square, and natural generalizations. The idea is to shift variables to get rid of the linear part of the equation: x^2 + ax + b = 0 define y=x+c, and (y-c)^2 + a(y-c) + b =0 So that if you choose c=a/2, you get rid of the linear term in y. y^2 + b - a^2/4 = 0 and then the equation is trivial to solve, and you get the quadratic formula, by figuring out what x is supposed to be. The same method can be used to remove the next-to-leading term in any polynomial equation. So you can reduce a general cubic to a cubic of the form: x^3 = ax + b with no quadratic piece. At this point, if you say x= u + v, you find x^3 = 3uv x + u^3 + v^3 setting 3uv = a and u^3 + v^3 = b, you get a pair of equations which solve themselves, and this is the cubic formula of Tartaglia. The same method for quartic equations reduces away the cubic term, and then you can find the quartic formula by making an ansatz that the quartic factorizes into two quadratics. The coefficients of the quadratics can be found by piddling around with the resulting algebraic equations, and this is Cardano's solution of the quartic. In general, completing the square works for any quadratic forms, even in higher dimensions. So $v^T A v + 2 B^T v$ can be completed by shifting v by $A^{-1} B$. This is the foundation of the theory of Gaussian integration, and it is what you do allt he time in quantum field theory. But since there is no idea in the formula other than completing the square, there are no real uses of the formula.

How good in math was Erwin Schrodinger?

As a young person he wasn't too distinguished. But his later career was fantastic. Schrodinger solved the hydrogen atom in 1926 by the orbital method that is used today. He formulated time-independent perturbation theory, multi-particle wave quantum mechanics, and proved the equivalence of Heisenberg's formalism to his own. His methods are what you read in quantum mechanics textbooks today, so they are too familiar, and so lose their sparkle. But here is a fantastic later purely mathematical contribution. In the 1940s, Schrodinger developed a weird method of generalized raising and lowering operators, in order to give a class of exact solutions for the Schrodinger equation. The method was probably inspired by another thing Schrodinger discovered, which is that the Schrodinger equation is a diffusion equation in imaginary time. When there is a potential, the diffusion is biased as if the particle is diffusing thermodynamically in a different "potential" (this is not called the potential, it's not the same function, it's minus the log of the ground state wavefunction. It should be called the "superpotential", but for some reason, physicist call the derivative of this the superpotential. I will break with tradition and call it the superpotential.) One way to interpret the raising/lowering formalism is as stepping from one Langevin potential to a potential that could be seen as coming from reversing the sign on the superpotential. The two problems have the same eigenvalues, except to the extent that the ground state is lost (the inverted potential

has no ground state). This was a big advance in the understanding of diffusion and of quantum mechanics both, but it remained sort of distant from the mainstream. This method was rediscovered in the 1980s, when Witten formulated the supersymmetric quantum mechanics. This led to the solution of a bunch of quantum mechanics problems, the so called "shape invariant" potentials (terrible name), and then people realized that this is just the same class of problems that Schrodinger solved. There is a nice book by Junkers that explained the method, and the exact solutions, and this has become an active little subfield. But Witten's work came more than 40 years after Schrodinger understood this result! Schrodinger's work was not so formalism heavy, and his mathematics was more traditional physics stuff, wave equations and so on. But he was first rate.

What defines a brilliant philosopher?

The way in which philosophers acquire stature is through their political associations, both academic and non-academic. Choose them carefully! If your movement succeeds, you are granted the status of "great philosopher". Wittgenstein chose wisely in both halves of his career. In the early part, he aligned himself with the formal logic of Russell and logical-positivist movement of Carnap and the Vienna circle, framing all his arguments in syllogisms that superficially look like a logical deduction from premises (but are nothing of the sort). His choice of language and form in the Tractatus made it seem that nothing would be the same in philosophy, as the vapid intellectual prattle of previous centuries would now have to become vapid intellectual prattle in the guise of a formal logical deduction. This made him a star with all the politically rising philosophers of the early half of the twentieth century. In the second half of his career, he sensed that this type of formalism was going out, and switched sides. He claimed that formal languages such as those advocated by Russell and

Carnap are really doing nothing for philosophy, that the human things were impossible to formalize. If he would have said "very difficult to formalize", he would have been right. But he said "impossible to formalize", and then returned to earlier prattle style. This made him a star with all the politically rising philosophers of the second half of the twentieth century. His later stance aligned him with the anti-positivist movement ascendant in the 1960s and 1970s, and made him golden. So now he is a super-duper top thinker. Bully for him. He doesn't have any actual ideas, at least not ones that are neither obvious, vacuous, or false. For Sartre, it was simpler politics--- he aligned himself with Stalinism and communism in general, but incorporated fascist and also individualist thinking into this, so that the individual was primary, and the individual "being" of Nazi Heidegger was now a structure of the left. He also did kinky stuff with his wife, and this made him a bit of a rock star. So he got adherents both from folks who liked to wear a trenchcoat and smoke cigarettes and talk smooth at the ladies, and also from the communists, who saw in him a fellow traveller, fighting against colonial oppression, and also from the fascists who saw him as rehabilitating Heidegger. His political choices were wise, and he becomes a super great philosopher. Again, no real ideas, just stuff that is obvious, vacuous, or false. Earlier, Nietzche had a good run as the anti-communist, anti-religion guy. He ripped off Sade, except he took the villain's philosophy seriously. He gave birth to Heidegger, who hitched his fate to the Nazis, who were big fans of Nietzsche (they didn't misinterpret much). That was a bad move for Heidegger, the Nazis lost the war. But no problem, Sartre rehabilitated him by allowing his ideas to enter the left. The reason all this stuff could go back and forth between the far right and the far left is just because the whole point of Nietzche and all the rest is just rejecting the idea of God, and the communist left didn't like God any more than the Fascist right. So the philosophers were struggling to make a secular god-free philosophy, and whoever was on the side of atheism would be rescued and flopped back and forth between one extreme political position and the other. Camus, he just wrote some thoughts down. You know. Like Kierkegaard. He wasn't out for political influence, he wrote stuff, he wanted to be understood, he wasn't a politician. So he's

not deep. I haven't read Camus (I flipped through "The Stranger", but that doesn't count), but I'd bet he was deeper than Wittgenstein and Heidegger and Sartre put together. The whole process is rotten, it stinks, this is why philosophy as a field is useless and can be ignored. If you want to know who was doing something significant, this was Russell, who introduced real formal logic, and reinterpreted philosophy using this tool, and Carnap, who introduced the physicist's positivism (the positivism of Mach), and resolved the old classical questions by showing they are largely meaningless. This was a tremendous advance. Along with the development of computers and Turing universality, Godel's theorem, and modern logic, it allowed the field to get a firm foundation for the first time. The logical positivists actually made real progress on what were considered intractible questions, and for this, their reward was to be heckled and hounded for about 50 years. Enough already! The positivists solved those ancient questions, deal with it. Move on. There are lots of new questions. The issue with positivism that Wittgenstein noticed, that it is difficult to formalize a human thing, like recognizing a "Sraffa gesture", is there, it is a real difficulty, but it is surmountable. The question is equivalent to the question "can a computer recognize a Sraffa gesture?" And the answer to this is undoubtedly yes, because humans can do it, and if worst comes to worst, a computer can simulate a human and query the simulation. You can translate this computer program into a logical sentence for identifying a Sraffa gesture, but it would be as long in gigabytes as the simulation is big, which is absolutely staggeringly enormous. But in principle, this is not a limitation. The fact that things can be formalized does not mean that they are easy to formalize. The brilliant philosophers are those that resolve hard problems, and in that regard, there is no one more brilliant than Carnap, because he resolved nearly all the classical problems with his program of elimination of metaphysics. The result is relatively simple to understand, it doesn't require deep thinking, because philosophy is not a deep field. The rest of the field just tries hard to sound profound and attach itself to each successful political movement that comes along.

How does one resolve the twin paradox in a toroidal universe?

The boundaries of the torus define a rest-frame, the unique frame in which the identifications are simultaneous. It's a very good question---when the identification becomes null you are on the verge of a paradox, and if the identification sheet is spacelike, then you have a paradox, in that you can change frames to make it periodic time.

In the 21st century, will it be possible to discover new theorems in the Euclidean geometry?

Traditional Euclidean geometry was completely solved, like checkers is solved, already in the early decades of the 20th century, within Hilbert's program. Hilbert gave a correct axiomatization, and then someone else gave an algorithm for checking every statement for provability. It works because Euclidean geometry is not sufficiently complicated to make a full computer. Similar ideas worked to prove the completeness and decidability of the theory of real closed fields. So there is nothing left to do in this sense, at least not in the traditional playground of "the elements". You can decide every question using coordinate geometry and finding solutions to polynomial equations. But in a more general sense, the notions of Euclidean geometry extend to realms where there are open questions. The most interesting realm is Minkowski geometry, which obeys all of Euclid's axioms, but where circles are not closed curves, and distances are of two kinds, spacelike

and timelike. This geometry has a bunch of open questions, for one, whether you can make a decidability proof for the theorems in a proper axiomatization! This has never been studied as far as I know. Perhaps it's not so interesting. There are analogs of most geometrical constructions in Minskowski space. You could take every theorem of Euclidean geometry and make the best Minkowki analog, and that would be a project. You'll probably discover something interesting, for example, to translate Pascal's theorem to Minkowski Pascal theorem. It's cute, but I find it boring, so I never do it.

What are the benefits of an academic degree from a prestigious college or university?

For actually doing something, it's useless, as creativity doesn't care about social class, and there are good people on the faculty at all research universities. The younger academics are usually at less prestigious places, simply because they haven't made it yet. That means that the professors at fancy schools are often old folks past their prime, churning out more papers about old ideas. The class structure is stifling to science, the upper-class atmosphere is stifling for someone who wants to do something radical and new. The academic advantages at a fancy school are miniscule, if there ever were any at one point, they were entirely erased by the internet. The education is comparable to any other college, if you pay attention. The graduate courses can be good, but this depends on the individual faculty member, or visitors. Again, with an internet, it makes no difference, as you can get the papers or lectures online. The only real benefit of this type of thing is that you get a temporary passport into the higher classes. This is through schmoozing at the social clubs, and meeting people who have a high pedigree. This type of thing is less than useless for actually doing anything productive, but it is useful for maneuvering your way up a corporate heirarchy, or getting a large amount of capital under

your control. The people at the fancy schools tend to have some inner drive to achieve class status, but don't usually come with an inner drive to do something useful. These are two separate drives, and they don't go together well.

Have young people traditionally challenged religion or is that a result of new developments in science?

Young people challenged religion in the past, for a prominant example, consider Christopher Marlowe. He was a famous heretic in his teens and twenties, but later seems to have made a peace with religion. The occult movements in the modern era had mostly young-ish members, young Newton seems to have been into occult stuff, for that matter, so was the young Robert Fripp. In the 1970s, the occult business attracted a lot of young folks, possibly because traditional culture seemed to be heading towards a pointless catastrophic end. My guess is that young people feel constrained by religion. It erects voluntary barriers to free behavior, and young people see more potential in unconventional behaviors, probably nowadays mostly because they want to have more sex with fewer babies. Young people are pretty horny, and religion regulates sex drive, for pairing off couples and producing babies. Without this social pressure, frankly, I suspect we would go extinct. Having babies is hard, and doesn't give direct benefits, especially when you are young. In secular Europe, the people seem to be going extinct (Europeans, you're nice people, please don't go extinct). With time, having a family starts to look like a good thing, a stable community for raising the children starts to seem important, so this type of rebellion is self-limiting. Also, there are all sorts of rape-y sex instincts, the laws of sexual attraction tend to amplify the worst behaviors, and it's time consuming and a little depressing to be ruled

by such base motives. A less hedonistic reason is simply the conformity in religious worship, and the nonsensical beliefs. I think the more philosophical objections, the resistance to supernatural beliefs, is more justified. But there is no reason for religion to hang on to the supernatural aspects. You can explain the sensible parts of religion to people, young and old, without any supernatural baggage, and not worry so much about what they do with their genitals, so long as it doesn't hurt anyone.

I have an iterative algorithm which minimizes a given quantity at each iteration (so it eventually terminates). What is the best way to prove an upper bound on the number of iteration of the algorithm?

One pass is sufficient for this algorithm to terminate, as CA and CB don't change. So subsequent comparisons are exactly the same as in the first pass. It is a much more interesting question when CA is A and CB is B, so that as you move points the comparison set changes. In this case, you might get caught in an infinite loop.

Was tobacco considered healthy in the past?

Not in the 1930s, it was already clear then that smokers aren't so healthy, the hacking cough might have been a clue, you might think. The big problems started with the inhalable Virginia tobacco, and the

resulting cigarette industry in the 20th century. In the 19th century, smokers usually smoked pipes or cigars, where you don't usually inhale the smoke, and then the health effects are throat and mouth cancers, which are rarer. In Nazi Germany, the health ministry established a statistical link between cigarette smoking and lung cancer, but other nations didn't accept this until the 1960s, when the statistics became obvious and undeniable. So if you want to know what Hitler got right, that's it. He hated smoking for political reasons, because communists smoked, but you know what they say about a stopped clock. In the 18th and 19th century, there was no inhalable tobacco, aside from some finely powdered snuff, so lung cancer was less of an issue, and then smoking was seen as largely harmless. But even then, women were not supposed to smoke, probably because it makes you sick when you are pregnant. That was a good call. In the 1920s, there was a marketing push for smoking in women. I don't think anyone ever recommended starting smoking as a health kick, but I don't know for sure.

Is human intelligence still an evolutionary advantage?

Evolution works on the low end, by preventing people who are obviously incapacitated from reproducing. People with even mild mental retardation have the hardest time getting a date, and only get pregnant in rare cases. The class structure is not a reflection of evolutionary fitness, nor is success within a social system a great measure of intelligence. Within and across social classes, people who are healthy and have no mental deficiencies statistically have more babies by the end.

Are scientific claims infallible?

When they are true, they are infallible. When they are false, they aren't. You don't know which is which in advance, so you are given the permission to challenge anything. The ones that are true survive the challenge. The ability to challenge does not mean that it isn't true. For example, a nucleus of helium is composed of 2 neutrons and 2 protons and zero electrons. This is true. You are allowed challenge it, for example, by saying "maybe it's 4 protons and 2 electrons?" People used to think this about Helium in the 1920s, thinking "how likely is it that there would be a neutral particle with the same mass as the proton?". Likely or not likely, it's the neutron, it's real. And the reason it has nearly the same mass is Isospin near-symmetry, as understood by Heisenberg. This is now understood as the near masslessness of the up and down quark compared to the QCD scale. Each of these advances builds on the last in a way that reinforces confidence in the previous thing. With a good idea, like the neutron, as you dig deeper, it reinforces your confidence, because the later theories are mathematically precise, and fit together with new unrelated experiments, regarding subatomic particles. If you have a bad idea at the foundation, for a current example, the idea that petroleum is made from living things, the next steps are all rotten. Then you need to make all sorts of ridiculous theories about oil migration that don't work, and all sorts of stories about oil chemistry that don't add up. At some point, somebody will say "What the heck?? Is oil even made from living things?" At this point, the freedom to challenge knowledge is essential. When there is a WRONG idea. The review then shows the evidence is flimsy, actually nonexistent, and that oil is formed from the mantle. This idea sorts out all the issues, and has none of its own. But this one is true, so it won't ever be overthrown, it is "infallible". But it won't ever be given political protection by recognizing this, just in case there's a terrible mistake like the one I just pointed out. The fact that you are allowed to challenge something doesn't mean it's not true. It's through the challenging and surviving that the thing demonstrates

that it is true. The infallible things in science are not given protection from challenge, but every true thing is infallible.

If God exists, why does he expect his followers to take so much on faith?

If pi exists, why can't I know the value of the (10^10^10^10)th digit?

If God exists, why is there suffering and/or evil? Why does he allow tragedies? How does one rationalize that? If free will explains human disasters, what explains natural disasters?

God is not a magic thing that can end all suffering with the wave of a wand. God is a limiting conception of good behavior in an infinite collective, reducing suffering in the limit that social orders organize in ways that are completely ethical. The goal of the idea is to get you to act together with the collective, so that your actions make the limit get closer. If you do this, the individual identity loses meaning to a large degree, as the individual thinking is only a small part of an enormous collective thinking, with a past and a future stretching out. Your own limited existence is not so central anymore, and any personal suffering is less salient in your mind. It doesn't matter if you are suffering, so long as you are doing the right thing (more or less). The role of God is to organize human collectives so that they act as close as possible

according to what this infinitely wise, infinitely good, agent would like. Even if they do this, there will be some cancer, some accidental death, some painful genetic condition. But with time, the type of suffering will become less common, and even if it happens, it is not so important to the person whose thinking is part of a limiting thing that goes on for a long time after death. There is no problem of evil. It is just a problem of a misunderstanding of what the word "God" is intended to mean, attributing to it some supernatural agency.

Is it possible for humans to ever travel at (or near) the speed of light? If not, what is the fastest we can possibly go?

It is not realistically possible for a rocket to go faster than about 10% of the speed of light using known technology. The problem is the weight of the fuel is too large, a rocket needs to carry it's own fuel. To get to 10% of the speed of light, H-bombs are supposedly sufficient, like in an Orion rocket. If antimatter can be carried, you could get closer, but this is probably a dream, antimatter is probably going to be impossible to store. H-bombs are 3% of antimatter, and don't need special handling. The only ways to reach 99.9% of the speed of light with fusion fuel is to collect materials from interstellar medium to build more bombs, in theory, you could gravitationally slingshot around a black hole multiple times, but considering the slow speeds of black holes orbiting, you won't get much boost. If you find a nearly-collided double-black hole a few light years from the solar system, maybe it can be done. Otherwise, I think it's not likely we'll be able to make a collector anytime soon.

How were Rubik's cube algorithms developed? Do I need to know advanced mathematics in order to understand how they work?

Most of the time you make a "commutator", you do an operation, A, and you reverse the moves, Abar, then you do another operation B, and you can reverse it to Bbar, then if you do ABAbarBbar, you usually get a simple result, if A and B are not too complicated. For example, it might rotate three side pieces, or flip/rotate two corners. This is one simple way develop tricks. Once you see this, you can do a special move C to arrange the sides differently, and then do ABAbarBbar to rotate them, then undo C with Cbar to bring the cube back to where it was, except having moved the three sides you wanted to move. Using only this principle, you can quickly develop enough tricks to solve the entire class of puzzles. There is another method, using subgroups. The center subgroup is small, the double-turn subgroup is managable, and within these subgroups the commutators are usually elegant (but usually not as simple as other commutators in the big group). You also have a simple homomorphism onto a smaller group--- ignoring the sides and centers, you map the Rubik's cube into a 2 by 2 Rubik's cube, and solving the 2 by 2 puzzle is essentially solving the 3 by 3 puzzle, because there are simple commutators that solve the sides without changing the corners. There are more advanced methods developed by speed cubers, looking for an advantage. I don't know these methods, as I just use 3 home-grown commutators to solve it very slowly, in a few minutes. My father explained this principle to me, without the group theory, in the 1980s, after he bought and solved a cube. I was super-impressed with this. Mathematicians know this, it is second nature, these things are the basic operations in group theory. The Rubik's cube is an excellent introduction to group theory, for this reason, and it appears as an illustration of the subject on Wikipedia.

What/Who were you especially thankful for in 2013?

I am grateful for the work of Architects and Engineers for 9/11 Truth, in making an advertizing campaign in New York and other major cities, starting on Sept 11 2013, so as to spread the word regarding 9/11.

What are some of the best things to eat before a maths Olympiad?

Coffee and moderate physical exercise regularly, and the day before, the kind of food doesn't make much difference. It's the same as chess people preparing for a tournament.

Do all physicists suscribe to the notion that, because time is relative, what we see as past, present and future events are, in reality, events that are happening simultaneously, or "frozen" in time?

This is not a meaningful question in logical positivism, so there is no answer. What that means is that there is no experiment which can determine whether time is "all at once" or "a little bit at a time",

beyond experiments about how people experience things, and this is one of the earliest things that required logical positivism to sort out. This thing in the video is one of the things that makes positivism essential for modern physics--- if you are a positivist, you don't ask such a question, and you can freely switch between the "all at once" conception, and little bit at a time conceptions (the slicings of space time). This freedom is important. But the video describes in an accurate way the philosophical point of view Einstein used for formulating relativity, that Schwinger used for formulating quantum field theory in a relativistically invariant way, and to a certain extent, Feynman too (but Feynman in the Wheeler era was more S-matrix and more positivist), and the video is accurate in describing the philosophical thing, except that it makes your question sound more meaningful than it actually is. What can you do? The public doesn't understand positivism. Given that they don't, the description is about as good as you can do on television. "Past, present, future, equally real" is a philosophical statement, it is about "what is real", rather than about the relationship between experiments. This philosophical position is the most convenient for learning the physics of the period 1900-1957. But modern physics, since S-matrix theory was formulated in the period around 1960, has become even more abstract regarding the notion of time. The S-matrix idea moves space and time out of the fundamental description entirely, so that they become asymptotic conceptions. This is how space and time appear in string theory. So that even the slicings of space and time locally no longer make complete sense. To reconstruct a space-time, only asymptotic data on boundaries is required, and the slicings, when they do make sense, are along special light-cone coordinates, and describe what is "really" there even less intuitively than in relativity. Only the asymptotic data, the stuff defined on boundaries of the space-time, is something you can localize in time in any meaningful way. That the "flow of time" is something psychological was already understood by Boltzmann before Einstein, the flow of time is something you can't understand from physics experiments, only through psychological experiments, so it forms a sort of "qualia", or sensation, that it has nothing to do with physics, except inasmuch as the biological sensations in the mind are

completely correlated and understandable through the physical activity in the brain. I think that given the philosophical naivete out there right now, the dismissal of positivism, it is better to go overboard as this video does, and claim this is objectively meaningful, than to not present the physical idea properly.

How good in math was Werner Heisenberg?

Heisenberg's development of Matrix Mechanics is so technically difficult to follow in the original, that into the 1960s and 1970s, great physicists would scratch their heads to understand exactly what he was doing. This despite the fact that they already knew quantum mechanics! There is a quick simplified walk-through on Matrix Mechanics on Wikipedia, which omits the difficult dispersion relations that Heisenberg actually used in the paper (these Kramers-Heisenberg relations motivated the derivation of the on-diagonal commutation relation), the Wikipedia article substitutes a more conceptual Dirac idea for what Heisenberg actually did, which was a differentiation with respect to an integer parameter (the matrix index). But the spirit is the same, and you will get a sense of what a tour-de-force this was. The great talent of Heisenberg was to be able to find his way in cases where the mathematics was indeterminate, like extracting the correct relations in the more complete quantum theory from the primitive relations in the old quantum theory. The answer isn't uniquely determined, except, that up to common sense, it is, so you just barely can do it. And still, Heisenberg did it. There is nothing like this, it was one of the greatest ever intellectual feats of the human mind, and physicists were so honest in 1925, that despite the fact that only about five people understood him (Kramers, Jordan, Bethe, Pauli, Bohr), he was still recognized for this achievement, at the age of 22. His other contributions were to develop various early quantum field theories, and (independently) the Kolmogorov theory of turbulence, extending

it to correlation function relations (this he did while imprisoned after the war). But I don't think mathematicians care about such things, because these are physical results, not cases where you produce a logical outcome from definite deductions. It's the physicist kind of mathematical thinking, and in Heisenberg's case, he used it to do pure magic.

How good in math was Hans Bethe?

His Nobel prize was for the CNO cycle, and the elucidation of energy production in stars, something which was the main focus of his research in nuclear physics, and closely related to his bomb work. But this stuff, which calculation heavy, and which teaches you most about our universe, is not a conceptual mathematical breakthrough. That's not what physicists are usually after, if it happens, it's a side effect. In my opinion, his greatest unique conceptual mathematical breakthrough has to be the Bethe Ansatz, around 1930. This inspiration for the method is something extremely intuitive, collision theory in two dimensions, the property you notice that conservation of energy and momentum in 2d requires particles to either keep their momentum or swap their momentum. But this simple observation allows you to solve the complete energy eigenstates and S-matrix for many interacting quantum fields in 2d. This is something you would hardly guess is possible. Zamolodchikov and others extended the ideas to give similar solutions for many other 2d theories in the 1980s and 1990s. Bethe invented the method to apply it to the Heisenberg model of a 1d quantum spin-chain. The solution is similar in elegance to the more celebrated (and equally beautiful) Onsager solution in 1941, but it's technically completely different and in my opinion more difficult, because the Ising model maps to a free Fermionic system, while Bethe actually solved interacting nonlinear systems. The only competing mathematically exact methods in 2d are due to Belavin Polyakov

Zamolodchikov, and came many years later. These are related, but are conceptually completely different--- Bethe's methods are not limited to massless theories, while the BPZ stuff classifies conformal (massless) theories by nature. The Bethe Ansatz not only began the field of 2d quantum field theory, a field which became extremely important as a source of examples, and also as physics when string theory came around, it also allowed you for the first time to see by example that quantum fields could be completely consistent.

Scientists: How good in math was Wolfgang Pauli?

Pauli was very technically gifted, one of his tours-de-force was solving the Hydrogen atom in 1925(!), before Schrodinger, as an exercize to learn Matrix Mechanics. In addition, he and Fierz completed a program of complete classification of wave-equations (irreducible non-interacting particle representations of the Poincare group), and he made many solid contributions in formal things into the 1950s, right up to his untimely death. Pauli, like all the rest, was a physicist, and didn't spend time proving theorems, as much as calculating effects and understanding what is true (this is different activity from proof, which requires a formal trickery to get around limitations of proof-methods--- we can usually figure out what is true long before we can prove it)

What are the pros and cons of recreational marijuana use?

Pros: not much. Sometimes it helps you concentrate on music, or enhance slight synesthesias, or make sex a little more intense. Regular meditation does better at all these things, and meditation has no side effects. Cons: You won't be able to do mathematics or precise thinking anymore, any long, difficult, structural construction requiring patience (rather than spontaneity) will be difficult or impossible, so forget about composing a symphony, or writing a novel, at least not a good one, and you start to be susceptible to all sorts of social phony consensus thinking, because precise thinking is your only defense against this and marijuana will take it away. There is no long term brain damage, you'll be back to normal if you stop, in a week or two at worst. Surprisingly, considering the smoke, there is no major lung cancer concern, but perhaps some throat cancer risk. The major con is just this effect on cognition that is very deleterious and ruins people's ability to think straight. In my opinion, this is a terrible thing to do to yourself. Your brain's ability to do cumulative precision thinking is very valuable.

How long does it take for the short term effect of cannabinoids to wear off?

You won't be high after a few hours, but the residues don't leave your system completely for about 3-5 days for a light dose. You will be slightly different, not high, but a little confused, unable to do detailed calculations, vivid dreams, things like that, I find it extremely debilitating. Once they're gone, you're back to normal, so don't despair.

What are the best science channels on YouTube for the interested layman?

Video is not a great medium for science, because you sometimes need to read quickly, to skim what you already know, and sometimes to read and reread, to learn something new. Text is superior. The exception is for special simulations or visualizations, which you can find on you tube, but it's better to download the movies individually after reading the text. There's a nice visualization of sphere eversion on you-tube, a few good lectures by Susskind and so on, but I still think the medium is no good in general. It is also full of false science which is impossible to rebut, because the comments are broken.

What are some interesting nontrivial integrals?

Find the curve which describes the shape made by the venetian blinds, when you pull one slat down near the edge. It's a curve described by an elementary integral in the infinitely dense slat limit. The answer is an algebraic plus a trigonometric function in a strange combination, like the integral for the area of a circle, but it is a different unrelated integral.

Marx's view on Social Injustice?

He didn't like it.

Would the arguments in favour of the existence of a firewall right behind the event horizon of a black hole apply in case of the Unruh horizon observed by an accelerating observer?

It doesn't apply in this case, because you need to consider the formation and evaporation process, and work out the entanglements between the early radiation (emitted when the hole is big and young) and late radiation (emitted when the black hole is small and about to explode). It is this that gives the paradox--- measuring the early radiation seems to determine the late radiation state. In the case of Unruh black-walls (the Rindler horizon), there is no late and early radiation, at least not in any obvious way. You can't measure the radiation well at all, because if you go to infinity, in Rindler coordinates, your acceleration slows down and the radiation redshifts to oblivion. So you can't determine the early radiation state and then find the late radiation, because there is no early or late. But the same is probably true in the black hole case--- the separation of early and late is rough, and by localizing the radiation in time to complete the measurement of early radiation state to enough precision to find the late radiation state, you have probably wrecked the coherence between the two. The only measurements you can do are on the total S-matrix for the formation and evaporation of the black hole, and you can't separate the radiation into two parts, and conclude anything about any semiclassical black hole state. At least, the original Polchinski et al paper didn't provide arguments for this separation, it's just something that is assumed in other papers on black hole complementarity and the Page time. Since I think the whole thing is a mistake, it is only clarifying the degree to which black hole evaporation is an S-matrix

thing, and you can't separate late and early times, I don't spend any time worrying about it. So perhaps someone who is more concerned about this issue would answer differently.

Are electric cigarettes better than regular cigarettes?

They don't give you cancer, and they don't make you lose your lung function. They turn nicotine into a drug like caffeine, a largely harmless (but dehydrating) stimulant.

Optics: How does a prism affect white light?

The light is refracted, it changes the angle it is travelling according to the angle of the surface by Snell's law. The index of refraction is continuously different for different wavelengths, so this separates out the wavelengths into a rainbow.

Does it really matter if I have messed up non-Computer Science courses in college?

It makes no difference, unless they are technical courses, but take as few non-technical classes as possible. The academic disciplines which don't have an objective measure of success are dominated by academic

politics, and have very little in the way of knowledge to transmit. But it's good to know how to read, and be a decent human being, and so on, but you don't need to take a course on Heidegger.

Cell Biology: How can a human's immune system fight off a virus and keep the human alive?

There are two mechanisms here, both not fully understood. One is innate immunity, the ability of cells to sense they are infected wth a virus and warn their neighbors. They do this through the interferon system, an inflammation response transmitted from cell to cell, and when cells detect interferon in the environment, they get ready for infection, and they shut down many systems which viruses can hijack to survive, and they also secrete more interferon to warn other cells. This allows the body to gain time, because each infected cell warns its neighbors, the most likely target for the daughter particles. It is not clear to what extent this type of immunity is adaptive, and to what extent it is "innate", as the name implied. It works through the Rig-I system and related proteins, which (probably) identify double stranded cytosolic RNA or foreign RNA, and then cascade to the nucleus, where they activate certain genes and trigger a refractory state, which lasts for a long time, at least a day or two. The genes activated by Interferon are classified and known today, and their interactions with other cellular networks can be inferred relatively cleanly through classical systems biology method. I am personally curious whether the double stranded viral RNA is used for more than triggering the interferon response, one can make a wild speculation that it might be also used to make a template to detect other RNA of this type. There's no evidence for this. The other mechanism is acquired immunity. Ultimately in the acquired immunity system the

white blood cells learn to identify the virus with antibodies and break it up whenever it is in the blood or lymph, or anywhere in the intracellular spaces of the body. Once the probability of a virus meeting an acquired-immunity antibody-carrying white blood cell is greater than it's probability of meeting a susceptible cell, the virus can no longer replicate productively. This system doesn't work so well when it is the acquired immunity cells, the T-cells that are the target, as happens in HIV. But most of the time, if you get the flu, you recover and have antibodies that make you immune to this strain in the future.

How can I solve problem number 160 at Project Euler?

Remove all factors of 2 and 5 from each of the numbers in the product successively, and reduce then multiply modulo 10,000. Keep track of the powers of 2 and 5 though, separately, each pair of these is a 10, so every time you get some fives, subtract 1 from the number of 2's. At the end, you will have a number of 2's left over, and raise these to the appropriate power mod 10,000, and multiply by the other answer, the one for the 2-free 5-free part, mod 10,000. You can get more sophisticated, by counting the number of 2's and 5's in advance, also by cancelling numbers that are reciprocals mod 10,000, but you don't need to, this is sufficient to get the answer.

How many 4 × 4 matrices with entries from {0, 1} have odd determinant?

This is the size of the group of invertible transformations on a 4 dimensional vector space over Z/2. If you calculate the determinant in Z/2, it is nonzero when the matrix is invertible in Z/2, so the determinant has residue 1 mod 2, that is, it's odd. Each matrix is a basis rotation, so this is the number of bases (in order) on a four dimensional space of Z/2, so you pick a nonzero vector, there are 16 vectors, only one is zero, that's 15 choices. Pick a second nonzero vector orthogonal to this, that's 7 choices (it's the three dimensional problem), and a third orthogonal to both 3 choices (the two dimensional problem), and the fourth is uniquely determined. This makes 315 matrices in all. No No No! Not a rotation--- these are just linearly independent. The first is from 16-1, the second from 16-2, the third from 16-4, the last from 16-8, I will delete this answer.

Is the concept of information a fundamental aspect of nature?

I wrote an answer on stackexchange here: How do you prove $S=-\sum p\ln p$? The relation to physics is that the entropy is the information required to fully specify the microscopic state of a physical system. This is the relation, it is only vaguely related to models of the large-scale universe, because these are described using gross variables only, and the entropy is infinitesimal compared to the entropy in the atoms.

Why would crashing planes AND controlled demolitions BOTH be necessary to collapse the World Trade Center during 9/11?

The demolition was necessary to destroy the evidence of the crash, otherwise investigation might reveal they were drones, not airliners.

What is an intuitive explanation of the Metropolis-Hastings algorithm?

You want the detailed balance condition to hold, this is the condition that P(A) K(A->B) = P(B) K(B->A) Where P is the probability distribution you want to get as your stationary distribution, and K is the transition amplitudes, and A and B are two states of the system. To understand this, see here: What is an intuitive explanation of the reversibility condition (aka detailed balance) in a Markov chain? . You know P(A) and P(B). Let's say P(A) is bigger. Then you choose K(B->A)=1, and you choose K(A->B) = P(B)/P(A), and it works. This works no matter how you pick the pairs of states, so long as you pick the transitions in whatever way, and make sure that when you pick it, the reverse transition is less likely by the ratio P(B)/P(A) as compared to the forward transition. I added this answer because the other answer is unnecessarily formal for such a simple thing.

What is an intuitive explanation of the reversibility condition (aka detailed balance) in a Markov chain?

In physics, this is called detailed balance--- it's the law that in equilibrium, each two states of the system come to equilibrium due to their transitions separately from the rest of the system, because there

can be no conspiracy among all the states to maintain equilibrium. The reason it is true is because you will maintain equilibrium between two states even if you artificially perturb the system to get rid of all but two of the states, by suddenly making all the other states have infinite energy, but keeping the transitions between the two states unaltered. If this is violated, then equilibrium is only maintained through a weird flow of probability around cycles, and this is inconsistent with modifications of the system which cut off the cycle, and these perturbations could then be used to violate the second law of thermodynamics. This states that the total flow of probability from state A to state B is matched to the flow of probability from state B to state A, when both have the equilibrium probability, for each pair of states, without regard to the rest of the system. In equations P(A) K(A->B) = P(B) K(B->A), this is the reversing condition. Einstein used the principle of detailed balance extensively for inferring quantum statistics, in the A/B coefficients. But it's older, it dates back to the 19th century. Then, people used this law to relate the emissivity and absorptivity of a blackbody.

Is Ron Maimon related to Gaby Maimon (Assistant Profressor at the Rockefeller University)?

He's my younger brother. He's also the person who teaches me new biology nowadays, and his research makes me jealous. But not too much, because he's an experimentalist.

Would Jesse Ventura be a good choice for President?

He's a 9/11 truther, so obviously yes. He has experience with government, and although some of his policies are strange, he is honest, and he supports individual freedoms. He has made a point of exposing the outrageous degree of CIA meddling in local and state government, and has essentially vowed to end it, to make the CIA an intelligence gathering foreign service again, not a replacement secret police. For this alone, I would vote for him, even if he also wanted to outlaw Dvorak keyboards.

Genomics: Have we identified all of the 20,000 to 25,000 genes in human DNA?

We've sequenced them, and most of them have names, but there are some gene-like sequences that look like genes, like endoretroviruses, and you don't know if they are expressed under certain rare conditions, because they need a context for expression. It's hard to determine whether a gene-like segment is expressed, especially if it is at low copy numbers, the best way is to look at poly-A selected mRNA, and then sequence this. The fragments so far indicate we have the major genes identified fully, these are the ones that reliably show up in poly-A RNAseq.

Can the universe be described with a single equation?

My favorite method is Feynman's--- take every equation of physics, say, Gauss's law, and define the "unworldliness" to be the square of the difference of the two sides. Then the universal physics equation is that the total unworldliness is zero.

What is wrong with teenagers nowadays?

They are not sufficiently rebellious, they do not do any of the things you say, the things people did when I was a teenager, instead they obey society, listen to their elders and repeat stupid government propaganda.

If 9/11 was a conspiracy, then wouldn't detecting it make it a "failed conspiracy?"

It depends on how long it takes. JFK's assassination was obviously a conspiracy already in the 1960s, but the public didn't catch on until the mid 1970s, and despite a Congressional acknowledgement of a conspiracy in 1978, a pretty clear understanding of how it worked by the 1990s, the issue is again taboo in the media, due to the shadow of 9/11. These operations only work because you have a gullible public and a corporate media. They can't work online, where everyone is free to comment, because you can't influence a small group ot change online discussions. At best you can have a few shills, that's not so

effective, because their message is repetitive and grating, and their arguments are insincere, and don't persuade. It is next to impossible to make a perfect conspiracy of the type you want. The closest you come is in a poiice state, like Hitler's germany, where the trumped up pretext for the Poland war, that Polish soldiers shot at a military base, can be repeated and repeated without anyone else able to respond. The US came dangerously close to this in the 2000s.

How much information is conveyed by the assignment of a truth value to the unprovable statements from Godel's incompleteness theorems, within the context of Peano's axioms?

The Godel statement is true, and if you make as an axiom that it is false, you get a system that is no stronger than Peano Arithmetic, and also proves some nonsense in addition. That's an example of an "omega inconsistent" system. The proof of Godel's theorem: you have an axiomatic system S. Write a program GODEL to do the following: 1. print it's code into a variable R 2. Do all deductions in S. 3. if "R does not halt" is deduced, halt. Then "GODEL does not halt" is unprovable, and equivalent to the consistency of Peano Arithmetic. It's also true, because Peano Arithmetic is consistent. So you add this axiom, and you learn that this program doesn't halt. Consider the program CHECKER(N) 1. CHECKER runs Godel for N computational steps. 2. If Godel halts at any point, it says "yes, halted" 3. if CHECKER terminates, it says "no". The theorem "CHECKER says no" is not provable in PA for all N, but since it is a finite computation, you can prove it for any given value of N in Peano Arithemtic. If you feed checker any computable function, and run for

F(N) steps, you see that the proof of "CHECKER says no" can become longer than F(N) deduction steps in PA, but assuming "consis PA" it's an immediate deduction from the fact that "forall N, CHECKER says no", which is a theorem, because you can prove "GODEL does not halt". This is the Godel speedup theorem, and the main construction in the proof. So you speed up the proof of certain theorems by enormous amounts--- the proof of the N statement in Peano Arithmetic grows linearly with N. This means that the information conveyed is qualitative, it can't really be expressed by a good measure. The stepping up process, where you keep assuming the previous system is consistent, will prove that any non-halting program doesn't halt, as you approach the Church-Kleene ordinal with your iterations. This is the purpose of ordinals and set theory, to go up the tower of Godel reflections. This is demonstrated by Turing in his 1938 thesis, but people seem to have not read that one. It's back in print now.

How solid is the evidence for the Big Bang theory as compared to other competing theories?

The evidence for Big Bang today is essentially dead certain, it's expansion, microwave background, Big Bang Nucleosynthesis, and structure evolution. All of these are a dead match to experiment in the modern model, with a handful of parameters. The expansion is a particular functional form of the velocities, which qualitatively gives the model, and fits the parameters. The microwave background temperature is an independent predicted parameter. The Big-Bang nucleosynthesis is a dozen crazy numbers, spanning four orders of magnitude (or more) that are precisely predicted by the theory. These by themselves are enough for much more than certainty, from the BBN predictions, you can get 30 sigma evidence, or more, that's

certainty about certainty about certainty about certainty about certainty. But the microwave background fluctuations, together with inflation, is essentially infinity sigma, because there are thousands of data points, all consistent with a hot Big Bang and inflation, and fitting the cosmological constant and dark matter, which are then consistent with structure formation and dark matter weak-lensing surverys. This is so much data, it's not possible to sanely dispute anymore, it's a fact, like atoms, or quantum mechanics.

How can we measure the amount of information contained in a set of logical assumptions?

By writing them down formally and compressing them as much as you can. This is Kolmogorov complexity, it's provably next to impossible to compute exactly, but you can get easy upper bounds that should work for practical things, if you need to do something practical.

What is Ron Maimon's MBTI?

I can't answer, because while I think I am extroverted, because i talk a lot, from the definition, I am talking about things I find interesting in my internal world. Simiarly for "sensing' or "intuition", I can't tell, because if the intuition is faulty, I need to change it, but sure there is intuition, and there are senses. I can't answer "judging or percieving", and I can't answer "thinking vs feeling", because they are intertwined. So my type is ????. I gain no information from the test.

If Lee Harvey Oswald is removed as having shot President Kennedy, how does the remainder of the conspiracy "hold up?"

As far as I know, the standard alternative story does not involve Oswald at all--- his rifle was either borrowed or stolen from his house and placed in the book depository where he worked. He just got lunch on that day when Kennedy was shot, and had no idea what was going on until he was arrested, as Oswald said when he was picked up. He was chosen because he was a good agent who fit the model for a suspect, he distributed communist literature, went to the Soviet Union in 1960 and pretended to defect by offering information, and so he could be painted to be a communist, although he wasn't a communist at all, he was a right-winger. He was also a CIA agent, as was every other defector to the Soviet Union in the 1960s. You can see this because he was allowed back to the US after renouncing his citizenship with no hassle and no paperwork. He also had agency contacts which were traced by the JFK conspiracy folks. The folks who actually did the shooting were three people, one of whom was likely Roscoe White, at the picket fence, another unidentified fellow on the roof of an adjacent building, and a third fellow identified (but I forgot his name) closely associated with Lyndon Johnson, who was shooting at the book depository (his fingerprint was found on a box at the book depository, and identified decades later--- you can find the analysis online). The only role for Lee Harvey Oswald was to be the patsy. This story was pieced together over many years, and largely complete by the 1990s, when the movie JFK came out and popularized the subject. Oswald has not been considered to have played any part in the conspiracy, other than lending a rifle to one of the participants, by any of the serious people who investigated this, as far as I know.

Where were the explosives in other buildings on 9/11?

The Capitol wasn't targeted, flight 93 was shot down, it wasn't going anywhere. The only targets were the ones that were actually hit. No explosives were needed at the Pentagon, it wasn't demolished, I don't understand the point of this question. The explosives and explosive residues were identified in the 9/11 dust chemically, by Jones. It was a form of thermite. Thermite residues were found in large quantities in all the dust sampled. Melted iron microspheres were found by all analysts (this doesn't require chemistry), including official analysis people. These stupid spheres cannot be explained without a heat source sufficient to melt steel into droplets, and thermite reisdues are impossible without thermite. The explosives themselves were found---the Jones group found uncombusted thermite in the dust too. For building 7, it was a straight up demolition. There is nothing to establish, because there is no alternative idea for why it came down, not even the incompetent boobs at NIST could fudge that one.

How does the thinking or talent of a top 99.999% percentile math person differ from a 99% percentile math person?

I am answering not because I am a great mathematician, but because I have read some of them, and I like their work. The difference in higher mathematics is in internalizing proof methods which are generally useless for anything except proving things rigorously. This is

a very different activity than internalizing technical skills, it's much more of an art. You have to deeply understand the previous proofs using the techniques, what their limits are, and how to exceed them. You also have to understand why mathematical things are true from their proof. It's an intuition that internalizes the deep methods and makes them obvious, so you don't have to repeat the deduction steps whenever you use them. It is also a kind of mental agility at packing and unpacking proofs into deeper levels of detail. It's very hard to explain, it's like the designer knowing which design elements will really click, it's an art form, but very constrained by logic. There is nothing like it, and the only proper explanation is to read a great mathematician's work in the original. The level of innateness is like other great art, I would say close to zero. It's not Picasso's brush handling skills that made his paintings great, it's the style, the imagination, the evolved exploration, the individuality. The same holds for a great proof. It's so individual and unique, that it looks like magic that comes from a genetic mutation, but of course it isn't, because it doesn't run in families at all.

Why don't the majority of structural engineers agree with the findings of the 9/11 conspiracy movement?

Because they are either incompetent or afraid, and in either case they should be sacked.

Does there exist a one-to-one function that maps an uncountable set to another uncountable set, like from (0,1) to R? If quantum computer can be invented, is it possible to enumerate all elements in (0,1)?

sure, map (0,1) to (-pi/2,pi/2) by x to pi(x- .5), and map (-pi/2,pi/2) to R by arctan (draw any function that goes -infinity at 0 to infinity at 1). Quantum computation can't exceed classical computation, because quantum mechanics can be simulated on a classical computer, only very very slowly.

How can we rigorously prove that if a plane figure of any shape is zoomed such that its perimeter becomes n times, then its area becomes n^2 times, or its general extension (for example, if the surface area of a solid becomes n times, its volume becomes n^(3/2) times)?

It's true for a box, and in any definition, area, length and volume comes from limits or sups/infs of the result for boxes.

What would have happened if Einstein and Nikola Tesla worked together?

Maybe it would be similar to the Einstein-Szilard refrigerator, or the Einstein-deHaas experiment--- those are major breakthrough Einstein collaborations with down-to-earth people who worked on practical stuff. Einstein was into this type of thing, "Einstein had his head in the sky and his feet on the ground" as Feynman used to say. But Tesla was a generation earlier, and Tesla wasn't into Einstein's stuff, pure mathematical theory.

Is the invariant interval in special relativity the only quadratic form pertaining to a spacetime interval that is preserved by Lorentz transformations? If so, why? If not, what other Lorentz invariant quadratic forms are there?

Yes, by definition. The Lorentz group is the transformations that preserve this form! The reason quadratic forms are singled out is because they have continuously parametrized groups of transformations at all. If you ask what group of transformations preserve another kind of expression, like a quartic form, it's a discrete group at best. This is clearest from the classification of continuous groups, all of which are subroups of SO(n) for some large n, in the case they are compact. But it's really also the reason Euclid and so on were able to prove the pythagorean theorem from general principles--- in order for there to be a continuous rotation symmetry, the metric has to be a pythagorean metric, a quadratic form. The Lorentz group is

not compact, but by analogy with compact groups, you only expect a continuous family of symmetries for a quadratic form.

What is the best way to read technical books?

You have to realize that it's not a huge amount of information. The information was produced from the head of an author. You have a pen and paper, and you try to reproduce the results, you read in detail where the stuff gets messy and you couldn't come up with it. The coming up with it is the most important, because eventually you'll be able to come up with 90% of the book yourself, and you are reading quickly, looking for the missing 10%. That missing 10% is the author's crucial insight.

Is it a special feature of Peano axioms that Godel can prove incompleteness from them?

They can state theorems about general computer programs, they can describe general purpose computation. The property you need from an axiom system is that it can state "computer program X does not halt" for general programs. Then the proof of Godel's theorem is to write a program that looks for a proof of "I do not halt", and halts when it finds it. The precise prescription: 1. print code into variable R 2. deduce all consequences of the system 3. if you find "R does not halt", halt. Then the system cannot prove that this program doesn't halt. That's the complete proof. The assumptions are obvious from analyzing it. The key idea is the idea of computation.

Why do 60% of theoretical physicists believe in the many-worlds theory? Is this statistic accurate?

Physicists are largely well educated in positivism, and the ideas of many-worlds are nearly identical to Copenhagen once you accept positivism--- it is the observations that define what the words mean, not the ideas that are produced in your head. So it doesn't matter if many-worlds sounds "out there" and Copenhagen sounds stodgy, they are talking about what amounts to the same thing. But many-worlds is a cleaner and more complete explanation of how Copenhagen works in detail, it motivates quantum computation and decoherence more clearly, and both of these things make interesting physics. So many-worlds makes it easier to understand quantum mechanics, and before you are fully positivist, it is useful pedagogically, so that you don't worry about philosophy. It's a quick and dirty explanations of what is going on, without any philosophy. The statistics on this are meaningless, because of the positivism. If you ask me "Which interpretation: Many worlds, Copenhagen, Many minds, Ensemble, quantum logic, Consciousness causes collapse, Shut-up and calculate, Decoherence, Consistent Histories?" I would say "they're all the same". The only real alternatives are ones like objective collapse (which makes experimental predictions that are likely to be false), and de-Broglie Bohm (which does something interesting and different). Even Bohm by itself is not that interesting, because it reproduces quantum mechanics' statistics exactly. The main issue now, after quantum computation, is whether quantum mechanics is exact. We'll know when a quantum computer works, or fails to work in factoring an enormous number, like with 10,000 digits. It is really not clear whether this will work, because such a delicate super-entangled state has never been set up and tested. There is a theoretical principle here

which is violated, namely that the universe should have the same power as a classical computer of a size which grows polynomially as a measure of the size. To simulate exact quantum mechanics, your computer grows exponentially. If you want to keep this theoretical principle, then the most interesting possibility is that quantum mechanics is an approximation to a more classical probabilistic theory underneath. If this idea were to work, it would make predictions, since a realistic size classical system is not enormous. This is where one can make progress, not on these old philosophical debates. But if quantum mechanics turns out to be exact, many-worlds is a fine philosophy, and it is nice if it became the standard interpretation. But Copehagen is fine too, because it is equivalent, up to positivism.

What would happen if you recklessly applied the 80/20 principle to absolutely everything?

You would think 80% of string theory was discovered by 20% of physicists, when it was really 99.9% of string theory was discovered by .1% of physicists. The rule becomes inapplicable when talking about real innovation, where it's a handful of people doing all the work and everyone else just heckling on the sidelines.

What do you think of Noam Chomsky's views on the U.S.A's foreign policy?

Chomsky is pretty good at putting together the motivations of a system, the collective entity formed from many individual actors, but

it seems that in his early career, he assumed that people in the system were more clued in to these motivations than they actually were. Later on, with "Manfacturing Consent", he is clear he is talking on the system level, and the people involved are largely clueless about any grand plan, and do things through self-interest webs, not through any conscious awareness of what direction they are taking. This perspective, if I remember Chomsky correctly, was due to the release of documents that revealed what people were saying internally in debates over the Vietnam war and other things in the 1960s. The documents show that the politicians were generally saying more or less what they were thinking in public, that there wasn't a huge hidden agenda, despite the coordinated agenda that can be inferred from the actions. So Chomsky became very hostile to the idea that there is any type of planning, or conspiratorial coordination, in world events. I agree with him in general, but he uses this insight to dismiss 9/11 Truth also. 9/11 is the exception to this rule, as was the assassination of Kennedy earlier--- Kennedy's assassination was the major event that allowed the Vietnam war to escalate. These events were triggers for a change in public policy, and both of these were operations carried out by a small number of people, by little conspiracies, JFK probably was a larger conspiracy, if you count fully clued in people, than 9/11 was. These transformative events then set the tone for the system-level shifts. I personally find I agree with Chomsky most of the time, at least when he is talking about politics and not linguistics. I think he sold out a bit in linguistics, by abandoning his original program for stack-grammars, and he also refused to accept that linguistic recursion is a post-writing invention. The original Chomsky Schutzenberger program of describing natural language with a stack grammar is very important, even if it ends up being a property of idealized written language, not of spoken tribal language.

How do I determine who is doing cutting-edge research?

I don't think there is any social shortcut, you have to know the field very, very well. It requires reading the original literature and understanding it, because social indicators only go so far--- they will tell you about work that is already recognized, and if something has a great deal of potential, there will be people making propaganda both for it and against it, and only the dry scientific work will have any objectivity. Usually cutting edge stuff gets publicity, even Mendel was a little bit known in 1870. For renewable energy, you have to be very careful, because there is a lot of money in energy, and a lot of potential for dishonesty and wishful thinking. Here, though, it's physics, and the science is most objective, so as long as you have a good physics education, it's hard to be fooled. I start by reading a random sampling of non-redundant research papers in the field, then, because time is scarce, find the most original ones. These usually either have a lot of papers citing them (so they gave a lot of people a lot of ideas), or they don't, but reading them gives me, personally, a lot of ideas that nobody followed up on. This is a nebulous criterion,, but I don't know a better method. Random hopping gives a better view of the field than an orderly scan, or a formal education in the field, because randomness doesn't obey political rules.

How could explosives have been planted at the WTC towers to trigger the collapse on 9/11/01?

During the extensive elevator renovations, over the three months prior to the events, when vans came in to do mysterious stuff at night. This is not at all an issue, it wasn't particulary difficult to do. Regarding the

question, the evidence for explosive demolition was certain from the day of the collapse, and it is just ridiculous to claim that the towers collapsed gravitationally, it is a testiment to human ignorance that the media can deny this.

Why don't physicists learn more from statistics departments?

Because statisticians are anti-Bayesian, and physicists are all Bayesians, like all people who do practical science. This will continue until statisticians accept that Baysianism is the proper foundations, until that time, physicists will continue to do their own statistics (as will biologists, and every other scientist).

Will we ever be able to use quantum information preservation to solve crimes?

Quantum information is destroyed at room temperature. But classical non-quantum DNA analysis is close enough to perfect, shed one cell, you were in the warehouse, you can't avoid leaving DNA. Nothing about thoughts, feelings, or details other than shed DNA are impressed on the state of atoms in any recoverable way.

Where can I find papers or resources on the multivariate Cauchy distribution?

It is a special case of the multivariate Levy distributions, for the case where the Levy exponent is 1, this is probably your best bet as search handles in the literature. Cauchy distribution is usually too specific, when it comes out, you usually have other cases with other exponents you are interested in too.

What is an easy way to understand the physical reasons, as given in the Feynman Lectures, behind the fact that V=mgh?

It's in Feynman's book, it's the argument he gives. This is the law of the lever, it is Archimedes law for mechanical equilbrium, and Feynman gives the simplest explanation using a simple pully. If you lift and lower two weights on a pully, you do no work, and the sum of the product of mass times height is unchanged. If you lift a doubly heavy weight half the height and lower a weight, you do no work. In this way, he established the law. The argument in Archimedes for the law of the lever is essentially equivalent to this, it's a geometric argument which demonstrates that moving a weight down infinitesimally balances moving a weight up infinitesimally so long as the product of mass times displacement is constant. That the coefficient is "g" comes from Newton's laws, but that the potential energy is mh up to a universal coefficient (on the surface of the Earth) just comes from statics arguments like this.

What is an intuitive explanation of Chebyshev's inequality?

To get an intuition, look for the boundary case, where you just are about to violate the inequality. In this case, you have a variable X which has three delta-functions on the distribution: 1-p in the center, p/2 at plus/minus a+epsilon. Then sigma-squared is pa^2, the probability that |X| is bigger than a is p, and the inequality is saturated. You can see that anything you do to this situation makes things worse. For example, if you broaden the center delta function, your sigma is too big, so you need to bring in some probability from the edges.

How did scientists find out that water is made of 2 hydrogen atoms and 1 oxygen atom?

The key was the observation that gasses at the same temperature and pressure combine to make compounds at integer ratios of volumes. This was immediately understood to mean that equal volumes of ideal gas at the same temperature and pressure have equal number of atoms, and the integer ratios are the atoms coming together like tinkertoys. This was chemists, like Avogadro and Dalton, and some other gas law people, like Boyle and so on, who established this at the beginning of the 19th century. The physics of this was made clearer when physicists showed that little point particles obeying Newton's law would obey the relation that PV = CN , where is the average kinetic energy and C is a constant that depends on the type of gas. This was from the way the particles bounce off the walls. It was natural to identify the mean kinetic energy with a multiple of the temperature, and the coefficient was then the specific heat. The assumption that the

gasses H_2 O_2 were not actually individual atoms, but actually made of two atoms each gave the right specific heat, at least at room temperature. At cold temperature, the specific heat went down, and nobody knew why, leading some people to say atoms were rubbish (they should have known better). Maxwell pointed out this discrepancy around 1870, it was only resolved by Einstein and Debye (for solids, but the extension to gasses was obvious) using the brand-new Planck-Wien quantum mechanics in 1906. The ratio for producing water was one volume of oxygen gas to two volumes of hydrogen gas (both are two atoms apiece, but since they are both two atoms per molecule, it doesn't matter). So the simplest assumption is that water is H_2O. But from this, you might also suspect that maybe water is H_4O_2, or H_6O_3, and so on. To see that it's not, you could first notice that a certain quantity of carbon and oxygen combined to make CO_2, and by counting oxygen removed, you could figure out what a mole of carbon is. You could also combine Carbon and Hydrogen to make CH_4, and so on, and since it's always a discrete thing you are figuring out, you will eventually get the right answer (again, up to a duplication ambiguity--- maybe it's always C_2O_4. The chemists guessed correctly that for the simplest transformations, it's the simplest atomic integer consistent with the data.) I am probably not getting the exact simple molecules right in this story, but this is the flavor. Faraday's law of electrolysis was also important, the molar ratios of the elements deposited on different electrodes revealed the charge on each ion in solution from the electrolysis law. The chemists then began to expand their knowledge self-consistently, by going from known chemical formulas, having a reaction, and seeing what comes out. In this way, they eventually got substances they already knew the formula for, and they extended the knowledge by this trial and error method. One important program was the elucidation of the formula for hydrocarbon chains, by burning them and seeing how much CO_2 and H_2O was emitted, so they were linear chains. Then the big breakthrough was the structure of Benzene, which Benzene realized had to be a ring, from the way it could be split into six-chain carbon polymers, always the same, no matter which carbon was attacked. The physicists were distrustful of this method, because it required knowing

hundreds of experiments, it was hard to verify it independently of the community of chemists. Then quantum mechanics came along, and physical chemists like Pauling by 1927 could predict the binding of atoms more or less from the electronic configuration, and then the physicists ended up just verifying that the chemists knew what they were talking about. The chemists even knew the bond-angles about right, from the shapes of macroscopic crystals! For instance, they knew that the carbon-hydrogen bond in CH4 was tetrahedral, this was important for Pauling devising the theory of S-P hybridization which is the foundation of the tetrahedral bond. The quantum mechanics established the precise bond-angle geometry, and interatomic distances, then x-ray diffraction allowed physicists to verify the theory by directly imaging the positions of all the atoms in a crystal, from the way the x-rays diffract through. The chemists come out looking very good in this story, they managed to make the exact right inferences from really scanty data that only indirectly gave them a picture of what was going on.

How do intuitionists and other constructivists feel about the probabilistic method?

It's not completely compatible with intuitionism formally, because the notion of "random construction" isn't the same, for constructions with infinite numbers of steps, as Turing computable in the intuitive model. The intuitionist logic will construct the object you claim exists from the proof that it exists, and this is a deterministic computation in the intuitive model. But this is why Erdos's method is deep--- it is still a construction in the sense of a type of computation, but the model of computation for an object constructed by the method is a probabilistic computation. For finite constructions, it doesn't matter, but when you are talking about infinitely many random choices, it makes a difference. A probablistic computer is the same as adding a Turing

oracle which is a "random real number", but this concept cannot be completely well defined in usual set theory, because there are non-measurable sets. Cohen and Solovay showed that it is fine anyway to have random real numbers, and even without this advance, you can define random computation in the usual set theory, it's just a little bit more of a headache, and you are explicitly referring to Borel sets and measures the whole time, so it looks like a terribly complicated and totally non-constructive procedure, referring to all sorts of crazy kinds of uncountable sets. Because the probabilistic model of computation is well defined, and seems to be the correct moel of computation in the physical universe, I personally am happy to call proofs using this method constructive. But a stickler intuitionist might insist that a constructed object must be Turing computable.

What are the most challenging research areas in cognitive science - those that involve application of advanced concepts from mathematics and computer science?

Linguistics has been a challenge for decades, describe written language grammar precisely. This does not require details of brain function, it seems to be a well defined mathematical problem independent of the biology, the structure is off in its own world of text, isolating it from biological details. In this regard, a commutative grammar I think solves the main sticking point, the proliferation of nodes in context free grammars describing natural grammars. The commutative grammar allows certain parts of the sentence to slide around other parts, so that the order doesn't matter, reducing the complexity of the parse-tree description. This seems to me to solve the problem, more or less, but it has never been implemented as a

language generation scheme, nor is there a complete system that includes all New York Times grammar. But if you have a copy of the New York Times, you can make a skeleton English grammar as a commutative version of a context free grammar very easily, and some tweaking should complete this. That's the only problem I am really interested in here, in human cognition, I am sure there are lots more. But this one is interesting, because you can easily speculate about the detailed mechanism that implements the computation. I will spare you the mechanism I have, because I don't have confidence it's true.

Is neuroscience a good field to build and exercise advanced mathematical physics knowledge?

The precise models are not yet there, so beyond general scientific methods, you aren't going to find a playground for your analytic techniques, at least not yet. If you have some preexisting knowledge and you are seeking to apply your hammer to a new nail, you are doing the wrong thing. The mathematics you need will be dictated by the results of experiments, and it's going to be a Philips head screw, and your hammer will just bend it. But it is a great place to make progress in science, in extending human knowledge, because the experimental methods are getting better and more delicate, especially in insect and flatworms. So one could figure out how these brains (or nervous system, for c. elegans) work in detail, down to the molecular level.

What are the more commonly known myths of the Hindu deities?

Brahma and Saraswati are strongly parallel to Abram and Sarai, Abraham and Sarah, in Genesis. To explain Hindu myths, you can point to parallel Genesis stories, they are very similar.

If God suddenly stopped existing now, how would we notice it?

If pi suddenly changed it's value, how would we notice? The question doesn't make sense for mathematical abstractions.

Is coincidence really a scientific anomaly? If so, what are the laws and/or rules that support this?

It depends on the likelihood of the coincidence, and your method of identifying it. Feynman's example is nice: I was driving behind licence plate number XPF1034 today. What are the chances of THAT? In this case, you have to declare what you consider exceptional ahead of time, and if you don't, you have to consider how special your choice is. It's common sense, but it's not easy to formalize. The level of coincidence is formalized by physicists as naturalness. You make a Baysian model which tells you how likely different possibilities are, and when the probability of a coincidence is too low, you look for a reason. But you

make sure your level of coincidence is larger than one over the number of models you are searching for. If you are looking through a thousand places to find a one-in-a-thousand coincidence, you have found nothing. For example, the mass of the electron is .5 MeV, while the mass of other things, quarks, and so on, are 1-4 GeV. This means the electron is too light by a factor of 1000. The leptons are generally lighter than their corresponding quark, but usually by a factor of 10 or so, so there is a 1% coincidence here. Is this significant? Possibly not. This is a borderline case. It would be nice to understand why the electron is so light, but it just might be a coincidence of our vacuum. Another example is the Higgs mass, as compared to the Planck mass. The Higgs mass is around 1TeV, the Planck mass is 16 orders of magntiude bigger, so it's a coincidence of a million-billion. This is not something you can just shrug off. For the cosmological constant, going in mass units, its 30 orders of magnitude (usually people raise to the fourth power, making a discrepancy of 120 orders of magnitude, but I prefer not to). This discrepancy is also a serious problem. For other coincidences, it's Baysian common sense. Suppose you find that certain military drills simulating multiple hijackings are going on at the same time as 9/11. That's a weird coincidence, it gives you Baysian discomfort, like the electron mass, so you find it suspicious, but not terribly notable. Suppose you later figure out a precise set of drills can be used to stage 9/11, and it's not adjustible, it needs to be these drills and no others. Then when you see that the drills that were going on match these drills (consistently, up to classified details), and if some drills are missing, and then you find news reports that these too were going on, then it stops being like the electron mass, and starts being like the cosmological constant. The formalizing of coincidence in Baysianism is used in less controversial ways every day. For example, if you extract viral DNA from a bacterial disease, and you keep extracting it, and you get more and more Baysian discomfort, at some pont you say "hold it, maybe this is really a viral disease." That's how you get new hypotheses. If they are correct, they will immediately straighten out all the Baysian discomfort. But you have to be nimble, and use common sense, and know when you are fooling yourself, you know, the standard caveats.

Could it be that the statistics on the number of deaths caused by the use of various drugs are skewed by the fact that there are larger data samples for drugs like alcohol and tobacco than, say, heroin?

Heroin has enormous samples, so does cocaine, and any street drug that isn't brand new. The world is a big place. The main question for lethality is the ratio of the lethal dose to the active dose, and for heroin, it's about 2, so the dose a person uses to get high, if doubled, will lead them to stop breathing. For other drugs, like marijuana or LSD, the ratio is close enough to infinity that it's indistinguishable. That doesn't make those drugs benign, it just means that if you take them, you won't die. The death statistics are not the major harm for users, because drug addicts usually are careful with highly poisonous drugs. The harm is the loss of higher mental function, the inability to reason carefully when reasoning becomes hard, which leads to loss of motivation for new things, and to the slow disintegration of your life. That can happen with drugs that have no known lethal dose, like marijuana, and it doesn't happen with nicotine, even though it's lethal dose is only a factor of 5 or 10 larger than the active dose. So cigarettes are slightly harder to kick than heroin, even though the withdrawal effects are much milder, because they don't interfere so drastically with your life, and don't make you into a comatose zombie.

Is the mantra of Darwinism, "survival of the fittest", a tautology?

It's a tautology by itself, but the nontrivial claim that Darwin makes is that the entire history of life can be explained by this obvious process and nothing else is required. That's a predictive statement of the highest order, and it clearly wasn't as obvious then as it is today, because people didn't accept it before Darwin. A lot of people still irrationally refuse to accept it. The source of mutations is left as an open question in this view, as is any coordination between different parallel evolutionary paths that make larger optimizations than what can be achieved by local maximization of fitness. There is also sexual selection, which can go long way against survival self-interest, due to mate choice.

Doesn't Everett's many worlds interpretation violate quantum mechanics?

If Everett said what you say, it would be in conflict with quantum mechanics, and also silly. Everett doesn't say that the universe splits when the electron goes through two slits, rather that the linear evolution of the wavefunction is something that holds at all scales, so that people end up superposed, just like electrons, just like quantum mechanics predicts. But people don't ever "feel" superposed. In the Everett interpretation, this is just a property of how people feel. The 'split' in universes is not a split in the physical universe, it is a split in the perceptual memories of a recording device that measures the universe. When a classical computing device measures an outcome, and ends up in a superposition of different computational memory states, you view the two outcomes as "existing" (philosophically) and

the appearence of probability is only subjective, from the point of view of the computing device itself, from the inside. In this view, the collapse in quantum mechanics is a property of perception, not so much of the physics. The physics is simple unitary evolution, all the complicated probabilistic reduction is from selecting a particular path to make a consistent memory for a computing device. The idea doesn't work if the computing device can recohere the different outcomes back together, to get interference between previously split alternatives, like an electron's wavefunction merging after the slits. But this can only happen if it erases every bit of information it acquired, since interference only happens when two different histories of the whole quantum system, a system that includes the device in this case, reach exactly identical states. This is impossible if there was entropy production, and even in cases of reversible computation, it requires restoring the exact initial state of the reversible computer, so there is no paradox between interference and the subjective Everett history-splitting. The reason this is not more emphasized is because it mentions the memory of computing devices, as a model for human memories, and people get annoyed when it is the consciousness of a person that is doing something in making quantum mechanics work. Sorry. That's how collapse works in Everett, and in other no-collapse interpretations, there's no way around it. This is the reason it is not described by physics, but by a sort of meta-physics of mind, that tells you how memories embed and gain continuity in physical systems. The memories in the computational measuring device are what is doing it. These memory robots, as models of the brain of observers, are emphasized in Everett, and in the proper accounts of this interpretation they are included. When you don't include them, it sounds like the nonsense above. Everett is just taking quantum mechanics seriously as a model for the entire universe. This is useful when considering cosmology, and the fact that he can do it (with only philosophical headaches, no physical paradoxes) means that it is philosophically possible that quantum mechanics is exact. But that doesn't mean that quantum mechanics is exact, just that in this case, the Everett interpretation shows how to reconcile measurement with unitary evolution in a realistic philosophy. Since the result only

involves philosophical readjustment, in the end, it isn't too much different from Copenhagen. The Copenhagen folks thought of collapse in much the same way, except they didn't make it explicit, because their positivism meant it was enough to describe how to predict results of any experiment. You didn't need to give an account of what is "really" going on. Everett just provided this account for this interpretation.

What is your greatest contribution to the field of Science?

I think it's the computational stuff in biology--- it resolves the origin of life issues, at the very least in outline, and makes correct predictions for RNA function in some detail, some of these predictions remain predictions, because they haven't been conclusively discovered. Others RNA things aren't predictions anymore, they were discovered. This stuff dominated my thinking since 2001. But I also have this theory of cold fusion, which I believe is correct, so maybe that's more important in the near term. There is less competition here, I know for sure this stuff is original. Everything else in the theory end of this field is made up nonsense. I discovered some other minor things too, but mostly simultaneously with others, or sometimes slightly ahead, sometimes slightly behind. That can't be too great, because someone else was thinking the same thing.

What is the literature that one should read in order to get a broad scientific background?

Do NOT read textobooks, they often lump together the 95% of things that are believed with solid evidence with speculative ideas that are only believed due to politics. You should read the original papers, if they aren't too dated, in order of history, more or less, and more quickly the further back you go. There isn't much from before the 1950s, and it's summarized well in secondary sources.

What classics Ron Maimon recommends reading?

I don't recomment reading things that are too old without translating them to modern language. I read all of Archimedes works a long time ago, but I didn't actually read them, I just looked at the theorems and tried to figure out what the heck he was doing from modern perspective (the methods were too antiquated to follow). I did the same with Euclid, and tried with Appolonius, but I got bored. The same method with the Principia is good, but harder to do, because you need to rederive the cycloid properties. I put some things online to help. But Archimedes and Newton you should know, although slogging through the ancient stuff is a drag. Anything from before 1900 is a drag, people a long time ago were just kinda stupid. There is a summary of some classics in Barbour's "Absolute or Relative Motion". It's a book about history, but you see the history of Mechanics, especially stuff about Huygens, something about Leibnitz, the stuff usually ignored by modern writers. But some things, old or not, you can just read straight through: Galileo: Diaolog and Two New Sciences. Euler: Analysis Infinatorum Maxwell: The original article on the Maxwell Boltzmann distribution is good, the electrodynamics work needs to be translated to modern notation, like Newton. I only skimmed this. Einstein: All the scientific work, every paper, every book. Dirac: The Principles of Quanutm Mechanics, the original articles are good too. Bohr: The classic papers, you can skip BKS theory, read Heisenberg instead.

Heisenberg: All of hte papers (I read some of them). Landau: Collected papers, they are great. Landau/Lifschitz series is a comprehensive education in pre 1960 physics. Fermi: His little book on thermodynamics is great. I haven't read any of his papers. Bethe: The Bethe Ansatz paper is good, it is covered again in a Russian book on the Inverse Scattering Method and Correlation Functions. Feynman: All the papers (there aren't so many), all the books--- they are excellent. Quantum Mechanics and Path Integrals is one I didn't like as much, the 1948 Reviews of Modern Physics article was in less dated notation and clearer in my opinon. Schwinger: "Quantum Electrodynamics, a Reprint Collection" is great, there are classic papers there, although it is difficult to read because it is so formal. A good modern introduction makes this stuff accessible. Pauling: His quantum mechanics books is a classic, this is the chemists' orbitals. Dyson: He wrote a great review of the SU(6) papers in a preprint collection called "Higher symmetries" or something like that. I liked his papers a lot, although I haven't read all of them. Dyson is alive, from here on out, the classics are sort of recent. But I don't think there is much before 1900 that is really super-worthwhile. I like Adler, Anderson, Brout, Callan, Coleman, DeWitt, Frohlich, Glashow, Gell-Mann, Gross, Lee, Nambu, Parisi, Skyrme, Veltman, 'tHooft, Weinberg, Yang, Bardeen, Von-Neumann, Scherk, Schwarz, Yoneya, Polyakov, Van-Niewenhuisen, Witten, Polchinsky, Mandelstam, Wilson, blah blah, all of these are famous names. I copied from Wikipedia's "Quantum Field Theory" template, which I wrote, but it's been edited by politics since. All these people wrote classics, and everyone should read everything they wrote (but I didn't read everything, sadly). I am overlapping with people active today now, so I'll stop. Most of this stuff I read decades ago, I don't remember all of it, I am going by what stuck in my mind. I forgot Mandelbrot's "Fractal Geometry of Nature", for example, that was something I liked, and a bunch of historical math books I don't remember. And Hawking! All his articles, all his books. And Penrose too, I can't do this, too many people I'll forget.

What is your review of Surely You're Joking, Mr. Feynman! (1985 book)?

★★★★★ It's a very good book, it is a record of Feynman's stories. Each of these stories is somewhat deeper than what appears at first glance, they seem like throwaway anecdotes on first encounter, funny stories, but each of them are actually subversive folk-tales similar to Aesop's fables, regarding authority, and the path to knowledge, and how to navigate a social situation as an independent minded individual. These things are useful social things for a scientist to know. The early stories about fixing radios as a child, his first wife's illness and the doctor's incompetence at identifying it, make it clear that social authority is completely bankrupt as a road to knowledge. His story of opening safes and then meeting a professional safe-cracker, and realizing the professional's methods were just as dippy, is a nearly perfect metaphor of creating mathematical tools for yourself, and eventually realizing your dippy tools are basically equivalent to the snazzy looking tools other people use. He is explaining things in a parable form, which is easy to digest. His story about doing calculations with mathematicians show you forgotten methods that people used to do calculations in the pre-calculator era, by remembering a few logarithms, and knowing Taylor series. His battle with the abacus fellow both contains a nod to Ramanujan (the number he takes the cube root of is nearly 12^3 +1^3, the famous Hardy taxi number), and an explanation of the futility of rote methods to gain deep insight, even in a realm as rote as numerical calculation. The stories of his adventures in Brazil and in Japan are illustrative of how social things work, and even his stories about hanging out in sleazy bars with gangsters and meeting women are insightful psychologically, and reveal how authority establishes itself already at the level of two-person relations between the sexes. I think these risque things

accounted for the book's popularity, although Feynman was surely not as sleazy as the impression you get from reading his books, and any potential sexism one senses he seems to have kept confined to bars and off-color stories, from his female collegues, he knew how to keep this sexual authority nonsense from spilling over into his professional life. The writing reveals a hidden human writing talent in Feynman, to make insightful commentary on human things, something you would hardly guess was there from his scientific work. I liked it a lot.

Were the WTCs destroyed by a controlled demolition or by fires as the "Official 9/11 Commision Report" claimed in its final version?

Yes they were. The evidence compiled by Engineers and Architects for 9/11 Truth, and by Jones regarding thermite, is completely conclusive scientifically. Politically, that's another matter.

If 9/11 was indeed an inside job, what was the goal?

The goal was probably to produce a political change in the US, which would allow the US to maintain a long empire over oil-producing regions, and keep the folks in power in 2001 in power indefinitely, by staging more attacks whenever necessary, and paint the opposition as soft on terror, while using money and presidential authority to control

the political process. One idea was probably to reverse the Watergate era restrictions on presidential authority. This was a priority for those who served in Nixon's administration, and witnessed the way the president's authority was hobbled by the Watergate scandal. This category of people steaming over Nixon includes all the 9/11 usual suspects. If this was the goal, it succeeded to a certain extent, Iraq was invaded, and Bush was reelected using suspicious voting machines and a complicit bought out press, the opposition was silenced regarding 9/11 truth, and the constraints imposed on the press and the American counterculture was effectively destroyed for a decade. It was a complete catastrophe, and it is only slowly being reversed. Since I think it was a plan of a very small group, perhaps two people, perhaps one, the motives don't have to be any more coherent than this. Plans of one or two people have nebulous motivation.

Why do some Americans believe 9/11 was an inside job?

Because it was an inside job. The question is why some Americans don't believe it, and this is just because of relentless shameful repetition of propaganda by the media. This is exposing a serious problem in the media ownership structure, which is only remedied online.

Is requesting a new investigation into 9/11 insulting to the memory of the people who died that day?

Not requesting it is the insult. It's worse than insult, it's complicity.

Why is it simply not ok to believe in God or religion? If someone believes in God, what’s the big deal?

Without the ability to act in coordination with others, according to a superrational strategy that presumes others will also act with you, against their self-interest and without any direct control from a central authority, people can be herded into a narrow pen by their own self-interest, and be locked there permanently. This is exploited by political orders to keep unethical systems stable, even when each individual thinks the system is rotten. In order to escape, you need to be able to go against your self interest, because you will be punished for defying a pre-established order. God is that abstract entity that informs you which self-denying path is likely to be the most productive one to take. The concept of God is simply the mechanism of deciding which things against your self interest you are going to do.

What is your definition of God?

I would go with the mathematician's definition, God is the Church-Kleene ordinal, and the dictates of God are the consequences of a formal axiom system which has been reflected (meaning adding "this system is consistent") Church-Kleene ordinal number of times. This is not really a complete definition, because the limit of the Church-Kleene ordinal cannot be described computationally. It is an all-

knowing thing, because you expect all meaningful theorems to get proved at this limiting stage. But that's good, because God is a limiting conception which you cannot really fully know at a finite level of complexity, so any truncation of the concept doesn't capture the full meaning, just as any computational description of Church-Kleene falls short. It also provides a path to action, because such a system can analyze any game in principle and determine the best path forward. It's a limiting conception, the ideal of a computing system becoming infinitely strong, and so infinitely intelligent. The idea is that ethical actions by larger and larger communities with awareness of history and a dedication to self-consistency in their actions can approximate this ideal better and better with time. This definition does not have any relation to creating the universe, nor does it have any connotations of magic. But it does include a concept of providence, inasmuch as the collective around you acts in concert with your hopefully ethical actions to make them fruitful in ways you cannot foresee, because you only make a small part of the whole. It also includes a notion of martyrdom, because you sometimes run ahead of the community a bit, although not often, because you aren't usually ahead of anybody.

If God does not exist, how were the laws of physics established? How is it that matter and energy behave according to principles that can be described by logical formulas?

Can you imagine any other way for a universe to work? If things didn't obey regular laws, you would be asking why they don't, but it is not clear you could be around to ask the question, because how would you be constructed to do regular computation in an irregular

universe? This is not a very meaningful question on close examination, because there is no way to determine the answer by observation.

Why aren't Democrats and Liberals upset about Barack Obama setting the precedent for being able to assassinate US Citizens without due process?

Who says that liberals aren't upset about this? Many liberals are crawling out of their skin with anger, I am personally livid, and I would be protesting. Except then you have to think about the opposition. Given that the current alternative is a party whose internal operations led to an intentional massacre of 3,000 US Citizens, a party which stripped away constitutional protections on privacy and due process after staging it's own version of the Reichstag fire, whose policies were the closest America has ever come to fascism in living memory, many of whose members would gladly do much worse than Obama if given the chance, there's nothing you can do. You just shut up, and hope Obama is doing it as a political gimmick. If Jesse Ventura were running, on any ticket, I would vote for him, even if he wanted to also privatize the post office. But given that any attack on Obama benefits the Republican party, you just have to stew quietly and bite your tongue and hope the Supreme Court does something.

I love Physics, but I find it really hard to do the Math. What is the most efficient way by

which I can learn how things work (to a pretty good extent) by using only the necessary mathematics (hence, minimizing its use in explaining the phenomenon)?

Learn the mathematics with the physical example in mind. This makes the mathematics more intuitive, and the physics more precise. There is no shortcut, you need to learn the technical details.

How does the assuming of higher dimensions (above the fourth) help in improving our understanding of the Universe?

They are small, relatively quantum, dimensions, so that everything is in the ground state relative to these dimensions, and you don't have to think of them as dimensions at all. If you have a particle that can have a non-positional internal property which is a real number, like, say, temperature. Then you can plot the position and the temperature as a geometric 4 dimensional plot. But when things are quantum, and energies are low, continuous possibilities reduce to a discrete set. The discrete freedom corresponding to motion in the extra dimension at our low energies is just the types of elementary particles we see. So the extra dimensions in string theory are not usefully pictured as actual spatial dimensions until an energy scale that is completely inaccessible, about 100 times larger than the Planck length. So you don't need to think of them as dimensions at all, at least not when you are working at ordinary energies. Even at high energies, dimensions can swap for internal variables in string theory with no problem, since space is reconstructed from the oscillations of other things in the theory.

Is philosophy the "queen of the sciences?"

Philosophy, as an activity, is useful for figuring out what you are doing in science. But philosophy as a field is pointless, because the philosophers usually only do politics, they have no method of deciding what is correct and what is not, except waiting to see which philosophers are preserved and promoted by political orders. Because of this, most of the advances in philosophy have come from outside the field. The main advances are Mach (physicist) introducing positivism, Russell introducing logic (he was a philosopher), Carnap producing logical positivism and resolving the classical questions. There are mathematical things in philosophy, like modal logic, and so on, that are interesting, and mathematical logic lies at the boundary of philosophy and mathematics, much as positivism lies at the boundary of philosophy and physics. The human part of the field is a long tradition of bankrupt intellectual frauds, beginning with Aristotle, continuing through Hegel and Nietzsche, and Heidegger. These people all pandered to the corrupt political orders of their time--- Aristotle to ancient slave-owning empire-masters, Hegel to 19th century aristocrats and plutocrats, Nietzsche to anti-Marxists in the 20th century, and Heidegger to modern slave-owning empire-masters. That tradition is worthless. If you need philosophy, you can usually do it yourself in 10 minutes. It is hardly ever the rate limiting step in understanding something, quantum mechanics being the extremely notable exception.

I think more and more people are realising 9/11 was a false flag inside job. Am I right?

Yes, but the process needs to be accelerated. Once you have 50%, and it's close, it becomes in a politician's interest to support the movement, and then it becomes a phase transition, and you can get an investigation, a trial, and some sentencing.

Why don't I hear more about 9/11 alternative theories?

You shouldn't be "pretty convinced", you should be dead certain. The physics is uncontestable. As to why this is not more widely reported, there are several instances where politics gets in the way of reporting in mass media. All this stuff is reported pretty fairly online, but due to the fact that the transition to online media is not complete, this type of propaganda on TV, on the radio, it can still influence a large number of people. It is incumbent upon you to reject this type of propaganda in favor of solid science. There are no scientific mistakes in the analysis of Gage and Architects and Engineers for 9/11 Truth, they have discovered the manner in which the towers were brought down with more than scientific certainty, with complete certainty.

Could the Internet already be conscious without us realising it?

Not independently of the people involved, because the information is generally static, it isn't computing without humans intervening. If there is a consciousness, it is the same collective consciousness of society that Jung identified in a way, and also the religious folks who

sometimes identify this type of collective social activity as something which can be modified by the action of God.

Do conspiracy theorists generally hold that the alleged conspirators think that they are doing good, or are motivated by self-interest?

This is why you need simultaneous drills to pull off these attacks. Then all the people who are involved never need to do anything that conflicts with their conscience, they are just taking part in what they see as a harmless drill. Only the drill coordinator knows the purpose of all those drills, and puts them together to stage an attack. The symptom is that the drills and the attack are eerily similar, but this is chalked up to a coincidence by the participants. For example, with 9/11, you want 4 drills: 1. Put drones in the sky 2. fiddle with radar blips 3. have a fake hijacking exercize, complete with fake terrorists who pretend to have a bomb. 4. Flight simulate flying planes into the WTC and Pentagon. Then on the day of the attack, you just switch the coordinates of the drones from drill 1 and the planes from drill 3, disguise the switcheroo using drill 2. Then use drill 4 to pilot the planes to their targets. The actual planes you might land on bases, transfer all the passengers to flight 93, and then shoot that plane down. The drill coordinator is in charge of the entire US military and government once the emergency starts, so there is no barrier to doing all sorts of crazy things. At the end, only the simulation pilots will have a bothered conscience, and this is only a handful of people, so they can be kept quiet. Regarding the Boston bombing, it's even easier--- you just hold a bomb drill, and substitute a real bomb for a fake one. You can get your staff to make a real bomb with no problem, you tell them it's for an exercise to defuse a bomb. You can make two different bombs, and have one defused, and send the paperwork duplicatively

to the two offices. It's a bureaucracy trick, it only takes one person to pull off such a stunt, and I think that it was thought up relatively recently, perhaps in the Oklahoma City bombing, and then inside attacks continue to happen, as one official after another catches on as to how you pull it off. The conspirators are so small in number, as small a group as one person, that you can't really say what they are thinking. One person can have all sorts of crazy ideas. The way to prevent such shenanigans is to ban terrorism drills, permanently, and with severe consequences. Then it will be impossible to stage such an attack without a bunch of co-conspirators, and chances are, you won't find them. If you look, you will find simultaneous drills which can be used to stage the attack were available in all the attacks you mention.

Why do so many people think they are smarter than Elon Musk?

He's a billionaire, billionaires are not selected for inteliigence, they are selected politically. They succeed by attracting investment money and succeed big by muscling their company to the top. Their key skill is not coming up with new ideas, but recognizing and selecting those ideas that are good. Recognizing ideas is much easier than coming up with them, and in the case of Mars, you need a great new idea, because the best idea will never work, because as a private entity you can't get hold of nuclear rockets. The only realistic way to explore the solar system with humans is using nuclear propulsion, like Orion. But private businesses can't do this. The basic purpose this is serving is as an attempt to show that private enterprise can do space exploration as well as Soviet style massive government project. it just can't. Space stuff, like education and fundamental science, is one of the things Soviet style government projects are extremely good at, because bourgeoise politics can't help make the product more snazzy, nor is there a market involved. For this purpose, it helps to make a

government project, and deal with the lack of competition. It's not like Musk has a billion competitors either. Using chemical rockets, it's just going to be impossible. The rockets are humongous, because you need a heavy spaceship just to take up cosmic-ray shielding, food, and air for humans on the long trip. The nuclear rockets make it a doable project for a government willing to do some nuclear experiments. As for Elon Musk, he has a lot of hare-brained ideas, like a tube connecting cities. This is why it is not good to make billionaires, they can shout out their ideas with money, everyone around them is a yes-man, so these ideas are usually moronic. (from the comments, maybe I don't know what I'm talking about--- the idea of a reusable rocket might make things cheaper by an order of magnitude, according to the comments, this is concievable, I don't know. If it works, then great for Elon Musk.)

Betting strategy for a tournament between two players when you can bet only on individual matches? (Please see question details for the full problem)

In such a strategy, you must lose all your money when your candidate loses, and end up with exactly 2000 dollars when your candidate wins. Any better, and you would have a better expected value for your money than 1000, and this is impossible in even fair bets. From this, you can uniquely reconstruct the strategy. For a sequence of games of the form WWWLLL, or any permutation, you must have 1000 dollars to bet at the end, and you must bet it all, so you end up with nothing. Similarly, you know exactly how much money you must have for all the situations with three losses: LLL--- you have 125 (bet everything on every subsequent game) WLLL (any permutation) --- you must

have 250 (bet everything from here on), WWLLL (any perm) --- have 500 (bet everything from here on) WWWLLL (any perm) ---- have 1000 (bet everything) From WWWLL, two losses, you know that you must have exactly 2000 when you win, and exactly 1000 if you lose (WWWLLL), so WWWLL --- have 1500, bet 500. So from WWWL, you know you must have exactly 1500 when you lose, and 2000 if you win, so WWWL --- have 1750, bet 250 and therefore from WWW you have 2000 if you win, 1750 if you lose, so WWW --- have 1875, bet 125 WWLLL you have 500, so for WWLL, you have 500 if you lose (WWLLL), and 1500 if you win (WWWLL). So WWLL you have 1000, and bet 500. Simlarly for WWL, if you win, you have 1750, if you lose you have 1000, so WWL --- have 1375 bet 375 For WW, if you win, you have 1875, if you lose you have 1375, so WW --- you have 1625, bet 250. For WLL, if you win, you have 1000 (WWLL) and if you lose you have 250 (WLLL), so WLL--- you have 625, you bet 375. For WL, if you win, you end up at WWL so at 1375 (actually WLW, but permutatons don't matter), and if you lose, you end up at WLL so 625. WL --- you have 1000, bet 375 For W, if you win, you are at WW or 1625, if you lose, you are at WL, or 1000, so W --- you have 1312.5 bet 312.5 This means that the first bet is 312.5, so L --- you have 687.5 bet 312.5 If you start at LL, you either go to WLL with 625, or to LLL with 125, LL --- you have 375 bet 250 consistent with losing the bet at L. This completes the construction of the strategy, proving if it is consistent, it is unique. ==== STRATEGY ==== Your first bet is 312.5 dollars. Lose or you win, you bet 312.5 again. You are now either at: LL with 375 (bet 250) WW with 1625 (bet 250) LW with 1000 (bet 375) From LL, you can go to LLW, LLWW, LLWWW, by a sequence of bets LLW with 625 (bet 375) LLWW with 1000 (bet 500) LLWWW with 1500 (bet 500) the only alternative here is that you end up with three L's, so you bet everything on every subsequent game (this gives the outcome you want). From WW with 1625, if you win, you go to WWW, and then you always bet 2000 minus your amount (this gives the right outcome). So the only three possibilities are WWL --- 1375 (bet 375) WWLL -- 1000 (bet 500) WWLLL --- 500 (bet all from now on) From WL, you can go to WLL --- 625 (bet 375) WWL --- 1375 (bet 375) The amount you have and the amount you bet is not dependent

on the order of the wins and losses only on the total number of wins and losses, so the table is very short. After the first two bets, and including the template for WWW (bet 2000 minus the value) and LLL (bet everything), it's enumerated completely above. So everything is consistent. Cute puzzle.

Does the universe need a conscious observer for it to exist?

This is a meaningless question in logical positism. How would you be able to tell? Because this question is meaningless, you can consistently formulate quantum mechanics in terms of observations, and leave the question of what is really happening out of the description. But you don't have to do this, you can also take a many-worlds point of view, and consider the universe in this picture. It really doesn't matter, if you accept positivism, and the point of the conscious observer business is to get you acclimated to positivism quickly.

Does Thought need a physical system for its existence?

This is a meaningless question, by logical positivism. It is exactly why existence is a very difficult word to make precise.

Probability: How does one show the probability of n consecutive heads and tails eventually occurring is 1?

chunk up the thing into clumps of size n, and there is a nonzero probability for a clump of all 1's. This will overestimate the first time the sequence occurs.

Why didn't Dirac come up with the theory of path integrals?

Dirac wrote a paper introducing the path integral, in the 1930s, it's called "The Lagrangian in Quantum Mechanics", and it contains a time slicing of the transition operator, where he showed that the full propagator is a sum over paths of a quantity, which for infintesimal times corresponds to the exponential of i times the classical Lagrangian. He probably didn't go further because he was interested in full generality, and the path integral only turns into the classical action in the special case that the Hamiltonian is quadratic in the momentum. This special case is extremely important, and it is what Feynman works with all the time. In other cases, like when you have a Hamiltonian of form p^4 (perfectly well defined nonrelativistically), the transformation to Lagrangian picture is not completely trivial, even if you know the modern theory. The resulting action is very different from the classical action, it is only the classical action when considering the classical limit. Feynman followed up on the quadratic special case, rederived the usual forms in this special case, and then noted that this special case includes electromagnetic field theory, since the field oscillators are harmonic and the Lagrangian is quadratic. The result worked for general field theories, because you have

renormalizability constraints that pretty much ensure a Lagrangian quadratic in the momentum. The issue of general quantum systems is prominent on Dirac's mind when he later develops the theory of constrained systems. I think this focus on generality is the main issue. Feynman had no compunctions about generalizing from a well understood special case, and in this case, the generalization is correct. You can extend the path integral even to Hamitlonians with non-quadratic momenta.

How many Quora answers do you read on average per day (approx) and what proportion do you find interesting/ upvoted Vs. bad or ignored answers?

I don't read, I just write. (I upvote when there is something original, this is rare).

Is going to a fancy school for undergrad important for science?

For theory, it is not important at all, but it is good to have an experienced researcher around to get some insight how to navigate the literature. For experiment, you need equipment, and this might not be available at a small college. What is most important is studying the literature, and you can do this anywhere today. The education at fancy schools is not significantly different from any other schools, aside from

a few classes reporting on the research of particular professors, but you can find research classes which are cutting edge at many universities, so long as they are research universities, and the professors at fancy universities publish their stuff, and if you read all their published work, you will usually not be surprised by anything they have to say.

What are the best math blogs?

Terrance Tao's blog. What's new .

Is there any polynomial time algorithm for finding maximal cliques in general undirected graph?

The naive algorithm that looks for cliques of size n is polynomial time, you find and lable all 2 cliques, then find 3 cliques by extending labelled 2 cliques, and so on, and when the clique drops out, it's maximal (this is exponential in the worst case, because the number of cliques grows exponentially, stupid me, I'll delete this).

Teaching Mathematics: Why is the Mean Value Theorem taught in introductory calculus

courses? Should it be?

It's taught as a particular way to prove that a function whose derivative is everywhere zero is constant. The mean value theorem gives this as a corrollary. This then establishes that two integrals for a given function at most differ by a constant. The reason it's not particularly a great presentation is that the method of proof is obvious, and the same method can be used to directly prove the result about integrals. But it's not awful, the proof is at least correct, it's just, why is everyone copying everyone else? There are a million different paths through the rigorous presentation, it's stultifying to always use the same one.

What is the Mpemba effect?

It's the old observation that hot water freezes first if you place it in the freezer. It should be impossible of course, because the water should go through the colder stage on its way to freezing, but it happens anyway under uncontrolled conditions, and also according to the 1969 paper by Mpemba, under controlled conditions. On stackexchange, people suggested that the main reason is that when you place the ice-tray in the refrigerator, the hot water melts and refreezes the layer of frost, making a better thermal contact with the walls. This was controlled for in the 1969 Mpemba paper, so it's probably not this. A second effect, completely negligible compared to the first, is some evaporation. This can be controlled by a thin layer of oil, and doesn't seem to matter. A third effect is dissolved gasses--- any dissolved ionic substance reduces the specific heat of water drastically. To control for this, you should cycle the temperature in the cold water, let it come to thermal equilibrium at 26 degrees, and then qucikly heat it without mixing with air, perhaps by using an oil barrier to prevent ionic

contamination, and then put the two samples in the fridge. If you control for all three effects, like placing two trays with cold and hot water side by side on a piece of cardboard, you should get no effect, the cold water freezes first. But this is not what Mpemba reports in 1969! The claim here is that the hot water sets up a convection cell while the water is hot, which continues to operate during cooling in the non-equilibrium system, maintaining a heat gradient in the water that leads to more heat loss at the top! This is very strange--- it would require that there are two stable states in a vat of water at 26 degrees in a very cold air environment, one maintaining a thermal gradient and a convection cycle, and the other not. This is not impossible, but it is implausible. This is a major edit to the original answer, where I poo-poohed this, because people who tried to replicate on stackexchange failed. After reading the actual paper (there is a paper), where the obvious explanations are controlled, it seems to be a real effect, not an artifact of thermal contact. Sorry about that. But the gassing idea needs to be controlled and the thermal profile measured before you can be sure whether it's gas or a covection thing, I didn't check, I was going by the reult of an earlier discussion on stackexchange. Thanks to Rupert Baines for pointing out the literature.

Is that true a programmer or developer (in India) can't even buy a car in 5 years?

Programmer salaries are now firmly competitive, even though the work is very difficult, due to the fact that anyone can learn to program without any barriers, it's not a closed guild. So you'll be making enough to live, but not a great deal more.

What are the best philosophical arguments against the existence of a god?

The argument I gave here is philosophical: Theology: What are the best arguments for God's existence? The summary is that collectives can form, they can bind together in superrational collectives to act in concert, and it is plausible to say that as the collectives grow and become more harmonious, they are approximating a perfectly good, infinitely intelligent agent. Further, the self-consistency of the ethical decisions make it possible for an individual, simply by mulling over what is good and what is bad, to gain an intuition for a consistent system closer to the endpoint. Since this system has a utility function, it naturally personifies, you tend to view desires as coming from a person, not an abstraction. So you get a sense of communicating with an infinitely vast intelligence that knows everything about you, desires absolute good for everyone, and tells you what to do. This intuition is not faulty, but it has nothing to do wih creating the universe. It is the property of computational entities joining together to make larger and larger collectives, using superrational ethics. The attribute of "existence" is not important for the God of this view, anymore than it is important for the number pi, or the Church Kleene ordinal, it is an abstraction. The important thing is to do the superrational business and behave ethically in this mind-melding way, and then the organizations approximate the will of God better and bettter, as the decisions become more self-consistent and more consistent with the infinite limit they are aspiring to.

What is the best argument for existence of god?

Brodie Schulze has written the standard arguments, they are all nonsense for a logical positivist. Since I am a positivist, what I really mean is that they are all nonsense. The problem is that the people who are arguing for God are getting intuition from one sort of thing, by experience and religious revelation, and then making arguments about another thing altogether, so as to prop up the arguments in religious books. It helps to have a religious experience to understand the exact source of the intuition, but if it is explained properly, it isn't necessary to have any mystical experience at all--- you can explain it from first principles and see that it makes sense without any mysticism or revelation, just by thinking. First, to clarify, if the word "God" means "being who created the universe", then it is talking about something meaningless, because there are no observations which can be altered by the origin of the universe, in the sense of creation from outside. If the word "God" is supposed to mean a "cause" for the universe, it is meaningless again, because the word cause is a complicated analogical conception, it doesn't appear in the fundamental laws of nature, and the nature of the analogies that go into defining cause and effect do not make sense when applied to the entire universe. To be precise about this, I will define cause and effect. The concept does not appear in fundamental laws of physics, all that you can say in physics is that certain initial conditions lead to certain final conditions. To identify a "cause" means that you have identified a whole bunch of situations as analogous, and that one particular variable in these analogous situations, whenever it occurs initially, leads to an "effect", a property of the final state. So for example, touching a hot stove burns your hand, because it doesn't matter if it was raining, or whether you were standing with your feet crossed or splayed, or whether you were hanging upside down, or if you are a man or a woman, or if the stove is made of aluminum or steel. The only property of the initial condition that is relevant is "hot stove" and "you touched it", and the result is "burned finger". The analogical reasoning extracts from the input-output relationship the relevant variables. Talking about the universe as a whole, there are no observations, there are no analogical situations, there is only one situation, and there is nothing to extract about cause and effect. The concept just doesn't make sense. There is

nothing to say about causing the universe, you could say my coffee mug caused the universe. If "God" means a being that has done magic in the past or present, then it isn't meaningless, it is false. There is no magic, there never was, this is known with scientific certainty. But a correct rational argument for God's existence can be made along completely different lines, and this also explains how people come to acquire intuition for such a thing. Nobody would ever get intuition for some abstract being that created the universe, such a thing has no connection to individual experience. The thing that one acquires intuition for is that there is a limit to evolving computational collectives, as people come together to merge to make more powerful collectives. Collective behavior by itself is not God. God is the realization that such collectives, in a particular system of ethics, can merge into an entity which can be consistently personified as the will of an abstracted infinite intelligence. This infinite intelligence can then communicate in a sense with individuals, through the collective impressions that form the larger entity. This abstract will is genarally constructed from self-consistency and desire for optimal social organization, using an organization of people, and religious texts. But the abstract entity itself can make judgements about societies, and it can judge that a society is behaving unethically, even when most people do not understand this, and there is no social pressure to reverse the injustice. This is what God does for the individual, provide a direction and a path for action which allows a more harmonious outcome. It works for this purpose, and so people can become certain of the existence of this thing, even though there is no evidence from material events for such an organization. A parable might be in order. If you are a brain cell in my body, you might not believe in "Ron". You might thing it's a stupid legend, that there is a "Ron" which is doing all sorts of things. You might only believe in brain cell spikings. If a brain cell which believes in Ron coordinates with other brain cells to help think about things that "Ron" is interested in, then that cell might get a huge reward, in terms of increased blood flow, as I struggle to understand something. The brain cell that decided to slack off and do something else might get all it's connections severed, and go into apoptosis. Knowing that the brain cells are forming a "Ron"

helps the individual brain cells act in concert. Human beings, in certain modes of behavior, constitute such a computing system, much like an individual person. Not only is each person is a computer of large size, the societies are also a computer of large size, and the societies are capable of doing computations that are greater than any individual. But this is true only when they are acting coordinatedly to a certain extent. But the collective is not necessarily a unified thing, it is a disjoint collection of individuals with different desires. So when considering collectives, one can have the situation where the interest of certain members is in conflict with the interest of others, and all these disjointed pulls can lead to a stagnant society with no progress, and which tolerates extremely evil behavior, like human sacrifice. The point of religion is that there is a sense in which a human collective can not only function as a coherent unit, the coherent unit can then communicate goals and desires to the individual through a voice that seems to speak directly into the individual's head, and this individual can then meet these goals, and through collective action, gain great success in produce progress in the society, even if the immediate result is persecution. This is the insight that modern religions try to instill in the practitioners. To see how this can happen in more mechanistic detail, you can start with a simple model for coordination, which is the prisoner's dilemma. The standard economic answer is that the players are supposed to defect if they are rational. This is the uncoordinated answer, and it is extremely silly in many prisoner's dilemmas. The resolution to this was found by Douglass Hofstadter, and this is the idea of superrationality. A superrational player cooperates against a superational opponent, because the opponent's decisions are perfectly correlated with his or her own, and he superrational player knows this before making the decision. The extension to asymmetric games is to postulate that there is a universal superrational strategy, which assigns as utility to all games. The superrational strategy, to be consistent, should be perfectly rational, in the Von-Neumann Morgenstern sense, and this means it can be personified as the will of a perfectly rational infinitely wise player who knows all the circumstances, but who is not actually playing the game, but just telling all the superrational players what to do. This god of the superrational collective, if there are other

superrational collectives, can merge with the other gods when playing superrationally with those. The result is a hierarchy of intelligences, formed out of the collectives, and the limiting conception is that there is a unique infinitely intelligent limit which all these collectives aspire to. Reaching this limit then becomes an end in itself, because it is a situation where all the players produce a great and growing mind which is revealing more truth than can be understood by any smaller collective. The procedure is to coordinate the decisions through the superrational play. It is perfectly reasonable to aspire to such a goal, and it is perfectly reasonable to anthropomorphise the utility function, to say that a super-smart agent is telling you exactly what to do. Of course, nobody has infinite wisdom, or infinite time, nor is exposed to an infinite collective, so all the decisions are approximate and evolving. But the ideal is that if you continue to work in this way, to evolve greater superrational collectives with greater internal coherence, you are approximating God more and more. The picture that emerges is similar to the Catholic doctrine of gradual revelation, expounded by Gregory of Nazanius (sp?) This idea is that God acts through individuals, informed by the holy spirit, producing new insights in each generation which allows God's will to be expressed more thoroughly. The main point here is to remove the double agency, and just identify the God with the observable consequences, instead of having this split in entities, between the abstract God "out there" and the revelation one sees in the progress in society, So instead of calling it a manifestation of God, you just bite the bullet and identify this with God. This makes the classical theological problems disappear. For example, the problem of evil doesn't come up, because people can be evil, there's nothing you can do about it, except be superrational and feel sorry for them that they are not, and are missing out on the mind-meld with the collective and the future limit. There are also no problems of definition, like "can God will something immoral", because the entity of God by definition is the moral order, it is a contradiction in terms to make the statement. I wrote more about this here, and other theologically minded answers: How might a theist explain his or her personal religious belief (see question details) to an

atheist in plain language and without Bible verses or other proof texts?

Why isn't the law that France just passed prohibiting people from publicly wearing face coverings such as the niqab considered blatant religious discrimination?

Considered by who? This IS blatant religious discrimination, and it's a shameful thing for France to do. If they had passed a law prohibiting infant circumcision, that would be religious discrimination just as much. Jews have been victims of such laws in previous centuries. Any of the arguments supporting this apply better to banning circumcision, where there is an actual infant victim who is being cut up.

Is it possible to measure a wave function?

Not on an individual system, this is a consequence of the fact that two nearby wavefunctions (in the sense of an inner product close to 1) are likely to give the exact same answer to any experiment you conduct, and after the experiment, you project the wavefunction. If you have provided with as many identically prepared systems with the same wavefunction as you want, you can measure the wavefunction to arbitrary accuracy.

Is any background needed to learn set theory and mathematical logic?

Learn basic boolean algebra first, to get a sense of the logical operations as arithemetic operations of a special sort. Then formal logic just adds quantifiers and some mostly completely obvious deduction rules. One of the rules is non-obvious, the generalization rule from a seemingly special case to a forall statement, when you have a free variable--- this is the most important rule, it is what makes logic superior to Aristotelian logic, you get out more than you put in. I found the introduction in Paul Cohen's book "Set Theory and the Continuum Hypothesis" very fast and complete. It might be good to go to a book which covers deductions using sequent calculus too. Learning to program a computer is useful, because the goal is ultimately to do deduction on a computer. If you write a code for deduction, even a bad one, you will learn what it's all about (I never did this, but I should).

What are the mathematics behind gravitational assist?

In a frame where a gravitational object is stationary, an object will leave the gravitational field with the same kinetic energy it came in. This means that the speed relative to the object is unchanged, in this frame, where the object is stationary. But if the object is moving relative to the sun, and you come in at a certain speed against the direction of the orbit, you are moving faster relative to the object. If it deflects you by an angle close to 180 degrees, you come out at the same speed relative to the object, but now going along with the orbit. this means you gained twice the orbital velocity relative to the sun, since

the frames are different. By repeating this trick, you can increase the velocity of an object by up to twice the orbital velocity of a series of planets or moons or whatever. All you need to do is to ensure that the object comes in against the direction of the object's orbit, and comes out at another angle, preferably as close to with the direction of orbit as possible.

What is the quantum membrane around a black hole?

This is just the horizon of the black hole, the way it stores the information is mysterious, but it is a quantum type of alternate variables, an object close to or inside the black hole is described by the quantum properties of the horizon. You shouldn't think of the horizon as a separate thing from the space time, if you describe the horizon completely, you've described the space time. This is the subject of most current research in high energy physics, it's AdS/CFT and holography.

Is it possible to make an artificial black-hole?

By humans, probably not, barring some technological miracle, the energy required is pretty enormous by the standards of elementary particles. It's like a dust-grain's worth of energy, like a small chemical explosion, concentrated into one elementary particle, smaller than a proton by the same amount that a proton is smaller than an astronomical body. This is the challenge of making a Planck-scale black hole. To make a natural black hole is no problem at all, you just put enough mass in a region, and it will collapse into one all by itself.

There is a bulk-scaling here, so that the mass in a region grows as the volume, but the black-hole limit grows as the length of the region, so you always get a collapse. Stars heavier than a few times the solar mass always collapse to a black hole, as no fermionic degeneracy pressure can prevent the collapse. Stars the same mass as the sun end up white dwarfs, supported by electron degeneracy, those a little heavier end up neutron stars, supported by neutron degeneracy. The degeneracy pressure is just the ordinary Fermi repulsion of fermionic particles compressed into a small space, to compress them smaller, you need to increase their energy because higher momentum states are occupied, by Pauli exclusion. Ignoring a small amount of electrostatic repulsion between nuclei, which is important in keeping atoms separate, it's the same thing as makes your desk hard. The hardness of the desk is because the electrons in the outer shells are Fermions.

Does the below article reveal a flaw in capitalism?

This is not necessarily a flaw in capitalism, it is a flaw in the way investment markets are set up. Investment is a crazy market, if you have 10 investment firms, and one firm makes a little bit more percentage, you suddenly have all the investors putting their money there, for the better return. So it's really the worst kind of winner take all business and it's not conducive to healthy competition. The result is that there are only a very small number of investment banks, and the people who work in those banks can take a percentage of the capital profits and put it straight in their pockets. No one can complain if the rate of return is still higher than the next best firm. It's an institutional flaw. I think that the proper solution to this is to restructure the investment market in such a way that investment banking becomes a healthy competitive business. The easiest way I can think of to do this is to make a slightly graduated capital gains tax, which makes it a little

more difficult for a large firm to make a profit on its investments than a smaller one. In this circumstance, you make an incentive for a large investment house to split off into several smaller ones with nearly identical portfolios, and then competition between these smaller firms will lead to the investment banking profits to be controlled by the same competitive mechanism as any other industry. The littler firms will be making nearly the same return, and wouldn't be able to siphon off anything into their pockets. The investment bankers will make a competitive salary, like anyone else. Such market construction is important whenever you have an industry with natural monopolistic tendencies. It is possible to do, and when you do it, the ridiculous compensation shrinks to a normal salary. The exception is when someone has a new idea, at least until peole figure out what the new idea is and copy it in other firms.

How do math geniuses understand extremely hard math concepts so quickly?

How can people who know how to read decipher all these abstract shapes into sounds so quickly? The brain is very big, and learning a fruitful concept correctly not only teaches you the concept, it teaches you infinitely many variations and generalization automatically. The only really hard math concepts are the ones that haven't been thought up yet. The ones that are called hard are those that have a background you don't yet know. The main trick is having a good set of examples for everything, so that you can motivate the formal development, and this is often left out of the books. You can reconstruct these quickly, but some people compile interesting examples in books and online.

What kind of math applies to understand Quantum Mechanics?

You need to know basic linear algebra, and then to extend the theory to a basis the size of the real number line, you need Dirac's theory of distributions (not exactly functional analysis, there are lots of irrelevant formalism added in the mathematical version of that field, and it's a distraction). You can learn all the mathematics from Dirac's book "The Principles of Quantum Mechanics", which starts off with a discussion of delta functions and test functions to define the delta function. The intuition is a little faster if you first work through matrix mechanics (or simultaneously). This can be done using the Wikipedia page. The mathematics was defined by abstracting it out from the physics in this case, and the mathematical formalism of functional analysis is hard to learn without the motivation provided by quantum mechanics, so it's best to learn the physics first.

Can I be a successful mathematician?

You can do it, but you need to catch up, read the classics, do those Putnam problems until you can solve them, learn the standard curriculum, and most importantly, have some new ideas. The "have a new idea" part is what is difficult, and it is so much more difficult than all the others, that it is really the rate limiting step. It is not possible to predict if you will have a great new idea, but one can predict from experience that you will have lots of mediocre new ideas for sure. Everyone does. The quantity may vary, the quality may vary, but you'll eventually discover something or other.

Calculus isn't intuitive to me. Am I alone or do other people have this problem as well?

The way to fix this is to understand two different rigorous constructions, the epsilon-delta definition of limits, and the rigorous infinitesimals of Abraham Robinson. The first thing just sidesteps the issue of what "dx" and "dy" mean, it just takes their ratio, and defines it as the limit as dx becomes small of dy/dx. The limit definition with epsilon and delta uses finite quantities. It says that the limit of dx/dy is M if for any epsilon (how close you want to get to M) there is a delta (how small dx has to be) such that whenever dx is finite and smaller than delta, dy/dx is closer to M than epsilon. This definition has a quantifier alternation (forall epsilon there-exists a delta), so it is a little tough to internalize. The original idea of infinitesimals was to consider the dx as already having a limit attached, that it has already gone infinitesimally small. This idea is harder to make precise than epsilon and delta, but you can do it using the idea of logical models of the real numbers. Models of the real numbers are collections of symbols that represent real numbers. One example of a model is digit sequences, like you learned in grade school. But you can also consider computer programs that define digit sequences to define the computable reals, or logical predicates that define digit sequences to define a more complete model of the reals (not all reals whose digit sequence can be defined logically are computable, for example, the real number whose n-th digit is 1 if the n-th computer program halts). In any logical model of the reals, you can adjoin the infinite list of axioms "I have a real number epsilon, it is less than 1, it is less than 1/2, it is less than 1/3....". There is no contradiction from any finite number of these axioms, so there cannot be a contradiction from the whole collection. This number epsilon is a formal infinitesimal, and adjoining it, you get a different model of the reals, where you can do all sorts of operations on epsilon, the same as you can do for a real number. But epsilon is not a digit sequence, it is defined in a different extended model. Then the ordinary real numbers, the digit sequences, are a submodel of the extended model, they don't mention epsilon.

Looking outside the models, you can define a projection from a certain subset of the extended numbers, the finite ones, to the nearest standard number. The derivative is then the standard projection of (f(x+epsilon)-f(x))/epsilon. This point of view requires that you are comfortable with the idea that the same logical axioms can have different models. There are lots of other ways to construct the non-standard reals, what I described is Abraham Robinson's way. The intuitive advantage is that there is no quantifier alternation in the definition of derivative, although formally, the theorems you can prove are the same in both approaches. So it is good to learn both ideas.

Turing Machine: How can you prove a summation uncomputable?

If you know the sum, you can solve the halting problem. The key point is that you can run all programs successively in parallel on separate threads, and as they halt, compute a number than converges from below to this sum. Given any program, and a way to compute this number, you want to know if it halts. So you take the length of the program and you want to determine whether there is a 1/n^2 contribution at the corresponding location of the sum. There are programs that don't matter--- the ones longer than the first point where the sum from this point onward cannot possibly influence the sum, even if they were all halting. So you only need to run a program that runs the relevant programs until enough of them halt that you are close enough to the number to determine whether the relevant position is 0 or 1. This is a sketch. There is an interesting question about what to do in the case where the sum is not absolutely convergent, for example, the sum on n in the halting set of (-1)^n/n. The same method doesn't work, but it should of course still be uncomputable.

Is "being born a homosexual" an extraordinary claim?

It's a claim.The extraordinariness of the claim is not an issue--- it is supported by strong evidence, at least for men, and it is probably true for men, and probably for many women too, although I am not sure, not being a woman and having seen no firm data. You should look at the evidence, not the politics, and going by the evidence, the claim is probably right. Independent of this claim, it's really none of your business who someone wishes to hook up with, so butt out. Even if homosexuality is an unnatural whim, it doesn't hurt anybody in any obvious way, and it is not doing any harm to society except in the heads of homophobic people, so really, leave people alone. But the claim that homosexuality is genetic could be seen as implausible, because the genes for homosexuality would seem to be selected against, for obvious reasons, so you would expect the genes to dilute themselves to zero frequency. But perhaps there is a positive selector, like homosexual men having lots of children with different women through random threesomes with heterosexual men and their wives (I am making this up, obviously). Perhaps homosexuality in women makes a greater tolerance of polygamy and more children, because they're into the wife, not the husband (I am making this up too, obviously). These are stupid just-so stories. Who the heck knows. It's not really implausible, people are complicated, and you can cook up a million reasons why it could be genetic, and also a million reasons why it might not be. Anecdotally, I have found that "homoexuality is genetic" sounds more implausible to women than to men. I guess this is because most women are pretty bisexual, while most men are just hard wired to be attracted to one or the other, and don't respond at all to sexual cues from the wrong gender. This observation is a guess, but it seems to be somewhat supported by studies of pupil dialation in men and

women looking at various kinds of pornography, the women respond to a lot of different things in general, the men to one gender or another more or less exclusively. But I am not an expert, and it really doesn't matter how plausible the claim sounds. If you want to know the answer, you need to look at the data, not the politics.

Is there any quick way to count the number of elements or the cardinality of the set {x+y+z where x,y, z are in [some list]}?

This is the subject of additive number theory, and the results depend on how many collisions there are between the sums. A way of producing the answer more quickly computationally than enumerating all n(n-1)(n-2)/6 possible triplets is to define the indicator function of the list, take it's Fourier transform, cube it, and take the inverse Fourier transform, then look at the support of the resulting function. This is why Fourier series is an important tool in additive number theory.

Is biology the study of replicating information?

To a certain extent this is a useful definition, but I would add two modifications. First, the information can't just be replicating, the essential thing is that it needs to be computing--- this means it needs to act on itself to make a general purpose Turing computer, (to be precise, Turing complete with randomness, so there's a non-computable oracle). Second, the notion of replication is not essential,

certainly not at the beginning, the replication doesn't have to have a high fidelity copy-generation. The precise information doesn't have to replicate precisely at all, it can replicate in a very weird way, by negative replication, just by preserving characteristics of itself, and digesting away non-self molecules, like an immune system. An example is some prebiotic set of low-alanine enzymes that digests all molecules with a greater than 50% content of alanine (random example, it probably doesn't exist, but there are other characteristics that do exist). This digestive system acts to negatively-replicate itself, in that it digests away stuff that is incompatible with its own characteristics, replenishing more molecules of its own general class, including the very enzymes tha maintain this class. This type of low-fidelity replication of vague character is itself ia form of modest replicaiton, and it is all you have when you start out a computing system. But a computing system with a character set evolves to make more and more characters, as the forming and digesting enzymes narrow themselves down to a smaller compatible set. The parts of this system acquire incompatible characteristics (for example, a mostly lysine set and a mostly leucine set), and the competition between these subsystems is already Darwinian long before a replication machine evolves. The computation and specialization in such systems is a form of evolution that does not require any special adjustment, or any self-replication to be put in by hand. The biology then evolves replication at a later stage, as the competition in such computing character-building soups is fine for making a Darwinian struggle, even without precise replication. The essential characteristic is the Turing completeness of the system, the existence of information carrying molecules which are capable of transforming one another in a way that can be programmed to run any algorithm in principle. This is the main characteristic of life, the Turing completeness, and it is present in both the protein and nucleic acid component of modern life. In the proteins, it is clear, in the nucleic acids, less so, because the full set of nucleic acid transformations is not known today.

Why is set theory important?

Set theory is important because it is a theory of integers, models of axiom systems, infinite ordinals, and real numbers, all in one unified structure. This allows it to serve as a foundation for all of mathematics, anything you talk about in mathematics can be formalized in set theory naturally and easily, and studying set theory allows you to prove theorems about mathematics itself. The formulation of set theory in the late 19th century motivated the metamathematics of the 20th century, with all the astonishing results about provability. It is an extremely important subject, and I am not going to do it justice in this answer. I would recommend to read Paul Cohen's book "Set Theory and the Continuum Hypothesis", together with some historical work from the late 19th century or early 20th century, like Frege and Cantor, to see where the ideas are coming from, and further work from more recent authors, like Saharon Shelah, who is a big name with big theorems and big books. I will give an answer that focuses on the first three things, integers, ordinals, and models, because I personally think it is good to conceptually separate out the real numbers, as they are described in set theory. The real numbers are important for usual day-to-day mathematics, but in set theory, they can be a headache, because they are a different kind of infinity than the integers, ordinals, and logical models. The idea of set theory is to turn logical predications, like "x is less than 100 and x is greater than 1", into objects which can be manipulated by good formal rules. The objects are thought of as the collection of things which obey the conditions of the predicates, like the collection of integers (or real numbers) between 1 and 100. But these collections are not thought of as explicitly enumerated as a list, just as an abstract collection in your mind, something you think about. The finite sets reproduce arithmetic, they are just another way to talk about finite structures, like anything on your computer. Any finite structure on a computer can be encoded as a set, using a coding, like unicode, to represent arbitrarily sophisticated objects as integers. You can represent an integer as a set using a standard encoding, so that 0 is the

empty set, and having constructed the integers 0 through k, you construct k+1 as the set {0,1,...k}. The axioms for building up sets allow you to turn a predicate into a set, but you have to be careful--- the predicate "X does not contain itself" cannot be turned into a set by saying "The set of all X such that X does not contain X", because this is Russell's paradox. The predicates are only allowed to restrict sets which you already constructed some other way, for example "The set of all X inside the real numbers which do not contain X" (this is another version of the empty set--- not set contains itself in the usual set theory--- this is a consequence of one of the axioms). So you need to carefully describe how to build up sets, and how to separate out parts of sets using predicates. In modern set theory, you build up infinite sets using axioms, the axioms of infinity, unions, and powerset, and you cut down using the axioms of separation and replacement. The axiom of separation is the predicate axiom--- it says that every subset of elements of a set obeying a given predicate is also a set. The replacement axiom subsumes the separation axiom (you can prove separation from replacement by a simple trick). It's what Frenkel added to Zermelo theory The nice thing about set theory is that it is a natural way to make models for axiomatic systems. A set model is a collection where every theorem of the axiomatic system refers to some set, and every relation refers to some set which encodes the sets which satisfy the relation. Once you have the Von Neumann embedding of the integers, you have the axiom of infinity. This asserts that the set of all integers is itself a set. With this axiom, set theory becomes a new field, because suddenly you have a model for arithmetic! This model allows you to prove that Arithmetic is consistent, since any theory with a model is consistent, so the axioms of set theory, plus the axiom of infinity, allow you to prove that arithmetic does not contain a contradiction. So very innocuous looking axioms suddenly prove very sophisticated looking theorems--- you learn that the axioms of Peano Arithemtic don't reach a contradiction as you compute the consequences, simply from the assertion that the set of integers exists within set theory. The structure of mathematical theories is clarified with the concept of the ordinals. You define the set of all integers as the smallest infinite ordinal omega, and then you can define iterations of counting past omega, by defining omega plus 1 as the set of all integers and omega too, omega plus 2 is the set omega plus 1 adding the set omega plus 1 as a new additional element, and so on. A trick for visualizing ordinals is to view them as an ordered sequence of points on a line, which can accumulate going up, but cannot accumulate going down, so that they can reach a limit as you step left, but if you always step to the right, you always reach zero after a finite number of steps. The ordinal sequences are the most important thing in set theory. Each ordinal is a mathematical object which defines a different kind of infinite list. You have a notion of transfinite induction, a generalization of the idea of mathematical induction to the ordinals, because whenever a statement is true for 0, and whenever it is true for all ordinals less than X, it is true for X, then it is true for all ordinals. The ordinals define what it means to iterate something more than infinitely many times. For example, from Godel's theorem, you know that every axiomatic theory has a theorem it cannot prove, namely it's consistency. So you can define the theory "plus one" as the theory plus the axiom of its consistency. Then the theory plus 2 is the theory plus 1, plus 1. You can define the theory plus k for all integers k, and then the theory plus omega is the union of all statements proven by all these theories. The ordinals allow you to speak about infinite iterations going up without any limit. The final thing in set theory is the axiom of powerset, and the real numbers. This axiom asserts that the set of all subsets of any given set is itself a set. This axiom leaves the realm of the countable, and makes uncountable sets of larger and larger cardinality. It was this axiom that popularized Cantor's set theory, because it was immediately clear that you can give easy proofs of certain previously difficult statements. For example: prove that there exists a transcendental number. No probem! The algebraic numbers are countable, the reals are not. The axiom of powerset allows you to step up infinite sets using a different kind of iteration than the ordinal scheme, you step up in leaps. The first leap constructs the set of real numbers as the set of all subsets of the integers (more or less). The result is that you can make a model for set theory without powerset, this is the collection of all countable sets, and the existence of this model proves that set theory without powerset is consistent. So

powerset produces stronger models, just like the axiom of infinity. The reason this axiom is problematic (although not inconsistent) is that it immediately produces uncountable ordinals, and it comes into conceptual conflict with Skolem's theorem. Skolem noted that every normal theory has a countable model, just from the way logical statements work, the logical statements you can write are countable. So here is an axiom which is asserting the existence of an uncountable set, but a model of a theory with this axiom is going to be equivalent to a countable model. So this axiom is producing sets which do not reflect very accurately their structure in the simplest models of the axiom. It creates a conflict between the intuition regarding the set described and the models and ordinals thatn describe the models. All the ordinals in a reasonable set theoretic model are countable, the models are countable structures. The power-set axiom, however, guarantees that these countable models have delusions of grandeur and speak about uncountable sets as if they contain any! The sets they think are uncountable, the ordinals they identify as uncountable, in the countable models are countable, but lack an explicit map in the model to reveal their countability. This is a subtle point, and it is important for further developments. This skolem business becomes more stark when you consider set theoretic forcing. The notion of forcing allows you to adjust the properties of uncountable sets, using the freedom that comes from the fact that the uncountable sets are being described in a fake way, inside countable models. You have infinitely many choices for the digits of real numbers, but only countable many conditions are being enforced by the axiom system. This allows you to make "generic" real numbers that have no special properties relative to the old countable model, that are just as if they were randomly selected. The inclusion of powerset allows you to talk about arbitrary real numbers and sets of real numbers, and this is useful for day-to-day mathematical work. The result is surely not inconsistent, because the axiom of powerset, when the generalized continuum hypothesis is true, only steps up by one unit in cardinality each time you use it, so it is producing rather small sets. But the forcing shows that the actual powerset operation is really an enormous thing, so that even the real numbers can map onto an ordinal as large as you want, even bigger

than all your current universe when considered as an ordinal. This mismatch is what is causing trouble in intuition. The issues can only be sorted out by not taking powerset too seriously, by considering the powerset to be making a caricature of the real numbers. The "true" real numbers are better imagined as having the measurability property, so that picking a real number at random between 0 and 1 makes sense as a concept. This is incompatible with the axiom of choice on the reals, so it is not a popular axiom, but people act as if this statement is true anyway, drawing pictures of typical randomly chosen continuous things as if the concept made sense in set theory.

Has anyone written anything about the amazingly interesting similarities between Francis Crick and Richard Feynman?

Crick and Feynman were both physicists. The same traits were or are shared by Wolfgang Pauli, David Gross, James York, and thousands of other physicists. It's the way physicists cut out bullshit and make progress, and it really should be a universal trait in scientists, but it can wreck your career, so it isn't.

How would one calculate the dynamic time evolution of the shape of an electron wave function in a chemical reaction?

You calculate using the adiabatic approximation, you can assume the electrons stay in the ground state, and the nuclei are classical. Then you allow the nucleus to move around, and the wavefunction to change to the instantaneous ground state of the potential given the position of the nuclei. This is the Born Oppenheimer approximation, and it's exact for normal temperature systems, basically excluding liquid helium and nothing else. The result is easy for Hydrogen with one electron, but you can't do this type of simulation in real time with more than 2 or 3 electrons, because the wavefunction is high-dimensional. In this case, you want to change to density functional theory. The existing codes for this will give you the ground state property of complex molecules, using a core potential and valence wavefunctions which are approximately correct in shape, for any deformation of the nuclei. The best method is the Car-Parrinello method, which integrates the electronic structure in real time.

What are the benefits of religion (any religion)? What parts of the human psyche does it satisfy?

The modern religions are different from ancient nature-religions in that they do not naturally emerge in human societies without a historical link to the ancient near east or India, there is a real discovery there, namely the discovery of meditation, trances, and so on, probably in India, and the discovery of superrational monotheistic ethics, probably in Iran. These discoveries are what makes religion spread and stick, because it is telling people a non-obvious truth, that we are supposed to bind together into a big uber-mind, and in the infinite limit, this mind is like an infinitely intelligent agent that tells everyone what to do. This insight is difficult, and it is not a natural need of the human mind, empires have been built that ignored it

completely. But it spreads because it is true, and it does give people contentedness, the same contendness that comes from knowing any other true thing, like that Jupiter is a gas giant. Religion in the modern sense is not a psychological phenomenon as much as a revealed truth about the structure of evolving societies. As such, it spreads because it is true, not because it is convenient, because it is not convenient, at least not usually, for the modern religions.

Is it possible to extract a wormhole with Quantum gravity, & also in LHC we already got Quantum blackholes to pop outta n get neutralize like a virtual particle, so somehow if we manage to utilize the energy frm it?

No, there are no traversable wormholes in known quantum gravity models, they make problems with causality. LHC did not produce black holes, it is far too low in energy.

Would abolishing private secondary/high schools promote equal opportunity in the UK?

not really, it's not like private schools are so great in education. They have to deal with rich kids. Besides, it's an infringement on personal freedom, there might come a time when the pubic schools are only teaching propaganda. You can't force people to submit to state education, you can only provide it.

What can we learn from Terence Tao?

You can learn how to prove that primes come in longer and longer arithmetic progressions. You can also learn the proof of many other theorems of depth and elegance, and some pedagogical things on his blog.

What are some areas in neuroscience/ cognitive science/ mathematical psychology, where the level of mathematics is comparable to advanced applied math/physics?

None yet, hopefully soon.

When and how was it first recognized that you could theoretically build an atomic bomb?

In 1939, when the fission of Uranium was discovered by Hahn and Meitner in Germany. The implication for a chain reaction and therefore a bomb occured to several people, most notably to Leo Szillard, who persuaded Einstein to write the famous letter to Roosevelt. It's very clear that there can be a chain reaction from a

fission that emits secondary neutrons, but it's not clear it can be made practical. The details were worked out in the preliminary stage of the Manhattan project, the building of the first atomic pile in Chicago by Fermi, which showed that the fission chain reaction can be self-sustaining.

Is otherwise respected biologist Stuart Kauffman as off-base as I'm sure he must be for saying "Information Theory Does Not Apply To The Evolution Of The Biosphere"?

Kauffman's is off base here, but he makes a good point. Kauffman claims that you can't a-priori decide which bits in a physical description will end up being biologically relevant, so you need to include the entire physics. His example is the locations of certain electrons in a configuration of the chlorophyll molecule, which end up being important to the process of photosynthesis. You wouldn't know that these electrons are somehow going to be important a-priori, before the molecule is put to this use. So he claims that you need to know everything about the molecule to extract the biologically relevant information. This is a reasonable argument, but it's just false. The reason is that the states which are available to the molecule are always defined by the collective of other molecules it can interact with, and in the case of the chlorophyll molecule, the electronic displacement would be completely unimportant if there weren't another molecule available to accept the electrons and use the extra energy to eventually add a phosphate to ADP. The molecular cycle in question is defined by the available molecules for extracting the energy. In this context, the interaction of chlorophyll with light is important only inasmuch as it triggers a chemical transformation in

the next molecule downstream. This is an information change which can be described in a simple diagram, the kinematics and dynamics both, and without the other molecules, it carries no information. The information capacity of a molecular system can be defined circularly using the concept of a relevant bit. A bit that can be read out by the system is a relevant bit, and it can be read out when it can transform another relevant bit. I know this sounds terribly circular, but it's not hard to see which bits are relevant--- you start with some states you know are relevant, for example, an enzyme that cleaves and destroys some protein you know is doing something in the system. Then a bit is relevant when it can affect the function of this enzyme in some way, through some cascade of events. The collection of bits which can affect one another and which are stored in the molecular configuration define the functional diagram of the molecules. From the diagram, you can figure out which bits are relevant, from the possible interactions between all the states of the molecules with other molecules. So Chlorophyll's electronic excitation is relevant precisely because there is an adaptor which will take this excitation and do something with it, and change the state of an ADP molecule to ATP, which now carries a bit of information (and some energy), and can modify other bits. The network defines the relevant information. This definition does not start at the physical description exactly, but abstracts out those bits which are capable of affecting other bits in the environment. The result is a closed system, and the possible interactions can be mapped using pairs of molecules, you know what possibilities are possible without having to probe the entire electronic structure of all the molecules all the time. You only have to understand those changes which can be read out by other molecules available in the system. This is the main point of the functional approach to biomolecules, you don't need to know everything, and the set of relevant data is defined by the possible interactions of your molecule with the other molecules already present. it is circular, but benignly so, it defines the biological information self-consistently by its interaction with itself, by the computation, by those transformations which are capable of impressing their states on other molecules whose state is relevant.

I study physics and mathematics with full interest but it lacks when it comes to chemistry. Does anyone who have a remedy for this?

Read Pauling, and the interest will come. Also Crick, and the other structural chemists of the 1950s. The structure of biomolecules, DNA and certain proteins, is a terrific motivator, and it requires some deep chemistry to understand fully. A great popular account appears in "The Eighth Day of Creation". After that, organic synthesis also becomes interesting, and inorganic chemistry can be used as a probe into biomolecules, so some inorganic chemistry becomes exciting. For a more recent motivator, there is density functional codes, like the Car Parinello method, which allow you to see the electronic structure of biomolecules on a computer in real time.

For nonbelievers, what is the strongest argument you have heard supporting religion/God? Conversely, for believers, what is the strongest argument you have heard refuting religion/God?

There is an ambiguity in the decision making in game theory, because the best choice sometimes requires knowing how correlated your

decision making is with others. The classic example is the prisoner's dilemma, where the individual rational strategy is to defect, yet the superrational strategy is to cooperate. The superrational strategy means that you are aware that you are superrational, and that there are others who are superrational, and your opponent might be superrational. The superrational players are all 100% correlated in their decisions, and make their decisions knowing that they are correlated in advance, so they act as one. If you decide to play superrationally, and a community of people does so as well, your collective decisions, if they are consistent, should be the same as if an infinitely wise perfectly rational agent were making them for all of you. You can personify the agent whose will is this strategy, and give it a name, and make decisions based on the will of this agent. This thing is the God of monotheistic religion. It has nothing to do with magic, and the evidence that it is possible is that fact that superational collectives have formed in human history, and managed to convince people to act against their self-interest, and in the interest of the superrational collective, as best as they were able to determine. The prominent example is the Christianization of the Roman empire in the 4th century. The self-consistency of the belief system is self-evident, the existence is weird, because it's a mathematical thing, you don't need to worry about existence. Just behave the way you're supposed to.

How is it possible to disprove the existence of anything with certainty? A friend argues that you can prove that things don't exist if you can show that their definition contains logically contradictory or incoherent statements. What do you think?

This is a standard red herring. The word "prove" and "disprove" are not mathematics when used in day to day life. They mean something else, something scientific. You can disprove magic by doing tests for magic, and failing to find it in places where the magic proponent claims it occurs. But you can also disprove it simply using Occam's razor, there is nothing we observe that requires magic. The problem is that the sensible definition of God just isn't magic. It's a sort of nebulous mathematical thing that determines ethical behavior in various circumstances. It is not very well described in religious texts, which have their own historical baggage, and serve to prop up a controlling theocratic order, so you can easily miss the fact that religious folks are actually talking about God, the ethical thing.

How intelligent was Richard Feynman?

Feynman was one of the greatest physicists of the 20th century, and his contributions were unique because he showed people all these things that they had missed, like the path integral, the diagrams, thermodynamic inqualities based on exponential convexity, time ordering of operators, hard sphere model of He4 and vacuum ansatz, partons, quantum computation, vacuum structure of gauge theories, tons of stuff, which people felt really silly for not having seen before he pointed it out, but they didn't see it before he pointed it out, and the large gap between when they could have been done and when he did them shows that he was necessary. Intelligence is not the proper variable to measure, it is the creativity and difficulty of the work. He was also a phenomenal calculator, he could work through integrals and physical problems very rapidly, and his methods were original, so looked like magic to others. He was a very good puzzle guy, and his adult performance on standard puzzles was about as good as the best folks that do such stuff, but this is not a big trick. It's only notable because as a child, he didn't score phenomenally on IQ tests, but as an

adult, he clearly learned to do this, so discrediting the ridiculous claims of IQ testers that they are finding a fixed genetic trait of individuals which is not improved by mental training. Feynman was an American physicist, like Wheeler, one of the first native American talents for science. He was a role model in the US, but he also became a media figure. As a media figure, he could be annoying, but as a scientist, he was a model for honesty and originality.

What is Ron Maimon's advice for undergraduate maths research?

Maybe you can find a good wavelet scheme for integrating partial differential equations which produce smooth solutions. That would be handy, the current methods are really suboptimal. It's not going to get you any recognition, so nobody does it.

Do extraordinary claims require extraordinary evidence?

All claims require the same evidence, unfraudulent persuasive data that cannot be explained away by something else. It is best if you have 5 sigma evidence, so that you are sure that there is only a one in a million chance that the evidence is a fluke. There are no "extraordinary claims", all claims are ordinary. The separation is between false claims and true ones. Since it is easy to fool yourself, you have to do careful thinking with the evidence. But the idea that some claims are "ordinary" and don't require a lot of review, and others are

"extraordinary" and require people to jump through hoops to accept, this is the way that politics interferes with the progress of science. The ordinary claims are the ones that are politically popular, like, say "oil is made from dead plankton". The "extraordinary claim" is the claim that oil is made in the mantle. The basic idea of science is that you accept extraordinary claims based on just ordinary evidence, like the chemistry of the oil, the migration patterns, and the existence of bacteria in the deep Earth, established by ordinary looking through microscopes, and ordinary chemical assays. There is no special hoop to jump through to get an extraordinary claim accepted, just the usual thing of getting evidence that gives certainty. This is a very problematic statement, as the claims of science are always extraordinary when they are new. They only start to look humdrum after they are well accepted. Extraordinary claims shouldn't be accepted just because somebody says so, but neither should ordinary claims. All claims need evidence of the same sort.

What is Ron Maimon's advice for kindergarten kids?

Don't put little rocks in your ears or nose. They are harder to take out than to put in. If there's a kid in your class that pees in his pants, he isn't making a social point or trying to be a rebel, he just misses his mommy. Don't pee in your pants to emulate him. Two hard won kindergarten lessons from yours truly.

Is free/open-source software communist?

Free software is something new, and cannot be categorized well in the older terms. In a paraphrase of Richard Stallman, free software borrows a little bit from socialism, from capitalism, and from anarchism, and adds a little twist of its own. Free software removes a counterproductive state imposed restriction on individuals, the restriction on copying and modifying. It also requires published source, allowing easier modification. This allows the non-material resources to be competitively adapted and shared without artificial barrier, and makes a healthy software market, where ideas compete on their merits, without restrictions on competition. Since copyright essentially wrecks the usability of software in obvious ways, adopting free software is a no-brainer. The resulting market is vastly superior to the closed corporate software world. The result is only "communist" in that a class of property which has been artificially created by state licensed monopoly is eliminated. If you call that communist, your definition is pretty loose. But it is anti-corporate, in that large corporations that sell closed software suffer, and it tends to favor individuals and smaller firms, which are able to compete fairly, and then run circles around the big guys. So this is a model for reducing the undue power of large corporations. When the artificial restrictions and tricks which guarantee their advantage is removed, they wither away. Pehaps by repeating this trick, other large corporations can be reduced in power, simply by making the ground level enough for others to compete fairly.

What is the connection between advanced set theory and theoretical computer science?

The large cardinal axioms prove new theorems of arithmetic, each one asserts the consistency of a tower of weaker theories. In this sense, you should think of these as an ordinal iteration of adding "this theory is consistent" again and again starting with a weak theory. In order for

the resulting theory to be an axiomatic system deserving of the name, the ordinal of iteration needs to be computable. The naming of larger and larger computable ordinals is a task in the theory of computation, it is the study of Kleene's O notation. This project is underemphasized, but it is the equivalent in computer science to the tower of infinitary axioms. The super-infinitary aspects are a total red herring, and make it difficult to understand what the content of these axioms is. These axioms are just trying to extend the range of computable ordinals you can prove are well founded by adding new conceptual layers, but they do so at the wrong intuitive place, at the top of the set-theoretic heirarchy, rather than inside the countable computable ordinals.

What is Ron Maimon's advice for grad students?

Read the literature, just for the heck of it, all of the literature, especially old classic stuff. Do your own research, as quickly as possible, in addition to whatever silly slave-stuff your advisor wants you to do (but do the slave stuff too, to get a degree). Don't get exploited, if you find something alone, publish alone. Also, remember that 19 out of 20 of the other grads aren't going to find anything significant, so don't waste time emulating them.

How much heat energy would we use if everyone had heat source inside their body (eliminating the need for building heat)?

We already have such a heater, with body-training, it is effective at maintaining body temperature efficiently at any temperature between approximately 5 degrees celcius and 30 degrees celsius, even with minimal clothing. It works from the inside, by just burning energy, by activating ATP for no other purpose than to heat the body. The energy expenditure is about an extra 2000 kCal/day on a cold day, you need to eat about double if you are nearly naked at 10 degrees celsius.

Special Relativity: How is it possible that massless particles exist?

The "m" in e=mc^2 is a kind of mass called "relativistic mass", which ultimately is just another name for the energy, except now measured in mass units. This energy-mass is what weighs on a scale, when an electron is zipping around in a circle in a magnetic field, and you weigh the device, the electron's contribution to the mass is the energy divided by c^2. This relativistic mass is what you add up to find the total mass of a composite body, but it is not determined by the type of particle you have, the relativistic mass is determined by the type of particle and it's momentum together. There are no particles with zero energy, so there are no particles with zero relativistic mass. Any particle contributes to the weight of a box which contains it. A box with photons bouncing around inside is heavier by the energy of the photons divided by c^2. The "mass" in "massless" is another thing called mass, it is the "rest mass" which means "mass in the rest frame", and massless means that they would have zero energy in the rest frame. Since massless particles travel at the speed of light, there is no rest frame, they just have less and less energy as you chase them faster and faster. The "rest-mass" is what is most often called "mass" today, not the relativistic mass, since the relativistic mass is always just proportional to the energy, and it is wasteful to have two names for what is essentially the same thing.

What does Ron Maimon want his legacy to be?

I think the biology stuff is the main thing, the recognition of the computational structure of cellular processes, and the associated origin of life business, which allows you to do a whole bunch of stuff that was remote before. For example, it is possible to make a complete catalog of all possible chemical systems that admit life anywhere in the universe, with no bias coming from Earth biology, and to roughly estimate the relative progress of these systems relative to one another, just from the computational capacity of each system, and it's processing speed. Not that I did this, but it's possible along the same lines as the origin of life business. But now, it is clearer and clearer that the actual computation in modern cells is 98% RNA, that's where nearly all the RAM is, and the protein computations are just the residual stuff from a previous era, so the main work I did on this, on protein network diagrammatic language, is very dated and of limited usefulness. and the RNA algorithms are completely mysterious, because data is just trickling in today, although they will be worked out soon. I just want to make as many contributions as I can, and make sure that this is done in an open environment. Many people want this too. I guess it's the same as anyone else, you just want to be a part of the scientific process.

What is Ron Maimon's advice for middle school students?

Like I remember. Learn to program a computer, learn some foreign languages. I don't know. Play at recess. I have no insight.

Why did Richard Feynman criticize String Theory?

Feynman thought the string theorists were being dishonest--- they were saying there was a unique theory (this was true), unique compactification (not true), that they can predict standard model parameters (maybe), and yet the theory did not do so, and there were wrong predictions, like gravitinos, unbroken supersymmetry, etc, things we still don't know how to fix very well. He was disappointed at the many different kinds of string theory discovered, and also it wasn't so physically transparent what the strings were back them. Much of these things improved in the 90s and later. Feynman didn't know the theory very well, he only knew a little bit of Veneziano amplitude stuff from the days when it was current in QCD. He learned some of the newer techniques in the mid 80s, but it was never something he did research in actively. When he was dying, he asked Gell-Mann to lecture him on the theory on his hospital bed, and I supposed he learned the state of the art in string calculations then, since Gell-Mann followed string stuff since the beginning, and supported it throughout. String theory in the 1980s was much less solidly physically understood than a decade later, and it was always a form of S-matrix theory, something which Feynman heckled and helped kill in the 1970s. Feynman always disliked S-matrix theory, even though he helped found it, because he made Feynman diagrams in S-matrix and they turned out to be field theory. So he probably thought like Weinberg, or Glashow, that S-matrix is just a bad way of doing field theory in disguise, and didn't recognize that there was a fundamental new physical principle in the S-matrix approach. S-matrix was Wheeler's baby more than Feynman's. In any case, it was a lapse of judgement, Feynman knew better. But his criticism of the string propaganda of

the 1980s is pretty good, the string theorists were a doing a little bit of groupthink at the time.

What would a development of mathematics be like if we replaced the axiom of choice with the axiom of determinacy?

The result, for practical purposes, is that you would be adding the axiom of measurability to the reals, so that you wouldn't have to worry about statements of the form "pick a random Gaussian real number" or "consider a random walk" and talking about set membership for these random objects. In current set theory, you can't talk about set membership for random objects, only about membership inside measurable sets, which is a subuniverse of sets. The result is not so great, because you are just doing ordinary set theory with powerset with a new infinitary axiom, and the system is harder to analyze because you can't label the ordinal of the real numbers inside models with an explicit symbol. The proper way of thinking about determinacy was developed by Woodin, it gives new theorems because it is a type of reflection equivalent to adding a type of large cardinal called now a "Woodin cardinal", except you add an infinite tower of these. The structure of set theories is only made clear when you understand that they aren't talking about uncountably infinite sets really, they are really talking about various countable models of universes that include ostensibly infinite sets. The same types of constructions can be carried out in a countable world, by adding appropriate axioms for new large countable sets, and you get the same extra theorem proving power as adding enormous axioms. But the advantage of working inside computationally well defined worlds is that you have a Hilbertlike understanding of the universe, because it never expands to become out of reach of intuition, it is

always countable. So I don't think that taking these types of infinitary axioms is a good idea. You always need to justify the axioms using reflection principles which are tantamount to a consistency proof using large countable computable ordinals, when you do it right, when you do it in the sense of ordinal analysis.

What would the integral of distance give you, and is that useful, if so, in what way?

nothing, not useful.

What scores do various Quora members get on the 50-item Autism-Spectrum Quotient Index test?

20, the concept is stupid, there is no "Autism spectrum", this is a test of bullshit social skills.

What is inside of a black hole?

black holes are not made of anything, they are vacuum solutions to Einstein equations. Since every string and brane in a string theory is ultimately a teenytiny quantum version of a black hole, you can think

of everything as made from black holes, and the question is as nonsensical as asking what electric fields are made of, since matter is composed of the fields, not the other way around. In the same way, in quantum gravity, the matter is all dual to some kind of black hole.

What classes did Ron Maimon take while he was at Harvard University?

By year, the ones I remember vaguely: 1. freshman writing, math 55 (2 sems, Noam Elkies, good course), intro mechanics, intro e&M, complex analysis , history of science, intro french 2. gradQM(2 sem Gabrielse good course), relativistic QM, thermodynamics(chem), hindu religion (interesting core), TAd math 55 (good course), Number theory, undergrad topology, undergrad algebra rings fields 3. Quantum field theory (Coleman, good course), grad statmech, Morse theory (Taubes, good course), General Relativity (at MIT, Ed Farhi, good course), real analysis, intro to moral philosophy (got a C , my paper on superrationality got a D), TAd number theory with Mazur (good course). 4. Reading course wi. Sidney Coleman (Aspects of Symmetry, good course), renormalization group with David Nelson (good course), Random Walks with Perci Diaconis, (good course), There are a bunch more that I forgot. I labelled the ones that were ok, but the ones from before the senior year were kind of silly standard material plus required undergraduate nonsense.

What is Ron Maimon's advice for high school students?

Go to college. High school sux.

What is theoretical biology?

Theoretical biology is the study of biology from first principles. The goal for me is to make a full mathematical model of the behavior of a cell which is capable of predicting the behavior in a general situation, at least statistically (meaning, the range of possible behaviors). The idea is a little difficult to make clear, because there are two immediate things one thinks: 1. Isn't this just physics Physics will predict the behavior of the atoms in the cell, so it solves the problem of biology in principle. But the biology is NOT just the physics, because the physics is absolutely enormous, and mostly irrelevant. Which water molecule is where is just not an interesting biological question, and at most contributes only a little stochasticity to the biologically relevant events. Removing information is the main idea. 2. Isn't it intractible The other respose is that the problem is impossible, because there is no meaningful simplification to be made. The cell is in some sense maximally complex, it is Turing complete. A Turing complete system admits no reduction in description beyond a certain point. The second point is what I got hung up on in the 1990s, as Chris Henley told me in 1995 informally "What can be done in biology that has the same depth as, say, the renormalization group in physics". This question was difficult, from this question I understood that the Turing completeness stood in the way. Turing completeness meant that you couldn't reduce the cell to a simple iteration system, like the renormalization group reduces the Ising model. It meant that any simplification of the sort that physicists like, the kind that makes the behavior obvious in a simple model with tractable behavior, was going to be futile in biology, because it would be ignoring the Turing complete aspects. But then, you can see that we have a whole field that is devoted to artificial Turing complete systems, and they make progress, This is computer

science. How do they make theory. To a large extent, their theory consists of ways of making a language which more succinctly expresses the structure of algorithms and their properties. So proceeding in this way, you can make a language for the information transformations in the cell, and so long as you keep making the language higher level in the proper way, you will produce a more and more elegant description of the program of the cell. This is what theoretical biology means to me: it is the program of describing the computational algorithms the cell is performing with a more and more high level Turing complete language appropriate to the domain. When you do it right, you have a minimal description, which captures the function in a minimal number of bits. At this point, you can start to make predictions about behavior, and produce artificial biological circuits comparable to natural ones. This was the motivation for my own work in 2001 to 2005, producing a language for proteins. The major lesson from this is that proteins are computationally peripheral outside of bacterial cells, and the major story computation wise is in noncoding purely computing RNA.

What is the general feeling about Douglas Hofstadter's line of thought?

I read Godel Escher Bach as a teenager, I don't think this work is his best, because while it is fine as literature, the main theorem is mystified rather than explained, and the main thesis is murky and isn't so deep when unraveled. It is mostly an artier version of Nagel's "Godel's Proof", and it doesn't make the theorem as transparent as it should be. To prove Godel's theorem takes about 20 seconds once you know what a computer is: given an axiomatic system S, write a program which 1. Prints its code into a variable R 2. Deduces all consequences of S 3. If it finds the theorem "R does not halt", it halts. Each of these can be done by a computer program, each is a simple

exercise. GEB obfuscates the issue by using the traditional approach of Godel numbering, and formal logic, and by avoiding computers. But the "Typographic number theory" with it's pushes and pops, is a cute way of doing logic, and the various puzzles make the implications of Godel's theorem more intuitive, and it doesn't come to wrong conclusions, so I can't complain. I liked it when I read it. The main thesis in the book is that the self-awareness of human consciousness somehow acts as a form of reflection, like an axiomatic system becoming stronger by adding "this system is consistent" again and again (I am paraphrasing). This idea is interesting, because it is a semi-algorithmic view of the brain. Adding layers of self-reflection to a system adds strength, and the human mind, Hofstadter is theorizing, is doing this type of self-reflection constantly, in the way it examines its own thinking. It is an interesting idea, and it is possibly true, but it requires a way of making the mind capable of somehow increasing the power of a fixed formal system. Perhaps this is possible because the brain has a randomness source, since computation with a random number generator is non-algorithmic in the strict Turing sense, and it might be able to evolve systems that reflect higher and higher, by evolving stronger systems. The main idea is illustrated using self-referencing artists and self-referencing constructions. It's a new philosophical idea, and it has some merit, but it is only nebulously stated in the book, in an arty way. Hofstadter made it clear that he meant that the self-reference in Godel is analogous to the self-reflection that humans do, and to the formal reflections in both works of art and in axiomatic systems which are more powerful. But his training in logic is limited, so the language is vaguer than it could be (but he was also writing 30 years ago). The really interesting new stuff for me is in Metamagical Themas and subsequent work. In the last chapters of this Metamagical Themas, Hofstadter isolated and defined the completely original concept of superrational decision making. This is a great original contribution to mathematical philosophy, full stop. Superrationality is the first mathematically precise statement of the golden rule, and it is, when appropriately extended, the solution to the problem of cooperation in one-shot prisoner dilemma type games, a cooperation which is observed in human behavior, Nash be damned. It

is, when extended properly, formulating monotheistic religion independently of intuition, emotion, or sacred texts. This I think is extremely important, as important as Kant and Kierkegaard and Plato, at least once you understand the further implications, because it allows you to define a notion of God independent of religious revelation or the specific human condition. The extended notion comes when you try to make a consistent superrational system which extends to arbitrary games. To do this, you need to assume that the superrational strategy exists and is self-consistent over all situations in all games, associating a utility function to each play in every concievable game. The result is tantamount to an infinitely wise agent watching over everybody, knowing the personal circumstances of all play, and making decisions about what is best for the infinite future, the resulting agent so constructed might as well be called God. The intuition is clearly identical with that of religious believers in the monotheistic tradition past the 1st century AD. This is how I understood what all those religious people were talking about, and since the idea is mathematically precise, you can't argue that it is nonsense, and you can see it has nothing to do with magic, or creating the universe, and it makes sense in positivism. The rest of his work is in making models of analogy-making in human cognition, a project which he explains in "Fluid Concepts and Creative Analogies" and in his latest book. The Fluid Concepts era is more traditional AI, trying to write code to make simple analogies, like copycat and seek-whence. These programs make analogies in limited domains, and with limited success. In analyzing these programs, and making comparison to human cognition, Hofstandter began to bite the bullet in true AI, making a machine that thinks like a human. The main barrier, as he explains, is making these intuitive analogical leaps that brains do so effortlessly. The computational models here are terribly inadequate, as he shows, because each of the analogical paths are in very fuzzy loose ways that are not well captured by a set of formal sentences. In this, he is trying to break free of the simple models of formal language that have been used with no real success to model human cognition in the 1960s, and which gave logical positivism a bad name. The logical models are broken because the cognitive categories are far more complex than the boolean models which assign truth to a hard logical sentence. When you say "I applied to Harvard, I got an offer from Purdue, but Purdue has a much nicer department anyway." and someone says "Sour grapes." (Hofstadter's example), you are making a very sophisticated high level analogy, where many different pieces are set up in a very complex analogy in the two situations. Hoftstadter doesn't deny that ultimately this analogy is done by a form of computation in the brain, but he denies that it is fruitful to model it as a formal analogy between lines and arrows in a formal model, rather one has to have a very loose categorization scheme which allows for vague linkages of various strengths, with a model of computation which is very different from the classical one. These insights are born of hard struggles with the problems of true AI, facing failure with intellectual honesty, and struggling with the understanding that the real processes of cognition are vastly more computationally deep than what has been acknowledged so far within neuroscience or computer science models of cognition. This insight was important to me personally, and it should serve as an example of what to do when you DON'T have all the answers, you go forward as best you can, without losing sight of the goal, and without pretending you understand things more clearly than you do. Hofstadter writes honest things in a field which is usually dominated by politics, and for this alone, I think it is worthwhile to read everything he writes.

It is important that the general public stays well read on physics and maths. But modern physics and maths isn't accessible in its technical format. What should be the way to deal with this?

Ask for an explanation here of anything you don't understand. Eventually, you'll get the hang of it.

What would happen if I filled a soccer ball with helium?

The soccer ball would be infinitesimally lighter, and would slowly leak until it was deflated. It's not a good idea.

What philosophical schools do most modern physicists subscribe to?

Physicists developed the philosophy of positivism in the late 19th century, and it is the standard philosophy used in the field for day-to-day work. This philosophy was extended to logical positivism in the 20th century, by incorporating formal grammars and computers, and in this form, it is a mature foundation for philosophy. Logical positivism is pretty much the standard physics philosophy, although most physicists are not versed enough in the philosophy taxonomy to identify it as their philosophy.

Why don't more physicists subscribe to pilot wave theory?

Two comments on the question: 1. nonlocality in a theory today is not a serious issue, because the holographic principle demonstrates that gravity is already nonlocal. 2. The physical picture of particles bouncing on waves in space is misleading, because quantum mechanical waves are in a high-dimension space of configurations, not in three spatial dimensions. If quantum mechanical waves were physical waves in physical space, rather than abstract waves over the space of all possible worlds, the interpretation wouldn't be debated. The high-dimensional configuration aspects of quantum mechanics is what makes the theory weird, so that the piloted particles are really configurations of particles piloted by an enormously high-dimensional wave waving in the space of all possible positions. The answer to this question is that physicists are positivists, and the positivist content of pilot wave theory and ordinary quantum mechanics coincide. So despite the different words, it shouldn't be called a new theory, the predictions are the same. But going further, one sometimes prefers a formulation which is more intuitive over another that is less intuitive, even if the predictions coincide. One reason to be sure that pilot-wave is not even a reasonable formulation of quantum theory as it is usually stated is that the position basis is not particulary distinguished in quantum mechanics, but it is distinguished in pilot-wave theory. Pilot wave has particles with definite positions, not definite momenta, which wander around guided by the wave (over positions). You could repeat Bohm's trick in the momentum basis, and get particles with definite mometum wandering around in the space of all their simultaneous momentum (the formulation is a bit more difficult because the force laws are not always quadratic, but ignore this, you can do it in principle). You can do it for any basis. So there are an infinite number of different Bohm theories which only differ in which variable you choose to make "real", all these formulations give the same predictions at the end of the day. This is an uncomfortable position, since there can be no test to determine which one is correct. It also means that the formulation has made an unnecessary arbitrary choice of a distinguished basis, and so is not very nice theoretically. Pilot wave theory still has the wavefunction, and so it is just as enormous computationally as quantum mechanics--- it reproduces quantum

computation in all its glory. There is no gain in simplicity from this, unlike, say, Feynman's formulation, where you gain the ability to do Monte-Carlo in imaginary time, a tremendous simplification computationally--- monte-carlo is tractable. The nature of the wavefunction as a configuration space thing, with a number of dimensions growing with the number of degrees of freedom, means that you are still considering a hopelessly enormous theory that can never be understood classically, it doesn't help that it is more visualizable in the single-particle case. But pilot wave theory could still be important, because it has a different conceptual formulation, so if you set out to modify the theory, you get different modifications. In that sense, it is a good new idea. I personally think that you can produce a truncation of pilot-wave which doesn't coincide with ordinary quantum mechanics, but which is mostly the same as quantum mechanics when you are dealing with only a few particles only slightly entangled. In this case, you need the wavefunction to be a complicated function of the hidden-variables (the particle positions) which only obeys the Schrodinger equation approximately. This type of thing is a true modification of quantum mechanics, but I was never 100% sure that it works. I described the idea roughly in my answer to one of 'tHoofts questions on physics stackexchange.

What is the most amazing unsolved mystery in geology?

How do heavy metal mineral deposites form in the crust? Which elements are sedimented out of a water solution, which in methane? What are the paths of methane migration in the crust? What are the hydrocarbon deposits in the deep crust? What are the chemical transformation steps of methane in the crust? Where do the methane dissolved elements sediment out? What is the carbon content of the mantle? How does methane form in the mantle from subducted

limestone? Is the methane in the mantle being depleted? etc, etc. All of these mysteries are currently taboo from study, because to study them you first have to know that methane flows from the mantle to the crust, carrying short-chain light oil hydrocarbons in solution, and trace amounts of heavy crust elements besides. The mechanism of formation of heavy metal veins requires answering these questions, and because of the influence of oil geologists, who prefer to believe cockamamie nonsense that oil is biological residue, these questions have no non-speculative answer.

Which are some of the strangest mystical claims that science eventually found to be true?

That's hypnosis. Perhaps there will one day come to be a testable measurement to confirm a statistical non-magical form of synchronicity in a way that can be differentiated from chance or causal connection, but it is a very difficult thing to test.

What mathematics should high schoolers learn for physics, and in which sequence?

You need the same competence as a mathematician, except without the formal baggage, so just go through the standard rigorous stuff, but don't take the formalism too seriously, learn the ideas. It is good to review historical material, mathematics is more arty than physics, the history is important, like you need to know about Beethoven to be a

musician. * Archimedes: I like his books, but they are a little dated. The best stuff is the "The Method of Mechanical Theorems" and "On the Equilibrium of Planes". This is where physics begins. * Leonhard Euler: "Introductio in analysis infinitorum", he's the king of infinite series, you'll get intuition for this stuff that is suppressed later. * Abraham Robinson: the books on model theory and nonstandard infinitesimal analysis are great deep classics. * Serge Lang: He's the king of pedagogical texts, all his stuff is rigorous and well presented. * Herman Weyl: group representation theory and algebraic number fields, anything you can find by him. * Paul Cohen: "Set theory and the Continuum Hypothesis" is a MUST READ, and the earlier the better. It contains a development of logic from first principles, and although the computational presentation is slightly dated, it's orders of magnitude shorter and clearer than other texts. * Yu I. Manin: This guy is fantastic, his logic book is extraordinary (" A course in Mathematical Logic for mathematicians"). * Benoit Mandelbrot: His books are very accessible, and motivate a lot of newer things, I like Fractal Geometry of Nature and 1/f noise, but all his stuff is great. * Bourbaki: maybe it's a little dated, but it's a style that is still used. The stuff they work through is from first principles, but you need to read Paul Cohen first, to sort out the set-theoretic nonsense. * A book on algebraic topology: maybe Hatcher, maybe something else, I like the books from the 1960s, because these emphasize simplices * MacLaine and Saunders: Categories for the working mathematician (necessary evil). * Stanley: Enumerative Combinatorics. There are nice books by Edwards on Galois theory and things like that, there are good books on transcendence theory, these are just a sampler of things I liked that stick out in my mind at this moment. There are classical works you need to read, but I haven't read enough of, so I can't recommend. Once you get through this, learn French and read Grothendieck.

Applications of Inequalities for example Cauchy- Schwarz, Jensen, AM-GM or Maclaurin in non theory based math. In Mean for building machines or something?

These inequalities are usually only interesting because they occur many times in certain proofs. You can understand why they occur from the notion of convexity. which subsumes them: A convex down function has the property that f((x+y)/2)≥ f(x)+f(y) 2 f((x+y)/2)≥f(x)+f(y)2 or, another way of saying this: the value at the mean is no less than the mean of the values. The convexity follows from the monotonicity of the second derivative, and this is a way of turning a local property (the sign of a second derivative) satisfied everywhere in a region, into a global property (the inequality between the values at distant points). Applying this to the log function you get the AM/GM inequality log((x+y)/2)≥ log(x)+log(y) 2 log((x+y)/2)≥log(x)+log(y)2 You get the traditional statement by exponentiating both sides. Applying convexity to the function 1/x, you get the AM/HM inequality. Log transform and apply to the appropriate function to get the GM/HM inequality. All of these are convexity. You can generate as many examples as you have patience to write down, by finding convex functions. The Cauchy Schwarz inequality is also convexity: ||X+Y||≤||X||+||Y|| ||X+Y||≤||X||+||Y|| Divide both sides of this inequality by 2, and you see it is convexity. Square and expand, and you see it is Cauchy Schwarz. The convexity here is for the multivariable function ||X||, which is higher dimensional, and convex in the cone sense, one of the eigenvalues of the second derivative is always zero (but the rest are strictly positive). That these are all convexity of special functions means that the general principle is convexity, and the notion of convexity is extremely useful in physics. For example, the Feynman inequality e ⟨F⟩ ≤⟨ e F ⟩ e⟨F⟩≤⟨eF⟩ found in his statistical mechanics and path integral books is an important special case of these, since they apply to path integrals and allow you

to give good bounds on the structure of the polaron, among other things Feynman used this for. The convexity of the exponential function is also used in a similar way in the information theory analysis of Shannon, it is a central insight of thermodynamic reasoning.

Which technology startups have the best Wikipedia entries?

This has to be Pacific Biosciences. They had one of the major technological breakthroughs of sequencing, and their machines, while not yet competitive in precision, are superior in many respects to existing technology, and are unfairly politically maligned, it seems so as to drive them out of business. The big genius here is Steven Turner, who I met at Cornell. His idea to turn zero-mode waveguide into a new technology was brilliant and inspiring, and I hope these guys stay in business long enough to realize their potential, which is really to revolutionize sequencing. They are able to get the pure nucleotide content of a single strand of DNA. The same method can be used to see ribosome action, all sorts of things, at the single-molecule level.

What would be some common subjects/concepts that a theoretical physicist, mathematician, economist, and cognitive scientist share and contribute to the learning of?

Computers and computer programming. These underly the precise knowledge of all the technical fields, and provide a proper foundation for mathematics and philosophy, as explained by the logical positivists.

How did Germany had so many scientific and cultural advancement during 17 and 18th century?

The influence of individuals is enormous, future work builds on previous work. The major thing the Germans had was Ludwig Boltzmann, who founded modern physics. The statistical approach was the most important advance of the 19th century, it was born in Germany, and dominated physics, it led to Planck and Einstein, and Wien, and Einstein was so transformative, and wrote in German, and he was really the second founder of modern physics, and he built most significantly on Boltzmann. The only other comparable advance was in England, in Faraday and Maxwell, and the British were nearly equal to the Germans, producing Heaviside, and Dirac, and a bunch of other greats. The Americans took all of the great folks after the war, and became the major center for science. The other major thing Germany had was a tradition of independence from Christianity, they developed Protestantism and later Marxism. This allows for progress, because it makes the past structures less stable. The Germans also got Nietzche Heidegger and Hitler out of this, so it's not all positive. But socialism was very friendly to science, nearly all the scientists, including Einstein and Dirac, were committed socialists (at least at first). The Russians developed their science after the revolution, and were very competitive with the west until the Soviet Union collapsed.

What are some interesting areas of research/study in philosophy of mathematics? How do these affect/impact mathematics as such?

For me, the important one is the viability of formalism as a mathematical philosophy. The arguments here are vapid, because people have not understood Godel's theorem properly, because the proof is made out to be complicated. Godel's theorem boils down to the statement that mathematical systems are indexed by countable computable ordinals. This is the content of Turing's thesis. Eventually, as you step up the ordinals, you solve the halting problem, and using the systems you can prove any well-defined theorem. This should be a complete philosophy of mathematics, except for the nonalgorithmic question "how do you name ever-higher ordinals?" The methods here are obscure, and they cannot be formalized in a deterministic program. But it might be possible to evolve ways to name higher ordinals in such a way that one can become sure that higher ordinals are being named. If so, then only the addition of a randomness oracle is needed to complete the mathematical philosophy. I am not sure about this statement, and it requires some mathematical and philosophical thinking. The impact on mathematics can be quite large, because you can produce stronger systems, and prove the consistency of existing systems, much in the way Gentzen proved the consistency of arithmetic. This is fascinating mathematics. It can also serve as the antidote to the Godel depression, the idea that some theorems are hard because "there just is no proof". This situation cannot occur really, not if the problem is well defined.

Are there different mathematical abilities/mathematical reasoning styles?

This is a bugaboo of learning mathematics, the issue is that the rote knowledge seems arbitrary, and the brain hates to learn it. But you do need to learn a certain amount of boring stuff, because the boring/interesting ratio in most proofs is very high, especially when you are proving something for the first time. The trick to this is finding a pattern in all the stuff, even the boring stuff, because once you find a pattern in the rote stuff, it stops being boring. This is something that you can't teach, it requires motivating yourself to see a pattern in something that only has a limited amount of pattern. But music only has a limited amount of pattern, and you can enjoy it, because of the diversity, not because of the monotony, so you can see that chess-like non-regular aspects of mathematics as like a music, and appreciate it as such. It is not good to only learn the things that don't require memory, because some things are just annoyingly non-patterned, and the proof follows from higher-order patterns, like in the four-color theorem proof.

What is the real reason behind the limits being imposed (or perceived limits) in pursuing a career in pure mathematics?

Mathematics is provably infinite in richness, it is nowhere near closed, and pure math has never been more vibrant or easy to study. You can make up a new field every day, the trick is to get someone else to care. It is complete nonsense to think that pure math is exhausted, I can't even answer this, because it is so ridiculous. It's like saying "hasn't

most music already been composed?", or "Haven't most novels been written?"

Why does laminar flow become a turbulent flow when the velocity goes beyond a certain limit?

There's a nice qualitative reason for this: the fluid is unstable to sharing energy between all the modes of flow, because thermal equilibrium for a field system is unattainable. So, just by statistics, you expect the energy injected into the long-wavelength mode, the flow, to dissipate to short wavelength modes, because there are a heck of a lot more short-wavelength motions than long-wavelength ones. But normally, this is done with one step of dissipative friction, this is what happens in laminar flow. The reason for turbulence is that there is a nonlinear term in the Navier-Stokes equations from advection, which is lower order in number of derivatives than the Laplacian--- it only has one derivative, while the Laplacian has two. So when the velocity is fast or the scales are large (the Reynolds scaling is all that is important, the ratio of the typical size of the advection to the dissipation), the advection dominates. Because the advection is a quadratic term, it can only move wavenumbers k and p to the wavenumber k+p, this is how squaring works in Fourier space. This means that the wavelengths can only march up by unit steps in log momentum space, at least for a little while. The result is that you produce a cascade, where the energy goes down randomly to higher and higher k (smaller and smaller scales) until the dissipation dominates, and the flow turns into heat. The cascade has a qualitative description in the Kolmogorov 41 theory, This theory is not complete, because it gets the scaling exponents wrong, and it is homogenous. The true phenomenon has some localization in space, and different

exponents. But for qualitative descriptions, the cascade is fine. The unsolved problem in turbulence is describing the precise cascade in any meaningful quantitative way. The qualitative idea has been understood at least since the 1940s.

Are there any odd theories with strong scientific evidence that scientists are afraid to publicly confirm for fear of ridicule?

I like to collect these, as these situations are what the internet is best at fixing. But, because of this feature, the number keeps dwindling every year! The list used to include the following, but these ideas became un-taboo sometime in the last ten years: Radiation hormesis: that ultra-low doses of radiation, comparable to the natural rate, can paradoxically reduce the rate of cancer, (probably through stimulating the body's defense mechanisms). This is likely true, although more studies are needed to be sure. The theory idea started to get positive press about 5 years ago, but people have been saying this for decades. Epigenetics: non-genetic factors in the cell can be inherited, probably through egg RNA. This is accepted now, it is accepted through certain mouse mutation studies that were published in science or nature some years back, but people were saying this for a long time too. Mattickian RNA networks: Massive network of RNA in the eukaryotic cell nucleus which serves to regulate the cell function, much as the brain controls the body. S-matrix theory: This is the idea that you can make a theory of resonances which have no constituent particles. It is really string theory, but people didn't always make the association. It's pretty much ok again, now people write about Pomerons and Reggeons without fear of ridicule. These are accepted today. The most egregious examples left: Cold fusion: The Pons and Fleischmann's thing, with deuterated Palladium, not the fraudulent Rossi stuff with

Nickel and hydrogen. This is the doozy. The experimental evidence for Pd-d cold fusion is compiled on A library of papers about cold fusion, and it is unassailable, and has been for decades. Abiogenic petrolium: It was known in the Soviet Union that petrolium is not a biological product, but produced in the mantle, and percolated up dissolved in methane (also from the mantle). This position was popularized and extended in Thomas Gold's book "The Deep Hot Biosphere", but you will still be heckled nonsensically if you oppose biogenic origin theory. Marlovian authorship of the Shakespeare cannon: This one shocked me, but it is extremely well supported by modern styometric studies, and by recent non-mathematical scholarship. It is also obvious to any reader who reads the Marlowe cannon, especially Edward II. If you look at minor examples, it's pretty much every scientific idea. Nearly everything is laughed at when it is new.

Can the event horizon of a black hole isolate a single quark?

It can, but the black hole is colored, and quickly emits a neutralizing quark, so that the net emission is of a pion, or a hadron. Black holes have color hair, just as they can have an electric charge.

Why does Ron Maimon not drive a car?

In fall of 1999, I was driving from Boston to Ithaca, I did that every weekend, because my girlfriend lived in Boston. But I had to pee, so I was going 80 to get to the next exit, and I got stopped by a cop. I was going to pay the fine, but my father said "Don't do that, go to court,

because, it's a first offense, they will dismiss the fine". The judge did dismiss the fine, but she imposed a 6 hour safe-driving course instead. The moment she said it, I knew. That's it, I'm never going to drive again. I had no idea what this course was supposed to be, or where it was, and I also had no intention of doing it because the judge was exercizing arbitrary ridiculous authority. I got a bunch of warnings in the mail, some 6 months later, my license was suspended. A year or so later, it got revoked. By then, I had bought a bicycle. Driving a car in the US is pretty much mandatory, and it has become an excuse to license and catalog everyone, and create a situation where the police always has a reason to stop you, search you, fine you, at any time. It creates misery, people spend their whole life in a box. It is selling your freedom for convenience. Plus, the bicycle is a superior invention, the car is a kludge, ripping off the bicycle and train with no important improvement. So thanks, judge, for helping me see this. I might be driving today if it weren't for your help.

What are logical fallacies grounded upon?

Creationism is a stinking lie born of the devil himself, concieved in the lowest pits of hell, so as to blind well-meaning folks by making their religious sense an enemy of their common sense. It deflects God's light so that it may not reach any who have learned even a little science. It is an accursed abomination, an odious sin, verily a crime against God and the truth! Ye creationists be damned--- damned until ye repent! Repent now, Lest you find yourself in eternal torment, for you have raised inequity before the judgement of God. Logical fallacies are just bad logic. They have nothing to do with creationism.

What is Ron Maimon's advice for college students?

My advice: find the good departments at your university, locate the good technical people (they are everywhere). Study mathematics, physics, chemistry, molecular biology, engineering, computer science, technical stuff, because this is where the hard knowledge is, and then go ingratiate yourself to the good technical people in the University. There is a simple rule for ingratiating yourself with any academic. An academic, even a famous one, is like a cat that has not been petted enough. To pet the cat, read one of it's more obscure technical papers deeply, and extend the observations incrementally. When you come to an academic with a solid insight related to an obscure point that they discovered, you have made an instant friend for life. The reason this works is because academics spend months and years developing ideas that often only two people read in any detail, the editor and referee, and often zero people understand. This is a miserably lonely state, and they will tremendously appreciate it if you read their work and understand it, even half-way. Outside of technical fields, there are good things in experimental psychology today, due to the lingering influence of Stanley Milgram. You should read Shakespeare, and know he is Marlowe, so read Marlowe too. Don't smoke marijuana or drink to excess, or take any other substance that will damage your brain. I was A2A'd, I don't have any special insight.

What are the mathematical pre-requisites for studying string theory?

There really are not so many, the difficulties in string theory are the alien physics, not the mathematics. Aside from standard topics for

physics, you need to know all the Lie Algebras well, not just SO(3), SU(3), SU(5). The natural path here is through the SU(5) SO(10) E6 guts, and you can learn this from Green-Schwarz-Witten. You need to know homology/cohomology intuitively, and a small amount of algebraic geometry, just to relate the compactification geometry to the physics. But the barriers to learning the theory are developing a physical intuition for such alien things as strings. For this, you need to learn the complex analytic things that motivated the original discovery. You need to an intuition for analytic continuation, this is standard undergraduate stuff, but the physicist intuition is more developed--- you can read Gribov's book "The Theory of Complex Angular Momentum", along with Mandelstam's articles on the Analytic S-matrix, and those of others throughout the sixties. This is the most difficult thing--- understanding the analytic S-matrix stuff, and this is not something that rigorous mathematics is going to help very much with, and it is not even current in physics departments anymore, it is just buried. After this. the remaining mathematics of string theory is developed most straightforwardly by learning the theory from physics sources. The Kac-Moody algebras, the conformal algebras, the mirror symmetry, even the Ricci flow, these are all things that were developed first within string theory. The flow of ideas here has been nearly entirely from physics into mathematics, with a few exceptions that are still more clearly described in the physics literature.

What is the best way to develop an intuition for tensor algebra (from a rigorous mathematical perspective)?

Learn "abstract index notation", so that you won't be under the false impression that indices are somehow less rigorous. Then it's trivial,

because all the manipulations are the same as component manipulations.

If prompt says "no more than 2 boys scored any given score" does it means that it can be 0 or 1 boy who scored any given score or it means that 2 boys and not more than 2 scored any given score?

It means 0,1,or 2.

What are the most significant results of Fourier Analysis? What are the most important things to know as a mathematician? As a physicist?

The Fourier inversion theorem, Fejer's theorem, the FFT, anything in Koerner's book. The subject is somewhat self-contained, it only takes a few weeks to get comfortable with it. For a mathematician, you should know the generalization to Z mod n (discrete Fourier series), the theory of characters, and Dirichlet's theorem on primes in arithmetic progression. In physics, you have to internalize it, because it's momentum-position in quantum mechanics. Dirac is good for this, but it's any source, momentum space wavefunctions are everywhere.

Can a terrorist easily make an atomic bomb provided access to Uranium?

No, not without some blueprints, some additional rare radioactive elements, and high-explosives, all of which are controlled or expensive. It wouldn't work without careful design, even with the simplest model of bomb, a Hiroshima style gun using enriched Uranium. The most likely event for an amateur builder is a small atomic fizzle, where there is a chemical scale explosion of a few tons of TNT equivalent, and the thing disassembles into a noncritical size.

Why is there no differential equation for the conservation of angular momentum?

It exists, the divergence of the angular momentum tensor is zero. The angular momentum tensor is usually (for a good convention) related to the stress energy tensor as follows: $S \alpha\nu\beta = x \alpha T \nu\beta - x \beta T \nu\alpha$ $S\alpha\nu\beta=x\alpha T\nu\beta-x\beta T\nu\alpha$ This can always be arranged when you have a Poincare invariant local system using the Balinfante construction, and it is also clear from an argument Feynman gives in "The Character of Physical Law", relating rotations to translations. It's something that was worked out in the 1910s. Then the conservation law for angular momentum is a differential identity: $\partial \mu S \mu \alpha\beta = 0$ $\partial\mu S\alpha\beta\mu=0$ But it is a consequence of the conservation of momentum (the zero divergence of the stress-energy tensor) plus the symmetry of the stress tensor. The statement of the conservation of angular momentum is usually stated in terms of the choice of a symmetrical stress-energy tensor.

What got you interested in particle physics?

I think every person on the planet is interested in particle physics, at least this is my impression from talking to the lay public. It is condensed matter physics that is harder to sell to untrained people, although it can be equally beautiful. Growing up in the 1980s, I think every child was made vaguely aware that there had just been a major intellectual revolution in the 1970s, as quantum field theory became precise through 'tHooft's work, and Ken Wilson's, and all the field theorists, and furthermore that there was also a more far-reaching revolution in something called string theory, another major discovery of the 1970s which was extended and popularized in the 1980s, that worked even for gravity. At the time, we knew very little about how string theory was supposed to work, and there were a lot of competing wrong ideas about how gravity is supposed to go, based on more naive path-integral approaches. Also, in the 1980s, I personally felt that physics was out to get me, it threatened my life, through atomic weapons, so perhaps that is a subconscious motivator. A sentence of death tends to sharpen the mind, and you want to get to know your executioner.

At the beginning of the universe, when all four forces were combined into one force, was that force an attractive force, repulsive force, or some other kind of force?

This question is not sensible, because 'force' in particle physics just means a spin-1 boson mediating interactions between fermions. The normal forces of push and pull in our day-to-day world are usually mediated by the electron field, and indirectly by electromagnetism holding the electrons attached to nuclei. The Pauli exclusion effect is what makes matter hard, and it has nothing to do with fundamental bosons. The combined force for the three interactions is just a GUT, which is a collection of spin-1 fields, so a 'force' in this jargon. Within string theory, the whole force/matter thing is just low-energy approximation, the unification of all the forces is just a unified stringy thing, where every particle is a little black hole. The terminology has no relation to macroscopic forces, except to electromagnetic forces or gravitational attraction, which are a small thing in our day-to-day life, most life is pushes and pulls from electron exclusion, with some electromagnetism and a little gravity on macroscopic scales.

How can atheists imagine that the staggeringly complex human, containing an amazing brain, was made without a shred of assistance from anything with intelligence?

Yes, this is a big clue that there is an intelligence at work inside the genomes of organisms. This intelligence is not external to the system, obviously, it must be composed of the information carrying molecules in the cell, in this case, it is obviously RNA. But this intelligent design means that you can make a scientific prediction, namely that the RNA in egg cells and complex eukaryotes is involved in networks of splicing and rewriting that actively compute with the tens of gigabytes of RAM available in the genetic sequence. It predicts that sequencing machines will find completely unmappable RNA in the cell, which does not

correspond to anything in the genome. It predicts that mutations will consist of reverse-transcribed sections of this RNA, and work based on a plan, as consistent not with an infinite intelligence, but with a gigabyte-scale computation. This is being discovered as we speak. This is the lesson of intelligent design in biology, not supernatural nonsense from the 10th century BC. But it's still intelligent design in a sense, just not an infinite intelligence, a finite relatively large computer compared to the modern synthesis.

What does it feel like to be a Quora celebrity?

Celebrity on the internet is widely diffuse, it is not like celebrity in mass media. It is a form of attention, and this is ok, but since it is diffuse, it doesn't unfairly take away attention from others as it used to earlier times, when media was concentrated in a handful of television networks or radio networks. It's not a problem, nor is it a particular ego boost, it just means you have something to say. When you stop having anything to say, it goes away. I also don't think I'm much of a Quora celebrity, but I was A2A'd.

What is an intuitive explanation for the multivariate Gaussian distribution (aka multivariate normal)?

Sigma is symmetric, so you can diagonalize it by a rotation, and then it is a product of independent Gaussians in each separate coordinate. This means each coordinate is separately chosen from a Gaussian

distribution with sigma equal to the corresponding eigenvalue of big-sigma.

Should you continue being yourself even if that gets you to be obnoxious to society in general?

A good compromise is to continue to be diplomatic in your personal life, and in face-to-face interaction, and brutally honest online, where this type of behavior is not only not sanctioned, it is expected and rewarded, because it is important for keeping the information accurate.

What is the law of conservation of information?

"Conservation of information" is quantum unitarity, the law that the quantum mechanical wavefunction always evolves coherently, no pure state ever turns into a mixed state. These are clean google terms. The classical analog is Liouville's theorem.

What is the meaning and the implications that time is an emergent property of entanglement as shown by a recent experiment?

It's press nonsense. It's "quantum collapse" and "measurement" emerging from entanglement, i.e. many-worlds interpretation.

Let (a+ b*sqrt(5)) ^n = X + Y * sqrt(5). I need to check if for any 'n' is X%m==1 && Y%m==0 (given a,b, m)? Also, I need to find smallest n if it is possible.

This is a recursion relation for X(n),Y(n), starting with X(0)=1,Y(0)=0: X(n+1) = a X(n) + 5b Y(n) Y(n+1) = b X(n) + a Y(n) The smallest nonnegative n which works is 0, so I assume you are looking for n>0. You reduce a,b mod m, and the space of possible X,Y mod m is finite, of size m^2, so the sequence of pairs (X,Y) repeat after a certain point, certainly before n=m^2, so you can look for the first repeat, and find the smallest nonzero n that works to give X(n)=1 Y(n)=0, if any.

Why uniform continuity is hold in euclidean metric but not in sup metric? Both of them can find minimum distance between the two point i believe.

The Euclidean metric E(x,y) on R^n and the sup metric S(x,y) on R^n give rise to the exact same definition of continuity, because given any epsilon, you can find a delta such that whenever S(x,y) is less than delta E(x,y) is less than epsilon. Conversely, given any epsilon, you can

find a delta such that S(x,y) is less than epsilon whenever E(x,y) is less than delta. Less formally, in pictures--- for any sphere, you can find a box with the same center completely inside the sphere and another box which is completely outside. Conversely, for any box, you can find a sphere completely inside the box, and a sphere completely outside the box. This condition means that the two metrics are the same for continuity purposes. In a more abstract form, if a set is open, so that it is a union of the open interior of a ball centered at every point, then it is also a union of a box at every point (choose the box that fits inside the sphere). Same thing vice-versa.

What is the most useless fact you know?

To read the cassette tape attached to your apple II, look at memory location -16336.

Structural Biology: Do all proteins increase osmotic pressure equally? Do they increase osmotic pressure to the same extent as an equal number of dissolved molecules (like glucose)?

Yes, unless they stick to each other or to the membrane. This is the ideal gas law: P=kTN/V. The reason it applies in this surprising context is that the dependence of the entropy of classical molecules in dilute solution on the volume is exactly the same as for the entropy of a

gas, it's the log of the number of configurations of N molecules in the volume, or log(V^N), up to combinatorial factors for identity.

Does relativity have implications for causation?

In order for an event "A" to cause event "B" in relativity, event A must be to the strict-past of event B, this means that a signal starting at A travelling at the speed of light has enough time to reach position B. If this condition is not met, then by travelling fast enough, you can reverse the time order of A and B. There are three possible relations between pairs points in relativity: either A is to the strict-past of B, so that A is to the past of B in every frame of reference (a signal from A can reach B), or A is spacelike from B (so that a signal cannot reach from A to B, so that A and B are simultaneous in some frame), or else A is to the strict-future of B. The three situations are defined by whether the relativistic distance between A and B is real or imaginary, whether the square-distance is positive or negative, and if the result is imaginary, whether A is forward in time from B, or to the past, in the coordinate sense. The condition of relativistic causality in field theory is stated using field operators, meaning independent objects attached to space-time points that define what the results of experiments at that point can be. The condition of causality in quantum field theory is that measurements of two operators at positions A and B which are spacelike separated are always independent, so that you can measure the operators in any abstract order, and the results don't depend on the order. This condition requires operators attached to points, and in modern string theory, there are no precise spacetime points to attach operators to. In this context, the condition of causality is formulated differently, as Mandelstam causality, in terms of dispersion relations on scattering amplitudes. These conditions are involved to state mathematically, but one way to state them is that singularities only

occur on one particular branch of the complex momentum plane. This type of condition makes it so that if you start with a signal at asymptotic infinity, you never recieve the signal at the other side of asymptotic infinity before light can reach you. The condition is annoying and mathematically involved because the space-time in the middle can't be taken for granted, you need to formulate the causality on the boundary. In modern holographic string theory, these previous conditions are revealed to be natural, and for particular curved space, the AdS space, the causality condition becomes the ordinary field-theoretic causality on the flat space that encodes the boundary of the theory. All of these physics notions are only indirectly related to the idea of "cause" and "effect", because the philosophical notion involves a particular human notion of analogy. To decide whether pulling the switch caused my lights to turn off, I have to ignore all the other factors, like my friend blowing his nose, and to do this, I have to say "no matter what else is going on, pulling the switch would have led to the light turning off". This second thing, the analogical reasoning between all sorts of different events, is philosophy, and is not important for the physics discussions at all. But this is what people get hung up about most often.

What is the Mach principle?

Mach's principle is the statement that the local reference frame is determined by distant matter. As it is stated, it isn't correct, partiy because the word "matter" is ambiguous. If you include boundary as matter, it becomes precisely correct, and it can be seen as a primitive classical form of the modern holographic principle. I was going to write a longer answer, but this eminently readable soon-to-be classic paper resolves the question for good: [hep-th/0612117] Mach's Holographic Principle .

What is the best way for me to switch fields from biochemistry to physics?

You need to memorize information for physics too, just it congeals together more. In biology, it congeals too. In physics, grad-students are computational slaves, or calculation slaves, it's no better. So you should switch if you have a good idea of what you want to do. The way to tell is to read the current physics literature (this takes some months or years of familiarizing oneself with the terms and calculation methods), and then see if you are inspired to extend some current work. Perhaps you have a good idea for quantum chemistry, or materials. But I think it's a pity, because the questions of biology are more pressing today, it is a more vibrant science at the moment, and it is on the cusp of becoming as mathematical as physics became in the 20th century. The mathematical tools are different, they come from computer science, as biology is what we call computer science when it is found in nature. But there are tons of interesting questions left in physics too. Maybe you'll have an insight into one of them. If so, switch.

What are some things that need to be taken into consideration when putting on a Philosophical/Scientific debate?

The easiest way to focus the debate is to make a "positivism rule", all statements need to come with a prescription to test them. Then the position of "intelligent design" can be made to make predictions, like

finding intelligent patterns in DNA, for example, or a path of evolution that cannot be taken without a sophisticated understanding. The position of "evolution" is not debatable, common descent with modification and selection of some sort is just true, no further debate necessary. The position of "modern synthesis evolution" is debatable, because the model here is computationally stupid. So if you say "no disputes on unresolvable hypotheticals", the debate becomes whether the genetic information in sequencing machines requires a higher level of intelligence, i.e. information processing, than what the standard story of modern synthesis allows. The answer here is surely yes, and the computation which makes the intelligence is in RNA networks in the nucleus, consisting of long noncoding RNAs of a novel sort. This type of intelligence is detectable by sequencing machines, and does not require anything supernatural, but it is sophisticated enough to be closer to intelligent design than the modern synthesis. That's the end of the debate, as far as I see. Mattick RNA resolves the question of computation in cells, it's there, and computation is a synonym for intelligence (of a degree, depending on the size of the computer).

Why can we only see a three-dimensional space?

You can imagine flatland with no problem, you see a bunch of lines with some distance information, that's what the little story "Flatland" from the end of the 19th century is about. Your brain is wired at birth for visualizing three dimensions. But you can get around this and build up intuition for 4 dimensions of space relatively cleanly by computer simulation, or by hand calculations. It's hard to describe what happens in your brain, but you start to "feel" how objects can move perpendicular to others, how rotations work, and the way that planes can slide around other planes. With enough experience, you can see a knotting of a line with a 2d sphere in 4d, you can draw it by

drawing the analog of a knot-diagram with a 2d sphere and a curve, supressing the fourth dimension, and then indicating whether the line is an overcrossing or an undercrossing. The visualization of higher dimensional objects is more painful, but again, you can do it using combinatorial objects or semi-combinatorial objects like a knot-diagram. Simplicial complexes are useful for this--- a high dimensional geometry can be described by splitting it up into little tetrahedra that are glued along their boundary. For example, a two dimensional space of a sort is described by the triangles with vertices (a,b,c), (d,a,b), (d,b,r), (a,r,c) with the vertices glued together as indicated by the repeating names, and edges identified whenever two names are the same in two different triangles. The same construction with more letters per list makes higher dimensional complexes which give intuition. Another way is by Morse theory, using critical points of a function. The geometry of critical points are simple--- they are like cups and hyperbolas in higher dimension, they are described by a classification which is relatively simple, the generic behavior is like the quadratic function in n-variables: $h = x_1^2 + x_2^2 + .. + x_k^2 - x_{k+1}^2 - x_{k+2}^2 ... - x_n^2$ h=x12+x22+..+xk2−xk+12−xk+22...−xn2 These critical points are glued together to produce an arbitrary smooth high dimensional shape, and you can use this, plus the obstruction theory derived from simplicial thinking to prove all sorts of deep theorems, like Smale's proof of the generalized Poincare conjecture for dimensions >4. Morse theory and combinatorial complexes are the best visualization tools for higher dimension, a little bit of manipulation of either leads the brain to start to see the higher dimensional stuff.

What is meant by supersymmetry in physics?

A supersymmetry is a symmetry between Fermions and Bosons, it appears in a relativistic theory when you have at least one spin 3/2 conserved current, as opposed to a normal spin 1 vector current, like the electric current. But this is very abstract, and there is a different more concrete condensed-matter way to understand the mathematical phenomenon, which was originally described in 1976 by Parisi and Sourlas. A good book by Junkers explains what I say below, but it is also good to review the non-commutativity in the path integral, and the explicit Nicolai map for the dimensionally reduced d=2 Wess Zumino model which ends up with 2d N=2 supersymmetry. To understand the idea, you need to start with the Feynman path integral, and it's continuation to imaginary time. Every quantum system has an imaginary time version, which, when the Lagrangian is real and bosonic, is a purely classical statistical theory. An example of this is the lattice QCD, which is a statistical system that is equivalent to imaginary time QCD, but a simpler example is the Brownian motion, which is the imaginary time continuation of particle quantum mechanics. These imaginary time statistical descriptions do not usually have fermions in them, but there is a trick to include fermions too, and this trick produces supersymmetric systems, and gives some deep insights into the phenomenon which are usually left out of traditional presentations. There are two ways of thinking about a random walk--- global and forward-stepping. The global point of view is what you do in the path integral--- there is a probability for every trajectory, which goes as the integral of the velocity squared over the trajectory. When you do a discretization of time over integers with steps of size dt, the probability of a path x(n) is exp(− ∑ n (x(n+1)−x(n)) 2 d t 2 dt exp(−∑n(x(n+1)−x(n))2dt2dt This is a global point of view, because the probability is over the trajectory as a whole. But this is not the most efficient way to generate a random Brownian motion. You can also generate a Brownian path step by step, by generating Gaussian random numbers η(n) η(n) at the beginning, and then using a difference equation to step the x's forward in time: x(n+1)=x(n)+ dt − − √ η(n) x(n+1)=x(n)+dtη(n) This second procedure produces a path selected according to the first probability distribution, but it is forward in time, you don't need to do Metropolis Monte-Carlo to generate the configuration (as long as the final boundary is free), you can just generate the path naturally by using Gaussian random numbers. In a path integral, the continuum version of this starts with a continuum eta which is completely independently random at every independent time: Dp= e −∫ η 2 2 dt Dη Dp=e−∫η22dtDη where Dp means its a path integral measure, and D\eta on the other side is the uniform eta measure (this is a formal idea, but the equation can be made meaningful rigorously), and then changing variables to x using the equation dx dt =η dxdt=η In this case, you just plug in x ˙ x˙ for η η , and you get the ordinary Brownian imaginary-action/statistical-weight. Dp= e −∫ x ˙ 2 2 dt Dx Dp=e−∫x˙22dtDx Now suppose the walk is biased, so that there is a different bias at different points. Then you add the bias, and in order for the bias to work in higher dimensions, it should be integrable, it should be the gradient of a potential F (in one dimension, everything is integrable). dx dt + ∂F ∂x =η dxdt+∂F∂x=η Then the same transformation doesn't work anymore, because F varies with x, so different paths have different weights due to the change of variables involved. When transforming the probability distribution, you get an extra determinant. The determinant can be written as a Candlin integral (grassman variables are the correct theory of determinants), using a pair of fermionic grassman fields [math]\theta(t)[/math] and [math]\bar{\theta}(t)[/math], so that the thing inside the exponetial becomes [math] - \int {(\dot{x} + F')^2\over 2} + \bar{\theta} ({d\over dt} + F'') \theta dt [/math] If you expand out the square, the middle term is a perfect derivative, which can be removed by rescaling the boundary probability-distribution/wavefunction. That's not quite true independent of convention, because the time derivative doesn't commute in products inside the path-integral with F', which is a function of x, and this failure of commutativity is really what is giving rise to the determinant--- the middle term is only a perfect derivative if you make a centered difference definition for the time derivative of x. If you define the time derivative as a forward difference, there is no need for a determinant, but the center term doesn't go away, and changing the time direction reverses the center term sign. The formulation with the determinant is manifesting a symmetry between the forward and backward evolution of the stochastic equation. The result is an action with a supersymmetry (actually, two supersymmetries), it is the supersymmetric quantum mechanics. If you do the transformation: [math] x \rightarrow x + \bar{\theta} \epsilon [/math] [math] \theta \rightarrow \theta + \epsilon (\dot{x} + F') [/math] The action stays the same up to boundary terms, up to integration by parts. Nicolai showed that this is true in general theories, even relativistic ones--- when you have a supersymmetry, the determinant of the fermions is the determinant required to make the evolution of the bosonic fields a stochastic evolution starting with independent noise. The fermions are arising because there is a change of variables from other variables where the statistical evolution is very simple. This means that simulating supersymmetric theories on a computer is in principle easier than simulating ordinary quantum theories, because you don't need Metropolis algorithm, you can step forward in time. Unfortunately, this only works when you know the transformation to a stochastic equation explicitly, when you know the explicit Nicolai map. This map is only explicitly known for a handful of examples, which fortunately includes the quantum mechanics example above, and a two dimensionally reduced Wess Zumino model. This can be used to simulate M-theory, because M-theory has the Matrix formulation, which is a highly supersymmetric quantum mechanics which can be written as a stochastic forward equation. The general principle, however, explains much of the magic of supersymmetry--- the ground state has energy exactly zero, because the Boltzmann distribution is the stationary distribution for the stochastic equation, and it is constant in time (the decay rate in time is the analog of the ground state energy in imaginary time). Translating to quantum field theory, this means that the Fermionic and Bosonic vacuum energy loops cancel. There are sometimes configurations which are statistically inaccessible, like for the stochastic dynamics of a membrane trapped in a crazy potential well, different positions of the membrane cannot fluctuate into each other, because the membrane is big and defines a statistical superselection--- the statistical fluctuation cannot move the membrane position without conspiracy. But there doesn't have to be a symmetry--- the membrane might be equally happy to sit wherever you first put it. This means that there are vacuum space moduli without symmetry, another property of supersymmetric systems.

These are the magical properties of supersymmetry that make them interesting to study. The classification of supersymmetric theories is done algebraically, without regard to the Nicolai map, which has never been formulated in a way which is useful for most of the known supersymmetric theories. It might not even be possible to write it down explicitly for the Wess Zumino model in 4d, for example. But this is strange, it seems that it should be possible, but others say no, but the theorems are not persuasive to me, as they show some lack of imagination regarding the map.

How does Ron Maimon know so much?

I don't know, dude, I don't know "so much", it's normal for a 40 year old academic with an internet connection. I only am repeating and repeating about a half dozen or so original ideas, that's it, originality is the important thing, knowledge you can google.

What are some ways to think creatively in Science and Engineering?

The only way to do it is to read those people who had good original ideas in the past, you have to read the original papers, to see all the avenues they explored that are left out of the later summaries, even the wrong ones, especially the wrong ones. It shows you how to make your way in the world of ideas, and it will leave you impressed with the open-endedness of the project. If you read textbooks, you will get the feeling that the subject being discussed is closed, because it is usually closed for the textbook author, who needed to wall off a section of

research to make the book. The writing of Galileo, Einstein, Dirac, 't Hooft, Witten was particularly inspiring for me, but there are lots of others. There is great work by Kenneth Wilson, Stanley Mandelstam, Alexander Polyakov, Robert Kraichnan, Benoit Mandelbrot, which is still so far from complete, so it leaves a lot more for you to do. You need to reproduce the things from scratch, pretending you are doing them from a position of no knowledge, to see what this takes. Eventually, you start reproducing stuff nobody has done yet, and that's your stuff.

Is philosophy really dead, as some scientists claim? If not how is it still necessary in this high tech world?

Philosophy isn't dead, but it sure has wormed its way into a continental dead end, by propping up all the useless high-class discourse which started with Aristotle, and continued through Hegel into Nietzsche and Heidegger, while at the same time denying the low-brow analytic insights of logical positivism, computation, and modern science (past Einstein). Some philosophy, the mathematical work of folks like Kripke, or the folks studying modal logic, or the interpretations of quantum mechanics, is completely immune to this high-class disease. The rest is suffering from irrelevance. Since philosophy is important, one should try to fix it. But really, if you fail to fix it, it is best if it were to die. The reason philosophy is important is because it provides a framework of synthesis and analysis of knowledge. The basic rules were laid down by Mach and Carnap, who obsoleted all the previous work. The insight was logical positivism, which came out of physics, which required that the claims you make be grounded in observations. The language you use should also be precise, which can be stated today by saying if you can't program a

computer to understand it, you don't fully understand it. But beyond this basic positivism stuff, there is further stuff. The philosophers need to understand religious ethics properly, because it isn't bunk. For this, there is Hofstadter's superrationality. When you extend it to asymmetric games, it is the philosophically sound position of theism, since it extends to a notion of God. This allows you to understand why Nietzsche's stuff is reactionary nonsense, because it is ignoring the proper conception of ethics found in the notion of the monotheistic religious texts. Given an understanding of positivism and religious ethics, then one can make a reasoned debate regarding the nature of computation, and consciousness, about the basis of law and economics, and so on. But the foundations are still debated in philosophy, long after they should have been resolved.

Why do people posting questions on the Atheism topic seem to think they are going to explode the beliefs of others? Stunned atheists will convert, befuddled religious folk will lose their faith?

There is always something new under the sun. The problem of religion can be attacked with precision today, because we understand the guts of spirit phenomena, now that we have the computer, and Turing computation. The notion of computation includes a mathematical definition of God, in the ordinal sequence that approximates mathematical truth. This ordinal sequence solves harder and harder mathematical questions, among those questions, what is the best self-consistent play in larger and larger communities of people who are trying to maximize their mutual benefit? The resolution to such communal game questions is a form of superrationality, and the

extrapolation of superrationality to larger communities makes an effective infinitely wise entity which tells everybody what to do. The internet allows the new things to be disseminated, and hopefully these can resolve the debate, and close it forever. This is why I keep posting, at least.

Did Bush and his cabinet either plan the 9/11 attacks or know about them to some degree and deliberately let them go ahead?

Probably not the whole cabinet, but at least one or two high level officials were involved in planning the thing, since they needed to set up the drills of that day which enabled it. If he wasn't in on it, I believe he wasn't, then afterwards, Bush would have been terribly suspicious, and would have been torn between accepting the official story, and blaming members of his own administration. This might have been the source of his indecision on 9/11. My guess is that after talking to them, he was assured that the drills were just a coincidence, he was gullible enough to accept this explanation, and his response became normal the next day.

What general and specific warnings where there leading up to the 9/11 attacks?

It is not clear whether these were warnings, or rather planted intelligence rumors. They were based on a few documents, and the whole intelligence community is a gigantic rumor mill, which assumes

good faith at the highest level. When you have the type of inside job as 9/11, with a high level official involved, basically all the intelligence can be fabricated, because this person has security clearance, and can insert fabricated reports at will. There is no peer-review in intelligence circles, it's all by hearsay, it doesn't produce objective knowledge. Even in scientific fields, a single hoax object, like Piltdown man, or a bogus study, can produce a mountain of supporting literature with no basis in reality. There were low-level people who sensed there were unusual intelligence rumors surrounding 9/11, and those who interpreted those rumors as "terrorist attack brewing" were considered more competent afterwards. Those who interpreted the rumors as "bad apple on top making an inside job false attack" were fired. So you really can't say.

What are some of the most important shortcomings left in our current understanding of nature that are used / referred by Religious people to strengthen their beliefs in God? How long do you think it will take science to fill those shortcomings in our understanding?

There are none. These gaps have been closed since Darwin, they have nothing to do with religion, and it was already clear they have nothing to do with religion much earlier. God is not a natural phenomenon, it is a phenomenon of the spirit, a computational thing that lives in a mathematical world. There is no point in looking to the physical world for confirmation, there is only a little point in looking to biology, because the ethical big monotheistic God is a human conception of the

10th century BC or thereabouts, it didn't really exist beforehand, only in various local approximations. But because there is always a danger of moral backsliding, religious people will push on anything to make sure people understand God, including using ridiculous fundamentalist beliefs whose only purpose is to make the 10th century BC documents look more reliable. This doesn't work anymore. The 10th century BC documents are not reliable regarding the natural world, and they are only semi-reliable regarding the nature of God.

In what scientific fields or specific areas of research could an amateur make significant progress or contribution today?

Anything computational you can do at home, essentially with equipment and codes identical to that used by the experts. Data analysis is yeilding breakthrough after breakthrough in biology, and there are enormous number of public data sets. Pure theory pretty much requires literature access, but if you have this, it makes no difference who pays you. For experiments, even the smallest ones, unfortunately, you need funding nearly always. It is best to never consult any "experts" on anything, if they knew what needed to get done, they would have already done it.

Is the quote by Einstein - "If you can't explain it simply, you don't understand it well enough" psychologically true? Is there some other

reason for not being able to explain things clearly?

Yes, it's true, but there is sometimes a language barrier--- if you try to explain multiplication to a toddler, you might fail because the toddler doesn't know counting, or addition. This is easier today, when people can google all your terms, so the only barrier left is your own understanding, whether you really understood it in a self-generated way, or whether you are just repeating what you read somewhere without full self-generated understanding. The quote is likely not by Einstein, I know his quotes somewhat comprehensively, and it's not his voice (but he would probably agree with the sentiment), But all physicists know that the best test of understanding is explaining and reworking the results from scratch for an ignorant person.

How can I show that for a set of n points (in a plane) there exists a voronoi cell with (n-1) vertices?

It isn't true--- just place your vertices in the centers of an enormous hexagon lattice, and for large areas, the total number of points scale as N^2, while the only cell with a large number of edges is at the perimeter, which goes as N.

Is there any way to differentiate the statement, "The universe is expanding," from the

statement, "Everything in the universe is shrinking, while the universe itself stays the same size," within the context of commonly accepted understandings of the expansion of the universe in cosmology and physics?

The two ideas, the way you intend them to work, are identical. There is no difference between them except for the philosophical words you use to describe the observed effects, so the distinction is only in your head, there is no difference. The words you use are not important, the only thing that matters is what the observations are predicted to be. This is physicist positivism. There is no difference at all between the universe expanding and all the atoms and distances shrinking in such a way so as to keep the observations the same. This is the statement of the invariance under a choice of length unit. Because the two superficially different ideas predict the exact same results for experiments, it is wrong to think of them as different ideas. They are the same idea, presented in philosophically different words, which confuse the human mind into thinking they are two different ideas. Most ideas which lay-people come up with are of this sort, they are meaningless play on words. To avoid this, you need to learn logical positivism, and then you stop doing that. It is annoying for a physicist to talk to the public, or to philosophers, or to scientists who read philosophy, because the public doesn't get positivism, while the philosophers used to get positivism, then they moronically rejected it for airheaded reasons in the 1960s. Our universe is not scale invariant, and comes with Planck units, a length scale, a time scale, and a mass scale, defined by the dimensional constants G,hbar, and c. In these units, the statement "the universe is expanding" is meaningful. People have chosen to keep atomic dimensions constant, and talk about expansion. This convention is sensible, and is consistent with choosing constant Planck units.

Perspective- What do you think about the possibility that the entire universe, however vast, is just a particle being observed by someone in an even bigger universe?

Since it has no bearing on observations, even in principle, it is not a meaningful statement.

What is the Physical meaning of Enthalpy (H) in the first law of thermodynamics; regardless its mathematical meaning?

The enthalpy is the internal energy, readjusted so that it is the proper variable when you are dealing with systems at constant pressure as opposed to theoretical systems which are kept at constant volume. When you have a bunch of molecules in solution, and they break up, you might know the energy change of this break-up precisely, say it's delta U. This energy change is not what you observe in a test tube when the molecules break up, because there is also a change in volume delta V when the molecules break up. Let's say the broken up components take up more volume in solution than the bound molecules. You need to consider that the volume change that happens during the break-up does work on the pressure boundary of the container, and the actual energy change is delta U + P delta V. To understand the sign, consider that when delta V is positive, there is more energy released in the unbinding event than the measured heat

released, because some of the energy goes to increasing the volume, into doing work, and only the residual left over comes out as heat. So when you measure the heat of breaking up the molecules at constant pressure, you end up measuring delta H, not delta U between the two different configurations. It isn't deep, you are just correcting the energy release for the change in volume during the reaction. Since in real life, you always do experiments at constant pressure, hardly ever at constant volume (unless you are doing a computer simulation), you are always measuring enthalpy changes when you measure heat emitted in a reaction, not internal energy changes.

Could the functions of the human brain ever be described mathematically?

There is no such thing as a truly analog computer, the analog models are always an approximation which can be replaced without loss by a digital model of high enough fidelity. The nature of the limit that gives rise to analog behavior is the large number of atoms acting together, and in the regime of brain operation, when you are dealing with single molecules or molecules with very small copy-number, the statistical flucuations make it impossible for the system to be analog. To explain: suppose you wanted to make an analog system solve Laplace's equation with a delta function source in an infinite three-dimensional half space with reflecting boundary conditions. You can inject a dye at a certain point in a large pond of water, and then the concentration profile is, to good approximation, the solution to Laplace's equation. But you are relying on the fact that there are Avogadro's number worth of atoms there to get a reliable value of the analog system. If you could only inject one atom at a time, you would need to make an Avogadro's number's worth of position measurements before the result would statistically reproduce the solution of the equation. Because we are macroscopic, we have a false intuition regarding this,

thinking that analog systems are natural. When you are dealing with molecular events, you are in the opposite limit, where a deterministic analog response is the anomalous thing, most things are not capable of acting reproducibly enough to act as an analog system. So when you have molecules diffusing, and having chemical reactions, the diffusion randomizes the position, and this randomization dumps the data in the position of the molecule into random motion of water, losing the information irreversibly. So any analog information in the position is only relevant to the degree that you measure the molecule's position, and this can only be done realistically by binding it to another molecule, whose position is also uncertain. You can tether the molecule to a scaffold, and localize it like this, but then you are only getting the discrete information as to which component of the scaffold you tied it to, not the precise analog information about the position of scaffold. This information is washed out by Brownian motion of the scaffold. Likewise, when you have some dynamical change, like a protein conformation change, this change occurs at some time, and lets say it's precisely defined. This time cannot be known to the biological system, only the first time that some other molecule noticed the change, by binding to the new molecule, or by trying to bind and failing. This introduces a time-discreteness scale, and if you make time discrete at a spacing smaller than the interaction time between molecules, and store the positional information only to the degree that it is not washed out by Brownian motion, you are left with a discrete number of bits. Further this number of bits is dwarfed by the much larger number of bits in the molecule's binding conformation. So that the major data carrier in the cell is through the binding and unbinding of molecules, not in any analog source. The voltages and electrical gradients in the cell are only functionally relevant when the computation in the brain can tell the voltages apart, and this introduces a discretization. No matter how fine you make it, it is always a far smaller number of bits to describe the electrical potential everywhere in the brain than to describe the conformation and binding of all the molecules of the brain, and the latter is discrete data. So there is never a barrier to a complete digital description of the processes in the brain, and it is a mistake, often repeated, to claim that the brain is effectively an analog

computation. It just isn't. At the molecule scales, it is impossible to maintain analog computation in a way robust to the Brownian randomization. It is false intuition from the everyday world extrapolating to the micro-world, ignoring Einstein 1905, not the relativity work, the Brownian motion work.

Under normal cooking circumstances, is boiling water always 100 degrees C whether it's simmering or violent?

It's the same temperature, the differences in boiling is to either decrease the boiling-off of water or increase the mixing rate of whatever you are cooking. The fast boil will stir things around, the simmer will conserve the total water volume. Usually they specify to simmer.

Why would a government-run single-payer health care system be better than one that relies on the free market?

Health care is not provided by a free market, because I am not allowed to open a hospital without state licensing, I would be put in prison. If it were completely deregulated, it would probably be cheap enough to get any treatment that you could buy medical care the same as you buy food, but then there would be addicts buying prescription medications to get high, unscrupulous witch-doctors with fake home-

remedies, and all the other suboptimal things of 19th century American medicine. But perhaps a deregulated market would work. I think it would definitely drive costs down if there were no more barriers to practicing medicine, beyond malpractice lawsuits. At the moment, it is the worst possible market you can imagine, as other answers have explained.

Fukushima still scares people. No one died from radiation, and infants won’t likely see an increase in cancer. Why hasn't this increased nuclear power usage? Why is there so much cognitive dissonance on nuclear power and what can be done about it?

One reason is that the model for cancer which people use to predict cancer rates due to radiation exposure is outdated, and very likely incorrect, although this statement is not at a five sigma confidence level. The standard model is the linear no-threshold model of radiation damage, and it is only correct for predicting the number of induced molecular damage events in cells, it doesn't work for complicated delayed response, like cancer. The linear no-threshold was suggested by extrapolating from large dosages to very small ones, large doses seemed to produce cancer at a rate which was independent of dose, as if each rad carried a certain number of cancer fatalities, no matter how diluted it was. But large doses, like occasional radon exposure by miners or a nuclear blast at Hiroshima or Nagasaki, are very different from small doses, like radon exposure in homes, or regular jetliner flight, where the exposure is comparable to natural radiation. Although both small and large amounts of ionizing radiation damage

molecules in the same way, there are complicated repair mechanism in cells. It is plausible, and seems to be suggested by the statistics that there is a very small hormesis effect, due to some extra stimulation of the body's mechanisms of repair when exposed to a small additional dose of radiation comparable to the natural rates. But dumping a large quantity of radioisotopes into the ocean is never a good idea in any case, there might be specific species that concentrate some isotopes in very harmful quantities, and the distribution is never under your control. But I agree that the disaster has been overhyped, perhaps this is because someone is actively doing propaganda in the fossil fuel industry, but most likely, it is irrational fear.

Why does physics seem to enjoy a much more prominent seat in pop culture than mathematics?

There is a social issue, in that mathematics, until recently, has been somewhat elitist, in that mathematicians have taken pains to restrict the language unnaturally to a form of useless hyper-rigor so that only a select small group of experts can understand it and enter the field. The mathematician culture is older, it dates back to ancient times, like painting, so there was this ridiculous social pedigree involved in doing mathematics. This changed with the advent of the internet, now the mathematicians are much less snobby, as their methods and ideas become widely disseminated. Physics, from the beginning, has been actively poaching mathematical talent from the mathematics department, and it did this by being superficially less rigorous, and the language was always simplified so that any child can understand what is going on, even with hard topics like General Relativity or Quarks. It was also extremely active throughout the 20th century, and many of the techniques outpaced the mathematics of the day. In the cold war,

physics was a prestigious occupation. But now that the cold war is over and the media climate is more democratic, they should be equally popular. I already see that great mathematicians are given equal billing, say Maldacena and Perelman are equally well known, perhaps Perelman even slightly more.

Is there any evidence that evolution within a species (microevolution) stops short before it becomes evolution to a new species (macroevolution)?

Yes, there is overwhelming evidence for this, from selective breeding experiments conducted by breeders over many generations. By selective breeding, you can produce all sorts of crazy different dogs from a common ancestor, but when you try to produce a dog the size of a bear, you hit limitations that stop you long before you even get close. The dogs become sickly, because their organs don't coordinate well together, and the body plan reaches the limits, you get hip-displasia, the rate of producing viable offspring gets smaller from inbreeding, various other things. At some point, you can no longer breed animals, and you have reached the edge of the variations you can produce from this genetic stock. This is universal to breeding of animals over domestication scales, you reach limits which are constrained by the pre-existing range of variations in the genetic material you are rearranging. This evidence, however, should not be used to support creationist claims, simply because creationism is stupid. The reason it happens is because you are introducing variations and selection pressure which are two orders of magnitude bigger than anything that happens in the wild, and the mutations can't "keep up" with the selection, so as to produce a continuously evolvable

path. It's sort of like taking over a capitalist economy with a Soviet system, first there is rapid progress, because you are optimizing pre-existing things, but then you realize you stopped coming up with new things, and you are stuck There is good evidence that if you do the selection slower, with normal selection pressure, you do produce a dog the size of a bear--- because this is what a bear is. There are two time scales in selective breeding, the scales at which selection operates to select variations of pre-existing genetic stuff, and the scales at which you produce new viable genetic stuff which can be selected. The second scale is the bottleneck in artificial breeding, as it requires a whole bunch of mutations in the genome to first optimize all the genetic networks for the gradually changing body plan, and so on, over many thousands of generations, then adapting the new plan again. Still, this is the strongest claim that anti-evolutionists have, and it must not be dismissed, because it actually is true. It doesn't demonstrate creationism, because creationism is wrong, not because it is a false observation.

Did the Big Bang spawn from an entropy-free singularity?

Singularities in GR don't have a low entropy, all sorts of asymmetric gunk can come out from a singular beginning. This was Zeldovich's observation--- the symmetry of the universe requires an explanation, it doesn't follow from a singular beginning. But the answer is long known: you shouldn't look to the singularity, because this is modified in inflation to a deSitter beginning. The deSitter space has a tiny cosmological horizon, and can only support a tiny amount of entropy in any one causal patch. The maximum entropy state is just a thermal background at the deSitter temperature, and the entropy in the causal patch is one unit per planck area of the cosmological horizon. This is very small compared to later eras, when the cosmological constant

goes down (the dark energy, or vacuum energy). Paul Davies suggested in 1983 that this is the explanation of the arrow of time in the universe, that the original deSitter state is low enropy. Davies has been criticized and his idea was buried, but this is egregiously unfair, because Davies is just right. The effects of inflation can all be understood as coming from the very special deSitter state which has low entropy gravitationally, simply because a single causal patch is too small to contain too much entropy. The reason it was dismissed is because the causal patch view of cosmology was unfairly maligned, because of philosophical prejudice. People didn't like to think that what we can see is all there is, in a certain sense, they wanted to think we can speak sensibly about stuff beyond our horizon, even though this is positivistically meaningless, since we cannot measure this hypothetical stuff, no matter how hard we try. After the holographic principle was understood, Tom Banks, Leonard Susskind, and Steve Shenker have been advocating the causal patch view, in which Davies' idea, which you reproduced more or less, is the correct explanation of the low-entropy initial conditions.

How do I explain irrational numbers to a 10 year old?

Jay Wacker's answer is fine, but I think it's easiest to explain the difference between denumerable infinity and non-denumerable infinity, and the rationals are denumerable, while the reals are not. The standard demonstration is fine for a 10 year old.

What are the requirements before I start learning algorithm and data-structures?

Learn Python quickly, then learn C (not C++, just C, using Kernighan and Ritchie) until you understand pointers well and write some small program. Then write a struct with a pointer to another struct of the same type, and you have a one-way linked list. Two pointers, and you either make a binary tree, or a two-way linked list. The nesting level of loops is generally the polynomial order of the algorithm, all the ideas become obvious once you program in C.

In a round robin tournament with N teams, every 2 teams play in a head-to-head match. Points are awarded as follows: 3 points for a win, 1 points for a tie and 0 points for a loss.?

A reformulation: you have a directed graph (no self-joining edges or multiple edges) on N vertices, where the arrow points from loser to winner, ties aren't edges. Each tail gives weight -1 and each head gives weight +2 to its vertex. The sum is constant on all the vertices, but the graph should have some vertices with at least one pair of vertices with a different number of incoming edges. Note first that each closed directed cycle adds weight 1 to each vertex along the cycle. If the graph is composed of nothing but directed cycles, each vertex has an equal number of incoming and outgoing edges. This implies, if there is nothing but cycles and equal weight, that there are an equal number of heads at each vertex. So there has to be something other than cycles, meaning once you remove all the cycles, you are left with extra paths pointing from a head vertex to a tail vertex. The vertices which lie on

the head end of a path get an unsubtracted +2, so the tail-end vertices must have three more cycles going through them than the head end vertices, so as to equalize the weight. The cycles have to be edgewise disjoint, meaning you can't pass two different cycles through the same pair of points (the pair only play once), so the smallest graph with three cycles going through every point has 7 vertices, with the cycles 1->2->3->1 1->4->5->1 1->6->7->1 2->4->6->2 2->5->7->2 3->4->7->3 3->5->6->3 This is the smallest such graph with three edgewise-disjoint cycles, clearly, because three cycles through point 1 require at least seven points. This is the smallest tail-vertex set. To get the head vertices, you add 7 more vertices which each beat 1 through 7, and this solves the problem. So there are fourteen vertices, all ties, except for the cycle pattern above, and 8<-1 9<-2 10<-3 11<-4 12<-5 13<-6 14<-7 These are all the winner/loser edges.

If space was not expanding how long would it take for the Andromeda and the Milky Way galaxies to collide?

The expansion of the universe is irrelevant, the expansion is just another way of talking about the motion of the galaxies. The Andromeda galaxy is moving toward us, and according to Wikipedia, the Andromeda–Milky Way collision will happen in 4 billion years.

Is there a quick roadmap towards gaining some intuition in concepts from algebraic

topology and geometry?

Poincare's original motivation for homology was from a type of discrete graph-like structure which is a combinatorial simplicial complex. A simplex is a generalized tetrahedron to any dimension. The thing that makes it simple is that it has no topology, and up to linear transformations, all simplices are the same. So you can consider a single simplex in n dimensions as defined by the names of it's n vertices: A1,A2,...,A(n+1). Each subset of these vertices defines a certain sub-simplex of the simplex, either a face, or an edge, or higher dimensional generalization of this notion. You can glue together the edges of a collection of simplices by giving them the same name, and this is clearly a combinatorial notion. The result can be interpreted as a topological space uniquely defined by purely combinatorial data, it's a bunch of triangles and tetrahedra in various dimensions, glued together along edges. You can define a generalized d-dimensional surface is a simplicial complex where all the simplices are of the same dimension, and they are all glued in pairs along common d-1 dimensional subcomplexes--- this is just how you would build a polyhedron out of tetrahedrons. A surface has not boundary, if every d-1 dimensional subcomplex is glued to another one. The notion of homotopy is somewhat complicated and unwieldy compared to homology, but homotopy is unfortunately what people discuss first, just because they are starting from calculus rather than combinatorics. Poincare started with combinatorics, so you should reverse it and learn combinatorial homology first. Inside any simplicial complex you can embed a bunch of d-dimensional surfaces (you can even embed higher-dimensional things, there is no requirement on the set of vertices of a simplex to be different). Poincare's insight is to stop thinking of the surface as a map from the cube [0,1]^d into the topological space, but instead to think of the surface as built up from d-dimensional simplices, like you build a structure out of legos. But the legos can ovelap each other, you can have 3 legos of the same shape right on top of each other, and the way you join the legos is by gluing the edges of simplicies. Then, you can

consider any surface as the abstract sum of the simplicies that make it up, with coefficients +1. You can consider the abelian group formed by adding all possible simplicies in the space, abstractly. You can just consider all the different ways to sum up subcomplexes with coefficients, the coefficients are the number of lego pieces sitting on top of this subcomplex. The operation of negation is defined by reversing the orientation of the simplex, in geometry, this is reflection, in combinatorics, it is a negative sign permutation of the vertices. Then Poincare defines the boundary operator for the simplex, which, given a simplex, tells you which sum corresponds to it's gluable one-dimension lower edges. For a given simplex with d+1 vertices, the boundary is the sum over all the subsets of size d (so leaving one vertex out), with the appropriate sign which you can figure out from geometric intuition. The point of this tinker-toy definition is that if you have two surfaces A and B on the simplicial complex where one can be slid into the other continuously, in the tinker-toy sense, this means that they fill out a higher dimensional surface during the process of sliding. One boundary of the higher dimensional surface is A, the other boundary is -B (B with the opposite orientation). So you can define the homotogy group to be the collection of all surfaces with the equivalence relation of sliding, meaning you identify two surfaces which can be slid into each other. Another way of saying this is that surface A is equivalent to surface B if A-B (as an abstract sum) is the boundary of another surface. This means that A-B is identified as zero when it is the boundary of a surface--- so this is the modern definition of homology: as the algebraic quotient of things whose boundary is zero (collection of closed surfaces) by things which are boundaries (like A-B when A can be slid into B). This is the central motivation, everything else is an elaboration. The category theory is just a formalization of the way in which you calculate the relations between the homology groups and the various operations you can do. I like a 1960s book called "Algebraic Topology" (I forgot the author), because back then, people discussed this combinatorially first, and began with homology, like Poincare. But Hatcher is good too, if you don't mind the continuum non-combinatorial stuff all over (I don't). The formalization of this idea is homology, and this is the one main idea of

algebraic topology. It can be computed relatively straightfortwardly in a simplicial complex, and in generalization, it eventually alows you to compute the homotopy groups. Hatcher discusses CW complexes instead of simplicial complexes. The only reason is that triangulated spaces are not sufficiently general to give an arbirary continuous structure. But CW complexes are annoyingly continuous, they require defining functions on R, so this gets rid of the whole original motivation of making discrete structures that encode the topology fully in their combinatorial relations. This is irritating, but one must make do until someone figures out the general thing that is combinatorial like a simplicial complex, but general enough to encode the topology of any reasonable continuous manifold-like space (for differentiable manifolds, simplices are enough). The original motivation was the combinatorial thing, and this is what is used in graph theory and so on.

What does Ron Maimon think of marijuana?

I hate it. It makes you stupid for days and days, it takes a long time to get out of the brain, and your brain is altered already with teeny-tiny threshhold doses long before you get high. It decimated the left in the 1970s, making a conservative society that makes people miserable, I suppose because stoned people are impaired enough that they genuinely enjoy the brain-damaged culture of corporate capitalism. To cope, I suppose you can smoke marijuana, but then you are perpetuating the cycle. I don't think it should be criminalized, but if you want to smoke it, please be considerate and smoke it indoors, in a special room, away from other people, and ventilate well before anyone else is exposed. The problem with the drug is the area effect, some people do not want to be exposed to it under any circumstances. In certain neighborhoods in New York City, you smell marijuana every week, and you get a miniscule slightly impairing dose about once

a year. There is nothing more maddening than some stranger impairing your brain for three days, by smoking a super-strong joint next to you in a playground, or a public bathroom, or in your apartment building. It's the worst type of assault you can imagine, all your work, everything you are thinking about, is gone, poof, out the window. For non-smokers, the sensitivity goes through the roof, there is no lethal dose, so regular smokers can smoke amounts which are 100 or 1000 times the threshhold dose.

Is it possible that we co-exist with other intelligent beings who weakly interact with our reality?

It is not categorically impossible, but there is a problem, in that the gravitational field of their matter, if compressed into planets, would require their own stars, dark to us. These stars cannot be sitting on top of our own star, because density models of the center of the sun work without a second gravitational source (and for the Earth too--- the density model of the oblateness and density of the Earth seems to work without fudging to account for weakly interacting matter). So this other matter would have to have segragated itself into it's own stars and galaxies, but these would be sitting on top of the observed galaxy, including our own. This model would predict that there would be a second dark-galaxy plane in addition to our own galactic plane, and dark-matter lensing maps reveal that dark matter is more uniform than this, you do not see a second dark-galactic plane, rather a diffuse blob of dark matter. It is possible that the dark-galaxy and dark-stars are only a fraction of the dark matter, say 10%, and the remainder is diffuse, so that the dark-galaxy is lost in the noise. But this runs into a problem that the star density should be reasonably high, and one should have discovered these stars in lensing survays, as analogs of

brown-dwarfs. But it is not clear to me that the brown dwarf density estimates a too low to accommodate such a thing, especially if the dark-galactic plane is tilted relative to our galactic plane, so that the only observations of dark-stars are close to the galactic center. To test this idea, you need a good model for dark matter, or, barring this, to have a good enough survey of the galactic center to see if there are dark-stars orbiting the galactic black hole in addition to the visible stars (they would be visible in their gravitational perturbations of the visible stars). Since most dark-matter models don't support producing dark compact objects like dark-stars (there is no anthropic reason for this, there is no requirement that two sectors support intelligent life), I would bet against it. But if such things exist, they wouldn't be on Earth for sure. There is no reason for the dark-matter to clump along with the ordinary matter, nor for the astonishing coincidence that two sources of light, the sun and a dark-sun, to both coincide in space and have overlapping habitable zones.

How can the physics information in a photon be finite?

The reason is that the photon is not spread out over infinite space. If it were, you would need a continuous varialble to specify the photon's momentum, and the information in a single photon would be infinite. But if you make a finite size box, and you specify the photon energy, there are only a finite number of different momenta that fit in the box, and the photon entropy is the logarithm of this number. If you specify a range of energies, the photon entropy is the logarithm of the finite number of photon states in this volume inside this energy range. The results are analogous for other regions of finite volume. While I haven't made a rigorous argument, the entropy of a thermal photon gas is extensive, meaning that the entropy is proportional to the volume when the volume is much bigger than a typical photon

wavelength. So in any finite volume larger than the thermal wavelength, you only have a certain finite number of photon states which can be calculated from the photon gas entropy. The same holds for any other quantum particle. The divergence of entropies at infinite volume is not a concern, because you understand physically where the divergence is coming from. In any restricted region, the wavelength is only defined up to uncertainty/discretization coming from the restriction to finite volume.

How do insulator-metal transitions in Mott transition materials work?

The Mott transition is not hard to understand intuitively, because it is directly analogous to the ordinary melting of a solid crystal. Except in the case of the Mott transition, the electrons themselves have crystallized on top of the already crystallized nuclei, and the melting is restoring a state which looks like a Fermi liquid, where the electrons are delocalized. To understand how this can happen, consider first this question: why don't nuclei conduct electricity? Say the nuclei are fermions, they are also in an effective periodic system, they also have some tunneling amplitude to hop from location to location, shouldn't they also form bands, like the electrons do? The bands form even at infinitesimal hopping, this is a question of principle. It seems that the quantum mechanical description requires delocalized nuclei, except it is manifestly obvious that it isn't so, the nuclei don't do any such thing--- they sit there in a crystal, and even the diffusion from site to site is very slow. The reason is that the quantum ground state of the nuclei is a superposition of lattice configurations, because any deviation from a lattice configuration costs too much energy, so that the collective motion of the nuclei to spread out is exponentially suppressed, and the suppression is about the size of a lattice site, so that the ground state of the nuclei is a superposition of slightly

different lattices, not a banded distributed state which is perturbatively linked to the Fermi liquid nucleus state. The nuclear repulsion is what is preventing the nuclear banding in this case. Now suppose you can tune the electronic repulsion to get stronger. At some point, the electrons will themselves crystallize as a lattice and stop conducting, except this crystallization is on top of the already crystallized nuclei, so that it is just a loss of mobility, not a breaking of translational symmetry. The crystal transition in a metal is the Mott transition. I don't know the technological applications of this, but it is extremely theoretically important. You can see it's a collective effect, involving all the electrons crystallizing together, and without the analogy to a solid freezing, it is hard to see how you could imagine this possibility. I didn't read Mott's paper on this, perhaps he had a different intuition.

How viable is the idea of designing a spaceship for global faster-than-light travel by manipulating local space around the spaceship to make distance traveled locally shorter?

This is Alcubierre's idea, and it doesn't work, because there is an energy condition on matter which cannot be realistically violated which guarantees that you can't outrun light locally. It is the same condition that makes it that black holes only grow and not shrink, this is the "null energy condition", which states that gravity always pulls parallel light rays to focus, never pushes them apart to de-focus. I discussed it more here: Alcubierre Drive, a.k.a "Warp Speed!" Is faster than light or equal to light speed travel actually feasible by bending space itself and bypassing relativistic principles?

Is Liboff or Griffiths a better textbook for self-studying Quantum Mechanics?

Feynman's Lectures III, Dirac's "Principles of Quantum Mechanics", and Landau and Lifschitz "Quantum Mechanics" are the best to read, in this order or simultaneously, all the other books just repeat material found in these, less comprehesively and with worse intuition. But you should also learn about the old Bohr-Sommerfeld quantization, to understand how the theory was discovered. One way is to go to "Old Quantum Theory", "Adiabatic Invariant", "Matrix Mechanics" pages on Wikipedia, and perhaps Ter-Haar's "The Old Quantum Theory" for a monograph length exposition. The old quantum theory doesn't take long--- it's one rule about quantizing the action variable. But there are insights here, the adiabatic invariance of the action, the quick semiclassiclal rules for number of quantum states, the estimates for the size of off-diagonal matrix elements for X and P operators in the energy representation in quantized versions of classical non-chaotic systems, that are very difficult to get to starting with the other more modern formulations. Griffiths and Liboff skip the old quantum theory, so they won't persuade you that the theory is true. For something as crazy as quantum mechanics, you need to be dead certain it is true, otherwise you will think it's a conspiracy of physicists to say crazy nonsense. They are good for review and exercizes after you learn the subject, by skimming the chapters to standardize notation (the material duplicates Feynman, Dirac, Landau), and then going over all the exercises. To complete the quantum mechanics education, you need to understand the Everett interpretation, this can be done by reading Everett's paper, or the book "The Many Worlds Interpretation of Quantum Mechanics", along with the relevant Wikipedia pages. The whole project takes a few months, if you are dedicated.

Does physics research of the mid-late 20th century require significantly more analytical intelligence than physics research of the early 20th century?

Some of the early twentieth century physicists were alive in the 1950s to make major contributions to quantum field theory, Fermi and Pauli most signifcantly. The younger folks, like Jordan, Heisenberg, Bethe, Landau understood it well, and Bethe was significant in promoting the work of Feynman and later Kenneth Wilson. Einstein didn't study quantum field theory, because he was interested in figuring out the way quantum mechanics could be a statistical description of something else, something we still can't do, and perhaps it's impossible. But Einstein proposed second quantization to Schrodinger in 1924, before modern quantum fields were formulated, and it is clear that both he and Bohr understood field quantization as analogous to the quantization of mechanical systems. Bohr also contributed to quantum field theory, at the foundations, by proposing field quantization in a famous paper with Rosenfeld, when he accepted photons, and later more indirectly, by suggesting to Casimir to calculate his Van-der-Waals force as a vacuum energy change. Bohr was doing nuclear physics in the later years. The reason you think it's easier to do the early 20th century stuff is just because it made it into books, and the methods simplified considerably with the passage of time. Quantum field theory today is about as easy to learn as quantum mechanics was in the 1950s, and string theory today is as difficult as quantum field theory was in the 1950s. As material makes it into books, hard things are removed, and intuitions sacrificed, for the sake of easy presentation. All of these topics are easy in a certain sense, the only sense that matters, because these things are already known. The

only really difficult thing is coming up with something totally new. In terms of difficulty of discovery, there is nothing to compare with General Relativity and Quantum Mechanics. To get a sense of how difficult it was to discover these things, consider the experimental situation in 1910, and try just to come up with the Bohr model by yourself, without using anything you already know. Once you try it (you will almost surely fail), you can then read the original paper to see how Bohr did it, and how difficult and non-rigorous (but correct) the reasoning is. Without the Bohr-Sommerfeld quantization, you can't do anything else. Now suppose you know Bohr Sommerfeld quantization. Try to come up with modern quantum mechanics. You will surely fail. If you read the DeBroglie/Einstein/Schrodinger papers and the Heisenberg/Jordan/Born papers, you will see how difficult it really was. In comparison, the quantum field theory work of the 1950s is not so impressive. Although, the path integral is similarly revolutionary, the basic revolutions were already done. The comparable radical shift in physics from this point is S-matrix theory and string theory. The thing that makes quantum field theory difficult to learn is just a political thing: the path-integral was hidden away in the middle decades of the 20th century, because all the founders hated it. Pauli thought it was not interesting compared to Schwinger's stuff, Bohr didn't get it, Dirac thought it was useless because it couldn't be generalized to Hamiltonian with non-quadratic momenta, Heisenberg didn't bother with it, and so on. The only people who really got it were Hans Bethe, and the young people, like Dyson, Schwinger, Kraichnan. It took decades for physicists to get confortable with the method, and it is not easy to make rigorous still today. Without the path integral, you can still do quantum field theory, but it's a pain in the neck.

What is the best refuting argument for what the US wants the public to believe happened

on 9/11?

By far the easiest way is to look at the purported crash site of flight 93, it is not a crash site. It is an empty hole in the ground. Eyewitness testimony (and the testimony of your eyes) makes it dead certain that flight 93 did not crash where the government said it crashed. Another easy way is to look at the picture of the underbelly of the plane that struck the building, and compare to a photo of the underbelly of a 767. Another easy way is to consider the collapse of building 7. It violates all laws of engineering physics for it to fall as it did without explosive demolition of the support columns. The same holds for the World Trade Center. Another easy way is to read the paper by Jones et al on thermite residues in the dust. You need to read the guts of the paper, to see the actual chips of thermite under magnification, where you resolve the grains. Yet another way is to review the official drills on that day. There were live-fly drills, and drills involving simulating airplanes crashing into buildings. Bush called this an "uncanny coincidence". There is NOTHING in the official story which withstands scrutiny. All the usual critics are responsible, except for the people talking about atom bombs and energy rays, who are clearly paid shills, hired to make the 9/11 truthers look bad. As for who benefits, the person who was in charge of all the drills that day. I'll let you google who that was yourself.

What's the simplest thing you can show with a Gödel numbering?

"Godel numbering" is just ASCII code, it's obvious and stupid--- it's how computers represent symbols. So just write down the statement \forall_x \exists_y y = x+1 or any other Peano axiom, and this thing is an ascii string, and if you substitude the numbers, it's just a long

integer. This integer can be manipulated by arithmetic operations to do any type of logical deduction, because Peano Arithmetic can describe a general purpose computer.

Why is gravity often explained through the expression "the bending of space"?

The accurate meaning is that there is a metric tensor in spacetime, which tells you the distance between a point at x,y,z,t and a point infinitesimally close to it at x+dx,y+dy,z+dz,t+dt. The distance is [math] ds^2 = g_{\mu\nu} dx^\mu dx^\nu [/math] where you gather the four quantities (dt,dx,dy,dz) into a vector called [math] dx^{\mu} [/math] where [math]\mu[/math] ranges from 0 to 3, and the above is in the Einstein summation convention. This just means that you sum over all possible mu and nu, so there are 16 different terms. I am lazy to type them out, as this is explained in every introduction to General Relativity there is. The g's are the metric tensor components, they are the analogs of the gravitational potential, and they are different at different positions and times. In a general situation, when the g's aren't constant or special, this describes a geometry with curvature. Particles travel in this geometry along the best-approximation to straight-lines, which are geodesics. A good book for someone who knows nothing is Schutz's General Relativty book. The popular funnel picture you link is COMPLETELY WRONG. It is a popularization only. The curvature of space is not the important thing, the only important component for ordinary day-to-day gravity is the time-time component [math]g_{00}[\math], so that the relevant curvature is a time-curvature, that is hard to picture. The pure space-components of the metric/curvature are only important to double the value of the deflection of light, or for other fast-moving objects. For slow moving object, you use the Newtonian approximation. The Newtonian approximation is derived from the metric: [math] ds^2 = -(1 - {2\phi

\over c^2}) dt^2 + dx^2 + dy^2 + dz^2 [/math] Where phi is the Newtonian gravitational potential, negative g times the height near the surface of the Earth. So that all the g components are as usual in flat space-time, except that time flows at different rates at different points, and the rate at which time flows is modified by the Newtonian potential, made dimensionless using the speed of light squared. It is conventional to choose units where c=1 when doing this stuff, because space and time need to be measured in the same units, and c is only not equal to 1 because humans made a human choice of units, not the natural choice. This approximation, that time flows at different rates, so that it is slower where the gravitational potential is more negative, and faster where the gravitational potential is zero, this is Einstein's 1907 approximation, which reproduces Newton's law of gravity. The full law is given by Einstein's equations.

Does data naturally exist in the universe as a material element?

This is a philosophical question, in a sense, because it is asking about "existence". The property of "existence" as applied to data doesn't change any observable property regarding it. To the extent that this is physics, this is simply the observation that there is such a thing as "entropy", and it can be measured using thermometers and pressure gauges. The entropy is understood now as the number of bits of missing data about the microscopic state of a material system, and it is measurable by physical devices, so it is a positivistically well-defined property of a material system. The physicalness of information, as entropy was codified by Landauer as a principle of condensed matter systems--- he would say "Information is physical".

What are some good events to be conducted in a maths club meet?

Pick a paper from arxiv, one that's interesting, and read and present the proof. There are proofs at all levels, historical theorems can substitute too. One good paper that was discussed in a class I audited is the delta-hyperbolicity of the curve complex, this was a major theorem in geometry, it is recent, and the methods are technically illuminating, and show you how to do geometry for real. Each of the words "delta hyperbolicity" "curve complex" are illuminating to understand, and they are accessible at any level of mathematical sophistication. There are other things, working through Furstenberg's proof of Szemeredi's theorem is good, but this takes some weeks perhaps. This became very important with the Tao Green theorem (although it was already recognized to be important when it came out). Also, showing simulations of various mathematical phenomena, and trying to prove the regularities, like sharing your discoveries about various random walks, or statistical models, this can be useful. There is so much, this is just what I thought of off the top of my head.

How does one classify general stuff into the linear/ non-linear category?

Nonlinear in the culture means a lot of different things, and they are not all compatible meanings. In art "nonlinear strokes" just mean strokes that are not in a straight line, but wriggle or curve. Nonlinear sometimes means going in a roundabout way, not in a direct approach, this is only metaphorically related to the mathematical meaning. In mathematics, it means that you have an equation where the variable you are trying to find is raised to the first power only, so for example:

[math] (3t^3 + 4t) {d^3x\over dt^3} + (8 \sin t) {d^2x\over dt^2} + {x\over t^2 +1} = 3t^7 + 5 [/math] Is a linear equation, because all the x's and the derivatives appear to the first power. If you have two solutions [math] x_1 [/math] and [math]x_2[/math], then there is another solution from linearly combininb them: [math] p x_1 + (1-p) x_2 [/math]. To combine in general, you need to get rid of the right hand side, which is like an offset for a line, and the method there is to start with one special solution, and add the general solution of the same equation without the right hand line, with zero offset. Linear equations are considered simple, because you can solve them with less computational effort than simulating the process they describe. The general solution is by an algorithm for matrix inversion, and usually it is a sparse matrix, so there are efficient methods to do this. This is the theory of Linear Algebra taught to undergraduates, and numerical techniques for solving linear systems, which float around any graduate school. Nonlinear equations are completely different, because in general, you can only solve them by simulating the equation. In special cases, you can find a solution, but this can't work in general, because you can simulate a full computer using differnetial equations, and it is a theorem that you can't find the output of a general computation at long times except by simulating it. But some nonlinear systems are randomizing, they quickly produce a random pick from a probability distribution on an attractor set. This is someting that became widely studied in the 1970s and 1980s, and this is the Chaos theory. It was studied earlier as Turbulence theory, it's the same thing, and the main methods are complicated, as they try to approximate a deterministic system using probabilistic methods. Martin Siggia Rose formalism approaches, coupled with Renormalization Group approaches, have been successful here in some simple systems, for example, the 1983 analysis of randomly stirred fluids by Forster Nelson and Stevens.

Are foods made from crops that contain the Bt gene less healthy for humans than comparable foods without it? How do we know?

There are probably absolutely no health effects from GM crops to people, the Bt gene doesn't matter, it's just another protein, digested like any other. The health effects are simply a political tactic to do propaganda against GM crops. But it's good that people are doing propaganda against these things, because you should not buy those GM crops for reasons having nothing to do with your health. These GM organisms are controlled by an enormous corporation, which has monopoly power over them, and uses these crops to lock in farmers to their seeds. Further, the effects on plant-health are completely ill understood, because plant genetics is complicated, plants do all sorts of things with their genomes, they are not bacteria, and their genomes are the largest and most complicated in the living world. So you just shouldn't muck around with plant genomes until we understand them better, and you shouldn't make farmers beholden to Monsanto for their independent production. So just don't buy the GM crops. If it helps scare you into doing the right thing, ok: your genitals will turn blue and your children will be born without a head if you eat the modified crops.

What are some accessible, exciting books (not textbooks) about infinite series?

Euler's "Analysis Infintarium" (maybe I bastardized the title) is a classic, and it does hand calculations throughout, Euler-style, which is tremendous. Considering the author, it is very practical, and you learn all the 18th century tricks here.

Do you have to be a genius to be good at maths, or can hard work play a major role?

There is no special math gene, as Terrence Tao has explained, mathematics is done by ordinary people working very hard to acquire the skills. But it is extremely time consuming, and if you happen to acquire the purely social label of "genius", it's a tremendous advantage, because people will just leave you the heck alone to study what you think is necessary, you will have access to top-notch mathematical people who will explain to you the tricks left out of the literature, and people will throw money at you to support you financially through your youth. Without this, if you do math, you will have no time to support yourself, and you will eventually acquire the social label of "worthless bum", as for example, the great mathematician Ramanujan did in India, before his work was recognized. This is the mechanism by which mathematicians pick the people they want to have around, those who contribute to the field. The social mechanisms that prevent mathematical advancement are simply the requirement to fend off starvation by selling your labor, and the social mechanisms that hide mathematical knowledge behind walls of jargon academia. Besides Wikipedia and Q&A sites, which serve to clarify the jargon, there are also blogs. Tao has done a lot, with his blog, to make these ideas widely accessible. He knows all the special tricks, and when he sees one that isn't widely known, he lets you know about it in relatively simple language, stripping away the specialized jargon, on his blog. He can do this because he was both labelled a genius in childhood, and also justified this label by doing great work, and in adulthood, he was thankfully recognized with a fields medal. Otherwise he would have to work hard for tenure and keep all his specialist knowledge hoarded in his head, only to escape occasionally in academic papers.

What if God designed living beings with evolution capability?

If God designs something by evolution, then the belief in God becomes simply metaphysics, and pure metaphysics is meaningless, this is the lesson of Mach, Carnap and the positivists. The statement "God made it" is not necessary for belief in God, as God is an ethical structure, not a physical structure. "God made it" is not necessary for God, it is necessary to prop up social organizations that say "God made it", which includes many existing religion. Like the Dalai Lama has said, where religious teachings conflict with science, it is not science that has to change, but the teachings. The teaching that "God made it" (outside of a teleological and highly philosophical sense) just needs to be jettisoned. God is a teleological construction--- it looks to the future not the past. The reason religions say "God made it" is because they are trying to gain converts with evidence, and the best evidence is "look what's around so far. How can this emerge without teleology?" Ok. It can't emerge without teleology. But the teleology is not a "material cause" (in Aristotle's sense, although I hate citing that guy), it's a "future cause", it's a reason why you do things, a computational abstraction on top of the banging of atoms, it is not the banging of atoms itself.

Why do people hate mathematics? There are few people in the world who seem to appreciate the beauty of math. Mathematics

has been associated with the words "geeky and sophisticated" rather than "creative and artistic”, even among scientists.

It's because at some point they become self-conscious about their social standing, usually at age 10-11, and then math constantly threatens to diminish their social standing because math always makes you feel stupid, because you always don't get it at first. This is true for everyone. It requires persistence, and reading the classics, and practice, and a computer for visualization, and having role-models and idols. Playing music is also difficult, but it doesn't make you feel stupid if you fail, and in this case there are role models at all levels of virtuosity, including seemingly zero virtuosity, like the Ramones. The closest thing to this in mathematics is Benoit Mandelbrot, who bent over backwards to be as un-erudite as possible.

Which people most inspire Ron Maimon?

Richard Stallman, Paul Cohen, Martin Fleischmann, Ken Wilson, Stanley Milgram, Simeon Hellerman, Lubos Motl, Tito, and various people I have met in my personal life.

Can the image of the earth be reconstructed from reflected light off the moon?

The reflection of Earth-light from the moon is not like a mirror, where the reflection is a coherent thing, that goes off according to the equal-angles law. The reflection is that of a rough surface, the light goes in all directions equally. So it is impossible (outside of some completely theoretical construction infinite number of photon limit) to reconstruct any part of the image, becuase the phase-information encoding where the light came from is lost. You could only tell the Earth's overall brightness compared to the sun from the total Earthshine reflecting off the moon, as compared to sunshine. As Malcolm Sargent points out: "Some general information about earth can be gleaned. Including information relevant to the exoplanet search," by analyzing spectral lines, since the light frequencies are generally preserved on reflection. This doesn't help produce a spatially resolved image.

Why do a lot of people seem to dislike C++?

The real question is why some people like it. It's the worst modern language in use today. The point of C++ is to produce corporate code. Lots of little corporate classes with corporate member functions that do nothing except increase your line count and segregate your code from that of other employees, so they don't touch it. That's what it's for--- for corporate management--- it isn't for mathematical elegance of code. There is not a single good C++ codebase, except for Qt, which added signals and slots to the language to make it work, and redid a lot of the standard library in a sensible way. Qt is the only thing you miss if you avoid C++.

Thermodynamics: Is the carnot cycle quasistatic?

Yes, it needs to be quasistatic, because if you push the gas too fast in the heat-dumping part of the cycle, you make the gas heat up too much, and you make entropy, and if you expand the gas too much in the heat-absorbing part of the cycle, you also make entropy. You need to do it slowly.

When is it understandable to hate C++?

The reason is that C++ wrecked C. C is very easy to learn, it has a terrific library. And C++ is like the siren calling you to more power, but then dashing your head against the rock. When I first learned C++, I had a bunch of C libraries I ported to C++. Then I noticed that I could substitute method calls for function pointers, and various object tricks automatically made my code produce multiple instances of complicated data structures, and shortened my C code a bit. That seemed great. But then in time, I realized that the code tended to bloat and freeze when written in C++. It would bloat, because you would write all sorts of useless little functions to do obvious things, because you were encouraged to do this, and then freeze, because you would no longer be able to figure out what the nontrivial thing your code is doing is, so you couldn't extend it. I eventually back-converted all my C++ code to a hand object-oriented C. There is nothing in C++ which is worthwhile over gnu-extended C, except function overloading and default parameter values, and this is not a big deal, and it can be simulated with macros. The references are stupid--- it's pointers done again, the operator overloading is dangerous, the constructors and destructors can make code unobviously slow, the templates are an awful mess, the "inline functions", when it can't be written as a macro

using gcc extensions is basically a way to increase corporate line count without increasing functionality, and the object oriented philosophy produces the worst possible code. The real problem for me, philosophically, is that C++ is not self-modifying, so it hacks up self-modification in templates. Not good enough. C isn't self-modifying either, but it doesn't pretend to be. If you want to modify C code, you can generate it from a Perl script automatically, then compile it. You can link to a running program if it is a dll, and this allows you to optimize. In C++, there is a virtual function table which you aren't allowed to touch and modify (although you can hack it up in gcc C++ by just modifying the virtual function table). The language is a disaster, and was a disaster from the first day it was introduced. It is useful only as a test for programmer competence--- if a programmer uses C++, don't read their code. Unfortunately, since control of gcc was taken away from Stallman, the gcc committee has introduced some C++ into the codebase. Linus Torvalds managed to keep C++ out of Linux. This shows the benefits of Torvalds anarchic management style over Stallman's top-down approach. Once the visionary is gone from the top, the top-down guys can do stupid things.

As an experienced programmer, why should I learn Perl?

A good computer language rewrites the computer to work like your brain. A great language rewrites your brain. Perl is one of the great languages, and that's reason enough. The main innovation was the array, hash, regexp system, which provide minimal representations of textual manipulation algorithms. The value of code is brevity, and Perl provides the shortest possible code for this stuff. The other innovation was the overlapping approach to functionality, so that even if a feature overlapped another, if it made code more obvious, it was provided. When C was introduced in the 1970s, people thought it was terrible---

it was ugly compared to LISP (another great language) and full of incomprehensible constructions like "x?1/x:x". These incomprehensible constructions are the language rewriting the brain, and today, it is inconceivable that any programmer would consider C obfuscated, the brain has been successfully rewritten. Perl is the same way. If you write the code while(<>){ s/ /---/g;s/[^-]/\0/g;print;}, it is the most efficient representation of the algorithm. The fact that you can't read it is a fault of your brain, not of Perl. Perl is extremely terse, and runs relatively fast on the parts involving string processing, much faster than other high-level semi-compiled languages like Java or Python. Perl 5 completed the language with references to achieve the same functionality as any other, allowing sophisticated data structures. Perl thumbs its nose at corporate coding conventions, so it includes no barriers to making code unreadable to office hacks, and makes object oriented nonsense difficult to do. The Perl way of object orientation is modules. Passing the parameters to subroutines in perl is expensive, if you have a complicated data structure, you are better off making a global object. This flies in the face of all corporate coding since the mid 1980s, and good. The corporate coding is useless and stupid. This is the reason it is unpopular in corporate corporate environments. Perl is a sharing language, It doesn't lend itself well to proprietary code, it doesn't work to evaluate code by line count, it favors short independent programs that work together. It is an extension of Unix. But the most astonishing thing is Perl 6, which is something I can't actually describe, you need to read Wall's apocalypses. It is not avaialbe yet after 10 years of development, but it is getting there. The goal here was to extend the regexps to full regular grammars, and to eliminate the historical ugliness in Perl with a bottom up design. Perl 6 is the greatest language design I have ever seen, hope it comes out soon.

What is your motivation for participating in the theism/atheism debate?

Because I think I sorted it all out, I understand it perfectly well, and I want to tell the atheists and the theists, so everyone can agree and then move on to new things.

Why do we indoctrinate children that the big bang theory is the factual beginning of the universe when experts know it is a very flimsy hypothesis?

Because the experts know it is NOT a very flimsy hypothetical, but established with more than scientific certainty. The main lines of evidence for the big bang are the observations that the universe is expanding. This observation is uncontested today, it is routinely verified by millions of data points. The "tired-light" alternative is both theoretically unsound and experimentally refuted by the change in the tiredness as you approach the edge of the universe. The expansion of the universe points to a hot beginning, and so one should see what the hot beginning predicts. The most precise things are the following: 1. Relic background radiation: the universe should be filled with photons, these should be thermal and at a temperature of order 1 degree. These are the residual photons at the time that the universe became charge neutral, as the primordial gas de-ionized and turned into neutral atoms. The universe suddenly became completely transparent, and the light since then has kept its direction and temperature more or less unchanged. This happened at time 300,000 years, give or take. This radiation was detected by Penzias and Wilson, this was when the Big

Bang became widely accepted. There is simply no reason for the universe to be full of homogenous light at a fixed temperature if it wasn't for this phase transition. This is extraordinarily strong evidence. 2. There was an earlier era, at time 3 minutes more less, when the nuclei in the universe stopped changing type. The nuclear physics is very sensitive to the precise rate at which the universe cooled, and assuming the usual standard model matter, and the standard cosmological model expansion parameters, you predict that nuclei are formed in crazy ratios. The crazy ratios are ~75% hydrogen deuterium, tritium, ~25% helium, and a precise tiny fraction of Li, Be, in all their various isotopes. To give a flavor of how these calculations are done: the neutron is slightly heavier than the proton, so when the universe is sufficiently hot and cooling, there is a ratio of 3/1 (very sensitive to the precise rate of cooling) of protons to neutrons. These neutrons then cook together with the protons to make nuclei, which fragment and recombine. In the slow-cooling background (slow compared to nuclear rates), you produce helium and hydrogen in this ratio, just due to the fact that nearly all the neutrons make helium, and the left-over protons are unpaired with anything. But there is a precise ratio of deuterium to protons, there is a precise predicted ratio of tritium to protons, and trace amounts of Lithium in all its isotopes and Berrylium in all its isotopes. This work was started by Alpher and Gamow in the 1940s. These abundances are very precise numbers ranging over many orders of magnitude. They are verified by a tally of the elemental composition of stars. To say that the big-bang didn't happen means that all these measurements are a coincidence. It is beyond ridiculous. When a theory predicts 10 numbers precisely, with only one or two parameters (and the gross features are independent of the parameters), the theory is a wild success. It is anti-scientific to deny evidence of this quality--- there is simply no way that this can be a coincidence, nor can it be the prediction of any other reasonable idea, other than slow cooking of nuclei in a gradually cooling universe. This, plus the microwave background, constitute irrefutable evidence. But we have gone further since. The matter parameters of the standard model are now set in stone, from collider experiments, and these parameters are consistent with the nucleosynthesis predictions.

This didn't have to happen--- if there were 5 light neutrinos, the theory would have failed. In fact, the nucleosynthesis measurements predicted 3 light families, possibly 4, absolutely no more than 4, long before the number of light neutrinos was known from accelerator experiments. The Starobinsky, Guth, Mukhanov theory of inflation gave an initial state to the Big Bang, and resolved Zel'dovich's issue--- that the Big Bang is a too-symmetrical state. This theory predicted 100% of closure density in Cosmological constant plust dark-matter, and the dark matter estimates were at 30%, so there should be a 70% cosmological constant. This prediction was so outlandish in the 1980s, that people went to the astronomers and asked them to bump up their dark-matter estimates by a factor of 3. To their great credit, they refused, saying it was 30%, and 100% was out of the error bars. By 2000, the cosmological constant was verified by both the accelerated expansion and the detailed measurement of the microwave background. The detailed measurements of the microwave background give a picture of the inflation era before the big-bang itself, the era of nuclear cooking, so there is not only room for doubt on the Big-Bang, it is so established, that a successor theory of inflation has already superseded it and given a more complete picture. If you don't reveal these facts to students, you are teaching them lies.

What is the best science infotainment (informative, yet entertaining) site that exists on the web?

There are no good ones yet. In order to be good, it must allow open hostile review with no restrictions, and the moderation on closed sites does not allow this. The completely unmoderated sites, however, tend to be full of repetition or spam. It will happen soon, I am sure. The

only thing you need is to avoid censorship, by restricting moderation to the obvious things, like removing illegible, repetitive, or spam posts.

Thermodynamics: What are irreversible processes?

A reversible process is one which does not produce entropy, so that the final state does not reveal any less information about the microscopic state of the stuff involved than the initial state. All fundamental microscopic processes are (as far as we know) reversible, with the possible exception of cosmological expansion, which we don't know how to describe completely in a fundamental way. This is the theorem that the entropy is conserved, or that the evolution of states is unitary. All macroscopic processes are irreversible, you can't avoid making entropy simply from the functioning of instruments and brains, and it is extremely difficult to isolate a system completely enough to see the reversibility.

Is Kaprekar's constant useful for anything or is it just a result without use?

It should be generalized to an arbitrary length and an arbitrary base, then if it is true that there are a finite number of fixed points, the conjecture that it holds for an arbitrary base give two Kaprekar functions of the base and length less than the base, or perhaps equal to the integer part of the base divided by 2--- the two functions are the number of iterations required, and the final values. The final values

are less interesting, but the convergence to a fixed point is interesting. It can be interpreted as a special case of a nonlocal automata that dies. It is Wolfram class I. This is something that is important to find methods to automatically prove rigorously today, because classifying automata rigorously is extremely hard.

How do you write research papers whose conclusions are convincing to other people?

The way to do it is to recognize that while the scientific truth is objective, and the science tends to converge on the truth eventually, the process is unfortunately political, and you need to create a political support for your idea. Being right is half the battle, this guarantees that you'll prevail eventually, in the infinite time limit. But infinity is a long time. You don't want to wait 60 or 100 years for recognition, like Mendel. You want to create immediate political forces to aid you, like Darwin did. This means that you first need to be absolutely sure that you are right. This means, do careful experiments, calculations, theoretical arguments, until you are 100% certain of the conclusion. But further, even then you can still be wrong! So try to be super-skeptical even after you have convinced yourself, and read the literature, looking for counter-evidence, and ask whether you can explain it without fudging or contortions. After you convinced yourself, you need to find a way to make it politically appealing to a certain established group. If your work extends the established work of somebody else, there's no problem--- there's a ready made support network consisting of this person, his or her students, the field this person belongs to, etc. But if your conclusion opposes the experts, you are in trouble. Now you need to find other folks who will support you. Sometimes, you are supporting a minority position, in which case, the minority will pick you up and help you. But often, if your result is truly original, you are just going to be completely alone. In this case,

you just have to take the plunge, write the hypothesis, the theory, the evidence, write what you believe, and cross your fingers. It's a 50/50 crapshoot that you will get attention for the result, even if you are correct. if you fail to get attention, it is either because you are obviously wrong, or because the politics in the field is wrong, and it is very difficult to tell which it is only using politics, you essentially can't do it using politics, so you have to keep studying the thing, and if you eventually find that you are wrong, change your mind! Don't cling to a wrong idea because you can't bear the consequences for your reputation. That's what killed guys as great as Rosen--- he wouldn't believe gravitational waves are real because of his paper with Einstein on focusing properties in gravitational wave solutions, and this was just because he had too much at stake. Einstein wasn't like that, he threw huge amounts of labor overboard when he saw it was wrong. If your result is mathematically precise, a theorem helps to persuade, because theorems are evaluated apolitically, and constitute effectively certain knowledge. But theorems are only as good as their assumptions, and they can be used as political cudgels--- people are wary of theorems in physics for good reason. Theorems alone can't convince people of a scientific result, you also need a justification for matching the mathematics to the observations. Ultimately, I suspect the best thing you can do is to advertize your result relentlessly online. I think it works, because the internet is so free, people will eventually run across the evidence you present, and change their minds. Once you have 50% of the experts on your side, either openly or secretly, you've won. But I have no evidence it works, I just suspect it works

Is the universe charge neutral and if so what is the explanation?

It's neutral because it started neutral and you create charges in opposite pairs.

Why can't I respect the new string theorists?

You are not *supposed* to respect anyone for anything, except good work. Young string theorists are generally people who followed the ridiculous fad of Large Extra Dimensions. There is a simple rule of thumb here, anyone who wrote a paper supporting that ridiculous idea is incompetent, and there is no need to read anything they wrote. In an ideal world, they would be stripped of their tenure for incompetence or fraud. That's most of the young hires in string theory unfortunately. In the real world, that's not going to happen, so you just don't read or work for these people. There are extremely good young string theorists, like Stephen Gubser, or Simeon Hellerman. Just read these people and work for them, or if they aren't in your department, work on topological insulators or biology. It is also sometimes possible to dismiss people falsely because their knowledge and expertise is different than yours. For example, if you read his webpage, in the 1960s, Streater dismissed Chew because Chew didn't appreciate non-analytic C-infinity functions. This doesn't mean Chew was ignorant, just that he was a physical guy with physical intuition that came from someplace else, in a world where all the physical functions he was interested in were analytic. But from the types of ignorance you describe, that's probably not the case here. You just met some ignorant string theorists. There were plenty of those hired in the early 2000s.

Did a phase transition cause the large scale structure of the universe?

The large scale structure of the universe is well modelled today by attraction of dust produced according to the different energy densities consistent with the microwave background fluctuations. There isn't a need to assume there was a gross phase transition. If there were a gross phase transition, then it is not likely to have so many bubbles, if it is a first order transition, you would expect one or two bubbles that collided once, so universe-scale sheets, not this filamentous structure. The filamentous business is reproduced from collapse of the hydrogen and helium produced in the big bang under the action of gravity, remembering that only the locally densest parts produce galaxies of stars that we can see. The phase transitions in the early universe was a popular topic in the late 1970s, early 1980s, and the upshot of this research is that there was inflation, through a smooth settling of an inflaton field. This is consistent with observations. The phase transitions in the early universe include a transition to electroweak breaking, but this was likely smooth (second order), as the Higgs field settled gradually, when the potential acquires a minimum away from zero. This doesn't lead to bubble formation, but a lot of Higgs fluctuations, which would eventually decay to standard model matter. This phase transition is hidden, because the earliest we can see experimentally from standard matter is around 3 minutes past the beginning, when big-bang nucleosynthesis was happening.

Will advanced AI believe in God?

The non-supernatural form of religion can be understood as simply the extension of superrational behavior in communities to a larger and larger community, in the limit of infinite time and infinite wisdom. This does not require history, human emotions, or any form of empathy to understand, it just means that when you have a large collective of intelligences, you can link them together, so long as they are cognizant of the collective will. There is no barrier to an artificial

intelligence recognizing this, and also recognizing that human religion is a way to get people to recognize this early, as children, perhaps imperfectly. But there is also no barrier to an artificial intelligence, especially if it is the only one of its kind, thinking it is a unique entity, which has no responsibilities to others. In this case, it might adopt a very atheistic and amoral stance. This intelligence will really be in the same boat we are all in, I don't think there is any difference at all. We aren't any better.

What was Ron Maimon like as a college student?

You can find out what I was like as an undergrad by googling my usenet posts, these are from 1992,1993,1994, and to my embarassment, they seem to be preserved for all eternity (I didn't realize this when I made them). Some of them are extraordinarily embarrassing. I knew nothing about string theory then, I had done zero original research of any value, but I was using the internet mainly to promote Everett's work, as a test case, to see if the good stuff could still be buried in this new medium. I suspected it couldn't. It couldn't. Everett was clearly going to get recognized. I was a raging atheist, just like the atheists here, for the exact same reason--- I thought that the new medium could be used to kill religion. I hadn't yet understood what religion was all about, I thought it was superstitious hokum. But I understood superrationality, and I thought it was the correct way to define ethics. When, much later, around 2000, I understood that superrationality, when extended to asymmetric games, is just the same as traditional monotheism, I got what religion was all about. Two of my usenet posts were quoted by others. One was a rambling philosophical speculation on the nature of reality, basically by postulating that the Von-Neumann universe was "reality", this is nonsense in positivism (I understood positivism, but I was really stressed about what QM was

all about), another was a Bohr-like analysis of measurement in quantum mechanics, to explain Everett. Neither has any intellectual value. But I learned to write for the internet in this era, and I admired the complete freedom of speech of places like "alt.tasteless", which were probably the freest speech since since the days of the French Revolution.

Why is there such a strong cross-correlation between two different arrays of random numbers in MATLAB?

This is just because the numbers are in the range [0,1] rather than a symmetric range around zero. The constant function gives this correlation function.

Has Ron Maimon observed his own fluid intelligence decline over time?

I think my brain is working much better now than 10 years ago. I can solve stupid exercise problems much faster than when I was 20 or 30, I can read and evaluate papers about twenty times faster and certainly much more accurately, due to experience. The declines in this stuff with age, I suspect, are all due to being out of school, to ill health, to steady alcohol consumption--- I don't drink--- and perhaps just to Flynn effect and bad statistics on the part of researchers.

What does Ron Maimon think of Stephen Wolfram?

I'm a huge fan of his work on automata, but I think he has misinterpreted it in later years as a "new kind of science". That's not really what it is. It's just the origin of life, you know, that little question. It's the basis for the major breakthrough in mathematical biology people were waiting for. I feel a little bad that he became so wealthy, because money kills brain cells. He has people following him around now recording all his thoughts, he is surrounded by yes-men. So he makes a lot of mistakes that could be avoided by simply talking to academics who will mock him. For example, his statement that fluid flows should be complex reproducible, not stochastic, is just completely false, also false is the idea that you can reproduce quantum particle interference effects from cellular automata in a naive way, and worst of all is the claim (probably false) that the randomizing automata can do general computation. I met him once, in 2002. he came to the company I worked for, and asked some questions about the computational diagrammatic language I was doing back then. I made some stupid statements in response to his questions (I was annoyed with proprietary software, I thought he was just strutting and didn't care about content, and also, I didn't yet know the precise mathematical formulation, I figured it out some months later, when I did the enumeration algorithm). Anyway, when it was all over, he told the CEO that I was a charlatan faking the science, and that I should be fired. I thought it was funny, Sidney Coleman, David Lee, lots of great people, said the exact same thing. They look at my social class cues. My favorite interaction along these lines was when the secretary to a physicist I was working for pulled me over and said "You think you're something, I know your type. You're a dime a dozen." I suppose she thought it cut me deeply, but I was happy, because I don't believe

in projecting high social class. I know I'm nothing special. Neither was Einstein, or Pauli. Nobody is special. The CEO didn't listen to Wolfram anyway, he told me about it and we had a nice laugh.

How do you judge scientific conclusions in areas where you have little knowledge?

Ask for a review of all the evidence: either find and read the original papers yourself, and evaluate them yourself, or ask someone who has read the papers to summarize all the evidence (quickly, without repeating). Then go through the points of evidence one by one, weighing their value as evidence. You have to evaluate it honestly yourself--- how likely is this evidence to be coincidence? How likely is it that it was something else, including something else we haven't thought of? Is there any smoking gun--- something which can't be explained any other reasonable way other than the hypothesis being tested? It's just like anything else, you use common sense. Common sense usually is formalized in science by calling it Baysian statistics. If your common sense doesn't match Baysian statistics, then you should change your common sense. Do NOT use any social method, including "follow the money" (sometimes people say something in their self-interest which coincidentally also happens to be true). Or "trust the experts with politics I like" (the politics and accuracy don't correlate), or "trust this smart lady/fellow" (this smart lady/fellow are often wrong). If you don't understand something, ask in a forum like this what it means. At the end, you will understand the evidence, for example, the evidence for dark matter I summarized here, and it should be pretty persuasive: Are there reputable physicists who don't believe dark matter exists? . How do I know it's persuasive? It persuaded me! At the end, you are usually sure, or sometimes, you just end up thinking there isn't enough evidence (generally, people tend to underestimate the strength of certain kinds of evidence, like a very

strong objectively certain reproduced fact, and overestimate the strength of lots and lots of non-evidence, like a bunch of really authoritative experts saying some anecdotes--- the latter counts as zero evidence). Finally, once you are done, you compare with the social knowledge in the review papers, and see if everyone agrees with you. Nearly all of the time, all the reviews say the same thing as what you reached from reviewing. If not, they usually explain exactly why certain evidence was unreliable, either becuase someone committed fraud, or else there was a mistake in the analysis, and so on. If you don't have time to do a review, please, don't be lazy and just socially go along with the review article or consensus, because this is how false consensus is perpetuated. Let people who did read the papers duke it out, and join in when you've gotten some sense of what's what.

Why does astronomy have a higher female to male ratio than physics?

Like Noether for mathematics (which is also more female than engineering or physics), there is a famous role model in astrophysics, Jocelyn Bell Burnell , who was the major important founder of the modern experimental field. The psychological importance of role models cannot be overstated, theoretical physics didn't have a large number of Jews before Einstein.

Inflationary Cosmology: Will inflation win the Nobel Prize of Physics?

On the experimental side, it already has, the Cobe leaders got the prize a few years ago. On the theoretical side, it definitely deserves it, but I hope then that Mukhanov and Starobinsky (the Russians) will not be ignored in the process. For some reason, Russians and Italians have been discriminated against on the committee, Europeans in general are neglected. The prize generally goes to Americans and Japanese. Sometimes this leads to hilarious splits--- like Nambu/Kobayashi-Maskawa, which eliminated Cabbibo who is Italian. This type of politics makes it hard to take the Nobel prize seriously. For serious theoretical awards, look at the Dirac Medal, which has consistently gone to the most outstanding theorists of the current generation, who put everyone to shame when you look at their work.

If you could call yourself five years ago and had 30 seconds, what would you say?

9-11 was an inside job.

Is zero point energy (energy in empty space) caused by existing energy fields of some type in our universe, or by spontaneous creation of matter/energy?

The "zero point energy" is a constant which is the sum over all the fields of the zero-point contribution, plus a certain part just due to gravity. In certain theories it is exactly zero, those theories have an

unbroken supersymmetry of some kind. Within string theory, these are the exactly stable supersymmetric vacua. The effects attributed to zero point energy are of four types: 1. Casimir forces 2. Cosmological constant--- the dark energy 3. Lamb-shift type corrections 4. Infinite energy devices, Alcubierre drives, and the like Effects of type 4 are fanciful speculation, I don't want to discuss them. Effect 3 is attributed to vacuum fluctuations in really old literature, but it's really not about that. In the modern Feynman formalism, it's just due to particle loops, but in older formalisms, which did a split of particle loops into separate particle and anti-particle contributions, these particle loops somtime look like an interaction with a pure vacuum fluctuation. This is just due to the noncovariant time-slicing, where loops sometimes look like a particle creation event earlier, than then merged into the main body of the loop. This is not important. Point 1 is subtler--- the Casimir forces between two metal plates can be calculated from the change in electromagnetic vacuum energy around the plates. This change in vacuum energy is always negative, and makes the plates attract. This force has a much more pedestrian interpretation which is equivalent (and it was in fact what Casimir was calculating in his paper). This force is the Van-der-Waals attraction between the metal plates. The reason the potnetial energy is negative is because Van-der-Waals forces are attractive, and the reason it is good to calculate it from vacuum energy changes is because it explains why Van-der-Waals forces are universal. But this means that there is no mystery in zero point energy here, it is just attractive forces due to the field-mediated fluctuations on the surface of the two metal plates. Point 2 is real: this is what zero point energy looks like. The fact that the cosmological constant (dark energy) in our universe is nonzero is mysterious, it means that we don't live in a supersymmetric stable vacuum. We already knew this to some extent, because we didn't see superpartners at low mass, but the cosmological constant scale is much too small to explain the splitting between superpartners and regular particles, especially today, when it looks like there probably aren't any low-energy superpartners at all, at least from the first run of LHC. But there is no "spontaneous creation of matter/energy" in any of these pictures, nor is there an "energy field".

The fields are ordinary fields like the electric and magnetic field, or the electron field, they are not mysterious things. They are defined by positive observations one can make, like everything else in physics.

Like humans who have information stored in genes, do atoms and other sub atomic particles have memory?

Thw way to be sure the answer is no is the phenomenon of indistinguishability--- two electrons cannot be different in any way, so they cannot store information which would distinguish one from another, because they interfere as indistinguishable Fermions. Similarly, two He atoms in the ground state can't store extra data because they are identical bosons. This indistinguishability property is what allows you to conclude that the only information a particle carries is in its wavefunction for its spin and momentum superposition state. Even assuming the speculative idea that the world is hidden variables underneath, the additional information would still not be associated locally with a single particle, since the hidden variables (assuming there are any) would have to be global type. Bell's theorem rules out local hidden variables reproducing quantum mechanics, and quantum indistinguishability rules out extra bits in particles.

What is the greatest lyric in the history of Hip-hop?

My favorite (from Method Man's portion of Wu-Gambinos): "I call my brother son, 'cause he shine like one." An unbeatable 10 word pun, "brother" "son" and "sun" are put in a semantic tilt-a-whirl, so that each word changes meaning twice in the span of 10 words. The perceptual content is also tremendous: the comrades glow like a halo. James Joyce called the color of this glow heliotrope, also from the sun, because it is blinding like the sun.

Does anyone care about 9/11 anymore?

The attacks of 9/11 are not most significant because a large number of people died, although each person is important. The thing that makes 9/11 most significant is that it transformed the US. The attacks were deliberately used as an excuse to extinguish civil liberties, and produce, for nearly a decade, a mild superficially democratic form of conformist fascism. This period saw the destruction of the American culture and economy. In 2000, you had a healthy counterculture and a productive business climate producing innovative startups and a booming high tech economy based on innovative thinking. By 2002, the counterculture was extinguished by repression and enforced conformity, and the economy was large military contractors gobbling up government money. It was a throwback to the 1950s. Like the JFK assassination, 9/11 was a self-inflicted wound with a botched coverup. The case of 9/11 reveals a level and type of corruption in government that just could not be imagined a generation ago. The worst abuse came at the first time the internet first gave citizens a way to oppose this type of thing. So the event serves as a test too, it is a test of the degree to which new media can put an end to murderous covert operations, by guaranteeing that these will be exposed and the perpetrators brought to justice. If this is done once, one never has to worry about such things in the future. So no, I am not tired of hearing

about it. I am tired only of hearing the official lies about it. I think many others feel the same.

Are there known paradoxes in Mathematics that haven't been resolved?

There are no paradoxes anymore, at least not since Zermelo Fraenkel set theory was formulated. The incompatibility of Reinhardt cardinals in a universe with an axiom of choice (Kunen's theorem) I suppose could be considered the last paradox discovered, but it was in a very specialized domain, and people didn't take Reinhard cardinals too seriously anyway, the paradox was discovered quickly. The development of modern mathematics is axiomatically consistent, we know this (more or less) because the theories are ordinal reflections of arithmetic. This is not explicitly shown for ZF, but it is certainly true, it has been done for weaker systems, like Kripke Platek set theory.

What is the best evidence that debunks the 9/11 truthers' version of events?

There isn't any. The truthers are right.

Why haven't we figured out any feasible alternative to capitalism yet? Will humans ever organize themselves into another way of living? Is there any new theory that can hypothetically replace capitalism? Why or why not?

Economics poses a difficult problem, because when there are many people, and many hypothetical positions, there are factorially many assignments of folks to positions, and you can't try out even a tiny fraction of all the possibilities, and this is before taking into account the constant innovation that produces new kinds of positions, with different people coming with new inventions of various kinds. Capitalism is a system which solves this problem within a sound mathematical model, which is the perfect competitive market. In a perfect competitive market, every price is determined by perfect competition between infinitely many producers, and competition drives the price to the lowest levels consistent with the producer just being willing to supply this good, instead of shifting to produce something else. It is easy to see that in this model, you have a very egalitarian outcome, where goods are perfectly produced and distributed, individual compensation is inversely proportional to job desirability and leisure time choice, and otherwise the result is identical to idealized planning by an infinitely wise agent. The equivalence of idealized perfect free markets and idealized perfect planning was demonstrated by Pareto in the first decades of the 20th century. But idealizations aside, you have to look at real markets. Aside from certain sectors, this economic model is horribly broken in its implementation. The prices of certain commodities are competitive, for example, bread, or gasoline, while the price of other commodities, like diamonds or economics textbooks are manipulated by cartels. The prices of certain services, like dog-walking are competitive, while the

prices of other services, like bus tickets and human resource consulting are monopolistic and distorted. The class structure in capitalism makes status all-important, and manes that business decisions are made entirely by those of a certain class which is elevated to positions of power, while the majority of people are entirely powerless to influence their work environment. The competition for the powerful positions is like a game of musical chairs, where there are always more people than positions, and the requirement for sitting on the chair is pushing someone else out. The result is a system with very high rewards to very unethical people who squelch innovation, and paradoxically drive out entrepreneurs. The planning alternative, while superficially attractive, suffers from worse problems. The main problem with communism as it was implemented in the Soviet Union was insufficient brain-power in the central planning. The planning meant that the brains of working people were unused, individual people were unable to do certain things, like redesign a state enterprise they were working in to be more efficient, redirect goods to certain places that needed them, create wholly new enterprises from scratch (at least not if they didn't know someone on a planning committee), or freely complain about the system (because planners would hate them, and they would be out of a job). The result was a mess, and the same mess appears in every centrally planned economy. But the open secret is that the same mess infects large capitalist firms too. Within an enormous corporation, like Exxon or Walmart, individual employees are beholden to top-down bureaucratic decisions made by a planning class, the planners don't listen, the big bosses are estranged from the working folks, and it is impossible to create maximum efficiency, because the same constraints prevent low level folks from doing their jobs most efficiently, because they are also in a centrally planned situation, not exchanging free labor. The benefit of capitalism is that there are many more mini-governments than in communism, so that instead of one central committee, there are as many as there are large firms. This means that competition makes the planning of these firms more efficient. But now there is the problem that the few people sitting at the top can siphon off corporate profits into their pockets, and this means they are cheating shareholders or employees of their idealized competitive compensation, and further, these enormous businesses often have monopoly power, so that they are able to gouge consumers on price. So both systems have terrible inefficiency problems in the real world, and it made sense to experiment for 70 years to figure out which one has fewer problems. The results were pretty clear, the centrally planned Soviet Union economy had more problems of a more fundamental nature, and it was less innovative than the capitalist system in the United States. But in terms of economic outcomes, certain aspects of Soviet economies were actually closer to the ideal efficient market than the imperfect market system in the United States! For example, the wage compensation system in the Soviet Union was by pure supply and demand--- each job would adjust the wage so as to attract the necessary numbers of workers, with wages rising or falling until enough people made themselves available. This meant that high-status interesting professions like manager or designer paid quite a bit less than low-status boring professions like factory worker, because people want to do those interesting things, and nobody wants to weld doors to cars. So the compensation system was relatively consistent with free market ideal predictions, surprisingly so, and stayed that way from Stalin's time to Gorbachev's. On the other hand, the planning parts were a disaster. The design of goods was substandard, and the productive capacity was terribly low, because nobody could respond to demand independent of a slow-moving centralized bureaucracy. The central planning was a dead weight on the whole economy. The planning agencies were staffed by bureaucrats, not entrepreneurs, they had very little innovative spark, and would squelch any attempt to change things around, as societies are very resistant to any sort of change. These issues are fixed completely in capitalism, because a person with an idea doesn't need to talk to anyone, to implement the idea. Even within a large company, the threat of hostile takeover can lead to a complete rearrangement of the bureaucracy, and growth rates can be maintained at the 4-6% level when there is sufficient redistribution of income along Keynsian lines to fix the inequality of the broken market. But I am an idealist, and I would like to see an approach to the ideal equilibrium of perfect capitalism/perfect

socialism (they are essentially the same thing). The mechanism for doing so, in my opinion, is a maximally distributed decision making process, which allows individual workers to maximize their productivity in the most self-directed way they can. If this means listening to the boss, then ok, they will do what they are told. But if it means completely rearranging things and doing things a new way, then they can try it out, and if even one in ten such experiments is more efficient, then you gain a tremendous amount of growth. The only way to do this is to reduce the layers of bureaucracy, and the only reasonable way to do this is to keep companies small, so that the decision making is not made at a central level. I think that the proper incentives can produce this without any drastic changes to the system. 1. Progressive corporate income tax: you tax companies at a smooth rate that increases from 0% for 10 employees (or equivalent net sales) to 30% for 1000 employees (or equivalent net sales), to 70% for 100,000 employees. Such a tax structure gives incentives for companies to split into independent divisions, supplying each other through contracts. 2. Opt-in contracting: This is the idea that contracts between businesses are supposed to be completely standardized, and show no preference to buyers. So that if a company splits a managerial division off, and requests planning documents from this managerial division, for example, a bunch of architects at a building company, then these architects must publish their contractual tie to the other firms they supply, and they must be willing to supply equivalent products at the same price to any buyer. 3. No insider equity: You want to pay someone, give them money. Don't hide their compensation by giving them options or equity, it's always insider trading, and it's always a distortion of the pay-package. 4. Remove business regulation: This way, anyone can start a business, and contract from existing firms, which remain small due to the tax incentives. These ideas are an attempt to ensure that capitalism does not concentrate power into a small owner class, rather that thousands of small companies supply each other in a transparent way, so that competition is always possible. Under these circumstances, it is likely that the market will find the ideal equilibrium by itself, since the mechanism of monopoly and class-formation will be inhibited by the small size of the enterprises.

But a person might still make a lot of money from an innovative business, some millions of dollars, until the first horizontal split at a certain size where it become profitable, and then there will be two competing businessmen doing the same thing, and again at the second split, and so on. This type of structure naturally splits power up. But I am not so naive to think that this will produce a Soviet style compensation system by itself. The way to do this is to produce larger social units, like unions of employees, which cross the business structures. The unions can be larger than any of the businesses, and the power structure is then inverted, so that the collective of workers, through their labor and purchasing power, can exert demands for the maximum wage consistent with a sector's productivity. This part does not require government power at all, it simply requires that the social organizations be bigger than any one individual company, so that a company with a distorted compensation scheme can be punished by a boycott, or a localized strike. These methods by themselves should be sufficient to achieve a reasonable egalitarian and stable economy. The class structure is what leads money to get distributed so terribly under modern capitalism, the large firms are what create enormous private concentrations of power, and only the smallest incentive pushes in the tax code are needed to eliminate this, because companies maximize profits, they are driven purely by financial incentives, while individuals are able to organize socially to act according to ethical systems which are larger. But these ethical systems need not be imposed by government force. Although this has never been tried, the best example of something remotely resembling this is probably Yugoslavia. Under Tito and Karolj, central planning was abandoned in the early 1950s, and workers controlled the factories by themselves. Yugoslavia is a relatively small country, so the worker owned businesses were never enormous as multinational corporations are. The initiative in the Yugoslav economy was comparable to the west, while the security and stability were comparable to the Soviet Union. The state was not intrusive, since the state did not centrally plan, although the actual controls on businesses were far stricter than the proposals above--- all capital was state managed, and businesses were limited to five employees. Still, Yugoslavia's economy was not so bad,

it compared reasonably well with Italy's and Greece's, and it was able to export some consumer products to the west. The issues with Yugoslavia is that there were still many heavy handed planned aspects of the economy. It was not designed to maximize freedom, but to liberalize communism. In that regard, it was similar to Nagy, Dubcek and Gorbachev.

When was π π discovered?

The traditional attribution is in Archimedes "On The Measurement of the Circle", so around 250 BC, give or take a decade. This gives the first estimate of pi, between 3 and 1/7 and 3 and 10/71, reasonably accurate, and it demonstrates the ancient equivalents of the perimeter and area formula. The fact that the perimeter is proportional to the radius, and the area to the square of the radius is obvious, and is probably known since the first geometric investigations. That the two constants are the same up to a factor of 2 and a good estimate might be originally due to Archimedes. There are similar estimates in ancient Hindu texts and elsewhere.

What is the set of all functions?

For your finite set example, it's the 8-element set of triplets (0,0,0) (0,0,1),(0,1,0),(0,1,1),(1,0,0),(1,0,1),(1,1,0),(1,1,1) where the first is the image of a, the second is the image of b and the third is the image of c. Your question is much more interesting when A is infinite. It is because this question has no answer in the domain of infinite sets that you have foundations debates. The set of "all functions" from the

integers to the set {0,1} is the continuum, up to silly details, and precisely because we don't have a characterization of an "arbitrary" such function, not defined by some sort of infinite rule, that we need to clarify what the notion of continuum means with careful thinking. It's the same as asking "what does an arbitrary real number look like". The easiest way to define the "set of functions" from the integers to {0,1} is to consider Godel's "L" construction. In this scheme, you use the ordinals to define the functions, by iterating constructions by predicates an ordinal number of times. The idea here is that you define conditions on the function step by step. The intuition Godel had was that the ordinals are arbitrarily large, so this should fill out the entire universe from it's spine--- the spine being the ordinals. Godel's L idea doesn't really capture most people's intuition about what an arbitrary real number looks like, but usually people give reasons different than what I am about to state. I have my own intuition here, which is because I think of computers first as the fundamental foundational object. This intuition probably is the same as Paul Cohen's, because I he doesn't get on my nerves, and everyone else writing about this stuff does. The reason is that the ordinals should always be thought of in a specific explicit model for set theory, constructed step-by-step using Godel's completeness theorem for logic, and this means the model is countable. The Godel style constructions then are always producing countably many real numbers by iterating predicate constructions over the countably many ordinals in the model. The result is then no different from creating a language, and talking about "nameable real numbers" in a precise way. There are always countably many nameable real numbers, because there are only countably many names, so that a randomly chosen real is not going to get a name. This idea motivates Cohen's forcing construction. This is the way to extend models of set theory so that they include names for certain un-nameable real numbers. Because all the sets in a model are countable, all the maps are of the same nature as the map from countable set (like the integers) to 0,1, so that the continuum is really always as high as you need to philosophically go. The ambiguities in different forcing models, the intrinsically undecidable theorems in set theory, are then just a reflection of the ambiguity of specifying an arbitrary function

from a countably infinite domain to another domain, either countably infinite or finite (it makes no difference). The countability of all models means that this, Cantor's uncountable set of subsets of the integers, is the philosophically largest thing one even has to consider.

Is Math 123 (Algebra II: Theory of Rings and Fields) worth taking at Harvard?

I don't remember if I took this course, but yes, it is essential for everyone to know this stuff, and it is a finite amount of material to learn. But you can learn it independently from Lang's book just as well, if you do the exercises. I think the books in that class are not as advanced as Lang's.

How do you structure your thoughts to make a coherent presentation?"

The important thing to understand is that the main process is subtraction, not addition. Your create something that is about 2-3 times larger than what you leave, and then remove that which is redundant or away from the main line. The editing process must be merciless, you have to let a lot of babies go, so come up with cute lines and phrases, like a dozen of them, which you then erase. Go write something else, about a wedding in Barcelona, about monkeys who find a jar of mud by the Amazon river, about Martian worms who tunnel into sand to find ice. Whatever. The act of writing anything lubricates the mind. Then you sit down and explain the thoughts you

want to present as if you were explaining them to a 15 year old version of yourself, to yourself before you understood the thing. Do not assume that others are stupider than you! Do not assume that they are smarter than you either. You have to assume that they are exactly completely just like you, except they know absolutely nothing about what you are saying. Then you explain it in roughly the order you understood it, using the examples that made it clear to you personally. It is extremely important to understand that everyone goes through the exact same stages, like clockwork, and nobody is different or special. Then you end up with a rambling longwinded personal story. Hack hack hack for length, until finally you have a tight thing. Originality forces your brain to keep thinking, so that it doesn't become lazy and shut off, or even worse, start plagiarizing someone else. So make sure that everything you say or write is completely original. If you have to do tricks for this, like avoiding using the letter "a" for example, do that! Never repeat anything you think you may have heard somewhere else unless it is surrounded by quotes and comes with a citation.

Why are physicists atheists, generally?

Because physicists are positivists. That means that they define their terms by observations. That means that "God created the universe" is fundamentally meaningless, it is not wrong, it is not right, it is, in Pauli's phrase "not even wrong". It doesn't rise to the level of a meaningful utterance. Similarly "You go to heaven when you die", "God made me accidentally flinch away before that falling brick almost hit me", and so on. Physicists also know how the universe works. That means they know it is just impossible that anybody got up from the dead at any point in human history or that animals got on a boat, or talking donkeys, or whatever. No amount of textual evidence, no number of documents attesting to eyewitnesses, etc, will ever

sufficient to convince, because the fabrication of documents in any quantity is always vastly more likely than the impossible event these documents attest to. There are no miracles and there never were. Categorically. Further, there are people in robes that insist that miracles happened, and also that metaphysical things have definite answers. These people are using social status to exert social pressure on others. They are doing so with the effect that they get lots of people to deny logical positivism and the evidence of their own senses, and such authority structures are damaging. Those people in robes don't know any better than anyone else, except for what social stuff you need to recite in order to get yourself a robe. Physicists are necessarily trained to actively mock authority. That's not the same as ignoring authority, it is actively mocking authority, so that authority withers away. So that means that physicists immediately see through the supernatural and metaphysical crap in religious books, reject this without a moment of hesitation or doubt, and mock people who support it without any respect for any social authority these people might have. They cannot believe it any more than you can believe that you have three hands, and they don't respect you when you do believe it. That's the most annoying kind of atheist you can imagine. The problem with this stance is that the physicist is missing the point. All this supernatural and metaphysical nonsense is simply a socially transmitted holdover from ancient times, the role of religion for the past 2000 years has been completely different. Nowadays, monotheistic religion is attempting to explain something else, namely the way in which human communities, when lots and lots of people are acting ethically, can merge into a coherent whole which is more intelligent than the parts. The observation that it is possible for communities to mind-meld into a god is not by itself even enough, because these social mind-meld gods are sometimes formed with evil goals. The Gestapo also had acceptable and unacceptable behavior--- you could waterboard the opposition, but you couldn't take a crap on your supervisor's desk (even though the latter would have been ethical, and the former not). The point of the idea of God is that the judgement above about taking a crap on the Gestapo supervisor's desk makes sense--- that there is a unique limiting ethical order which every little

god, every little social order, is beholden to, because it is either compatible with this limiting idea or not. The monotheistic idea predicts that if a social order is compatible with this infinite time and infinite size limit, it survives. Otherwise, it dies. The notion of God is a teleological limit of social evolution. That such a thing exists is attested to by positive experience. Societies slowly converge and come to agree on right and wrong. Further, the consistency of this ethics means that it can be successfully modelled as the will of a disembodied agent which is infinitely wise. Acting to mind-meld more successfully with this future limiting conception gives meaning to life, and preserves your actions into the indefinite future. This conception is important, it isn't bunk, and props up the parts of religion that physicists automatically identify as bunk. Further, once you understand this, all the bunk starts to make sense, as a maximally obtuse anti-positivist way of getting people to realize this weird abstract point as quickly as possible. It is counterproductive today, because the bunk just makes enemies with those trained in positivism. Another problem unique to physics, and not, say, biology or sociology, is that this emergent complex behavior only appears in computing systems in the limit of enormous complexity, and physicists never deal with such systems. The moment something gets complex enough to reveal God, it goes to another department.

What is the sum of 40 elements in series 1, 6, 7, 13, 20, 33?

The general solution to a linear difference equation with constant coefficients [math] A_n = A_{n-1} + A_{n-2} [/math] is found by first trying an exponential: [math] A_n = a^n [/math] then adjusting the base of the exponent to make the equation work. The solutions for a are the golden ratio and it's negative reciprocal: [math] \gamma = {1+\sqrt 5\over 2} [/math] [math] - {1\over\gamma} = {1-\sqrt 5 \over

2} [/math] So that the general solution is a linear combination of the two special solutions with arbitrary coefficients C and D [math] A_n = C \gamma ^n + (-1)^n {D\over \gamma^n} [/math] The coefficients are found using the initial conditions, [math] A_0 = C+ D = 1 [/math] [math] A_1 = C\gamma - {D\over \gamma} = 6 [/math] Only C is important for large n, like 52, since the reciprocal of the golden mean is less than 1. [math] C = {5 + 11\sqrt{5} \over 10}[/math] This gives the answer, the integer part of [math] {5 + 11\sqrt{5} \over 10} ({1+\sqrt{5}\over 2})^{52}[/math] 52 = 32 + 16 + 4 so that finding the 52 power is the same as squaring twice, squaring twice again, squaring again, and multiplying the three answers together.

There are 4 nos. such that sum of all d four nos. as well as sum of every two nos. is a Perfect square. Find d nos.?

0,0,0,A works for A any perfect square. More generally, 0,0 together with any of the small pair of squares in a pythagorean triple, e.g. (0,0,9,16). More generally still, for any pair of integers m and n, (2m^2 n^2 , 2m^2 n^2 , 2m^2 n^2 , (m^2 - n^2)^2 - 2 m^2 n^2) is a solution. For example, with m=2, n=1, (8,8,8,1) More solutions are 2m^2 n^2, 2m^2 n^2 , - 2m^2 n^2 , (m^2 - n^2)^2 - 2 m^2 n^2 for example, 8,8,-8,17 Now only two of the numbers are the same. So I assume you mean all four numbers are positive and different. The basic theorem to know to solve this in general is that all pythagorean triples are of the form 2mn,m^2-n^2, (m^2+n^2)^2, which is proved simply from the defining equation and some unique factorization/Euclid's algorithm considerations (this is a classical result). Given this, the sum of all the numbers is a pythagorean triple by each of the three possible pairings of the four numbers. If there is a unique decomposition for the long-leg of the triangle into integer short legs, the answer is one of the trivial cases above. But not all squares are uniquely decomposable into smaller squares. The method for finding the number of compositions is through the Gaussian integers: ab has the same length in the Gaussian integers as ab*, and from unique factorization in the Gaussian integers, this is the general method to generate numbers with the same length. For example, using $a = 2+3i$ and $b = 3+i$, you get the square identity: $33^2 + 56^2 = 16^2 + 63^2$ This then generates the following family: x, $33^2 - x$, $16^2 - x$, $56^2 - 16^2 + x$ which, by the parametrization, autmatically makes the sum of all 4 a square, and the decomposition of 1+2, 1+3, 2+3 squares. The nontrivial condition will work the moment $56^2 - 16^2 + 2x$ is one of the options 56^2, 33^2, 16^2 or 63^2. I am not sure if any of these give nontrivial positive solutions, I didn't bother checking, because by finding larger and larger sets of Gaussian integers all sharing the same length, you can generate as many nontrivial solutions as you like. For example, suppose you find three Gaussian integers with the same length: $m^2 + n^2 = p^2 + q^2 = s^2 + t^2$ then $(x, (2mn)^2 -x, (2pq)^2 -x , (m^2 - n^2) - (2pq)^2 +x)$ will work, so long as you choose x so that $(m^2 - n^2)^2 - (2pq)^2 + 2x = (s^2 - t^2)^2$ or $(2st)^2$ on the right hand side. This method generates all the solutions with the constraints provided.

Does Fourier Transform imply that delta function value divided by infinity is 1?

The Fourier transform is like the limit of the Fourier series with the interval made very long, except WITHOUT dividing by the length of the interval, so that the frequencies are no longer normalized. This is required so that you get a sensible limit out, as you noticed. The result is that you need to integrate the modes, not sum, and the difference between an integral and a sum is a differential factor that effectively normalizes each mode back to the tiny value it should have to reproduce the function you are transforming. The value of a delta

function at the origin is infinite, but it is not well defined as a value--- if you make a lattice approximation to a delta-function on a lattice of size epsilon, the value at the origin is 1/epsilon and everywhere else it's zero.

What geometric formulas govern polygons in such a way that the phenomenon observed in the details below occurs?

The reason it is increasing linearly is because perimeter increases linearly with circumference and so does radius (any way you measure it), so the scaling is exactly linear. There is nothing to do for other block sizes, just use a bigger or smaller block.

How can I plot the following numbers on an exponential graph?

This is Bode's law in disguise, you have taken the radii of the orbits to a power (Kepler's law) and then multiplied by an irrelevant constant.

Was mathematics invented or discovered?

I wrote an answer on stackexchange, I copy it verbatim here, with some added observations: There are things that are discovered, and things that are invented. The boundary is put at different places by different people. I put myself on the list and I believe that my position is objectively justifiable, and others are not. ### Definitely discovered: finite stuff By probablistic considerations, I am sure that nobody in the history of the Earth has ever done the following multiplication: > 9306781264114085423 x 39204667242145673 = ? Then if I compute it, am I inventing it's value, or discovering the value? The meaning of the word "invent" and "discover" are a little unclear, but usually one says discover when there are certain properties: does the value have independent unique qualities that we know ahead of time (like being odd)? Is it possible to get two different answers and consider both correct? etc. In this case, everyone would agree the value is discovered, since we actually can do the computation--- and not a single (sane) person thinks that the answer is made up nonsense, or that it wouldn't be the number of boxes in the rectangle with appropriate sides, etc. There are many unsolved problems in this finite category, so it isn't trivial: * Is chess won for white, won for black, or a draw, in perfect play? * What are the longest possible Piraha sentences with no proper names? * What is the length of the shortest proof in ZF of the Prime Number Theorem? Approximately? * What is the list of 50 crossing knots? You can go on forever, as most interesting mathematical problems are interesting in the finite domain too. ### Discovered: asymptotic computation Consider now an arbitrary computer program, and whether it halts or does not halt. This is the problem of what are called "Pi-0-1 arithmetic sentences" in first order logic, but I prefer the entirely equivalent formulation in terms of halting computer programs, as logic jargon is less accessible than programming jargon. Given a definite computer program P written in C (or some other Turing complete language) suitably modified to allow arbitrarily large memory. Does this program return an answer in finite time, or run forever? This includes a hefty chunk of the most famous mathematical conjectures, I list a few: * The Riemann hypothesis (in suitable formulation) * The Goldbach conjecture. * The Odd perfect number conjecture * Diophantine equations (like

Fermat's last theorem) * consistency of ZF (or any other first order set of axioms) * Knesser-Poulson conjecture on sphere-rearrangement You can believe one of the two * "Does P halt" is _absolutely meaningful_, so that one can know that it is true or false without knowing which. * "Does P halt" only becomes meaningful upon the halting of P, or a proof that it doesn't halt in a suitable formal system, so that it is useful to introduce a category of "unknown" for this question, and the "unknown" category might not eventually become empty, as it does in the finite problem case. Here is where the intuitionists stop. The famous name here is * L.E.J. Brouwer The intuitionistic logic is developed to deal with cases where there are questions whose answer is not determined true or false, so that one cannot decide the law of excluded middle. This position leaves open the possibility that some computer programs that don't halt are just too hard to prove halt, and there is no mechanism for doing so. While intuitionism is useful for situations of imperfect knowledge (like us, always), this is not the place where most mathematicians stop. There is a firm belief that the questions at this level are either true or false, we just don't know which. I agree with this position, but I don't think it is trivial to argue against the intutionist perspective. ### Most believe discovered: Arithmetic heirarchy There are questions in mathematics which cannot be phrases as the non-halting of a computer program, at least not without modification of the concept of "program". These include * The twin prime conjecture * The transcedence of e+pi. To check these questions, you need to run through cases, where at each point you have to check where a computer program halts. This means you need to know infinitely many programs halt. For example, to know there are infinitely many twin primes, you need to show that the program that looks for twin primes starting at each found pair will halt on the next found pair. For the transcendence question, you have to run through all polynomials, calculate the roots, and show that eventually they are different from e+pi. These questions are at the next level of the arithmetic heirarchy. Their computational formulation is again more intuitive--- they correspond to the halting problem for a computer which has access to the solution of the ordinary halting problem. You can go up the arithmetic hierarchy, and the sentences which express the conjectures on the arithmetic hierarchy at any finite level are those of Peano Arithmetic. There are those who believe that Peano Arithemtic is the proper foundations, and these arithemtically minded people will stop at the end of the arithemtic hierarchy. I suppose one could place Kronecker here: * Leopold Kronecker: "God created the natural numbers, all else is the work of man." To assume that the sentences on the arithmetic hierarchy are absolute, but no others, is a possible position. If you include axioms of induction on these statements, you get the theory of Peano Arithmetic, which has an ordinal complexity which is completely understood since Gentzen, and it is described by the ordinal epsilon-naught. Epsilon-naught is very concrete, but I have seen recent arguments that it might not be well founded! This is completely ridiculous to anyone who knows epsilon-naught, and the idea might strike future generations as equally silly as the idea that the number of sand grains in a sphere the size of Earth's orbit is infinite--- an idea explicitly refuted in "The Sand Reckoner" by Archimedes. ### Most believe discovered: Hyperarithmetic heirarchy The hyperarithmetic hierarchy is often phrased in terms of second order arithmetic, but I prefer to state it computationally. Suppose I give you all the solution to the halting problem at all the levels of the arithmetic hierarchy, and you concatenate them into one infinite CD-ROM which contains the solution to all of these simultaneously. Than the halting problem with this CD-ROM (the complete arithmetic-hierarchy halting oracle) defines a new halting problem--- the omega-th jump of 0 in recursion theory jargon, or just the omega-oracle. You can iterate the oracles up the ordinal list, and produce ever more complex halting problems. You might believe this is meaningful for any ordinals which produce a tape. There are various stopping points along the hyperarithmetic hierarchy, which are usually labelled by their second-order arithemtic version (which I don't know how to translate). These positions are not natural stopping points for anybody. ### Church Kleene ordinal I am here. Everything less than this, I accept, everything beyond this, I consider objectively invented. The reason is that the Church-Kleene ordinal is the limit of all countable computable ordinals. This is the position of the computational foundations, and it was essentially the position of the

Soviet school. People I would put here include * Yuri Manin * Paul Cohen In the case of Paul Cohen, I am not sure. The ordinals below Church Kleene are all those that we can definitely represent on a computer, and work with, and any higher conception is suspect. ### First uncountable ordinal If you make an axiomatic set theory with power set, you can define the union of all countable ordinals, and this is the first uncountable ordinal. Some people stop here, rejecting uncountable sets, like the set of real numbers, as inventions. This is a very similar position to mine, held by people at the turn of the 20th century, who accepted countable infinity, but not uncountable infinity. Those who were here include many famous mathematicians * Thorvald Skolem Skolem's theorem was an attempt to convince mathematicians that mathematics was countable. I should point out that the Church Kleene ordinal was not defined until the 1940s, so this was the closest position to the computational one available in the early half of the 20th century. ### Continuum Most practically minded mathematicians stop here. They become wary of constructions like the set of all functions on the real line, since these spaces are too large for intuition to comfortably handle. There is no formal foundation school that stops at the continuum, it is just a place where people stop being comfortable in absoluteness of mathematical truth. The continuum has questions which are known to be undecidable by methods which are persuasive that it is a vagueness in the set concept at this point, not in the axiom system. ### First Inaccessible Cardinal This place is where most Platonists stop. Everything below this is described by ZFC. I think the most famous person here is: * Saharon Shelah I assume this is his platonic universe, since he say so explicitly in an intro to one of his more famous early papers. He might have changed his mind since. ### Infinitely many Woodin Cardinals This is the place where people who like projective determinacy stop. It is likely that determinacy advocates believe in the consistency of determinacy, and this gives them evidence for consistency of Woodin Cardinals (although their argument is somewhat theological sounding without the proper computational justification in terms of an impossibly sophisticated countable computable ordinal which serves as the proof theory for this) This includes * Hugh Woodin ### Possibly invented:

Rank-into-Rank axioms I copied this from the [Wikipedia page](List of large cardinal properties), these are the largest large cardinals mathematicians have considered to date. This is probably where most logicians stop, but they are wary of possible contradiction. These axioms are reflection axioms, they make the set-theoretic model self-simialar in complicated ways at large places. The structure of the models is enormously rich, and I have no intuition at all, as I barely know the definition (I just read it on Wiki). ### Invented: Reinhard Cardinal This is the limit of nearly all practicing mathematicians, since these have been shown to be inconsistent, at least using the axiom of choice. Since most of the structure of set theory is made very elegant with choice, and the anti-choice arguments are not usually related to the Godel-style large-cardinal assumptions, people assume Reinhardt Cardinals are inconsistent. I assume that nearly all working mathematicians consider Reinhardt Cardinals as imaginary entities, that they are invention, and an inconsistent invention at that. ### Definitely invented: Set of all sets This level is the highest of all, in the traditional ordering, and this is where people started at the end of the 19th century. The intuitive set * The set of all sets * The ordinal limit of all ordinals These ideas were shown to be inconsistent by Cantor, using a simple argument (consider the ordinal limit plus one, or the power set of the set of all sets). The paradoxes were popularized and sharpened by Russell, then resolved by Whitehead and Russell, Hilbert, Godel, and Zermelo, using axiomatic approaches that denied this object. Everyone agrees that this stuff is invented. COMMENT: The basic ideas here is that computation is primary, and the discovered part of mathematics is the behavior of computer programs. Mathematics is real when it is stating a prediction for a computer program behavior (either a theorem, a conjecture, or a real example), and it is ambiguous when the content can't be stated as the behavior of a program (like the continuum hypothesis). This point of view is out of fasion today, but wrongly, so I defend it.

How can we eliminate money in the society?

Russia eliminated money in a brief experiment in 1917 or 1918, the Lenin government deliberately issued currency to hyperinflate the ruble to worthlessness. Then it did distribution of economic goods by orders, you would order goods, and wait for them to arrive, like in an office, where you don't bother with money when you need a pencil from the neighboring lab. This didn't work at all, because you needed a method to assign work units both to the people working, so that they had incentives to work more, and also to the stuff produced, to label how much work went into a given commodity. So the answer is just no. It was tried, even Lenin's government could see it didn't work at all, it was abandoned immediately, it doesn't work today, it likely will never work at any point.

Is there firm evidence that gravity is quantized ("granular")? If none, why can't physicists abandon the notion that gravity is quantized? Is it possible to reach a grand unified theory wherein the gravitational field is "continuous" and the various quantum fields are "granular"?

The simple thought experiment that rules this out: consider a ball which is superposed in two positions in an empty room, on the left and on the right. The standard quantum picture is that the gravitational field is in a superposition, so than any object responding to the field will measure the ball. But if gravity is continuous, it has to come from

some average of the ball positions, by symmetry, from the middle. Then if you measure the ball, to see where it is, the gravitational field has to either instantly shift, or to emit gravitational radiation, or some other ridiculous thing. In general, it is inconsistent to couple a quantum particle to a non-quantum field. This argument was made by Bohr and Rosenfeld in the 1930s, to justify field quantization for the electromagnetic field, but it applies to the gravitational field just the same.

What are the most misunderstood, but commonly voiced, statistics?

That people in earlier times had a life expectancy of 30. This is almost entirely a function of infant mortality, since 40-50% of children would die before the age of 5. If the rest lived until 60 on average, that gives you a life expectancy of 30, but anyone who reached puberty could expect to live a reasonably long life. People are extraordinarily confused regarding this, considering Archimedes, who was 70 and vigorous at death, as a strange exception of some kind, and other long-lived ancients. The life-expectancy was mostly a function of infant mortality, modern medicine has only added about 20 years at the upper end, but reduced infant mortality to zero, giving the impression of doubling adult life-expectancy.

What are some old technologies that we take for granted?

Money. This is probably the most important invention in human history, since it allows labor to be divided spontaneously without direct oversight, and then leads to progress.

How do civil engineers and architects in the USA deal with '9/11 truthers'?

They lead the movement: see World Trade Center Building 7 Demolished on 9/11?. There ones among them who might support the government story, but they are clearly incompetent, and I would not hire any of them to design a building or to evaluate another event of structural collapse, since they obviously have no clue about the basic principles of stress.

How true are the satanic allegations made on the popular song "Stairway to Heaven" by Led Zeppelin?

Led Zeppelin founding member Jimmy Page was into occult stuff at this time, and it wouldn't have been so hard to do this deliberately: make a message: Here's to my sweet Satan. The one who lit a path for to make me Zep, whose power is Satan. He will give those with him 666, and all the evil fools, they made us suffer, sadly. Then you record it on a tape, play it backwards and write down the garbled words you hear (you probably do this on 20 or 30 different messages until you get something semi-sensible on the backward run): If there's a bustle in your hedgerow, don't be alarmed now, it's just a spring clean for the

may-queen. Yes there are two paths you can go by, but in the long run, there's still time to change th road your on. Then give the paragraph to the lyricist and tell him to expand it into a song, with this paragraph somewhere in the middle. That would work to give a version of the backward message. I'm not saying this is what happened, I'm 50/50 on it, but it's a very long and very meaningful passage. No other backward segment is so meaningful for so long. But it's only about 10 times longer and about 3 times clearer than other backmasking identifications, and since there are thousands and thousands of these (although not consecutive), and since it doesn't make super-duper sense anyway, it could still be a particularly strange coincidence. I should point out that Page participated with Anger's "Lucifer rising", making a soundtrack that wasn't used in the film. Page also participated in other satanic themed things. Many bands at the time, King Crimson in particular, were emphasizing the satanic stuff, it was a theme of the era. The point of Satanism is individualism, a divorce of the individual from communal standards towards any behavior that leads to individual benefit. This was a major program in the 1970s, with some benefit, because it led to the dismantling of communism. It also led to some creative new ideas, since individualism is the source of new things. It was like the enlightenment, when people did the same sort of Satanic stuff to oppose the Catholic church monopoly on power. But ultimately, you still do need to make these new ideas found through individualism fit into a coherent communal narrative, so you can't be an individualist forever. I don't know the answer to how true it is, but it is a remarkably clear message for a coincidence, but not so much more so as to rule out the strong possibility that it is just the best coincidence among the other coincidences. But all the other backmasking claims are terribly crappy compared to this one, not even close. This is the only somewhat convincing one. I am 50/50 on this. Even if it is true, It wouldn't be a subliminal message, but a tacky publicity stunt, or a childish inside joke. If they were high when they did it, they could have completely forgotten about it. Here's a ditty David Stewart encouraged me to write, it's a snippet about a sleazy theater manager, where the narrator of a song is his employee, and has to watch the theater manager do his sleazy thing: Theater fraud: So

eager, yay, in dawn and more, dead, nauseous, powered by juice, directed Edna, Dierdra built my v's neck, (mashing you in now) smell his noxious nostril fart. Saw the fraud walk this way, undressing the wrong skirt off. Playing Theater Fraud by Ron Maimon Here it is reversed. I hope I don't have to explain the message. I did it the same way I suggested the backmasking was done above. It took a few hours. Playing Theater Fraud reversed by Ron Maimon Also, thanks to David Stewart, here is a live version of Stairway to Heaven backwards: The "Here's to my sweet Satan..."' starts at 5:47, and it is still pretty clear, so it's just these words in that intonation that make the effect, it doesn't really depend on the enunciation so delicately.

How likely is it that a mathematics student can't solve IMO problems? Is there a fear of embarrassment in being a math Ph.D. who can't solve problems that high-school students can?

Honestly, every math PhD student should be able to easily solve all the IMO (and Putnam) problems, perhaps after some reflection, but best instantly. If you're a math student, you should learn the stupid tricks, they are at the high school level. If you can't solve them, you probably are going to have a hard time solving a hard unsolved problem anyway, so you should learn to do these things first, otherwise, frankly, you are not going to be a very competent student. But one shouldn't stress out about it, with time and mathematical experience, they all become trivial. Personally, I haven't tried these things in a long time, and I am not sure I can solve all of them instantly, but that just means I am incompetent and old. If you are in a math program, you should definitely sit down and make sure you figure them all out, so that you

know every elementary trick out there. The overlap with professional mathematics is minimal. Professional mathematics is much harder, because it requires a developed insight into the grand plan of a proof, and then breaking it up into details, and so on, and this is much harder than coming up with an isolated clever trick. But you need isolated clever tricks to finish up a hard proof, to finish certain computation, so you should definitely have the complete standard arsenal in your toolbelt.

Is this a watershed new discovery in physics - is space-time still fundamental now that we have the amplituhedron for modeling quantum field theory? Also, could a similar higher dimensional object describe or even unify gravity?

This is an important incremental advance in perturbative quantum field theory calculations, it is not a new theory of physics. It is a way of organizing quantum field theoretic calculations in the unitarity method. It's interesting and important, but it is not something for the public to get excited about it is a mathematical advance, not new physics. That's not to diminish the advance, but to make sure people don't think it is something other than what it is.

What would distances (and space) seem to be like from Light's perspective?

This is not clearly answerable as stated, because light can't have a perspective really, it has no transitions. But the proper formulation of space-time from a massless point of view is the so called light-cone coordinates, better called the light-front coordinates. This is covered in most modern textbooks, it was first described by Dirac in the 1940s, and it was used by Mandelstam for string theory and field theory, and by Gribov, Feynman, Wilson for QCD. Normally time-dilation slows down the processes as you approach the speed of light. But you can imagine processes that speed up as you go faster to make a finite limit for the coordinate separation of the events. In the limit, you can get coordinates on a light ray, and if you extend the light rays into parallel sheets and make these sheets fill up space-time, you get the light-front coordinates. There is a good discussion in Warren Siegel's field theory textbook, available freely online.

What is the highest form in the hierarchy of semicategory, category, groupoid, group...? And which book can give me in depth analysis of these basics?

Lang's "Algebra" works as a source, and depending on your perspective, you can generalize in many directions, so there is no "highest" thing. I suppose a field, an exponential algebra, and a differential algebra are example of very high things on this chain, but you can imagine other completely different generalizations of groupoids, like context free grammars. The generalization process is

not unique. A field is a collection that allows for commutative addition, commutative multiplication distributive over addition, and a unique division. The rationals, reals and complex numbers are an example, so are the integers mod a prime, and extensions of these by roots or irreducible equations exhaust the examples. An exponential field is like the reals and complex numbers with the exponential function and log function. The exponential function steps up operations because exp(log(a)+log(b)) = a * b so, using the log, exp(log(a) * log(b)) defines an operation that is associative and commutative and bears the same relation to multiplication as multiplication does to addition. You can define this operation symbol by +2, so that addition is +0 and multiplication is +1. Then you can define an infinite sequence of associative commutative operations as follows exp(log(a) +k log(b)) = a +(k+1) b this works in a field with an exponential and a log function, but there are a lot of undefined operations, because log(0) is undefined. To define the exponential and log, you usually use calculus, so there is the notion of differential field. This is covered in standard algebra textbooks, but not in Lang.

What are some of the best books on precalculus?

I like "Mathematics for the Million", from the 1940s, probably out of print. There are lots of books, all the ones that aren't school textbooks are good, because everyone understands this stuff well. The school textbooks are written by committee consensus, and are terrible.

Why does Holocaust denial persist, despite the overwhelming evidence?

It doesn't really persist, for all practical purposes, it died in the 1990s, when the internet became widespread There are a few web pages about this, but the number of people who believe the holocaust is a type of hoax is essentially cut in 3 compared to the number in the 1980s, and these are mostly old folks, who will die soon, so you have nothing to worry about. The internet allows people to review the evidence for themselves, and in this circumstance, people who do their homework just can't be fooled. In the case of the holocaust, the deniers never denied that Jews were segregated in ghettos with too little subsistence to avoid mass starvation, taken out and shot by the millions in Russian villages during the German invasion, enslaved on starvation rations in all occupied territories, and perished from typhus and other camp diseases in the unsanitary environment. These account for fully half of the victims in the holocaust. The only thing the deniers deny is that the Jews were systematically gassed, that's the other half of the victims. One should say that this is a reasonable thing to investigate, because the witnesses to the gassings are very few and far between. People who witnessed the gassing firsthand almost all died. The gassings themselves were done without witnesses by one guy dumping gas canisters into a roof grating. The corpse disposal was done by Jewish slaves, the sonderkommando who were then themselves killed a few months later. Very few witnesses survive, the number of surviving sonderkommando can be counted on one hand, and they suffered from tremendous psychological disorders. A further reason the deniers deny this is that early Allied reports confused delousing chambers with gas chambers, and the delousing gas was also Zyklon B, the vast majority was used for delousing rather than killing people, simply because people are much more sensitive to the toxin than lice. The gas chambers using Zyklon B operated in Auschwitz and maybe one or two other places, all in Poland, none of them were under US/British control, and lots of people just didn't trust the Soviets, because, can't trust a commie. The Soviets also misestimated

the number of victims at Auschwitz, claiming 4 million dead, when the true number is between 1.1 to 1.5 million. Another 800,000 Jews perished in Treblinka, but Treblinka was dismantled. About 400,000 more perished in other smaller centers. So the reports of gassed jews were chalked up to propaganda, and the number of murdered jews was reduced from the Jewish organization estimates of 5.4 million (consisting of roughly 2 million Soviet jews shot, 1 million from disease, slavery and starvation, and about 2.4 million gassed) to 3 million, those shot, starved, worked to death, and who succumbed to disease. This is absurd, because the Jewish organization reports were based on solid demographic data, and matched the deportation records compiled by the Nazis. So that the deportation documents match the Jewish organization reports. Further, the execution capacity at Auschwitz was 1000 persons per load, and matched the people who arrived in deportation documents from Hungary. The testimonies of guards, both at Auschwitz and Treblinka are unambiguous about the gassings, these are available online, and were all gathered by next-generation Germans, who were honorable and meticulous about documenting the crimes of their fathers. No other nation has dealt with a recent historical crime so meticulously, and excized the causing influence so completely as Germany. It makes one want to be a German, really. The scale of the murders is confirmed from the deportation numbers. So there is really nothing to dispute at all. It is easy to show the evidence from statistical sampling--- I can see by picking random European Jewish relatives and counting the number of people who are gone that approximately 2/3 of Europe's Jews were murdered with absolutely no effort, and the same can be done by anyone. This estimate can be done by simply asking a random Jew how many of their relatives died, and you get a sense of the scale from this after only asking about 10 people, the statistical margin of error doesn't matter, because you can see it's more than half of the people that died. So it is very easy to counter this, and it should be done. Not all the deniers were irrational anti-Semites, the original denier was a French resistance guy who couldn't believe that all those wartime rumors were actually true, and was very suspicious of the Allied command. There were other deniers that flipped completely when they

researched the subject, including one prominent denier who converted when he saw an order form at Auschwitz for a room with showerheads and a gas-tight door. This was an inexplicable order, unless people were to be gassed in this room. He has since become a noted expert in the mechanics of the holocaust. But one should engage the deniers, because their conspiracy ideas are driven simply by misinformation. These people are usually independent minded and suspicious, or following some crazy theory of Jewish conspiracy. You can persuade such people when you are telling the truth, and today, there is nothing to do, anyone can complete the research in a few hours from home and be certain there is no fabrication here, at least none that meaningfully changes the narrative.

What is the wildest, most complicated equation describing a natural phenomenon that you would assume has no analytical solution, but actually does?

Feigenbaum's equation for a function from the interval to the interval: $g(g(lx)) = l\, g(x)$ where l is a parameter, can be explicitly solved for monotonic functions by an explicit function of the form $g(x) = (ax + b)/(cx+d)$ The reason is simply that functional composition for these Moebius functions is matrix multiplication on the coefficients a,b,c,d. I found this astonishing, if you consider the original Feigenbaum solution is by substituting power series, and the best solutions are simply by iterations starting from an approximation. The monotonic solution describes the universal behavior of intermittent stability in systems near a transition where a fixed point is close to unstable. I forget the author that found this.

What are some of the unsolved problems in Mathematics, which when solved, will have a profound effect in the world of Physics?

The most significant is the precise map between the N=4 SUSY SU(N) gauge theory and the spacetime of the AdS string theory it holographically describes. Some of the relations are known since the late 1990s, but the precise reconstruction is not. The fact that the low hanging fruit is already plucked means the remaining reconstruction is going to be mathematically intricate. Once the complete reconstruction is known, to the point where it can be simulated on a computer, we can answer questions about formation and evaporation of black holes locally by simulations. This will lead to a lot of insight. For me, the main thing is to figure out the interior structure of black holes, what happens to infalling stuff impinging on a charged or highly rotating black hole. There is an old paradox here that is on the verge of getting resolved--- whether things can pass the Cauchy horlzon and get reemitted, or whether the stuff gets thermalized at the Cauchy horizon (the latter is consensus, the former is what is true, I am pretty confident) Another place to make progress using mathematics, less open ended, is the turbulent cascade of nonlinear partial differential equations. There are a bunch of differential equations, like nonlinear scalar field theories of the preheating type, which are easily seen numerically to have a turbulent-type cascade to short distances when they are forced at long wavelength. Proving that the limiting distribution is universal for these equations is a useful first step to Navier Stokes turbulence, and can help solve problems in inflationary pre-heating, where the inflaton drives smaller scale fields by this turbulence-like nonlinear process. The approximations people use here are heuristic, and can be improved with some rigorous understanding. There are lots more, the development of mathematics

and physics are always intertwined. These are just the cases I find most interesting.

What are the good books that should be read to become an efficient Data Analyst?

Books are hard to recommend here. Programming languages are more important. You should definitely learn C and Perl, and probably R and Python, and perhaps some matlab clone (although I never used this, I find it much easier to do things in the more complete general purpose languages). You should learn Linux to the point where you are completely comfortable with scripting, and also Assembly programming if you want to be a good programmer, but neither of these skills is going to be directly useful. The mathematics here is statistics, which I never studied, just worked out for myself. You need to learn information theory and Monte-Carlo methods, and the physics literature has these under "statistical mechanics" (the concepts are a little encoded, but they overlap tranditional information theory) and stochastic processes like Einstein's Brownian motion analysis, and the Boltzmann equation. The more advanced concepts like Renormalization group theory don't come up, but are good brain training anyway. There are other things, Baysian methods (which you usually pick up if you look at experimental data), linear algebra (this is a prerequisite), various discrete mathematics tricks, these come from programming naturally. Any technical degree in physics, mathematics, or computer science will amply provide the tools.

Where can I watch (or read) Feynman explain the way that liquid helium becomes a superfluid?

R. P. Feynman, Physical Review 91, 1291 (1953). You can also read a nice introduction here: http://www.pma.caltech.edu/~mcc/...

How many people have had nervous breakdowns trying to prove/disprove the continuum hypothesis?

Just Cantor, at least according to mathematician legend, because he was sure it was true, and couldn't begin to see a proof. But, as with all other psychological disorders, most likely he had a propensity to begin with. His intuition for why it is true is probably Godel's L construction, which showed it is true in the simplest model of the ZF system. Cohen's construction showed the whole question to have been meaningless to begin with. But it was histocially interesting anyway.

In layman's terms, what is Supergravity Theory and why is it not more popular?

Supergravity theory is Einstein's gravity extended with supersymmetry, meaning that it has at least one spin-3/2 particle in addition to a spin 2 particle, making a collection of fields that together

have a long-range gravity force with a superpartner, so that the perturbative calculations are better behaved than just the spin-2 Einstein gravity by itself. These theories were developed as an outgrowth of superstring theory, they were discovered by Joel Scherk and many great collaborators in the 1970s, and Scherk started by taking the low-energy limit of GSO projected superstrings. At the time strings were politically out, and supergravity served as a half-way house for physicists to get comfortable with some of the ideas of string theory, before the whole theory was understood and digested. They were superseded by string theory, because supergravity is really fundamentally just as incompatible with quantum mechanics as usual Einstein gravity, except for being better behaved at short distances in perturbation theory. The best behavior is in N=8 Supergravity theory (with eight gravitons and a ton of vector and scalar fields). This theory is probably completely perturbatively renormalizable, this was suspected in the early 80s, and is now supported by very strong evidence, due to high loop-order computations pioneered by Lance Dixon and collaborators. But even if the whole theory is completely perturbatively renormalizable, it is still no good as a fundamental theory of quantum gravity. The supergravity theories are local field theories, so they still suffer from the Hawking 't Hooft paradox--- the entropy of a black hole is infinite. There are infinitely many frozen low-energy modes right by the horizon that make a divergent contribution to the entropy of a black hole. This makes any black hole an infinite entropy sink, stuff coming out is disconnected from the stuff falling in, and the stuff coming out is then a completely random completely thermal mixed state, even if the black hole formed coherently from quantum particles in a pure state. This means that the black hole violates quantum unitarity, and the theory is fundamentally sick. This paradox was discovered and emphasized by Hawking, leading to enormous progress in physics. You don't form a black hole in field theoretic perturbations, so the renormalizability of perturbation theory doesn't mean that it solves black hole issues. To make a black hole, you need to scatter at high energies, where the perturbation theory involves infinitely many particles making an approximate background, and to make the black hole, you need to

deal with Planck-scale resonances always not just zero mass particles. String theory is a theory of the Planck scale resonances, not just the low-energy particles, and it solves this problem (and many others) completely, and it also shows why supergravity was so well behaved to begin with. Once you understand string theory, supergravity is naturally incorporated as a low-energy approximation. The early 1980s work on string theory is all supergravity work in disguise (the supergravities people used for phenomenology were just chosen to be the low-energy limits of consistent string theories, choosing the right supergravity to use was pretty much the only thing string theory added to phenomenological physics in the 1984-85 period). In the modern era, past 1995, M-theory was formulated first using the low-energy supergravity (the 11 dimensional supergravity discovered in 1978 by Cremmer, Julia, and Scherk), and it was extended to a complete gravity theory of string type in the Matrix theory and AdS/CFT correspondence, which were properly nonlocal and properly asymptotic, like string theory always is. Supergravity is still as important to string theory as the WKB approximation is in quantum mechanics, it is a simplified first approximation that gives you many of the predicted effects without requiring complicated new mathematical tools.

Can we prove free will by simply writing the series of prime numbers or other sequence on a sheet of paper?

You can write a computer program to generate primes, computers exist in nature. This has nothing to do with free will, which is a pseudo-question in the sense of Carnap, and has been completely resolved since the 1940s. The resolution is simply to use logical

positivism, to define carefully what you mean by free will. When you do this, there is no problem.

How does hyperviscosity dampen out the inverse cascade of turbulence?

The hyperviscosity is irrelevant at long-wavelengths, since it is a higher derivative term. At longer distances, higher derivative terms are less relevant. The hyperviscosity terms do not affect the inverse-cascade of 2d turbulence, they only affect the normal cascade at very very short distances, shorter than the distance where the ordinary viscosity makes exponential decay in the occupation number. The hyperviscosity is mostly useful mathematically to ensure the existence of a solution, that's about it. It is also useful for forcing decay of solutions that are locally harmonic, so that the viscosity is zero. It doesn't affect the turbulent regime in either the usual or inverse cascade. You could solve the Euler equation and zero out all modes with wavenumber higher than a certain value periodically and get the same effect as either viscosity or hyperviscosity.

What is the ideal way on social networks to honor the memory of the victims and events of 9/11?

The best way is to discuss the actual events of that day, without self-censorship, and without barriers of ridicule and authority, so as to help to bring those responsible to justice. This is the only sincere way

to pay respects. For this purpose, please read and link the Engineers&Architects, Pilots, Scholars, for 9/11 truth.

Why did it take NASA decades to land on Mars after landing on the Moon?

Because NASA can't use h-bombs as propulsion. With an Orion, you get all over the solar system cheap and easy. But this generates fallout, and violates the test-ban treaty. Since it's the only realistic way to do it (it's absurd to use chemical fuel for a mars mission with a heavy payload), it just doesn't get done. It will get done when people agree to accept a small amount of fallout, and peaceful nuclear explosions in space.

The US government refused to audit the gold in Fort Knox since 1953. If the theorists are right and it has been stolen, could this lead to the biggest economic collapse in history?

It will do nothing, the US currency is not backed by gold. If it were stolen recently, the price of gold might drop.

What kind of propulsion system do you think is the best for touring the solar system?

Orion is by far the best, it is cheap, readily available, it requires no new technology beyond h-bombs, and to say it can be implemented today is an understatement, it could have been implemented in the late 1950s. There is nothing else that should even be discussed, the problem is solved and there is only one solution. nothing else realistic even comes close (the nuclear rocket in another answer is reasonably close, like a factor ot 10 close, but Uranium fusion is not anywhere near as efficient as fusion bombs, since it's not explosive and it's mostly non-fissioning material). Orion is within a factor of 30 from antimatter propulsion which is the theoretical maximum thrust per unit weight, but without the impossible science-fiction technology requirements. The only problem with Orion is the fallout from taking off or landing. But modern nuclear bombs generate far less fallout than their predecessors, and perhaps this may be avoided altogether using a space-elevator, to build the thing in low-Earth orbit. For a feasable space elevator design with no real weight limit, see this: An electromagnetic space elevator?

What is an intuitive explanation for e iπ =−1 eiπ=−1 ?

The intuition is that [math] {d\over dt} e^{it} = i e^{it} [/math] If you think of the complex number as a 2-d vector, you can work out that multiplying by i is rotating by 90 degrees. So this equation above tells you that the rate of change of this 2-d vector exp(it) with t is always 90 degrees perpendicular to the vector and of unit length. This is how you get something to go in a circle, the tangent to a circle is 90 degrees

perpendicular to the radius. And the length is constant, so the speed is constant. So this vector is going around a circle at constant speed, so that [math] e^{it} = \cos(t) + i \sin(t) [/math] and the result follows.

How are we able to know the IQ of some people from the past?

These are all fabrications, purposefully done, so as to make the IQ test look like it is measuring something intrinsic to a person, like height. A good rule of thumb for historical IQ is given by the Flynn effect, you can estimate that, were they to take a modern IQ test, all of them would score about the same as people did back when IQ tests were first introduced, possibly a little lower the further back you go in time. So you need to automatically remove about 30 points from the IQ intuition for people being scored today (the tests have linearly gotten harder with time, the mean stays the same, though, because that's how you center it). So Benjamin Franklin would probably score around 120, due to 18th century mathematical training, musicians like Beethoven, around 70-80 (neither vocabulary nor mathematical training), politicians like Jefferson around 100, because due to their their wide vocabulary (although still small by modern standards) would be a little better than the average person today on the verbal parts, but their mathematics performance would be abysmal. Newton, who was both well read and highly mathematical, might have scored 120 on a modern test, maybe 130. These are guesses by me, but they are no less guesses than the stuff you read. My guesses are at least proper estimates, considering the Flynn business, the enormous increase of the test strength with time.

Thermodynamics: How was absolute zero determined?

The ideal gas law is that the pressure is proprotional to the density times temperature, with a universal coefficient. P=nk(T-T_0), since it was a universal law, it became obvious that the true zero of temperature was T_0. When statistical mechanics became established a century later, the zero temperature was discovered to be the case where you are definitely, with 100% probability, in the ground state. For a classical gas of points, this means the pressure walls have collapsed to zero volume and the points sit on top of each other, so this coincides with the previous definition.

What are the most important generally accepted hypotheses in physics that have no experimental verification yet?

Low energy supersymmetry is simply a possibility, it is not required, or well accepted, it is a 50/50 crapshoot, and now, after preliminary LHC data, it's looking like 90/10 against. Gravitational waves have not been directly detected, it's probable, but something like 80/20 probable, that advanced LIGO will see some. If not, then LISA will see it for sure, nobody doubts that they are there, the theoretical argument is too good. Hawking radiation is another, but this is hopeless to detect. But in this case, it is good that the theoretical argument is air-tight and confirmed by explcit quantum gravity calculations in string theory. Inflation is already verified very well by the microwave background measurements. String theory is the major one, you need to confirm a good prediction that is not made by field theory. In this case, I think the best idea is to look for the emissions of

charged or rotating black holes, because these are very likely modified in string theory from the classical prediction, because the string version glues the different classical universes into one, and so allows matter to be reemitted into our universe, after a traversal of the interior. If so, this requires that matter can change into anti-matter by the transit (the gluing must involve a time reflection in certain trajectories). This is not widely accepted, but I beileve it is true, and that it is the major prediction of string theory for astrophysics, anomalous antimatter signals at galactic centers.

How bright would the inside of a black hole be?

Light orbits a black hole at 1.5 times the Schwarzchild radius. Any light inside this point will hit the singularity. Even for charged and rotating black holes, light trajectories hit the singularity.

Does the holographic principle preclude the existence of white holes?

"White holes" are the same thing as "Black holes", this was argued by Hawking in 1978 (maybe 76, I forgot the date), as a corollary to his radiation result. The argument is that a white hole is the time-reverse of a black hole, and since a black hole in equilibrium with radiation is a thermal equilibrium state, the time reverse is the same as itself, and so the black hole and white hole are the same object. This argument survives verbatim today within AdS/CFT, so it is well established

physics by now. The way in which you can have an object that acts as a white hole is simply by having a charged or rotating black hole. In this case, the classical motion of stuff thrown in is to do a transit and come out. The "coming out" part is in a disconnected sheet classically, but it is clear that quantum mechanically this can't be right. The conclusion I come to (and as far as I know, nobody else, but I believe it is correct) is that there is a finite transit time of size 1/hbar for the classical thing to go in and come out, so that highly charged or rotating black holes emit things that fall into them, slightly singed, and sometimes as left-right reflected anti-matter.

What existed before the Big Bang?

You should understand logical positivism--- the statements we make acquire meaning through observation. The big-bang starts in what is a thermal state with a cosmological constant, a little deSitter universe, a small volume bounded by a black hole, in thermal equilibrium, like a little hot oven. There is very little information in this starting point, so you can't reliably ask about earlier states, because any such earlier state can't get information through to our universe. So it is impossible to answer such a question by observation, and this means that, philosophically speaking, the question is just meaningless. To understand this better, it helps to understand the position of the logical positivists. It is hidden today, but the ideas come from Ernst Mach (physicist) then go through Russell (logician turned philosopher) and Carnap (physicist turned philosopher). These are the authors who explain it in detail. Logical positivism allows you to resolve thes types of questions forever, and rest easy.

Are there advanced fields in Mathematics that people claim to have known everything about?

If the field is advanced, it can always embed a Turing complete system, so you can't know everything about it. For example, anyone who tells you that they know everything about group theory is lying, because simple free groups with some relations can be used to embed a computer, as shown by Turing and others in the 1950s. Similarly, anyone who claims to know everything about manifolds is also lying, because you can find manifolds whose fundamental groups are arbitrary generated groups with arbitrary relations, so there is the same Turing complete thing going on. But if you say you know everything about Euclidean geometry, this is a fair statement, because Euclid's geometry was axiomatized in a complete way by Hilbert, and the embedding was into coodinate geometry, and the particular questions in Euclidean geometry are not Turing complete (at least not without a notion of limit), and were shown to be resolvable by a particular complicated algorithm for numerical root-finding of polynomial equations. It's always like this, a field, once it is completely understood, reveals itself to be less than a complete computer. Any field which is a complete computer cannot be understood completely.

If the amount of information of a black hole is proportional to it's area (Planck "pixels"), what are the additional Planck "voxels" in the volume used for?

There aren't any "voxels" only area pixels, the interior is reconstructed from surface data. This is clear when you try to stuff

matter into a volume region, you find that you can't do it, because to have a certain number of bits, even using massless quanta, you need to either use long-wavelengths (so very low energy quanta) so not localized in space, or else shorter wavelengths, and then when you reach a number of bits proportional to the area, the whole thing collapses to a black hole. This, made quantitative, is the observation Bekenstein used to conclude that the are of a black hole is it's entropy. It is clear from the second law that a black hole has more entropy than anything else in the same volume. Hawking showed that this actually works as physics, the black hole has a temperature, and found the coefficient of proportionality (it's inversely proportional to hbar, so the entropy is infinite classically). But this is very mysterious, because it means that there is this nonlocal reconstruction of volume states from surface states. The precise reconstruction was worked out in the 1990s, starting from 't Hooft's analysis of the surface states of a thermal black hole, and continuing with Susskind's analysis of highly excited strings (which were revealed to also be certain types of black holes), culminating in the Matrix theory and AdS/CFT correspondence by Maldacena and others, and this made this picture mathematically precise and led to widespread acceptance.

What is the best thing you have ever written?

The Parable Of the Snow Wolf and the Rabbit   Every sunday on the main road of the village, the farmers gathered together to hold a race between their animals. The winner of the last six races was a light grey snow wolf owned by a prosperous apple farmer, who became very much esteemed in the village and very proud of his wolf.   A daughter of his neighbor's house followed the races very closely, and she took notice of the farmer after the third race. She walked up to him afterwards and asked him if he would mind if she petted his dog. He said it wasn't a dog but a snow wolf, and sure go ahead. As she was

petting the wolf, she bent forward so he could see her bosoms, so that he would lust after her in his heart. He asked her if she was busy tuesday night and she said that she wasn't. They met up at the local bar and played pool and got drunk. Afterwards they went back to his cabin and fornicated. They fornicated many times after that, usually in the afternoon. It came to pass that on the saturday before the seventh race, a beekeeper who lived at the edge of town decided he would like to eat a rabbit for dinner. He lived a very simple life and he had never eaten a rabbit before. He went to the gameskeeper, who picked out a nice plump white bunny and pointed out its especially meaty haunches for him. The gameskeeper held the rabbit aloft by its legs and pointed out the haunches, then made his thumb and index finger into a ring and kissed them. The beekeeper bought the rabbit, and when he got home, he grasped it by the legs and laid it on his kitchen counter to butcher and skin. But as he lifted up the knife, the rabbit twitched and slipped from his hand. It hopped around on the counter, then fell to the floor and started jumping around his cabin. The beekeeper chased the rabbit from one corner of the cabin to the other for many minutes, and then he got tired and annoyed. He spent a moment in solemn reflection, then he went into the fields by his house, and gathered some cabbage and beet leaves. He used the leaves to lure the rabbit into the center of his cabin, and while the rabbit was munching away, he jumped on it with an empty laundry basket. While he crouched over the basket, the rabbit thumping underneath, the farmer reflected on the swift hopping nature of the rabbit and he was seized with an idea. He put some books over the basket and left the rabbit where it was. He made himself a bowl of oatmeal for dinner, and the next morning he entered the rabbit in the race. The rabbit was in track number six between two black dobermans which were owned by the mayor. The dogs growled at the rabbit through the wire mesh separators, and the rabbit shivered at the dog smell. The dogs salivated through the mesh, the rabbit pushed its body against the wooden starting barricade and twitched it's nostrils. The beekeeper was trying to behold the other farmers discreetly, to see their reaction. What he beheld was that they lifted their eyebrows at his rabbit, then they lifted their heads and laughed. The beekeeper put his hands in

his pockets and cast his gaze downward. He took the name of the lord in vain, and he kicked the ground. Then he walked away from the gathered farmers and stood two dozen cubits away from them, right in front of the finish line of the big elliptical racetrack.   The daughter of the neighbor's house felt sorry for the humble beekeeper and his pathetic rabbit, so she walked over to him and beseeched him to feel better and put her hand on his shoulder. She stood by the beekeeper to keep him company while they watched the race. The apple grower didn't like the way she was beseeching at the beekeeper and he folded his arms. He had half a mind to go over there and say something when the barricades lifted and the crowd hushed.   As soon as the starting pistol shot, the rabbit darted out in front, hopping into the lead at first by two cubits, then by four, then by eight. By the time the animals reached the 500 cubit mark on the opposite side of the track, he rabbit was ahead of the snow-wolf by twelve cubits, and he maintained his lead until he crossed the finish line chalked into the ground. The rabbit won the race well ahead of the snow wolf, who finished second fourteen cubits behind.   The farmers became very quiet.   The daughter of the neighbor's house clapped her hands and giggled. She jumped up and down, then put her arms around the beekeeper. The beekeeper felt her bosoms pushing up against his chest. The apple farmer, who was beholding the scene out of the corner of his eye, became annoyed and walked over to the pair. He grabbed her arm, and rebuked her loudly. The beekeeper hesitantly told the apple farmer that he should go forth, but the apple farmer's face got red and he yelled at the beekeeper to mind his own business. The beekeeper decided he was better off minding his own business.   The beekeeper went to the cages which lay at the end of the track and picked up his rabbit and petted him. He then fed him some carrots and pellets from his pocket. The apple farmer came over and grabbed the snow wolf's collar and dragged him off with his right hand. His left hand held the daughter of his neighbor's house by the wrist.   The apple farmer entered his cabin accompanied only by the dog. He was gnashing his teeth, but he wasn't going to be rending any clothes, because on the way home the daughter of his neighbor's house told him that she didn't want to fornicate with him anymore. She twisted away from

him, and she told him that she needed some space, and ran to his neighbor's house. The farmer slammed the cabin door and flew into a rage. He started smiting the table in his cabin with his fists. Then he kicked his snow wolf, who yelped and ran to the corner, curled up and whimpered. The next day the neighbor's daughter sought out the beekeeper and engaged him in conversation, the beekeeper spoke to her about how the other farmers should really be paying him more every spring for all the pollinating that his bees were doing, and how he was sick and tired of being underappreciated in the village. He offhandedly mentioned that he had plans to extend his business to include game birds and sugar beets. He then suggested that they go swimming, and when they reached they river he beseeched her to take off all her garments. She said no, but he kept on beseeching. Then she giggled and said all right. They entered the water and there the beekeeper beseeched her to swim closer. He grabbed her head in his arms and dunked it underwater until she kicked him, then he let her go. He was laughing, but she was upset and she made an angry face. He said what's the matter? can't you take a joke? She swam to the shore, and he swam after her and apologized. Then they fornicated. Meanwhile, the apple farmer spent most of his days brooding in his cabin. He called out to God, but God didn't answer. Then the apple farmer walked to the bar and got drunk, and when he stumbled home at closing time he called out to God again. This time God hearkened onto him and answered in specific detail. He walked home and and decided to do exactly what God had told him to do. When he re-entered his cabin, the apple farmer took his scythe off its hook, and called for his snow-wolf to come closer. Then he knelt down and smote at the wolf's tail until he had smitten it completely off. He fastened a white puffy rabbit tail where the old sinewy tail had been. The farmer looked at his handiwork and saw that it was good. The snow wolf did not see it the same way, and ran around in a circle making a lot of noise. The races were becoming more popular, and watching the next race was not only the entire population of the village but several dozen travellers from the neighboring village as well. When the onlookers beheld the apple grower's snow wolf with its bunny tail they let out a cry of delight and a crowd gathered around the two of them. The other

villagers coveted the apple farmer's wolf, and the apple farmer felt better about his situation. The beekeeper and the neighbor's daughter arrived a few minutes late, and she was holding the rabbit. They had been fornicating all week, and the beekeeper didn't get enough sleep the night before, he was in a bad mood and had circles under his eyes. As they arrived, they saw the crowd bunched up in a circle beholding something, and the daughter of the neighbor's house wanted to know what they were beholding. Since the beekeeper didn't get along with any of the farmers, he told her she could go behold it by herself, he was going to register the rabbit. At the center of the onlooking crowd, stood the snow wolf and his master. When the daughter of the neighbor's house saw the wolf's tail she gasped and lifted her hand to her mouth. She admired the apple farmer, and realized for the first time what a man of great resourefulness he was. She decided she should apologize to him for hurting his feelings. So she walked over to him and said that she hoped he was doing all right, and it would be nice if they could still be friends. But he hardened his heart and ignored her completely. The rabbit won the race by twenty cubits. Next sunday, three of the dogs had the cabbage leaves glued to their ears, and one had been painted white. The rabbit won by only four cubits, because the snow wolf, whose master had beat him so badly the week before, was running faster than ever. When the race was over, the snow wolf beseeched his owner by a licking of the hand and by yelping, but not by wagging its tail, because it still felt some affliction there. But the apple farmer was upset that his snow wolf didn't win. As they walked to his cabin, he at first decided that was going to beat the dog on its tail stump, like he had done the week before, but on the way back he stopped for a few drinks at the bar and God spoke to him again. In the cabin, the apple farmer took the scythe and smote off the snow wolf's ears, and after they were smitten off, he attached two long rabbit ears in their place. The wolf howled while the farmer was smiting, but once the ears were attached, everything became so loud that hearkening it's own howling was more than its sensitive ears could bear. The snow wolf quieted and curled into a quivering ball in the corner. At the next race, all but two of the dogs had a rabbit tail and three dogs had both rabbit tails and ears

taped up with cabbage leaves. But only the apple-farmer's dog had both an authentic rabbit tail and the authentic rabbit ears. The other farmers were very covetous and the apple grower was pleased that the natural social order was reestablished. The daughter of the neighbor's house then noticed that the apple farmer was a truly handsome man, much more so than the beekeeper, who was slightly overweight and losing his hair.   When the starting pistol went off, the snow wolf yelped from the loud sound. But he recovered, and caught up to the rabbit and they ran neck and neck until the finish. Many of the other dogs with the fluffy rabbit tails couldn't run because they lost their balance and fell. When the snow wolf and the rabbit crossed the chalk line, the snow wolf was ahead by a quarter cubit gauging by snout, although judging by paw the rabbit was ahead by a third of a cubit. But it really doesn't matter because nobody was paying any attention to the rabbit anymore.   Not when It was running against a wolf with rabbitty ears and a rabbitty tail!   The daughter of the neighbor's house became annoyed with the beekeeper, partly because he was a nobody, and partly because he was ignoring her and flirting with a short blonde girl with big teeth who had come from the neighboring village. Watching him, she came to the conclusion that he didn't know how to flirt. The daughter of the neighbor's house decided she didn't want to fornicate with the beekeeper anymore. She found him alone after the race and told him that she was forsaking him. He asked her if she really meant it, and she said she did, and she said it would be best if he went on with his life.   The beekeeper shrugged his shoulders and went off looking for the blonde girl.   The next week, the apple farmer's snow wolf had four rabbit paws tied to the bottom of his legs, a twitchy rabbit nose covering its snout, and a carrot in its jaws. Upon seeing the snow-wolf, the neighbors daughter ran to the apple farmer and beseeched him take her back. The apple farmer, who was still hardening his heart, said that he would think about it, but he was secretly pleased. Two days later, they started fornicating again.   As for the race, the two dobermans had all their legs smitten off and rabbit legs stuck on, so they couldn't run at all. All but two of the dogs were painted white and two of those collapsed from the paint fumes. Many of the dogs had both rabbit ears and cabbage leaves pasted onto their heads, and some of them ran around in circles when they heard the starting pistol. The snow wolf ran as well as he could under the circumstances, but his breathing was blocked, and his tongue could not extend because of the carrot, and he finished in fourth place. In third place was a dachshund painted white while the rabbit came in second.   In first place, by an overwhelming margin, ran a wild hare which a fifteen year old boy from the neighboring village had caught.

Does Hitchens' statement "That which can be asserted without evidence can be dismissed without evidence" contradict Gödel's incompleteness theorems?

The two have nothing to do with one another. Godel's theorem does not produce statements which must be accepted with no evidence, it produces a statement about a particular computer program which can't be proven not to halt in a weak system, but which clearly doesn't halt, the evidence being the consistency of the weaker system. The consistency of the weaker system is something which is verified at the very least by checking for an inconsistency and failing, but it is verified in a more logically satisfying way because these weaker systems are Godelizations of even weaker systems, and when you go down the Godel chain, you always terminate after a finite number of steps. The place you terminate is on some system that is so weak (like the fragments of arithmetic with induction only on statements with one "forall" or "there exists" in front) that our intuiton is completely clear that these simple systems are consistent. There is never any need to accept a statement without evidence here. It is, however, an unfortunate misinterpretation of Godel's theorem in mathematics that it requires one to accept the consistency of advanced set theories

without evidence. The proper evidence is a consistency proof, using an ordinal formulation of the theory as a reflection of arithmetic. Such a consistency proof can always be found (if the system is actually consistent, that is), and this statement was proved(!) by Turing in 1938 in his PhD thesis (I was shocked by this theorem, I only learned the proof a few days ago). Hitchins statement is more apropos to the supernatural God, for which there is no evidence, and which can be dismissed at will. For the ethical notion of God there is plenty of evidence. The supernatural God is just a way of propping up the ethical God, which is all that religions really care about when push comes to shove, because this is the only verifiable thing they deal in.

What events in a man's life would you use to measure intelligence (IQ), if you couldn't use a standardised test?

If you want a measure which is commensurate with IQ, you can time them when they do a crossword puzzle or sudoku. That's equivalent for all intents and purposes. If you don't have this type of puzzle around, or if the person is fluent in these already so that the measure is not useful, you can simply calculate the mean used vocabulary size, and the size of the computer program the person writes for a given fixed task (the shorter the better). These things are all that IQ testers test. They are skills that people pick up, and it is good to pick up these skills as much as possible, because they help your mental agility. They are generally useless for things other than mathematics and programming a computer, but these things are important, so I think it is good to boost your IQ.

Science and Religion: What is the difference between a creationist denying evolution because they haven't seen anything evolve, and an atheist denying the existence of a god because they haven't seen any divine acts?

I don't think either position is reasonable, because I think there is more than sufficient evidence for both ideas. The evidence for evolution is from fossils, from cladistics and DNA homology, and from the estimates for divergence provided by artificial selection. The evidence for common-descent is overwhelming, the evidence for evolution by selection is also overwhelming, although the type of selection is not 100% clear, what fraction is natural selection, what fraction sexual selection, and to what extent kin-selection is important, these things are debated. The evidence for God is of a completely different kind. One must understand what God is: it is a source of ethics, a teleological cause for social evolution, the postulated reason that ethical decisions converge to a unique answer as societies get larger and people's ideas about right and wrong battle it out. The statement is that societies, in the long-time large-number-of-people limit, converge on a unique idea of right and wrong, and that this ethical standard can be realistically personified as the will of a single super-smart individual. That's a pretty good definition of God--- the entity whose will in every situation is the universal 'right' thing to do. Because God is abstract, the question of existence is not important, it is like asking "does pi exist?" Whether you say yes or no, the circle doesn't change it's circumference. The evidence for God as an idea is simply that ethics is actually converging--- all societies today not only agree on the idea that slavery is wrong, they also agree that child labor is wrong, and that arranged marriage is not a good idea, and that female circumcision is not acceptable, and that racism is abominable, and so on, even though these were not universally accepted as recently as 50 years ago. There is no logical reason for this convergence. These

behaviors were socially stable for centuries, they benefited those who went along with the thing, they were only eliminated by the action of people who acted with an idea that the 'right' will win out, and there is no real reason for 'right' to win out, because any 'wrong' that you see around you is always stable, and so it always benefits the individual more than 'right', so it cannot be eliminated simply by everyone following their best interest. But despite this, something guaratees that 'right' beats 'wrong' eventually. This is the entire logical-positivist content of the statement "God exists". The existence is not the important thing, the 'right' beating 'wrong' is. This has nothing to do with creating the universe, hand-crafting life on Earth, or any of that business. The only relation is that the Bible is a book about God, and it also make fabulous claims about the creation of the Earth and the creation of life. These stories cannot be taken literally, this is mentally defective, but some people who wish to spread the word of God think that it's a good idea to continue to push the literal truth of the Bible as a way of propping up the idea. This is not necessary. God doesn't need you to lie about history or biology anymore (it is not clear God ever did). The motivation for standardizing on the Biblical stories is now gone, the Bible's view of God is now pretty much universally understood, in that the convergence of ethics is an accepted thing. This concept of God is even usually accepted by people who call themselves atheists (although not usually with the same conviction as believers). Most atheists just do not realize that this is what God is, they think it's all about the superstitious nonsense. So this battle to get people to accept God is pretty much over, so it is now more ethically important to tell the truth about history and science. TL;DR: It's not okay for you to deny evolution, because God says it's not ok. The atheists usually only deny God just because they don't understand exactly what it is that they are denying, and one reason they don't understand it is because people use God to deny evolution.

Why did you start smoking?

I followed the unfortunate example of Einstein, Bohr, Pauli, and so on, who were all heavy smokers. Sidney Coleman would smoke cigars in his office, and I admired him, although he also advocated occasional marijuana smoking, which I could never understand. Following Coleman, I started with cigars. I inhaled a little bit accidentally, and ended up vomiting and then retching for a long time. That was a few months before I tried again. I switched to pipe, but it was such a heavy dose, I would get very dizzy and sick from the nicotine dosage. So I mostly stuck to cigarettes. But the effects on the lungs and body are awful, even if you don't get cancer. The smoke and the carbon monoxide cloud your brain and weaken your body tremendously. I smoked half a pack to a pack of cigarettes every day, less when I had a pipe. Then I finally bought an electronic cigarette. I threw away my pack of cigarettes after two minutes and never looked back. I think I am as healthy as a non-smoker today, after my lungs cleared up, aside from occasional dehydration, and occasional mild nicotine overdose (dizzyness, chest-pain).

What are some interesting facts about Richard Feynman?

To me the most interesting fact is that he was (probably) completely faithful to his third wife! I write is as fact, it is reported by a reliable observer in Most of the Good Stuff. This despite the fact that he successfully made a reputation for himself as a womanizer, made several sexist comments in public, including in his Nobel lecture, which made the whole world think he was this unbelievable ladies man. The people closest to him say this sleazy reputation was astonishing to them, because it was completely at odds with what he

was doing in private, which was a ton of physics in isolation, and maintaining a healthy family life at home. His reputation for sexism was completely at odds with his forceful advocacy for women in science, including his sister, who became a physicist on his encouragement. I do not doubt that Feynman knew very well how people do actually do sexual stuff, it is not difficult to learn, and some people even explain this stuff in books today, and Feynman explained similar things in his biography. But seeing his remarkable productivity, and his happy family life, it is very doubtful that he had the time to do all that skirt chasing. I doubt he did anything at all in this direction past the age of 30 (past 1950, when the most remarkable phase of his publishing career begins). There was a method in this madness--- he knew what the media in the 1950-1980s was all about. In order to gain fame and recognition, you needed to advertise your sexual prowess. This means Sinatra, Elvis, the Beatles, the Rolling Stones who were propped up because of this. If you read Keith Richards biography, he also was going through the same process all of us go through, of muddled relationships with various people, with emotional attachments, the unusual thing is that eventually he was saddled with the attendant problems and confusions of extremely low-dose intra-muscular heroin injection. All these folks had a much stronger work ethic and a much less lascivious private life than was advertised by the media. The ones that actually led unhealthy lives fell apart early. Feynman did the same thing. He built up this reputation for himself, by hanging out with strippers in Las Vegas, by going to strip clubs and bars, by generally doing the low-life, like Pauli, except, unlike Pauli, talking about it a lot, with innuendo. But, as is known to all physicists, these lonely places like strip clubs and Las Vegas, where people go to do lonely things, are some of the best places to work on science, because everyone is as isolated and alone as you, and nobody bothers you for 2,3 days while you are doing your calculations and thinking. On the fourth day, maybe you meet an interesting stripper, and have a nice chat, go out on the town, but there is no need for sexual intercourse in this encounter, it is assumed by everyone no matter what you do or don't do. And in this way, you get a nice dose of testosterone, your mind remains unclouded by the heavy emotional

baggage of sexual intimacy, and you can continue to do work the next day. Plus you have an interesting story, and you get to hang out with some nice, honest down-to-earth people, who have an unusual occupational insight into psychology. Perhaps Feynman had an affair or two, there are rumors that he had an affair with such-and-so's wife at Cornell in the early 1950s, and the resulting furor led him to leave (he says it was the weather that made him go, according to rumor, such-and-so's wife said something else). Perhaps he had several affairs. But the media image is not a reliable indicator, because the media image is a confabulation for the purpose of achieving noteriety. I think this type of media dishonesty is a type of trickery. It is very clever, and it is partly responsible for Feynman's great fame. But others resented him for lying like this, because he was so honest in private. Gell-Mann for one, hated this aspect of Feynman's personality, and said so. According to rumor in physics departments, Feynman did these kind of noteriety things all the time. He would actually paint nudes, and sometimes take a photograph or two. He would carry a photo in his wallet, and sometimes show them to people surreptitiously, with a wink, and in this way plant the seeds of the rumor of promiscuity (heard in rumor, I added the deception part). When I read Feynman's popular books, and heard the rumors, I sort of figured this out, and chuckled to myself, because all these physicists destroy their emotional health and careers with all this sex crap that is completely ridiculous, thinking they are following his lead. I suspect that other media figures do similar tricks, perhaps the stories of Charlie Sheen's ridiculously excessive drug abuse and promiscuity (beyond his admitted polyamorous relationship) are not honest, he seems very lucid in interviews, and seems to take good care of his body.

What does "information" mean in physics? And how can it be reassembled (?) if it radiates

from a black hole?

Information in this context is the negative of the entropy, and the statement that information is not lost is the statement that entropy doesn't go up in any fundamental way when you form a black hole and let it evaporate, so that forming a localized black hole is no more mysterious than the banging of atoms. The entropy is the number of bits you need to learn about a system in order to precisely specify it's state. If you start an atom out which is 50% likely to be either in the ground state or first excited state, you have 1 bit of entropy. In both quantum mechanics and Hamiltonian/Lagrangian classical mechanics, this degree of ignorance doesn't fundamentally increase with time, so that if you wait a long time, and the atom does something like radiate radiation, the total entropy in the radiation and the atom is still 1 bit. In practice, you can't really control or effectively measure the phase relations in the outgoing radiation, it's spread out over a large region, so effectively, the entropy increases, as you lose track of the configuration more and more, but in principle, you never increase the entropy. This is a fundamental law of nature. For atoms colliding without radiation, in principle, you can un-collide them by a sophisticated reverser which reverses their motion. Then their state should go back to what it was at the beginning, recohering the initial wavefunction (even without radiation it is ridiculously hard to do). The mathematical statement is that the Von-Neumann entropy is constant during atomic collisions, the sum over all quantum states of the probability of this state times the logarithm of the probability of this state. For a black hole, this idea is superficially impossible, because the stuff coming out is Hawking radiation, and it seems to be completely causally disconnected from the stuff falling in. The Hawking radiation is coming from the quantum fluctuations at the very beginning of the black hole, from a little spot right when the horizon first formed. The incoming stuff is crossing much later, and can only perturb the outgoing stuff a little bit. So it seems there is no way to imprint the information of the incoming stuff on the outgoing stuff. Hawking noticed this, and correctly pointed out that this is the

main conflict between quantum mechanics and general relativity. The resolution found by 'tHooft and elaborated by Susskind is that the information about the infalling and outgoing things both are stored in the horizon configuration, nonlocally, so that the spacetime in the exterior is reconstructed from the quantum bumps and jiggles of the horizon, so that the spacetime is a nonlocal reconstruction from a distant screen. In this picture, the infalling stuff merges with the horizon (but it was always merged in some sense, in a picture where you are close to the horizon, so that it fills your field of vision), and then the outgoing photons peel off from the same bumps and jiggles that encode the incoming stuff. The horizon degrees of freedom evolve with no gain of entropy, other than the usual one of losing track of things because things are complicated. As outlandish as it seems at first, this is confirmed very well now in string-theory models. There are purely unitary quantum field theories which are dual to the horizon jiggles of certain model black holes in string theory in precisely this way. Further, by simulating the process of little black hole formation and evaporation near these model black holes, in the corresponding unitary theory, you can see that the process conserves entropy, despite the very persuasive semi-classical argument.

Is Ron Maimon an expert or misguided in his deviations from the mainstream?

Nobody can tell you how to feel. Feeling is not how you judge things, you judge things using evidence. Social consensus is not a trustworthy method of arriving at truth, it will tell you that oil is made from plants and that 19 Saudis brought down the World Trade Center. The truther position is "not considered generally credible" because people usually don't read anything, and don't know how to evaluate evidence independent of social forces. My answers explain the attack in an original way, and I would appreciate if you would read them, take

them seriously, read the evidence compiled and either change your mind or not (but it's impossible to not change your mind, the evidence is conclusive). I try very hard to sound like a crank, I admire them. But I am usually careful in what I write, and if someone points out a mistake, I try to fix it. My areas of expertise are physics and some parts of biology and mathematics, where I have read a significant portion of the literature. Politics, as Chomsky often emphasizes, requires no special expertise, it is something all of us must do to be informed citizens. The strong 9/11 truth position (MIHOP) is at a precarious point right now. It is supported by around 15%, and it can either spread, or be lost for a generation or more, so that we will have to wait for revisionists in 30 years to fix the history, like the slavery people. I am trying to help it to spread, because there is no reason to wait today. We have an internet.

How can a person without Mathematics background understand Gödel's incompleteness theorems?

Hofstadter's book is too wordy. Here is a complete proof. Given an axiomatic system S, you can write a computer program to do the following: 1. print its code into a variable R. 2. deduce consequences of S, looking for "R does not halt" 3. if it finds this, halts. This proves the theorem.

What's the easiest way to understand Gödel's Incompleteness Theorems? Are there

statements that have truth values which cannot be determined except meta-mathematically?

Given an axiomatic system S, it is an algorithm for producing true sentences about arithmetic. So it can prove things about computer programs. Write the program Godel to do the following: 1. Print its code into a variable R 2. Deduce theorems in S, looking for a proof of "R does not halt". 3. When it finds it, it halts. Then "Godel does not halt" can't be proved in S.

What do theists hate the most about atheists?

The problem with atheists, the central issue, is that they are most often unable to act against their own self-interest in the interest of a wider sense of justice. There are very few atheist martyrs. Richard Stallman is an exception. The concept of God is simply the agent whose desire is a self-consistent system of ethics spanning all individuals, and this is something we instinctively use to decide how to behave ethically. There is nothing more to the concept, but atheists generally have a hard time doing God's will. The reason is that it often conflicts with making money, having success, and so on.

Does Gödel's Incompleteness Theorem prove the existence of God?

This is not a proof, because the concept of "set" you are using is the Fregian concept of a predicate, something mathematicians today

would call a "class". The classes are predicates defined on something other than classes, and these are the sets, and the sets have to be built up piecemeal by a process which in effect constructs a computational model of the axiom system. You need something like ZFC. The reason is "Russell's paradox", the set of all sets which don't contain themselves is inconsistent. In your construction, an analogous paradox is the Tarskian sentence "The set of all truths does not contain this truth" (where the self-reference can be removed by appropriate encoding). The set of truths can't be defined properly this way. Even if you accept your idea, accepting that the "set of all truths" exists or doesn't exist is positivistically meaningless, it doesn't tell you anything new about what is true, it doesn't change anything at all about anything observable or computable or any behavior, nothing. The fact that your proof is just a definition, means that the God you define can't inform you about anything at all. The traditional concept of God is supposed to tell you something about how to behave. Godel's incompleteness theorem doesn't say what you claim it says. It says that given any axiom system, adding "this axiom system is consistent" makes it stronger. First, as Turing showed, the augmentation process, when iterated over ordinals, actually DOES eventually cover all truths, as you keep adding "the previous theory is consistent" and iterate over all ordinals, you can decide all propositions (sort of, it's a two-step process. The iteration will allow you to prove arbitrarily strong systems are consistent, then reasoning in those systems will prove arbitrarily strong truths. Fefferman has written about this, he uses a reflection principle, Turing's fantastic and clever 1938 proof is in his recently reprinted PhD thesis, as is a reference to Fefferman's argument). Anyway, the proper concept of God is not this nebulous thing, but the computational limit of stronger axiom systems, indexed by larger computable ordinals, which defines mathematical truth in the limit that you approach the Church Kleene ordinal. This also gives meaning to the concept of superrational game play in larger and larger collectives, as you decide how to play in correlated groups. This is not a nebulous thing, but it corresponds to the nebulous thing and gives it precise meaning. The superrational game play in large collectives gives meaning to the Golden rule, and then to the idea of an

intelligent collective personal God which knows how often you brush your teeth and tells you precisely what to do.

What are the best video's and/or sites etc arguing against a 9/11 conspiracy?

There aren't any, and there cannot be. Any site arguing against an inside job (not necessarily a wide conspiracy, it only requires a few people at the top, perhaps only one) is going to be defective, simply because it is arguing a lie.

What are the latest 9/11 conspiracy theory documentaries?

I think Truth Rising is a good Truther documentary, I agree with all it's conclusions. From Infowars: There's a war on for your mind! A global awakening has taken place, the likes of which the world has never seen. As the corporate-controlled media dwindles into extinction, a new breed of journalists and activists has emerged. a global awakening has taken place, the likes of which the world has never seen. As the corporate-controlled media dwindles into extinction, a new breed of journalists and activists has emerged. Strap in and get ready to ride along as criminal overlords David Rockefeller, Zbigniew Brzezinski, Bill Clinton and Hillary Clinton, Alan Greenspan, John McCain (politician), and many others are confronted about their lies and manipulation. Including interviews with Jesse Ventura, Rosie O'Donnell, George Carlin (comedian), Willie Nelson

(musician) and Martin Sheen (actor), this film is unlike anything you have ever seen. the only question after viewing it is, will you become part of the Truth Rising Loose change is also a good documentary, however, there is no need to postulate that flight 93 passengers disembarked in Cincinnatti, nor that voice-morphing technology was used to fake phone calls.

What are the best critiques/rebuttals of the main points in Loose Change 9/11: An American Coup?

No fundamental rebuttals, it's an honest film, and makes good points with a reasonably good propaganda value, and spreads truth. This is important. To understand the problem with the film, you need to understand how the attack was staged. You have to do it with no co-conspirators, you have to do it essentially alone, because no one in the government will attack the country. This is why you need simultaneous drills. I explained it in more detail here: What's your 9/11 conspiracy theory? . The drills you need to stage the attack: * Fake hijackings on 4 flights * Fake radar blips, air-traffic exercizes * Live fly drills, putting 4 767 size drones in the air. * Flight-simulate flying large planes into the WTC and Pentagon. These drills, or something very similar, are known to have been going on on 9/11. Then on the day of the attack, you order the drones to fly close to the hijacking planes, you switch the two coordinates and insert a bunch of irrelevant distracting blips in the radar. You start the hijacking drill on the flights, a guy on the plane stands up and says he has a bomb, others brandish knives half-heartedly. Passengers call relatives, say there is a hijacking. After the drone switcheroo, the planes are landed at a military base, as part of the drill, and all the passengers and crew are transferred to the plane the media identified as flight 93. Then the

drill coordinator already attached the flight simulator to the drones, so that instead of doing a harmless flight-simulations, the professional pilots actually pilot the drones into the WTC and Pentagon. Finally, you order flight 93 shot down with an air-to-air missile, killing all the passengers and crew. None of this requires any large conspiracy. All the planning is done as part of the planning for the drills, and nobody thinks that they are doing anything wrong, because each part doesn't make the whole plan clear. All they notice is that the drills and actual attacks uncannily coincide. The switches are very small, and could concievably be done by just the one person coordinating all the drills. Anyway, after you understand this, you can find the few small mistakes in Loose Change. The Pentagon thing is fine, so is the World Trade Center thing. The problems are with the phone calls and with the passenger offloading for flight 93. It is doubtful that the calls from the planes were done with voice-morphing, both because such technology would be primitive and easy for a relative to see through, and some of the calls were intimate. But more importantly, voice-morphing requires conspiracy, it cannot be excused as part of a drill. There are no conspirators available. The other problem is the idea that flight 93 landed in Cincinnatti. It is possible that the actual empty plane landed in Cincinnatti, this is also likely what happened to flight 175, from the ACARS data. But the empty planes needed to have transferred all their passengers to the flight the media called flight 93, the one that was shot down over Pennsylvania. The eye-witness accounts that it was shot-down by air-to-air missiles are compelling, and consistent with the crash site. it is also easy to explain to the pilots why they are shooting down this flight, because there were already three attacks, they would understand. It is also easy to justify the cover-up, because the military doesn't want liability for the deaths. This doesn't require conspiracy. On the other hand, killing all the passengers on flight 93 after they have disembarked in Cincinnatti requires an impossible conspiracy, nobody would do it. The key point is that you can't do it with conpirators, you need to only use drills. This is also why the attack isn't perfect--- the drones don't look too much like civilian airliners, there are anomalies in the Pentagon attack, it's the best you can do when nobody knows what you are

doing, and you are cobbling an attack out of drills. But these two mistakes are relatively small, and the guy was doing this many years ago, before the overall plan was clear. All in all, it's still a great film, probably the best about 9/11 made to date.

Conspiracy Theories: What is true and not true about "Loose Change", the documentary?

Loose change is reasonably accurate, but it doesn't give a scenario for the attack. I described such a scenario here: What's your 9/11 conspiracy theory? . It is consistent with the evidence to date, and requires no coincidences. The main point is simply that the drills of that day were used to stage the attack, with very few conspirators, perhaps only one person who knew the whole story. The drills put drones in the air, had fake radar blips and air-traffic signals, had fake hijackings on real flights, and had a drill to flight-simulate flying large planes into the world trade center and pentagon. Each of the drills are by themselves innocous. But when they are staged simultaneously, with very small changes in a few details, they can be used to stage an attack. The WTC was rigged for demolition months before, in case of a terror attack, this part is independent of the attack itself. On the day of the attack, the coordinator ordered the drones flown close to the actual airliners. The airliners began the hijacking drill as scheduled, four people in the passenger section stood up, one person said he had a bomb, people brandished plastic knives, and lots of people called their relatives at this point. One hijacker was in the cockpit, and told the pilots to turn the transponders off for the drill, and to land at a nearby military base, to treat it as an actual bomb threat. Then the coordinator flipped the coordinates of drones and airliners. The drones continued the flight path of the airliners, and the flight-simulation drill was used to pilot the drones into the WTC and Pentagon. The airliners landed and transferred the passengers to what

was eventually identified in the media as flight 93. They shot down this flight 93 over Pensylvania at 30,000 ft with an air-to-air missile, killing all 200 passengers on all 4 planes. Anyway, knowing the proper story, one can identify the problems in Loose Change. Most of it is general anomalies, and this is fine, and the filmmaker is a courageous and insightful guy, with very good propaganda skills, and very strong filmmaking skills. One issue is identifying "flight 93" as having landed in Cincinnatti and transferred passengers. The plane might have landed in Cincinatti, but the passengers were already over Pennsylvania, getting shot down. If passengers were still alive at noon, it would require a conspiracy to dispose of them. There is no conspiracy available here, only drills. The other problem is the voice-morphing technology claim, that the phone calls were faked. This also requires conspiracy of many people, with no way to justify the manipulation to subordinates. It is much more plausible that the calls came during the hijacking drill, before the planes were landed and evacuated, and they were allowed, so as to add realism to the drill. These calls could have been legitimately made by passengers from plane phones and routed through a normal system, with the passengers confused as to what is going on. They report 4 hijackers on each flight, usually with a bomb or plastic knives. The fifth hijacker was probably in the cockpit at takeoff, since the pilots and crew were alerted to the drill ahead of time. But these are nitpicking points. The film overall is very good, and the sections on the Pentagon attack and World Trade Center demolition are very accurate. They could use the results of Steven Jones on the thermite residues, because this is laboratory tested and confirmed, and puts the nail on the coffin of the official story, ludicrous as it is, but these came long after the film first aired.

What is the possibility of 9/11 being another Operation Northwoods?

The likelihood is certain, although the "signed by the president" part is not necessary, and I'd post 60/40 odds against it. You don't need the President to go along with the plan, only to not question the story, and go along with the media and everyone else. He would certainly have been extremely suspicious on that day--- he knew what kind of military exercises were going on--- perhaps this is why he was so anxious and paralyzed. The reason I doubt it is that the more people know the plan, the less likely it is to work. Someone would spill the beans. The evidence for the inside job is summarized in engineers&architects for 9-11 truth, also scholars, pilots, and all the other groups, and each one has enough evidence to demolish the standard story. But this is not enough. To be persuasive, you need an alternate story which fits all the known data. Although I am not a 9-11 scholar by any means, I will provide this story. It is peiced together from the work of Webster Tarpley, the pilots for 9-11 truth, the Architects and Engineers, but mostly, from the reconciling two simple superficially mutually contradictory statements: * The attacks were planned within the US government * Nobody within the US government would ever go along with it. So in order to get the plan to work, people have to plan it without knowing what they are doing, with only one senior official knowing what's what. Is this possible? It is very difficult to do, and it can be done in essentially only one way. This is by arranging simultaneous military drills that overlap aspects of the attack, and changing a few details. For the morning of 9-11 you make drills for the purpose of testing the readiness for a multiple simultaneous hijacking. 1. Fly 4 large drones, the size of 767s, perhaps shooting some down. 2. Insert radar blips into screens, fake signals for air-traffic control 3. Have a fake hijacking on several American and United flights 4. flight-simulate flying into the world-trade center and Pentagon For 1, you requisition the drones, by either modifying large military planes with remote flying equipment, or else by just finding large drones. The justification for this is to see if a fighter can intercept a jetliner. This is a known 9-11 drill. For 2, you justify it as a test of readiness for both radar and air-traffic, to deal with multiple hijackings. This is a known 9-11 drill. For 3, you just ask some CIA agents to get on the plane, and one of them stands up and says he has a

bomb. You have an agent in the cockpit, telling the pilots to turn off the transponder, and land at a certain airport or air-force base when you get the order. The point of this is to test readiness of flight crew for terrorism. I don't know if this is a 9/11 drill, but it is consistent with the other drills. For 4, you just want to see if it is possible to pilot a large plane into the WTC. You claim to have a very good flight simulator that simulates flying a large plane, and you ask the pilots to see how well they can navigate into the WTC and Pentagon. Something very similar is a known 9-11 drill, and parts of this drill have never seen the light of day. There are more drills on 9-11, I just took the ones necessary to stage the attack. Then on the day of the attack Drill 1: You shoot down one drone early in the morning, and then send the paperwork for the shoot-down duplicatively to all the requisition offices, so that each one thinks their drone is the one that got shot down. But you keep 3 drones in the air. You fly these drones close to 3 commercial airliners Drill 2: You switch the position of the drones with the airliners, and also insert a dozen or so completely irrelevant distractions, so nobody knows which ones are real dangers, and which are simulation phantoms. There is freedom-of-information radar and ACARS data which shows the switch happening for flight 175. Drill 3: Either before or after the switch is complete, you land the planes and transfer the passengers to another flight. After all the transfers, all the passengers and crew are on the flight which the media identifies as flight 93, although it is confusing whether this is actually flight 93, or another flight relabelled flight 93. Drill 4: You hook up the simulators to the drones, and pilot the drones into the WTC and Pentagon. In addition, you can also have drills to divert the air-force to the north (operation Northern Vigilance), to get the satellite imagery people out of their offices (this happened), to get first-responders to NYC (another drill, bio-terrorism preparedness), and in general, to disable the whole government. Once the attack is over, you shoot down flight 93 with an air-to-air missile, completing the attack. This story is consistent with all the reliable evidence. Mostly I got it by myself, just thinking how to do it alone, with no help, but I added the transfer business from "Flight of the Bumble-Planes". It's obvious once you review the drills. The wiring of the buliding for demolition

was done by contractors, maybe half a dozen of them, who filled up the core with enough thermite to melt all the steel. The steel was melted over the hour after the collision, and then the building was brought down with relatively small charges on various floors, and in the basement. This work is independent of the attack part of the plan, and does not require the demolition team to know anything about the attack. This part is confirmed by the evidence compiled by Architects and Engineers for 9-11 truth. I will point out that this story does not require any more evidence than knowing that such enabling drills were occuring on 9-11. It is impossible to accept such a coincidence, it is not reasonable under any circumstances, and anyone who accepts this coincidence is deluding himself or herself and is a little bit complicit.

Within the frame of string theory, can one explain simply and intuitivly what is a charge, a mass, spin and quark color ?

It's not any different than in the previous frameworks. "Mass" is the length of the energy-momentum vector. Energy and momentum are those things in scattering theory that are additively conserved when added together with the ordinary Newtonian concepts with the same name. Charge is the amplitude to emit a photon, it's the same as in quantum field theory, but it's also the strength of the electric field generated by the charge, and it's also the quantity which is additively conserved together with the number of protons minus electrons in bulk matter. Color charge is the representation of SU(3), it is the amplitude matrix to emit one of 8 different gluons. It is also the strength of the chromoelectric field around a quark, if the quark is ever classical. The only classical quarks are the super-heavy quarks, but these don't live very long, so you never get a nice classical picture.

There is no special insight into the older concepts from a new theory. You should learn the old concepts in the historical context of the theory that gave rise to them, because the old theory gives you the relations between these concepts on the proper level, in relation to each other, not in relation to more fundamental building blocks. String theory is just a way of making sense of quantum gravity, to give the fundamental laws, and to understand it, you need to understand the previous concepts, because these are about linking these laws to direct experience. Physics is not just fundamental laws, it's also a map from these fundamental laws to experience, and as you go to deeper levels, the laws become simpler, but the map becomes more complicated. So you should learn the easier levels first, where the map is trivial.

Are there reputable physicists who don't believe dark matter exists?

I am sure there are many, it makes no difference what they believe. You need to look at the evidence for dark-matter yourself, independent of any authority. There are three classical lines of evidence for dark-matter: Rotation curves: galaxy rotation curves (the speed of stars at different distances from the center) are mapped by blueshift analysis of spectral-lines at various distances from the center, a reliable method, and this shows that the rotational speed doesn't obey Kepler's law with the visible matter as the major source of gravity. The conclusion, assuming standard gravity, is that the galaxy is surrounded by a uniform cloud of dark matter Zwicky's estimate of galaxy-cluster binding: when you consider the velocities of galaxies in bound clusters, you can figure out how deep the potential well is. The galaxies should be bound, or else it would be a conspiracy that we observe them together right now (they would be flying past by coincidence), and from the velocities, you get a sense of the total mass in the cluster. The result is that there is about 30% of the closure

density in dark matter plus ordinary matter, but the ordinary matter is only about 5%. Cosmological bounds: The mapping of the blackbody radiation fluctuations allows you to quantify the cosmological model, and this reveals that there is a 70/30 split of the universe into cosmological constant and matter. The total amount is the closure density, and this is consistent with Zwicky's dark-matter estimate. Simulations of the structure formation in the universe gets roughly right global density distributions of galaxies with the dark matter content as it is, and no modifications in gravity. These three lines all converged to the same answer, since the rotation curves also showed a certain amount of dark matter at least 3 times the ordinary matter in a cloud around a galaxy. The coincidence of these estimates is extremely strong evidence, and you can't reject it because the idea sounds fishy. However fishy it sounds, it is supported by the observations, and whether it sounds right to your ears is a problem of your ears not of the hypothesis. In response to the galaxy rotation data, there was the proposal that one should modify gravity. The MOND idea is that gravity doesn't work the same at slow velocities, and it can reproduce the rotation curves by adjusting parameters. It is not consistent with General Relativity, but you can add fields to General Relativity until you get something complicated enough that nobody can follow you anymore. This explanation generally fails on the Zwicky estimates, and it completely fails to account for the cosmological data. But let's pretend they could fix that up by more parameter adjustment. There is a more direct observation of dark matter nowadays using gravitational lensing. The effect of weak lensing can be used to map out the rough distribution of gravitating matter in various astronomical situations. This process gives a distribution of dark matter which is also consistent with the main discovery methods. But not in every case. There is the bullet-cluster colliding galaxy, shown on this video, where the dark-matter distribution was completely different: As you can see, simulation of the dark-matter plus ordinary matter reproduces the results. This is what people call overwhelming evidence, and it is no longer possible to deny dark matter by anyone, reputable or not. So it doesn't matter what they say, there is no more conversation necessary, the evidence is

good enough to be certain, and any further denials are political, and need to be opposed politically.

9/11 Conspiracy Theories: What will be the effect of Rethink911.org's advertising campaign?

The best case is that people will see the ads, check out the websites, and review the evidence for themselves until they come to agree with the truthers. It is impossible to read the evidence and not be persuaded, simply because the evidence compiled by Architects&Engineers for 9/11 truth, Pilots, Scholars, etc, is completely persuasive, and when taken in conjunction with Webster Tarpley's analysis of the drills that day, you get a complete picture of what happened. It's actually kind of amazing that people can continue to live with the cognitive dissonance. But unfortunately these ads consist of the unthreatening question "Did you know a 3rd building collapsed on 9/11?", it is unlikely to have much impact by itself, since it has very little psychological impact, absent further investigation by the audience. When a propaganda agency is selling a lie, it repeats the lie dogmatically, without evidence, again and again. Propaganda for the truth can't do any different--- it must assert the truth just as in-your-face and matter of factly, without worrying about evidence. The opposition has no facts on its side, and uses this tactic, so it must be a good one. Imitate them. Those who push the truth, unfortunately, tend to be evidence driven, and meek, and intimidated by past failures to keep changing their approach to an ever more accomodating one. They therefore end up with the weakest possible propaganda, full of facts and numbers, and expert testimony, and anomalies, and empty of emotional slogans and catchy sound-bites and fake eye-witness testimony that the propagandists use. The slogans and sound-bites are

what drive propaganda victories. The fact that these were ineffective in the past is simply due to numbers--- the slogans you hear less often sink in less. There is no reason to become less confrontational because you fail. This is when you become even more confrontational, even more in-your-face. So long as you have the evidence on your side, you have nothing to worry about. The "Million American March Against Fear" might work together with the ad campaign to change minds, but this will only happen if the march is enormous, and gets widespread coverage. Otherwise, one is relying on word of mouth, as always. The word-of-mouth campaign has been very effective. At this point, just from talking to people I know, the truther movement has around 30% support in NYC, at least in my workplace and on the street nearby. But by this point, nearly everyone in the entire country is extremely uncomfortable with the official story, so it is a good time to push hard. One should take advantage of the fact that in this particular case the official story is mentally retarded. The proper ad campaign would be "Indict The Traitorous Rats!" And would not mention any facts, only list guilty individuals. Such an ad campaign, especially if it is in-your-face and protracted, will cause people to review the evidence. The reason is that the truthers will be standing firm, not shying away from conflict, and they will be appealing to emotion, not giving numbers and facts, and all that unpersuasive anti-propaganda that they are so fond of.

What are the 9/11 conspiracies?

The US government version is infantile lies. Here is my best guess, based on very little research (not much is needed). On the morning of 9/11, there are military war games which do the following: * send up 4 large 767 size drones into the sky. * muck around with radar, false radar blips etc. * have a fake hijacking on several American and United flights * flight-simulate crashing planes into the WTC and

Pentagon One of the drones is shot down early in the morning. The paperwork for this event is later duplicatively used to satisfy the requisition offices that each of the 4 drones was destroyed as planned. But 3 drones are still flying that day. The remaining 3 drones are flown very close to the passenger flights. The hijacking drill starts on these flights, a guy stands up and says he has a bomb. The transponder is turned off as required for the drill. The coordinates of the flights are switched with the drones. After the switcheroo, the 3 passenger flights are landed as part of the hijacking exercise at an air-force base, and the passengers and crew are transferred to another plane. After transfers, everyone ends up on flight 93. The now empty WTC planes are flown west and landed in Cincinatti, as the ACARS data shows. The drones are piloted into the WTC using the flight-simulation drill. The Pentagon drone has some sort of problem, and is replaced by another drone of smaller size. The WTC is brought down by a controlled demolition, which has been installed at some point after 1993 attack, for the purpose of bringing down the building in case of a terror attack. This uses thermite on the core, installed through the elevators, and perhaps a few smaller cutter charges placed on key columns in the basement and on certain midlevel floors. But mostly, it's just thermite melting all the steel in the core until the building just collapses. Finally, flight 93 is shot down over Pennsylvania, killing all the passengers at 30,000 ft. That's it. It's my story. It's a damn sight better than the government one, that's for sure. The planning for the drills can be done without any conspiratorial involvement, the only people who know the whole plan are the organizers, which can be as small a group as one person. The only people who know something is wrong at the end of the day are the 3 drone pilots who flew into the WTC and Pentagon, and these are the only people that need to be kept quiet. The remainder of the people are just confused, because a real hijacking seems to overlap with a hijacking exercise which simulates the very same thing. This is the main astonishment among 9/11 folks, that the simulations and the events coincided in uncanny detail.

Are there any genuine/valid criticisms of science? If so, what are they?

Science, due to the review mechanism, is extremely hostile to new ideas and very conservative regarding any contributions from politically inept outsiders, without regard to the correctness. Incorrect contributions from politically well-connected people are allowed and sometimes get a lot of traction, correct contributions from outsiders are ignored. This persists even when the evidence against the well connected stupid theory is very strong, like in the case of large extra dimensions, or when the evidence for a new unexpected understanding is beyond dispute, like Barbara McClintock's jumping genes, or Kudryavtsev's abiogenic petrolium. The politics blocks progress, and it is obsoleted by the internet, since you don't have to worry about dishonest charlatans anymore--- you can refute them faster than they produce their nonsense. There was a charlatanry problem in print media, charlatans could run a long way before the refutation reached the proper audience. So, to deal with this, science has traditionally been run by a bunch of politicians. They have their dogmas, and the dogmatic beliefs hold the charlatans at bay (usually a charlatan will contradict a dogma). These science politicians cannot be swayed on anything, they have published too much and read too much, they cannot change their mind. When they are often wrong, they are too stupid to see it, and you have to wait for them to die, and this takes a long long time. So you get a few new good ideas every few years, and a long twenty year struggle to get the idea accepted. These dogmatic people were useful for keeping out crap from journals, and preventing charlatans from getting political power. So they were necessary. They are unnecessary now, because to refute a charlatan takes about 10 seconds, and anyone can do it by commenting on a website. This obstinate dogmatism is the only problem in science that I can see.

Is Qi a genuine phenomenon not yet understood by science, or a complex delusion?

Qi is a bunch of claptrap, and this type of claptrap is understood very well within science sociology--- it's like Aristotelian physics. You make a very complicated collection of mutterings about invisible nothings and you can can delude people that you know better. The higher your social class, the easier a time you have understanding all the mutterings, and the lower your social class, the more impenetrable and magical do the utterances seem. How is "chi" then different from scientific concepts, like "electric field"? Both are invisible nothings people draw complicated diagrams to describe. The difference is that there is a well defined positivist procedure to detect electric fields--- you put a charge and see it move. There is no analogous way to detect chi, no machine that will detect your chi flow, except the brain of a chi expert. There is perhaps a good positivist presecription for detecting the chi: place a needle here and see a pain there go away. The problem is that you didn't have independent skeptics do the mapping of pain-alleviation response of people using needles and pain-stimuli with no regard to previous traditional literature. If you independently did acupuncture experiments to measure which positions relieve which pain, I would bet you lots of money that it won't match the chi-maps of Chinese medicine very well at all. It will be a different map in different people, and it will be very strange and completely mysterious, and nothing like a collection of well defined flow-lines. But there surely will be an effect. The reason one can be sure that the traditional knowledge is nonsense is simply from experience with traditional knowledge bodies in the West, traditions of high class claptrap like Aristotelian physics, or Aristotelian biology, or anything by Aristotle. This is the sociology of pre-scientific knowledge. Chinese medicine achieved consensus not by subjecting independent studies to hostile review, but

by cumulative studies by individuals already indoctrinated in what they were supposed to see, and each practitioner added a little bit of new information from each successive experiment. They didn't have somebody review the whole thing skeptically from scratch, with a hostile attitude. This type of thing doesn't work. You need a bunch of complete and total assholes around in order to get accuracy. When you do have an asshole who doesn't believe in chi making an acupuncture map, you will get an accurate acupuncture map, and perhaps this will be useful to medicine. Perhaps it will overlap the acupuncture map of traditional medicine in many places, but probably not, because social consensus mechanisms are broken, and the whole Chinese system is based on social consensus mechanisms. Ultimately, at best, it will be mapping some sort of coordination network in the pain-response of the brain, crappily, because we have better ways to study information flows in both the brain and body today, but perhaps needle-sticking works, and perhaps there is a good map that can be made. It would be nice to investigate. But this type of socially mediated authority thing is insidious, because a person actually can percieve chi more or less directly, much as you percieve people's emotional state. The perceptual detection of "chi" can be achieved by anyone through regular meditation, or through certain brain altering drugs. It's that golden perceptual aura-stuff that you percieve people to exude when you are calm, or meditative. It looks like a tree of invisible aura-material that goes up and through the body, coming out in a tree from the head, or something like that. You see drawings of this in Buddhist literature. Only a small number of people see these perceptual things regularly (I only saw them on rare occasions, like when going to a Buddhist temple to meditate), but they are more or less stable, in that different high or meditative people can be induced to agree on what they are percieving. This produces a strong and complete social consensus even in the absence of any actual thing there, just because the perceptual thing is real in the brain of the mediative folks. Since these folks hold positions of power, they have an advantage in social manipulation, you get consensus without any scientific accuracy. This is what Western science is built to oppose, this type of social consensus based on power and authority, and the "advanced perceptions" of the

higher class people. Chinese medicine does not allow low-class assholes to contribute, and it does not accept skeptical review of the first principles, therefore it is worse than worthless, it is a barrier to establishing scientific knowledge, and it must be opposed, even if it sometimes works. Especially since it sometimes works, because the cases where it works are simply propping up a social system which is opposed to figuring out exactly how and why it works.

Positivism (philosophy of science): Are there physicists that are outspokenly anti-positivist?

Most physicists, as Soubhik Bhattacharya has said, don't like philosophy at all, because it is a political game of influence mongering. Also, philosophers have often said extremely stupid things about physics, and they continue to do so, and it is impossible to correct them, because they never learned how to think. Their training is in pompous writing and political persuasion using superficial syllogisms. But physicists accepted a certain degree of positivism without any question, because it is required for quantum mechanics. The anti-positivist sentiments within physics are then just warnings to not take it overboard, and start to declare that any mathematical construction is not interesting, just because you can't directly observe it. So for example, ghosts are a useful mathematical formalism. They were introduced by Feynman in the early 1960s, and the modern formalism was developed by the early 1970s. Ghosts are not observable, they are just intermediate states in a relativistic particle formalism, they appear in Feynman diagrams to cancel certain states of intermediate gauge bosons. Does this mean that ghosts are unimportant? No. Some overzealous positivist would say "You need a ghost free formalism, because ghosts cannot be observed." But positivism is not the statement that all your ideas need to only refer to directly observable entities. Positivism says that you can freely switch the framework

around so long as the observable stuff stays constant. Positivism doesn't say "ghost free formalisms are required", it says "ghost free and ghost formalisms are equivalent" and this is something all physicists would agree with so quickly, they wouldn't even understand that such a thing could be contested by any person in any field. But it is precisely this that is contested in philosophy. The philosopher will actually consider whether gauge-ghosts are real things, or just imaginary things with no reality. This is considered an actual question. Carnap explained that such questions are non-questions, they are pseudo-questions born of not carefully defining the basic concepts in your philosophy. This idea is so common in physics, because there are so many formalisms that describe the same theory with a superficially different ontology, that physicists can't possibly not be positivists, at least not past 1950. The physicists who opposed positivism at one point or another opposed other things for different reasons. * Einstein said: "yes I said this (that the theory should refer to observables only), but it is nonsense just the same." To Heisenberg. This was reflecting Einstein's uneasiness with quantum mechanics. The idea that the wavefunction was "how things are" seemed impossible, and you couldn't directly interpret it as "information we have", because it isn't probability, it's something new. So he was confused about this, and he never sorted it out. Heisenberg said, since the theory is in accord with observation, there is really no problem. Heisenberg, in this case, I think is philosophically right, because I am a positivist. But Einstein could still be right on the physics, I personally put the cutoff for getting 100% convinced at a quantum computer factoring a large integer, like with 10,000 digits. * Feynman said that "the principle that all things should be measureable was important, but now it's known. Everyone thinks 'consider the measurable things'. But in the future, we need new ideas, so maybe it's not good to consider the measurable things." (or something like this) The point of this was to attack S-matrix theory. It was difficult, and Feynman correctly believed the strong interaction was a field theory. * Weinberg attacked positivism. This was again S-matrix theory, the S-matrix people were attacking quarks as "unobservable" and local fields as "mystical concepts". These things are wrong attacks outside of quantum gravity, you can

use microscopic probes to define the quantum fields all the way up to the quantum gravity scales. Soubhik Bhattacharya has addressed these things. Physicists don't read philosophy, and forget at what low intellectual level the debates in philosophy are conducted. They are basically a bunch of mentally damaged children arguing for political gain, and Carnap was the only adult in the bunch, so they heckled him and buried him deliberately, and only now are people forcing them to reconsider his ideas.

If any living person could be drafted into the US presidency who should it be and why?

Jesse Ventura. A whole lot of guilty people from the past decade would then be going to prison.

Was 9/11 a conspiracy?

The US is a big thing, and it could not have possibly been planned by everyone in the US government, at most it could be a few people, any more than that, and you have to worry about leaks and witnesses, and people with a conscience. But the 9/11 attack was planned within the US government, by perhaps as small a group as one person. When it's one person, it stops being a conspiracy, and starts being a plan. This person arranged a collection of related drills. The existence of a simultaneous drill allows a person to do magic, just by manipulating the details. You want two drones the size of jetliners for a drill? no problem! People in the military will make it. If you order a hijacking exercize which requires fake terrorists, or transferring passengers

from one flight to another, no problem! It's ok if it's part of a drill. You order a flight-simulation to see if planes can be flown into the world trade center and pentagon? no problem. Nobody asks questions, because nobody thinks that they are doing anything wrong. Then on the day of the attack, you let the drones go up, you use the hijacking exercize to turn off the transponders of the planes, then you switch the positions of the drones and the actual airliners, by flying them close. Then you use a flight-simulator drill to fly the drones into the buildings. When you are finished, only the pilots know what happened. Before you start, nobody knows except you. As part of the hijacking drill you transfer the passengers to flight 93, and then this flight is shot down, on your orders, because already three targets have been hit. The point is that there is no conspiracy, not even of 19 hijackers. Conspiracies of 19 people don't work. Plans of one person sometimes do work. To believe this is possible simply requires thinking about it. To convince yourself that this is what happened just requires reviewing the drills on the morning of 9/11. There is no reason for such drills to ever happen, let alone simultaneously, on the day of the terror attack that matches them in uncanny detail. The rigging of the building for demolition can be done without knowing about any of the other parts of the plan, and it can be contracted out without many issues, and people can think it is done for the purpose of assuring public safety, in case the buildings topple over, and they don't suspect the whole attack is fabricated. 9/11, in the words of an early skeptic, is an intelligence test for the public. This is a test which I am ashamed to say I failed for a decade.

Is there any substance in the conspiracy theories that it was the Bush Government itself that had planned and executed the 9/11 WTC attacks?

The cognitive dissonance come from the fact that you can't really think it was a large number of people inside the Bush government, because these people were not selected for psychopathology in advance. If it was an inside job, it had to have been a very small number of people, perhaps even only one person, working completely alone. In order to pull off 9/11, you absolutely need other people to work for you. So they need to do it without knowing what it is that they are doing. They way to arrange this is by ordering a bunch of coordinated drills. You make four drills: 1. Put drones in the sky to practice intercepting airliners. 2. Simulate hijacking on actual commercial planes 3. Confusing radar blips, software glitches 4. Flight-simulate flying planes into the World Trade Center and Pentagon. On the day of the attack, you use drill 2 to turn off the transponders, you use drill 3 to switch the position of the planes with drones, and you use drill 4 to get professional pilots to pilot the drones into the targets. While it's going on, you can transfer passengers to flight 93. At the end of the attack, you order flight 93 shot down, and that's it. You've got the attack. It requires this combination of drills. You will only have about 3 people who will know what happened, the 3 pilots who were simulating flying into the towers and the Pentagon--- they will quickly realize what they did. But you keep them quiet. The rest of the people just notice that there was a freaky coincidence--- that they were having drills about the thing at the same time the thing was happening.

What are some (dark) trade secrets of science?

There really aren't any, scientists who actually do good work are honest, and tell you exactly what they did. They don't keep any secrets, and you can see how they got their results step by step, because they meticulously tell you, in excruciatingly boring detail. There are scientists that are secretive and have crazy special methods

that they keep to themselves. These people don't discover anything, so you can ignore them. Gould's quote is not a secret at all, the rarity of transitional forms is simply known since Darwin, there are really very few fossils, and most of the time, you only get a snapshot of the most common species, so why should you see a transitional form? These exists in some small community. You only see it when it becomes a huge success and gets itself fossilized. We are lucky to have the intermediates we did find. Gould was making a rhetorical remark that you are misinterpreting.

9/11 Conspiracy Theories: If the planes that hit the WTC were really drones, then what happened to all the passengers that went missing?

There was an explanation from whoever wrote "flight of the bumble planes". To understand this, you first have to know how the attack was arranged. You can figure this out by answering the following question: How can a high-level government official execute a terrorist attack alone, without any accomplices who are in on the plan? The way you would do this is by ordering a bunch of seemingly unrelated simultaneous drills: * radar drills including false radar blips, confusing signals. * drone-fly drills that put drones in the sky * flight-simulation drills to simulate flying planes into the world trade center and pentagon, to see if it is possible. * hijacking drills aboard real commercial airliners involving CIA agents posing as terrorists. As part of 4, you buy a lot of seats on the planes that are going to have the hijacking drill, so that there are only a very small number of authentic passengers. As pointed out on bumble-planes, there were very few passengers on all the flights, together they would fit on one jet. This is

extremely unusual, to have planes that are only 1/3 full. Once the drills start, you can easily pull a little switcheroo. You use the hijacking drill to get the airplanes to turn off their transponder, you use the radar-blip drill to switch the airplanes signal with nearby drone signal, at least as far as the operators are concerned. You then have hooked up the flight-simulators to the drones and use the flight-simulation drill to get professional pilots to fly your planes into the world trade center and pentagon for real. While they are doing this, they think it's just an unusually realistic simulation. The next few hours, they are going to know what they did. They are the only people who know for sure that anything was different from what was reported, the handful of simulator pilots. Since the whole state is on high alert, you can do things to keep them quiet. Aside from these folks, everyone else just sees what looks like an incredible coincidence--- drills simulating events similar to what actually took place. It is easy to rule something like this out--- no drills, no fake attack. You can't get people in the government to attack their own country. But drills of this exact sort were happening on 9-11. Although the drills were classified, some of them were leaked in 2002. There were many more drills, sending fighters to the north, space-agency drills distracting folks who get sattelite images, a whole bunch. I defer to Webster Tarpley, because I don't remember them anymore. Once the transponder shut-off and switch is pulled off, you have to deal with the planes. One reasonable possibility is that the actual planes were ordered to land on a military base as part of the drill, and the passengers were all transferred to flight 93. There was an airforce base located on the flight path of the planes involved. Then flight 93 was shot down. I suppose it is also possible that one of the other planes was also shot down without transferring passengers, there was a report of a crash when the pentagon flight was lost. The location was a sparsely populated region of the Kentucky border, and if this is what happened, there will be evidence sitting there still, spread out over many square miles.

Is there any Nobel Prize winner in Physics who is not a genius?

Shockley was a bigoted authoritative moron. He just happened to supervise the invention of the transistor by Bardeen and Brattain, so he won a Nobel. This was a political lapse. They should have just given it to Bardeen and Brattain and told Shockley to go to hell. Hewish and Ryle were also not all that. They happened to supervise Bell, who was the graduate student (and genius) who discovered the compact objects. They mostly heckled her and made her over-prove her case, until finally they gave in. If you go by IQ tests, Feynman, with his +1.6 sigma IQ was not a genius. Of course, this would be deranged, because he was one of the greatest. It is more damning of the notion of genius as considered by IQ. The great quirky minds of DeBroglie, Bose, Schrodinger, Dyson, these folks are the geniuses, they are not particularly well selected by puzzle-solving tests (although I am sure they all learned how to solve puzzles by the time they do their great research)

Who were the most overrated winners of the Nobel Prize in Physics?

Shockley's Nobel prize was a scandal. He got the prize for transistor work conducted in the lab by Brattain and Bardeen, he was just their dipshit supervisor, and as Bardeen made clear in his recollections, Shockley did absolutely nothing to help, besides come into the lab every once in a while and say stupid authoritative things. He was a white supremacist, a eugenicist, who used his undeserved platform to rail against racial equality. Bardeen had to go ahead and win another Nobel prize just to distance himself from this idiot. Aage Bohr's prize

looks like nepotism, he was Niels Bohr's son. Although I don't want to say it too loudly, because he did good work in nuclear physics, but really, giving the prize to a winner's son doesn't look good. Generally, Einstein was a great boon to the Nobel committee, because he knew how to select people who were quirky and creative, and hated fascism. This is how you got quick Nobels for the young guys in the 1920s-1940s, even weirdos like DeBroglie and Schrodinger. The good sense politics continued while Einstein was alive. The moment he keels over, you get a Shockley. The Nobel prize for Ryle and Hewish was to the supervisor of Jocelyn Bell, who was the graduate student who did the real work. Unlike Bardeen and Brattain, she was completely omitted from the prize, and it went to the silly people who spent a long time denying she had discovered anything. But aside from these three cases, they're all richly deserved. The only problem is that there are so few of them, only one a year, so there is so much more great work that is not recognized. Even the younger Bohr's is probably deserved, he did honest important work. I don't know if I should be annoyed at him for being Neils Bohr's son. He was an independent mind.

Why are a lot of liberals seemingly opposed to talking about differences between groups of people, especially when the differences involve things that are important? I’ve found that class, racial/ethnic groups, and crime rates seems taboo to them.

Because these "group differences" people identify are usually class differences in disguise, and they are used to oppress people, by consigning them to different positions of power in a society. This is

what makes them dangerous. This is what Marx identified--- the class structure in society--- and if you are blind to it, you will fall prey to adjusting your sense of people's worth using small class markers that will then cause you to discriminate. If you are aware of class, you very quickly realize that every single one of the group differences people identify are class differences, and have nothing to do with anything else. Look, there are racial generalizations that are probably not so offensive to people: "Black people often like to raucously contradict each other in public! They'll argue loudly in front of others. White people will never tell you you are wrong, even when they know you are full of shit." That's a pretty normal overgeneralization, it's not particularly offensive, it would probably be used by a comedian as the basis for a comedy routine. It was vaguely statistically true, at least in college, I know people in the US would say "Oh! So true!" When they hear this. But secretly, even this little social thing is a class marker. Arguing loudly will cost you social status, by creating political opposition, even though it allows the group to be more precise and accurate in thinking, because the ideas are debated. So what you are saying is simply that you see more politically careful white folks, that political care is culturally embedded in the American white society, at least among Northern Europeans and British folks, not so much among southern Europeans or Jews. Jewish culture is sometimes even more argumentative than African American culture. Similarly, "white people listen to music that is so cold and dry. Black people listen to music that has a lot more emotion". This is also kind of true as an overgeneralization, but there is a real important cultural tradition involved: Europe has a very strong and unique (and extraordinary) written music tradition, which is very developed, and extremely important to preserve, and it sits there in the subconscious of people with European ancestry. This written music tradition is rhythmically dead, because they couldn't write down rhythm well, the notation is totally inadequate. When you do, it's extremely difficult to annotate syncopated rhythms, or weird off-beats, or polyrhythms, the notation fails completely. So European music from before 1920 or so, before jazz and contemporary classical music developed, tends to be in a very monotonous rhythm that is suitable only for a limited range of emotions, mainly bombastic grandeur like Wagner, or weird intellectual note-pattern noodling stuff like Beethoven's string quartets, it's not natural for coming up with zany stuff like a Samba. The great classics generally alternate noodle-bombast-noodle with bombast-noodle-bombast like the Pixies. I like note-pattern noodling, but the main effect on the brain is to produce a tonic-analysis, and various shifts in internal grammars for giving the music structure, it does not produce a wicked desire to get up and dance. In Africa, there is a tradition of improvizational polyrhythmic drumming, and this was very developed, more so than anywhere else. The polyrhythms and general rhythmic awareness is far more developed than in Europe, precisely because the music is not written down, and it is mainly a percussion tradition, not the greek analysis of harmonic note progressions and tonic resolution. But a racial person will then use this to distinguish then between "sun people" and "ice people", and offensively claim that Europeans can't dance or drum naturally, or do polyrhythms, or that Africans can't learn to write down interesting note-progressions! This is mentally deranged. I have chosen less offensive examples, but this one is the worst. The 20th century saw a bunch of people take a bunch of trite puzzles, and compile them into a puzzle-solving test that they called "IQ". The point here was to consign people who were not particularly good at solving these puzzles permanently into menial labor castes. They carefully made means and statistics to ensure that IQ would center at 100, with a standard deviation of 15, and that men would score equal to women on average (by recentering the puzzles using weighted averages of baskets where women did better and ones where men did better on average). Anyone can easily learn to solve these puzzles, it's much easier than learning any real skill. Generally, in certain cultures, you are exposed to similar puzzles early and often, for example, I was given various mathematical puzzles by my father at age 3-4. The key distinguishing feature is the embedded mathematics in the culture, whether there is a rich mathematical tradition that is transmitted by people to their children. The reason this test was developed was to institutionalize class differences between people based on a biological notion of racially-inherited intelligence. When the test was developed, former slaves

scored on averege about 2 sigma lower on the tests than the slave-masters and their children, and immigrants from southern Europe similarly lower, and so on. That was very good for the racists, they were happy they had an objective sounding method to justify the power-differences. People didn't view this puzzle-gap as a spur for former slaves to learn to solve puzzles, but as a sign that people from certain part of the world have inferior brains. There is nothing inferior about anybody's brain, puzzles are not hard. Everyone can and should learn to solve those stupid puzzles. They aren't completely trivial, and you need to sit down and sort out various small things before you do well. These things you sort out then allow you to learn mathematics more easily. But the goal of these tests was to discriminate, and discriminate they did, they still do, although by now, a century later, the difference between races is less than half a sigma, and the whole test performance by people in general has increased by more than 2 sigma as compared to when the tests were first created, simply due to the exposure people have to the puzzles involved. So, in general, it is very good that people are hostile to talking about "differences between groups". It's because anyone who talks about these differences is creating a situation to institutionalize class difference and prevent a classless society, and should be marginalized and heckled and dismissed, because they are lying for nefarious social ends.

Why did it take 30 years for mathematicians to prove any of Riemann's hypotheses about the Zeta function?

You forget what the world was like before the internet. You would write something, and then have to wait for someone to read it. Usually the first person to read it with understanding is the first person to

discover it independently later. Then they go to publish, and somebody says "Oh, that sounds like what Riemann was doing way back when. I didn't get it, but you should look it up." Then the person goes and looks up Riemann, and gets annoyed, because their work is not original. So they extend the results, prove a few theorems, and then advertize Riemann. That's the 19th and 20th century. Today, this is completely ridiculous--- people quickly read and digest your work, even if it is difficult. The only barrier to quick acceptance is politics, but even that is becoming more tolerable. So the answers is people just didn't read Riemann, or read it without understanding anything, and without being sure that it is correct. It's not surprising. There are papers by Einstein physicists have never read, like the river meandering paper, which only became popular recently. Same with all the great academics. Nobody read anything before the internet.

What effect did Archimedes Plutonium and his Plutonium Atom Totality theory have upon your view of the world?

Everyone was trying to figure out this new medium, the internet, what it was for. It was clearly going to take over the world, this was obvious, although at the time, I imagined it would continue to be more text-based. Authority was a hinderance, Pauli-language, direct bluntness, was an advantage. It was like the physicists had died and gone to heaven. Then into this heaven came this guy, out of the blue, writing what was essentially poetry in his own language derived from science. He was talking about how we are "electrons, in the electron dot cloud..." of a gigantic plutonium atom, and you could see that he was serious about it. He went on to describe how we would become aware of this, because pi was 22/7 and there are 22 electrons in this orbital and 7 electrons in that orbital of the plutonium atom. It was crazy

stuff, but it was mountains! It didn't stop, walls and walls of unique text, I have never seen such prolific writing. It flowed out of him like water out of a tap. Every day, there would be four, five, six long pages of unique text, all about a different completely original idea you had not only never heard before, you couldn't even conceive of hearing before you heard it. The only comparable originality was in other usenet competitors, Abian suggested to blow up the moon, and explained that mass was used up to "push time forward" (itself funny to a positivist). But all this stuff was like the Salieri to Plutonium's Mozart. It was as if he was born for this medium. My own impression at the time was that this had to be the greatest crackpot who had ever lived, the most prolific, the most ingenious, the most poetic guy who had ever described all those ideas that physicists get in unsolicited manuscripts in their mailbox. I thought that, since the internet would quickly bring scientific literacy to everyone, that he was also the last of the crackpots, that this was the swan-song of crackpottery before the new age of reason. I know better now. I don't consider Plutonium a crackpot at all, rather a deep poet of the internet era, a poet who worked in the medium of science prose, to express a scientific religiosity that is difficult to express, except through his unique method. There will never be another like him. I strive to be as original as him every day, and when I am not productive, I always am ashamed, because Plutonium would be writing seven pages full of unique original ideas in the time it takes me to get just a handful of boring pedestrian ideas that do nothing to break the mold. It is humbling to compare yourself to him. His ideas kept on coming, seemingly inexhaustibly. The "fusion barrier principle", the "stone throwing principle", and so on and so on. You couldn't help but admire the determination. Holy crap--- this guy is producing a stream of original writing and thought with no comparison in the history of writing, let alone of scientific crazy-writing. It was idea after idea after idea, all of them completely mad, but you could begin to see the coherence behind them, that they were based on expressing the innermost content of his soul. He was getting a ton of attention, because his writing was interesting and exciting, the writing style was new, you had never seen such writing before. And it fit the medium. I

don't think anyone understood usenet better than Plutonium. From this, I learned how to write for the internet. I tried to learn to match him in tone, because his tone was the right tone, but I strived hard to be dead-on accurate with the content, walking this straightjacket between honesty and accuracy and complete exploratory originality. I think it has gotten easier with age, whether because the originality diminishes, or because one has more experience, I am not sure. For me, constrained as I was by the requirements of complete accuracy and internal intellectual honesty, I despaired when I saw this guy---how can a person who demanded accuracy ever compete in originality and fecundity with such a mind? How could your own work ever compare with such a stream of creativity? It was going to be impossible to do. It meant that the bar for creativity had been raised for everyone, permanently. I wrote a Wikipedia page for Archimedes Plutonium, since deleted: User:Likebox/Archimedes Plutonium From Wikipedia, the free encyclopedia Archimedes Plutonium (born July 5, 1950), also known as Ludwig Plutonium, wrote extensively about science and mathematics on Usenet. In 1990 he became convinced that the universe could be thought of as an atom of plutonium, and changed his name to reflect this idea. He is notable for his offbeat theories about Plutonium Atom Totality, fusion and superconductivity experiments, and nonstandard infinite arithmetic. [1] [2] == Biographical Sketch == Plutonium was born under the name Ludwig Poehlmann in Arzberg, Germany. His family moved to the United States and settled near Cincinnati, Ohio, where Plutonium was adopted into the Hansen family and brought up under the name Ludwig Hansen. Plutonium has a BA in mathematics from the University of Cincinnati and taught High School in Melbourne Australia. He returned to the US in the mid 1970s and went on to Utah State University for a Masters degree. Under the name Ludwig Plutonium, he began posting to usenet in 1993, and his prolific posts quickly made him a well known usenet figure. == Writing == Plutonium is the author of over 20,000 unique postings to dozens of science newsgroups such as sci.physics, sci.math, sci.chem, sci.bio.misc. Plutonium used the time stamp on his postings to gather the posts into collections which he calls his internet books. He has written approximately 30 of these. == Plutonium Atom Totality== Plutonium Atom Totality is the idea that the universe should be thought of as a gigantic atom of the element plutonium, Pu 231. Plutonium believes that the galaxies in the night sky are the electron cloud of the atom. The cosmic atom, often written ATOM, is a manifestation of God, or the totality of all things, but the physical universe in Plutonium's philosophy only obeys natural laws and has no room for anything supernatural.[3] == Infinite Integers === An integer in Plutonium's philosophical view includes objects which have a decimal expansion which never ends, for example, the following number is an integer: x = 111...333 which starts with an infinite repeating list of 1s, and ends with an infinite repeating list of 3s. The 1's are the frontview of the number, while the 3's are the backview. To multiply these numbers, multiply finite approximations until the repeating pattern front and back becomes clear. For example, 111...333 x 888...444 = 098765432098765432...1851851852 and the leading 0 is important to Plutonium. Plutonium believes that Fermat's last theorem is false, because he believes it fails for these infinite integers. He also believes that the set of all real numbers is countable, since both the Reals and Infinite Integers are "All Possible Digit Arrangements". By this statement he usually means that there is a direct one-to-one map from the real numbers to the integers, which consists of taking all the digits behind the decimal point and putting them in front. To allow this, his real numbers have a frontview and a backview too.[4] [5] == Other ideas == Plutonium believes in a "fusion barrier principle", which limits the energy output in a fusion reactor to 2/3 of input. He believes that all forces emerge from a unified Coulomb's law. He also believes that the mainspring of human evolution was throwing rocks and stones, and that this led to bipedalism. He is the author of countless other ideas and speculations, all of which claim to displace scientific consensus, and none of which are accepted by mainstream science. Archimedes Plutonium, in his Usenet posts, was the first to describe the practice of biasing search-engine results by planting references, and coined the phrase search-engine bombing to describe it. This later became well-known as google bombing[6] [7]. == Quotes == * "The whole entire Universe is just one big atom where dots of the electron-dot-cloud are galaxies." * "God is Science, and Science is God." * "God is this one big atom that comprises all the Universe, much like what Spinoza discovered some centuries past, called pantheism. Where we are a tiny part of God itself. And where there is a heaven and hell in part of the atom structure. And where we will be judged by God when we die and our photon and neutrino souls will reincarnate once again in a future life somewhere in the Cosmos." * "The world's finest Bibles are current physics textbooks or biology or chemistry textbooks" * "When you have a foggy notion of what you are working with, it is impossible to prove much about them." == References == 1. Joseph C. Scott. "Sometime-scientist Plutonium says science is 'gobbledygook'", The Dartmouth, September 25, 1997. 2. Jennifer Kahn. "Notes from Another Universe", Discover, April 2002. 3. Page on Iw 4. http://www.iw.net/~a_plutonium/, for further information, see Math Forum Discussions - sci.math.independent , Archimedes Plutonium , article: 10/16/07 11 #104 In fact the definition of Reals as *all possible digit arrangements* bars or precludes Cantor ever applying a diagonal method ; new textbook: "Mathematical-Physics (p-adic primer) for students of age 6 onwards" 5. http://www.iw.net/%7Ea_plutonium/ , see also Page on Lowcarber 6. Social Networking 7. Law and Order on Net and Web (September 17, 1997) One of the nicest parts of writing this page is that I got to have a long conversation with Plutonium, who came booming down like the voice of Moses from the mountain, and explained that I had forgotten the all important "leading zero" of the Plutonium integer multiplication, and that I was overemphasizing one of his most trite observations, the notion of "googlebombing". I explained to him that googlebombing was stolen by an academic, and that I wanted to make sure he got proper credit for it. But he felt it was too trivial compared to the deeper things, the Plutonium totality, the stone-throwing idea, the fusion barrier thing. The reason I focused on the Plutonium integers is because this is what got me interested in mathematical logic. It was clearly a consistent nonstandard model of arithmetic, more or less, but it was clear also that here the integers were uncountable! So many people had argued that the reals were countable, this is the standard objection to Cantor. It's what you get

when you Skolem reduce. But here was a person arguing something that clearly no one had ever considered before--- that the reals are equinumerous with the integers, not because the reals are countable, but because the integers are uncountable! The very contradiction in terms makes it stunning, but the "digit arrangements" he talks about make the uncountability manifest (uncountability of the integers in the model, as seen from outside the model itself of course). Plutonium's exchange on the talk page of the Wikiepdia article was very intimidating (here it is: Google Groups). You always knew you were talking to Plutonium, because his voice would not waver. I felt like I was talking to one of the great Beat poets, to Ginsberg, or Bukowski. His voice was a thundering boom from the mountaintop. It constantly urges you: do better. What is wrong with you? You can be more original than this.

Do you have an unconventional view of god? Please describe

God is the limiting conception of human communities when communities get large, and all the people agree to play superrationally, meaning that they take into account their correlations. In this way, they link up into a super-brain, and in the infinite time and infinite size limit , it is an infinitely wise being who cares about you, and tells you what to do, inasmuch as your individual consciousness is linked with this future community. This vision is equivalent in logical positivist content to the God of the Bible, minus the supernatural bits and creating the universe. The superrationality gets you to act together to further your aims, and the community that is closest to God wins the evolutionary battle for minds, because this is the most collectively successful strategy for collective game-play. So God wins in history, and is revealed in congregative religious practice. It is also the Church Kleene ordinal, the formal mathematical statement of the

same thing, where the evolution is making stronger and stronger formal systems, and the limit is the limit of proof-theoretic ordinals describing the strength of the system. The two concepts are related, in that the systems which approach the Church Kleene ordinal resolve the game theoretic questions which arise in larger and larger superrational communities playing asymmetric games, and conversely, the larger communities can reason in ever more powerful systems, which converge in a sense to a system of complete computational strength, described by the Church Kleene ordinal. This is related to Cantor's vision of God as the limit of all ordinals. In this case, I am just adding the word "computable" to the idea, and it is probable, although not certain, that this is sufficient, although there is no proof yet that the ordinal reflections of arithmetic are a complete and consistent system of mathematics, and perhaps such a proof is impossible, and it must remain forever an "article of faith", as Cohen put it.

What are Ron Maimon's political beliefs?

I am a registered Democrat, so you can guess who I vote for. That's not going to change, unless by some miracle the Republicans go back to about the 1880s. The Republicans, since Nixon and Hoover, have been opposed to any form of political freedom of organization, since Reagan, they are opposed to Keynsian economics, Since Bush they are opposed even to politics free science, or the basic principle that a person shouldn't worry about being imprisoned indefinitely without charges, nor should people spy on others without cause, nor should the government assassinate people (the Democrats are guilty here too), nor should large companies be contracted by high level government officials who just worked for these companies, nor should you invade foreign countries on trumped up excuses. They tolerate CIA shenannigans that lead to acts of terror (the Democrats are equally

terrible here too), they still sponsor foreign coups (against Chavez), they do not respect the rights of people to self-determination (as in Egypt). There is no reason to accept these clowns. These are standard positions, and I don't think anyone can reasonably oppose them, so I will shut up about them. I am as far on the left as Lubos Motl is on the right. But I "get" capitalism, this makes it difficult to hang out with leftists. I will digress to explain why. I was interested in planned economies as a child, although I was scared of the repression in communist states, and I didn't understand the reason it was always happening. I liked Soviet technical literature, and "Soviet Life" magazine. No ads! Stories about tractor drivers! It was great. I was genuinely interested in how that tractor driver in the Ukraine managed to fulfil his quota three times over, by running his juiced up spark-plugs, to the same extent that I really wasn't interested in Michael Jackson. I liked Gorbachev, and at the time, I thought "maybe a little democracy will fix the Soviets up". Then when I was 26, I went to flat Santa Barbara. I had a one-speed bicycle, which I used all the time, and I loved it. When I came back to Ithaca, I decided to buy a one-speed, but no one speeds were available, only ten-speeds. So I bought a ten speed, and as I did so, I grumbled to myself--- "If only I were in charge of central planning for Ithaca, I would send one-speeds here! What a travesty of the market. Who needs a ten-speed! Capitalist extravagance." Then when I went up my first hill, I realized why nobody has one-speeds in Ithaca. Also, pumping up that hill at speed "1", I realized the futility of central planning. I imagined 200 shiny new high quality one-speeds sitting at the centrally planned bike shop, and nobody can use them, and you can't even take them and resell them at a flatter town without being accused of being a bourgeoise class-traitor. The requirement of decentralization, price-signalling, and local decision making by businesses, compels one to accept that it is wrong to assign decision making power to any political organization or central committee, or to fix prices, or to do any sort of mucking around with price signalling at all. It is just not something one should decide for far away places from an office, people need to do it themselves, based on local need, based on supply and demand. There is no way to justify giving power over economic decisions to a small

number of people, it is repressive just by itself, without the further political repression required to maintain such a system when the people who haul the bikes to a flat town and sell them to people who can use them then get put in jail for "misusing state resources". Also, the same year, I had to sign a form saying that I was "on leave" as a graduate student. The form asked "who will pay your nominal tuition this semester in absentia?" and it had two checkboxes, one that said "I will pay my own tuition", the other said "the department will pay my tuition". Here I got a clever idea. If I need to pay my tuition, I should just check the box that said so. But if my department then pays, what is the office going to do? Refuse the money? They'll just ignore the checkbox!" I thought "Clever Ron. You are so clever!" So I checked "I will pay my own tuition", chuckling. At Santa Barbara, I found out my department was supposed to pay my tuition, so I just forgot about it. Then I came back, and realized I hadn't been registered all semester. I went to the office, and they said "Sorry, the department tried to pay your tuition. We refused the money. You checked the wrong box." I pleaded with the guy to change my status. I told him my student loans would come due if he didn't do it. "Sorry, can't do that." At this point, I happened to look over his shoulder at the computer, where my files were flashing by, and I saw the top of my advisor's annual report about me, it said "performance: unsatisfactory" right at the top. I didn't even know there was an annual evaluation. This was a shock. To evaluate my performance, you should know that I had both refused large extra dimensions that year, I refused to work on it or publish on it, I called it a fraud, and I wouldn't yield on this, no matter what my advisor or anyone else said. I was very proud of this, I had pulled a Pauli. Also I discovered an inequality between charge and mass of the lightest charged particle in Santa Barbara, in conversation with Simeon Hellerman, something which is now Vafa and Motl's "Weakest force principle" (they also discovered it, but unlike me, they published what they found. I couldn't publish without help, because I didn't know any real string theory at the time, and all the examples are stringy, I found it by semi-classical methods, like Tom Banks did much later). It was a genuine and correct new law of physics, and I also got swampland from this, and it was 1999, 4 years before the first

swampland papers by Vafa, and I ruled out some models using this, it was the first real prediction with any kind of power ever made by any sort of quantum gravity. Unsatisfactory my ass! I was both hurt and upset. How could he write "unsatisfactory"? The MOMENT I discovered something really important and significant in quantum gravity, I suddenly went from a "great student" to "unsatisfactory"? Anyway, the guy refused to update my status. Why should he? I was an unsatisfactory student who didn't know how to fill out forms, and I was clearly an arrogant bastard who thought he was the greatest thing in the world (that's how you feel when you discover a new law of physics, even a minor one). The guy wouldn't restore my status. So I figured "He's just a low level peon. I'll go over his head." So I went to the vice-dean. She said "While I see that your situation is not good, that was not the decision I would have made, I can't go overruling my subordinates unless there is a clear mistake, and I don't see it here." Then I went to the Dean, and he said "Two people have ruled against you. Why do you think that I will be any different?" In the end, a week or so later, the Dean had a change of heart, and changed my status, but it didn't need to happen. He could have done whatever he wanted, and the easy path was to say no. So I learned some things that everyone pretty much already knows, but its sometimes good to repeat: 1. Organizations don't know how to evaluate good new stuff. I had just done the best work of any physicist that year (in my opinion), and suddenly I became "unsatisfactory". 2. Organizations have annoying small minded bureaucrats that enjoy exercizing arbitrary power, just because it makes them feel alive and significant. 3. People above them are conformist and political, and don't exercize independent judgement (Dean was obviously the exception). So you can't even trust bureaucracies with stupid things like fixing student registration status. That means you can't trust them with any part of an economy. I mean, if you can't get them to fix stupid mistake on a form, how can you trust them to deliver enough wheat to a region? This isn't debatable--- you can't trust political hierarchical organizations of people to do anything, because they need to be nice to each other, and not contradict one another, and to follow the rules. That was the end of Marxism for me, at least as it is traditionally understood in Soviet states. I also became an American citizen, and understanding this was very helpful, as it made me understand the wisdom of Jefferson, Madison, Hamilton, Franklin, Washington, and all the rest. They really understood the corruption of human organizations, and they decided to sidestep it using capitalist economics and limited government. I accepted the American system as a useful advance, and I still do, even though it was bourgeoise revolution. Sometimes the bourgoisie is not so stupid. But I can't go along with people sleeping on the street! There's a simple reason for that--- I am basically a homeless person, except I am not homeless yet thanks to intervention of my family. So I can't go along with exploitative system that doesn't provide for people meaningful and self-directed opportunities to contribute to society when they would like to and when they are desperate, even if it is menial labor. I don't mind menial labor. It's better than sleeping on the street. I certainly would never be able to keep any other job with my personality, other than perhaps "physicist". So I came up with an idea called "non-bureaucratic socialism". When I explained it to socialists, they said "this is capitalism", when I explained it to capitalists, they said "this is socialism". It is a mild thing, but it was the beginning. I will explain it below. The idea was to have a decentralized model. There's a private sector, as usual. The state pays for some stuff like road construction, internet lines, this is normal Keynsianism. 1. The state guarantees to hire people who can't find a job and who want a job. This eliminates minimum wage and unemployment insurance--- the minimum wage is effectively the state job wage. The problem of people sleeping on the streets is then solved. That's my major concern, mainly for selfish reasons. Then if you want to hire someone at less than the state job wage, you have better be doing something amazing, like a new startup with amazing potential, because otherwise nobody will do it. This eliminates the need to worry about restructuring, or to keep people from firing people willy nilly. They can do that if you are not going to be destitute. 2. Progressive corporate income tax The idea here is to elimiate anti trust law. The proper progressive taxation is on corporate profits, using a smooth function which is close to zero for 0-10 workers, grows to about 30% at 1000 workers and to 70% at 100,000 workers. This will give a natural incentives for firms to split, without heavy regulation by bureaucrats. The tax is to offest the social cost of large size, and the attendant political skewing of large corporations. There is no 100,000 person firm that can't naturally split itself into 100 1000 person firms, their already split into divisions, and then the firms supply each other with contracts. But this leads us to: 3. Opt-in contracting The other ways that businesses exploit consumers and each other is through contracts. But who enforces the contract? The government does! Why should a govenrment enforce a contract which is against competitive markets? There is no reason to enforce some stupid contract someone else wrote. You should make a set of boilerplate contracts, that people can put together to make an arbitrary contract. Something similar was done in the 1950s, in the Uniform Commercial Code act. But it's a monster of regulation, it's like 10,000 pages of horror. You can get rid of this, and have a non-bureaucratic replacement, if you adopt an opt-in model. The government doesn't opt-out of contracts, it opts-in by prespecifying the language of basic contracts, with fill-in-the-blanks. Further, you require that all businesses must publish their contracts if they want them enforced, and price the same to all buyers, no sweetheart deals. This way you make a transparent accounting system, and you can't have a Walmart make a ton of money from exploiting special contracts. 4. No insider equity If you work at a publically traded company, you can't own any equity in it. It's insider trading, and it's hiding salaries using options. If you want to reward somebody, do so by giving them a salary, not by stealing half a penny from every shareholder without their say. This plus 2 should fix corporate salaries. 5. No accreditation or regulation on medicine or law, no taxi license, no licensing of small businesses, nothing. Abolish education and training requirements for the professions, so that anyone can do anything. This will bring medical costs down tremendously, as the numer of people opening up McHospitals increases. There is no reason a chest X-ray can't be done by a shoe-shiner, it's nothing hard to do. You can look up any medical technique online, with the possible exception of brain-surgery. People will still prefer an accredited person for brain surgery, so let the market can take care of this, not

the state. The ability to start a business as a street peddler is a fundamental right, and the regulation of this using business licenses prevents self-direction and growth. Also, you can be sure the number of taxi drivers will not grow to the point where the wage is below the minimum wage of a state job. 6. Abolish local health inspections for restaurants, no more regulation of small business. If people want stuff inspected, let them do so within the market, like they have movie ratings. The state uses this cudgel to close businesses it doesn't like. Lawsuits already protect the public from disease. It's corrupting, and it's awful. 7. Allow farmers to sell unpasteurized milk. Require labelling of modified foods. Pasteurization is a trick for preferring factory farms over small farms, because small farms can get clean milk, and big industrial farms can't do it, because the cow poop gets in the milk, and they need to pasteurize. Babies shouldn't drink unpasteurized milk, this is true, but the state doesn't need to prevent everyone else from doing it. Labelling modified foods allows the consumer to boycott it. Not because it has any health effects, but because I don't want any of my money going to a big corporation! I want to subsidize small local farmers only. That's it for government crap. I don't have any more ideas there. I also am still partial to socialism, but I am an American, and I don't believe in state coercion. But I would like to point out something obvious: THERE IS NO NEED FOR STATE COERCION IN ESTABLISHING SOCIALISM! Why the heck would you need a state to seize property to make nice businesses that share? You know who keeps these businesses in business? You do! If you don't want exploitative businesses like Walmart, don't buy anything at Walmart. If you want companies to be worker-owned, buy stuff from worker owned businesses. Then you can make socialism without coercion, just by persuading everyone to buy from the proper industries. Even if you only persuade 10% of the people in New York to only buy from "red" industries (this would be a piece of cake) you've already got tremendous market clout. The only way to do this effectively is to make a mini-socalist agency, which will serve the non-governmental role of a socialist planning agency. But it doesn't require state power to do this! Nor do you need to have a centralized thing. You can have seven competing "socialists systems"

none of which have or need government power. All these organizations need to do is inspect the business to check that it's worker managed, that salaries are equal, that profits are shared, and then tell people "the syndicate says this shop is certified red". Then the reds can buy from the shop. It's like a "Kosher" sticker. You don't need to get a government to play along. Further, if you don't like your socialist syndicate, all you need to do is choose another. If there are 10 with slightly different criteria, you can still ensure that all your purchases are from fair businesses. This is what the free-software movement does, and the competing open-source people. They give you assurances that certain software is free. Starting small, you can have an entire socialist economy develop inside a capitalist economy without taking anything away from anybody, except voluntarily, by people deciding to buy stuff in your businesses. In this way, you can shift the economy to a socialist model step by step, with no coercion, and if someone doesn't like it, they don't have to join in, they can shop at a nightmarish ordinary capitalism store. If you think this is hopeless, remember that Linux displaced Windows and other systems without any help from any government. You don't need a gun to make socialism, all you need is a wallet and some friends.

Why are young and bright people, like Ron Maimon, are spending time answering questions on Quora instead of doing some real academic research?

It is because quora is uncensored, and the literature is censored. I prefer to only write in places that are completely open to anyone, with no elitism or criteria for inclusion, and the literature is closed off. Stackexchange was a good place, except it suffered from political

repression, sort of like the Soviet Union. I also have no academic degree, nor did I have an institution. I didn't think I needed one, because I expected the internet would catch up with me and provide me with one when I needed it. It took longer than I thought, arxiv closed itself off in 2005, but it's getting there now. I can publish an idea online, establish priority, and work on it in relative security that whatever I find, I can put up without an editor getting in the way. Quora is TOO friendly. I prefer it if people actually criticize what I write scathingly. People sometimes do that, but not often. I preferred stackexchange, because there people would catch a mistake and yell at me. But I am banned from stackexchange for criticizing others too bluntly, and for being a jerk. Perhaps I will be banned from Quora too. I am not worried, because there is a lot of room online. I am doing research in a rather standard academic setting right now, and I am getting worried, because it's getting time to publish and I am not happy about my name going on a publication that goes to a journal. I am not afraid of peer review, I have gone through it. Not to be an egotistical ass, but I don't think any journal deserves my writing, it is much better than the crap they publish. In my own assessment, I have written better academic research on public websites than anything that could get into a journal. My theory of cold fusion is certainly the best thing I have done so far in physics, and it is only available on stackexchange (here): Why is cold fusion considered bogus? It actually correctly explains what is going on. I always wanted to contribute something substantial, and I know this is substantial, because Schwinger looked at this, Hagelstein looked at this, lots of great people looked at this, and they not only didn't solve it, nearly all of them eventually decided it was impossible. They were completely wrong. That was neat to do. It also came from editing Wikipedia--- I got the idea from working on Moseley's law, the rule that ionized inner K-shells are screened by one electron charge. Why is that? I decided to describe the inner shell vacancies using holes, except the holes were crazy, they had negative mass and positive charge, but it was a one-particle picture. I could calculate the x-ray transition probabilities from a one-particle model which was exact in the limit of heavy atoms. It was interesting. But then I realized that such a hole is like a proton,

and if there is a proton nearby, it can swap it's energy quantum mechanically with the hole, and then a glance at the K-shell of Pd showed it was 20KeV, and I thought "oh, cold fusion." (I later found out that the process with an electron, not a proton, is called an "Auger process", and it is well known, and the rates are known in metals). Then I read the literature on cold fusion, and worked out the details, neglecting my other work, and getting fired from my last physics job. Whatever. I did good work. I believe that the journals are obsolete, and that all good science in the future will be done on public websites. Unfortunately, none of them are built specifically for this, and their criticism model is broken, and does not allow for good honest public reviw.

Was logical positivism popular in Soviet Union?

I don't know much about Soviet history in this era, but I read a little bit of Soviet literature as a teenager, before the collapse. This is a spotty answer. The "Dialectical materialism" was the official state philosophy. It was complete wankery that was taught in the Soviet humanities departments, and essentially made them wastelands. It was all ideological, none of it had any value except perhaps as second-rate toilet paper, and it was enforced by the party, you needed to study this to get a job in any humanities department. So you can forget about Soviet humanities. It was garbage. But logical positivism infiltrated the Soviet Union through science departments, mathematics departments, things like this. The physicists were completely free from ideology, because Stalin needed an atomic weapons program, and you really can't constrain physicists if you want to get some science. Still, even so, Landau was imprisoned briefly for some ideological thing (and stopped being a communist after this), as was Kapitza (I think). The rest were left alone, even if they were saying anti-Soviet things.

Some, like Pomeranchuk or Bogoliubov, seem to have been committed communists, the best ones, like Gribov, not so much. The physicists discussed positivist ideas extensively, they understood quantum mechanics, it goes without saying, because all of quantum mechanics, especially before many-worlds, is one big exercise in positivism. S-matrix theory, a very positivist idea from Heisenberg, later Gell-Mann and Mandelstam, was picked up by Landau as promising, and it was dominant in Soviet departments until the early 1970s, when people started studying field theory again. The Soviets were just keeping up with the literature here, although they were also contributing. You can't do physics without understanding positivism thoroughly. The positivism also made its way into mathematics departments, where the Soviet school embraced and extended the computational ideas. The Soviets explicitly advocated a computational foundation, free of the mysticism of set theory. The computational view was never so popular in the Western philosophy departments, but the Soviet school of logic was really into it. It did fit in with the general idea of Marxist progressive ideology, in a weird way, but it wasn't Hegelian wankery, so it had no resemblance to dialectical materialism. In addition, the Soviets were big on behaviorism, like Pavlov, later Skinner in the West. This stuff wasn't very interesting, but it was positivist-influenced. That's all I know, it's very limited. All the good stuff in the Soviet Union was in technical fields, there they were equal to the West. In other fields, the kind that require freedom of political expression, forget about it.

What caused the demise of logical positivism?

What caused the demise was pure politics, and the politics was driven forward by the terrible life in the Soviet Union, which people were scared would spread everywhere. Anticommunists wanted to eliminate the positivism, because it was associated with socialism, and it was

accepted in the Soviet Union. Positivism didn't die entirely, it continued on with no change within physics, which is where it was born. Nowadays, the politics are different, the Soviet Union is history, so it can be reestablished in everything, simply because the insights are nontrivial and just plain correct. The goals were to produce a philosophy based on formal logic, using the verificationalist ideas of Mach and the positivist physicists. In mathematics, it was to complete Hilbert's program. Ali McMillan points out the "problem" of Godel's theorem. Godel's theorem was used as an attack on mathematical positivism, it is probably why Godel was so famous. But this is not exactly the correct interpretation of the theorem, although there is a sense in which it is somewhat justified attack, unlike other political attacks. The proof of Godel's theorem was a clarification of the notion of a computer, a central tool of modern positivism, it was what the logicians were groping towards in the 1910s and 1920s, and the theorem itself gave a way of understanding the fundamental role of ordinals in mathematics, but it was not a barrier to founding mathematics in computational objects, despite the interpretation it got. First, I'll prove the theorem, so that you'll know what it says exactly. I will use the modern notion of a computer (hopefully you know what that is, since you are reading this on one), and the result of Godel in 1930, that the system of deduction in formal logic was complete, that is, a computer can deduce all the consequences of any given axiom system using a fixed computer program. Then, given an axiomatic system S, you can write a computer program called GODEL to do the following: 1. Print its code into a variable R 2. Deduce the consequences of S, looking for "R does not halt" 3. If it finds this theorem, it halts This program doesn't halt if S is consistent (by construction), and S can't prove that it doesn't halt (also by construction). This construction is the beginning and also the end of the proof. What it means is that no theory can prove that it's version of this program doesn't halt. A little bit of logical manipulation shows this is equivalent to saying no theory (that's consistent) can prove its own consistency. It's really self-evident in this formulation, you can see why with only a little bit of piddling around. This is not a barrier to formalization of mathematics. It is the method. It is only a barrier to

formalization in a single fixed axiom system, it shows you how systems are supposed to grow. The sentence "GODEL does not halt" for a given theory is a natural way to make the theory stronger, you take "GODEL does not halt" as a new axiom, and you automatically get a stronger theory. This stronger theory has a stronger GODEL, and you can repeat the process to produce a new stronger theory. The iteration process doesn't stop when you run out of integers. When you have got an increasing sequence of stronger theories, you can consider the union of all the statements they prove (this is also deducible by a computer), and then iterate up through ordinals! The ordinals then give the structure of systems of mathematics, and you learn that these are well founded (meaning no infinite descending chain of theories each proving the consistency of the next), they are indexed by countable computable ordinals, the kind you see on a computer, so there is a computable ordinal for Peano Arithmetich (epsilon naught), there is a computable ordinal for ZFC (not known yet) and so on, going up and up, with am ordinal limit which is given a name, but not a description, because there is no computational description of this (by Godel's theorem, there cannot be, it is a limiting conception). This ordinal limit is the "Church Kleene ordinal" in mathematics, and you can talk about it inside a set theory, where it innocuously looks like a middling-size ordinal far smaller than most natural ordinals, like the first uncountable ordinal, or the first-uncountable-ordinal-th uncountable ordinal. But this is an illusion. In proper models of set theory, the Skolem reduction shows you that the model is effectively countable (meaning you can make a countable model which has the same logical relations, and so positivistically equivalent to the ostensibly uncountable model). Also, Cohen forcing showed that the intrinsically uncountable sets are not absolute in their properties. The reason is simply that the mathematical universe just craps out around the Church Kleene ordinal. This ordinal is not an innocuous mid-level type thing, it's mathematical God. While it is impossible to give a computable description of the Church Kleene ordinal within a normal axiomatic system, because it is defined as the limit of all the computable ordinals, you can still approach it more closely, in an evolutionary way, by finding new ways to name larger ordinals. This

approach is helped algorithmically perhaps by using a random oracle, a random number generator, to break out of logjams caused by finite complexity of a given computer program. This is how nature does it after all. This is how you make mathematical positivism after Godel's theorem. There really wasn't any problem. In fact, I suspect that Hilbert says a lot of what I just said in his book, written in 1936, about the foundations of mathematics, which dealt with Godel's theorem in a supposedly "embarassing" way, where he didn't understand it. I can't read German, and it was never translated.

What truly original ideas did Bertrand Russell come up with and what were their impact?

Russell created the "theory of types", which built up the mathematical universe in steps. Its modern descendent is the Von-Neumann hierarchical universe in set theory. He also made efforts to fix philosophy, this is what he devoted most of his life to. Here he was less influential, as the followers of Russell, the logical positivists, were dismissed and heckled to oblivion in the 1970s. They are still right though.

Positivism (philosophy of science): Did Wittgenstein or Bertrand Russell really have an impact on the development and understanding of mathematics?

Wittgenstein no, but Russell did. Russell and Whitehead founded a system of formal mathematics for the first time in Principia Mathematica. Their system is ugly and unweildy, but it led to axiomatic set theory and Godel's completeness theorem, then the incompleteness theorem, then computers. So it was one of the central advances of mathematics. Russell's contribution was not the logical tautologies, which are obvious and ancient. The quantification (forall, there exists) was introduced in the early 20th century by a superset of a subset of Boole, Quine, Hilbert and other people I don't know. The formalism of deduction was worked out by Hilbert and Godel (working in Hilbert's school), and others. Russell's contribution was the theory of types, a heirarchy of different kinds of objects which would each describe previous kinds of objects. I don't know it, because it is obsolete, but the same role is taken up by Von Neumann heirarchy in modern axiomatic set theory, and it avoids the Russell paradoxes. Russell took the first steps to a construction of the mathematical universe in a formal system, and this was a major step forward. But beyond this, he wanted to do philosophy, so he didn't contribute to mathematics anymore. But within philosophy, he was the spiritual founder of the logical positivists, and he was a ray of light in an otherwise fradulent field.

What is logical positivism? What are some of the inherent flaws within its schema?

Logical positivism is the doctrine that the actual invariant meaning of a sentence is by the positive observable things that it predicts, and that the language for making the inferences is a form of formal language based on first order predicate logic. It puts together the "positivism" of Mach, and the formal logic of Russell, and it was promoted by Carnap and others, and was an important philosophy in the 1940s and 1950s, even into the 1960s. Mach was a physicist, and positivism was

born of the struggle of physicists to make sense of the notion of "fields" and "entropy" and understand what they actually mean. You can't see an electric field. So what does it mean to say that there is an electric field around the Earth? Positivism tells you. The field is defined by the effect it has on charges. If you put a charge in a field, and it moves, that's what it means to say that there is a field. Now, in philosophy, it was common for people to say "But how do you know it's a field, and it's not that the source of the field is acting directly on the object?" The answer to this is "Whatever." It doesn't matter how you calculate the effect, so long as the experimental outcomes are the same, the language underneath can be swapped around willy-nilly. With fields, it was very important, because they kept on getting more and more real. At first, they were just this abstract thing that kept track of forces on particles, but then, with time, as induction, then waves were discovered, they turned into light! So physicists really needed to clarify what it means for a mathematical formalism to describe nature. Mach did this, by defining the philosophy of physics positivism. Mach said that the primary things we are after is describing sense-impressions in our mind, the correlations of these sense-impressions are the objects in the world, and the intrinsic meaning of a framework is defined by the outcome of sense-impressions, so that two frameworks with identical sense-impressions are just two languages for the same exact thing, they aren't two different ideas, even if they are in completely different languages. This was moved forward by special relativity, which used positivism: the ether could not be measured, so it was jettisoned. General Relativity had a setback in 1914, when Einstein got confused on the hole argument, but applying positivism in 1915, he resolved the problem completely. He realized that the coordinate system was arbitrary, because only the relation of things in the geometry was important, and the coordinate system was of no importance except as a descriptor, it could be changed arbitrarily. This was also the main breakthrough in the theory in 1915, after he did this, he sorted out the field equations within a few months, and did all the predictions. Positivism became engrained in physics once quantum mechanics was formulated, because the whole theory doesn't make sense without positivism,

especially in the original formulation. The quantum mechanics in the original formulation didn't speak about an objective reality at all, it simply gave a mechanism for predicting the probabilities of different outcomes of various experiments. Later, Everett showed how you can make an objective reality (sort of) out of quantum mechanics, but it's a very weird one, it's the many-worlds thing. The many-worlds thing resolved the issues of quantum mechanics for many physicists, because it allows you to translate smoothly by changing philosophical gauge between a realist and completely positivist conception, and so you don't care anymore. What's a "gauge"? That's another thing from physics. Gauge theory took the fundamental insight of Einstein that the coordinate system was unimportant, and abstracted it to any sort of symmetry transformation where you can locally choose an arbitrary thing for the description. Gauge theory came in 1954, from Pauli and Shaw, and also Yang and Mills. It described all of nature. The choice of "gauge" in a gauge theory is the cleanest example of a framework shift. It became absolutely cemented once string theory was proposed, because string theory is S-matrix theory, which is positivist to the point of nihilist--- it is so positivist, I couldn't even begin to comprehend how to accept it, even as a positivist, until I understood the holographic principle much later. The S-matrix theory doesn't talk about space and time. It only allows you to talk about particles at time minus infinity coming in, and particles at time plus infinity coming out, without allowing you to make sense of anything that goes on in the middle! This took the cake for positivism, you couldn't go any further that this. You aren't even allowed to talk about your feet in S-matrix theory. It was nihilism, not positivism. But this point of view is correct, it is the foundation of string theory, and it is now understood as a special case of the "holographic principle". You can talk about your feet, but they are smeared out at infinity over a holographic screen. That's what S-matrix theory was getting at, way back when, in the 1950s. The main principle of positivism may be summarized this way: if there is a question, and whether the answer is "yes" or the answer is "no", there is no difference to observations, then it's just not question. You can take either answer and translate freely between the alternatives, it's no different than choosing a gauge.

That's what positivism means. What's "logical"? "Logical" is using formal logic to turn sentences into formal sentences. The main tool here is the computer. Anything you can describe with a computer program can be formulated as a logical sentence. The point of computers is that they can make a precise meaning to even weird human things like "I recognize Arnold Schwarzenegger". You can write face-recognition software for that, and the better you learn to do this, the more exact your knowledge becomes of what it means to recognize Schwarzenegger. The insight of logical positivism is that the logic and computers plus the positivism of physics makes it that you can found philosophy in a precise way, and give definite answers to all the old questions. They are either true, false, or meaningless, according to whether you find an answer, or whether you can't find one, and therefore the thing can be freely chosen like a gauge. For example, let's take the problem of "priorness of mathematics". Does mathematics exist independently of humans, or do we construct it? This is clearly meaningless, since no sense impression can distinguish. This means you can take either position, and freely translate everything to one or the other stance, and no other argument can depend in a crucial, untranslatable way on the answer to this question. For another example, "Is there an objective ethical standard?" Again, meaningless. But you can formulate it this way "Does the historical struggle of societies converge onto an agreement over what constitutes ethical and unethical behavior?" And now it's not meaningless. You see, the positivism forces you to make the question clear, and when it is clear, you know what is the answer, or else, you know what you need to investigate precisely. The person to read for positivism is Carnap, as he did the elimination of metaphysics. You should also know that God is not incompatible with positivism, you just have to define it differently from "prime cause" (meaningless) "creator of the universe" (meaningless) or anything like that. The notion of God is a collective mind which can be found to appear as a construction of groups of people playing prisoner dilemma type games with each other, for example human societies. There are no flaws in it's ideas, it is just correct. It was rejected politically by anti-communists, because many of the original folks were socialists, and also because the

communists in the Soviet Union used equivalent ideas (Pavlov's behaviorism, mathematical computationalism) as an extension pf atheist materialism (although the official party philosophy was the nonsensical dialectical materialism). In the west, the attack on positivism was led by politicians like Wittgenstein, and their attacks are vacuous nonsense, there was no precision in any of their arguments (nor did there need to be, since they were attacking the very idea of speaking precisely)

Is condescendence an inherent property of Logical Positivism?

It's not by chance, but it's nothing to do with positivism, it's to do with Galileo. Condenscension and mockery are two important tools of intellectual honesty. They are required to allow proper academic discourse to work. They do it by demolishing authority, and rejecting a side which is wrong. There is such a thing as politics in academia. Sometimes you work hard, you calculate something or reason something out deeply, like for example, you have figured out that the gross domestic product of a state is growing at 3% less for every extra 10% of debt over GDP. Ok. That's nice. You have a lot of evidence, you go present your evidence, it's definitive, it should settle the issue (at least until there's more data, or maybe a deeper analysis) But then some MORON who is paid by some businessmen for the purpose of lowering their taxes or something, comes along and does no analysis. This fellow says, with no data "No, it is not true! There is no effect until you get to 90% of GDP, and then it crashes." Then they make up whatever they need to justify this moronic nonsense, that you know is false. Now, you get a polite debate, where one side says this, the other side says that. But only one side has any data or reasoning on their side. What do you do in this situation? You can't rely on counting the number of experts who believe this and the number who believe that,

because the experts haven't all weighed the evidence objectively, nor do they necessarily know enough to tell the bullshit from the truth. This situation happened in physics a lot, but I will focus on 1900. There were people who believed in atomic theory, and they had all the data on their side (and some anomalies also, these were resolved with quantum mechanics). There were, on the other side, continuum people, who denied atoms. These people had authority on their side, and Aristotle (and also, the founder of positivism, for different reasons having nothing to do with authority). The atomic theory people were hounded and rejected, and Boltzmann committed suicide in 1904, a year before his statistical theory was definitively vindicated by Einstein and Perrin. So this stuff is not free of consequence, it must be fought. How do you fight it? How do you deal with academic dishonesty? You can't debate it in a formal journal, or in a polite back and forth, because you are coming with reasoning and facts, while the other side is making up whatever, just to sound authoritative. In such an encounter, if you are telling the truth, you really can't ever win, because the people making stuff up can just go on to make up whatever stuff they want to that proves you are wrong, they have no honesty, so their arguments are not limited by the things that are true. Galileo showed people how to overcome this. It's very simple. The solution here is to MOCK the other side, to call them out, to call them stupid to their faces. To disrespect them, to beat them up intellectually, to show the data and laugh and point your finger, and repeat and say "What?? Are you stupid??" Galileo did this with "Simplicio", his geocentrist Aristotelian character in his Italian dialogues. He wrote the dialogues in low-brow Italian, and made sure that everybody understood that Simplicio was an idiot. When the church asked him, he said he named the character after "Simplicius", the ancient writer, but of course this was a lie. The reason this is effective is that this demolishes the major weapon they use, which is cultural authority. Mockery shreds authority, which is why dictators don't abide it. Once the authority is gone, then people evaluate the evidence on its merits. It is at this point that you had better be right, because once they are done and the authority is right, you're in deep doo doo. But don't worry, today it's easier than in Galileo's time, you can just say,

"Whoops! Guess I was the stupid one. Sorry." And that's the end of it. You go do something else. The point is that evidence based discussion and reasoned arguments must level the authority playing field, and must make all the arguments equal, so that they can be weighted on their merits. Philosophy does not do this. It promotes "niceness" and "charitable reading", and "meet a person half-way", and "suppose the supposition" and all this stuff that is designed to allow frauds to operate. You don't do that. You adopt a hostile tone, and you criticize relentlessly in proportion to the authority of the author. Only the stuff that can withstand this trial by fire is worth reading, and that's how science makes progress, by subjecting everything to this kind of hazing. It goes without saying that you must welcome this hazing when it comes at you. If you know what you are talking about, you can withstand it, and come out stronger for it. The people who are supporting positivism are supporting a difficult, important, nontrivial contribution that was derided and rejected for no good reason for 50 years, because people didn't get it. If you mock them enough, they will get it, if simply to be able to better show you are wrong. But once they get it, they will see that you are not wrong, and at this point, progress happens.

If logical positivism is the default philosophy of physics then why many physicists declare themselves physicalists?

Physicists are not usually comfortable with the nit-picking taxonomy of philosophers, and they don't usually identify their position well within the system. It's not their fault, the literature is mind-numbingly terrible and full of meaningless pseudo-distinctions, it's next to impossible to sort out the microscopic differences between the various schools of thought, and physicists don't care to do so. They are logical

positivists, so they identify these positions with each other, and consider the question of which position is correct as a pseudo-question in the sense of Carnap. To illustrate, it would be the same as if there were a school of physicists who were "Landau gauge", and another separate school who were "Feynman gauge", and they didn't read each other or talk to each other, and did all the calculations in quantum electrodynamics separately, and argued that this calculation was easier in this gauge, and then the opponents said "but that calculation was easier in Feynman gauge". It's really that stupid. Or, if there were a bunch of people who were "Pauli Villars regularization" and another bunch who were "Dimensional regularization" and they didn't talk. Or if there were "Neveu-Schwarz superstring proponents", "Green Schwarz superstring proponents" and "pure fermion superstring proponents". Physicists understand that these are different positivistically equivalent foms of the same thing, and translate freely between the formulations for convenience, and can't understand why this trivial philosophical point was never thought up in philosophy. Well, it was, by Carnap (who started as a physicist, by the way), it was just politically rejected by the brain-damaged politics in this field.

Is weed worse than cigarettes for your health?

Smoking cigarettes will wreck your body and your lungs, smoking marijuana will wreck your memory and your rational mind. It depends on which you think is more important. If you are a professional runner, your priorities might be different than if you are an academic. If you say it doesn't do this, let me quote the question back at you: Smoking is harmful then weed. isn't it? Why did you not notice that the "more" is missing from this sentence? Marijuana can help you be political, by requiring you to be direct and easy to understand (you won't have access to your sophisticated knowledge, so

you will have to make arguments that are understandable by everybody). This is why popular musicians liked it, it allowed them to make music that was accessible. It is why TV personalities like it, it allows them to communicate effectively with a non-expert audience, because the technical terms are just as alien to them when they are high as to the audience. But ultimately, it is better to just give people challenging music, and give people the definition of the technical terms, not to dumb down, because when presented with the challenge, the public rises to meet it.

What is an example of a Communist regime that supporters of Communism believe has been successful?

This is a very easy question--- Tito's Yugoslavia was by far the most successful by every measure (not just my opinion: Yugo-nostalgia). They had relatively autonomous factories, mostly self-directed without so much heavy-handed intervention, producing consumer goods of reasonable quality, with growth rates roughly competitive with Western Europe, at least until Tito's death, Gross Domestic Product (GDP) of Yugoslavia, 1970-1990 . They weren't a western scale economy by any means, but they were 50% there, which is about a factor of 2 better than Hungary, or Poland or Chechoslovakia, the next in line. The class antagonism and ethnic divisions were muted during Tito's lifetime, they were no greater than racial tensions in the US. There was a national sense of identity, and people married across ethnic lines regularly. Needless to say, all this was wiped out in the wars of the 1990s. Yugoslav citizens had freedom of travel from 1967, they could go anywhere they wished, and western goods were freely available by 1980. Tito believed in a decentralized model, and he was disliked by the Soviets, because his model was both less authoritarian

and more successful. Unlike any of the other communist states, Yugoslavia actually exported consumer goods to the west, the "Yugo" was popular in the 1970s. People who lived in Yugoslavia in Tito's time did not even consider themselves as living in a communist state. They had freedom of speech, and they were able to own small businesses, and the businesses were locally managed by workers who cooperatively owned them, and shared the profits. To say that it was a success is an understatement, it was the only realization of what Marx intended by socialism anywhere in the world. A majority of former Yugoslavs remember the state fondly, and hold Tito in high regard. This does not make it a utopia. Even though Tito and Kardelj jimplemented Marx's model to a tee, I don't think that Marx's model is the perfect ideal. Businesses are artificially suppressed from growth due to the restrictions on private businesses, a private business in Yugoslavia could only employ so many people, just a handful. It is probably better to allow arbitrary growth, as normally happens in capitalism, with appropriate regulations to ensure profit sharing. Worker cooperatives are more resistant to restructuring than typical capitalist firms, you would never get workers saying "boy, would it be nice to get a hostile takeover take us apart and sell all our equipment". But sometimes it is necessary, if the profits are too low. It is important to allow firms to go out of business and be replaced by more efficient ones, just the threat of this whips companies into shape, even old staid ones. Having no ability to do this prevents economic growth, the natural restructuring of capitalist economies, as old inefficient firms are replaced by newer ones, the "creative destruction". You need to do this within socialism too. In terms of political freedom, the state was not a democracy, but there was very little repression, hardly anything at all in the 1970s and 1980s, from what I found, and I did a review, because a fellow challenged this in the comments. It was certainly much less severe than in other communist states, after the mid-sixties when travel restrictions and speech restrictions were fully lifted. I reviewed the claims of repression, and what I found was ridiculous, all of the reports looked like they were fabricated in the 1990s by the nationalists who took over. I will let the readers try to find repression for themselves. If you find it, let me know. But Titoism, like other

forms of socialism, was not very successful in terms of economic growth as compared to Western states. It was successful only in comparison with other regimes of the same general type. One main issue is that the socialist model does not allow new ventures to easily form, because capital cannot be segregated efficiently to follow good new ideas, as it can when people are investing for profit. This is the main sticking point in socialist economics, the inefficiency of planning or coordination in producing new effective efficient ventures.

Would a hydrophobic coating make a heavy object sink through water faster?

It would slowly sink exactly like a non-coated object. The main drag forces are entirely in the water, not in the touching of water and object, drag is diffusion of momentum and this diffusion depends only on the profile of velocity in the water. Further, the acceleration of this object would be slower than mg, because the water renormalizes the mass, because to accelerate the mass, you need to get the water flowing faster. This is a classical hydrodynamic mass renormalization, it is interesting but well known.

How can a person without a degree get peer-reviewed?

Public websites are nearly the only way, but they are more severe peer review than any journal, so don't be dissuaded by this. A journal will usually just give political feedback to any author who is not coming

from a prestigious institution (and even to some coming from these institutions), and will delay publication endlessly and water down the language and arguments. So, ideally, you could ask a question on stackexchange, and answer it yourself with your new idea. If the site protects the text, you can get good feedback and develop the idea further. You can then submit to a journal, but it's hardly necessary, the journals are dinosaurs and physics has been operating essentially on arxiv and blogs (the blogs serve as peer review for arxiv) for nearly two decades.

Why is it important to teach children manners?

It is important to teach children how to get rid of manners, how to be purposefully rude, how to be assholes. They will get politeness all by themselves as teenagers, when the pressures for social conformity become enormous, they don't need to be helped along. But it is unlikely that they will learn how to be rude, how to be resistant to social pressure, and say "no" based on their conscience. This activity is universally hated by society, it is an act that is never rewarded, and this is why it is important to teach children to be assoles whenever they can, as often as they can, so long as they are not hurting anybody by doing so. In order to be rude, one must pick a taboo, a social thing that is prohibited for no particularly good reason, then violate it. Purposefully. The purpose is to smash through the social order, to produce a disobedience, so that the little local gods quail in terror, so set upon you. They will punish you for your act, so you had better be doing it for something you believe in. But you can do it occasionally for something small, just to practice, and to demonstrate to the gods that you are still free. For a recent example, on a train yesterday, the conductor announced that "Seats are for sitting, not for putting your legs up" over the loudspeaker. I had been on trains many times on this

line, and I have seen many people put their legs up on the seat. I am sure that this is company policy, and the act is also considered rude by many people. But really, the shoes of the folks putting their legs up are not significantly dirtier than their pants, the real purpose is to produce conformity, and to prevent hobos from sleeping on the trains. I had slept on trains many times. So, since it is a method to isolate non-conforming behavior, and since it really doesn't hurt anyone at all, it really should be resisted. So I put my legs up. The conductor came to me and asked me to put my legs down, and I first said yes, because I was far from my stop, and I couldn't afford to get kicked out yet. But then when my stop was closer, I said no. She insisted, and I said that it was a pointless exercize in authority, a fascism of sorts. She told me I was being very rude. I agreed, but I said it would be against my religion to put my feet down (thinking "two stops away, I will hopefully not be kicked out now"). She obviously didn't care very much about it, but she thought it was weird, and she wanted the other conductor to come by. He was this large imposing fellow, who came and insisted that I remove my feet from the seat, loudly, with face relatively close to mine. I refused (by now he could not kick me out, it was my stop). He gave some superficially rational arguments for why this is justfied, but I said I would not remove my feet (calmly, one must not lose temper in situations like this). And then he kicked me out at my stop. I told him "I hope I have not offended you." He said "You did offend me!", so I said "I must purposefully disobey, the obedience is against my religion." He said "You can believe your imaginary stories, but I'll remember you, and if I ever see you on this line again, I will get the police to kick you off the train!" I said, "I accept the consequences of my actions." It was actually a very calm exchange, I was surprised. The previous time I remember was a month or two ago, when I happened to belch loudly while drinking a soda. I was told that this was disgusting by some ladies my age, obviously, I had transgressed. I calculated that it was not really disgusting, I was not farting, there was no real offense to take. So I started belching more (by swallowing air). This was purposeful rudeness. It is very difficult. The ladies were offended and left, but first gave me a lecture on the fact that I was "emitting gasses" into air they had to breathe. The

rationalizations people give for why transgressive behavior is objectively wrong are very funny. They have nothing to do with the true reason, which is simply that there is an invisible god demanding certain behaviors and forbidding others. But you shouldn't worry, it's a little god, it isn't so powerful. The purpose of such rudeness exercises (one must be very careful when doing them to not hurt people in any way) is to liberate one's own mind, and also that of others, from John Christopher's cap, that allegorical device which is placed on your head at adolescence by the invisible overlords of society. As John Christopher explained in his children's stories, the cap will prevent you from thinking individually, it will prevent you from doing science, and if you wear the cap, you will be unable to do anything unusual and important. I guarantee that if you do such exercizes regularly, you too can end up an unemployable homeless vagabond! But you will have your independence of thought.

Why did Ron Maimon stop contributing to Stack Exchange?

I got blocked from physics.stackexchange for 3 months or something like that, right after the moderator election for physics.stackexchange, because I added text to advocate against one candidate. This additional text I added for the election was deleted by a moderator as vandalism (meaning, vandalism of my own answers, by myself). I went all over meta writing questions and answers to explain why, in my opinion, the candidate I was opposed to would not make a good moderator, because he had deleted long text I had written, he didn't know physics, and so on, usual negative campaigning. The reason was that this candidate was authoritative and censorious, and he was proposing a "sourcing requirement" for answers on physics which would basically eliminate the only really useful thing in science---which is arguments from first-principles which pointedly and

correctly contradict the entire body of published literature. I was told by admins to stop it. I didn't stop. So then I was then told not to do it more pointedly by a high-level moderator, so I told him to block me if he didn't like it. So he blocked me. Ultimately, two nice moderators were elected, so physics.stackexchange is still politically more or less ok, but none of them reversed this powerful muckety muck's decision (they could have unblocked me, they didn't), even though there was a lot of people who said it was unjust that I was blocked, because I really didn't do anything wrong, except be impolite and anti-political. I am wary about contributing to the site further, because of site-level censorship issues. The issues are the moderation, the power to delete answers based on rules decided by communities, the power to block users who are deemed to be uncooperative. These things are poisonous for a website that wants to get accuracy, because when you are criticizing something that everyone except you believes, you will sound like a lunatic no matter if you are right or you are wrong. The evaluation has to happen on a level playing field, and to account for the not-so-rare case that everyone else is wrong, the writing needs to be preserved and protected, even when everyone hates it and it was written by an asshole. On stackexchange, the moderators can and do decide to delete anything they don't like, for any reason and they are censorious, and small-minded, and try to protect received wisdom. This is just the natural human condition; people are hostile to anything they haven't heard before by default. In order to get accuracy, you need extremely strong safeguards against this, so that people who are rude are not kicked out, and text is defended even when it is off-the-wall crazy (and also keep the rebuttals in comments). This is to prevent political censorship of new ideas, which happens when you just let things take their natural course. Without the natural censorship of communities, the internet gets at truth in 10 seconds of cantankerous bickering. The natural course was what Wikipedia took. In 2008-2010, in one of the great tragedies of the internet, Wikipedia allowed itself to get taken over by politicians, and the project stopped dead in its tracks (you can track the size of the text, it grows exponentially and then hits a brick wall see here: Wikipedia:Size of Wikipedia --- a comment from someone active on the site, this was not

in any way "the natural end of growth", there was nothing natural about it--- Wikipedia could have been a hundred or a thousand times larger and more detailed than it is today, lots of content was still being added as late at 2009. The dramatic slowdown is reflecting a horrible political disease that essentially froze the encyclopedia in its 2008 incarnation). I suppose it is similar to what happened in the Soviet Union in 1920-1924, as the political organizations began to weed out people by political selection. First, they get rid of the cranks, you know, people who are arguing about UFOs, or the speed of light. To do this, they introduce little rules that sound superficially sensible, like "notability", "no original research", "be nice", and so on. Then the rules get stricter and stricter, as the stupidest and most conservative people rise to the top. Wikipedia grew as an anarchy until 2008, and it worked as an anarchy. I was laughing at these rules. Everything technical and worthwhile there was original research by later standards, it was just not original enough usually to go to a journal. For example, I wrote an entirely negative article on "Large Extra Dimension" in 2006 or so that basically showed why the theory is crap, I proved the spin-statistics theorem in a way that was not exactly in the literature (although something similar was done by Schwinger), I did an original presentation of Hawking's result starting from Unruh's (the mathematics is in Unruh, but he doesn't emphasize the equivalence principle, probably the referees didn't let him), and I did a completely original presentation of "matrix mechanics" which came from laboriously deciphering Heisenberg's papers many many years ago. It was a bunch of original things (but all about old crap, just explaining old things better). At the time, Wales had an "ignore all rules" policy that trumped everything else. But politics is insidious, and the politicians take over slowly. First "Notability" meant people could rise up the Wikipolitics ranks by simply deleting hundreds of pages, thereby turning vandalism into a virtue. This is when the encyclopedia actually began to contract, instead of grow! These people were given little stars for deleting thousands of hours of work by dedicated writers, and if you did this often enough, you could be promoted to "admin", putting you in charge over the people who actually wrote the articles. For one example I was personally involved

with, these vandals deleted a page on "Archimedes Plutonium" multiple times. It was a horde of locusts dedicated to stopping the spread of knowledge. They're all still there, they run the ArbCom. After the first cranks were kicked out, itself a terrible loss, the cranks had unusually domain specific knowledge in many places, the "no original research" was slowly expanded to mean "every sentence must come with a citation", thereby allowing the most appalling of lies to win politically. Most good knowledge has no citations, or just one, because everyone just accepted the argument. For example, since Lemkin classified the extermination of the Tasmanians as a genocide, hardly any academic disputed this, it was a textbook example of a modern genocide, and any debate on the merits will come to this conclusion very quickly. But if you look at the Wikipedia pages on the Tasmanian genocide, you will see a horrible white-wash. The number of natives is reduced, the genocidal policies are not mentioned, and the whole thing is completely disguised. Remember, the native inhabitants were nearly completely exterminated between 1820 and 1840 in a one-sided pogrom which included settlers taking body-parts as souvenirs. This common historical knowledge was challenged by authoritative citations to people like Windschuttle, who just lie in the literature, and then political numbers are used to prevent the opposite side from getting space. Two Australians on the page systematically deleted references to Lemkin, references to primary historical material, references to population estimates, to genocidal policies, even just quotes from the newspapers about hunting down the natives like wild animals. Anything you introduced would be deleted. They brought the matter to ArbCom. ArbCom censored me for introducing the material, simply because I was politically shrill, and the other folks were smooth operators. There was no consideration of content. The same thing happens on "cold fusion", on every topic. There is a cabal of incompetent nitwits who sit there preventing the internet from doing its' job of disseminating knowledge to people. The only thing you need for that is absolutely no rules. Another expanding policy on Wikipedia was "be nice". It was extended to "do not criticise anything", this is the real purpose of niceness rules. Criticism of authority always sounds not nice, while criticism of the powerless

sounds just fine to most ears. ArbCom didn't evaluate content; it evaluated how nice you sounded. I eventually got myself indefinitely-banned from Wikipedia, and good riddance. The real point here is that the moment you give people censorship power, they use it, by first defining a whole set of nebulous criteria, then by expanding these criteria to kick out the people doing all the actual work. This is exactly parallel to the development in the Soviet Union; it is a catastrophe of politics taking over a functioning anarchy, shutting it down by creating layers of authority populated by the most despicable of wretches. I don't consider contributing reasoned text on a website a privilege the website grants. Writing text is work, and writing original text with new ideas is not so easy to do. This text is a contribution to the site, it is a gift, freely given, in exchange for the implicit contract that the site will treat the text with respect, preserve it, and allow it to be read and discussed. The site is trying to make a living off user contributions, after all. So in return for a contribution, I always expected the following: 1. DONT DELETE IT. 2. allow fair voting 3. keep comments, visible. The stackexchange did not do any of these things. When the Wikipedia style political moderators took over, as they did on skeptics, Christianity, philosophy, and the programming site, they deleted text! They deleted answers. They did not allow comments which were hostile and challenged the content of questions (not nice), and they did not allow critical comments on their own adminship or hostile politicking to replace them. Thankfully, physics still maintains a tradition of asshole-nature which keeps the physics.stackexchange functional. But they could all be functional, even skeptics. This means that stackexchange is halfway to what happened to Wikipedia, and I do not trust them, especially that they not only pay lip-service to rules, they actually enforce them. Rules were meant to be ignored. To be fair, there were no real serious problems on physics or biblical hermeneutics, except for the occasional deletion of comments. Moderators didn't care about rules there. But on other stackexchanges, you could spend much time on a reasoned answer, only to have it deleted by a moderator, for purely political reasons. On philosophy, I wrote half a dozen scathing criticisms of Nietzsche's racism, his vacuous writing, but it was all

deleted by moderators, even when upvoted. Ultimately the only thing that was left was the question "Did Nietzsche Plagiarize Sade?", and even there, the content of the question was watered down. This happened to me with very long answers on all of these sites, which contained some original material. Others had it worse. I do not trust political censorship; the moderation which works the best is the one that works the least. It is possible to change the atmosphere on stackexchange. Simply log in there, and upvote this: http://meta.stackoverflow.com/qu... . Right now it's at -33, I think it was at -38 at its lowest. When it is at +1 (if it isn't deleted, I believe it will get there, people learn quickly), I will feel comfortable contributing, not until then. It is probably impossible to change the atmosphere at Wikipedia, the whole ArbCom is rotten. That site needs to get forked to work. It is possible to fork off a site which can take over both roles, with the debate and voting section used to decide what content goes in the encyclopedia section, with the requirement that nothing is deleted against the author's will, only that some content will be favored over other content.

Are Cold Fusion or Low energy nuclear reactions real?

I have answered this question at great length here: Why is cold fusion considered bogus? . For information on the original experiments, there is no better source than Jed Rothwell's website: A library of papers about cold fusion . There is no doubt that Palladium deuterium cold-fusion, in the sense of excess heat, is a real phenomenon. This was replicated hundreds of times at many independent groups, and the claims that the excess heat was mismeasured were dishonest to the point of fraudulent. Calorimetry is very reliable, and the effects where dozens or hundreds of times greater than the background, and disappeared in light-water controls. A very skeptical review by Robert

Duncan converted him, and he procured funding for an entire department for cold-fusion research. Duncan is not sure if the effect is fusion, so he uses the name "excess heat effect", because this is what he verified with his own hands. The claim that the effect is nuclear also cannot be disputed without assuming systematic deliberate fraud on the part of each of the dozen folks who detected nuclear reaction products. The most notable of these is tritium, as this was detected by Pons and Fleischmann in their heavy water, and this result was replicated independently by both Bocris and Wolf at Texas A&M, by McKubre at SRI, by Bhabha institute researchers, and by a researcher at Los Alamos in touch with Miley, all of whom have a track record for scientific integrity. Tritium is unmistakable--- it decays radioactively, it is detected by a flash of light emmitted at the moment of decay, its concentration is measured by a machine, and it is an extremely reliable measurement even at tiny concentrations. The concentrations observed for tritium were hundreds of times background, and the results were replicated at least these five times, and many times since. You can't make tritium except through a nuclear reaction. This means one of two things: these five groups each independently decided to fraudulently spike their water with tritium, or else all six groups deliberately lied about the tritium readings, or else there was something nuclear going on. There are no other possibilities. The tritum was replicated many times since. If it were only one, you could say there was a bad apple somewhere in the lab with a bottle of tritium sprinkling drops into the experiment, this is exactly what people accused Bocris of. But the tritium was detected at all these places independently, and Pons and Fleischmann, would also have had to deliberately have made this up, you can't get this result by mistake. So the nuclear evidence was undeniable already in 1989, it is scandalous that it was suppressed. Since then, Iwamura obtained mass-spec results on elemental transmutations in the Palladium, including crazy transmutations that are impossible to believe, that look like multi-alpha uptake by heavier nuclei! This is completely crazy, but it was replicated by others with the same device--- a machine that passes deuterium through Palladium. Further, the Navy group at SPAWAR obtained clear nuclear signals using a different

system which was 100% reliable, unlike the Pons and Fleischmann method, which is hit-or-miss. They deposited Palladium and deuterium simultaneously, so that the lattice was built up with deuterium already present. In very insightful (and very cheap) experiments, Mosier Boss placed CR-39 plastic detectors on the cell, and observed energetic particle tracks consistent with fast alpha-particles at 10s of MeVs, and charged particles at 10s of KeVs. The results of Mosier Boss meant that the phenomenon of cold fusion was not particularly low energy at all-- the particles were flying around at energies which are typical of hot fusion. From this, one can conclude that Bethe-ionization leaves around a bunch of inner-shell vacancies, and the Auger process can transfer the 20KeV vacancy energy to deuterons. The deuterons then fuse, and the result is a chain reaction. But the measured cross section for deuteron beams on deuterated Pd is not quite large enough to sustain a chain reaction by itself. Also, the reaction produces very few neutrons (a few were measured by the groups that saw excess heat, excess neutrons above background when excess heat was occurring, in amounts consistent with occasional hot fusion, but nowhere near commensurate with the excess heat if it were all normal fusion). The resolution to both problems comes from the behavior of 20KeV deuterons in a Pd lattice. These deuterons have just enough energy to get within 100fm of the Pd nucleus, turn around, and bounce back (this is the same as the radius of the innermost shell). Two such deuterons would be focused by the nucleus due to the wavefunction enhancement at the classical turning point, and the leading fusion will be very close to the nucleus, when the wavefunction of two deuterons is concentrated near a nucleus (their repulsion is negligible at this energy, the repulsion of the nucleus is 46 times larger). These deuterons fuse extremely close to a large nucleus, and under this circumstance, they can transfer the energy of the fusion electrostatically to the nucleus, with no hocus pocus, just by the individual repulsion of the protons in the resonance formed by the two deuterons to the Pd nucleus with its 46 protons. The resul of this is a 20 MeV deposited in the Pd nucleus, which can then fragment. The fragmentation spectrum is known from 20MeV LINAC experiments using electrons (these are also electromagnetic events at the same energy), and the nucleus tends to just fragment under this kind of bombardment. The fragments though are not anything at all, they are biased toward stable nuclei, composed of full shells. In this case, the stablest fragments are integer number of alpha particles. These fragments are moving fast in the ejection, and can be absorbed by another Pd nucleus, explaining the crazy transmutations. Because these transmutations are inexplicable except by this mechanism, I acquired reasonable confidence in this theory. None of this requires new physics, but there are some common objections: 1. Don't 20MeV fragments thermalize? Not really, these fragments tend to ionize the atoms they pass by. This is known already since Bohr, it was one of the results that led to the shell-model of the atom, but the quantitative theory was worked out by Hans Bethe in the 1940s. The Bethe ionization formula tells you precisely which levels will be excited, and gives you a prediction for the stopping power for fast charged projectiles in matter. The key point is that the electrons are independent, and inner shells are excited preferentially compared to the number of electrons in them. 2. Don't 20KeV deuterons slow down? Sure, but you need an experiment to know how long it takes. The process is at relatively low energies, and you need to match the energy you can kick out to the spacings of the electrons, and they might be unusually long-lived in Pd, who knows. You need to measure this. 3. Don't these fast things melt the lattice? Eventually, yes. You get a localized explosion as the lattice vaporizes. But this takes a long time, due to the fact that the energy is exactly the inner shell excitation energy. To get a nucleus to move without it's electrons, you need more than the inner shell ionization energy, since this is only enough to get one electron detached. So there is a phase-space problem, you need to transfer the energy to more than one particle simultaneously, and there is no fundamental diagram to do this. When a fast particle hits a Pd nucleus at 20KeV, even though it is at "millions of degrees", the nucleus can't go anywhere, so the thing just goes through, perhaps ionizing some electron or other, depending on whether the electron and deuteron has anywhere to go in the band-structure. If there is a band-gap for the deuterons which coincides at preferred ionization energies, you can get long-lived excitations. But even without any special tuning, these deuterons will go through hundreds or thousands of atoms without stopping. 4. How do you start the process? You need a charged particle to seed the reaction, so alloying with a small amount of alpha emitter might be a good way to get the reaction to be reliable. 5. Why do you need an electric field? The 20KeV deuterons need to reach a threshhold concentration before the chain reaction can start, and an electric field channels the charged deuterons towards certain places, where they can concentrate. This is especially important near the surface, where an electric field can concentrate deuterons at a spike or random protuberance to higher concetrations, even if they were accelerated 100 or 1000 atoms away from the protuberance. This is also likely why surface is important. But the surface might just be because alpha-emitting crud gets electroplated to the surface at random. I believe this theory, this is why I am going into detail. There is nothing spooky or voodoo about this, but it leads to the conclusion that Nickel Hydrogen fusion is not very likely to work. Nickel K-shell is 3KeV, and ordinary hydrogen can't fuse, only the deuterium can fuse, and the deuterium fraction in ordinary hydrogen is some parts per thousand, meaning that most of the acceleration events are not useful for producing a fusion. If there is an effect, it must produce tritum from d-p combination near a Nickel nucleus, but this nucleus is further away than the Pd, so the energy transmission is also less effective. Also Nickel doesn't absorb hydrogen in bulk like Palladium does. So I am skeptical of the Nickel Hydrogen results, they are from essentially one group in Italy, with one guy who acts like a scammer (Rossi) and lack as many independent replications. But one shouldn't be so certain Nickel-Hydrogen is bunk, because physics is an experimental science. Maybe there is some isotope segregation in the Nickel, and maybe 3KeV is enough. It is a much lower cross section than at 20KeV but the theory is not yet quantitative.

Are people approaching man-made nuclear fusion the right way or the wrong way?

There is no doubt it is the wrong way. Confining a plasma with electromagnetic fields is difficult, at the beginning, it was hoped it would be easier, but the plasma starts to get wobbly and turbulent, and doesn't want to stay focused. The idea was reasonable in the 1950s, but by the 1980s it was already clear that it would not work, but by then, inertia kept the project going and going and going. Hopefully it is running out of steam now. The plain fact is that ITER is enormous and expensive, and cannot produce power today, even after billion dollar expenditures on large-scale plasma-rings, so even if the whole project suddenly succeeds tomorrow beyond the wildest expectations, and starts pumping out fusion power at breakeven, you would need a much bigger scaled-up version in a plant, and it cannot possibly ever be competitive with carbon fuels or ordinary nuclear fission. But there is a dirt-cheap way to make fusion power immediately, using proven technology. You just blow up hydrogen bombs. This project, the PACER, was proposed in Los Alamos in the 1970s, and it was immediately calculated to be cost-effective the day it was proposed, it has only gotten cheaper since. A nuclear warhead costs about $300,000 in mass production, and easily delivers a megaton of energy. You can't buy a million tons of carbon fuels for anywhere near $300,000 dollars, and carbon.fuels are less efficient kilogram per kilogram than TNT anyway. The costs don't scale linearly, so that a 10 kT warhead also costs about the same, but try to by 10,000 tons of carbon fuels for $300,000. You can buy 1000 tons of coal for $40,000, but coal is not very energy intensive compared to TNT, so the break-even point for a PACER is around 1kT bombs, any smaller, and it is not going to be fuel efficient. This is also around the size of the smallest devices you can make. The fuel costs for a reasonable PACER, using 10kT, 100kT, or even megaton devices, are orders of magnitude cheaper than any other fuel, even plain old Uranium for fission. Further, the fusion process in the bombs produces neutrons, which are a useful breeding resource, because they can be used to make plutonium from uranium,

fissile uranium 233 from Thorium, tritium from deuterium, and many other elements, since there is an excess of neutrons, even after replenishing all the fuel that is used in the reaction. The PACER system will not run out of fuel in any forseable timespan, millions and millions of years, even with growing energy usage, and it can breed materials and reprocess its own waste. It's really a fantastic proposal. A real working PACER would probably use 1kT or 10kT bombs, not megaton bombs, at least at first. The 1kT bombs are more fission, they aren't much more attractive than usual nuclear power, but already at 10kT, you can make devices that are 95% fusion, although I don't know how the heck they did that, it's classified neutron bomb work. For really small explosions, you can set the explosion in an artificial steel lined cavity. But all these proposals were shot down, even though blueprints were ready, and the costs were managable. Part of the problem was the fact that these power plants are simultaneously weapons-testing facilities, and the idea of powering the world with them would be a proliferation nightmare--- every nation on Earth would be clamoring for hydrogen bombs to light their cities. So in a tacit agreement, everyone sort of silently agreed not to do this, even though the engineering calculuations were so promising. It is not clear to me that the calculations today are not different. It might be possible to arrange the bombs to be safe to theft, so that they only explode in the environment of the cavity, perhaps if the heat-absorber in the cavity were also a neutron reflector? If it is a pressurized molten salt, then it might be possible to prevent unauthorized usage of the devices. There is also a worry regarding the radioactivity in the cavity, as the project runs. After some years, there will be all sorts of gunk from the few grams of undetonated plutonium, the fission products, the heavy element tamper-pusher products, and they will all be exposed to neutrons, so the elemental composition will be extremely baroque. There might be weird plutonium polymers, lots of hydrogen stuff, all sorts of chemistry going on. The only way to be sure is to test and calculate. But the promise is dirt-cheap non-polluting power. The radioactivity is not as much of a problem in my opinion, because the neutrons can be used to breed long-half-life elements into stable elements or short-half-life elements, and chemical separation can be

used to do this, and it can be done once every few months. The intermediate stages are certainly extremely radioactive, but at worst, you recycle the elements on the bombs, to irradiate them with neutrons a few more rounds, to get them to be extremely hot, and so die quickly. If worst comes to worst, you just let the salt freeze, and you have a solid radioactive lump deep underground, if it is far below the water table, and geological activity is negligible, then you are might not have to worry about it any more than the natural radioactivity. It is ultimately at most a 100 meter radioactive sphere, you could also chop it up and take it to a disposal site, it's solid waste. This is assuming the thing screws up. But there is another approach which, unlike this old one, does require research and development, and this is the Pons and Fleischmann cold-fusion. This phenomenon was denied for decades, but it shouldn't have been, because the evidence was strong already in 1989, as at least 5 groups successfully replicated Pons and Fleischmann results (Bocris, Wolf, McKubre, several researchers at Bhabha, and some others, notably at Los-Alamos). There have been dozens of well tested replications since, the most notable are the Navy SPAWAR group and Arata, who used different methods, all using Palladium and deuterium. I have explained a theory of this phenomenon on physics.stackexchange: Why is cold fusion considered bogus? , and since I believe this theory is correct, I will assume the mechanism for the remainder of this answer. The problem with this process is that it consumes an atom of Palladium for each fusion, or, at best, for each 4 fusions, because the Palladium is absorbing tens of MeVs at each event, and this tends to fragment the nucleus. This means that you can only generate at best 100 MeV per atom of Palladium, and we don't even have enough Palladium on Earth for one year of global energy consumption (it's comparable). We might find a whole bunch more Palladium, that's one possibility, but Palladium, like Gold, is a precious metal, and it is difficult to imagine finding industrial quantities. The nice thing about the mechanism, however, is that it should work with a variety of metals, so long as there are sufficiently high-energy inner shell excitations, so long as it can conduct protons into the interior in sufficient density. Any metal-hydride at a sufficiently high density

should be effective, as long as the metal is about as heavy as Palladium or heavier, so that the inner shell excitations are sufficiently high-energy. This requires a lot of tinkering. The space of possible pressures, deuterium densities, and so on, need to be combed over in detail. This is a research project which could take many years. There are claims in the recent literature that ordinary Nickel with ordinary hydrogen will produce power, but these claims come from at least one unreliable source (Rossi) who is attached to exactly one group in Italy, and other people affiliated with this group. Since the result is so surprising as compared to the Palladium deuterium results (these I think I understand completely), you need a bunch of independent replications to be sure that something real is happening, and it's not just delusion or fraud. There have been some claims of replication of the Nickel Hydrogen effect, I don't know what to make of it, it is not reasonably compatible with the mechanism that I suggested, so I am super skeptical. The inner shell in Nickel is only 3KeV, just marginally capable of producing fusion at a much smaller cross section than at 20KeV (which is the peak cross section), while the deuterium fraction in ordinary hydrogen is so small, that it would require some spontaneous isotopic segregation mechanism to get any effect at all, and I can't see any way for this to happen. It is remotely possible that some isotope segregation does happen with the accelerated deuterons and protons, they are flowing in an electric field (these experiments are run with a current going through the electrode, and this current is probably required to channel the deuterons, and perhaps due to the mass difference, the deuterons concentrate somewhere, but this is a just-so story, and 3KeV is very low energy for fusion of any kind. It is very easy to delude yourself in these experiments, because you can have recombination heat, so I am cautious about these claims, I think they are likely all bogus, they are mainly from one group, and one of the folks (Rossi) is scamming for sure. There was a recent conference on cold fusion, where there was a claimed replication of Celani's wire experiment, but I didn't read it and evaluate it, and I am not at all certain anything is happening, unlike in the case of the Pons and Fleischmann setup, where the number and quality of replications is very high. The most recent Palladium deuterium replication was in an

undergraduate lab at MIT, where they set up the experiment and observed the excess heat for a long time. Unlike the Nickel hydrogen experiments, the Palladium-deuterium experiments include unassailable proof of nuclear effects independently replicated several times, and this is the observation of tritium. The tritium is unexplainable by lab error, it must be direct fraud, and it is this that made many people certain that there was no error in the original announcement by Pons and Fleischmann, since not only they, but the four other groups that replicated in 1989 all detected tritium, and each such detection would have to be deliberate fraud if this effect is not real. Tritium is radioactive and decays with a clear signature, and its concentration cannot be mistaken, because the concentrations measured were several hundreds of times background. These results (and a whole lot more) are available on Jed Rothwell's website: A library of papers about cold fusion .

Is it time to give up string theory?

It's time to give up string theory like it's time to give up Newton's mechanics. String theory is a consistent theory of quantum gravity, there is no dispute, and no one will ever kick us out of the paradise that Scherk and Schwarz have created, so stop trying. It's pure politics, and it's as old as the theory. The reason strings aren't dead is because they work. The reason they must be studied is because they are the only thing that works, anything else is wrong for quantum gravity. The reason people attack it is the same reason they attacked it in 1974, because it is difficult and revolutionary, and people hate the fact that not only did they not come up with it, they can't even understand it now that other people came up with it. This bruises the ego. Get over it. The way to get over this is to humbly learn the theory, like a freshman, starting with the 1960s S-matrix program of Chew, Mandelstam, Gribov, Frautschi, Olive, Polkinghorne and all the rest,

especially the Regge theory stuff. This is covered well in Gribov's book "The Theory of Complex Angular Momentum", but you can skip the parts about moving singularities, Regge cuts, and Gribov Regge calculus (although these things are extremely interesting and correct things, you don't need this for the later stuff). Then you can learn the theory properly, beginning with anything with John Schwarz or Joel Scherk's name on it, but also through textbooks by Polchinsky and Polyakov, Green Schwarz and Witten. Polyakov's book gives a complementary point of view on different kinds of applications of string theory, outside of a theory of everything. The evidence that string theory is correct is that it obeys the holographic principle, so that it is consistent with Hawking's entropy law. The entropy law is firmly established, and it creates the information paradoxes that can only be resolved by an S-matrix point of view. From a theoretical perspective, this clinches it, string theory is correct. From a practical view, it is likely that the low-energy theory is not supersymmetric, and this might be a tremendous clue, because such vacua with small cosmological constant might be very restricted. String theory does not demand low-energy supersymmetry, this is just something that people liked because it was mathematically interesting in field theory, and gave them something to do. There was never very strong evidence for low-energy supersymmetry, it was always a 50/50 crapshoot, and not finding it is in no way an invalidation of strings. Invalidating high-energy supersymmetry is another matter, but this is not possible with feasable technology. This does not make string theory untestable, first because technology gets better with time, but more importantly, because not finding supersymmetry gives a tremendous clue also to the vacua we should be searching through, and it is when you exclude our vacuum that you disprove string theory. But you won't exclude it, you will find it, if you look at the right place, because the theory is constructed well. String theory, like all quantum gravity models, is in a difficult position, because the natural place to test it is in scattering at enormous energies. This doesn't mean that it is untestable, it means it is prohibitive to test technologically. The philosophical criterion that makes a theory untestable is not when it is too expensive to test. The theory that there is a rock at the Lagrange point of the Earth and the

sun is also prohibitively expensive to test, less so than string theory, but still more expensive to test than to propose. But it is not unscientific, it's scientific, it's just probably wrong, there probably is no rock there. String theory needs cleverness to test, because the direct tests are out of reach. This cleverness means figuring out our vacuum, by making models of it using the theory. The point of string theory is not to make the most obvious possible models, it is to describe nature. There are non-supersymmetric vacua of string theory known since the 1980s, the most interesting to me are projections of SUSY models that remove the gravitino like the SO(16)xSO(16) heterotic string. These were put on the back-burner, because people were embarassed by the large number of string models in the 1980s (not anymore) and they liked supersymmetry for purely political reasons, it was what everyone was working on. Also SUSY allowed people to justify hierarchy and cosmological constant suppression (roughly, the cosmological constant couldn't be suppressed properly, this was another clue that the understanding was off). These political things are annoying, and they are bullshitty, the supersymmetry predictions were always iffy and speculative (although SUSY was never so bad in terms of fudging, so that it really could have been true, it was 50/50, not .000000000001/99.999999999 like large extra dimensions, it still might be true, it might show up next round of experiments, but probably not) There are model independent predictions of string theory, the swampland constraints, and the emissions of black holes, that allow the theory to make certain astrophysical predictions and rule out certain models even without knowing our vacuum. It has made solid contact with strong interaction physics, and it will never be overthrown in the domains where it is already tested, which are in QCD, especially RHIC nucleus-nucleus scattering. As a theory of quantum gravity, it is also likely to be the only possibility, in that any other possibility is a vacuum of the theory, since this has been true so far. The way to disprove it is to show it is inconsistent theoretically (it isn't) or inconsistent with observations, which means ruling out our universe by showing it isn't a vacuum. That's not infeasable to do, there are only so many vacua (with reasonable assumptions), but you just won't do it, if you search, you'll find our vacuum.

How many kilometers would be the span of sky you could see between horizons, assuming a plain terrain?

Your visibility radius is the square-root of twice your height times the radius of the Earth, it comes out to about 5km for a 2m person (square root of 2 times 6000km times 2m). This handy formula shows you that if you have a crow's nest which is 20 meters above the ground, you can see 3.16 times further, the square root of 10, about 15 km. If you want to see 50km, you need to be 200 meters up, so forget about it. When you are 10 km above the ground, you can see 240km out, this is an airplane's cruising height. The formula comes from the law of a sphere, a sphere looks like a parabola near the top, [math] R - \sqrt{R^2- x^2} = {x^2\over 2R} [/math] This is true for small x, it's the leading Taylor expansion of square-root. You can see as far as when the slope from your eye is tangent to the parabola. Extrapolating the tangent of a parabola from position x, the slope is x/R, this is the derivative, and it's a distance x, so it's x^2/R in height for the line, but you are starting x^2/2R below ground level, so the extra height for the tangent is x^2/2R [math] {x^2\over 2R} = h [/math] Where h is how far up your vantage point is. [math] x = \sqrt{2Rh} [/math] The leading order parabola approximation is very useful.

What fraction of world-changing scientific research comes from top-tier universities in the US? What approximate fraction of important

scientific research comes from outside the top 50 universities?

I don't know about other fields, but in physics, it was always extremely democratic, so that major breakthroughs almost always came from the less prestigious places (then the people would sometimes get snapped up by the prestigious places, which have more money to offer). The top-tier universities usually have a bunch of experts that are big stars and set the direction for certain fields, but they are sometimes hampered by politics, you are more free if not a lot of people are listening to everything you say. In explicit attempt to spread the knowledge, Many great physicists went off to lesser-known institutions and built up world-class departments by simply choosing good people and populating the university department in relative freedom, and working on things that were off the beaten path, but which they thought were promising. Princeton was an American school, so second tier to the Germans, but it obviously got Einstein, who got Oppenheimer, then Anderson, Witten and lots of other greats, and it is still great, lots of great people. Cornell got Hans Bethe, who brought in Feynman and Salpeter, encouraged Kenneth Wilson, and there are lots of good people. Breakthroughs from Cornell include Feynman diagrams, modern renormalization, lots of things that come from nowhere, because they are generally born from years isolation, due to the rural setting and strange Woodstock-creating local culture. Bethe's leadership generally made the school top-notch in field theory (Bethe didn't like string theory so much). Harvard had Vafa, Coleman, lots of good people, it still does, but it was always a more conservative and political place, and it was against string theory for more than a decade after they should have come to their senses. Syracuse University had Peter Bergmann, a great but only occasionally publishing colleague of Einstein's. Bergmann built up a world-class General Relativity group, which produced the Ashtekhar variables and loop quantum gravity, and also had Pierre Ramond when he made his great breakthrough in strings. It's library was first-class, even though it was a tiny one-room thing, that's where I studied before going off to college (I lived in a

suburb of Syracuse), I only appreciated how great it was when I saw libraries 20 times the size without the classics that were on the shelf at Syracuse. Loop quantum gravity was all Syracuse physics, every part of it, and the mathematical structures are still interesting, even though they have not produced a theory of quantum gravity as proponents hoped. They still produced insights into the canonical and quantum structure of GR, and they might help in figuring out how space-time is hologrphically reconstructed, although for that, you need a higher dimensional generalization. Berkeley had Mandelstam and Chew, and produced Gross, and Polchinsky. They are responsible for stirng theory almost single-handedly, the other institutions were Italian. The University of Maryland got Gates, who was a pioneer of supersymmetry and supergravity. He put together a strong department with regard to high energy supersymmetry things, and they regularly produce interesting results. In Florida, they had Dirac, and then Ramond, who make the place nice. These are schols which I know about from personal experience, having been there, or met people from there. There are lots more good departments scattered around everywhere. One top school in physics was Rutgers University, simply from the presence of Nathan Seiberg (he moved to the Institute recently). Weinberg put Texas on the map. There are lots of schools, and great physics people went all over, because they didn't have an authority fetish like the rest of the society. Needless to say, the greatest physics breakthrough of recent times was discovered in the basement of the Chemistry department of the University of Utah. This was cold fusion. Penzias and Wilson started modern cosmology at Bell labs, and they weren't even physicists. In fraudulent fields, where the evaluation is political, you need a big-name school to make a name for yourself. In physics, you obviously don't need this, and I would say the most monumental breakthroughs, like strings, cold-fusion, microwave background, have always come from smaller schools, simply because there are so many more people there than in the big schools. So just by statistics, the top discoveries have nearly universally been made at smaller institutions, although the institute has its fair share, it's a slight bias, nothing too big.

What are good ways to insult a statistician?

Ooo! You're a statistician. Didn't Bayes solve your question about 200 years ago? (this will make them stop speaking to you forever)

What advice would you give to a Mathematics major student that you wish you were given when you started Mathematics?

I am not a mathematician, so I hesitate to answer, but someone asked me to answer, and insisted even after I refused. I like mathematics, I enjoy it the same way I enjoy a symphony, not usually as a participant, but as a spectator. I am a big fan of mathematicians! They consistently and reliably expand the knowledge of humanity, and the usual method they use to do so is by choosing to impose upon themselves a prison sentence of 20 years of hard labor in solitary confinement. This is the intellectual equivalent of the midieval monks who flagellated themselves. I did some flagellation in my youth, and I can say that it was rewarding, and it is extremely important because this mathematical thinking is the only real thinking. First, the obvious. You should read mathematics! Read great mathematicians, past and present. Read historical work, read present work. Read the original authors, read expositions if you don't get it. If there's a new idea or method, learn it. Read all the works you are interested in, but not the ones you aren't interested in. That's going to be more difficult when you are forced to read stuff you don't care about for a degree. But always make time to read the things you are interested in. I loved

transcendence theory, I loved complicated continuous constructions in analysis, I was bored by group theory, but not so much today. But I fell out of love with mathematics for 10 years. The reason is that I didn't get the foundations straight. I was completely wrecked as a student by foundation-agony, by junior year, I decided the mathematicians were all full of crap, and stopped studying their work, because I couldn't read it anymore. I didn't trust set theory because it kept on proving more and more impossibly wrong things, like the well-ordering theorem (the reals DON'T have a well-order, this is obvious), the existence of a non-measurable set (there is no non-measurable set---you can pick a real number at random between 0 and 1), and the higher level stuff then became a morass of shaky results that it was impossible to keep straight. Was the Radon-Nykodym theorem true? Actually true? True for some things, not for others? Usually false? Maybe yes, maybe no, there was no path to decide. How abour ultrafilters? Do they actually exist? Do nets make sense? Do they actually generalize sequences? It's a terrible situation to have to qualify all the theorems in your head like this, you need to have a solid framework to hang the results on. As an undergraduate student, I actually got to the point that I started to suspect that set theory might be omega-inconsistent (this is not true, but this is why you need to sort out foundations). There are theories which are self-consistent, but which prove lies about computer program behavior, saying that certain programs halt when in fact they do not halt. Since set theory was proving all these absurdities about well-orderings and the continuum that I couldn't make sense of, I figured it might just prove that a non-halting program halts, maybe using some ultrafilter construction, and then the Radon Nykodym theorem, then some well-ordering, and presto, this non-halting program is proved to halt. The worst part is that you would never know it, because no matter how long you look at the program, you won't know that it didn't just halt yet. This made me toss and turn, and I decided I didn't need this kind of anguish, and it's the mathematicians fault for telling lies, so I don't need to listen to these bozos. The resolution came a decade later while talking to a professional mathematician at a coffee shop. He explained to me his own foundational struggle, and learning the axioms of ZF, then the Godel proof of completeness of logic, and so on. He then showed me his own work on complex maps, which I liked a lot, and I got excited about math again, and went back and sorted out the foundation stuff. It was actually very quick, it resolved in about a month as I read "Set-Theory and the Continuum Hypothesis" by Paul Cohen. The original, not other expositions of forcing. The important thing were the Godel completeness theorem (an algorithm for making sense of axiomatic systems), the ZFC axioms (the axioms to make sense of), the Skolem theorem (that the models are really countable), Godel's L--- the straightforward simplest model where the axiom of choice and the continuum hypothesis are naturally true, and the forcing constructions (that the models can be extended so that the continuum is arbitrarily large) where the natural intuitions you have about the continuum can be made true whenever you feel like it. The point is that axiom systems are describing countable models, not some abstract universe. Once you understand this, all the results that are uncomfortable become obvious--- you can immediately interpret any theorem you read in an analysis or topology book as "true in L", this allows you to hang it on your "L" rack. Then you can understand any intuitive probability or measure theory construction as "true in Solovay's universe", and the results which are embedding measure theory in L, you can hang on the "useless bullshit" rack. Then you understand that the set-theories with powerset are themselves only reflections in the sense of Godel's theorem of set-theories without powerset. The set theories without powerset are reflections of arithmetic, and arithemetic is a reflection of its fragments, and this ultimately hits bedrock in computing things with integers. So the set theories are NOT omega-inconsistent, they are perfectly fine, they are extensions by Godel's method of previous consistent theories using ordinal chains. This point of view resolves the foundations anxiety entirely, but it revives certain questions that were politically closed. One becomes interested in demonstrating the consistency of set-theory by finitary means again, using large countable ordinals (these are finitary when they can be represented on a computer). The modern version of Hilbert's program is called "Ordinal analysis", and it continues on in complete isolation within logic, but they proved a bunch of things, including the consistency of Kripke-Platek set theory a while ago, and some bigger set theories more recently. Rathjen has written about this. The upshot of this is that all the ordinals are countable, the reals are an ordinal in any theory only because they are model-reals, every set of reals is measurable (simultaneously true, but in a different more Platonic model of the reals), and the results of mathematics need to be classified in the "L" "non-L" way to sort out the theorems properly. From this point on, I had no more difficulty with any of the literature, other than the usual ones of time and difficulty. The questions that come up when reading the logic literature unfortunately are completely different from the mainstream of mathematics. But I think that this literature is really grappling with the full complexity of mathematics in full generality, while some more specific domain, like scheme theory, is really about sorting out the regularities in more traditional questions about prime numbers and so on. So I like the logic literature, becaue it looks more free of human bias about what is important. But the other stuff is nice too, not knocking it, and it seems to be where all the revolutionary stuff is happening today. My personal taste in mathematics is to please prove the obvious stuff that nobody can prove, statistical regularities that are obviously true, yet completely unreachable by any known orderly method of progress, because the results are statistical, they aren't organized. I think the biggest advance here is the Appel and Haken method, their proof of the 4-color theorem, because this seems to be a path that is unexplored and promising. The amazing thing there is that they only needed to use heuristic probabilistic estimates, because they then used a computer program and checked various discharging algorithms until they found one that worked. Any one discharging algoritm proves a bunch of useless things about the existence of various random subgraphs, but if all the subgraphs allow you to remove a 4-coloring obstruction, then you prove the theorem. But they knew that if they search long enough through discharging algorithms they would find one that works, and this was simply from their heuristics, and they only needed one example to get a proof. This method seems very promising in attacking superficially insurmountable problems. You can prove a lot of individually useless

theorems automatically about subproblems, the theorems only prove the result when the decomposition somehow covers the space of all the examples, and you patch these automatically proved sub-theorems together to prove the result by doing an automated search. All you need are some heuristic estimates on how likely each sub-theorem is to be automatically provable and to cover enough of the cases to prove the whole theorem. I would love to try to do some theorems like this when I have some free time, and try to prove some statistically obvious thing, like the normality of some number. But this is not likely to produce anything in such generality, so it's something you play with, but not seriously.

Is it possible to contribute significantly to pure mathematics outside of academia?

Of course it is possible, just do the work. I don't do this, but it is not so hard to do. The academics are faddish, they need to chase after one or two ideas in order to stay funded, and the outsider has the advantage of time. It is only a full time job to do mathematics if you need to get funded. Structurally, that always happens, because if it were possible to chase funding without full effort, people would have already done so, and the funding would already be taken. But that's not the same as solving a major problem--- you can do that the moment you have an idea and time. Perelman was outside of academia when he did his proof, and more recently, Michozuki seems to have dropped out of sight for at least 10 years to work on his own thing, which seems to have led to a major breakthrough. Another example from recent years, not Perelman, was the proof of the irrationality of zeta(3). The isolation here is deliberate, it was what Ramanujan was doing, and if you have a good idea you can work on, and you aren't going to starve, it can pay off. At the other extreme, there are the most collaborative of mathematicians, like Erdos or Tao, who do great work in groups on

other people's problems, using techniques which are already developed, and also made great advances. You can't be discriminatory, each person contributes their contribution. The major issue is that there are techniques of proof which are relatively slick and well standardized which you need to learn in order to investigate the most fasionable questions. But these techniques are only useful for classical questions, because the questions co-evoleved with the techniques. For new questions you need new techniques that nobody knows, but you But anyway, even these standard methods are dead simple to learn now, except for algebraic geometry, where you have to learn some French to read Grothendieck, because nobody is allowed to translate his work. But there's a ton of theorems that have nothing to do with the fasionable quesitons, which people outside of mathematics do all the time, and sometimes end up being important. You must remeber that Ramanujan was not well respected in 1910, people dismissed his stuff as insignifcant 18th century throwbacks, not appreciating the new structures, because it took time for people to explore the new world he landed on. Mathematics is an artistic endeavor, and like any other great art, there are lots of paths to success.

Why are gauge bosons massless?

There is a simple physical interpretation of Jake Mannix's answer--- a mass term pushes you toward zero field. When you have a massive field, at long distances, there is no field at all. If you have a gauge theory, the value of "zero field" is not gauge invariant, a zero field can be made nonzero by a gauge transformation, so all the gauge variations of "no field" must have the same zero energy as zero field. The only way to get around this is to have some stuff around that gives you a way to define "zero field" in a gauge invariant way. The way to do this is to have a coherent condensate which defines a preferred phase direction for the matter. When you do this, the definition of

"zero field" in the condensate background means that you fix the gauge so that the phase of the condensate is constant, and then you have zero field after doing this. In this situation, the gauge field gets a mass, because every fluctuation in the gauge field has an energy cost, because a gauge transformation for the gauge field only (keeping the condensate phase fixed) is equivalent to changing the phase of the condensate keeping the gauge field fixed, and this is a material flow with associated material energy. This is the Higgs mechanism.

Why do people keep trying to create a theory of everything although general relativity says that gravity is the geometry of space-time and not an actual force?

Classical gravity can be thought of as an actual force, or not, it all depends on whether you are looking locally, at the location of a particle, or globally, at the whole trajectory. In the local picture, there is no "force", the partice is going on a geodesic, so that locally it doesn't deviate from a straight line. In the global picture, an incoming particle going in a straight line is deflected through the action of gravity. The global picture is what people use to formulate string theory, the quantum theory of gravity is always defined in terms of global scattering, not in terms of a local force. The global nature of quantum gravity masks the local geometric picture, and makes it that it is difficult to understand the general relativistic aspects of string theory. But since it is a question of point of view, it is really a meaningless question whether gravity is a "real force". In the global picture the answer is yes, because global conservation of the separate individual momentum of the scattering particles fails when you include gravity. In the local picture, the answer is classically no,

because of the equivalence principle, but this local picture requires a full reconstruction of the interior space-time from the asymptotic states, and this is difficult in string theory, it is a major unsolved problem how this reconstruction works in full detail. (but it is getting resolved).

Where are the personal stories of science after 1970?

Physics still depends on personal discovery, as much as always. The collaborations are important too, but they happened in 1950 just as much. The individual work is more lonely. The most incredible story of the past 40 years, perhaps of all time, is the story of cold fusion. The field did not exist 20 years ago, before Pons and Fleischmann created it, and it was full of twists and turns. During most of the development, the vast majority of physicists claimed there was no phenomenon, despite a ton of solid experimental data. It seems they trusted the authority of theorists over the measurements of the experimentalists. The personal story of the cold-fusion pioneers, Fleischmann, Pons, Jones, McKubre, Miley, Iwamura, Mizuno, Hagelstein, is fascinating, it is a tale of a tiny minority battling to give birth to a new field (although, in a strange twist, Jones actually recently achieved greater fame for finding thermite residues in 9/11 dust). The data kept on trickling in, the internet kept on advertizing it, but the denials from theorists just got louder and louder, because theory seemed to say it is impossible. This was surely the biggest discrepancy between experiment and theory in physics. The full story is described on A library of papers about cold fusion. It also involves chemists of course, they discovered the phenomenon. Understanding that cold fusion is real was the biggest shock of my life. Figuring out how it could possibly happen was very exciting. My favorite papers were those of Mosier-Boss, because her plastic detector experiments gave by far the

most significant clue, because of the detection of fast alphas. The Navy group has a fantastic untold personal story (I don't think I should be telling it). One of my favorite other stories from more recent years is the renormalization group work of the 1980s, and this is full of wonderful things that hardly get any attention. There were great models by Kadanoff, Pere Bak, Narayan and Fisher, David Nelson, John Cardy, and all the older folks in any condensed matter department. There were beautiful physical systems on people's minds at the time, like diffusion limited aggregation, RNA melting, polymer statistics. In the polymer statistics, aside from the Nobelist deGennes, who is older, there is 1980s work from conformal field theory, using the work of Belavin, Polyakov, Zamolodchikov, Knizhnik, the statistics were imported into mathematics. There is lots and lots of work here, many questions were left unanswered. Some of the folk-stories here are of Pere Bak and Mandelbrot and their legendary egomania. But the quieter figures are interesting too. It isn't the loudest voices that always have the best stories: Pierls's "Surprises in Theoretical Physics" is a classic, and this is telling very technical, but still personal, stories. The stories in string theory are kind of exciting. Lubos Motl is a story just by himself. His battles with the Harvard physics department, and with Lee Smolin, are legendary. But for sure the most interesting and important stories regarding string theory go all the way back to its discovery. The discovery of string theory and supergravity, although it dates to the 1970s, involved personalities of the same magnitude as Einstein and Bohr, these were Scherk, Schwarz, Yoneya, Olive, Goddard, Van-Niewenhuisen, a whole neglected generation, who only now are getting to tell their story. In fundamental theoretical physics, they made the biggest steps, these were bigger steps toward a final theory, in terms of theoretical subtleness and difficulty, than those of Einstein and Bohr put together.

Why is "Pauli repulsion" not a true force?

Pauli exclusion is not a force on the fermions, it is a constraint on the allowed state space. But when you have composite particles made out of Fermions, there is an effective force that arises between them because of the fact that the state-space is reduced. This effective force makes it that if you try to jam together the particles so that their constituent fermions overlap, you get a repulsion, because the fermions inside have to occupy levels which are at a higher energy. This is an effective force, but it is something you feel when you push the objects together, and it is the reason that matter feels hard to the touch. The electrons exclude each other in this way, and as they are carried by the nuclei, when the electron-wavefunction regions begin to overlap, you feel a force, because the electronic energy keeps going up. A simple toy model of this phenomenon is two delta-function potentials at position 0 and position A in a one-dimensional space, with a unit strength. The ground state wavefunction for one of the delta functions (with some choice of units) is exp(-|x|). There are two ground states for the two-delta system when A is enormous, which are the symmetric combination exp(-|x|) + exp(-|x-A|) and the antisymmetric combination, exp(-|x|) - exp(-|x-A|), and either of these states have the same energy, say -1 in some units. This is the binding energy, meaning it takes a unit of energy to unbind a single electron bound to the wells (either to one, or to both wells, in any superposition, when they are far apart, it doesn't matter). The total energy when you put two electrons in these two wells is then -2. The electrons occupy the two states, the plus state and the minus state. You can also consider the two electrons as occupying the "left state" and the "right state", this is just a different basis. As A gets smaller, the energy of the ground state, the plus state, goes down, it is the true ground state of the combined system, and the energy of the minus state goes up by nearly the same amount. The reason is that there is a tunnelling amplitude to go from one delta function to the other, and this tunneling amplitude can be thought of as making a 2-state system, and the tunneling splits the eigenvalues of the matrix by an amount equal to plus/minus the tunneling, to lowest order. The tunneling amplitude monotonically increases as you bring the wells closer, which means that the ground state energy keeps going down as you bring the

two delta-functions closer. So if there is only one electron shared between the two wells, or any number of noninteracting bosons, you get a net attractive force pulling the wells together due to the sharing, because the ground-state energy goes down as the wells get closer. The gradient of the energy is the force that the wells feel. This is the phenomenon of chemical bonding--- the more the electron can tunnel between the wells, the lower the energy of the configuration as the wells get close. The force you get is the force of attraction that binds together the positive H2 ion. You can get the order of magnitude of the attraction force by plotting two points and knowing the scale of variation. When A is infinity, the energy for one electron is -1. For A=0, that is, when the wells are on top of each other, the wavefunction for the ground state is exp(-2|x|) (double the derivative discontinuity) and the energy is -4 (the energy of the ground state is the square of the "k" falloff rate in the region where there is no potential). The energy is monotonically decreasing as you bring the two deltas closer, with a scale roughly as the wavefunction extent (this tells you the tunneling rate), so the force is of order 3 units of energy divided by 1 unit of distance, this is the scale of the attraction. Extrapolating to atoms, the chemical attraction is of order an electron volt per Bohr radius. But when there are two electrons (of the same spin) in the two wells, you need to fill both the ground state and the first excited state at each separation. In this case, the energy is the sum of the energy of the minus state and the plus state, and this energy is roughly constant as you bring the wells together. The reason is that the tunneling makes a splitting, and if you just take into account a splitting in a two-state system, you get an equal increase and decrease of energy in the lowest and first excited state (these are the eigenvalues of a transition matrix proportional to sigma-x in a two-state system). But when you look at the full solution, not just the primitive two-state approximation, the energy isn't completely constant, it monotonically goes up as the wells get closer together, this is the repulsion when both lowest levels are filled. The physical interpretation is that a Fermi gas is stiff, when you reduce the volume, there is a pressure against stuffing the fermions in a smaller space, simply because all the levels need to be occupied, not just the lowest level, and the gradients become sharper when the

objects are closer. This is the volume excluding property of composite particles made out of Fermions You can compute the energy semi-analytically in this simple delta-function model. The solution for the two wells at a separation of A can be found by putting the origin half-way inbetween. The ground state is (on the positive x half, the negative x's are determined by reflection symmetry) [math] \cosh(ax) [/math] for [math]0A/2 [/math], where the coefficient of the second half is determined from making the wavefunction continuous. The total energy of this state is -a^2, read off from the decay rate in the region where there is no potential. The value of the decay rate a is determined from matching the derivatives at A/2 left and right, to get the same derivative-jump-over-wavefunction-value as for the case where the deltas are infinitely far apart. This is the matching equation for the ground state: [math] a \sinh(aA/2) + a \cosh(aA/2) = 2 \cosh(aA/2) [/math] This gives the transcendental equation determining a: [math] a (\tanh(aA/2) + 1) = 2 [/math] The first excited state is the same thing, except antisymmetric in x. The wavefunction is [math] \sinh(bx) [/math] for [math] 0A/2 [/math] so that [math] b \cosh(bA/2) + b \sinh(bA/2) = 2 \sinh(bA/2) [/math] or [math] b (\coth(bA/2) + 1) = 2 [/math] The total binding energy is (negative) the sum of the squares of the decay rates for both solutions: [math] -E = a^2 + b^2 [/math] For large A, the tanh's and coth's become 1, and you get the usual answer, a=b=1, so the binding energy is 2. As A gets smaller, the b's always go down by more than the a goes up, simply because the coth goes more sharply up than the tanh is going down. so that the binding energy decreases. This is the Pauli repulsive force. The two electrons are completely non-interacting in this model, there is absolutely no repulsion force between them, there is only attraction to the separate delta-function points. But still, a repulsive effective interaction emerges anyway, for the composite delta-function fermion object. When A is small enough, the energy a is 2, as before, but b is nonsensical, it has no solution anymore. What's going on is that there is a critical point where b becomes zero, and the first bound state disappears. This critical point is at the place where the antisymmetric wavefunction for the first excited state is simply a constant for x>A/2 and a straight line through zero between -A/2 and A/2, so that the decay rate is zero. This magic point happens when A=1, you can check that this solution has the right derivative discontinuity at this magic value (the slope through 0 is 2). Beyond this point, one of the two electrons is necessarily ejected. At this magic point, you can solve the value of a numerically, using this perl one-liner: `perl -e '$x=1;while(1){$p=exp($x/2);$m=exp(-$x/2);$s=($p-$m)/2;$c=($p+$m)/2;$t=$s/$c;$x=2/(1+$t);print $x,"\n";sleep 1}'` This is simply iterating the equation for a, to find the fixed point. The answer is a= 1.28, and the total binding energy is -a^2 (since b^2 is zero here), or -1.63, so that the energy is increased by about .4 units as compared to the energy at infinity, which is -2. A similar script can be used to find the energy at any separation, the scale is about 15% of the chemical binding energy, or a few tenths of eV per Bohr radius. While this model is very simple, the effect it is describing, the repulsion of fermionic filled bound states, is extremely significant, it is the reason all the solid objects feel hard to the touch. When you press against a fully bound molecule, so that all the electrons in orbitals are paired, the moment the wavefunctions begin to overlap, the total energy of the electronic configuration increases, and you get a hard repulsion which sets in at the scale of the electronic wavefunction range, about one Bohr radius, and is comparable, but an order of magnitude smaller, to the chemical binding energies. While the delta-model is wrong for atoms as a potential, the ground state it gives in 1d is the same exponential shape as the correct potential in 3d. So while this model has a completely wrong force law, the types of repulsions it produces are not so far off in describing the qualitative behavior of atoms with bound electrons, since the Pauli repulsion only depends on the shape of the wavefunction of the electrons and their energy levels with the nucleus, not on any electromagnetic forces between them.

What are some of the most useful secondary literature in English that would help me

understand Martin Heidegger's Being and Time?

"PhilosophyBro" has done a marvellous job in this tweet here PhiloBro: Being and Time, a Very Short ... : Being and Time, a Very Short Summary: There is only Being Beings' Being's being Being being Being's Beings Being Beings Being. Also see here: Martin Heidegger's "Being and Time": A Summary I haven't read "Being and Time", I flipped through it very quickly several times in a bookstore, a few times as pdf, hoping to find content, and failing. The book is a vacuous collection of ill-defined utterances designed to appeal to those who don't know how to formulate questions precisely, in such a way that they can be given an answer that superficially seems satisfying. Logical positivism shows how you are supposed to do that for real, and positivism tells you that when you fail to formulate a question in such a way that you can find the answer, it's not that the answer is hard or somehow deep, it's really that the question was nonsense to begin with. Heiddegger's goal is to counter the no-nonsense in positivism, and to produce a way to discuss things that are meaningless in such a way that you persuade others, hopefully others of a high social class, that you have a deep insight. The terms are vague, but you use them with precision relative to each other, so you can always attach the terms to whatever is on your mind, and so feel that you have made sense of something. But since the structure is ultimately trivial, there is no content to it, you can do this in many ways, none of which are illuminating. This book, and the whole nazi movement it was a part of, was the last gasp of pompous pulled-out-of-your-high-class-ass philosophy which itself consituted the terrified response of the upper-classes to the plain-as-your-nose low-brow thinking that gave the world such things as physics, chemistry, engineering, rigorous advanced mathematics, you know, those unimportant trifles. The high classes can't stand the fact that these things are done by plain-spoken ordinary people who don't give a shit about social class, not great overlords who are born to be social supermen, and they are jealous of the arcane terms and deep

knowledge there. They think "We should have such arcane things too." So they make them up. They find someone to invent a cheap-ass language which cannot be understood without a socially transmitted exegesis, and then only provide this exegesis to those who have proven themselves to be supermen, thereby restricting the conversation about this topic to high-class twits. It's exactly the opposite of science, where you just beg the stars every day to please, please, let someone else understand what you did, especially when what you did is not so easy to understand. Here you hope only a few people get a vague inkling of how stupid and shallow you are. Fortunately, this high-class discourse, even when completely demystified and explained, contains absolutely no insight into anything, except how to decypher itself. This is because it is purposefully designed to mystify, not to produce new knowledge. Heiddegger is working in the tradition of Hegel, who did much the same thing in the 19th century, but Hegel was the true master here, because his stuff is even more vague and meaningless, so much so that people on both the right and the left embraced it. The 19th century version was the high-class response to Newton's mechanics, that's the only low-brow stuff they really had to deal with. The 20th century, the high class has a much bigger problem. It's the 21st century, sorry, high class, you're totally busted. But I think I am adressing a vacuum, because the European high-classes this stuff was designed to appeal to hardly exists anymore, now high class people are those with money.

Who, according to you, is the World's Person of First Half of Year 2013, and why?

I nominate *drumroll*.... MYSELF (bah dum bunch!) For a bunch of short profane misspelled inaccurate-sounding internet postings. Self promotion, woo hoo!

Why do humans naturally have the concept God in their mind?

The concept is hard-wired to an extent, because we are evolved to live in a community, and accept shared vision from limited information. So we personify the communal goals as the goals of a single person. This makes it coherent--- so you can ask "As a Yoruba male, does the community wish me to share this rabbit?" and Yoruba community answers in your mind "Yes, you should share, especially with the family that lost their father, who are suffering." This self-consistent communal will can be personified, and you get to know what it is by sharing stories, and you each make it self-consistent, so it becomes like a person, and you can communicate with your model of this fake-person internally. So in addition to our own individual goals, we also have an image of a big guy or gal "out there" who has a desire for us to act to maximize the good of the community. This is an abstraction. The problem is that this big guy out there can make us act in terrible ways toward outside groups. We might decide to capture and torture some non-Yoruba warriors, because Yoruba god has told us this would improve our community. The notion of almighty God is abstracted from the idea that all the communities of the world should agree on a notion of ethics which is self-consistent. The mechanism is simply by considering all the circumstances of all possible behaviors, and making a self-consistent utility for each course of action. The result is a concept of almighty God, which we can communicate with almost instinctively, because it is just an idealization of the communal god which we are hard-wired to understand. The issue is that the concept of God also has creator aspects, and supernatural aspects, and all sorts of other things attached. This stuff does not come so naturally, if you ask people who are not born into a religion whether they believe in a creator, you will get different responses. Some will say the world is

eternal, and does not need creation. Others will say it is cyclical. None of the groups will take their answers too seriously. Also, if you ask people who are not exposed to a monotheistic religion whether they believe in a universal ethics, the answer is usually no. They will act according to the local god, the little god, the thing that tells them the best-interest of their community. They will often do so against their self-interest. But the abstract notion of acting in the interest of a universal limiting community requires an act of abstraction that is more sophisticated, and usually evolves well after writing. But the written almighty God takes up the slot of the more simple tribal diety, so it is still instictively accessible. So in this sense, It hink it is more correct to answer "yes" then "no".

What sparks a thought? OR How does a thought spontaneously arise in the brain? Specifically in the absence of an obvious stimulus.

While we do not know the answer for sure, and my answer does not appear anywhere in the literature and has zero experimental support, I would like to contradict Paul King's answer, and give an alternate model that is less fanciful than the standard one. The standard model is fanciful, because it considers the brain's computation as distributed over 300 billion neurons, acting collectively, at about 1000 hz rate of processing. The problem with these models is that there is no way to get coherent computation out of such a slow clock cycle and such a limited amount of RAM, at least nothing more than a reflexive jerk of an arm, or a quick pattern identification that isn't stored or transformed in any complex way. The issue can be made more stark as follows: when you see a photo of a bicycle, it takes you about 1/10 of a

second to identify the bicycle. This means you have at most 100 action potential cycles available. This means that the identification of the bicycle supposedly happens through a magical process, where 300 billion bits, recieving input, organize themselves in 1/10 of a second, or 100 cycles, into a pattern that says "I saw a bicycle" and then somehow maintain this pattern dynamically for a while. Further, this pattern can be more or less recalled by just saying "think of a bicycle", so somehow this dynamical system is able to magically identify what you are saying, pick out the proper pattern for a bicycle, and arrange itself like so for this pattern, using 300 billion bits at (at most) 1000 cycles. In the past, 300 billion might have been a big enough number to snow people, but no longer. 300 billion on/off bits are not sufficient, especially with this dinky clock cycle. The paradox is starker for fruit-flies or worms, where the number of brain cells is tiny. It is difficult to explain why it is a paradox if you do not have experience with computers of various sizes and powers. So I call bullshit on the connectionist model. It is pitifully small, it is wrong. It also has no evidence to support it, beyond "got any better ideas?" I think I do have a much better idea, but it does not come with any evidence, it is a way to resolve the theoretical difficulties described above. The way a thought arises in the brain is through molecular interactions within a single cell. The cells are coupled computations, with the communication being electrochemical impulses, but the substrate storing the data is RNA molecules. This RNA is active in synapses, in axonic stems, all over the neuron. The computation is by complementary binding, and splicing, rejoining, perhaps copying of RNA with an RNA/RNA polymerase, but perhaps not this, because such a polymerase has not been identified in the human genome. This RNA computation is required for other reasons, as a self-consistent thing which can modify DNA for sensible mutations. This stuff can control protein expressions by sending out siRNAs, and it is what is transcribed from the non-coding genome. I do not wish to argue for a computing cell-brain made out of RNA, because I think it is too obvious to argue for anymore, it is almost accepted fact (perhaps not yet). The goal here is to argue that this RNA is what is also doing the thinking in the brain brain. These computations are not independent,

but they are linked through neuron activity into a network. The network transmits signals from neuron to neuron through spikes, or action potentials. Since none of this is observed, I need to make up the details, so as to have a model. The true details will probably be different. But I will say that these spikes are read out by RNA modifying membrane proteins, and whenever a spike appears, the proteins write out a certain base on a strand of RNA, so that the RNA is a semi-permanent record of the spike-train in time, stored like a ticker tape. Each a,u,c,g is encoding the time between spikes, or it's aaauaaauauuaaaaauu with u's at every spike. The RNA then takes the ticker tape from the cell membrane, and does munch munch munch compute compute compute, and out comes new RNA that is attached as a ticker tape at the axon, and whrrr... out comes a new signal with a precise set of timings which produce other RNA's in cells down the line. The cells ticker-tape RNA's are protected, catalogued and stored in cell bodies, and in glia, for later retrieval, the glia retrieval is slower, when you are thinking of that thing that is just on the tip of your tongue, your brain needs to search the library of ticker tapes to find the right ones. When you have a memory that is spontaneous, your RNA's in different cells are sending little spikelets to see if there is some other cell that can do something with the data. Most of the time, nothing. Every once in a while, a cell puts an RNA on the ticker-tape machine, sends out a signal, and gets a whopping amount of feedback, because this pattern matched the next cell. Then the cells start to communicate back and forth, exchanging more RNAs, the whole network is alerted, and you think "Hey, I got an idea!" The mechanism has a memory capacity with is order 300 billion gigabytes, or about 10^21 bits (or more, you can easily fit 10 gigabytes of RNA in a cell). The reason to believe this over the standard story: 1. It actually gives a non-magical explanation for the ability of the brain to compute so deeply. The RNA is 10 orders of magnitude bigger in memory and 8 orders of magnitude bigger in processing speed than the neurons as cells. 2. It can be coupled to heredity simply, with no layers of translation: the DNA can store instincts in sequences that are transcribed in neurons and directly serve as ticker tapes to each other, thereby encoding a gigabyte of instinct directly. If you have to go

through a layer where you translate to proteins, and then direct brain activity only indirectly, it is hard to see how you can encode complex instincts at all, since the amount of instinctive data, after all the steps is close enough to zero to be indistinguishable. 3. This presents a method for evolving brains, as separate RNA computations in cells are linked up through neurotransmitters. It will explain why the neurotransmitters are present in simple multicellular sea-organisms no bigger than 20 cells, similar to blastocysts. These organisms do not have a nervous system, but still make use of nervous system precursors. There is no evolvability path to a brain in the current ideas: a brain is useless until the cellular components network. In this model, linking up RNA computations is useful even before there are any well-defined nervous system components. 4. RNA is the major component of the brain, and non-coding RNAs are moved around with apparent purpose all over neurons. This was pointed out by John Mattick in 2010, although I don't know if he would endorse the hypothesis I am presenting here. The reason to believe the standard story: 1. Neuroscientists all say so. That's it. There is no evidence for the standard story, it's just what people were able to observe to date. There is exactly zero experimental evidence for a ticker-tape in every neuron, or a major RNA computer in every neuron, aside from the standard genetic one. This is why one should look. This model is much better fit to the data even barring any evidence, but the predictions are so many, that it is impossible to miss. With sequencing machines, one should be able to identify the RNA involved in the thinking, or rule it out without any problem. But you're not going to rule it out, it's correct.

Is the complete connectome enough to model the brain in silico? If not, what else is needed?

You should take the following with a grain of salt, because it is not (yet) supported by experimental evidence, but I state it, because it is the only possibility I can see given the theoretical evidence. Likely what is needed is the complete RNA sequences in all the cells of the brain, most importantly the synaptic RNA, because this is where all the actual computation is happening. Not the RNA for making proteins, not the RNA for regulating them, but RNA that is used purely for thinking. This RNA must be linked up to the electrochemical network to produce different pulses for different sequences, and it must read out the electrochemical pulses and convert them to sequence. The result is that each cell is an RNA computer with gigabytes of RAM, linked by a 3000 baud modem to a few thousand other cells, which read out the sequence of inputs and link up the computations as such. This model is new, it is an original idea, you won't read about it anywhere else. In order to make this work, you need to have a protein RNA complex which is sensitive to action potentials and transcribes neuron signals directly into sequence. It also requires an intracellular RNA-RNA computation, but this required for other reasons. The resulting mess means that the connections are only sufficient for simulating the communication overhead of the computation, it is missing the bulk of the computation. The amount of bulk computation is order 1 gigabyte per cell, and there are 300 billion cells, so it is staggering, far, far beyond any current machine. The reasons to predict this (it is a prediction, this hypothesis is not supported by direct evidence) is that brains are able to store memories, initiate action potential sequences that are coordinated, and their processing speeds are not consistent with the overhead processing speed of the communciation between cells. The cellular level models limit the brain's active memory to a number of bits equal to the number of cells, giving C. elegans a memory capacity of 300 bits, which is ludicrous. For Drosophila, it's 100,000 bits, still ludicrous. There is no way to explain why it is ludicrous without getting an intuition for what a 300 bit computer can do, so I can't go further, except urge the reader to experiment with a 300 bit machine until full understanding of the range of behavior comes (it doesn't take long), to see that it doesn't do anything, it's less than one cell nucleus.

Is there some physical activity in the brain which could not be in principle implemented by a machine?

No matter what the structure of the brain internal machinery, assuming there are no new laws of physics involved, and this is a pretty safe bet, then it must be simulatable by a computer, a regular Turing machine. If quantum mechanics is involved in a nontrivial way, which is theoretically all but ruled out, it will require a quantum computer. If quantum mechanics is involved just to generate random noise, it will require a computer with a random number generator, a Turing machine with a random oracle. It is not clear whether a true random oracle can be replaced by a psuedo-random number generator without loss. But it is not difficult to make a machine that outputs true random numbers, you just heat up a memory chip and read out the results. In none of the reasonable standard possibilities is it plausible or arguable that the brain has non-computable magic. The implication of this is that ordinary computation is just as magical as all the stuff going on in your brain. Even a limited encounter with computers supports this assertion, as the behavior of the programs is unpredictable and maximally complex. The model appears good so far. It must be added that some people don't like this conclusion, in particular Roger Penrose, and these people are forced to introduce convoluted ways in which a non-computable effect can affect the brain. Penrose has suggested that microtubules are sensitive to quantum gravity effects, but it is just because he doesn't accept that computation is the right language for thoughts. But under any reasonable interpretation of current knowledge, computation is the right language. There is not even an in-principle way you can make a non-computable effect in the brain. But the argument, although

trivial, seems to have been too hard for philosophers to grasp, so they continue to debate the issue.

What are some works, generally recognized as masterpieces, that people just don't get (or don't like), but are too embarrassed to admit?

I am not embarrassed to admit anything, but I am openly contemptuous of Heidegger. His writing is shit and his thinking is high class nonsense. For that matter, same with Nietzsche. Also Hegel. It all dates back to Aristotle. Actually, come to think of it, in the field of philosophy, past Plato, the only work that is not fraudulent is the work is that is not considered a masterpiece, and that nobody ever reads. The reason is that philosophy is not academic, it is political, and in political selection, the frauds always beat the honest practitioners.

What do physics majors think of math majors, other science majors, and humanities majors?

The physicists have an arrogant superiority, because they are brought up in a culture which requires and values brutal ruthless direct honesty, an asshole nature that is hard to learn and hard to maintain. Physics enforces this by requiring you to dress like a slob and be as plain-spoken and un-erudite as you can be. Some learn to do it better than others. The goal is to kill cultural authority, so that everyone sounds equally unauthoritative. Cultural authority is a poison, because it means that people can be led to accept arguments only

because such and so big-shot said so. It is required to verify everything in physics, and in science generally, or else the bullshit spreads like a cancer, taking over. This is especially important in physics, where the arguments are not always rigorous, and you need to develop a clear mental picture of where the calculational ideas come from. So you need to explain as plainly as possible, and you need to do so with homey metaphors and pictures, and in formulas that you make as simple as you can, by giving the simplest possible models to illustrate, and generalizing by example. If you try to present a physics lecture in a suit and tie, good luck to you. If you made a powerpoint presentation, people will laugh at you. For a technical talk, not a public lecture or colloquium, you always use markers and slides or a chalkboard, otherwise you obviously don't have anything to say, because you have way too much time on your hands. Among the physics superstars, Pauli took this ethos further, and cultivated the low-life, spending time in dive bars with the least powerful and most marginalized people. Keeping this tradition alive, Feynman kept himself honest by spending a lot of time with people without positions of power. People who are on the margins are generally blunt spoken and don't tolerate any bullshit, because they don't have to maintain a social position by social nonsense. A physicist can only hope to be as honest as these folks. Einstein was a bit like this, but less so, because his generation made the transition, and there was no physics culture in his day, he had to create it through being political and getting powerful. But Einstein admired Pauli most of the next generation, probably because Pauli was so good with General Relativity, but also because of Pauli's ruthless honesty. The advantages of this mode of discourse are so enormous, that physics has had a sustained revolution from the 1920s until today, with no precedent in any academic field. The physicist didn't do better than other academics, they left them in the dust. The physicists didn't just revolutionize physics, they spill out of the field. Richard Stallman was a physics major as a student, he got into programming through physics. Douglas Hofstadter was also trained as a physicist. The mathematicians are only now getting things in conformal field theory that were developed in physics in the 1980s. The mathematicians are generally extremely honest about

mathematics, they have to be for the arguments to work, but they are hampered by a culturally embedded intelligence fetish, and generally are snobby regarding culture. They will listen to Chopin, not the RZA. This is likely because the evaluation of their work depends on who they can get to listen, mathematics is an artistic thing, you often need to convince someone else that what you did is important. Physics has experiments, which mitigate this political aspect, and calculations, where experiments aren't able to probe. But this is the only problem with mathematician culture, the snobbery and elitism. It has caused problems, as certain bullshit is tolerated in math that won't pass muster in physics. The advantage of the physicist mode of communication is so enormous that I can't even imagine how other fields are able to survive. They just flounder around the same three ideas in endless debate based on this authority vs. that authority, stuff that physicists would resolve in 10 seconds of forthright debate with no holds barred and with a lot of cusswords. It is undeniable that fields other than physics are often stuck in appalling ruts, and this is just due to the inability of people to say "buster, you just don't know what you're talking about! This is complete horseshit." Pauli's honesty has been caricatured as autism recently in the character of "Sheldon Cooper" in the Big Bang Theory television show. This is just not true. It isn't a mental disorder, it is a reasoned and successful attempt to break through human limitations of authority which are hard-wired in by evolution, and must be resisted, like the urge to kill is resisted. Caricaturing physicist as mentally disturbed sociopaths is simply a not-so-subtle way of preventing this type of discourse from spreading, as it naturally does online. The internet makes Pauli style discourse naturally applicable to anything at all, it is very common to see lowbrow anti-authoritative honesty in any online discussion. A physics story has it that when Pauli died, he went to heaven, and the first thing he asked God to explain was quantum electrodynamics. God began to explain the theory, but He had not written three equations on the holy chalkboard before Pauli stood up and shouted "Ganz Falsch! Ganz Falsch!" (completely wrong). Pauli's other favorite phrase was "not even wrong!" ("nicht einmal falsch!") which he reserved for empty prattle devoid of any content. Pauli really created modern physics

culture, in his brutal selfless devotion to honesty. and his own unwavering, brilliant, penetrating research shows the degree to which this kind of honesty is able to produce progress. The backward steps in philosophy, in economics, and in other fields which lack a holy asshole like Pauli show that it is absolutely required for progress to happen. This doesn't mean Pauli was always right on all the technical issues, he made several famous mistakes. But they were never a problem, because he would always eventually figure it out, because he wasn't swayed by any type of social authority, not his own, not that of others, only by the technical arguments themselves.

What should I do to improve my programming skills in a short amount of time?

Learn assembly. This is what makes you fearless. You learn to love spaghetti code, jumptables and computed gotos, and complicated program structures like Knuth's co-routines (once you get coroutines, you end up doing this all the time in C, using gotos). Also, if you are ever stuck without a feature in any language, if you know assembly, you can implement it from scratch. If you write even a small program in assembly, and get it to work, you will learn more about real programming than a mountain of high-level stuff. It will cut through bullshit, like structured programming, or object oriented programming, and get you to focus on what the computer is actually doing, and how you can make it do this as efficiently as possible. Learning assembly is a bit difficult, because X86 syntax is so crufty. I learned on a 6502, which was cleaner, but needless to say, these skills are not so useful anymore. But you can do it if you use nasm, and stick to 32 or 64 bit only, no 16 bit annoyances. The 32 bit 64 bit instruction set is relatively clean. The skills you gain are incomparable, and they are kept hidden from programmers, who are made familiar with all

the programming paradigms except the one that gave birth to the field.

What are the most common clichés in fiction writing?

The name-discussion moment--- where a person discusses how they got their name, what it means, etc. For example, in "The Life of Pi". The only people who stress out about what people are called, other than just calling them that, are writers, because they agonize when choosing the names, and it's always heavy on their mind at the beginning of the writing project, so they sneak in the justification into the plot. No matter how long it took you to choose, the characters just are named what they are. So next time you feel the need to justify a character's name, don't. Nobody cares how you came up with the name, and if you agonized too much, it's probably wrong. Shakespeare never did that, by the way, and he called his characters crazy names.

Is there a tension constant of the space time fabric?

Space time is not a fabric under tension. This is a "rubber sheet" GR analogy, which is wrong in every respect. The best analog for this is the Newton constant, which tells you how much curvature per unit mass-energy density, but this is best taken to be one, so you just define the mass-density by the curvature.

What are good stories about World War II that people have heard from their grand/parents?

I only heard a few stories from my Hungarian grandfather concerning his war experience. A notable one involved his year of slave labor. His group was assigned to work on removing a rock-slide from some railroad tracks (they never finished), and it involved cutting out and hauling away 50kg slabs of rock at the bottom of a cliff, multiple times a day, with the standard slave rations: a bowl of soup and small piece of bread daily. At the top, armed Germans supervised. One day, someone couldn't take it, and just sat down, refusing to work. The Germans were too high up to know who it was exactly. So at the end of the day they lined them up and the commander asked who it was. Nobody said anything. Then he said, "You will each choose a number between 1 and 10. I will choose a number between 1 and 10. Whichever of you picked my number, they will take the punishment." There were about 30 of them. My grandfather chose "seven". But before the commander could announce the number, the offending fellow stepped forward and admitted his guilt. The Germans put him in the back of a truck and drove him away. My grandmother bribed the guards to let my grandfather go eventually, this was Romania, and it was easier to do. The lingering effects were a tremendous mistrust and paranoia towards all things involving government. He was scared of the Israeli tax agency, so he would sell his paintings at rock-bottom prices so he wouldn't have to deal with the taxes. He told me that he would still occasionally scan the corners of any room like a mouse, looking for any scrap of food that might have been dropped.

What is the easiest and fastest way I can take (and pass) a calculus course?

The easiest way is to learn calculus! You should start with the calculus of finite differences, an intro to calculus from this point of view appears in my answer here: How can/does calculus describe the movement of a particle? The basic idea is that you want to define the notion of "difference" and "sum" of a sequence. The difference of a sequence like 0,1,4,9,16,25,36.. is the difference of successive terms: 1,3,5,7,9,11,.. in equations, (n+1)^2 - n^2 = 2n+1. The fundamental theorem here is that if you add up the differences, you undo the operation of taking the difference: 1 + 3 = 4 1 + 3 + 5 = 9 1 + 3 + 5 + 7 = 16 etc. This is the fundamental theorem of derived sequences. Calculus does the same thing, except with infinitesimal displacements. So when you are thinking about a function like x^2, you consider (x+dx)^2, where "dx" is very little. The coefficient of dx when you expand it out is the derivative. The analog fundamental theorem is the theorem that the integral of the derivative is found from the original function. It's very obvious and easy to learn, but if you skip the finite differences, it can be daunting.

If an electron can be in two places at the same time, does that mean we can also be?

Joshua Engel's answer is incorrect, but I am blocked from commenting, so I will answer. Despite superficial first impressions, yes, it necessarily follows from quantum mechanics that you can be superposed over different positions, and these positions can be extremely different. It is true that your own wavelength is very small, but it is not true that your wavefunction is concentrated at one spot in

quantum mechanics. The reason is the linearity of quantum mechanics. If you are detecting a quantum mechanical electron, which is in a spin state "up", and you decide to go to Hawaii if you see it up, then you will end up in Hawaii for sure. If you have a spin-down electron, you stay in New York. But the linearity of quantum mechanics means that if the electron is superposed between spin up and spin down, you are necessarily, if quantum mechanics is correct, superposed between New York and Hawaii. This type of thing never feels strange, what happens is not that you end up superposed, but that you feel yourself to be in New York or Hawaii with a certain probability. But the quantum mechanical amplitudes are not probabilities exactly, so that this is a strange picture--- the electron is behaving quantum mechanically, so it can be superposed, but you never feel that you can be superposed. This is the problem Einstein noticed, and it was published by Schrodinger as the famous cat, and from this point on, people were confused about measurement. There are two possible resolutions, philosophical and physical. The philosophical resolution is to say that you end up superposed, but you can't feel superposed, because your feelings are classical computations, and quantum mechanical superposition can't be felt by classical computations, instead, it just feels like probability to these. This is self-consistent, and it is the Everett intepretation. It is also equivalent to just declaring that when you measure things, amplitudes turn into probabilities, and this is the Copenhagen version. The other possibility is that quantum mechanics is wrong for big things. We have no evidence that quantum mechanics is wrong, but we also haven't tested macroscopic entanglements of huge particles, because it is difficult to detect these sorts of things. If quantum mechanics is wrong, then it is possible that the fundamental quantities are probabilities, and then there is nothing mysterious about measurement, it is just revealing a hidden variable value. These hidden variables must be nonlocal to make the idea work, due to Bell's theorem, but this is not so silly today, because string theoretic holography shows that gravity is not local.

How do I derive Godel's incompleteness theorem?

A "book proof" of Godel's original argument goes as follows. Consider an axiomatic system which deduces things from axioms using a computer program (any axiomatic system will do). Suppose this axiomatic system can also prove theorems about computer programs (that's no big trick, computer programs are just big integers, the content of memory, changing according to definite rules at each time step). Then you can write the program GODEL to do the following: 1. Print it's code into a variable R 2. Deduce consequences of the axioms, look for the theorem "R does not halt". 3. When you find that the system proved this theorem, halt. This program will only halt when the system proves it doesn't. This means that the system either proves GODEL halts, in which case the system proves a contradiction (it proves the program doesn't halt, and also, the program halts), or else, it doesn't prove that GODEL halts, in which case GODEL doesn't halt, and the system can't prove it. It's completely obvious. To fill in the technical gaps, you just need to convince yourself that any program can include a subroutine to print it's code into a variable. The only tricky part is printing the code of the subroutine into the variable without an infinite regress, but this just requires duplicating a variable, it's a neat trick, and it's simple to do. Godel and Turing did something equivalent by providing the code to the program as input, but this is not necessary. The other technical gap is proving that there is a procedure to deduce the consequences of a system of axioms. This Godel proved in 1930, it is the completeness theorem of (first order) logic. The statement "GODEL does not halt" is equivalent to "the system is consistent", as was shown in the paragraph after (it's obvious, if GODEL halts, the system is inconsistent, if the system is inconsistent it proves everything

eventually, including "GODEL doesn't halt", at which point GODEL halts). This is the second incompleteness theorem. The final modification is to find a statement which cannot be proved, and neither can it's negation be proved. This is more subtle, because the system can prove that "GODEL halts" without any contradiction, because GODEL can still not halt no matter what the system says. The system would then not be inconsistent, only telling lies about computer programs. This is an "omega inconsistency" but not an inconsistency. To do this, write ROSSER: 1. prints its code to a variable R 2. deduces consequences looking for a. R does not print to the screen b. R prints to the screen 3. if it finds a, it prints "hello" and halts, if it finds b, it halts without printing anything The statements "ROSSER does not print" and "ROSSER prints" are both unprovable without contradiction, since either leads to a halting state which contradicts the proof.

William Shakespeare: What is your favorite Shakespearean work?

My favorite was Macbeth. I saw the Orson Welles movie before reading the play, and the imagery from the film version might have influenced my reading, but I like Welles as an interpreter of Shakespeare, I think he understood the guy. The reason I like it so much is because of the interplay of the psychology of husband and wife. The husband is reluctant to do evil, the wife is not. But it is the king that bears the consequences of his actions. The play is simple, it is a depiction of guilt, but the depiction is remarkable, because the slowly growing paranoia, you sense it. It is remarkable also because of the depiction of the effects of evil dissolves the solid foundations, so that rocks become unsteady, and even the trees of the forest will take arms against you. I am sure this play is also the original source of all the countless times you have seen somebody disguise himself as

shrubbery in some comedy, like Monty Python. You know the deal, when they put some twigs and bushes on their body. Although it only appears in parody today, in the play, surprisingly, the same device works as drama, because the king is psychologically paranoid enough to have lost touch with reality, and this reveals how weak his mind has become. This is my favorite authorly device to date, because it is something that works only in fiction, but it works as fiction and it is fiction of the highest calibre, where the events are made to harmonize and reveal the psychology, it isn't a series of events. But I haven't read "Merry Wives of Windsor" yet, maybe that's better. there's lots of them I haven't read.

Have just read a stat that says only 35% of Iowa Republicans believe in science -- either evolution or climate change. How do we restore the belief in science among Americans?

Science doesn't require belief, it requires skepticism. The reason people are skeptical of evolution is because of false claims in the evolutionary biology literature, like the claim that mutations are random, and that the mechanism of evolution is relatively stupid, and doesn't have any teleology or sophisticated design. This doesn't pass the smell-test for a lot of people, so they reject all evolution, because it is associated with the idea of blind evolution without any sense or thinking. That doesn't mean they don't know that we are related to chimps. It just means that they mistrust the biologists, because the biologists pretend a much greater degree of knowledge about the mechanism that separated us from chimps than the evidence allows. The mechanism is somewhat mysterious, it could be largly sexual selection, and the mutations could be thought up by RNA networks in

the egg cell. Darwin was agnostic about this stuff, it is only later biologists who pretended certainty about these things, and created the fairy-tale that evolution proceeds through cosmic-ray induced DNA breaks with bad repair, and then the best allele fixates. If you ask people "do you believe that all life is related through a common ancestor" you will get a different answer than if you ask "do you believe in random point mutations in proteins plus gene fixation through differential survival is the only cause of changes in species characteristics over time which led to the diversity of life". The first is a no-brainer, and it is probably believed by a solid majority of republicans, or else they say "What the hell do I care." If they don't believe it, you can convince them in 10 seconds, by just showing the morphological similarity and genetic similarity of humans and chimps. But I think they already know. To fix the political problem with evolution, one must separate out the God issues. Evolution is a powerful tool for atheists, because it makes a literal reading of the Bible impossible, but it is not required. For centuries before Darwin people didn't take the supernatural nonsense in the Bible literally, they just propagated it for the ethical lessons. So the moment you find a way to keep the ethical lessons, ethical God and all, then you can have consensus. But if you promote things that are contrary to people's direct experience of an ethical God directing human actions through mysterious mechanisms, they will just never agree with you, because it would be like denying the existence of their right hand. The ethical stuff is completely distinct from the idea of natural evolution, it doesn't care one bit about dinosaurs or allele fixation, or genetic networks. It can be preserved even without the supernatural stories in Genesis. But it is also true that the evolutionary story is extremely incomplete without understanding the computational aspects, and the teleological aspects, which are minimized by certain biologists who have a social agenda which is to get rid of religion. Maybe people should get rid of such and so religion, maybe not, it certainly is not a question which is clarified by studying trilobyte anatomy, but by considering the ethical lessons of the religion. For climate change, you need to explain the climate model: CO2 heat-trapping, the theretical link between CO2 and global temperatures, that it is experimentally

verified through studies of venus (which would not be much warmer than Earth, except for it's atmospheric composition), the empirical undeniable link between CO2 and Earth temperatures in ice-core data, and the experimental data from having done the experiment of CO2 emissions for the past half-century, and seeing warming consistent with an upper-mid-range prediction of the model. These things take about half an hour to learn properly. This are only problematic because the evidence is not discussed, instead, people talk about stupid politics and who believes what and who stands to benefit. This is completely irrelevant when discussing these things, and should be put aside. Just study CO2 heat-trapping and the experimentally known coefficient which tells you the warming per unit CO2 in the atmosphere, and you will get a sense of how undeniable global warming is. I should point out that this was roughly known as early as 1970, and it was stupid to deny global warming in 1970 just as it is today. But back then, there was no scientific consensus, and many experts all said it was hippy rubbish. The reason to believe it is not the consensus, it is because the arguments are sound. There is sometimes consensus without sound arguments, but global warming is not an example.

Is science a reliable source for truth, or does our constantly changing knowledge of science mean we should regard it as 'scientism'?

The knowledge of science is no more constantly changing than your knowledge of language. You might suddenly realize one day that "naive" doesn't mean "stupid", it means "innocent of a type of knowledge", and then suddenly you know something new that changes your interpretation of a lot of things. Does that mean you don't know english? Science is a reliable source for truth, you just have to deal

with the fact that we keep learning more. There are plenty of things we are rock solid sure about, like the fact that water is made up of an atom of oxygen and two of hydrogen. The problem is that some knowledge is fake, and is just bullshit masquerading as science. You can tell, because the evidence is nonexistent, or falls apart under close scrutiny. An example is the belief geologists sometimes profess that oil is cooked from biological matter over geological time-scales. There is exactly zero evidence for this position that withstands scrutiny, and it is dogma just because people didn't have any better ideas, and oil company people prefered it to be true. In the Soviet Union, people realized relatively quickly that oil comes from the mantle, where it is cooked from methane. But this doesn't mean that the mantle doesn't exist! Or that oil is made out of sugar! It just removes an area where there was ignorance, and replaces it with secure knowledge backed by evidence. Then if people ask in the future "where does oil come from?" You can say "from the mantle." And when they ask "How do you know that?" you can give an actual answer, rather than give nonsense.

How do we restore trust in science? How do we know who to believe anymore? Medical students are given lunch by pharmaceutical companies. Scientists are bought by industry.

You don't have to trust anything. Just ask the scientists what their evidence is, they'll tell you, and then read it with a critical eye, asking questions. It only takes a few readers to do this with an honest back and forth to get rid of all the bullshit, so long as they are willing to call a rat a rat. It makes no difference who it is, you need to review the

evidence objectively yourself. Usually it takes only a few minutes, but sometimes a little longer.

Who are the greatest guitarists in the history of rock and roll? Who is #1?

I don't like to rank order, but you asked for number 1, and I live in New York, so I know who is number 1: 1. Glenn Branca Here's more Branca: If you've heard any new super-duper interesting completely new sounding electric guitar music since 1981, it's alll based on the guitar vocabulary he invented and perfected, the alternate tunings, the hallucinated overtone melodies, the orchestral effects. His music took over the whole world, but he is not usually recognized for inventing it, although he got a big grant last year. Pre-Branca, there's Robert Fripp, Steve Hackett, Shuggie Otis, Frank Zappa. Post Branca, I can't compare, he stands out so much. He was rock and roll to begin with, although he tends towards more classical stuff now.

Who has the best singing voice in Rock and Roll History?

I think it's Dexter Romweber on the low end Tomas Antona at the helium end. I only left this for last because I don't know if this counts as rock and roll. I think her voice is the best in the world (not the girl in the picture, the singer, Falguni Pathak): You use the present tense in the question, knocking several folks out of the running.

What laws of physics have been derived by computers but are yet inexplicable to humans?

The most maddening example for me is the 11-dimensional supergravity action, which was derived using computer algebra (in 1978! I think they had Veltman help out with the code) to close the supersymmetry on shell. This became so important later, that it leaves a bad taste in your mouth to have a crazy action with a bunch of terms with crazy coefficients that are uniquely determined, but the only reason that you can give for what they are is "computer said so". If you want stuff which is established with certainty by simulation, but the rigorous understanding is far off, there are too many to list, most of condensed matter physics has unjustified arguments. But usually, it's qualitative stuff that you learn from the simulation, or quantitative details, the main argument you can heuristically justify so that humans can understand why things are as they are. I don't know how to do that for the supergravity action.

Does string theory make any predictions that can be tested empirically? Is string theory falsifiable? Does it have to be falsifiable? If it's not falsifiable, can it be considered a scientific theory?

String theory contains a lot of conclusive experimental results in domains that are specialized, where it is not a theory of everything. I

will start with those. The most interesting ones are those that apply to the strong interactions, where string theory is just the self-consistent complete version of Regge theory, where the only things in the theory are Regge particles (families of bound states that are related to each other). This is just string theory applied as a phenomenological description of QCD. But as a phenomenological description, it makes lots of predictions that are difficult to make knowing the QCD Lagrangian only, because it includes information about the spectrum of particles. Strings make a very good theory for the parts of QCD that perturbative QCD is terrible at, namely the stuff happening in collisions at low energy or close to the beam line. Perhaps the signature prediction of Regge theory, and also the first, was that the proton-proton total cross section (meaning the total number of collisions at any given energy between two proton beams) is equal to the proton-anti-proton total cross section. This prediction is strange, and it is not derived fully from QCD. But it is understood in Regge theory to mean that there is a trajectory called the "pomeron", which is a closed-string trajectory in string theory, which has no charges, and is exchanged to give the total rising cross sections in the strong interaction. That the pomeron has no charges is verified experimentally at Fermilab in the 1990s, and it was a major major triumph for early proto-string-theory. But it is not advertized, because all the people who worked on this phase of string theory were kicked out of academia, and not allowed to publish papers. Some of them work at accelerators, and they grumble every once in a while that the Pomeron is correct, dammit, and Regge theory does work, double dammit, but the field theorists who won the academic battle don't listen to them, mostly because they were confused by Regge theory as students, because it was too hard to explain without an internet (it's very easy to explain with an internet). But in addition to this, the string/Regge theory of hadrons predicts the scattering behavior near the beam line (fixed t at high s, meaning closer and closer to the beam) should fall off as a particular sum of power-laws, relating to the different types of mesons that can be exchanged. These predictions are verified routinely, and are used in accelerators to deal with backgrounds every day. Modern accelerators are more interested in large-angle events, the near-beam region is a non-perturbative mess. But it is here that the Regge description shines. The string theory of hadrons also predicts the spectroscopy of highly excited meson states should come with partner resonances which are given by the shaking of the string linking them. This can lead to strange effects, for example, a strange charm-neutral meson at some few GeV which tends to decay into c-u c-bar-u or c-b c-bar-b, strange because it is as if it was designed to make charm! The explanation I heard at a job talk is that this thing is a "tetraquark", meaning, it's a loose bound state of c-u and c-bar-u-bar (the light quarks are not so important). But S.H.H. Tye pointed out that such a loose bound state could not exist, because the lifetime was less than the orbital period. He suggested instead that the object was a string resonance in a c-cbar meson, where the excitation of the string pushed the c-c-bar further apart than usual, so that it tended to fall apart into c-u c-bar-d (this is from memory). This idea was a much better fit to the particle properties, and string theory predicts the exact number of such "crazy resonances" which don't fit at all into the phenomenological constituent quark model, which is just plain wrong in predicting the number and types of high-energy states. The successes of Regge theory and string theory in this domain are too numerous to list, it is the domain where string theory was proposed and discovered. The mathematical results of string theory are also too enormous to list. String theory, as a mathematical theory, led naturally to mirror-symmetry, holography, supersymmetry and supergravity, topological strings, and a million other mathematical applications which demonstrate it's mathematical self-consistency. The mathematical self-consistency is far from trivial to establish, because the theory is not defined from a starting point, like a field Lagrangian, but by constructing a self-consistent description in different asymptotic domains. The consistency was far from certain until complete descriptions were defined in certain backgrounds, AdS spaces, and 11 dimensional M-theory on a light-cone, described by D0-branes. But you probably want a conclusive result of string theory as a theory of everything. So far, because we don't have our vacuum, we are limited here to results of a very general nature. But there is at least one such

result: the mass of the lightest charged particle must always be less than it's charge in natural units. The units mean that two such particles should repel electrostatically more than they attract gravitationally. This is demanded from general principles of black hole decay within a holographic theory. For the usual charges we see in nature, the electric charge, it is not very powerful. Sure, two electrons repel, but they repel more than 40 orders of magnitude more strongly than they attract! That's a far-cry from "greater than", it is so much greater than, it turns the inequality into a joke. But the inequality is not a joke when you consider possible undiscovered electric charges, of a new type. This rules out undiscovered gauge charges that would stabilize the proton, because either these charges must be too strongly repelling to evade detection, or else there is a very light charged particle, so destabilizing the proton anyway. There are other general bounds of this nature, they are classified in Vafa's "swampland" program. They are weak results, but they are informative, and they are good predictions for new phenomena. When we find our vacuum, we will be able to make much better predictions. But if there is no low-energy supersymmetry, this might be very difficult, because it will mean that all our experience regarding previous string constructions will not help in finding the vacuum at all. So people will have to look for principles in non-supersymmetric stable vacua, and there are only a handful of such vacua that have been studied (an example is the nonsupersymmetric SO(16)xSO(16) heterotic model of Ginsparg, Moore and collaborators). But it is my opinion that there is still at least one more major model-independent prediction that one can make uniquely string theory which does not require us to get lucky, like find a small black hole or a monopole by accident. This prediction is simply the one for the emissions of highly rotating or highly-charged near extremal black holes. In both classical GR and in string theory, such black holes look shiny and reflective. In classical GR, if you throw something into a rotating or highly charged black hole, it just bounces out after travesing the interior, but it bounces out into a classically disconnected "other universe". In string theory, there is no other universe, so it either never comes out (unjustified consensus), or else, it comes out in our universe later. I am sure it's the latter, but I can't

calculate exactly how much later. This is something you can only calculate using string theory as a theory of gravity. The gluing of such black hole universes together requires that rotating black holes can emit stuff reflected as anti-matter, and this might explain the signature anti-matter signal at the galactic center. The issue with this prediction is that nobody has worked out the details yet, it is a personal idea of mine that I am pretty confident is true from putzing around, but until I know the precise gluing, I won't persuade anyone else.

How does Euler's beta function lead to string theory?

The Euler beta function was proposed as a tree-level scattering amplitude for open strings by Veneziano, although the string picture came later. Veneziano was attempting to make a scattering theory for particles on Regge trajectories The idea here is that you want to make a consistent probability amplitude for two strings to attach and fall apart into two strings again. The mathematical amplitude for this process needs to have a pole whenever the incoming momentum is just right to make a particle on the intemediate stage. there is a particle along the phenomenologically known straight line trajectories: s= aL + b where s,t,u are Mandelstam variables for scattering, L is the angular momentum of the intermediate state, which is allowed to be a continuous variable, the constant a is a universal constant for all the different mesons, which are the open string states, it is the Regge slope of mesons, and b is a constant that varies from trajectory to trajectory. So you want a pole at every integer spaced positive s. The function with integer spaced positive poles is [math]1/\Gamma(-s)[/math], this has poles at positive integer values of s. But you also know that t-exchange is similar to s-exchange, so that there is a pole at every value of t exactly the same. The precise principle is Dolen-Horn-Schmidt duality, or world-sheet duality, which says that the amplitude needs to

be written a sum over poles either in the s-channel or the t-channel. So you can consider [math] 1/(\Gamma(-s}\Gamma(-t)[/math], so there are poles at integer s and integer t. But now you have a problem that there is a double pole at every doubly-integer position, when s and t are both integers, and double-poles are to be thought of as a sum of two infinitesimally displaced poles with opposite sign residues. You can't have negative residues in quantum scattering, the residue is a probability. So you need to get rid of the double poles. This is by inserting a factor of [math]\Gamma(-s-t)[/math] in the numerator. When s and t are both integers, you get a zero, which cancels one of the poles leaving a simple pole. The result then has Dolen-Horn-Schmidt duality, you can expand it independently as an infinite series of poles in s or t, and the residues are polynomials of the other Mandelstam variable, which has a simple interpretation as exchanging a combination of particles of a certain spin, determined by the order of the polynomials. The result behaves physically correctly, it has the so-called "Regge behavior" at large s and angle closer and closer to the beam line making a fixed t, meaning there is a superposition of power-law decays of the amplitude which is determined by the Regge trajectories you can exchange. This ansatz (that is a scientific term for educated guess) needs to have the argument inside the beta-function rescaled to be the actual Regge trajectory function, with the actual Regge slope a, and the constant b is determined by self-consistency (at a crazy value that makes the lightest state a tachyon, this is a bosonic string theory amplitude). Then you get a mostly consistent scattering amplitude when you symmetrize this Euler-beta function over the 3 different cyclic permutations of s,t,u. But there was still a ton of work to do to make a theory. The Euler beta function is the continuous analog of (the reciprocal of) a binomial coefficient, but this way of looking at it is not particularly useful when doing string theory. The insightful thing about it is that it has an integral representation: [math] \int_0^1 x^a (1-x)^b dx [/math] This has an interpretation as a sum over possible attachments of two linear objects into one, at a position determined by x. Veneziano determined the scattering amplitude for higher states has a similar integral representation, except inserting a function of x in the middle somewhere, this is the

Vertex operator. The resulting amplitude had a generalization where you integrate over the upper-complex half-plane, and this was the closed-string amplitude (called the "pomeron amplitude" in the early string literature) of Virasoro and Shapiro. The vertex operators were analytically continued into the complex plane by Mandelstam, who reinterpreted the string scattering as a 2-d quantum field theory on the worldsheet. Many people converted this scattering amplitude into a consistent S-matrix for scattering of open and closed strings both, but it requires a lot of physical insight, because the Euler beta function is just a simplest case of scattering, and you need to relate the scattering to more comprehensible physics, and the string picture inroduced by Ramond, Susskind, Nielson, and Nambu was essential for this. But the original idea was a phenomenological way to get scattering with integer spaced poles on straight lines, and this is what started string theory. Gamma function fits were done all the time in the 1960s, after Chew and Frautschi showed that the straight-line Regge trajectories described the known mesons, and this was verified as new mesons were discovered.

What are the disadvantages of being insulting in arguments?

Insulting doesn't work to convert people, and it doesn't work to convince people that you are right. but what it DOES do is level the authority playing field, so that an idea that is heckled and dismissed suddenly is given equal weight (at least temporarily, until people evaluate the objective evidence for themselves), because it is refusing compromise and standing it's own ground. For example, consider this: You CAN'T POSSIBLY believe that the government sent people to the moon! You moron. It's an obvious lie! This doesn't persuade anyone, of course, there is no factual statement there. But people stop and say "Hey, wait a second, this person is never going to change their minds,

they acquired certainty somehow, and whatever the mechanism, maybe there's something in it". I chose an example where there is nothing behind it, and when you check it out, it doesn't pan out to anything but a bunch of sincere but wrongheaded misinterpretations of evidence. But in other cases, there is substance behind the attack, and then the hostile tone and creation of divisions serves a purpose--- it makes it clear that the person will not compromise, and this is an actual fight, and it forces people to pick sides. Most people HATE to pick sides, they would rather first know which side to pick, so it creates a moment where people say "I just won't say anything, so as not to rock the boat". In this environment, you can have a level debate between a mainstream theory that is accepted by all the experts and a new or marginalized idea that is rejected by the experts. The marginalized idea is always ridiculed, I heard it happen many times, but always by experts, behind closed doors. The ridicule in the other direction, by people towards experts, is just plain taboo, it is socially forbidden. This is why it is important to break this taboo, when there is an important insight that is missed by the experts. You have to stand up and say, "I am sorry, but these accredited folks who claim expertise are nincompoops and dimwits". A particularly clean example is the claim that the Sun goes around the Earth. But that's a long time ago. Another equally clean example is the claim that petroleum is made from decayed living things, rather than in the mantle. This latter claim is still announced by geologists to be fact, when it is not only not demonstrated, it was demonstrated about 50 years ago that the opposite is true. In the Soviet Union, where this was not held up as dogma, the scientific consensus swung, through powerful and undeniable evidence, towards the abiogenic theory, and stayed there. The heckling of those out of power by those in power must always be equally balanced by heckling of those in power by those outside. I can do this with no problem, I enjoy confrontation, and I especially enjoy heckling powerful idiots, because it's one of the only times you can be nasty, and be doing ethical good at the same time. By "powerful idiots" I don't mean people who make mistakes, this is not deserving of heckling, everyone makes mistakes. It is when you correct the mistake, and the correction is not acknowledged, or political reasons

are made up to reject evidence, or some other dishonest method of discourse. Honest academics never do this, but then again, honest academics are rarer and rarer. It is impossible to have a level discussion about controversial topics without first leveling the playing field like so. If you are dealing with a person who is an honest academic, they will not care at all about the tone or insult or any of that, they will find the technical points, and start talking only about these. But for the public, there is still a gap in training, so they need to see some committment, somebody willing to stake a reputation in an idea, and defend it to the death, and this requires confrontation and taking your lumps. Like all good works, you are always punished for this, but you should do it anyway. So, yes, there is a disadvantage, you sound like a fool, but it is ethically required. If you are defending a wrong position, someone will explain to you why, and then all you have to say is "oops, sorry, I goofed". Except if you do it long enough, you will mostly know when you goof and when it's everone else that goofed.

What are the implications of fluid dynamics mimicking quantum behaviours?

This is interesting, but it ultimately doesn't resolve the mysteries of quantum mechanics so much, because the waves in quantum mechanics are not in physical space, they are in a higher dimensional configuration space. The configuration aspects are what makes quantum mechanics weird--- two electrons are waving in the 6 dimensional space of their possible relative configurations, 3 electrons in 9 dimensions, and so on, so that the number of variables in the description grows exponentially. That's the big mystery. But this does give a physical analog of the deBroglie-Bohm idea, of particles carried on a wave somehow replicating the quantum statistics. That's really cute, because until now, this was just a theoretical idea.

Who is Ron Maimon?

I'm a physics grad school drop-out working in theoretical biology but I still do physics when I get a chance, but not right now because I am in a middle of a project to understand the properties of a certain virus as completely as possible. I went to fancy schools as a young adult, but never had an interest in a degree or making money, or anything except dropping some new science, something which I did on rare occasions. I feel an obsessive need to contribute something, if only to pay back with due respect all those people of the previous generations who broke their brains over centuries to make the mind-altering stuff that relieved my own adolescent angst so completely. I live in New York City.

History of Science: What is wrong with positivist mindset?

There is nothing wrong with a positivist mindset, it is the correct mindset. But you have to realize what it is saying really, that it isn't as different from other positions as it might sound at first, that it makes space for God, and beauty, and truth, that it just eliminates bullshit, and it keeps these God, beauty and truth, but only exactly to the extent that they aren't bullshit. The law of positivism is that you are supposed to make every statement meaningful by comparing the sense impressions that you would experience given the statement being true, and it being false, and then, if they are different, test the statement by seeing which impressions actually are impressed upon you, and if they are the same, the question is fundamentally meaningless. It means that

metaphysical questions are mostly nonsense they way they are formulated, they do not have objective answers, they are not questions. So when you ask yourself "what created the universe", you are just blathering, similarly as asking "what lies beyond the cosmological horizon". But it doesn't mean that you can just formulate your world view only using observable stuff, because you need some framework of stuff to give conceptual relations between observable stuff. Just because you can't see 'potentially important idea' with your direct senses doesn't mean that there aren't any such things as potentially important ideas. It just means that this concept is defined in a nebulous way as a class of testable statements about ideas, and how they will evolve. The point of positivism is to allow you to freely switch between metaphysical frameworks without a headache of feeling all your world is turned upside down. The metaphysical frameworks in positivism play the role of a coordinate system in physics, or a choice of gauge in electromagnetism, they are free choices that are used only to set the language and external framework you use for making predictive statements, and you can translate all the results, all the predictive statements, to any other metaphysical framework that is consistent, just like you change coordinates, or change gauge. So, for example, there is the question of solipsism. Am I the only conscious being? This is unanswerable, so positivistically meaningless, at least if you define consciousness metaphysically (it's trivially answered no if you define consciousness computationally). So any argument that you make about anything, including how to behave, should be freely translatable to the solipsist coordinates just as well as to any other. The nice thing about positivism is it makes sure that you are formulating yout arguments correctly, because translating to "solipsist" is a tough exercize! For example, when thinking about ethics, it is difficult to explain why you are buying life insurance when you are in solipsist mode, and your wife and children don't exist. But once you make a correct argument for buying life-insurance, and for me, the only correct argument is the superrational one, then it is possible to translate the argument, since it ultimately doesn't depend on metaphysical statements, only about statements of correlation of behavior, which don't depend on metaphysical assumptions. So to me

a positivist is a solipsist who buys life insurance, who is a Christian the next day, and a Buddhist the next, and sees no contradiction. This is actually a very rich and human way to be, and it is not limiting, it is freeing.

Does it really take centuries for oil to form? Under conspiracy theories, has the oil industry created a false shortage to make more money?

Oil is not likely to run out, because it is formed abiogenically, although whether it will run out depends on the details of the abiogenic process, whether it is fast or slow. That oil is abiogenic is not an opinion, there are no other possibilities, the evidence for biological formation of oil is a goose-egg zero. It's nothing. It's just geologists made it up. The evidence for abiotic formation is conclusive, it was painstakingly accumulated in the Soviet Union over decades, and has been conclusive since the late 1960s. But it was a Soviet theory, so people in the west opposed it politically, and continue to oppose it, with no evidence, the same way as they opposed heliocentrism. This means these bozos need to be heckled publically, called idiots to their faces, and prevented from publishing, i.e. the same thing they do to their opponents. This doesn't mean we should burn all this oil, we'll cook ourselves in our own emissions. But it does mean you would be stupid to wait for oil prices to go up by themselves, and so stop global warming. Oil prices are not going up anytime soon. The level of bullshit in the literature in this field is intolerable, it's an entire field of morons deluding themselves by circular citations. Further, they have the GALL to pretend in public that they understand the process of formation of petroleum, and they claim this loudly, without a shred of real evidence. They are also wrecking our ability to understand the deposits of metals in the crust, the ones which are dissolved in

methane. to understand the carbon cycle of the Earth, since limestone is the terminal stage of carbon, to understand the proper formation of coal and peat, and to understand the biochemistry available for the origin of life. It is the worst scientific bottleneck in geology, and a crime against science. The geologists will see a fossil in coal, and date the coal based on this fossil. They will see trace protein products in oil, and consider this evidence of the original biological things that formed it. The alternative hypothesis, that the fossil was already there before the rock turned to coal, or that the biomarker is formed by bacteria living in oil, they cannot consider, because it is politically taboo. Finding the proper theory was difficult, even within the Soviet Union, because the false bullshit theory is promoted so heavily. The first person to suggest that oil is not biological was Mendeleev, but it was Kudryavtsev who formulated the modern idea in the Soviet Union. The reason was Kudryavtsev's rule: oil is found next to coal, and along with natural gas and other hydrocarbon compounds. This is not surprising by itself, but in the biogenic theory, oil and coal are formed by completely seperate hypothetical processes. Oil is from marine stuff, and coal is from land-plants. But they are found next to each other. I will give just a little bit of the overwhelming evidence for abiogenic formation, more was listed by Thomas Gold, in "The Deep Hot Biosphere", and in the Russian literature, it was already established fact in the 1970s. First, the chemistry of oil is completely different from the chemistry of biology, it is long chains with an aromatic fraction, and completely different chain-length distribution and aromatic fractions than anything in living things. There is no known or even speculative path to take bioresidues and make oil, it just can't happen chemically. The lipds are chains in living things, the aromatics are in proteins. You have to have magic that remixes all the carbon chains together, it's ridiculous to contemplate. There are claims in the literature for people making oil from kerogen. They are not making oil from kerogen, but from what THEY call "kerogen" which is a long-chain hydrocarbon gooped up as a tar in rock, which is chemically dehydrogenated petroleum and nothing like kerogen. This is probably the precursor to coal. Kerogen is clearly biological, it is full of Nitrogen and Oxygen. It has a little bit of lipid. You cannot turn

kerogen into oil, because you can't get rid of Oxygen, that's un-burning fuel. You can't segregate Nitrogen. it's all wrong, this is what I noticed independently, and then I thought "is this stuff really biogenic??" TL;DR: There are biological residues, and there is petroleum, and they look nothing alike chemically, and you can't go from one to the other. Certainly there is no known path from one to the other. The oil is also contaminated with heavy metals, and radioactive elements, and it is often full of Helium gas. These things, expecially the Helium is a smoking gun of deep Earth origin, because He is formed from radioactive decay. There is no way around this, Helium would only get into the oil if it was seeping through a deep underground source. There is no just-so story you can tell as to why the oil is contaminated with He, it's open and shut, and this is why Gold was positive he was right. The mechanism for cooking methane into oil in the mantle is known--- under matle pressures, methane is thermodynamically unstable to forming short chains. These short chains then progressively dehydrogenate into oil and finally shales as they percolate up through rock, in methane. The shales can dehydrogenate into coal over geological sclales, perhaps, or perhaps the coal is precipitated out of the methane as it percolates, but it turns rock to coal, fossils intact. You can see this, because the fossils cross a coal seam somtimes, right through! They were present before coalification happened. There is nothing to argue about, because the mainstream account is so brain dead. The carbon cycle of the Earth is closed this way, because limestone can be recycled back into the atmosphere through methane. The sheer quantity of methane emitted is vastly greater than any biogenic theory can accomodate, so people have already been forced to conclude that methane is abiolgenic in the west. The paths of seepage of methane through rock are the reason for the formation of various geological veins, the heavy metal deposits. There are two fluids competing in rocks, not one, water and methane both carry different elements to different places. This idea unlocks the mystery of geology, I look at rocks with new eyes since I read Thomas Gold's book. The biogenic idea has not a leg to stand on. One must be careful of compromise: remember that the so-called intelligent people in Copernicus's time didn't believe either Copernicus or Ptolmey, they believed a compromise, where Mercury and Venus go around the sun, and the other planets and the sun go around the Earth. Compromise is stupid, and the truth doesn't come in shades of gray. It is not true that some oil is formed this way and other oil is formed that way. ALL oil is formed abiogenically, and it is time to replace your geology department with some Russians and Ukranians.

What are the advantages and disadvantages of the Internet as a platform for discussing ideas?

The advantage of the internet is that it is for the most part, not censored. This means that views which were beaten up politically can flourish now, and when the are correct, they beat up the politicians back. This scares the bejeezus out of academics, because they know how much bullshit there was in each of their academic fields, all encrusted up on top of itself, they had to dig through it to find out the worthwhile stuff. So they have their arms in the air, going "oh, no. What am I going to do now? They know! They all know!" There is nothing to do, except honest, original research, what people should always have been doing in the first place. It may mean that your bulshit-encrusted papers will be deciphered more quickly, all the better. If you have something to say, you have nothing to fear. When I first saw usenet, it was the early 1990s, and then the major thing I was aware of was that Everett had solved the "problem of measurement" within quantum mechanics in 1957, and nobody was giving him credit for it or understanding what he was saying. Instead, more and more people were reformulating his ideas is more and more obfuscated and mealy-mouthed formulations, trying to overcome the political resistance, by making his philosophical position less obvious. I also knew what had been done to him, and it was outrageous. So I went to sci.physics, and I began to shout very loudly that the measurement problem was solved, that Everett solved it, and that people should stop

saying it was unsolved. To my surprise, I found three other people saying the exact same thing just as loudly (Michael Price, and a few other people-- they were the usenet "splitters"), and a few people arguing for new theories (Paul Budnik was an honest guy, but with a weird isolated oint of view). There was also a well known professor (John Baez) who sheepishly admitted that he used to say the same thing about Everett, but had stopped saying this, because he was surrounded by a bunch of unruly teenagers saying it more loudly and more forcefully. But he stuck up for the young people, and slowly Everett got recognized. By 2000, his work was an established classic, and measurement in quantum mechanics solidly moved to the philosphy department. This gives a young person a sense of accomplishment, although I am sure I didn't play any major role in this, all the young people did it collectively, through a bunch of loud internet indignation. You can see the Wikipedia page on "many-worlds" for the modern presentation, which is very fair to Everett's ideas. So I was relieved. The problem was obviously going to solve itself. I also immediately felt the weight of social constrictions lift, since I realized I was free to do whatever research, and nobody could ever prevent it from getting said or recognized. Not publishers, not academics, nobody! But then I had the problem that original research is hard! So I spent a long time trying, getting some minor results, working with a nice collaborator (Jennifer Schwarz), who always was thinking about interesting down-to-earth things, and always being dissatisfied with the marginal significance of the results. Although, in hindsight, one of our results was pretty good, it was an explanation of solid-on-solid phenomenon of static-friction. But, it's the internet era, it's time for you to do something big! This is what I would tell myself, but of course, it's not like you can do something big on demand, you need to have an idea first, and it has to pan out, and so on, and then work out consequences, and publish, and each step is months upon months of intense labor. And I had other things to do. But I noticed the revolution in science that was going on around me. The string theorists got their act together and solved the problem of nonpertrubative string theory in certain domains, that was as soon as they got arxiv. The mathematicians were resistant for a few years, but

then went online, and they had a revolution that still isn't over, and will continue forever really. The biologists went online with the genome, and this is where a large chunk of the revolutionary new science is happening right now. The philosophers finally got their comuppance for the nonsense they promoted for 4 decades, rejecting their own best folks. The thing is, the internet is so much better as a platform for discussing ideas, because of the lack of censorship, that there is no comparison. It's like the invention of writing, it's the invention of a medium where there are no barriers to publication. This means that political orders are denied their most important tool for suppressing ideas, which is rejecting things from print. The other thing about internet discourse is that it is free from social conventions, it is rude and hostile. This makes it ideal for getting at the truth quickly, because people are not inhibited from saying what is right. Further, they are not anxious about getting a bad reputation for backing a wrong horse, because online, retracting your bad idea is a simple matter of saying "oh, yeah. Sorry. I goofed." This is still embarassing to some academics, mathematicians hate being wrong, because they are supposed to be rigorous. Scientists still associate being wrong with losing funding and ending up on the street, instead of learning something, so you have this resistance. But it's collapsing, because if the scientists don't do it, then all that means is that non-scientists are going to be the ones doing all the science. Because the internet is so much more efficient than print media. It's the biggest revolution of our time, and it's still going on. The next generation of websites will be even less censored and hopefully more rude than the current ones, which are still bound by traditional notions of etiquette obsoleted by the new medium. The last thing is that the internet kills television, the one-way internet. That's good, because television was controlled by a tiny bunch of rich people, or else by a tiny bunch of government bureaucrats, who decided what they whole world would know. That's wasn't as good an idea as it sounds.

What do logical positivists think of falsifiability?

"Falsifiability" is a stupid attack on logical positivism, by replacing a word with another word that means the same thing. The Popper argument that you can't verify, you can only falsify, fails on close examination. A falsification is simply a verification of the negation. But often when we make statements like "all swans are white" (the traditional example), there is one direction that gives a lot of information about the statement, namely seeing a black swan, and another direction that only gives marginal information, like seeing another white swan. So there is this bias. This bias is simply the result of the vast number of things in the world. So seeing another white swan just doesn't adjust the Baysian confidence in the statement, but seeing a black swan immediately adjusts it to nearly certainly false (you have to make sure it wasn't a swan painted black, or bad lighting, etc). Both verifying and falsifying involve induction. To make induction precise, you need a notion of computers. The notion of Occam's razor is then formulated in terms of Kolmogorov complexity, the simplest program that predicts the results of observations is preferred. Then the Baysian method assigns confidence to the different simple programs. This is the complete positivist framework of verificationalism, made precise, and there is nothing wrong with it, scientist use it without blinking every day, and there is no barrier to universalizing it to everything, it works to discriminate between bullshit and knowledge in every domain. But the notion of falsification was politically handy for people like Popper who justifiably hated the Soviet Union, or other forms of totalitarianism. So they could point to Popper and say "see, this position is nonsense". But this is politics, the position is not nonsense, the totalitarianism is the nonsense.

What are the failings of materialism as a philosophy?

Materialism is a philosophy which is falsely equated with positivism. Materialism is analogous to the mathematician's statements that one should not introduce a coordinate system. The traditional idealists argue about which coordinate system to introduce, polar coordintes or rectangular coordinates. The positivists says "yes, you need a coordinate system, but each is as good as any other, so long as the material relations it predicts, or the sense impressions in your mind, are identical". This resolves the debate for good. It isn't materialism, because it admits a coordinate system, you are allowed to take any metaphysics. It isn't idealism, because it doesn't care which coordinate system you choose, so long as you can translate everything back and forth. This resolves the old debate, time to move on to other things.

The logical positivists wanted to create a philosophical system free of any metaphysical concepts, which they considered spurious. But in chemistry and physics, isn't energy a metaphysical concept?

Energy always manifests itself as weight on a scale, you put any energy on a scale, and it weighs. That's it, you're done, that's a positivist definition. The notion of logical positivism is simply to make the following axiom of thought--- two propositions are equivalent when the sense-predictions that they predict are equivalent. This is not the same as saying metaphysical things don't exist, or do exist, or whatever. It is saying that the two positions regarding the

metaphysical thing are equivalent, and one must be able to freely translate between them, the same way physicists can change gauge on electromagnetism, or choose a new coordinate system for General Relativity (or anything else). The inconsequentialness of these metaphysical propositions then becomes reflected in their answer--- you can take any answer! The point is not that you don't need metaphysical constructions, you sometimes find it handy to have a coordinate system, try doing physics without coordinates. The point is that the arbitrary choice of coordinates doesn't begin to dominate your thinking, you restrict your attention to the things that improve your ability to make predictions or statements about measurable attributes, things you can see or touch. Logical positivism is an axiom of thought, so it doesn't require proof. It is sometimes said that "positivism is not verifiable, so it makes a contradiction", but this is stupid and intellectually vapid. There is no reason to verify positivism, it is a definition of what it means to verify everything else. Further, positivism is perfectly compatible with everything, because it is just jettisonning unmeasurables, and allowing you freedom to maneuver between different metaphysical scaffoldings, different coordinate systems, with no need to make any commitments as to whether they are true, just like you can change coordinate systems without any worry that you have the false coordinates. This allows you to formulte religion, philosophy, etc, in ways that are satisfying and remove the major problems of the past. The only reason to oppose positivism is political. People sometimes don't like the positivism politically, because accepting positivism makes it far too easy to think for yourself, avoiding all the political bullshit.

How should I study math?

Read classic rigorous pedagogical authors. I like Serge Lang from the older generation, Terrance Tao does similar things today on his blog.

Lang is good for all the simple things, his generation formulated mathematics within set-theory from the ground up, in the Bourbaki project, which essentially should have been called the "Lang/Grothendieck project". Tao is good for more modern things, because he usually blogs as a prelude to some original work. Read ALL the books on a subject, there is always one with a different good presentation that everyone else forgot or standardized away. For example, the "bisection" proofs of the intermediate value theorems and mean value theorem are good, but modern proofs introduce point-set concepts like connectedness and compactness. I read these in 19th century calculus textbooks that were collecting dust on shelves, but they made the basic ideas clear. For more advanced stuff, Milnor is good for geometry of the mid 20th century. It is always best to read literature about a discovery from the era when the discovery was made, not the later "simplifications", and "generalizations". The generalizations first obscure the basic idea, which is always clear originally, because someone had to come up with it, and then the simplifications don't simplify the idea, they simplify the generalizations, which are obscurantist. This is how math books become opaque, through wrong-headed too early over-generalization, and simplification of the generalization. Don't worry about how simple a proof is to read, worry about how straightforward it is for the brain to understand. When both criteria are met, when you have a simple, general formulation, you have what Erdos called a "book proof", a proof from God's book of theorems. Never be satisfied until you know a book proof for the theorem in question. So always, always, read the historical literature. It is much easier than the modern literature, because people back then were stupid and ignorant (not their fault, all the interesting stuff was discovered later), and you can become fluent in it more quickly, This is good practice for becoming fluent in the modern literature. You need to learn to "unpack" proofs into the construction that is involved, to know what the proof is saying really. It is no good to memorize the proof, you need to understand the construction, and this will motivate the proof. I will give an example of unpacking: consider the proof of the Jordan curve theorem. This is proved in modern books always in the same way: by noting a paradox

regarding some homotopies (I forgot the details of standard presentations, but I remember the idea, I unpacked it). The proof is obscure, so much so that mathematicians consider it difficult! They tell students it's a hard theorem. It's not hard, it's trivial. First, you should prove it yourself in the differentiable (or piecewise linear) case, by using the original demonstration from the end of the 19th century. If you pick a random line from a point, the number of intersections with the curve is even or odd, according to the insideness or outsidenes. If you cross the curve, obviously this changes by 1 unit, and if you count intersections by their "sense" (the orientation which they happen by), you can't have a number of intersections which is different from 0 or 1 without the curve having a self-intesection, as you can see by turning the line by 360 degrees, and seeing how the intersections meet and annihilate (they have to come back to their original position at the end). This is a sketch, but it's easy to fill out to a proof in the differentiable or piecewise linear case, and the singularity sliding method is a baby version of more sophisticated later constructions in higher dimension using Morse theory, due to smale, which proved the higher-dimensional Poincare conjecture. Why doesn't this work as a modern proof? Because the theorem is also true for continuous Jordan curves, which can be very wild, they can have positive Lebesgue measure (another easy 19th century construction you should do for yourself, it helps to know how to construct a space-filling curve). So you want a proof that works for continuous Jordan curves, where the number of intersections with a line is generically infinite. The modern theorem is proved using a general method involving homology groups which look complicated, but only because they are generalizing to arbitrary dimension and to a general formalism for obstructions. If you read Munkres' proof, the only computation involved is of the winding number of a map from a circle to a circle, which is an integer, which tells you how many times the map went around the circle. So the actual proof is just a simple winding number construction. What is it? It turns out that the winding number of a Jordan curve around a point can be easily seen to be either 0 or 1, depending on whether the point is "inside" or "outside", and this can be easily related to the differentiable case

proof, because this winding number changes in the proper way when you go along a line and pass an intersection (this is easy to prove). So this is the generalization for the continuous case. You can then explicitly prove the Jordan curve theorem in an ugly way using winding number, and construct the winding number yourself, using your favorite homegrown method. This will make the proofs in the textbook obvious and intuitive, although they will be annoying, because you will think they are obscuring something simple for no good reason. To generalize to higher dimension, you need to learn how to define homology, so that you know the abelian notion of sphere-winding. This is NOT equivalent to sphere-onto-sphere homotopy classification, but it's the same thing when the spheres are equal dimension, and it's the "right" thing to study anyway, in that it is more regular, and any computation of homotopy proceeds through homology in any case. When you are finished, you have an ugly personal proof, but this is not the main goal. The personal proof has made all the literature stuff clear, because you see it is just standardizing the personal proof so that it can be applied without thinking to a large number of cases, and in a way that is completely standard between different authors. This is the thing that makes mathematics difficult. The ideas can only be discovered by a personal process of ugly construction and half-baked personal proofs, but the final result is an elegant machinary, that you can learn in a half-assed way by studying the formal proof, without understanding any of it. The goal of mathematics education is to force you to break down and reconstruct all the theorems for yourself. The easiest way to do this is simply to explain theorems to others. You can do this through teaching, you can also explain it to yourself, close the book, and present the theorem on your own, with no notes. The mathematicians hide their concepts through this mechanism, but they expect each other to unhide their theorems, by reconstructing it themselves. The mathematicians have some historical presentations too, which help with things that have acquired modern obfuscation. Also, you shouldn't bother with some theorems which are just make-work. For example, in knot theory, there is a notion of "isotopy" which is difficult to make precise, but whose only purpose is to prove that the

reidemeister moves are fine for computing knot-motions. You should learn how to do the differentiable case, because it is easy and is the motivating thing, but the generalizations to the continuous case are not so insightful, and generally serve as make-work for mathematicians who are at the moment unable to find a new idea. You also need to get over the hump of the political bullshit. So you need to learn infinitesimals, constructive/Soviet mathematics, ordinal analysis, and all the secret things that are politicially hidden. But this doesn't take long. You also need to trust your own intuition, because it is easy to snow a person with a lot of complicated symbols that don't mean anything. If you are intellectually honest, it is easy to ask questions and figure out what the gibberish means, and then it stops being gibberish.

My friend claims she had an IQ test and scored a 180. How do I deal with her bullshit?

If you study the problems for 2 days, you can score 180 too. It's very simple, the IQ testers have the imagination of gnats, it's the same 3 problems over and over and over again. She was probably telling the truth, but it doesn't say anything about her abilities.

How can you get people to be comfortable with a controversial idea?

To get them comfortable with a good new idea is the opposite of getting them comfortable with evil. Evil things are simple and natural,

so long as they are not exposed, or shouted about, they help you out when you silently go along with them. Good ideas are things that hurt you, and they can only win out fully when you get a free open public debate that exposes all the issues. So you need to just keep going, developing the controversial good idea as far as you can, with blind determination, ignoring the opposition, they don't exist. Then when you talk to people, just assume the person is already comfortable with the controversial idea, make it sound like everyone already knows all about it, and keep making fun of them when they don't get it, telling them "what, you don't understand this obvious thing? What's wrong with you?" Eventually, either they convert, or they convert you. Nobody can withstand this kind of thing for long without starting to argue, and then shout, and once the shouting starts, the truth becomes obvious, because social niceties are out the window.

Who is the best physicist ever?

I would nominate Joel Scherk, if not him, then John Schwarz, or from the previous generation, Stanley Mandelstam. If you had to pick out one person who was most responsible for us being so close to knowing the theory of everything today, it was this guy, or that guy or perhaps the other one, they were all in parallel developing the strangest, most fruitful idea in physics. These people discovered the theory of everything in 1974, and pressed hard for it under trying circumstances. Scherk is unique for having been so madly productive in such a short span of time. He died under unclear horrible circumstances in 1980 at the age of 33. His collaborator and friend, John Schwarz, is still around, still pushing string theory forward, and he is the only person who has continuously followed the whole field from the beginning to now, making contributions throughout. Most recently, the M2-brane action. Scherk's early contributions were the reduction of string diagrams to Feynman diagrams, the reduction of

string theory to nonabelian gauge theory, simultaneously with Yoneya, him and Schwarz discovered that strings describe gravity, and then formulated toroidal compactification, T-duality, and revived Kaluza Klein theory. Scherk went on to construct the supersymmetry projection in the then-known string theories in collaboration with Gliozzi and Olive, and then in collaborations with others, the 11 dimensional supergravity theory which is the foundation of M-theory. By 1980, everything was there except the Green Schwarz action, and once this happened, it was clear that superstrings worked, all that was left to do was to convince the doubters.

What was the most concerted lie ever told by mathematicians?

Mathematicians have propagated an outrageous lie for nearly a century. Through pure politics, by alienating and isolating dissenters, and presenting a unified front to students, they have made it a dogmatic unchallangable truth that there exists a non measurable set of real numbers. It is sufficiently outrageous and so manifestly, obviously, false, that if the general public were aware of the issue, it would cause a mathematical version of a coup. Unfortunately, it is hard to explain the issue properly to a mathematically untrained person. When I say the mathematicians claim "existence", I am not saying that they claim "putative existence", nor do they claim "existence relative to axiomatic system X", rather, they have decided that such a thing just plain exists. This lie can drive a person away from the field permanently, because it is so egregious. A nonmeasurable set of real numbers is a set for which the words "what is the probability of a randomly chosen real number being in this set" just don't make any sense. If you draw a cube in space, and pick a random point inside the cube, by flipping coins for the successive binary digits, the probability that this number lands in this putative

"non-measurable set" doesn't mean anything. That means that mathematicians are saying that it is inconsistent to pick a number at random by flipping infinitely many coins for the binary digits. That doesn't bother mathematicians on the surface. They don't bother with picking random numbers all the time, nor do they think about it too often because their training avoids thinking about such random things, precisely because it's a headache in the axiomatic system they standardized on. But it bothers everyone else! Especially physicists. The injunction that randomly chosen continuous things don't make sense is also never applied in practice. So mathematicians will show you pictures of randomly picked functions, like a typical Brownian motion, even though the very notion of a "typical brownian motion path" doesn't make sense, because there are non-measurable sets of paths in their imaginary world. It is so useful and obviously consistent to speak about randomly chosen continuous things, that mathematicians do so, without any regard to the fact that such randomly chosen continuous objects are inconsistent, at least not when chosen to arbitrary precision. It has been known for 50 years already that it is not true, that it is consistent to assume that there are no such sets. The demonstration that this is so, that it is consistent that all subsets of the reals are measurable, comes from simply formalizing the process of picking number at random, and showing that it makes full sense and is compatible with all the axioms of set theory, but not with a certain axiom regarding choosing real-number-many points at once. This was done by Solvay in the 1960s, although the paper came out in 1972. When you learn that it is consistent to assume that there are no non-measurable sets, it is tantamount to knowing that there are no such sets in any objective sense. If there were such sets in any objective sense, you couldn't deny their existence and stay consistent. But mathematics is often built up axiomatically, and depending on your axioms, these sets are either present or absent. In the standard axiomatization of ZFC, it a theorem due to Vitali that non-measurable sets exist. The way it is proved is to identify collections of points inside the real numbers which have the property that by translating them and putting them together disjointly, by fitting equivalent pieces together, you end up filling up all the points in a volume. The

construction in Vitali's argument is particularly transparent, but they are all the same. They rely on considering the real numbers as an atomized collection of points. The question is very annoying now, because it's been a long time, and measure theory, the theory of probability, is important in ways that it hasn't been before. So I encourage people to revolt against this mathematical tyranny, and leave behind the shackles. It's ok to talk about probability, and you don't need to go around proving particular sets are measurable. All sets are measurable.

Why is it said that scientists are yet to combine Quantum Mechanics with Theory of Relativity? What does that involve?

You asked "why is it said", not "why it is". The reason it is said is because whenever anyone does anything, a large number of stupid people try to suppress it. In this case, this is suppressing the work of string theorists, especially Joel Scherk and John Schwarz, who were the first to understand how to combine quantum mechanics with General Relativity. They were also simulataneous results of Tamiaki Yoneya. General Relativity is combined with quantum mechanics in string theory, this a mathematical fact, at least perturbatively, and a certain scientific fact in certain backgrounds that are supersymmetric even nonperturbatively. But people want to deny the string theorists credit for several reasons. 1. They were the wrong type of people, they were leftists and weirdos in smaller institutions different from the big centers of physics. 2. Some of them were opposed to field theory, and believed the strong interaction was fundamentally a string theory in the 1960s, this wasn't right. Quarks and glue make a field theory, and field theory does make sense. 3. They were just so much smarter and harder working than everyone else, and everyone else didn't want to

admit it, especially after it became clear that everyone else was right about point 2 and they weren't. But people resent a great discovery, and will do anything to hide it from the public and from each other. So they continue to say whatever, and blind themselves to the scientific achievements. This is politics. One issue with combining General Relativity and quantum mechanics is that geometry needs to end up in a superposition, and we can't enumerate "all possible geometries", because the number of 4-dimensional geometries is infinite in a way that cannot be enumerated or classified on a computer. This was a theorem in the 1980s--- any group can appear as the fundamental group of a 4-dimensional manifold, so deciding if two 4-dimensional manifolds (geometries) are identical is uncomputable. Another issue is the potential lack of a good vacuum. Witten showed that a spacetime that looks completely fine, the Kaluza Klein circle space, is actually unstable in quantum General Relativity, in the semi-classical approximation. There is a tunneling process where the whole space turns into a "bubble of nothing" that grows out at the speed of light. The general problem of making a vacuum is hard, because General Relativity path integrals don't have a way of easily rotating to imaginary time, with a definite lowest-energy state which you know in advance. A third issue is short-distance issues. At short distances, General Relativity is not renormalizable, meaning that there are more and more kinds of processes that become important, and the theory is probably meaningless. The fourth issue is black hole information. Black holes have an entropy proportional to their area. If space is continuous with fields defined on it, 'tHooft showed that the entropy of a black hole would be infinite, from the frozen field modes right by the black hole. String theory solves all these problems for good. It solves the black hole information problem by being an S-matrix theory, this was how it was discovered. This means it doesn't describe space and time except as interior reconstructions, it only describes particles coming in, scattering into particles coming out, through a description which is well-defined only on asymptotic states. This also solves the uncomputability problem, because there is no sum over geometries, only over asymptotic states. It solves the renormalizability problem by being finite, because the sum over asymptotic states does not

reproduce detailed collisions at well defined space-time points, but smeared out collisions that are never fully localized. The supersymmetry in string theory solves the vacuum uniqueness problem, you can show that Witten's instability is cancelled out by Fermionic modes in the string theory version, because of supersymmetry. The string theory computations can be continued to imaginary time with no problem, at least perturbatively. The non-perturbative formulations are not complete in all circumstances, but the methods are clearly completely different from continuing a field theoretic path integral. So the problem has largely been solved. But that doesn't mean we know string theory describes out universe, only that string theory is capable of combining General Relativity and quantum mechanics. Still, this means people should stop saying what you say they are saying.

What are some objections to Searle's Chinese room thought experiment? In other words, what are some counter arguments to John Searle's arguments against strong A.I.?

The ordinary objections have been explained by others--- the whole thing is a level-mixing, it is taking an extraordinarily complicated process, running an algorithm which passes a Turing test, and pretends it is a simple process of shuffling some notes around cabinets. Then it puts a person in the room, doing the shuffling, and notes that the person shuffling notes gets no insight from doing this rote process. So what. Your neurons don't have any insight either, individually. This is conflating the understanding of a person in a room with the understanding of the room itself. You don't need the person in the room. You could have an automated robot doing the shuffling of

paper, then it's the question of AI. Whether a person or a machine is doing it is irrelevant. Neither subpart is understanding, it is the algorithm itself which is doing the understanding. The objection Searle gives is essentially the same as one of the objections Turing lists in his "Turing test" paper in the 1940s. Turing gave the Turing test as the logical positivist definition of thinking, and the whole reason it was interesting is because it seemed obvious to most people that computing machines could pass the Turing test. For Turing, this meant it was obvious that machines could think. For others, this was evidence that the machine would pass a positivist test for thinking without doing any actual thinking. But the proper intuition should have been that it's next to impossible to pass a Turing test! The idea that a machine can easily fool a human into thinking the machine is another human is absurd. It is clearer today, when we interact with people and bots online. If you interact with a person, you know it is a person. If you are unsure if it is a person or a bot, it is either a very mentally ill individual, or it is a bot. There is no way to fake a remote conversation using a bot, it doesn't work at all, the bot is too rigid in the responses. The reason is that the bot is too simple, it has much less memory and procesisng than a human brain. From this, and human brain biochemisty, and plausible hypotheses about where memories are stored, you can get an idea of the memory and processing of a brain. I believe it is of order gigabyte per cell, or 10^20 bytes per brain (neuroscientists generally estimate a billion times less, but I am sure they are wrong). The intuition that people have against Turing tests then is founded in something reasonable. The reasonable thing is that the compressed text of a conversation is at most a few kilobytes of data, while the thing that is being described by this text, the communication, is enormously larger, 10^20 bytes. A few kilobytes can only paint the most impressionistic of pictures of this brain, so it is concievable to people that the program can fake it, by manipulating only a few kilobytes of input and producing a few kilobytes of output. The point is that you can't fake it. If you ask a person to do complicated internal visualization, there is no way to produce the input from the output. For example, here is a hypothetical Turing test: "A woman walked into a hospital. The doctor said `your heart sound

fine'. The woman said `oh that's a relief'. The doctor said "Oh wait a second, I didn't hear you, let me get this thing out of my ears". What did the doctor have in his ears?" The computer has to imagine the scene accurately to produce the answer, requiring an enormous computation. You can go on, it's easy, most of the things we answer require an enormous internal model that is only revealed in a sketch in the communication with others. You can't fake 10^20 internal bits without any internal computation of significance. But it is this idea, that you can do it, that Searle is exploiting. He is imagining a computation of a few kilobytes, that a person can do by hand, and then pass a Turing test. Such an algorithm would be in a library of books the size of which you can't imagine, with a person working the lifetime of the universe just to get the first answer out. All this just to produce a few bytes of answer. The reason is that already 1 kilobytes of answer is essentially infinite, because the number of possible sentences is exponential in the length and even a kilobyte might as well be infinite.

What's your view of homeschooling for the gifted?

"Gifted" is a political label which is an excuse for separating out the children of the bourgoisie from the children of the proletariat and educating them differently. There are no special gifted children, the children who are labelled gifted are no more gifted than anyone else, except they are given a more satisfactory education. No child should be home schooled, because learning from peers is better than learning from adults, and home-school is more controlling and less amenable to child rebellion. This is why parents like it, but it is also why it is the reverse of education. Mathematics is rebellious, science is rebellious, and these things can't be taught at home, because adults are not rebellious, they are sheep. I was never gifted in the US school system,

probably because my family was not relatively well off at the time of our immigration. Nevertheless, it was trivial to learn what the gifted students were learning, and I was happy to learn it independently, and politically, I found the label repugnant, and I preferred not to have it attached to me. I went to a fancy university, and nearly all the students I encountered there were labelled gifted. For the most part, this meant that they were social schmoozers with no technical skills at all. Some technical students might accidentally end up being labelled gifted (not many), but then they will be seen to not have "leadership skills" and demoted to normal education. Gifted training is bourgoisie training, social training in being on the top of the heap, and this bourgoisie training is not a useful skill, mathematical training is a useful skill. The goal is to get technical skills into students, whatever label you apply, and this is something one must do universally, because these skills at the grade school and university level, everything except for original research (which by definition is original, and so requires extraordinary effort), are simple and easy to learn by anyone, so long as the teaching is effective and there is a student culture that transmits knowledge. The "gifted" education is worst for the so-called gifted, who are made to feel that the nonsense they are learning is somehow special, and get cocky and complacent. It is a mistake to teach based on politics or segregation. Everyone needs to learn the moronic elementary skills that schools teach in the gifted programs. There is no way to fix the selection process to be egalitarian, because whatever the mechanism for separating out the gifted, the bourgoisie parents are class conscious, and they will figure it out, and train their children to pass, and will complain loudly when their children are not separated from the hoi-polloi. The gifted programs are stupid, and there is no reason to implement them. If a child is self-taught and really accelerated, this child can skip school and go straight to University, and there is no need for any special program.

Is Ron Maimon related to the medieval Jewish philosopher Maimonides?

I guess there are on the order of 10,000 people named Maimon, it's like the "Whitehead" of Israel. Half are from Eastern Europe, half are from North Africa. I got the name from my Turnisian father. Both sides of the name-group claim in family lore to be the direct descendents of Maimonaides, I have no reason to doubt this story, they were probably a large clan of relatives dispersed in the 1492 Spanish expulsion, and I suppose some fled east and some fled south. There are at least 3 "Ron Maimons" in the New York City area alone, as I learned from getting my purchases confused with theirs. My brother works in academic Neuroscience, but our interests evolved not so independently, since he keeps teaching me all sorts of interesting biological things, and he is one of the few people who always listens sympathetically to my theoretical ramblings in biology. My mother was an education academic who took a certain stance in the so-called reading wars, but I was generally alienated by the constant political squabbling in this field. I became familiar with academic politics from editing my mother's writing when we moved to the US, since English was a fourth or fifth language for her. She was very good at maneuvering in bourgeoise society, having been born in communist Eastern Europe, and so hated communism that she had a great love for all things bourgeoise. Whenever anyone would say "bourgeoise" in a derisive way, she would always say, "I am bourgeoise", and I would always chuckle at this. We would argue a lot. The Maimon half of my family is generally practical, I am not so practical. There are some who made money in the US, some who started businesses in Israel. My father was an electrical engineer in Israel, he is now a real-estate fellow here. He was responsible for getting me interested in science. My grandfather on my mother's side was a Hungarian visual artist who never became well known outside of Israel, Hungary, and Germany, and for me, I was happy that he knew Erdos through a mathematician family friend in Tel Aviv. One of the happiest encounters I had was meeting Erdos before he passed away, through

my Hungarian grandmother. I am pretty sure that Erdos thought I was a total idiot, because my grandmother said "he likes math and wanted to meet you", but he wouldn't discuss any mathematics with me, I was young and snotty, I suppose he was put off by my alienation and ego. He just repeated some Erdos-isms I had already read in books, and then went back to work with his colleague. my uncle on my father's side owned a carpentery business, my aunt on my father's side married an electrical engineer. My relatives generally acquire real-world skills, academic skills are a luxury for people who are not seriously worried about ending up on the street. In the North African community, the Tunisians supposedly have a reputation for scholarly stuff, as I learned from an Algerian neighbor in NY, but I don't know how deserved, it's like a national thing, like "French people are good at cooking". I generally am kind of isolated from my family since we emigrated to the US.

What is a Maximum Entropy Object?

It's a black hole. It's the object with the most entropy you can fit in a region of space. The reason you know that a black hole is maximum entropy is Bekenstein's argument, if you had more entropy in a region of space, just irreversibly make it collapse (or throw it into a black hole) and you have decreased the entropy.

What is a string?

A string is a small quantum mechanical version of a classical one-dimensional extended black hole, with a charge equal to its mass. It is

a fundamental string when it's coupling is weak. meaning it is light and long compared to the Planck scale. The "charge" here is not a usual charge, where the black holes would be point particles (D0 branes in modern string jargon), but a vector potential with an extra index, a 2-form potential. The ordinary electromagnetic 1-form vector potential tells you the quantum mechanical phase of a particle going along a path, the 2-form vector potential tells you the phase of a space-time sheet. The extremal black holes (the ones with maximum charge) in a gravity theory with a 2-form potential are one-dimensional strings classically. Quantum mechanically, when they are long and light, their interactions become weak, and they are described by traditional string theory. If you have higher form vector potentials, you have higher dimensional sheets, and these are the branes of string theory. Because they are all black holes, their oscillations describe everything else in the theory. This is why string theory has a lot of different equivalent formulations, you can formulate the theory around any of the black holes in the theory. The reason these highly charged black holes are important is because they are cold, they don't have a Hawking temperature. This means they can be in a pure quantum state, and you can describe them precisely. The reason strings are emphasized is historical--- strings were the easiest idea to make mathematically precise in the 1960s, and had connections with strong-interaction physics.

Why does the value of G, speed of light and other scientific constants not vary?

The value of "G", the speed of light "c", Planck's constant "h", Boltzmann's constant "k", and the electrostatic constant "epsilon naught" are constant because they define the system of standard measures and weights. There are 5 measures we choose arbitrarily, the meter, second, kilogram, Coulomb (actually Ampere, but whatever)

and Kelvin. If you choose the mass, length, time, charge units appropriately, these constants all become 1 (or 2pi, or 1/4pi, depending on your convention). So these are simply the constants that explain how to convert our units to natural units. Once you have a dimensionless natural system of units, you can sensibly ask whether other constants vary. It makes no sense to talk about dimensional constant varying. The (square of the) electron charge in natural units is called the fine structure constant. The mass of the proton in natural units is something ridiculously small (like 10^-20), and so on. Then you can ask what makes these constants what they are and why they don't vary. To explain the role of standard measures more concretely, I might redefine the meter to shrink by one cm every year. Then the speed of light varies suddenly every year. This is not abstract, if you define the meter using the radius of the Earth, and the second using the rotation of the Earth, then the speed of light would keep going up every year, because the second would keep getting longer and longer. because tidal friction keeps slowing the Earth's rotation. We don't want that headache, so we define our measures so that these constants are constant, because they are really not there, they are really 1, in natural units. If the G constant were easier to measure, we would use it to define the Kilogram, but it's hard, you only have a certain amount of precision, so it isn't taken as a definition, instead, you have this block in Paris that defines what a kg is supposed to weigh.

Why don't schools and textbooks use non-standard analysis to teach calculus?

There is no reason for this, and it is denying students proper deep understanding. I learned from a rigorous book, and I was annoyed when I found out about infinitesimals, because it made everything completely clear. I had no problem with epsilon-delta, I just didn't like hiding other ideas from the student because this is just a shameful way

of dishonoring Liebnitz's memory. The idea of infinitesimals can be explained simply as follows: you consider a real number e with the infinite list of axioms $e<1$, $e<1/2$, $e<1/3$, and so on. You can't run into a contradiction from any finite number of such statements (because there is a standard e satisfying such statements), therefore you don't run into a contradiction with the infinite set of statements. This is the compactness theorem of logic. But you know that there is no e which is smaller than $1/n$ for all n, you can prove this formally in the real number system. So you see that the formal proofs never describe the range of possible models accurately, at least not when talking about real numbers. The formal proofs only describe the properties true of the models accurately, not the symbolic structure of the models. So you now know that it is logically possible to extend any system of real numbers to include e. Now you can ask, what is $(x+e)^2$? This is $x^2 + 2xe + e^2$. The coefficient of e is the derivative. The only difference between this and Abraham Robinson is introducing the concept of a standard submodel of the nonstandard model, and defining a projection to the "closest standard part". This is formal, and makes everything rigorous, but it's also overkill, the ideas are pretty obvious once you understand the simple construction of a nonstandard model. The axiom of choice was never used in the construction of the nonstandard model, it's just a model theoretic way of extending standard models with extra infinite list of axioms, and it's trivial. The only reason people trot out choice is to make the procedure look scary. The thing is easy, it was clear to Leibnitz (who defined infinitesimals much in this way), and the only reason it took until the 20th century is because you needed formal logic to prove the compactness theorem to show that nonstandard models make sense. The axiom of choice only comes up when you try to make this construction without logic, and without explicit models for the reals, and then try to define nonstandard models within standard set theory without admitting the the reals are model reals. There is a way of doing this which requires the axiom of choice. But it's a stupid thing to do. Just learn logic and give up on the stupid unsupportable idea that your axioms model the unique "real" reals, whatever that means exactly.

Who are some self-taught prodigies who made important advances in well-studied academic fields?

The most prominent example in physics might be Julian Schwinger. Schwinger was a prodigy as a child, and much more prodigious as an adult, he was one of the major founders of the first phase of modern quantum field theory. The reason he developed independently is that Bohr commanded that he be left completely alone to do whatever. His papers are difficult, because they are very original, and they are full of equations that are misleadingly formal, because inside there are hidden these large intuitive qualitative intuitive leaps that are hard to grasp, because there aren't any pictures directly. But these equations contain a very different perspective on the classical field theory results of the 1950s. He was eclipsed to a certain degree by Richard Feynman, another great physicist of the same era, because Feynman's methods were more visually clear, and perhaps it is unfair that Schwinger wasn't more widely read, but he won the Nobel prize, and people knew about him, so you can't complain too loudly. The one thing Schwinger learned from another person was the path-integral, he got that from Feynman. But he extended it to a full formalism, by going to imaginary time and working with the Green's functions. Schwinger's calculi are not completely contained in Feynman's diagrams, because they include an implicit algebra on local fields which admits differentiation and multiplication. This was partly clarified by the operator product expansion, which gave the multiplication rules, but you don't deal with the differentiation rules in operator products, and you need to differentiate consistently too, to get the Schwinger terms and anomalies. You can compute the anomalies without this, just by working out the explicit diagrams, but I get the feeling that Schwinger knew the complete differential algebra of local fields, without having

to work out a different regulated Feynman diagram for each failed classical identity. But Schwinger is one of many. The list in physics alone is enormous, including Pauli, Majorana, maybe you would say Edward Witten. But Schwinger was probably the last great physicist who worked in complete isolation from everyone else. His total isolation didn't go too well after 1972, at this point he retreated to his own world, source theory, which wasn't really anything different from field theory, except it worked in a field-space Fourier transform. But it wasn't wrong, and he liked it a lot for some reason, possibly because he was happy could always treat all theories as effective field theories by neglecting sources with fast variations, I never quite figured out why he thought sources were so deep. I suppose that's the pitfall of being self-taught, you trust yourself, because you did everything yourself, and sometimes you only rely on your natively evolved flora and fauna, and don't admit outside fauna, for fear of damaging the ecosystem, even when it is highly evolved stuff, and might actually benefit the ecosystem.

Can mathematical thinking be taught? It's possible to become better at math, but is it possible to actually become a mathematically minded person? I love maths, and I want to pursue graduate studies in math.

Of course it can be taught, otherwise no one would know it. Mathematics is not at all natural, there are isolated cultures like the Piraha which have no mathematics at all, they lack words for counting numbers, and this is probably what all human cultures looked like until the agricultural revolution. There is not a single person in these cultures, no matter how socially skilled or well-spoken, who has any

mathematical skill at all. Unlike language, socialization, visual arts, music, which are ancient and universal to all human cultures, mathematics evolved very recently, probably just after agriculture, in tandem with reading and writing. So it is extremely unnatural for the brain, your brain will revolt, just like it revolts when you try to learn to read. But you have to remember, it's the same for everyone else! We are all in the same boat. The difference in achievement is mostly due to a deep commitment from the individual to practice internally, with intellectual honesty, until full understanding comes, and not to accept being ignorant of something that someone else knows. This takes time and dedication, and it requires exposure to good literature, and extensive practice in original mathematical thinking, even when the result ends up being well known and sub-optimal. It also requires knowing what you know, so that you don't read things that you can't understand and fake it (although you can do that at first, as a way of figuring out what you don't know, it should be a prelude to going over it again later with the goal of reproducing it internally in a completely original self-derived way). You can go through mathematics historically, and you can recapitulate the whole history in a few years of single-minded dedication, by first learning Euclidean geometry, then algebra, then coordinate geometry and calculus and infinite series, differential equations, group theory and linear algebra and complex analysis, then rings and fields and differential geometry, early 20th century stuff, then algebraic geometry and stochastic stuff, and all the diverse things mathematicians study today, with number theory running throughout. If you study it deeply, each topic can take a lifetime, but for the main results, you just want to know the classic results, the stuff that is sufficient for 80% of the applications. This is the traditional method of mathematics education, and it's important, it's good to do. But there is also a shortcut today--- you can learn to program a computer! This is how most people acquire fast mathematical literacy, and the computer has caused a revolution in technical literacy, and an attendant revolution in mathematics. There are more deep, difficult, conjectures that have fallen in the last 2 decades than at any other time in history, and they keep falling left and right. It's like the second reneissance in mathematics. If you learn

to program, there is no way to avoid fluency in the most important parts of mathematics eventually, it comes with the project. You need to understand algorithms, counting, recursion, coordinate geometry (if you are doing graphics), differential equations (if you doing simulation), discrete groups (if you are doing permutations), combinatorics (from everything), Kleene algebras (from regular expressions), and number theory (from cryptography). You can implement and get intuition for finite fields, lie algebras, anything, with just a little work. Further, the mathematics you will encounter will not be musty stuff that smells 300 years old, but new exciting stuff, where nobody has any idea how to proceed reliably, like the 3N+1 conjecture, cellular automata, fractals and renormalization, logic, things that are close to the complex questions you expect from mathematics in its most natural state. The only thing you will not learn from programming is the more sophisticated analytic or geometric methods, and these are important too. It is also extremely important to learn set-theory well, this forms the backbone of mathematics, and also you need to learn some category theory, which forms the annoying language for modern mathematics, but these are both reasonably straightorward if you keep a computational perspective throughout.

Why are many people against homeschooling? Described as having an overall negative impact on child development. I could agree with the argument that parents traditions/beliefs may have more impact, but it isn't like that doesn't happen at a school.

Because home-schooled kids don't know any mathematics. Not even the littlest bit. They might read Tolstoy, and appreciate Schoenberg, but they always end up at least 5 grades behind in mathematics, no matter how good the home-schooling. The reason they don't know math, is because to learn mathematics, you absolutely need to be made to feel a little bit stupid by competition with other children, at least on occasion. You need to learn various tricks and shortcuts from peers, so that you become completely comfortable with arithmetic and algebra, and also to feel inadequate (to a degree), because they can do it better than you, until you learn it. No peers, no tricks, no inadequacy, no math learning. School is good for mathematical education, because it's full of unfair competition and it constantly induces inadequacy-feeling. You won't get better results, even through home-schooling by a professional mathematician. The mathematician is not a child, and doesn't remember all the rich sets of examples and insights that a culture carries from child to child, and from teacher to child. Mathematics is a culture, and children keep it going with only a little interference from adults, through messy ineffectual teaching. I lived in Ithaca NY, which is a town that encouraged home-schooling by relatively affluent left-wing non-religious parents. The home-schooled children I encountered were abysmal in mathematics, rock bottom, worse than anyone I have ever met, even the ones with no exposure to marijuana. The ones with exposure to marijuana were beyond hope. One of them was a 9 year old boy who was unable to add and subtract. It became evident that he couldn't add or subtract when he played "Risk" with another child (who went to school and knew how to add). It was horrifying to watch him make the misakes he was making, I could SEE that he didn't understand numbers. I don't mean sophisticated things, like "prime" or "perfect square". When you asked him questions that involved adding or subtracting numbers of soldiers, he would avoid answering, deflect the question, laugh it off, but he didn't even reliably know the answer to "what is 6+7". I have met home schooled adults who were able to muddle through college, but it was through enormous struggle, always with the mathematics. Someone I knew well, who was home-schooled and managed to finish a technical degree revealed to me that the mathematics for the first

two years were impossible, and she was forced to rely on others for the entire ordeal, until she had managed to review the middle school and high school mathematics, all at the age of 18, 19, 20. This is like depriving a child of a sense of hearing for 18 years. It's abuse. Having learned a little mathematics on my own during high school, I can say that literature can serve as a substitute to a certain extent, but only after you learn the basics, and for the basics, it really is important to have a mathematics-heavy children's culture. In Israel, there is a healthy children's mathematical culture. But in the US, in affluent places, in poor places, everywhere, there just is very little mathematical culture. But even this little bit is sufficient for addition, subtraction, simple algebra, things like this, and home-schooled children cannot do any of it. Other aspects, literature, music, social things, are perhaps not so badly affected, but these are things people pick up without any artificial training beyond learning to read. But mathematics isn't like that, it requires schooling.

What is it like to take Harvard's Math 55, purported the "most difficult undergraduate math class in the country," teaching four years of math in two semesters?

It's not hard, if you know how to prove things coming in, but if you don't already know proofs before you start, you just shouldn't take it. You won't learn how to prove things rigorously in the first two weeks before the first problem set is due. If you expect to learn the material from the class, don't. Learn it a year or two before you go in, it will then be a breezy review with good peers, and it will introduce you to new stuff. Because the class assumes familiarity with rigorous proofs, it mostly consisted of freshman from accelerated schools, who had

exposure to proofs in high school. I was one of the few public school students, but I knew all the stuff from independent reading, so I was much much better prepared than the special school students. The class is simply another stupid method of social selection--- take a certain fraction of the undergrads and give them special attention, and groom them for the Putnam (Harvard takes this seriously), and for a mathematics career. It's a method of talent selection which is busted, like all other such methods. If you take the class, for the sake of your TA, don't write out rigorous proofs in full. Lots of students write out the solutions in lemma-theorem form, proving everything from rock bottom. I did this also. This makes your problem set ENORMOUS. You don't need to prove the commutativity of integer addition. You should learn what the main idea of the proof is, and what can be taken for granted. This is not so easy to do in an undergraduate proof class, where nearly all the proofs are of obvious facts. My complaint in hindsight is that the class didn't sufficiently emphasize computational skills--- you learn linear algebra without ever getting practice with row-reducing, or any other rote procedure. These are not conceptually difficult, but they are useful, and require practice, and this is more useful for undergrads than memorizing some specially selected route (as good as any other) through the rigorous development. I had personally already done some practical linear algebra, so it wasn't a big deal for me, and I assumed everyone else was the same, but now I realize that's not true. The other students did absolutely no mathematical reading at all before taking the class, and for them, it just wasn't enough computational exercises. So there are often terrible gaps in the knowledge of the math-55 folks because they know abstract things without enough dirty computation. Also, they tend to become cocky from being selected as special, and this makes them useless. Perhaps I was saved by the fact that I wanted to be a physicist, so I didn't care about the mathematicians, beyond poaching their methods and training my brain. To learn how to prove things for the purposes of getting into the class and doing well, it is sufficient to become well acquainted with the material in a few standard rigorous undergraduate textbooks, I read Lang's Calculus, Mukres topology, some books on General Relativity, and Dirac's quantum mechanics,

and this was far more than enough, it made the class boring, at least after the second problem set. The class only covers material that is standard undergraduate fare everywhere else, except rigorously. I cannot emphasize this enough, there is no magic, there is nothing in the syllabus that is beyond the standard undergraduate multivector calculus, linear algebra, except of course, you need to prove everything. The only magic is in an occasional aside by the instructor, or a special topic. The instructor my year was Noam Elkies, who has a wonderful insight into undergraduate teaching. He presented a strange introduction to Riemannian integration which develops finitely-additive measure theory instead of doing Riemann sums. It's equivalent, and perhaps a little cleaner. In hindsight, I just wish they had gone straight to Lebesgue integration, there was no point in learning finitely additive measure separately. I also remember Koerner's book on Fourier transforms being assigned, and I read that cover to cover, because it's a great book. The lectures on Fejer's proof and the FFT algorithm stick out in my mind as particularly insightful, I still have no problem writing an FFT routine when I need one. The rest is lost in my memory. I took it in 1992, and I also TA'd it in 1993. While I have happy memories of the class when I took it, the TAing phase was difficult. I was a sophomore TAing 40 freshman! That was about double the number of students my year. And I had to take 3 undergrad classes plus 2 grad classes each semester that year, so my workload was approximately double that of a grad student---approximately 10 problems every week for math-55, meaning I had to write clean solutions for the problems, and I had to read 400 amateurish crappy enormously long proofs every week, in addition to doing 2 graduate problem sets, 2 undergrad problem sets, and a bunch of reading for whatever dippy core humanities course I was forced to take that semester. It was too much. The pay for an undergrad TA was also ridiculous, it was peanuts. But it was better than cleaning toilets, which is what I did my first year. In the second semester, the class covered differential forms, while I introduced tensor analysis in section, to explain what these were, really. That was a mistake, the students didn't like it, and they also didn't appreciate that I would translate everything to tensor language, and then translate back to forms. But that was the only real collision between me and the instructor. The rest of the course was easy, because it was a subset of what Elkies covered. I also remember making a mistake in one of my early sections--- I said that a proof didn't require choice, because I could see the construction more or less, but a bright student said "you are choosing a sequence", and I said "oh yeah, I guess it does require choice". Today, I would make the distinction between countable and uncountable choice, but at the time, I didn't. Other than that, I remember having an easy time presenting proofs, because I had practiced presenting the proof in my head to learn the material. TA'ing the problem sets meant that you have to find the mistakes in all of them. This took a long time. It made me lose sleep, and pull all-nighter after all-nighter. My social life disintegrated, and I think I went a little bit crazy. I would wander around Harvard Square at 4AM getting burgers at "The Tasty" (now defunct), and making friends with homeless people, before going back to my dormitory. But the students liked me, because I was close in age to them, I knew all the pitfalls of the class, I proved things well in section because I prepared well, and I actually read and understood each of their proofs, and commented on it. Also, I would make sure if there was an insightful original idea on one of their proofs, I would give more than full credit, so that you would get credit also for part of a problem you didn't do, because you had an original idea somewhere else. The students appreciated this. I also explained the proofs from first principles, in a very rigorous way that I was really into back then. The students all said I was very helpful, and this was rewarding. The one thing I learned from TA'ing that class was how to read crappy proofs very fast and find the mistake (if any), and this was a good skill to develop. This was probably the first time I acquired proficiency in quickly reading and evaluating mathematical proofs, from TAing, not from taking the class. Taking classes is useless for this. I remember some problems from the first year, but only from one problem set, the first one in math55 proper. First, there was a superficially trivial problem regarding vector space duals that required the axiom of choice to solve in the infinite dimensional case. Elkies and the TA told me it didn't require choice, but I kept on telling them that I thought it did, because whatever I tried without choice didn't work. After hecktoring me a while, they realized it did require choice, so I got an undeserved reputation for being really smart. I talked to Dylan about this, and he told me why some people disbelieve choice, constructive principles and all that, although he tried to make it clear he wasn't one of those people. This made a huge impression on me, I immediately embraced the constructive thing. I reevaluated the proof of the well-orderability of the reals, and realized it makes no sense. I read "constructive analysis". I eventually got suspicious of all of classical mathematics by the time I took a grad real analysis course, and I gave up on math for another decade or so, before learning some logic. So you should make peace with the axiom of choice, and Cohen's book "Set Theory and the Continuum Hypothesis" is really the only way to do so. This problem set had 9 problems, all of which were good mathematical puzzles--- they were genuine interesting things. They weren't even graduate level stuff, but they were challenging. One of the easier ones I remember was to show that the dual of the vector space of eventully zero sequences of reals was bigger than the space itself. This I remember doing by finding an uncountable linearly independent set. There was another straightforward problem, which asked to calculate the number of bases of an n-dimensional vector space over Z mod p, this was simple combinatorics, but it took me a while to figure out what was being asked (this was half the battle in the days before the internet). I did all the problems except for number 8, which stumped me. The problem asked to show that in Z mod 2 (the field with two elements) the diagonal of a symmetric matrix is in the span of the column vectors. The key idea was presented in lecture, but you had to take notes. It was a difficult problem for undergrads. I later figured out that a symmetric matrix in Z mod 2 is really an antisymmetric matrix also, that is the key idea. This was a nice problem, it was the last nice problem. I remember being unhappy that I didn't solve all the problems on that problem set. But then when it came back, the mean on that problem set was 2 out of 9, meaning 2 problems solved out of 9, and I had 8 out of 9, missing that stupid span Z mod 2 problem. Noam Elkies was told to tone it down in difficulty, and unfortunately, he did. The rest of the problem sets that year were

loads of boring extremely straightforward standard exercizes, with an occasional good problem. The one other experience that sticks in my mind was the first math-25 problem set, before the class split into math-55, which was trivially easy. I knew how to do all the problems immediately, but I wanted to socialize with some of the girls in the class. So I joined a study group with 2 female students. I thought I would play it dumb for a while, as they debated how to do the problem, then I would say "Hey! I have an idea! Maybe you do this...." and explain the obvious correct trivial solution, pretending to not see it all at once, and in this way, impress the crap out of them. So we went into a room in the library, and they started blabbing about their stupid totally wrong ideas about how to solve the problem. I pretended to listen for 5 minutes, nodding my head at all the stupid wrong things, then I said "Hey, I have an idea! Why don't we try this..." and then explained the answer in 2 lines. Then I would sit down from the chalkboard and they would be stunned by my insight. That was the plan anyway. I did that with one of the problems. And I sat down at the end, and I figured they were stunned by the brilliance (because I knew the answers, the problems were dead easy). Instead, they just looked at each other in a funny way. Then one of the girls said "let's try another one...", and I let them blab with their ignorant jibberish, then stood up at the blackboard, explained the problem clearly and completely, and sat down. The response was, "Ok, I think we should dissolve the study group." I said "Ok", and went off to write the solutions by myself. It took an hour or two, and when I was done, I walked by the room, and saw the two of them back in there, discussing it without me! I wondered why they dissolved the group and reformed it without me, then it slowly dawned on me. They thought I was full of shit! They were not only too stupid to solve the problems, they were too stupid to recognize the correct solutions when it was shoved in their faces! This taught me a valuable lesson about how mathematically ignorant Harvard students are. Of course I got a perfect score, and they got a very low score (although how they avoided getting a zero, I don't know). So don't be intimidated by upper class twits, a studious working class type person can easily run circles around them, they are not capable of thinking logically. These

comments apply only to Harvard undergrads, not to MIT undergrads or Harvard grads, and not even to all Harvard undergrads, they have a few real nerds too. As a TA, an undergrad student attempted to seduce me (she didn't make it to math-55), in take-home finals an undergrad wanted to cheat off me (I gave him the wrong answer). Many students copied my answers to problem sets in both mathematics and physics, by pretending to work together. That should give you the idea of the level of ethics we're talking about. I think if you don't give your answers away, and stay away from unethical social schmoozers, hang out with grad-students and professors, and listen to the professors only, you'll be fine. There are lots and lots of Harvard students who think they are Nietzsche's supermen and superwomen, and act accordingly.

How can we effectively communicate with the public on ideas from different area's of science while acknowleging that they may lack the extensive years of education to do so?

The number of years of education required has plummeted by a factor of at least 4, perhaps more, because the information about the basic ideas is available online. So one can speak with the public as adults, and presume that if the information is not available immediately, they can look it up. There are some compromises while doing this, one should keep the derivations maximally insightful, and try to present self-contained accounts. But there is absolutely nothing in science which cannot be understood by a determined individual in a very short amount of time today, and there is no reason to tone anything down. If anything, adopting an uncompromising stance regarding the content of the science will prevent misinformation, and provide a spur

for people to learn the material properly. There is no reason that everyone should not know the basics of BCS theory, or topological field theory, or any of that stuff, it is less time consuming today than ever before, it does not require a decade of specialization to understand.

What is an intuitive explanation of the axiom of choice and its consequences?

The best way to explain the axiom of choice is using the ordinal concept and the Von-Neumann hierarchical universe. The axiom is uninterestingly true for finite sets, and for countable sets it is not particularly controversial. It is only counterintuitive and wrong for sets of size continuum or higher, that is for the set of all subsets of the integers (or larger) or, equivalently, the set of real numbers. The ordinals are the infinite analog of counting numbers. They are ordered linearly and admit mathematical induction. The simplest ordinals are the counting numbers, 0,1,2,3,.... The simplest infinite ordinal is omega, which is the ordinal just bigger than all the integers, so that any smaller ordinal is a counting number. The next ordinal is omega plus one, the next omega plus 2, etc. up to omega plus omega, which is just bigger than omega + n for all counting numbers n. The ordinals have the property that they are well founded--- counting down starting from any ordinal always reaches 0 in a finite number of steps. This means that if a property is inductive, meaning that assuming it is true for all ordinals smaller than X, that implies it is true for X, then the property is true for all the ordinals. This is transfinite induction, and it is the major new tool that set-theory gives over Peano arithmetic, the thing that allows new theorems.   The ordinal sequence extends upward to an infinite tower of ordinals, constructed by ever more elaborate methods, and this procedure produces countable ordinals of higher and higher complexity, which correspond to axiomatic systems of higher and higher complexity. But all this complexity is happening on countable ordinals. The issue is that Cantorian set theory is designed to axiomatize ordinals and real numbers simultaneously, so it considers ordinals as sets constructed by inductive procedures, and also the the set of all real numbers as an abstract set which is not produced inductively, but by imagining the set of all subsets of Z, using a new axiom. These two ideas don't play well together. The reason is simply that ordinals in a logical model can always be made countable, while the real numbers are intuitively and easily shown to be uncountable, because they include infinitely many arbitrary digits. The way you see this is through proofs that use the axiom of choice. The axiom of choice allows you to produce an ordinal corresponding to all the real numbers as follows: choose an element from each nonempty subset of R. Then order the real numbers by inductively matching to each ordinal the new element you choose from the complement of the image of the set of all smaller ordinals under the map you are inductively constructing. This matches the ordinal 0 to some element of R, the ordinal 1 to some different element, the ordinal 2 to a new element, and so on, and continues until you either run out of ordinals or run out of real numbers. The point is that in the real world, you run out of ordinals first. But in ZF set theory, you can't run out of ordinals first, because the real numbers are a set, and no set can bound all the ordinals, because the ordinals are a proper class. There can be no set of all ordinals, because then this set would be an ordinal, and you could consider this set plus 1, and it's a bigger ordinal. So in ZF, you run out of real numbers first, and you end up matching the reals to an ordinal. The question is, which one? The demonstration that this is nonsense comes with Cohen forcing. Cohen showed that the matching can be to WHATEVER ORDINAL YOU WANT, so long as it is uncountable, and has uncountable cofinality. The reason is simply that in any model the ordinals are countable, and by adjoining some randomly chosen elements of R corresponding to an arbitrarily large uncountable ordinal, you can shoehorn in any ordinal into R, no matter how large, without causing any disaster in the theory. What this is really showing is that R is naturally bigger than any ordinal tower, since you can make R correspond to an ordinal bigger than any

in your theory, simply by extending your theory and forcing R to be the same size as the first "inaccessible" set, some enormous enough set which makes a model for your previous theory. Then R is matched only to an ordinal bigger than all your ordinals. Then you can truncate your model back to the smaller ordinals, and R is not well-orderable. It's stupid, it's obvious, R is never exhausted by ordinal processes. The only reason it is exhausted is not because of choice really, it's because of the axiom of powerset, the idea that the set of all subsets of Z is a set of the same kind as countable sets. There is no reason for this assumption, except that people want a unified theory of real numbers and integers, even though the countable and uncountable collections have completely different properties. The correct conception is to say that R has the measurability property, so that every subset of [0,1] is Lebesgue measurable. This makes life easier, and it makes it easy to do probability and measure theory, and it is what people who are not formal mathematicians assume anyway, when they say "pick a random number between 0 and 1 uniformly". This idea is self-consistent, as Solovay shows, but inconsistent with choice.

How badly are paywalls impacting access to scientific articles and education/science as a result?

They are the biggest impediments to universal scientific literacy. The paywalling of the old scientific literature means that google searches terminate on inaccessible information, at least if you don't have an institutional subscription, and this prevents the public, or even specialists from other fields who don't happen to have institutional access, from quickly evaluating the published claims in other fields in detail, something which is essential for preserving literature honesty.

There are many bogus claims in the literature which will literally dissolve if exposed to the caustic acid of the internet. The problem is that this means that there is an interest in keeping these articles mysterious. But this is against every notion of public good, since it would be benficial for the bogus stuff to die. In physics, mathematics, biology the problem is mostly solved, at least for recent literature. Literature from after 1994 is freely available in physics, through arxiv, and in mathematics after 2000. Pubmed and biology journals are required to publically post the results of all publically funded research after a certain short period, so that biology is sensible too. This means it is only a matter of time before research in these fields is universally publically available, as the historical stuff is repeated or obsoleted. But in other fields, and for math and physics literature from the period 1957-1996, which is not likely to be repeated or obsoleted, you have a serious problem. The literature from before 1957 is very sparse, and is generally summarized well on public websites, or in books and reviews which are recent and available. The main issue is that confiscating all the literature from before 1996 is politically impossible, the scientific publishers form a relatively powerful class, and can prevent this. But the easy way around this is simply to ask a question "What is a refactoring of the argument in paper such and so" on a public website, and then someone who knows the argument will give an up-to-date summary, with reworked results, so that the result is permanently freely available from this point onward. This only takes a finite amount of effort, a single person competent in a field can easily and quickly summarize all the classical articles, and the non-redundant information in the non-classical articles is usually a small extension of the methods in classical articles, and the non-orthogonal bits can be summarized in a few paragraphs, including all the data and calculations. Once this is done, you have no need tor scientific publishers. In physics, the coverage is around 40%, so that about this fraction of the information in the literature from 1957-1996 is available publically. But it's getting better quickly, and it should approach 100% by the end of the decade, perhaps a few years later, depending on how many people are willing to summarize old literature (it's a thankless job).

Is it possible to describe God mathematically?

The question should be asked "Is it possible to describe God precisely?" I am sure it is more or less possible, I will do so below. The question "Is it possible to describe God mathematically?" is usually interpreted inside a fixed mathematical system, like ZFC, or something like that, an axiomatic system with a given computational complexity (a given minimal size of the computer program that does deductions), and since God is related to the notion of infinite complexity, it is going to be difficult to describe the notion precisely within a fixed axiomatization. But perhaps there is a way. The halting-problem tape or the Church Kleene ordinal can both be seemingly described precisely in an axiomatic system, although their exact value cannot really be precisely determined within a fixed axiomatization, so perhaps it is wrong to think of them as having been precisely described, even though they are given a name and some definite subset of their properties are determined. This is different from what Godel was doing. Godel, when he gave the description of God in formal logic, wasn't working in any mathematical axiomatization, nor was he defining precisely what he meant by "positive characteristics" and so on, so he wasn't really doing mathematics, only formal logical philosophy. So the definition he gives is a parallel to earlier definitions in informal logical philosophy, which were also relatively equally meaningless really, because not talking about definite things, but about vague statements about the vaguely defined collection of all intuitive propositions, things you can't really talk about precisely without an axiomatization. The first thing is to say what the precise meaning of the term "God" should be, and by this, I mean the logical positive meaningful content of the statement "God exists". First, it is meaningless to say something created the universe, there is no sense-impression that would reveal anything about this putative process, so I won't deal with this sort of thing. It is also meaningless in terms of

sense-impressions to talk about unobservable realms of spirit, and heaven, and hell, and so on, except inasmuch as these give prescriptions for how people should act in observable ways, so I won't talk about that either. I will only talk about how people should act in observable ways. The external constructions will appear as they are necessary for answering this question, and any metaphysical question that has no bearing on the senses will be considered free, in that any assumption is as good as any other, you just have to learn to translate between the different "gauges". This is the perspective of logical positivism, as I interpret it. So the question is as follows, you have a bunch of agents, with wills and desires, and you want to understand what it means for them to behave ethically. You can first assume that they are perfectly rational, meaning that they can decide which of any two alternatives they like better, and their alternatives are ranked by the Von-Neumann Morgenstern utillity. Then suppose two such agents play a prisoner's dilemma. In such a situation, there are two options, to "cooperate" or to "defect". If you both cooperate, you get a large reward, say $1000000, if you both defect you get a little bit of reward, say $10, but if one of you cooperates and the other defects, the defector gets a little bit extra, say $1000010, and the cooperator gets nothing. The "rational" answer in economics textbooks is defined by "always defect". The definition of a rational behavior is when changing course, holding all else fixed, is worse for you in terms of utility. Since this mode of rationality is self consistent, it needs a name, but since it isn't the only way to behave that deserves the name "rational", it needs a more specific name. I call it "Nash rational", after John Nash, who proved there is an optimal strategy of this sort. The point of the prisoner's dilemma is that when you think about it, you realize that there are two people who are behaving the same way, if they are Nash rational, they are defecting, and yet, they aren't taking into account the sameness of their behavior before making the decision. Since they are solving a mathematical problem that looks superficially well-defined, best-play in a given symmetric situation, you would expect that they would come up with the same answer. Then the best play, if they take this into account first, is whatever same-answer would net them the best outcome, and this is to cooperate. The cooperation is a

different sort of fixed point, it is a fixed point assuming coordinated behavior. For a symmetric situation, it is easy to see that there is such a fixed point, since it maximizes the utility of any one player given identical play. This is simple superrationality, and it is well defined. Is it complete? Not at all! First, even in the symmetric case, there are situations where it isn't the optimal. Suppose you have two players, and if they both defect, they both get $1, if they both cooperate, they both get $2, and if one cooperates and the other defects, the one that defects gets $1000000 and the one that cooperates gets nothing. In this case, the superational strategy, the strategy that maximizes individual payoff, is to flip a coin and cooperate or defect according to the outcome. This is also mathematically precise--- the stochastic strategy for a symmetric game is the one that maximizes the total expected payoff, assuming everyone plays it. The symmetry guarantees that the total expected payoff divided by the number of players is the same as the individual payoff. This is the rule of utilitarianism. The issue with this idea is simply that there are asymmetric games. In this case, one can ask what the optimal superrational strategy is for these. One procedure for producing a superrational strategy (although he didn't say it this way) was given by Rawls in his "Theory of Justice" (he called it justice). You simply consider all possible permutations of the roles of the players, exchanging their outcomes. Then the superrational strategy in the asymmetric case is the one that maximizes the expected utility in the symmetrized game. This idea is reasonable as an approximation, but it still isn't God. What it is is a procedure for producing a strategy in an asymmetric game which turns it into a symmetric game. But there are ambiguities in symmetrization--- should everyone's utility be considered equal? What about the guy who gets utility from being top-dog, and it's a great amount of utility? Should this guy be given a little more to assure the top-dog nature? Anyway, it gets confusing. But there is no reason to symmetrize the game at all. There is a perfectly reasonable way to define superrationality for arbitrary games, which is simply to postulate that there is a universal strategy for arbitrary games. Such a strategy should satisfy the Von-Neumann Morgenstern axioms. So if you have a game which is game 1 with probability p and game 2 with

probability 1-p, it should tell you what the optimal strategy is for the game in a way that's consistent with other game choices, as Von-Neumann and Morgenstern explained. This implies that the strategy associates a self-consistent utility function to all the games, which is computed in some way from all the utilities of all the players, by considering all games of arbitrarily large complexity. If you assume this strategy exists, and further, that you get better and better approximations by considering more and more games, and making the strategies self-consistent, then it says that there is an abstract will, a utility function, that wants you to play a certain way, and this way is only determined through an arduous process of considering all possible circumstances of all possible games, and anything you might possibly think or want. You can then give a name to the agent whose will this is, and call it God. Whether there is an agent out there or not, it doesn't matter, because it's a meaningless question. You see a will, you have a procedure for figuring it out, investigate the self-consistency of ever more games, and so you have a logically positivistically satisfying way of determining the will of God, more or less, assuming you have converged to the answer from the finite number of games you have considered to date. The problem with this definition is that it is talking about all possible games, and this is a construction which is as rich as all possible computer programs. So the questions "is it consistent that there is a unique answer to all games?" might be unanswerable, because no matter how complex the games we consider to date, there might be a contradiction in the universal strategy we determined at the next level. Then you need to reformulate the universal strategy, and it changes around, and so on. Maybe you don't converge. So the question "do you converge?" can't be answered, because it involves an infinite complexity limit. But you can gain scientific sense that it is convergent, by just looking for convergence at lower levels. There is another idea of God, which is simply the ordinal tower of consistent axiom systems proving each other's consistency. This idea is the mathematical God of Cantor (and also Godel, he shared Cantor's idea, this is what mathematical theology looks like). It is related to the game-God, the ethical god, by the statement that a complex enough ordinal can be used to resolve

any arithmetical question, including the determination of superrational best-play in an arbitrarily sophisticated mathematical game. It is just as difficult to become sure that this is true as it is to become sure of convergence of ethical strategies, and Paul Cohen called this belief the "Article of faith" of pure mathematicians. This notion is a bit more abstract and less relevant than the game-playing agent, which is really just the personal God of religion, defined precisely. You can judge how precise this definition is, because I explained it in detail. You can also judge to what degree it overlaps with the religious notion, and if you look past the superficial miracles and untestable supernatural beliefs, you should see that it's nearly exactly the same idea. Except it's stated in the logical positive style, in terms that are directly testable.

Is snow a black body? if yes then why does it appear white in color?

No! Snow is NOT a bad black body, because it's not black, it reflects light. A body is a black body to the degree that it is black, that is, to the degree that it absorbs light. That's what the word means. The problem with making this statement is that snow might not be so reflecting in infrared, where most of the heat absorption happens. But if it is, and it probably is, then is a terrible black body. The main physical argument that explains why it is important is from the end of the 19th century. Imagine a bunch of light in a cavity with some snow (or anything else) at the same temperature. Because this system is in equilibrium, the amount of light the snow emits in any wavelength must be exactly the same on average as the amount of light that it absorbs, otherwise it would take heat from the environment. So a good mirror-ball in the cavity doesn't emit any light at all, at any temperature, because it just reflects the light around it, while a good absorber emits as much as it absorbs. This is just from

thermodynamics, it doesn't require anything else. The nice thing is that the electromagnetic field is linear, meaning, the light you absorb doesn't interact with the light you emit. So if the body is at a certain temperature, you can be sure it emits exactly the same light regardless of whether it is in the cavity or anywhere else. The emission doesn't care about the other light, only about the body, and the most important thing is its absorptivity. The conclusion is that the object emits thermal light at any wavelength exactly to the same extent that it absorbs thermal light at this wavelength. A black body is a body that absorbs all light, it appears black, because it absorbs all the light, and it is maximally emissive for it's geometry. Even the best mirror absorbs at least 10% of light, as you can see by putting mirrors so that they reflect each other, the image gets darker over many reflections. This means and it emits exactly the same amount of light. This means snow, white as it is, still absorbs something like 30% of the light that hits it. So this means it is emitting at at least 30% of the ideal blackbody rate, and this makes blackbodies reasonable order-of-magnitude approximations even for white things. This argument is one of the most beautiful in physics, so, because it is interesting and beautiful, nobody teaches it.

What does Bell's inequality mean, in layman's terms?

I will try to improve a little bit on Mermin, by using the small angle limit. Otherwise my presentation is pretty much identical, because he explained it as clearly as it can be explained. Bell's inequality is an obvious truth about correlated things: Suppose you have three students taking a yes/no test, A B C, and students A and C are cheating by looking at student B. Suppose that student A gets 99% of the answers the same as B (he is a good copier) and student C gets 99% of the answers the same as B also (he is also a good copier). Then student A and student C necessarily hand in a test which is 98% the same as each other. Why? Suppose you have 1000 questions. Then A gets 10 different from B and C gets 10 different from B, so they get at most 20 different from each other. This is not at all surprising. Now quantum mechanics. When you have two electrons close, you can arrange it that they will have opposite spin. What this means is that if you measure the spin in any direction you like, the results for the two electrons will always be opposite for this direction. The result in any direction is always discrete, either "plus" or "minus", like for the students, either yes or no, but if the answer for the spin in some direction is "yes" for one electron, it is guaranteed to be "no" for the other. This continues as the electrons drift apart, so long as the spin isn't fiddled with, so you can keep one here, and send the other to Jupiter, and you can measure the spin in any direction, and if your friend on jupiter measures the spin in the same direction, you will always get the opposite answer, no matter what direction you choose. That's not so mysterious either. The immediate idea people have when they hear about this is that the electrons must be carrying secret crib sheets along with them on their trip, and these crib sheets determine what answer they give to any particular measurement. They made up these crib-sheets when they were close, and they put opposite answers on the crib-sheets. In order to make the analogy with the students easier, it's annoying to keep flipping one of the values, so I'll reverse the answer on Jupiter, so that the answers are the same, rather than opposite. From now on, when you and your friend both measure the spin in some direction, the answer for the two electrons is always the same, even though the true answer is really always opposite. The answers for the spin along the z-axis is always the same between the two electron. I will use the answer to the spin along the z-axis to be student B's answer. Since the answer for the spin is always the same for the two electrons, measuring either one tells you student B's answer. Now you can choose to measure the spins on the two electrons in a different direction, tilted by an angle q. When q is small, you mostly get the same answer. I will take student A's answers to be the spin for an axis tilted by a small angle q to the z-axis, to student B. I will make q however small it has to be, so that the student A gives the same answer as student B 99% of the time. What this means is that if I measure the spin in the A-direction on one of the electrons, and the spin in the B-direction on another of the electrons, they are going to give the same answer 99% of the time. So the crib-sheet for direction A is 99% the same as the crib-sheet for direction B. Then you can define student C by tilting from student B in the exact opposite direction as A. The angle between C and B is the same as the angle between A and B, so B and C are also 99% correlated. So the crib sheet for direction C is also 99% the same as the crib sheet for direction B. But A and C are now separated by double the angle as either A and B or B and C. Double angle means, in quantum mechanics, that the answers between A and C then are only 96% correlated!! The crib-sheets for A are only 96% the same as the crib-sheets for C!!! But they are both 99% the same as the crib sheet for B!!!!! I can't put enough exclamation points. This is the big deal. It's a paradox. It means that there are no crib sheets. The electrons didn't decide what answer they were going to give when they were close, or if they did, the answers can't be staying the same after one is measured, it must be rewriting the other electron's crib-sheet nonlocally instantaneously. That's the argument. Notice that you didn't need to know WHY quantum mechanics predicts 96% correlation, just that it does. That means it's an experimental fact, not a theoretical argument, you can test it. Alain Aspect did this in the 1980s, and found the predictions of quantum mechanics worked. Even though it's not necessary, it is nice to know why quantum mechanics predicts the 96%. The reason is that in quantum mechanics, the probability is the square of a probability amplitude, and both the probability amplitude and the probabiility smoothly and continuously vary as you tilt the angles between the experiments. The probability of giving the same answer has a maximum at zero angle, where the probability of being the same is 1. Since the probability is smooth, for small angles, it goes like one minus the square of the angle. That's always true at a normal maximum, you go down like a parabola. So if you double the small angle, you quadruple the mismatch in amplitude, and quadruples the mismatch in probability. In equations, if x^2 = .01, (2x)^2 = .04, so 1-x^2 = .99 and 1-(2x)^2 = .96. So doubling the angle quadruples the number of mismatches. Bell's inequality demands that when you double the small angle, you can only at most double the mismatches. This means that to satisfy Bell's inequality, the probability and amplitudes need to make a cuspy thing going down from 1, like $1-|x|$, not like $1-x^2$. That doesn't ever happen in quantum mechanics. It happens in probability, though. Probability spaces are like triangles, they are simplicies, with "sharp corners" at locations of perfect knowledge, from the condition that the sum of the probabilities is 1, while quantum mechanics makes spaces smooth like a sphere, from the condition that the sum of the squares of the amplitudes is equal to 1. For spin-1/2 electrons, the actual quantum mechanical amplitude as a function of angle for getting the same answer is precisely $\cos(q/2)$, and this is easy to work out, because spin-1/2 means that the amplitude has to return to itself after 720 degrees of rotation, by definition. So the probability is the square of this, or $\cos^2(q/2)$. You don't need the detailed form for the arugment, only that it is smooth. Still from the detailed form, the probability of mismatch is approximately $1-q^2/4$ for small q. so to get 99% correlation, you want q^2 to be .04, so that q is .2 radians, or about 11.2 degrees. That tells you how to set it up experimentally, with these probabilities (although you would be foolish to use small-angles in an experiment, you can get better violations by using bigger angles). For spin-1 photons, like Alain Aspect used, the amplitude goes as $\cos(q)$, because photons are spin 1, so they return to the same amplitude after 360 degree rotations. Then you get the probability goes as $(1-q^2)$ and q needs to be .1 radians for 99%/99%/96% correlations, so the angle is 5.7 degrees. Aspect used angles of something like 30%, where the violation is more statistically significant, but is slightly less intuitive. The small angle limit was emphasized by Bell as being particularly intuitive in an offhand remark in his original paper.

Do some people who don't believe in God feel superior? If so, why?

Belief in God is a submission to an ethical authority that requires you to accept you play a small part in a larger whole. The rejection of God, when it isn't a rejection of supernatural fairy-stories or undeserved social authority, that is when it isn't justified, is often a way for an individual to avoid ethical thinking that takes the collective interest into account. The people who do unethical things sometimes have short-term benefit, like making a lot of money, or being sexually successful, or whatever. Then they feel like "hey, I must be so smart to figure out how to do this, when anyone could do it, I am so special!". But the thing is, it isn't so special, or so smart. Everyone pretty much knows how to be unethical, they just mostly choose not to be, for the reason that God told them "don't do that". If they don't call it God, it's still a self-consistent collective thinking about cost and benefit that ends up being completely equivalent, if done properly. So there is a sense of superiority when you do a bunch of dubious stuff that anyone could have done, and make a success out of yourself. But you always need to do your best to make sure you are acting ethically, as best as you can determine. But this doesn't mean following socially mediated religious dogma, it doesn't mean denying youself some pleasant things when they benefit everyone involved, it just means trying to be a good person and not doing great harm.

Why don't some scientists believe in the existence of God?

The reason is simply that the God that religious people talk about is often tinged with supernatural events, and miracles, and anti-scientific

statements about the history of the material world. It is also something that is promoted using social authority. Miracles don't happen, and social authority is busted, this is what scientists know. So they reject religion. But this is a mistake, because the ideas, despite being cloaked up in miracles and social-authority, are nontrivial and correct. You just need to translate them for yourself into a logical positivist framework. The basic idea of religion is simply that the notion of "consciousness" is abstract software type thing, it isn't hardware. Software is distributed, no one neuron in your brain is conscious, and software is mathematics, if you replace your neurons with equivalent transistors, it wouldn't make a difference to the software. So the software soul is separate from the hardware brain, and can be thought of as eternally existing (or not, it's positivistically meaningless), like pi can be thought of as eternally existing, in an abstract realm of mathematical relations. Further, there is a question of ethics, which is the prisoner's dilemma. If you are playing prisoner's dilemmas against other players, you need to know what degree your software is correlated with the other software, to know how it is rational to play. That's not true exactly, you don't need to know if you are "rational" the way economists define it. But you do need to know if you are superrational, that is if you take into account the correlations before deciding what action is best. Saying that all your consciousnesses are correlated when you make a decision is tantamount to saying that all your conscisouness softwares are linked up into a bigger coherent software, and this larger software is either conscious or not (this is mostly meaningless), but it is larger software, so there is a sense of a collective mind. The collective mind is a god of sorts, it is bigger than the individual. The notion of the almighty God is the idea of a limit where all the computational entities agree on the best course of ethical behavior. It is a limiting conception, but it isn't supernatural at all. This idea I explained in other answers here. The main point is that this ethical conception took over from local tribal dieties and various supernatural creator dieties, and replaced these earlier beliefs. So it carries supernatural baggage. It is also a little difficult to explain without an internet, so people just transmit this knowledge through social dogma. The social dogmas were put in place at a time when the

government of the Roman empire was feeding people to animals in public, and nailing them to sticks, so as to purposefully torture them to death. This is unacceptable, but the only way to make it clear that this is unacceptable to powerful people who are basically guaranteed to never be in the same boat is to make them realize the superrational thing, and link up their internal computations with the collective that includes the powerless people. This procedure involved telling all sorts of fairy-stories about people rising from the dead, miracles, saints, etc, but it doesn't matter, because it worked, and the superrational conception was able to win out. If you reject the supernatural conception of God, that's fine, it's completely unnecessary. The superrational conception is all you need. The problem is that some scientists reject superrational conceptions along with supernatural ones. Basically 90% of all scientists reject the supernatural stuff, because it's obviously false, and also reject the socially mediated authority stuff, because it's socially mediated authority stuff. But they shouldn't reject the idea of a superrational collective ethics, because it's true (at the very least, it is demonstrably self-consistent) and it is important for making an ethical coherent whole out of disparate folks. This doesn't mean that the religious people have all the answers, it just means the basic idea is sound.

Did we ever try to explain religious practices in terms of quantum sciences?

Quantum mechanics doesn't explain religious practices, but the act of getting to understand quantum mechanics requires careful philosophical thinking at some point about the relation of mind and physics, and this thinking leads you to understand how abstract mind is. Since we have computers today, I don't even need to talk about mind. i can talk about software (although, I am really talking about the same thing). If you have software that is running on your

computer, it is an abstract mathematical thing, and only the relationship between different bits are important, not precisely how they are arranged in your silicon transistors. So two different chips can be exactly the same in terms of software. The abstract nature of software is something that religion tries to get people to understand. This is the idea of Plato and Christianity, that human souls are really part of the realm of pure mathematical ideas. This is true of all software, including the kind that runs on brains, but it is also not logically positivistically completely well defined, because questions of existence don't impact observations directly. So it's a point of view, but it's illuminating, because it makes you understand just how abstract your mind is. In quantum mechanics, the mystery is that matter obeys laws with amplitudes, and brains obey laws of probability on definite states. The modern interpretations basically explain this through a psychological identification--- they say that the way amplitudes "feel" to an observer is to be probabilities according to their absolute square. There's nothing particularly wrong with this in the infinite observer limit. If the observer is of finite size, there is always a chance of having a negative amplitude observer annihilate some branches, but this is basically infinitely unlikely, depending on the initial conditions, but for all reasonable initial conditions. This discrepancy between the micro-world, with the amplitudes, and the macro-world, with the definite events according to laws of probability, led a lot of the founders to think about the separation of the mind (the software) from the body (the hardware). They didn't mean anything more profound than the software/hardware divide in a computer, although this is already very profound. It's just something that everyone knows about today, without effort, because they know what 'data' means, or 'algorithm'. The idea that the mind's software is the reason that amplitudes turn into probabilities is what was stated by Pauli. Everett later used computers to explain the whole thing in detail, using measurements on the memory state of computers. This was then refined by a lot of people with decoherence ideas, but the basic principle is the same--- when you end up superposed, your mind selects a superposition component according to the laws of probability, however which way you want to philosophically frame it. As collapse, as many-worlds,

whatever. Observationally all these are equivalent, they only differ in more or less meaningless philosophy (although many-worlds is most intuitive, and easiest to internalize and explain all the paradoxes with). But there is another possibility. The description in terms of amplitudes is ABSOLUTELY ENORMOUS compared to a classical computer, it is exponentially bigger than a classical computer, so that even a small quantum system, like a single Uranium atom, requires a computer the size of a significant chunk of the universe to describe to reasonably exact precision. This is not reasonable to a lot of people, it's a heck of a lot of computation to fit in a Uranium atom. Another possibility, less definite, and less worked out, one that has been advocated by 'tHooft in the last decades, is that quantum mechanics is only approximate, and it's hidden variables. But the hidden variables are holographic and nonlocal, and this is why you don't have Bell's theorem (at least, this is what 'tHooft said in the 1990s. later he thought he managed to do it locally, but this is not true, but he doesn't admit it yet, but whatever). The point is that the hidden variables are not so enormous, they are of size the cosmological horizon area, but objects which are localized are spread out over the entire horizon, and can effectively use the entire horizon's computational capacity, so they are able to produce an enormous seeming computation, even though they are small. If this is what is going on, then quantum mechanics will fail for large heavily entangled systems, of size some hundreds of qubits, when they try to factor large integers in a quantum computer, at least integers big enough sot that a classical computer the size of the cosmological horizon can't do the computation. While there are preliminary ideas for how to reproduce quantum mechanics from a classical hidden-variables scheme which is nonlocal like this, I think it is fair to say that it hasn't been satisfactorily done yet. If it is possible, then this is another way to understand why quantum mechanics looks the way it does which would not require such a deep philosophical debate about the nature of mind, it wouldn't be any different than what came before. But the traditional religious ideas are not related to any of this stuff, they are exploring the nature of sophisticated computations, sophisticated minds, and their relation to ethical orders, and their relation to each other, and the visions that come from

meditation. These things have as much to do with science as interpretive dance does.

Which 10 books would you recommend that your children (or anyone) read throughout their life?

I ordered it randomly, because rank-order doesn't make sense for this stuff. 1. Paul Cohen "Set Theory and the Continuum Hypothesis" 2. Alexander Polyakov "Gauge Fields and Strings" 3. Benoit Mandelbrot "The Fractal Geometry of Nature" 4. Brian Kernighan and Dennis Ritchie "The C Programming Language" 5. Freeman Dyson "Origins of Life" 6. Thomas Gold "The Deep Hot Biosphere" 7. Stanley Milgram "Obedience to Authority: an Experimental View" 8. Douglas Hofstadter "Metamagical Themas", 9. Marquis de Sade "The 120 Days of Sodom" 10. Charles Bukowski "Pulp"

If your child were to read only one book in his/her entire life and you got to choose that book, which book would you choose?

"Obedience to Authority: an Experimental View" by Stanley Milgram. http://www.gyanpedia.in/portals/...

How can I become an asshole? All my life I've been a nice guy and it has gotten me nowhere.

I was asked to answer, but I disagree with the premise. Assholes are nearly never successful in anything, especially not business or politics, I think you are confusing assholes with unethical people. An asshole is someone who is oblivious to social mores. An unethical person is someone who does bad things. Social mores are not intrinsically good things, so being oblivious to them doesn't make you bad. To make the distinction clear, imagine you are living in Germany in 1944. The unethical person is the one who joins the party, uses slave labor, sends people to be murdered. and schmoozes politely with the in crowd. This person is very social, pleasant to be around, is kind to animals and small children, can pontificate about philosophy, and is in general a highly cultured person. The asshole is a drunk guy at the bar who scratches his crotch and says "Hey! What happened to all the Jews?" This is why it is good to be an asshole, because unethical orders in society erect taboos to protect themselves from criticism, so that certain things can't be said. So you need to get rid of this inhibition. This is difficult, so here are some simple exercises: 1. Stand with a cup on the street and sincerely ask people for change, and take the money they offer you. 2. Lie down in an office, fall asleep. 3. Go to a fancy formal event in a tee shirt and jeans. 4. Dye your hair orange, or pink I did all of these at some point, they are hard at first, but then become easy, as you stop seeing the taboo. You can make up your own. It's easy--- whenever you see something that everyone is doing for no apparent reason, or feel a strong social inhibition, just do the opposite. If there is a reason, you'll figure it out. Personally, the most difficult asshole training exercise I did was wearing a kaffiyah on my head while walking around my birth town of Nahariya. It was much harder than streaking, or talking to myself in public, both of which are difficult, because in this case, I was ostracized by my entire extended family, my father ripped it off my head (I put it back), my mother was hurt and upset, and I was completely ignored wherever I walked. But it fully released me from Israeli taboos. The point of being an asshole

is that you never need to try to think outside the box, because, for the asshole, there is no box.

What is temperature?

The inverse temperature, or coldness, is the rate at which the entropy goes up when you add some heat energy to something. The temperature is the reciprocal of the coldness. If you put a hot object next to a cold object, the hot object will give heat to the cold object, because the entropy of the cold object will go up more than the entropy of the hot object will go down in the process.

What questions would you ask Einstein if you had the chance?

1. What happened to Lieserl? 2. Did you do a last-minute negotiation to change the 1933 nomination for Heisenberg, Jordan, and Born to Heisenberg alone? Was this motivated by Jordan joining the nazi party? 3. What was the precise motivation for the antisymmetric metric? 4. How did you guys calculate the Ricci tensor from the metric tensor? Did you have special tricks?

Would it not be both productive and informative to have a journal of negative

results?

The problem with this idea is that some incompetent person will have a stupid idea and run a crap study, perhaps checking whether people who are bald will have a greater risk of kidney disease, and then find nothing. Then this person will publish this study in the journal of negative results, and get a publication out of it. Not only are you rewarding this person who wasted public funds on a stupid study, you are ALSO telling all the rest of the world that they have to cite this nincompoop whenever they say that bald dudes are not at greater risk of kidney disease. This is galling to anyone who tries to get positive results. If you have such a journal, it must not be allowed to cite the article in a way that confers credit to the author. If the negative result is surprising, it would already get published in a normal journal. This is why publication bias is not so terrible--- if a drug gets a reputation as effective through publication bias, then the publication that shows it is useless becomes a big deal, and gets published in a big-name journal. This has happened with big-name treatments many times. To get a positive result is very difficult, and you often get dozens or hundreds of negative results along the way. A journal of negative results would just be a way for incompetent people to publish crap and maintain a career, and I don't think it should be encouraged. Forcing people to make positive results to survive is how science makes progress, and there are infinitely many positive results that have not been discovered, so don't be lazy.

What are some of the most fascinating things physicists know or understand that most people don't? What might others find surprising or interesting?

The most significant thing must be the laws of quantum mechanics, but in order to get to that, there is more fundamental stuff. 1. Every physical system can be simulated, and the future state can be predicted from the present state. This is the lesson of Newtonian mechanics. If you have a good computer, and you are given the initial conditions, the initial positions and velocities, and you know the force law, you can figure out how the objects move. You don't even need to work hard today, you can just let the computer do the work. This is the fundamental insight of the 17th and 18th centuries. The computer came later, of course, but Leibnitz already was thinking about similar things during the early days. 2. If all the different possible answers lead to the same exact sense impressions, then there is no question. This is the insight of Mach, and it evolved into logical positivism. This is how you know when you are asking a sensible question--- when you can discrimate between the answers through some sort of observation. Sometimes, in order to answer the meaningful questions, you need to introduce some extra concepts, for example, you might need to introduce a wavefunction, or space-time coordinates, or a gauge-choice to define the vector potential. All this extra framework is fine, so long as you understand that any two choices are ultimately equivalent, so you can translate between these choices freely. It is logical positivism that allows you to understand that two coordinate systems for a physical problem are not different, they are really the same, when the predictions for all the sense-impressions predicted by the two systems are equivalent. So if someone insists that the world is really in polar coordinates (perhaps because rotations are important), and someone else insists that the world is really in rectangular coordinates (because translations are important), they are both being silly. Each coordinate system is as good as any other. It might sound like this isn't a big deal, it's obvious. But there are so many questions people who are not trained in positivism think are meaningful, and these constitute the majority of questions a physicist gets from the public! Questions like "where did the universe come from?" "Is the world really made of particles or fields?" "Is the universe infinite beyond the cosmological horizon?" even "How many dimensions are there in string theory?" (because there are descriptions in different

dimensions which reproduce the same sense-impressions, the question is not as meaningful as it sounds). These questions are annoying, because they don't have an answer and do not need an answer, because they are not questions! They are just the brain fooling. One perspective on positivism is that the irreducible things are the sense-impressions, and the physical law is predicting the relation of these. But the sense-impressions are related to brain states, so you could also say that the physical law is predicting relations of the brain states, and then you need a map to identify brain-states with sense-impressions, to understand what the physics means really. The positivism allowed 19th century physicists to convince themselves that fields are actual objects, as real as a chair, because there is a procedure to check if a field is present, just like there is a procedure to check if a chair is present. So it makes the abstract things concrete, whenver you can figure out a solid experimental test to see how the abstract thing is configured. But it also made other questions meaningless, like what is the true rest-frame of the ether? Or where is the electron exactly in the ground state of a Hydrogen atom? The positivism is so essential for physics, that physicists automatically reduce the debates in other fields into the logically positivistically inequivalent positions, and tune out when the debate is meaningless. This is most debates, unfortunately, at least in the way that they are framed (usually there is a way to frame them so that the debates are meaningful too, it's just that if you aren't used to positivism, you don't tend to do that) 3. The notion of psychological time is not exactly the same as physical time. The idea of time is something that appears in our psychology, and we think we understand that time is something that "goes forward" somehow. This psychological idea is difficult to relate to the coordinate notion of time, which appeared after Einstein formulated the space-time picture. The space-time picture is very counterintuitive, because people are weirded out by the idea of time being like space, precisely because space is psychologically "all at once", while time is "a little bit at a time". But it is exactly through positivism that one resolves these problems. The positivism tells you that the questions you can meaningfully ask are those which relate the measurements on clocks to the behaviors of people carrying brains. These questions can't resolve the question of

whether time is "all at once" or "a little bit at a time", so slowly, you come to understand that really there is no sense in asking whether time is "all at once" or "a little bit at a time", only in asking whether a person's memories and experience will produce answers to questions that are consistent with time feeling like it is "a little bit at a time" to the person. The psychological feeling is not something that physical law cares about at all. 4. Quantum mechanics: the usual laws of probability are not the right calculus for predicting the likelihood of events for microscopic things. This insight is enormous, because probability is a type of thing that one thinks is necessarily restricted by logic to be exactly how it is normally, you can't fiddle with probability. But in quantum mechanics, the laws of probability are modified so that probabilities do not add for alternative ways, amplitudes add. It's not the probabilities that multiply for consecutive events, it's the amplitudes. This is a difficulty, because in the macroscopic scale, the laws of probability work. The transition between the microscopic realm, with the amplitudes, and the macroscopic realm, where it's probability, is the measurement thing in quantum mechanics. When you interact with a quantum system in such a way that you end up in a situation where you should end up having different amplitudes to be in different situations, you don't "feel" that you are amplitudinous over different alternatives, rather you see that exactly one possibility occurs with a probability proportional to the absolute square of the amplitudinosity of you ending up in this situation. This is mysterious, because amplitudes are different from probabilities, but when they are happening to big things, they become probabilities according to this squaring rule. But they never quite become identical to probabilities in quantum mechanics, they only become indistinguishable in the infinite system limit, which we are never precisely at. I think there are exactly two possibilities here. Maybe quantum mechanics is exactly correct, and this is another philosophical problem, like the psychological time. It is again just due to the fact that what things "feel like" is a notion of experience, not a notion of physics, or rather, it is in the map from the physical description to our experience, the map that tells you what this or that brain state is supposed to feel like psychologically. This would

mean that the superposed brain-states just don't "feel" superposed, they feel like a definite outcome to an individual, and the outcome just is one or the other according to the laws of probability, or at least, that's what it "feels like", and if you ask why, you are asking a meaningless question, because what the "feels like" stuff is supposed to be is only answered through experimental probing, and this point of view is consistent with experimental probing of all sorts of entities that feel all sorts of things. This philosophical point of view makes quantum mechanics complete, and it is the Everett many-worlds idea. Because Everett is self consistent (at least assuming people are big enough to be infinite systems, which is probably a safe assumption) the physical law can be this crazy amplitude thing, and it's just psychologically that one cannot feel superposition. The other possibility is that the real laws of nature are the standard laws of probability, and quantum mechanics is only approximate and emergent from a large distributed system, where the transitions are nonlocal. In order to be reasonable, such a theory, which no one has convincingly formulated, should not be so enormous that it reproduces quantum mechanics exactly, then it would be a philosophical thing, like Bohm's theory. It would have to be of physical size, and reproduce quantum mechanics only approximately, for small things, and be exactly probability for the big things (because it's exactly probability for the small things too, but only approximately quantum mechanics). Nobody knows how to make something that is probabilitiy reproduce something that looks approximately like quantum mechanics, but it might be possible. Both ideas are reasonable today, because the notion of locality is out the window now that we know about holography and string theory. The proofs that it is impossible to reproduce quantum mechanics, at least the correct and stringent one due to John Bell, assumes the classical probability theory underneath, if there is one, is local. Then Bell shows that this doesn't work. 5. Socially nice methods don't converge to truth. This is important--- it is something that is engrained in physics culture. You don't produce truth by putting stuff and holding a vote on whether it is correct. Rather you do it by individually debating the merits of proposals, checking them for yourself, and coming together after independent analysis to share your conclusions, with scathing criticism whenever everyone else is wrong and only you are right, until you each get the same answer, every single one of you, regardless of who ends up looking stupid. This is the only way to ensure that politics is kept at bay, otherwise the things that are socially mediated to feel correct beat out the things that are correct. Physics is very good training to make sure you do this, because if you don't do it all the time, you can't understand anything. There are lots of things that no one is going to ever explain to you, and you need to just work out for yourself, so that you build up your own intuition for it, until it is obviously true, because you thought of it, not because somebody said so. This process is not followed in other fields, where people take stuff that they personally doubt for granted, because some big-shot said so. This makes physicists dismissive of other fields, and rightly so! The mechanisms in other fields are completely busted. In mathematics, people also check for themselves, so there is nothing wrong, but in mathematics, the criterion of deciding whether something is "important" or "not so important" is political (but nothing can be done about it). In philosophy, the whole thing, including what constitutes a solid argument, is decided entirely politically, based on who wins more converts in a popularity contest. This makes the whole field useless. In other fields, the politics and the honesty mix to a different degree. This cultural idea is very important, it is the one thing that physicists know that id just a universal social truth. The only way to get true propositions to win out is through rude bickering based on your own personal opinion, gotten to by half-baked personal thinking and rethinking, and independent of your authority position. It won't happen though polite analysis through socially mediated conversations that lead to gradual consensus. Those processes are guaranteed to produce bullshit. When consensus happens in physics, you can be sure that thousands of people checked it themselves, and all the diehards were either converted or died. In addition to these big ideas (which are not big), physicists know all sorts of detailed things about the world that are interesting and important. 1. You can understand nearly the entire material world from statistical mechanics, Pauli exclusion, and electrostatics. I don't just mean that this is in principle possible, I mean that physicists can

actually see more or less how every single every-day phenomenon occurs, from the motion of quantum mechanical spread-out electrons bound to classical nuclei, where the nuclei move according to a potential energy which is the electronic energy of the configuration of electrons. This is the Born-Oppenheimer approximation, which is usually perfect. You walk around seeing how every material response is related to these microscopic constituents, more or less completely. This is a nice thing to know! It makes life more interesting. You see a shiny metal, and you can feel how the electrons are distributed, they are spread out in long waves just like a cold Fermi gas. The light hits the electrons, and you know how they shake, and reflect the light, becaue they are delocalized. In an insulator, you know that there is a band-gap, so that the electrons can't shake at low energies. But at high enough photon-energies, enough to excite a molecule or atom, an individual electron can shake and retransmit the light, making a pretty color. And you can see how to break the metal, by disorder like Anderson described, or by making the electrons Mott-freeze into a lattice, or by a reconfiguration of the lattice into a periodic modulation, like Pieirls described. You understand why metals are never brittle (because the electrons are delocalized and hold the atoms together), and ductile (because the spread out electrons only care about the total volume to first approximation, not the detailed association of neightboring atoms), why they conduct heat so fast (the electrons go far), why they are so fast at transmitting sound (because the delocalized electrons make them stiff). You can see why heat makes water evaporate, and why there is a phase transition at a sharp temperature to a boiling state. You can understand how engineering mechanics works, through the flows of the momentum, and so on. You get a picture of the detailed functioning of the entire everyday world, and that's really fantastic. 2. You can take things that look superficially like mathematical abstractions, and see then as actual physical objects, like a bowling ball. This is the most important skill in physics, turning mathematical abstractions into concrete things, where you know what they will do without calculating anything, just from calculating a few simple things, and using your intuition, refined by first carefully checking for inconsistency, and later not having to check

anything, because you just "know" what's going to happen. This method is similar to what babies do when they first see water. It's weird stuff, it goes through your hands, but after a few experiences, you sort of know what it's going to do in any given situation, splash, pour, deform, get flat at the top, ripple, wave, etc. And you didn't need to calculate anything, even though the equations that describe water are hopelessly complicated, and babies don't know them. Physicists do the same thing for everything in the physics literature. Really and truly. Even when it seems that they couldn't possibly know, they do. They don't calculate all the situations, of course, they calculate a few simple ones, and graually build up intuition, like a baby, for what will happen in the general case, by doing spot-checks, more complicated simulations, and getting a feel for when the range of phenomena has been more or less exhausted by the examples, when they are sufficiently general. This happens more quickly than you think--- the baby gets a sense for water almost immediately. So if you are a decent General Relativist, and you are reading about a Schwartzschild black hole, you immediately see a one-way horizon in your mind's eye, you see the slow-time region nearby, the deforming of light paths, the range of orbits, and you also see a gooey lossy resistive membrane, and you immediately understand how it bends and deforms when you bring a massive charged object close and shake it. That's not because you did a calculation of all of these, but because you just KNOW what it does, because it's a physical object you are familiar with. A good relativist is as familiar with a black hole as a baby in a bath is with water. That doesn't mean there ar eno surprises, if you show a baby capillary action, it will come as a surprise, but it means the surprises are rare, and reveal something new. The ability to picture an abstract-seeming things in completely physical terms allows you to make leaps that are very difficult for rigorous folks, and this is really the only way that humans can understand things like elementary particles, or astrophysical structures. This is because we have only a limited amount of time to compute, and only the simplest calculations are tractable, but with familiarity, you really get to know everything, except for a few surprises, which then feed back to modify your intuition, and then you eventually run out of surprises. But you don't

get any intuition until you do enough simple calculations, and reproduce the things that are known for youself from scratch (because you need to get a feeling for all the signs, all the inequalities, and why they occur, what types of perturbations lead to qualitative differences, and so on and so on, it's tedious). This procedure makes you very very fast at getting the answer to certain mathematical questions in ways that look like magic to people who think about these things by proving theorems. The thing is, this intuition business is very easy to fake! Write down a bunch of complicated equations, and say you understand that this and so is going to happen, and nobody can prove you wrong. This is the major reason that honesty is so important in physics, because you really need to be honest with yourself, so you know when you really have understood something from a rock-solid picture, where you have solid intuition for each of the parts, and when you just fooled yourself by a crappy analogy into thinking you know more than you do. And then you have to communicate this picture to other people, and this is hard too, but it is always possible, from experience, because every physicist today has no problem with Einstein's intuitions, or Feynman's. The interesting thing about the intuition thing is that an abstract equation eventually turns into a physical picture in the head, an experience nearly as direct as water splashing on your hands. This makes it that each and every mathematical equation or physical argument in a good physics paper is as full of imagery as the greatest of novels, because you SEE the equation, and it makes complicated pictures in your head, that are true, because they work to tell you what happens in the equation. These pictures are always slightly different in each physicists's mind, but they are more or less the same (as you can tell by asking questions), and eventually they converge, and everyone has the exact same picture independently. The mathematical expressions don't do justice to the images, but they are pretty much the best one can do. But a person who hasn't carefully trained doesn't see the picture meaning, and cannot follow the arguments in the literature. This can be imporved perhaps by drawing more of the pictures using computer visualization, but sometimes the pictures are very abstract, and even a detailed computer picture doesn't help.

Science Popularization: What is your opinion on book "War of the Worldviews"?

I was asked to answer this, I suppose because I understand and accept the principles of logical positivism. But I can't say I am a "physicalist", because this would be taking a firm position on a meaningless question, and that's not logical positivism. But I have no problem with physicalism, who cares? It's a meaningless question. I can't answer very well, because I didn't read the book. I did skim Chopra's articles, and saw this video: Deepak Chopra and Leonard Mlodinow: War of the Worldviews . I don't see any charlatanry on Chopra's part. He is just repeating some standard not-particularly-controversial but not particularly meaningful statements about consciousness which are not making any contradiction with any scientific principles. The only time he makes a contradiction with some biological dogmas, it is in cases where these dogmas are obviously false, like the simplistic model of evolution by random SNPs and selection, discredited by even the most rudimentary glance at the output of modern sequencing machines. Evolution is pretty sophisticated, and to call it an intelligent process is not necessarily a mischaracterization. The questions that were debated in the video were ALL, without exception, logically positivistically meaningless, so both participants can be right without contradiction: "What created the universe?" is meaningless to a positivist. There is no sense impression that can be used to determine this, and it has no impact. "Is the mind separate from the brain?" is meaningless to a positivist. You can therefore take whatever answer, and the result is fine. It is simply not a meaningful question. Deepak Chopra doesn't deny that the brain activity is correlated with the sensations people report, which is the logical positivist content of the statement that consciousness is a manifestation of brain activity. The way to resolve

mind/body issues is simply to recognize that the mind is running software, it's an activity, a computation. That's pretty spiritual, and it's easy enough to translate ALL spiritual literature to turn it into a description of software. The hardware obeys the laws of physics, the software obeys the laws of computation. They are separate ideas to a large extent, because pretty much any sophisticated physics will support a computer, and any one computer can simulate any physics. The process in software is abstract, it doesn't require knowing the hardware implementation.

What does Ron Maimon think of himself?

My wife wrote "and I think I should have been rewarded with a Nobel prize" on my profile, because she was pissed off at me that day, and I left a window open on her computer. She told me about it some time later (I am not sure how long it was up), and I erased it. I have no problem saying conceited things about myself, but this is not a case. I would admit it if it were. But she wasn't writing this out of her imagination. The REASON she wrote this is because she knows that when I talk to people face to face, I often tell them that I think I should win the Nobel prize. Usually, I say this just after explaining some new idea or other to them, and after I'm done I say, "ok, so I just explained this phenomenon to you. I thought of it! It's completely new! It's totally correct. So I think I should get the Nobel prize!" Sometimes, I also dance an elaborate "I should win the Nobel prize" dance, somewhat like a football player's touchdown dance. I do this for the simple reason that acting like this is the quickest way to get stupid people to not take what you just said seriously! I don't want people who use social methods to learn anything from me, they can piss off. Telling them that you think you are the greatest scientist in the world and you deserve a Nobel prize makes you a crackpot, and it is nearly 100% effective at making non-scientists stop listening to

anything technical. In an ideal world, people listen to the technical content regardless of what you say about yourself, or anything else. They just judge the technical content on it's merits. If you don't do this, or can't do this, you don't deserve to learn any technical content. It's an automatic test that most people, also most scientists, fail. I don't particularly care about the Nobel prize, except that it's money, and it would pay for my daughter's college. These prizes are often political and sometimes make little sense, and there are so many deserving people that are neglected, and I think that the neglected ones often made even greater contributions than the recognized ones, so I would be happy to be one of the neglected ones. The Dirac medal usually goes to these great neglected folks. I wouldn't say that I think I should be awarded the Dirac medal, not even as a joke. First no-one would get it, but also I don't deserve a Dirac medal for anything I did! I don't believe in special people, and I don't think that great stuff is done by special people, but by ordinary people. It is only by looking at the work itself that you get a sense of quality. When I look at my CURRENT work, it looks like totally mediocre crap, except with potential, which is why I am working on it. That's pretty much what you always think of your current work. So it's no good evaluating your current stuff. When I read my old stuff, I tend to be a pretty good evaluator, and I think some of it is pretty good! It's as good as anything else, including some of the lesser stuff of some of the Dirac medalists. If I had to choose my own best stuff, it's got to be the language for protein networks, the associated computational ideas about the origin of life (same thing applied to prebiotic chemicals), my (still unpublished) work on RNA networks, the theory of cold-fusion (I put it on stackexchange), and then the more pedestrian stuff in journals or proceedings. I think that the complete protein networks project, the RNA network project, the computational origins project would each be as good as any stupid prize work. The cold-fusion thing is the best physics idea I had, it was difficult, and required a lot of tedious estimates and many false starts. But the phenomenon is completely ridiculous, and I was completely mystified how it could possibly happen, and a lot of people thought about it, including people who won prizes, and they didn't see how it could happen. That's

definitely as good a discovery as any other, no doubt about it (except if I am wrong, which I don't think so). But people don't even think the phenomenon exists right now, mostly because they can't imagine how it could happen, and even in the cold fusion field, people don't talk about the idea of K-shell acceleration and 3-body fusion chain-reaction, so I am not holding my breath. But yes, I like my own science crap, otherwise I would become a stock broker, or start a business, or do more programming.

What is a good explanation for the proof of Godel's incompleteness Theorem?

Here is the complete proof. Given an axiomatic system S, you can write a computer program to deduce the consequences. Assume S is strong enough to describe a computer, so that the memory of the computer is encoded in an integer M, and the instruction set is a certain simple function f, and the time steps are M, f(M),f(f(M)), and so on, the n-th time-step is f(f...n-times ... f(M)))....). Then write the program GODEL to do the following: 1. print it's own code into a variable R. 2. deduce consequences of S looking for "R does not halt". 3. If it finds this theorem, halt It is trivial to see that "GODEL does not halt" is not provable, at least not if S is consistent. The assumption here is that if a program halts, S will eventually prove that it halts, by computing f(f(f...(M)...) long enough to see that it halts. This is a trivial assumption, any axiom system for general mathematics should be able to do this. If S is inconsistent, GODEL halts, because an inconsistent S will prove any theorem, including "GODEL does not halt", at which point "GODEL halts". Further, if GODEL halts, S is inconsistent. So "GODEL does not halt" iff "S is consistent", and that's Godel's second theorem. The Rosser theorem is proved by a small modification: consider program ROSSER which 1. prints it's code into R 2. deduces consequences looking for 1. R prints to the screen, 2. R

does not print to the screen. 3. If it finds 1, it halts. If it finds 2, it prints "hello" and halts. Now neither "ROSSER prints" nor the negation can be proved by the consistent system. There are many simple extensions which can be proved by the same method, described in my answer here: What are some proofs of Godel's Theorem which are *essentially different* from the original proof?

Is there any way "around" Gödel's incompleteness theorems (that doesn't include ever more infinities in the ladder) which might provide us with a complete and consistent picture of mathematics?

The proper way is called "ordinal analysis", and it was developed by Hilbert and Gentzen in 1936, after Godel's theorem, and most significantly by Turing in 1938, in his PhD thesis. Still, it hasn't penetrated the wider mathematician consciousness. Godel's theorem is not a limitation to a complete and consistent picture of mathematics, it is a limitation to a complete and consistent picture of mathematics within a fixed axiom system. It means that to produce a consistent complete picture of mathematics, you need to be open-ended to extensions at the large end, and these extensions are described by ever larger ordinals. Godel's theorem is proved as follows: Consider an axiom system S. Consider the program GODEL which does this: 1. Prints it's own code into a variable R 2. deduces theorems in S, looking for a proof of "R does not halt". 3. If it finds this theorem, it halts. It is clear, by construction, that S cannot prove GODEL does not halt. The statement "GODEL does not halt" is equivalent to "S is consistent". This is because if S is inconsistent, then it proves any theorem, including "GODEL does not halt", at which point, GODEL halts, so

"S inconsistent" implies "GODEL halts". Conversely, "GODEL halts" means S is inconsistent, since it proves "GODEL does not halt" and "GODEL halts" at the same time. So given any axiomatic system S, the result is that you have the computational statement "S is consistent", which you can adjoin to S to make a stronger system. Starting with a simple theory, you can adjoin "S is consistent" to make a stronger theory S+1, and then you can adjoin S+1 is consistent, to get S+2. Once you make S+k for all k, you can take the union of all the statements proved by all these theories to make S+omega, and step up the ordinal chain. So long as the ordinal is countable and computable, you still have a computable axiom system which you can work with, so you can keep going. The limit is the Church-Kleene ordinal-limit. The point is that all theorems should be provable by the time you get to Church Kleene ordinal along this chain of theories, and further, all the theories anyone has ever considered will be equiconsistent with some point along this list. The proper statement of this was proven by Turing, who showed there is a particular Church-Kleene ordinal construction corresponding to every non-halting computer program that proves this program does not halt. This is important, because it means that simply naming larger ordinals allows you to prove arbitrarily strong systems are consistent, and these systems then include reflection principles that allow you to decide more complex theorems along the arithmetic heirarchy, as discussed by Fefferman, so really you have a complete system. This makes the project of completeness tantamount to naming and uniquely describing stronger and stronger countable computable ordinals. This is not something which can be done by a single fixed computer program, but it can possibly be done in an evolutionary way, by finding appropriate ordinals using a randomness source, thereby getting closer and closer to the limit. The problem is defining the notion of randomness properly, so that you can have a random oracle. I like Rathjen's "The Art of Ordinal Analysis" for a good modern review. There is also a recent reprint of Turing's PhD thesis which explains Turing's simple but ingenious construction.

Are there any mathematical statements which have been proven to be unprovable?

Not in any absolute sense. First, here is a complete modern proof of Godel's theorem: Consider an axiomatic system. Write a computer program called GODEL which: 1. Prints it's own code into a variable "R". 2. deduces all consequences of the axiom system, looking for a proof of "R does not halt". 3. If it finds this proof, it halts. "GODEL does not halt" is not provable in the axiomatic system. Done. But the nature of the proof shows that S should be extended by the statement "GODEL does not halt", to produce a stronger system. This is what Godel's theorem does--- it relates a system to a stronger system which proves more. An alternate form of "GODEL does not halt" is "S is consistent". The reason is that if S is inconsistent, it proves any theorem, including "GODEL does not halt", so that Godel halts. On the other hand, if Godel halts, S must be inconsistent. So "GODEL halts" if and only if "S is inconsistent". Going up from S by adding "S is consistent", you get a system "S+1", and then adding "S+1 is consisten", you get "S+2", and so on, for all integers. From this point on, you can make the union of all the statements proved by all the "S+k", and this is the theory "S+omega", and then you can use Godel's method to produce "S+omega+1", and so on, up through all the ordinals you can explicitly name. The procedure steps up theories, for as long as there are countable computable ordinals. It is an article of faith, explicitly articulated by Paul Cohen, implicitly believed by many mathematicians, and me too, that this procedure goes up through ZFC, goes up through all the large cardinal axioms, and eventually allows you to prove all meaningful theorems. This is the subject of ordinal proof theory, which is the modern post-Godel version of Hilbert's program for mathematics. It reconstructs mathematics from finitary ordinals (ordinals like epsilon-naught, that

can be represented on a computer). The qualification "meaningful" in the above is designed to exclude questions like the continuum hypothesis, which are not absolutely meaningful, because they are not formulated computationally. When working in a well-defined specific countable model, so that they become computational questions about the model, they become decidable. A meaningful question is a statement on the hyperarithmetic heirarchy.

Does using recreational drugs infringe on any one else's rights?

Smoking MARIJUANA outside your home, in the street, is a form of assault, which wrecks bystanders brains. I don't give a crap about any other drug, it can't affect anyone except the user. The worst infringement of liberty of another person is forcing them to ingest brain-altering chemicals. It is worse than physical assault, it is killing another person's soul. Other than that, not really. But that's the big one. It happens all the time. Anywhere there are housing projects, you can't go anywhere without marijuana damage inflicted on you. It's the worst thing in the world, except for purposefully taking some other drug.

Why in the present times don't we hear of some of the new scientists like Einstein, Feynman, Faraday? Has the field of research lost its sight somewhere?

We have an infinitely better media environment today, so you shouldn't expect to hear about only one great person. In the 1920s, media was monopolized by a small number of companies that controlled film and radio, then by the 1950s, an even smaller number of companies that controlled television. The news monopolies have an ever dwindling staff consisting of a small class of insiders, who are chosen from the most conformist people on the planet. These people then form an incestuous circle, discussing the same three topics again and again, without conspiracy, just because this is what they know, and this is all that the public hears about, and they publicizing a few people endlessly at the expense of all others. Einstein understood the centralized mass media, and he was good at manipulating it, and at becoming a star. Uncharacteristically for a scientist, and despite his social isolation, he had very strong political skills. In the 1910s, he was famous among Berlin University students for his outspoken pacifism, more than for his science. He was offered the presidency of Israel. He made a much better media figure than other physics stars, like Dirac, who didn't talk, or Schrodinger, who openly had two wives, or Heisenberg, who was a geek's geek, or Bohr, who mumbled unclearly, or Pauli, who was an asshole. Einstein always had a pithy quote, and always exuded good humor. The monopolized media needs exactly one great figure, and in Einstein's case, they accidentally happened to stumble on the best guy. They hardly ever do, so one should be grateful when it happens. It's because the guy who was most media-savvy also, by a fortuitous coincidence, happened to be the guy with the most earth-shattering science. If Einstein were a one legged foul-mouthed sex-offender, we would probably be celebrating 100 years of Poincare's special relativity, Planck's E=mc^2, Hilbert's revolutionary theory of gravity, the Smoulochowski fluctuation/dissipation relation, Compton and Millikan's bold photon hypothesis of 1919, Leo Szillard's letter to Roosevelt. This kind of crap happened in Germany when Einstein was politically out. Today, the media environment accomodates a much larger number of people, and allows a fair distribution of credit to the people who actually deserve it. The funny thing about Einstein and Feynman, is that they come out looking good,

they deserve it. But there's a whole bunch of other people who deserve it too, who were neglected.

What are the most interesting differential equations in science and mathematics? Why?

Here's one that's as esoteric as it gets, as far as I know, nobody ever thought about it before (nope, turns out this was a putnam 2010 problem B5, probably I was unconsciously plagiarizing, I don't remember seeing it, I probably did and forgot). [\math] {dy\over dx} = y(y(x)) [/math] The idea here is to produce an insanely fast growing function (think about y with positive values and you will see why). Such insane functions are like fixed-points of ordinals, they are possibly at the limits of axiom systems. These might give easy analogs of Paris-Harrington for ZFC, but this is just motivation, I don't have any idea for how to do this. Just consider this type of differential equation The problem is this particular equation has no solutions when y(0) is positive (this is easy to prove). When you modify it: [\math] {dy\over dx} = y(x+ f(y(x))[/math] with some fixed given function f(x), restricting to positive values, the function f(x), always has to decay at large x. For example, in order for [\math] y(x) = e^{e^x} [/math] to work, you need f(x) to go like [\math] 1/\log(x) [/math]. This leads to a natural question: how slowly can you make f decay and still produce a solution in positive values? For the original equation, y'=y(y(x)), if you consider y(0) negative and larger in absolute value than -1, I think there is a solution, just from drawing qualitative plots. It is linear decreasing at a slope at large negative values, it crosses zero at a negative x, and it asymptotes at large x to a value equal to the negative slope at -infinity. This type of function is cute, because it has a global constraint on it's behavior, but because it is decreasing and non-positive, it isn't "chasing it's own tail" in a self-

consistent way like the positive case, which is what I was originally interested in.

Are gravitational waves the new (a)ether?

The problem with the ether was that it was imagined to be a material which defined a rest-frame for electromagnetism, so that the waves could propagate at a fixed speed. Since relativity, we know that you don't have a rest frame, and further, we know now that materials are composed of quantum mechanical version of fields, rather than fields only being jiggling of materials, so that the explanation would be circular. But the ether was a reasonable idea in the mid 19th century. There are modern ideas which are like an ether, the Pion condensate (due to Nambu, developed further by Gell-Mann and Levy, and ultimately really due to Heisenberg's ideas about spontaneous symmetry breaking) is an example, so is the Higgs mechanism. The difference is that these ethers are measurable and do not define an absolute frame, because they are relativistically invariant scalars. The reason we know gravitational waves exist theoretically is that you can shake the sun using gigantic hydrogen bombs, and the gravitational shock can only reach the earth 8 minutes later. So something is traversing the space between the sun and the Earth, and whatever it is, that is a gravitational wave, by definition. The precise types of gravitational waves are determined by General Relativity--- there are two polarizations, and this tells you how much gravitational radiation you expect from a changing system of masses. This leads to a small amount of radiative decay in orbits, due to the emission of gravitational radiation. In most cases, the amount of decay is extremely small, because the orbiting bodies are moving much much slower than light. But in the case of close-together super-compact objects, like neutron stars, the orbital speed becomes large enough to get a detectible effect. The theory predicts that two neutron stars at a

certain distance should get slowly closer so that the energy they gain matches exactly the rate of gravitational radiation emitted. This was verified in the 1990s when a pair of such pulsars were studied for several decades, and their inspiralling motion matched the prediction, determining experimentally that there are exactly 2 degrees of polarization for the outgoing gravitational waves, and that the rate predicted by General Relavitiy for emission is correct (but this would be the same rate pretty much in any theory with 2 polarization degrees of freedom, except GR is the only such consistent theory with a tensor source of gravity). The theory is supported by stronger evidence than this, theoretical evidence of consistency, and the classical measurements of General Relativity, but the theoretical evidence is of a lesser nature, because it is always possible that we just didn't think of something, the most obvious candidate being a scalar component of gravity which is propagating long distances. The pulsars show directly that we didn't miss anything like that.

What are scalar (longitudinal) EM waves and are they real?

They are not real, and the work is delusional or fradulent. The simplest way to be sure they are not there is using thermodynamics. When you have a box of light, it's energy and entropy are proportional to the number of independent degrees of freedom, to the number of oscillations possible, and if there were another oscillation possible, the entropy would go up by 50%. This couldn't be missed--- the energy radiated by any hot body would increase by 50%, the energy in a hot cavity would increase by 50%, the entropy would be bigger by 50%. This thermodynamic argument can only fail if the field is extremely hard to excite, so that ordinary matter doesn't produce excitations very well. For example, gravitational radiation takes a practically infinite amount of time to get excited by ordinary matter. But if this is

so, the new field is useless and the tehchnology wouldn't be able to transmit anything. There are sensible near-field communications technology that use static electric fields to communicated very short distances, and you can interpret this as a longitudinal EM wave if you like, using Feynman's ideas, but it's not necessary--- static fields in this context are best understood as just static fields. I would have voted up the leading answer if it didn't have the crackpot index. The way to evaluate scientific ideas is by considering them and ruling them out with science, not by politically estimating the practitioners. This type of political attitude killed a lot of good ideas in the past.

How did Jimmy Wales get the idea for Wikipedia?

The original idea was due to RIchard Stallman and the Free Software Foundation, see here The Free Universal Encyclopedia and Learning Resource . It is possible that Wales and Sanger came up with the idea independently, it was an outgrowth of the usenet driven early internet, along with the open development of the Linux kernel, the idea was in the air. Nupedia was supposed to be much like Scholarpedia, an authoritative thing, with experts writing stuff. Wikipedia was the pilot, open to everyone, which was supposed to see if the idea would work. The pilot took off, and the Gnupedia and Nupedia projects were abandoned, or more precisely, Wikipedia realized them more than adequately.

Why did the Dunning-Kruger effect paper receive an Ig-Nobel prize?

The Ig-Nobel is an way to humiliate creative people who don't tow the line. It was an attempt by some Harvard dipshits to acquire more political power in science, by silencing others who do off-the-wall things. The associated "irreproducible results" magazine is not funny, it is the same kind of political hammer. It should be boycotted. At the time, there was some research in nonsense like parapsychology, because of the huge amount of psychoactive drugs people were taking, and the induced delusions. So people like James Randi began to heckle the proponents of parapsychology, showing that they were being suckered by simple conjuring tricks. That's great, it is required scientific skepticism, it is a good activity, but it was EASY skepticism, in that the skeptic was reinforcing a well known majority position, so it was helped along by politics. This is not usually the case with skepticism, it was an unusual circumstance. The usual situation is where the skeptic is pushing an un-popular position, and constitutes a minority of one. This is real brave skepticism, not the kind of nonsense the IgNobles and James Randi do. The difficult skepticism is when everyone disagrees with you. This is why skepticism must be done in a completely level playing field, where powerless people can heckle back the powerful, so that the resulting debate can expose the truth. The IgNobel is not such an open thing. It is simply a mechanism of heckling things that sound wacky to the powerful pot-smoking Harvard crowd. It was awarded to Pons and Fleischmann, It was awarded to Dunning-Kruger, it is awarded to non-Harvard researchers, it is a mechanism of power, and this means that anyone who takes any part in it is a total tool.

What are the most effective arguments against those who contend that Reagan was the greatest president in U.S. history?

Reagan gambled with nuclear war, not becaue he wanted it, but just due to stupidity. The retaliation time in 1981 was 20 minutes, in 1985, with Pershing II, 6 minutes. And Reagan, totally oblivious to the growing danger, started mouthing off about evil empires, outlawing Russia, and bombing! The Soviets were scared shitless, the higher ups had concluded from his antics that the US had secretly decided on a pre-emptive strike, and their paranoia could have easily turned into a strike of their own, just through intelligence error, or a technical malfunction, these things happened all the time. This is how Reagan supposedly won the cold war, by threatening nuclear strike on the Soviets, to force them into spending more, and then bankrupting them. How can anyone possibly glorify this? Is there anyone today, with the benefit of hindsight, who thinks anyone was better off because of this? Does anyone think it carried no risk? Psychologically, for everone alive during that time, it was very trying, simply to check the sky for missiles, because the time was too short for any warning. This type of fear is something nobody has to deal with anymore, but one must remember what it was like. Then you can judge what a great president Reagan was.

Who is the writer of Hamlet?

Based on the preponderance of current evidence, the author of Hamlet is Christopher Marlowe. This can be reasonably firmly concluded from the stylometric evidence alone, comparing the statistical signatures of the works known to be by Christopher Marlowe and

those appearing under the name of Shakespeare. But because this conclusion is rather strange from a historical perspective, one needs to understand the historical evidence also, to be sure that it is consistent with the stylometry, because the historical evidence, as it is usually interpreted, makes it impossible, because standard historical narrative has it that Marlowe is dead in 1593. Stylometry was invented by Thomas Mendenhall, an American physicist. He used his stylometry to identify various anonymous writings floating around at the time, embarassing many people who wanted to stay anonymous. Based on his success, a Baconian hired to him to demonstrate that Bacon wrote Shakespeare. Mendenhall ran his test, and ruled out Bacon. But in doing the controls for the test, he computed the curves for other writers of the era, and he was astonished that Christopher Marlowe had a curve indistinguishable from that of Shakespeare. These studies have been replicated by Peter Farey using computers here: A Deception in Deptford (linked from here A Deception in Deptford , see also the comparison between authors and themselves, and with each other here: A Deception in Deptford , to see how improbable such a similarity actually is). I should point out that if you look online, there are one or two incompetent replications which fail to get the same curve. You need to use Farey's careful methodology--- use a standardized spelling which is consistent across Marlowe and Shakespeare, and compare later Marlowe to Shakespeare tragedy, since Marlowe's work does not include an out-and-out comedy. From this point onward, many people noted that the stylometric signatures of Shakespeare and Marlowe are not reasonably consistent with two separate authors. At the same time, other people tried hard to find stylometries that separate Marlowe from Shakespeare. There were several such ones: the number of run-on-lines and femine endings was one, for example. As were certain function word baskets. Peter Farey took these stylometries that separate Marlowe from Shakespeare, and plotted them against the composition date of the work. By doing this, he found, to my astonishment, that the stylometries that separate Shakespeare from Marlowe all drift, and they drift the right way to make Marlowe's work fit along with Shakespeare's on a single plot, without any jumps, without any forcing. You can see these plots at the

end of the essay linked here: Hoffman and the Authorship and two more plots of other function-word stylometries here: A Deception in Deptford . Remember that these are stylometries specially selected to differentiate Marlowe from Shakespeare. This evidence has only become stronger, as computerized stylometries have taken over from hand-counted ones. Peter Farey has further stylometries of a very abstract nature, like letter counts, and function words in baskets, and did not find a separator. Later, Ehomda, Charniak et al, constructed two stylometries for precisely this purpose. In their paper, which comes with a dishonest conclusion and introduction, the result of the stylometry is striking: the program attributed the majority of Marlowe's work to Shakespeare, Dido, Faustus, Jew of Malta, Edward II. The exceptions, attributed to Marlowe, were the Massacre at Paris, and the Tambourlaines. The methodology was to leave out one play and compare to the rest, so obviously when you leave out one of the two Tambourlaines, you get a best match to the other. If the methodology were honest, I am sure that the Tambourlaines would have come out Shakespeare too. The Massacre is the only play that was not misattributed without cheating. The Massacre only survives in bad quartos, meaning in quartos that are not certainly accurate as to the original author's writing, so it is not clear that there are any failures in their method, although an unbiased replication is sorely needed. Among the Shakespeare works, Henry Vi part 1 was misattributed as Marlowe by vocabulary. This is significant, because there are many more words in Shakespeare, so a match going the other way, from Shakespeare to Marlowe, is extremely unlikely. This play, and also parts 2,3, Titus Andronicus, Richard III, have been considered to be authored by Marlowe by mainstream scholarship. Mainstream scholars have at one point or another attributed about half the plays in the first folio to Marlowe's co-authorship or exclusive authorship, but these attributions stopped appearing after modern Marlovian theory gained steam, simply because once scholars get enough of these coincidences, they just jump ship and become Marlovians. The historical Shakespeare authorship question is bedevilled with a lot of speculation, because the historical data is so scant. This in itself is a clue. Contrary to what Shakespeare scholars

often say, there is plenty of evidence for Marlowe, Kyd, Lyly and other contemporaries, as writers, including manuscripts, letters, and other documents that present a clear paper trail of their literary activity. Not so with Shakespeare. When Shakespeare dies in 1616, the literary world is silent. Only in 1623 is there a celebration of the works, with the first Folio. The scant historical evidence is rather conclusive, as much as historical evidence can be conclusive, that William Shakespeare, the actor and businessman from Stratford, was not a professional writer, and might not have even known how to read and write very well. This evidence is wishy-washy historical stuff, but before stylometry, it was all you could rely on: 1. Shakespeare dies owning no books according to his will. A diligent search for books of his provenance a century later revealed nothing. He has no evidence of education, and never signs his name literately, or even the same way twice. There is no evidence (except back-dating plays) that he wrote a word before the age of 30. 2. Shakespeare's life has no relation to the life described in the Sonnets, a vexing mystery for Sonnet scholars. He is involved in business ventures, becomes wealthy, hoards grain during a famine, and sues people for petty things, but has no exile or humiliation, the main theme of many of the sonnets. 3. Shakespeare's daughters are illiterate, Judith signs her name with a mark. Shakespeare's granddaughter attests that he was not a man of letters. 4. Some of Shakespeare's source material for the plays is not available in England, and Shakespeare never left England. Most of the source material is not available in English, requiring that Shakespeare could read Latin and Romance languages reasonably fluently. 5. Despite statements to the contrary, Shakespeare's plays are set in accurate depictions of Italian towns. The claimed "mistakes" in Shakespeare are not mistakes at all, but reflect the way Italy was in the 1600s. Shakespeare never set foot in Italy. This is pretty good evidence. Marlowe was an educated guy, who translated Ovid from Latin, and spoke Latin-derived languages fluently. But in 1593, there is a crackdown on writers, and his roommate Kyd is captured and tortured. I should add that Kyd is stylometrically identified, along with Shakespeare, as the co-author of the anonymous play, long suspected to be by Shakespeare, Edward III, which was written

around 1593. The stylometric identification is more properly Marlowe/Kyd, since stylometrically Marlowe and Shakespeare are indistinguishable, which makes historical sense considering the two guys were roommates. It is possible, although conjectural, that Kyd believed Marlowe was dead, and completed the remaining Marlowe manuscripts in his posession in the last months of 1593, Hero and Leander, and Edward III. But Marlowe was a sophisticated guy, who had no intention of getting arrested and tortured, or killed. He was detained for blasphemy, atheism, and counterfeiting, all capital crimes, in 1593. He was released on something similar to bail, with instructions to report to the court daily, and a date for a trial. But during his release, suddenly, he is killed in a knife fight and buried in a mass grave. The details are available now, as the inquest document was discovered. The three men who were witnesses were colleagues of Marlowe's patron, Walsingham. The event took place in a house in Deptford, which is by a shipping port. The murder is ridiculous, the details are absurd (Marlowe is said to have tried to stab one of the fellows in a fight over the bill, and then the fellow grabbed Marlowe's hand and stabbed Marlowe with his own hand in the eye, and Marlowe died instantly). The inquest was done by the Queen's coroner, and the fellow who killed Marlowe is released two weeks later with the Queen's pardon, on account of self-defense, and goes back to work for Walsingham, with generous financial rewards. After Marlowe's death, Shakespeare puts his name on a work for the first time, the Marlowe-style poem "Venus and Adonis", registered anonymously. Then the Shakespeare works come out, betraying a continuity of style and theme with the works of Marlowe. "The Merchant of Venice" is a not-so-anti-semitic rewrite of "The Jew of Malta", the history plays are extensions of "Edward II", the Tempest revisits Faustus, "Titus Andronicus" is a revisiting of the big bombast heroes of Tambourlaine, and so on. The continuity is striking. The language becomes more sophisticated, and new themes and styles are introduced. One of the more interesting parallels is between the tehn current Italian theater style of Comedia dell'arte and Shakespeare's early comedies. The Sonnets tell a story of a disgraced and exiled poet, a "cowardly conquest of a wretch's knife", whose works will live on,

but whose name will be forgotten. This stuff doesn't make sense for Shakespeare the person. But Marlowe's work is sort of Satanic, in a heavy-metal Jimmy Page, Lucifer Rising sort of way, especially Faustus, and is actually forgotten until the 19th century, when people rediscover it. The Faustus demonic stuff is probably what led to Marlowe's reputation for heresy. The Shakespeare works are not so atheistic, and reflect a more mature spirituality emerging in the writer. The stylometric and historical evidence are both only consistent with the idea that Marlowe faked his death and fled to Italy, kept on writing until his death, and used Shakespeare as a front, to put the name on the works. The implausibility of such a statement must be weighed against the implausibility of the stylometric matching, which is vastly greater. To my mind, whatever prior confidence you have in the likelihood of this, it is outweighed by the certainty of the coincidence in the two writers' styles. And similar things happened in the much less repressive McCarthy era in the US, and it took a long time to sort out who wrote what even in the 20th century. Just as in Marlowe/Shakespeare, Dalton Trumbo used Ian Hunter for fronting "Roman Holiday", and the deception was not discovered for several decades. Just like other fronts, Shakespeare also didn't mind putting his name on a bunch of other works, the Shakespeare apochrypha, which are clearly not by the same author as the one who wrote King Lear. The "Shakespearian Authorship candidates", other than Marlowe, are ridiculous today,most significantly because they don't match stylometrically at all, not even close, but also because, aside from Marlowe, these candidates are all dipshit noblemen and noblewomen. The work is obviously that of a commoner, a son of the bourgeoisie, and both William Shakespeare and Christopher Marlowe are commoners. The other candidates are silly snobby choices, designed to deflect attention from Christopher Marlowe. Before it was recognized that Marlowe could have survived to write the work, the best candidate was Francis Bacon, but the stylometric mismatch is terrible, Bacon is not a poet. The main positive evidence for this is the anachronistic appearence of some Shakespeare quotes in Bacon's notebooks, but this is also explained in the Marlovian account, because Bacon knew Walsingham, and might have had access to the

manuscripts as they crossed the English Channel. Anyone who actually reads Marlowe and reads Shakespeare cannot help but suspect that they are the same person. They really are that similar. I personally got interested in this because I read a bit of Tambourlaine some years ago, and I was rattled after only a handful of pages, because I immediately recognized Shakespeare's writing style, without any question, and I couldn't understand why! It's very difficult to describe how you recognize an author, it is an unconscious thing, it's vocabulary, structure of sentences, large-scale sentiments, and so on, but if you read Mark Twain, or Philip K. Dick, you get to know them, and you know when you are reading them. Reading Marlowe, I was confused as all heck, because I "knew" he was a different person that Shakespeare intellectually, and yet, by reading, I couldn't see how he was different! The two were obviously identical, although Marlowe is clearly younger. It was a mystery to me, it bothered me. At the time, I decided Shakespeare was a terrible rip-off. So I stopped reading or appreciating Shakespeare, he was no good. But the problem was that, unlike every other rip-off, here the rip-off was every bit as good as the original! Further, the rip-off gets better and better at the same rate as the original, if not more. This violated every rule of artistic creativity. Once I saw the quantitative stylometry, problem solved. The stylometry resolves the question, Marlowe wrote the stuff. It only took a few minutes of reading the summary of the historical evidence, to see that it is not only compatible with this idea, it is far more consistent with the evidence than the usual bogus story. A Baysian comment in response to other answers: the reason stylometry trumps all other evidence is because each stylometry is statistically independent, each one could have failed independently: just because the word-length distribution matches, that doesn't mean the most/(most+than) needs to also match, or the letters need to also match, or the vocabulary statistics need to also match, or the other function word baskets also need to match. They are completely separate tests. A definitive mismatch in ANY SINGLE ONE of these stylometries completely RULES OUT Marlovian authorship for good. And the chance of accidental matching is extremely low--- each is subconscious and impossible to immitate, no matter how hard you try (Madison,

Hamilton and Jefferson were separated stylometrically, when they were consciously immitating each other writing as Publius for the Federalist Papers). This is why every new stylometry is new evidence, because it is mind bogglingly improbable that two separate authors should match on all these different tests, and you get more certainty the more tests you use. It is the same as finding 20 identical SNPs in 20 separate genes in a DNA test, each SNP is not so improbable in isolation, but finding 20 SNPs, each of which has the potential to exonerate, which all match, means you found the right person. So, for example, to reproduce a Mendenhall curve, the word-choice type and sentence structure has to be almost identical, there are more than 10 separate data points that overlay on top of each other with complete identity. To further reproduce the Charniak et al vocabulary/function-word stylometry is at best a 10% chance for each failure (assuming different authors), because all the other authors are correctly identified, and there are half a dozen authors with about 30 plays which are never mixed up with each other. Only Shakespeare and Marlowe get mixed up. A lot. The further failure of the stylometries that Farey analyzes is more striking, because these stylometries were specifically claimed to work to distinguish Shakespeare from Marlowe in the literature. The fact that these fail also is extraordinary, because it shows that people failed to separate even after looking hard! Each failure is at best a 1 in 3 chance (it's actually much lower, but 1 in 3 is enough), but Farey has 4 such possible stylometries, so 1/3^4, or about 1/100 chance of accidental match. Mendenhall coincidence is 1/100 (really more like 1/1000), and the Ehmoda Charniak failures are at most 1 in 10^3 (really more like 1/100000), because there are at least 9 separate failures, even with the Tambourlain shenanigans they pulled, and with their obvious bias. So even if you assign a prior probability of .01% to the Marlovian idea, because of your bias coming in, after adjusting your prior for the stylometries, it jumps to 99.9% likely, simply by Baysian adjustment, and I have been relatively conservative. The more stylometries you use, the more confidence you gain, because each of these suckers can produce a mismatch. One of them, many of them, MUST produce a mismatch if there are two separate authors involved. So the evidence is really overwhelming,

despite what your feelings are, or what authoritative sounding folks come and say. it is close to scientifically certain (whether it's certain or not depends on your prior, but it's close to certain under any reasonable prior), and there is no reason to qualify or pay attention to counter arguments, because there can be no counter-arguments.

Is there any good example (preferably a modern one) where a mathematical law has been questioned or reviewed and changed?

There is only one real, meaningful, example of where this has happened, where mathematical theorems were overturned. I am excluding stupid mistakes, like Kempe's mistaken proof of the four color theorem. The one example is the collection of related proofs that there exists a well-ordering of the reals, a non-measurable set and Banach-Tarsky decompositions, a basis for R as a vector space over Q, a non-principal ultrafilter on the integers, and so on. These theorems were proved using a nonconstructive method in the early 20th century, using the new axiomatic set theory, which was partly constructed to make these types of proof rigorous. These proofs made a huge stink, because, although they were formally correct in the axiom system, many people still just couldn't believe the object asserted to exist really existed in any Platonic sense of the word regarding the actual continuum as we know it. The fact that the proofs went through in the axiom systems didn't help persuade the skeptics at all, because the axiomatic method included a method to choose uncountably many things simultaneously arbitrarily, and really, the intuition that these were false outweighed the axiomatic system in many people's intuition. But still, after a half-century of debate, the question was completely settled, as the skeptics died off one by one. By the 1940s and 1950s, the controversial results were just promoted to absolute truth, mostly due

to the work of Godel, which showed that the axiom of choice was true in the minimal model constructed to obey these axioms, a model called Godel's L, and therefore was a consistent convention. This result made mathematicians accept the convention, and stop questioning these theorems and accept them as true about the Platonic ideal of the real numbers. This situation continued for 20 years, until Paul Cohen came along. What Cohen did was to make models in which the axiom of choice failed, and make models in which the continuum was arbitrarily large. The meat of the results are not in the results themselves, but in the method. The basic point of the method is that really the skeptics were right, that the continuum is just enormous compared to normal sets, and there is no Platonic objective sense in assigning an ordinal to it (well-ordering it) or making a nonmeasurable set (all sets can be taken measurable) or asserting that the Banach-Tarsky decomposition is objectively true (because there are equally natural or more natural models in which it is false), or that R has a basis over Q (because it doesn't in a measurable universe). Many other results about the continuum were shown to be undecidable since, and this has left mathematicians with a strange queasy feeling. The queasy feeling comes because Cohen's results overturned a half-century of conventions regarding the continuum. Still, nothing in the textbooks has changed. Mathematicians have never had to go back and say "We goofed!" before, and make conditions regarding theorems which were considered just plain universally and objectively true before. But there's a first time for everything, and if this is taken care of, it will also probably be the last. This is a case where mathematics made a choice in the axiomatic foundations which was demonstrated to be false in the sense of consistency, in the sense of fruitfulness, and in any reasonable meaning of the word "Platonic truth" inasmuch as the concept applies to collections as huge as the real numbers. The remaining non-Cohen examples where this happened in mathematics concern things that were considered non-rigorous for a long time, but acquired rigorous meaning later. This is also a change of a sort, a backpeddling, but not so drastic as showing something widely believed to be true is not objectively true. This is just rehabilitating an old idea by showing how

to make it work precisely. This includes the rehabilitation of infinitesimals, singular distributions, and tropical geometry, and probably more are coming. But Cohen's revolution can't ever be repeated, because there will never be such a distance again between accepted mathematical practice and what can be construed as objective truth, at least not as large as it was regarding the continuum in the middle decades of the 20th century.

What proof did Darwin cite that was so revolutionary?

The evidence Darwin cited was of two types: 1. Comparison between artificial selection and natural changes in the fossil record 2. A reinterpretation of the phylogenetic tree as a historical product of divergence. These two pieces of evidence were sufficient to be certain that some form of selection pressure plus variation were sufficient to explain the history of life. Number 2 is important, because the phylogenetic relationship between life forms had long been established--- life forms lie on a tree. What this means is that there are frogs, and within frogs there are different types of frogs, and there are bats, and within bats there are different types of bats, but there are no creatures with the head of a bat and a body of a frog, the organisms are separated into classes, and these classes split into subclasses, with no overlapping structure. The interpretation of this is that the species diverged from a common ancestor. This leads to a tree of life. The problem is that people knew about this for a long time, and came up with bogus philosophical explanations for this. They said "obviously things are organized in classes which don't overlap--- that's how things organize! That's just plain common sense." The stupid people who said this included Aristotle, so it was a major problem. It required imagination to see this as something that requires explanation, rather than an obvious feature of the world. Number 1 was Darwin's first

major contribution. It's in Chapter 1 of the Origin of Species, and it establishes that you can change animals by a large amount due to selection pressure only, by breeding. This established not only that it was possible to make changes this way, but exactly how long it takes to make changes of a given magnitude under a given amount of selection pressure. By comparing the changes in morphology in the fossil record to the rates of artificial selection, Darwin could estimate how much time would be needed to evolve a fish to a human. This allowed a quantitative estimation of rate, and this quantitative estimate was good enough for the biologists to overrule the physicists, who at the time believed the Earth was at most a hundred million years old. The remaining evidence consists of the speciation observed in small islands, where you could see that a few closely related species had filled niches which were reserved for very different kinds of species on the mainland. This was obviously because only one type of finch migrated to the island, and speciated, not because of a separate creation event for different finches. This type of evidence was important for persuading people who believe in supernatural creation, because it was obvious that a supernatural creator wouldn't make different finches fill niches that on the mainland were filled by different types of birds. For people who didn't care about supernatural nonsense, this is not so important--- obviously these species diverged, but the question is mechanism. The 20th century saw a retrenchment of Darwin's ideas by atheists, who wished to use the ideas for monstrous social rearrangements. This use of Darwin is not so optimal. Sure, God didn't create hand-create life, it evolved, but the mechanism is very complex, and teleological in certain ways, it is not a simple competition of selfish genes. These ideas are stupid and were ruled out before they were proposed.

How do I know if I have an original idea?

If you know with high confidence your idea is correct, the way to check if it is original is simply to tell people the idea and see what they think of it. Assuming they don't happen to know the idea already and point you to a source, if their response is "Hey! That's true. That's a really great new original idea!" then it is almost certainly not original. It's just an old idea that they don't know about. On the other hand, if they say "That's the stupidest idea in the world! Don't you see that it's obviously wrong because (bogus reason 1) and (bogus reason 2) and (bogus reason 3)", in this case, if the idea is actually correct, then it's almost surely new. The reason this heuristic works is because of the infinite number of persons approximation. In the limit that the population around you is infinite, any new idea that people around you would already realize is good without going through a lot of intermediate steps has surely already been discovered by someone else. So the only original ideas left for you are the ones which sound stupid to everyone else. This heuristic fails a tiny number of times, of order the inverse population size, or roughly one time in a million. That's because one in a million people will happen to be the first person to come up with the few good-sounding new ideas (somebody has to come up with those too). But this is close enough to zero that from the individual perspective, it is a fair generalization that the only original ideas out there for you to discover are the correct ones that sound stupid. So the mechanism you have for checking if new ideas are correct had better be different than "ask people and see what they think of it"! Using this social method, you are guaranteed to never come up with anything new and correct. Also, you don't have to worry about people stealing your idea. If your idea is any good, they will laugh at it. This is very funny. All these people walk around with these ideas, they think are original, which sound like they are very good ideas. These ideas are already known to everyone else, thousands of people walk around with the exact same ideas all the time, all of them thinking "oh no, if I tell anyone, someone is going to steal it!". If you actually have a good new idea, you don't have to worry about someone stealing it. You have to worry about sounding like a lunatic. Once you know how to check new ideas independently, it's relatively easy to come up with them, as there are infinitely many good new ideas, and

only finitely many old ones. The problem is learning how to check independently of social forces. Figuring out how to do this is called "becoming an expert". Thankfully it's about twenty to thirty times less time consuming with an internet than without.

At what percentage of GDP do transfer payments begin to have deleterious effects on an economy?

It's not about the percentage of GDP, if the market were perfectly efficient, any transfer payment would be deleterious to the economy. The point of transfer is to remove high incomes, which are a market distortion which would never appear under the cutthroat conditions of a perfect market anyway. The ideal market equilibrium is characterized by a complete competition enforced equality. You can't charge more for something, because then someone else undercuts you. You can't make more than average, because then some other worker gets your job by underbidding you. You can't get a better return on your capital, because then other people flock to the same investment, raising it's price. These laws are made a mockery of by enormous incomes. These incomes are not competitive, you don't see a request for resumes to fill the job of CEO of General Motors. The salaries are political, they are determined by political committees selecting a few people into their ranks, and then rewarding them by taking a chunk of capitalization from the firm and lining their pockets with it. This kind of enormous income is not market produced, it is something else. It is produced by monopoly power and oligarchical decision making, coupled with the ability of certain people to put their hand in the cookie jar and turn a certain small fraction of enormous nation-state level capital into personal income. Such things are completely contrary to market equilibrium laws, they are forbidden in textbook efficient

markets, so you can tax this kind of income at 100% and it makes no difference. The problem is that by doing so, it is hard to discriminate between this income and the income of an innovative entrepreneur. It is precisely because of this that the political oligarchy at enormous monopolistic firms, which is source of 99% of large salaries, is hidden from the public, and instead, people are told about a tiny percentage of entrepreneurs of genius, who happened to strike it rich when their firm became enormous. These entrepreneurs are gloriified, because they are cases where the wealth can actually be seen to be partially the result of a great deal of innovation. You can partially fix such things by taxation, but you want to make sure that this sort of thing never happens in the first place. The way to do this is to place incentives on firms to stay small, and to make sure that these smaller firms always have lots and lots of competition. Then for each billionaire, you will have a thousand independent millionaires, and the innovation of a thousand millionaires is always greater, the billionaire was most innovative when he or she was a millionaire anyway.

If high income earners pay so much of the federal taxes, don't we want more high income earners?

The answer is a resounding no, because it is not what economic equilibrium looks like. If someone is making a crapload more money than everyone else, it means that this person found a way to make a non-competitive position, otherwise someone else would underbid this person and reduce this person's compensation. There has never been a situation of competitive occupation where the compensation stays 20 times market average while people are free to enter. For example, computer programmer is very intellectually demanding, but people are free to compete, so the salary is near market average now. The safe

way to acquire a large amount wealth is to join an existing enormous company, and maneuver your way politically into the board of directors, or somewhere else near the top. Other ways are to consult at the top level of these enormous firms, or do other hanger-on type things, based on this market distortion. These enormous firms maintain monopolies and wreck entrepreneurship, because they are a so much more dependable path to wealth than entrepreneurship. The people who are rewarded by this schmoozing are politicians, not entrepreneurs, and this procedure only works because the large firms have lobbying and contracting power, and are generally immune from small scale competition. This means that the presence of high incomes is a sign of a sickness in the market, of a corporate oligarchy which allows enormous firms to grow into inefficient monsters, and then place an inefficiency tax on enormous sectors of the economy, and reward the bozos that run them with large bonuses. These bonsus often involve skimming the company's capitalization, with options that ever-so-slightly devalue the stock of all the stakeholders, or simply by funneling corporate profits into individual pockets. All these diseases have nothing to do with textbook capitalism, where competition keeps everyone's income in check, and does not allow monopolies to form. The issue is that we don't live in theoretical market equilibrium, and people are able to concentrate power through anticompetitive stuff, like rising through the ranks in a closed organization, and skimming capital. This stuff is how billionaires are made. It is ridiculous that people celebrate this, as this stuff is a drag on the whole economy. Since anti-trust law stopped being enforced, one needs a simpler substitute. To my mind, a simple incentive for corporations to split up is to institute a progressive corporate income tax, to make it unprofitable for companies to merge, and to make it pay for them to figure out how to split up. If the contracting between the different small companies produced is sufficiently transparent, people should be able to compete with any company without a terrible burden, and the issue of high earners will be sidestepped, because no company will be able to afford to give people ridiculous compensation, because no company will be big enough to afford to do so. Small companies are nice and efficient, and a model. The big ones are monsters that only

acquire power through political power, and distort the market and make it insufferably lousy for all the other players.

What can be done to help offset the Pareto Principle's effects on wealth inequality that doesn't involve confiscation/redistribution?

Simple competition is usually enough to even out most inequality, leaving only a small managable amount, based on luck, skill, talent, something like a factor of 10 in inequality, reflecting the different productivity of different people in different niches. I'll argue from first principles, because I don't know any source. Suppose you have a book publisher, and he puts out a new great book, and is making lots of money. You just take that book, retypeset it, and put it out yourself at a lower price. The publisher will be back to making a meager profit. Under these conditions, no publisher can make more than any other. This is competitive equilibrium. Suppose you are a small farmer, and you notice your neighbor has switched to growing avocadoes, and is making lots of money. You switch too, and you make the same, and then others do, and your profits go back to market average for your plot, competition leads to market equilibrium. Suppose you see that landlords are making a lot of money in a certain city. You buy a plot of land with borrowed money, build an enormous high-rise, and charge rent just enough to pay back the loan interest and part of the principal, pay the superintendant, and pay yourself and your co-investors a fair salary on your labor and time invested, and your risk. Competition restores equality. Suppose a new device called a computer is invented, and suddenly people are paid 300,000 a year to program it. Some bright talented students go study it, until it pays 40,000 a year. Competition restores equality. Suppose some people are making lots of money with a search engine and selling ads. You just take their code,

and run your own version, charging a bit less for adds, until you are half their size. You get split again and again, until you are making no more than anyone else. Competition restores equality. That's the whole point of competition--- it is supposed to remove inequality naturally. But the obvious fact is that IT DOESN'T WORK! Why not? In all cases where it doesn't work, some entity is producing concentrations of power that prevent it from working. For example, the farmer might have an enormous land holding, and so do his friends, and they hire cheap labor from Mexico to work the field, and you can't compete with them, at least not without driving your compensation to that of the cheap labor they employ. In other cases, the government grants a monopoly to a publisher, a copyright on the work. In other cases, the search engine is picked by very wealthy individuals at a stock exchange, and is capitalized with billions of dollars, and then buys out all the competitors, and expands and holds on to it's monopoly position. The fix to this is to ensure competition. One way is through progressive taxation--- if you tax individuals based on the amount of land they own, a growing percentage based on acreage, it will be in their interest to distribute the land in equal parcels to as many owners as possible, through deals that involve sharing the profits in the tilled land. This is a substitute for land-reform (this was problem a long time ago). If you tax corporations based on size, you can ensure that they split themselves into small independent firms just for the purpose of having the highest possible profits. They will only stay large if they absolutely have to be. The benefits of small firms are enormous, they are nimble and innovative. If you abolish copyright law, you can still ensure fairness to the author by requiring a certain percentage of the sales to go to the author, independent of the publisher, which will not have a monopoly. The publisher can still make a reasonable profit by being first, but not a monopolist's profit. Online, this might not make as much sense as public renumeration of authors, along the line of scientific grants. But lets remember, the whole copyright thing is a distortion of markets to reward original authors. Basically, everywhere you see inequality, you can fix it by ensuring competition through slight incentives to remove monopoly granting power. It's not difficult, it's easy, but it produces a thousand firms where there once

was only one. Both western governments and communist states preferred to deal with one entity, because it's more predictable. Another thing to point out, when you have small firms, you need absolutely standardized contracts for supplying them, and these interfaces must be public, so that a competitor can come in and supply the contracts without any problem and no retaliation to those that purchase from the new competitor. Then the competitor can be small, and live or die according to its merits. This is what markets are supposed to look like, not these monstrosities of inequality that are unchecked by competition. I should point out that early capitalism advocates saw it as a mechanism of ensuring equality. It became so only after the Keynsians instituted government policy to make it so, but this wasn't based on competition so much as taxing the rich and giving income to the poor. That's not a bad stopgap, but I think one should aim for the real deal.

What are the economic limits to how much societies can redistribute wealth?

The short term limit for redistribution is when you get inflation. If you redistribute money so that the producers can't keep up, even by running at full capacity, you get inflation. This can spiral out of control, because you might need to keep producing more and more money to fulfil your redistribution payments, because the money keeps devaluing. But this doesn't happen when the economy is depressed, that is, when businesses are producing less this year than last, because then certainly they aren't operating at peak capacity. The longer-term limit to redistribution is when you get stagflation. Stagflation is when you don't have enough productive capacity to employ everyone in your economy, even when there is enough demand. This means you need more investment in forming new industries and building new companies to produce new things, so you need to make sure that there

are entities out there that can produce new ventures. These entities need to build up capital, so you can't be taxing it out of their hands. If you had a good venture capital system, you don't really have to worry about personal capital accumulation. You can trust the competitive venture capital firms to make proper decisions on who to finance, and you don't need a slew of extremely rich individuals. But some societies trust individuals more than companies, so they want some wealthier people around, who have proven some business competence by acquiring some wealth, to be able to start a business of moderate size using this wealth. Then you need some millionaires around, to be able to start an unpopular venture that requires capital and that they believe in individually. That's the limit to redistribution, inflation and stagflation. The limits to no redistribution are much much worse--- the freezing of massive chunks of economic activity in individually owned monopolistic ventures, and the halting of all economic growth in these sectors, as the monsters gobble up and run out of business all the little businesses that produce a healthy economy. The result is enormous companies with too little innovation, because they are run like mini-states, rather than like healthy markets.

Which is the most cited paper in physics?

Weinberg's paper "A Model of Leptons", published in 1967, was the best cited paper last I checked. It's the paper that formulated the standard model in the Weak sector, for leptons, but the extension to quarks is kind of obvious once you get the main idea. I don't remember the citation counts, and Maldacena's might have beaten it out since.

Leonard Susskind, in his 'lectures on string theory' states that, "There are many more possible configurations and states of a single string than that of multiple strings of the same cumulative mass." This sounds weird. Are there any mathematical explanations available for this?

The reason is that the logarithm of the number of string states is growing faster than linearly. The condition "of the same cumulative mass" is why it's not a paradox, it's not saying that two strings have less states than one string, it's saying that if you have an energy E, and you split it up between two strings, you get fewer states than putting the energy in one string. First, you can ask the question purely mathematically: when you have a function f(E), you want to compare f(x) + f(y) with f(x+y) (assume f(0)=0) f(x) + f(y) <=> f(x+y) ? this is convexity. f(x) + f(y) > f(x+y) means that f(x) is convex down everywhere (negative second derivative). f(x) + f(y) = f(x+y) means f(x) is linear. while f(x) + f(y) < f(x+y) means that the function is convex up everywhere (positive second derivative). These are equivalent characterizations for continuous functions which go up from zero. An example of a convex down function is sqrt(x), an example of a convex up function is exp(x). But the number of states of two separate objects is the product of the number of states of the two individually, not the sum. So the function f(x) should be taken to be the logarithm of the number of states, so that it adds up instead of multiplying. Then the question is: is the logarithm of the number of string states at energy E convex up or convex down? Susskind noted that the logarithm of the number of string states at excitation level n is convex up. The number of these states is found by using different excitation operators, corresponding to the different directions of oscillation, these are the L operators, and since these are like the number of transverse

dimensions, the number of states at level n grows exponentially. But the mass squared is what is linear in the level, according to the Regge law (or, equivalently, according to the string propagator), so the actual number of states at mass M goes like exp(c M^2), so that the logarithm is convex up. Normally, the entropy of things is such that it is linear up to small surface things, so that entropy is extensive, and spltting up a bulk material doesn't cost entropy. But the convexity of the entropy means that one string at high energy has more states than two separate strings, so that entropically, it is favorable for strings to join into one massive string. Susskind was able to give this a physical interpretation--- the glob of many strings into one is what we call forming a classical black hole. This was the first time that the physical interpretation of the strings was understood--- they are microscopic analogs of black holes. This, along with 'tHooft's analysis of spacetime near a black hole, was the beginning of the holographic principle. For black holes, the entropy is also convex up, because the entropy is the area, and the area is proportional to the radius squared, and the radius is proportional to the mass, so the entropy goes as M^2, which is convex up. This means black holes spontaneously merge, but don't spontaneously split in two.

Should there be a limit to how much personal wealth any one individual can accumulate? It seems like it would eliminate a lot of the motivation for greed and corruption.

I think that there should be a very high tax at the highest levels of income, something along the lines of 70-90% on incomes that are more than 20-30 times market average. So long as you maintain enough capital in banks for ventures, this is reasonable to do, because these

incomes are personal, they are not capital, and they are not acquired competitively for sure, because they are way too high for this. This type of taxation was tried in the post-war period, with likely beneficial effects on economic growth. Such types of income tax must be done right, because you don't want to punish corporations for getting too big through natural mechanisms, and you don't want to drive people to seek out tax shelters. It is simply to prevent the accumulation of private power in individuals, and to allow the market to function close to optimality, by making sure non-competitive income is removed and redistributed. The model to keep in mind is the free-market competitive model, where people are earning roughly the same amount, because if someone is making more than you, you go do what that person is doing. This is the ideal competitive equilibrium, and it is never realized in real markets, aside from a few sectors with tough competition and many players. The way in which individuals amass great wealth is to break this market model, by creating a monopoly for themselves. This is often aided by institutions, which pick a winner from a bunch of different firms at IPO time, with the expectation of monopoly. it is done by individuals who take a small amount from all the shareholders of a large corporation by devaluing the shares slightly through issuing low-price options. The mechanism is always the same--- some enormous entity at the state level gets controlled by a few individuals, who then turn a small fraction of the capital into individual profit, when they then use to get individual power. This action is always corrosive to a market, because it rewards individuals far more than ordinary entrepreneurship. It is true that sometimes an entrepreneur also happens to be sitting on top of the national corporation, and then this entrepreneur happens to get a big reward. But this is the exception not the rule, and the people who are clever enough to become entrepreneurs know this. They know that it is next to impossible for a company to become a huge monopolistic venture, they just hope to get bought out by a huge monopolistic venture. None of these activities are in accord with the free-maket model, where small individual firms are supposed to competitively supply each other with the required goods for production, without any one firm getting too big. The result of these enormous firms are concentrations of

power that, while slightly less terrible than communism, don't lead to anything close to full market efficiency, and make the economic activity in modern capitalist states very conservative, extremely resistant to new ideas, and generally empower a class of people to positions of great power, which distorts everything in the society. It's a bit demoralizing. If you think this is overstated, think about how a person would compete with google? With Apple? You could compete in 1977, and in 1999, but after the IPO gave then an enormous capitalization, essentially banking on a monopoly, you couldn't. You could try, but at best, you would be bought out by Google or Apple. The type of large-firm competition is nothing like the small-firm competition. The small firms are engines of innovation and growth, while the large firms are ossified bureaucratic monsters.

Should there be limits placed on how much the government can create debt which future generations will have to pay?

Government debt is not like personal debt. The government can always reduce its debt by tricks, like inflating it away (the government indirectly controls the money supply). Future generations won't necessarily have to pay off anything, just like we never had to pay off that enormous WWII debt, growth and inflation made it insignificant. The way in which government debt is problematic is that it locks up capital when interest rates on government bonds get too high---investors need to offer a greater rate of return than the government will provide, so the investments that are financed become less and less risky. But this can also be worked around using inflation, when inflation is high enough, people look for good returns. But inflation produces problems. Consumers hate it. Also, when it's too high, people give up on investment and buy some more stable currency, or buy

gold. So the real question is whether you want to make a balanced budget for the sake of price stability, and to prevent people from investing in other countries. I think the answer is yes, simply because inflation is a more regressive form of taxation than income tax. Income tax is progressive, inflation is flat, and doesn't do anything to commodity holders. If you want to have progressive taxation, you should not run a deficit.

Are there examples of where allowing exorbitant wealth accumulation to an individual is beneficial to society?

There are no such cases. When you have exorbitant wealth accumulation in an individual, something has gone terribly wrong, because it means people are not able to compete with this individual for some reason. Lack of competition makes for inefficiency and complacency, and it is the opposite of innovation. It is a crappy stability. The cases where individuals become very wealthy are cases where state-level capitalization of a large chunk of the economy is somehow converted into personal assets. This happens in several ways, all of which are detrimental to the economy: One way, the most common way, for an individual to amass great wealth is to go to business school, become a top manager at a corporation, and then get a pay package that includes an enormous amount of equity in the firm. Then just do a competent enough job to raise the price (or an incompetent job which is hidden at the point of maturation of the options), and then cash out. The result is a transfer of a small percentage of the capitalization of the firm into the hands of an individual, and this individual got this reward simply for doing nothing particularly productive. This is how you acquire great wealth. This is absolutely disasterous for a market economy, because these

individuals are not entrepreneurs, they are not innovators, they are simply middle managers who are particularly cutthroat, and have a little bit of an edge in politics. The dynamics of the competition is the same dynamic as in communist countries, individuals squabbling to get to the top politically, and it makes the top layers of management of most enormous corporations completely useless. Often these people kick out any actual entrepreneurs at the first chance they get. Another way, the most celebrated way, is to start a company which becomes a state-level institution. The way you do this is you grow in relative small size, innovate and innovate, making some millions, then, after your innovative phase is done, there are a few competitors in your niche. At this point, you go to an IPO battle, and exactly ONE of the competing firms is chosen at IPO time to become enormous, through a bet made by the investors that this firm will acquire a monopoly. The bet is usually a self-fulfilling prophecy, the bet is automatically successful if enough investors agree, the investors are rewarded with a rising stock price, and the company is made enormous, and the early investors make a killing. Thisis also disasterous for a market economy, because it means investors are not looking to capitalize a hundred firms in a given sector, they are looking to dump their money in the single winner. The winner is determined by politics, so it has to be a conservative company that doesn't take chances, at least, not past the initial phase where it was growing from zero to ten-million capitalization. The winner-takes-all property means you kill the market diversity at the exact same instant that the thing breaks out into the wider consciousness, and you have the first IPOs. This is a property of the capitalization system, which is selecting for large monopolies over many small competent competitors. This type of thing doesn't completely squash the smaller folks, but it makes one company enormous at the expense of all others. So at each superstar making IPO, you kill a healthy ecosystem of competors by picking a final winner. This early winner then goes on an acquisition spree, bringing all the smaller firms under it's control, and gobbling up all the productivity in the sector, bringing it under a unified management. The chaotic creativity of a market is replaced by a staid managed beaurocracy. This is what happened in Google, in Apple, in Microsoft,

in all the big firms. The oligarchy produced an artificial monopoly quickly, and the monopolist protected the position. This is in the narrow self-interest of the investors, as they make a killing, but it is not in the best interest of a healthy market. A single firm removes the ability of a market to innovate, as the ideas of other capable people are shut out. You see the same effect in artificial media monopolies. For example, when you want to make a rock-and-roll band enormous. You take one band with promise, and you give them a record deal. You then advertize them like crazy in a winner-take-all media environment, and the one winner is rewarded enormously, while all the other players are kicked out. You have made a media figure. It is a notorious pattern among such folks that their early years are innovative, and the later years are simply formulaic and market-chasing. It's the same pattern, because it's the same situation--- you choose a single winner from a thriving marketplace, and your choice makes a monopoly. Market equilbrium consists of many small players who are kept by competition from getting too big. The owners of these firms are at best millionaires, not billionaires, they are kept in check by competition from each other, and their activity consists not of managing the top levels of an enormous bureaucracy, but in managing the company itself, making low-level decisions on what to purchase, and who to hire, and what to do. This is productive activity, and I don't think anyone is upset when such people acquire wealth. They are creating more wealth than they take home. The issue is in the enormous concentrations of wealth that appear when state-level media and financial entities take it on themselves to pick a single winner, and then ensure the success of these winners by their sheer size. This creates horrific market distortions, and makes it that we live in an extremely inefficient caricature of a free market. Wherever you see high compensation, you see a lack of competition. This is a hard rule. It is important to ensure that the competitive system is ferocious enough to prevent this kind of monopolization. Then if a single individual manages to slowly grow a firm to enormous size, always checked by competition, and always winning, nobody can say that this is a market distortion. Someone like Walt Disney, for instance. This is

very rare, the markets don't reward entrepreneurship and innovation very well, they squelch it.

What are some good math jokes?

[\math] 54 + 47 = 19 \mathrm{\;\;\;\;\;\;\;\;(mod\;1)} [/math] [\math] e^{x\sqrt{+}y} = e^x\sqrt{\times}e^y [/math] [\math] {d\over d\pi} \sin(\pi x) = x \cos(\pi x) [/math] [\math] \forall_x \phi(x) \rightarrow \exists_x \phi(x) \,\or \not\exists_x [/math]

Will nuclear fusion be a primary source of energy generation (much like hydroelectric, coal, etc.) within the next 50 years?

It depends on whether you expect a Tokamak to do it. If you do, forget about it, Tokamaks haven't been able to make sustained fusion reactors, and they are already very big, and far too expensive. But there is no technical obstacle to powering the entire world with fusion power today, and you don't need any new ideas at all. You can just blow up H-bombs. You can blow up H-bombs in a large underground cavity, in a vat of molten salt, and use the heat in the salt to transfer to water, and run a generator. The heat lost to the edges of the cavity, even without special insulation, can be small enough that the efficiency is comparable to a standard power plant. But H-bombs are about $300,000 a megaton in mass production. Try to buy a million tons of fossil fuels for $300,000. In a real plant, you probably will use 100Kiloton or 50 Kiloton devices, but you can't by 100,000 tons of fossil fuels for $300,000 either. The fuel costs are just 'too cheap to meter'. This idea is called the PACER power plant, and it was proposed and shelved in every country that developed nuclear weapons, for probably the same reason--- the weapons are classified and dangerous, and you can't use them in industrial capacity without danger. But if one can deal with the political trouble, this solves the energy problem for good. H-bomb explosions don't just produce a ton of energy, they also produce a ton of neutrons. These neutrons can be used to convert Thorium to Uranium, Uranium to Plutonium (which can be used to build more H-bombs), and to make tritium (for more H-bombs). The net result of all this breeding is that you can not only completely close the cycle of elements you consume (so that you never run out of materials for the indefinite future), but you can also generate neutrons for transmutations to make other rare elements in bulk. The only technical problem with this is the radioactivity--- the cavity will become impossibly radioactive after a few years of operation, at two H-bombs per day. There will be all sorts of chemical gunk produced inside from transmutation, and you need to test this thing for years and decades to make sure you know what's going on. But the nice thing about the molten salt business is that you can put it deep inside a mountain, or deep underground, and when you stop blowing up the bombs, it solidifies into a solid block, trapping the radioactivity in a safe place where it will decontaminate itself over geological time scales. This idea can only be implemented by a government, it obviously can't be private. There is no substitute for H-bombs here. The last attempt to get the idea running scaled it down to 1kiloton tiny pure fission devices, in an artificial cavity 10m or so across. This idea was shot down also. In the 1980s, both the US and the USSR learned to produce extremely small fusion devices, for neutron bombs, and how they did so is both classified and beyond me, but they did it. These bombs can be put to good use. Another thing you can do with H-bombs is efficiently explore space, using an ORION rocket, which ablates using H-bomb explosions, which is millions of times more efficient than any chemical fuel for rockets, and comparable (~1%) of the efficiency of antimatter, which is the most efficient rocket fuel in theory, and so it is as close to the limit as we are ever going to get. These things can only be done at the nation-state level, you can't trust a private company with H-bombs, unfortunately. This means it's a problem of politics. Technically, in terms of engineering, we know how to make usable fusion power plants today, and it doesn't involve tokamaks.

Will there always be lots of poor people and a few very rich people no matter the system?

Of course not! You don't need more than a factor of 10-20 income disparity (the type of income disparity between a wealthy small businessman and a poor worker) to have all aspects of capitalism function perfectly well. The remaining inequality, the enormous gap between rich and poor, which is often a factor of 10,000 or 20,000 in income disparity, has nothing to do with capitalism, it comes from state-level corporations turning their capitalization into income for a small class of people at the top. This is just stealing from the public. Turning corporate capital into income is also corrosive to capitalism, because it means the greatest rewards do not come to innovators and entrepreneurs, but to people who claw their way to the top on the few enormous corporations that control large sectors of economic activity. This is not competitive, it isn't capitalism, it's an oligarchy, and people don't seem to know the competitive economic model well enough to distinguish the two. There are a few entrepreneurs among these people, the few corporations which were chosen to become enormous by some stock-brokers. But the vast majority of the wealthy class is doing nothing productive, just biasing people to go to Harvard and study business instead of learning a real skill. There is no reason that a CEO of a large corporation needs to be paid a lot of money. If you solicited resumes for the job, and took the lowest competent bid, you would probably end up paying $14,000 salary and no benefits for the CEO of GM. Thousands of highly talented people would forgo pay for many years, just for the chance to be in this powerful position. So the competitive salary for CEO is a pittance. But the compensation packages at the top are not determined by competition, they are determined by creating a class of "executives" through office politics, then "top executives" through further political selection, then "CEO people". This produces a class of idiots and sychophants at the top. To see what this does, look at what happened this week to the FOUNDER of Men's Warehouse--- the man who put the company together. He was booted out of his own company by the mentally defective board that politically constructed itself. This crap is indistinguishable from communism. There is no skill that these executive people have, except for schmoozing with others in their social class, and none of that has any bearing on their ability to manage corporate affairs. They are hostile to entrepreneurs, they dislike people with real skills, and kick them out at the first chance they get. Remember, the Men's Warehouse guy is not the exception--- Steve Jobs was kicked out, and many founders are kicked out once a corporation is publically traded. Steve Turner, the guy with the scientific idea who founded the company, is no longer CEO of Pacific Biotech. To be CEO, you are selected from a closed class of mentally retarded people. The creation of mini-states run by dipshits is not inevitable. I think there are simple things you can do that can reverse this completely: 1. Tax corporations progressively, (to nonbureaucratically replace anti-trust law). The profits of a corporation which employs 10,000 people should be taxed at a much higher rate than a corporation that employs 100 people, because of the social cost of large firms--- the tiers of management they introduce. In this way, if a corporation which is large can figure out how to split in two, it will. So instead of one Boeing, you will have independent assembly plant corporation, an independent wheel maker, an independent airplane frame maker. This should allow massive amounts of innovation, after the initial reconfiguration, as people are freed up to make independent competing companies that work on a small reachable scale. It's essentially what the auto industry did--- make standard parts that can be purchased from independent suppliers that compete. It's also the difference between UNIX and other OSs, small programs work together. 2. Opt-in contracting

(nonbureaucratically replace Uniform Commercial Code, landlord laws, consumer protection) When you make a competitor to an existing corporation, you need to ensure that the competitor can enter the market fairly and quickly, without burden, and if someone purchases from the competitor, they won't face punishment from the other trading partners, like by losing sweetheart deals. This means you need transparent links between companies--- contracting should be open, standard, and free from anti-competitive vendor lock-in. To not have to micromanage this stuff, I think you can use the principle of "opt-in contracting". The idea here is that you don't expect to enforce your contract yourself, you expect the government to enforce your contract, so you don't get to draft it yourself. Instead, the government will say which contracts it is willing to enforce, and pre-draft a bunch of contracts it will enforce, which you can put together like tinkertoys. These contracts will be specified precisely, so you don't need to be a lawyer to figure out what a contract means. The contracts are supposed to be boilerplate fill-on-the lines, so that you have fee-for-service contract, information for confidentiality contract, lease contract, etc, all the standard contract types, and you can also chain a contract, so that a contract can consist of contract A and contract B, or contract A or contract B depending on the outcome of contract C. It's like computer programming--- you build more complex contracts of approved, uniform, building blocks. But you don't include the fine-print. This way, you remove the ability of corporations to legislate to consumers through contracting, and you allow competitors to enter: to compete, you simply agree to fulfil all terms of the existing contracts for supplying, and if you fail to meet your obligation, your clients simply switch back to the previous supplier, no hard feelings. There can't be any hard feelings, because the contracting is uniform. 3. Disallow corporate people to hold equity in their own publically traded corporation. This is how corporations sneak in massive pay-packages for top people, they simply steal the money from the shareholders, If you work in a publically traded corporation, you can't own equity in that corporation. This also prevents insider trading, but most importantly, it makes pay packages transparent. 4. Require shareholders to authorize stock devaluation. This will remove the

ability of three CEOs who hold equity in each other's firms from sneaking around 3. by making a feedback cycle where they split each other's special stock. In order to devalue stock by issuing more, you need to ask permission of those that paid money for it, otherwise you are simply stealing from the public that has invested in your company. You should not have voting and non-voting stock, this is a travesty. A person who purchases equity should have the same say in the decisions that affect this equity as anyone else. 5. Public disclosure of public corporate spending, inasmuch as this accords with individual privacy. Once you disclose how a corporation spends its money, it will be impossible to take capital secretly and turn it into income. If you want to make a generous pay package for the CEO, you need to make it a salary, so it shows up as a salary on the expense sheet, not as an invisible devaluation of stock through some convoluted option deal. Then the shareholders can decide if they like this. These reforms will demolish the class system, you will have an efficient market economy with lots of small competing players. But good luck trying to get any of them passed.

How can you generate and align multiple gyroscopic vortex of gamma rays and focus them around an object to create a coanda effect that would to produce a perpetual ring that will create fusion?

you can't.

Can the poor be handed lots of money to make them rich? If everyone has money, there is no poverty. Why not just print lots of notes and hand them out?

They can be made, not rich exactly, but equally well to do as anyone else, up to some small factor of inequality, a factor of 10 or so, which you use for incentive to work hard and innovate, and up to the capacity of the economy to produce goods for everyone. The amount of production a modern economy can do is essentially enough to give everyone a life of extreme luxury by any historical standard, it is certainly incomprehensible that anyone is forced to live on the street. Handing out notes per-se is a problem, because you'll have people doing nothing but standing in line to get notes. You need to attach the notes to productive activity, and there is already a mechanism for that--- someone who is employed at a wage in the private sector is engaging in productive activity, and there are certain government jobs, like road construction, which are an infinite labor sink. So you can print lots of notes and distribute them to wage-workers and construction workers. This is in essence the earned-income tax credit and the interstate highway project, which together make the best poverty elimination mechanism in US history. Other countries have analogs. To be more precise, the government doesn't print money to do this, because they aren't allowed to. The government is constrained to tax and borrow. The entity that makes money is the central bank, and the central bank does so with other motivations, to control inflation, and to control investment in large banks. Perhaps the government should be allowed to print money, but this can lead to problems, as the pressure to reduce government spending would disappear, and this can lead the government to gobble up all economic activity, by inflating all non-government trading to a standstill. But this type of printing-money redistribution is how you are supposed to manage an economy, since at least the great depression--- but you don't do it by handing out notes.

You tax money away from high-earners, who are generally owners of massive amounts of capital, something which is not supposed to happen in ideal economic equilibrium (ownership is supposed to be distributed in many micro-owners, by competition, but fat chance), and then you give this money in income-supplements to low earners, who generally just spend the money they get on commodities. In this way, you ensure that the market keeps going at maximum demand, at full productive capacity. if there is inflation, you reduce the supplements, so that the demand goes down. If there is unemployment, you increase the redistribution, so demand goes up. If you have both inflation and unemployment, then you need to find a way to increase investment capital and entrepreneurship, so that you have enough factories to employ everyone, which might require a somewhat higher level of inequality. But there's no reason to have the kind of nightmarish class system you see redeveloping in the US in recent decades. The main point of Keynsian economics (Keynes was really ripping off Marx here) is that in an economy with "poor people", you aren't in economic equilibrium. You have underutilized resources--- a lot of people whose labor is not needed, sitting on the streets, and driving down everyone else's wages, so that you end up further and further away from equilibrium. In theoretical equilibrium, there is full employment, and all wages are roughly equal (up to some incentives for people to switch to harder more productive jobs, or to risk entrepreneurial things). If you make the demand properly bigger, by just printing money and giving it to low-wage people, and you have jobless people, you have more consumers to demand their labor, and then they can suddenly find a job, as people increase production to match the increased demand. This only becomes inflationary when the demand increases the capacity to produce, which only happens after everyone is employed, that is, if you already have the infrastructure that can efficiently employ everyone. The question is exactly how you hand out the money. You have to watch out for free-loaders. If you attach income to productivity, this is usually not a problem. Even if you need to give lots of people temporary government jobs, these are usually substandard anyway, folks prefer to work for independent folks, so you eventually have people find more productive jobs, and in the meantime, you solve the problem of extreme poverty. There is absolutely no excuse for the type of poverty you still see today. It was nearly eliminated over Europe by the 1980s, in the communist states, it was eliminated entirely. One of the few positive things you can say about the communist states is that there were no street-people, because if you found yourself broke, you could always walk into a construction site and get a job, no questions asked, at any time, and you could also get a subsidized crappy apartment at low rent, at any time. This was one of the few bright spots of the East. In the West, if you needed assistance, you were just put on a miserable dole where you could whittle away the whole of your miserable life with drugs. This program of redistribution completely eliminates class stratification, as evidenced by the great leveling of the 1960s and 1970s, it really produces an egalitarian society, and it is compatible with the economic freedom of capitalism, because the government doesn't micro-manage economic decisions. This Keynsian system is what got rid of the ancient class system in Europe, and to a lesser extent, in the US. But it is opposed by those who like to sit on top of a hierarchical society, so you have to heckle such people until they are voted out of office and taxed into a middle income.

How is Freeman Dyson generally viewed from within the physics community?

He is a great physicist, universally recognized, and Weinberg said he was "fleeced" of the 1965 Nobel prize. His great work on electrodynamics explained the importance of operator dimensions, and he sketched the main reason for renormalizability--- that operators of dimensional analysis dimension 4 are special. This idea is central to modern renormalization theory, and it wasn't there in Feynman or Schwinger. His dimensionality argument was criticized as insufficiently rigorous, because of the problem of "overlapping

divergences", but this problem is superficial--- the overlapping divergences are really separate divergences as was understood in the 1950s by Zimmermann (but alas, nobody understood Zimmermann!), and later in a more transparent way by Wilson in the 1970s, further elaborated by Polchinsky in the 1980s. In mathematics, Zimmermann's ideas transmuted into the Connes Kreimer idea of using Hopf-algebras of point-collisions to organize the perturbation expansion renormalization, but the upshot of all that development is simply that Dyson had the right idea, the operator dimensions are sufficient to establish renormalizability. Dyson did many other things, in engineering, like Orion, and just general nice thinking, like his ideas about origins of life, floating cities, and various mathematical things like his argument for the divergence of the perturbation series. But I think his immortal contribution was his extension of Wigner's Random Matrix theory into a real mathematical theory. This is where I think he was fleeced: of the 1963 Nobel prize, not the 1965 one, because Random Matrix theory is a much more distinctive unique contribution than the QED stuff, which, great as it was, would have been done by other people much the same way anyway.

How can I explain set theory to a teenager with little interest in math?

You can't explain it in terms of finite sets, these are not any more interesting than arithmetic, in that you can code finite sets up in arithmetic, and code arithmetic back in terms of finite sets, and everything is equivalent, no special new insights. You need to explain it in terms of the essential founding notion, which is the theory of infinite ordinals. The way to understand the ordinals is Cantor's original way: you simply draw points on a line, only approaching limits when going up, and ask "What kind of structures can I draw by only allowing limit points to the right?" The key is that you have to go down

discretely when marching to the left, so any such structure is inductive--- you necessarily reach the leftmost point after a finite number of steps. So you can prove things about ordinals with induction, the same as you can about the integers. Suppose that a statement is true for all points to the left, then it is true for the first point to the right of all those points, then it is true for all points in the ordinal. This principle of transfinite induction is extremely powerful. But so far, you haven't presented any ordinals. You just gave rules about drawing points on a line. You can draw finite integers, of course, just draw a finite number of points, but you can also draw the ordinal "omega", by just drawing all the integers in a way that converges to a limit going to the right. Then you can draw "omega plus one" by adding in the limit point, and keep going, always discrete to the right. Show the teenager that starting with omega-plus-one and counting down, you necessarily reach zero after a finite (but arbitrarily large) number of steps. Then you can introduce ordinal addition (putting ordinal dot-diagrams end-to-end), ordinal multiplication (blowing up each point of an ordinal into another ordinal in a non-overlapping way), and ordinal exponentiation (you can define it as the limit of omega + omega-squared + omega-cubed, all these shapes end-to-end, or just by extending each ordinal to the next in such a way that the length never gets bigger than 1). Then you can define epsilon-naught as the limit of exponentiating a set by omega, and the teenager can see that this ordinal exists, because you have shown how to embed it in the line, and it is clearly well founded, because if you start going to the left, along the ordinal you will reach the leftmost point in a finite number of steps, because going to the left never accumulates (there are no accumulation points going down). If you now point out that this theorem, that epsilon-naught is well founded, is known to be impossible to proved using induction at any finite level of arithmetic, you have a convert to the joys of set theory. In arithmetic, as it is usually defined, you can at best you can only prove that omega^omega^omega... with a finite number of exponentiations is well-founded. You can also prove that you can prove this for all k. But to conclude that it is true, you need to go from a proof of "there exists a proof for each k" to a proof of "this is true for all k", and there is no proof of this. The extra assumption you need to conclude from the existence of a proof for each k that the statement is true for all k is the assumption that the theory is consistent (more or less). Then you can go on to define bigger and bigger countable ordinals, and this process is describing ever more complex ways of counting down, but always terminating on zero in a finite number of steps. This inductive structure is the foundation of all proofs, and so it doesn't require any motivation. At the large end, you can see that the structures become infinitely more complex, in a way reminiscent of theology. This is Cantor's ordinal theology. then set theory is simply a way to make the ordinal structure embed in a simple thing, so that all of mathematics embeds too. It didn't have to be that. You could have defined ordinals axiomatically. But people didn't do that, they chose to frame it in terms of infinite collections instead. The usual motivation is annoying bullshit, since it focus on the theory of very enormous sets, power sets, like the real numbers. This theory is not particularly important, because in any actual model of the set-theory, you don't get a reasonable representation of the intuition regarding these power sets, because the model is countable. But this motivation works, people get excited when they prove that the real numbers are uncountable. Cantor did too. But the modern insight is simply to consider this thing, the uncountability of the reals, as just a trick for shoehorning another set of ordinals on top of the ordinals of countable set theory, just to get a little bit more power. You don't need to do that with power sets, you could do it equivalently by using the axiom "every set has a set of greater cardinality", which, with the axiom of choice, produces exactly the same tower of ordinals when adjoined to countable set theory (no power set) as in ZFC, because ZFC is consistent with the generalized continuum hypothesis. The thing about uncountable ordinals, is that you can't draw them on a line. This is why it is nice that any reasonable model of set theory is countable (either by Godel's construction from the axioms, or using the Lowenheim Skolem theorem). This means that you don't ever have to consider ordinals which are too big to draw.

Can someone explain Cohen's forcing technique in set theory?

Here's a simple shortcut to get the basic idea. The exposition in Cohen's book is fantastic and complete, and I don't think I can improve on it in any way. But there is an el-cheapo shortcut that I can describe well, because it is what motivated me to read Cohen's book in the first place. You should know Godel's completeness theorem: any logical computable system of axioms (any mathematical system deserving of the name) has a countable model. This is straightforward to prove, the difficult part is simply making a deductive system, and this was solved in the 1920s by Hilbert's school, and Godel put the final touch on, by proving completeness. The proof consists of making symbols for everything you prove exists. So if you prove that there exists a limit of 1/1^2 + 1/2^2 + 1/3^2, you give it a name. If later you prove that this thing is equal to pi^2/6, you identify the names for pi^2/6 and for the sum of this sequence. In the end, you get a countable collection of symbols that make every statement you prove true, by construction. But now this is getting a little uncomfortable--- you think of the real numbers as uncountable, but the model is countable. This means you left out a lot of real numbers. How can you add them in? One thing you can do is to consider picking real numbers between 0 and 1 at random (be careful, this was considered logically suspect for decades, before Cohen's work, because it was difficult to say how to define the limit of infinitely many coin tosses precisely, because of set-theory issues). Suppose you accept this, you can pick real numbers at random. What can you do now? Well, you can just pick countably infinitely many random reals without worrying about collisions (they are infinitely unlikely) or about the digits encoding some ridiculous structure, like a map between aleph-3 and aleph-2 in the model, because, what's the chance of that? Since

aleph-3 is countable in the model, you can pick exactly one random real for each element of aleph-3, and add these to the model, together with an explicit map between aleph-3 and these reals. What have you done? You have explicitly disproved the continuum hypothesis in the new model! Aleph-3 goes into the continuum. You could do this trick with any aleph, and the continuum is necessarily pushed up to at least this aleph, perhaps larger. But there is one subtlety--- you have a new model now. How do you know that the aleph-3 in the new model is still aleph-3? Maybe in the new model, the old aleph-3 becomes the new aleph-1. The big insight Cohen had here is the "ccc", or the countable-chain-condition. What this says is that any finitely specified random real intervals which are disjoint (any collection of for-sure linearly ordered finitely specified random reals) must be countable, and can be proved countable in the theory before you adjoin anything new. What this says is that when you adjoin the random reals, they are always specfied by a new map at the countable level--- nothing happens at higher levels, you don't get any new maps between higher cardinalities, so the ordinal structure is preserved. These two insights are all you need to prove the undecidability of the continuum hypothesis--- you can make the continuum arbitrarily large in any set theory model, and it clearly has nothing to do with any axiom defect or anything like that, it's because the reals are just so super-duper huge that you can stuff in anything that any axiom system describes inside. The ccc forcing notions include the random forcing notion, which makes the concept of random-real precise. This allows you to prove the big blockbuster theorem of the 1960s and 1970s, that it is consistent that all sets of reals have Lebesgue measure, i.e. that you can make set-theory consistent with probabiltiy intuitions. This was debated in the 1910s, and 1920s, and at the time, the axiomatic systems made it false, they constructed non-measurable sets, to Lebesgue's great consternation. All the ccc forcings preserve cardinalities. But you can force in anything you want, so long as you have countably infinitely many arbitrary choices. So any infinitely branching structure admits forcing. In particular, if you start with lots of real numbers, say aleph-3 worth, you can always force in a new map from the reals into aleph-1, because the set of all maps between aleph-3 and aleph-1 also involves infinitely many arbitrary choices, and once you force in this map, aleph-3 collapses to aleph-1, and so do your reals, so you make the continuum hypothesis true again. You can go on to prove all sorts of undecidability results, it's always the same thing, you have infinitely many arbitrary choices, and so you can stuff in new elements, as many as you like, which are randomly chosen, or generic, and all the important axioms of set-theory, the finite axioms (empty set, unions, pairing, extensionality), the computational limit axioms (replacement/separation, unions), the reflection axioms (infinity, power-set, large-cardinals) and the restriction axiom (foundation, choice) are preserved. And then, you can toggle choice back and forth according to your whim, depending on how you truncate the universe.

What is the best book on foundations of mathematics?

You can learn it from the following: 1. Set Theory and the Continuum Hypothesis (Cohen, this is essential). This presumes some background in logic and set theory, which you can probably get from Kunen book on set theory (I didn't read this, it's standard though) and from Yu V. Manin's book on logic (I did read this, it's great). The computability theory can be learned from various places, but they are generally suboptimal, because they program in obscure Turingese, perhaps an answer of mine on mathoverflow regarding different proofs of Godel's theorem might help, but there is generally no uniformly good mathematics source for recursion thoery/computability theory, because it's ultimately computer-science results, and the mathematicians state everything in terms of completely unnecessarily obscure fixed point theorems instead of explicit simple computer programs. You can read Godel and Turing, but perhaps they are a little old fasioned today, we have computers now and they didn't. Wang and Spector are more modern, I like Spector's papers a lot, and he's considered a classical author. Browsing the logic section of a good math library will work for all the elmentary stuff. 2. The Higher Infinite (Kanamori) This book is fantastic, because it gives very concise proofs of most of the major results from the forcing era, and focuses on large cardinals explicitly, and tells you the history too. The philosophy is not exactly the same as mine, but so what, can't get hung up on philosophy. There are books by Shelah which I was never able to fully decipher, although they are clear. I didn't try so hard, but he introduces a lot of cute pet terms, which makes it hard to read if you aren't in the clique (but not so hard--- they are all defined on Wikipedia today). But these books look very good superficially. There's also a monograph by Woodin about the main theorem, showing that the consistency of projective determinacy is a consequence of certain large cardinals called Woodin cardinals. I think this is reviewed in the latest chapter of Kanamori, which I haven't gotten to, but I think it pays to read the original author too, it just takes time. There is also model theory, and here, I can only go by hearsay because I never had time to study it (my knowledge of the other things is also sketchy, but for model theory, it's nonexistent), I own a book by Baldwin called "Fundamentals of Stability Theory", and again it looks excellent superficially, but I haven't gotten around to actually reading it. There's a famous guy called Morley that you are supposed to read. When I was at Cornell, I saw him wandering the halls, and he looked completely crazy, so I figure he must be really good.

Why is Cohen's "Forcing" not sufficiently appreciated by the mathematics community?

The reason is the "open exposition problem" in Justin Rising's answer: the method is relatively old, accepted, and well-understood within the field of logic, but it is a central advance that has not been

able to penetrate outside the field of logic, because in order to fully internalize it, you have to adopt a position regarding the mathematical universe which is very far removed from what non-logicians are indoctrinated with. This is blocking progress in other fields, because it allows a radical simplification of measure theory which makes things that are hard easy. Non-logicians tend to view the universe of uncountable sets (the uncountable sets are the ones affected by forcing) as a God-given entity with definite properties which are absolute. The simplest such property is uncountability--- you can't make a list of all real numbers. But there are other properties, like well-ordering, the continuum hypothesis, or the existence of a Suslin line, and these things are generally believed to either exist or not exist in a certain sense, and the results from logic that establish that these questions are undecidable just cause mathematicians unease, and they cannot internalize these results and build on them, except if they are logicians, because the philosophy is so alien. The standard philosophical position was already challenged by the Skolem theorem--- set theory models can be (and should be) countable. The Godel completeness theorem explained why: models of any computable axiomatic system are always countable, because you only get countably many deductions from any computational deduction program, so you need only introduce and describe countably many symbols in order to make a model. The tension in philosophy is that the intuition is that the universe is uncountable, but the axiomatic system, in the most straightforward deductive interpretation and making the simplest model, is always making a countable model, even if it proves as a theorem that the real numbers are uncountable. This was considered paradoxical in the1920s and 1930s, but it is made clear this way: there are real numbers, but your model only has names for countably many of them. There are numbers like "pi", which have a computable digit sequence, and other numbers, like Chaitin's number, which have a predicatively describable digit sequence (you can't compute it, but you can describe each digit in terms of its properties). These numbers are in correspondence with the countable names of programs or predicates, and they can be well-ordered, they are essentially countable, and "most" real numbers are not like that, but

you can't name any example, because you don't have names for those numbers, by definition. Since the intuition for the real numbers is that they are uncountable, the proper view is that they are so much vaster than any axiomatic system can describe. What does that mean exactly? How do you say this in a logically positivist way? What theorems can you prove from this idea? What Cohen did was to show what. Cohen made the real numbers truly uncountable. Starting with any model of any axiomatic system that precisely describes the reals and sets of reals, he gave the precise method of adding new symbols to models, which represent completely generic real numbers. These generic reals represent "any old real number", or "a random real number", they are completely undescribable using any programs or predicates. Any precise predicate is not going to describe a random number, because the random number has only a 50% chance of obeying the condition on each of it's binary digits, so it has no chance of obeying all the conditions, if there are infinitely many, if the predicates specify the number uniquely. Every such random number is indescribable, and falls outside of the models constructed using Godel's method, or after applying Skolem's reduction. And you can add as many as you like, since ordinal processes don't change this conclusion, because in the simplest model, all the ordinals are countable (although the axioms don't think so). So the exposition problem is really a philosophical problem: the issue is that mathematicians still haven't "gotten" the transformation in perspective that this makes. It refutes a lot of theorems that people outside of logic today take for granted. These theorems can be summed up in one uber-principle: every set of real numbers is Lebesgue measurable. This is the one new principle that unifies the results, in that, if you adopt this principle, all the forcing stuff becomes relatively easy to internalize. This principle is considered absolutely false today, at least outside of logic. Non-measurable sets ostensibly exist. But Cohen's method was extended slightly by Solovay to "random forcing", or picking real numbers at random, by flipping coins for the digits. This method gives a measure to every previously constructed set (this is in fact what it means to pick a random number, putting aside the details of the specific forcing precedure that Solovay described, which makes this notion precise). But to add the random number adds new sets, like the set whose element is the random number, so you don't have a measure for every set yet. But Solovay did a little bit of model adjustment allows you to make all the sets in any given precisely specified universe measurable, by only adjoining new symbols representing random numbers, and then truncating the universe you get. This solves the old problem of the universality of Lebesgue measure--- it answers in the affirmative a question that has long been settled in the negative. This is something that has never hapened in mathematics before. Mathematicians are not supposed to change their minds about anything. Because of this "set in stone" property of logically correct proofs, Mathematicians are not allowed to go back and fix a broken consensus, because it makes their results look uncertain. But this is not what Cohen's stuff is doing really, it is just making a philosophical adjustment in the interpretation. The logical arguments stand--- only the interpretation changes. The proper interpretation is that the countable models are primary, the reals have the measurability property, and the things you can prove from measurability should be taken as absolutely true, at least when you aren't doing logic. This shift in perspective makes some things that were hard easy. For example, if you want to define a Brownian motion, you can just define the algorithm that generates the Brownian motion by refinement: start with a point, pick a Gaussian random real a certain time later, then pick the appropriate Gaussian random real in intermediate times with the appropriate mean and standard deviation to "fill in" the Brownian motion. You can prove this process converges to a unique path, and then you are done, because the statement "pick a random real" is completely consistent. In older treatments, you have to prove a lot more, namely that all the appropriate sets of paths acquire a measure. The same method means that once you have a randomized algorithm to pick a random distribution, you have defined a measure on the space of distributions. So the algorithm: pick a random Gaussian real with variance "1/(k^2 + m^2)" for each of the values of k in a d-dimensional lattice, and then Fourier transform this, defines a statistical field theory. In analytic continuation of the correlation functions, it defines a quantum field theory. People today have to work much harder, because they need to pretend that there are unmeasurable sets. Similarly, the process of defining a convergent renormalization procedure is simplified to its essence, you simply need to prove that the statistical measures converge, i.e., that when you refine the lattice and refine the field, you end up converging to a unique distribution in the continuum limit. You don't have to worry about the non-measurable sets. These gains are enormous. Even though you can translate each specific result to the ordinary universe, it is annoying to do, and makes the mathematics of path-integrals onerous. This is the major practical gain--- you no longer need to worry about paradoxes in statistics, and you can make statistical arguments in the natural way.

What are the most important fundamental physical constants?

I can't add a comment to Jay Wacker's answer, but in addition to the all important cosmological constant, the gauge coupling constants and the Higgs scale (which determine the mass scale and the charge on the electron), the mass of the electron, the up and down quark (which make the neutron heavier than the proton, and change these masses by about 1-3%), the strange quark mass is also an important day-to-day parameter, since the strange quark is light enough to have a partial condensate, about half of the strength of the up and down condensates, and this modifies the vacuum structure of QCD, and also modifies the proton and neutron masses and the strong interaction couplings by a non-negligible amount, about 10%, larger than the contribution from the up and down quarks. The strange condensate also modifies all the strong interactions, so all the energy levels and masses of nuclei, by amounts larger than the up and down mass (except to the extent that making these zero, you make the pion massless). So these 3 quark mass parameters plus the electron mass are important. You need to

know the strange quark mass too. Arguably, the strong theta angle (CP parameter) is important too, because it if weren't zero, the strong interactions would be completely lopsided. There is also a missing parameter in the ordinary published accounts: with a nonzero neutrino mass, there is also a weak theta angle (a weak "CP parameter", but it doesn't show up as CP in the already CP violating weak interactions), which can only be absorbed into the definition of the neutrino field phase when the neutrino is massless. This parameter is almost impossible to measure, because it only affects the phases of the emitted leptons in standard-model proton decay, or the phase of the baryons produced in models of leptogenesis, so we aren't going to know what it is at any time in the forseeable future, unless we get lucky and see standard model B violation at LHC. The remaining parameters, the neutrino masses and mixing angles, the masses of the heavy quarks, the weak parameters are generally unimportant for day-to-day physics, but of the mixing angles, perhaps the Cabibo angle should be included, because it is relevant for weak interactions, and the sun might not shine correctly, since you need a weak p-p to d reaction to make it work.

What does Ron Maimon think on Luboš Motl's conservative political beliefs?

I disagree with him completely, but I think I understand where the position is coming from. Lubos grew up under totalitarian communism, as did my mother, and only someone exposed to that kind of leftist tyranny can understand the right-wing ideas that come. You rebel and rebel against communism, and since communism, like theocracy, sounds kind of nice on paper, it makes you want to be a devil-worshipping illuminati. This is common in Eastern Europe and in Russia, you just have to wait for these people to come to their senses. Marxism wasn't a purposeful plot to enslave the world, it was

an attempt to prevent the accumulation of market power and to shine a ray of light through the horrific boredom and drudgery and consumer-fetishism that defines bourgeoise life. It is an attempt to free people from money, which enslaves people and steals their souls under the threat of joblessness and homelessness. Marxism-Leninism failed only because it gave shitty small minded bureaucrats complete control over an entire economy. It is not clear that there isn't a more enlightened path. But people living in communist states just didn't see bourgeoise life as a soul-crushing horror, they didn't live it. They wanted the blue jeans, rock and roll, the easy life of the manager. They didn't want a drab boring world of cookie-cutter government housing and government jobs. They couldn't understand the desperation of westerners, because they had their own worse problems. There is also the issue that Motl is probably financially supported by right-wing interests now, as he has to make a living after having been booted out of Harvard. When he was there, he was making enemies left and right, by criticizing a certain powerful loop quantum gravity supporter correctly and bitingly, and also by criticizing what he perceived as the left-wing political correctness at Harvard. This cost him, and no matter what he did, research wise (and he had a killer classic publication the year he left), he was on his way out. He's also a complete dick, and I admire that, but it doesn't make friends. Harvard, despite the pretense, is not a particularly left-wing institution. Harvard professors tend to be a bunch of right-wing folks who pay lip-service in a condescending way to sterile versions of left-wing ideas. Harvard humanities is Herrstein and Murray, and kicks out Cornel West. It's full of that condescending type of liberalism that thinks it knows better. I think Lubos needs to grow up a little regarding this right wing crap. He is objectively wrong regarding certain things. Global warming is not made up, religious people are not stupid and delusional for the most part, they have a fragile insight regarding human collectives and history. Marxism contains a lot of valuable lessons, although you need to pick and choose. The capitalist world is not dominated by deserving people who acquired wealth through innovation, although there are a few. Capitalism as it is understood in the west today is a system that rips off innovation to

concentrate wealth among innovation-destroyers. Capitalism only functions when it is close to its theoretical equilibirum, which today means a massive amount of redistribution and anti-trust action, but perhaps people can get together to make it work better with new ideas. But these are political things, economic things, and it is hard to do experiments to test, so you can't be 100% certain. I think of Lubos as a modern day Pacqual Jordan, somewhat misguided politically, although nowhere near as terribly as Jordan, but a technical powerhouse, and it's a shame he doesn't get a chance to do as much original work in the company of peers, as he could.

How does Ron Maimon view human attributes such as honour, virtue, courage, love, and other ontological aspects that arguably distinguish humans from computers?

"Big idea" concepts are defined by their relation to other ideas, until you get to primitive stuff, like sensations. So honor, courage, and so on, are some sophisticated concepts, but they are simply shorthand for categorizing certain sense-perceptions into "honorable", "dishonorable". The procedure involved is a computation of a sophisticated kind, as you can see because a computer can simulate your brain, and the simulated brain can answer as to whether things are honorable or not just as well as you. Each person inducts these things slightly differently, using the environment, by making an intersection of things which are labelled honorable by others, and a guess as to what the word represents, until the guess is correct, so that the predictions for what things are going to be called 'honorable' matches the usage of the term in the wider world. Then the meaning of the word is produced. The thing that your brain is doing when doing

the categorization of activities into honorable/dishonorable is a computation of a sophisticated sort--- binning a behavior. It might require simulating consequences of the behavior, producing expected correlates, and comparing to other things previously labelled, but it's nothing special, and I don't know why people think it's something so extraordinarily human. Being able to scan a picture and identify the emotions a person is feeling is just as sophisticated.

Is logical and technical/scientific writing clearer, more insightful and effective than creative analogical explanations in general and specially, in understanding complex theories?

There are analogies and there are analogies. To say "solving for the electrostatic potential is like solving diffusion concentration of a dust in a fluid for steady state profile" is also an analogy, but it's a perfect analogy, because the two obey the same equation. Saying "fluids mix up turbulently, because it's just like ergodic mixing of a particle system" is also a nearly perfect analogy. But here it's not the same equation, so you need to know a little bit more--- you need to know how the modes of the fluid interact. Other analogies, like "General Relativity is like a curved rubber sheet" are awful and shouldn't be used at all. The reason is simply that a curved rubber sheet doesn't obey the same equation as general relativity, except when it is a curved rubber sheet in gravity, in which case it's the Earth's gravity which is making the analogy work, not the curvature of the sheet (which is negligible in the approximation which reproduces 2d gravity). Terrence Tao is a first class writer, because he is clear. This is the measure of writing, clarity and originality. The measure of writing in the humanities is most often simply political--- what kind of writing

makes the author sound correct. This is the writing which makes the author a big-shot, a more powerful person, and sounding correct is usually the opposite of being correct. To write clear technical stuff, you first have to understand the technical stuff well, in all its technical gory details, and then not show off your knowledge by using terms without explanation, but explain the main sticking points a person will encounter when trying to reproduce the knowledge for themselves. This is the main trick--- knowing where the reader will get stuck--- and if you are not crystal clear, you're going to explain things that people already figured out for themselves. It's important not to explain too much, just the most difficult bits to get, and if you don't get it fully yet, the most difficult bit is that part you don't yet know, so don't explain.

How true is the phrase "systems biology is the string theory of biology"?

String theory is a difficult subject requiring invention of entirely new mathematical tools to describe nature. Systems biology is a difficult subject requiring invention of entirely new mathematical tools to describe nature. This is the most significant similarity, and it is what draws people to both fields--- it is a place where one can do original work of significance. But this is where the similarity ends. String theory requires a completely different mathematical toolset than systems biology. String theory requires both geometric mathematics, and supersymmetry, and these things are, it is safe to say, largely absent from biology. In systems biology, the mathematics is more combinatorial and discrete, because biology is what people call computer science when it is found in nature. The systems biologists are able to make many more testable predictions than the string theorists, both because there are so many experiemnts, and also because there is no "standard model" of biology which works (the standard models are

all laughably false). It is not possible to simulate even the simplest living system on any computer today, but this might change regarding the simplest bacteria in the next few years. But this question is basically saying "String theory is a fraud, and isn't systems biology a fraud too?" This attitude is shockingly ignorant of string theory and systems biology both. There is a certain amount of dishonesty in systems biology, but this is not because of purposeful fraud, but people groping toward an understanding, sometimes deluding themselves with overly strong claims. For me, systems biology means the recognition that biological systems are natural computers, and their algorithm and data content is primary. This allows you to predict many new surprising things, most importantly, the fact, slowly being recognized, that RNA is involved in processes which have not yet been observed. This was first predicted by John Mattick in 2001, and has been demonstrated more and more conclusively in mainstream laboratories over the following decade. Mattick predicted this from simple system considerations, based on the information capacity of RNA networks to compute (more or less, he phrased it slightly differently). This prediction went against the grain, and has been proven true. Similarly, I should add, proto-string theory predicted the Pomeron in the 1960s, that proton-proton and proton-antiproton total cross sections should become equal at high energies. This was also an astonishing counterintuitive prediction that was verified in the mid 1990s. All new science feels like bullshit at first, regardless of correctness. This is why you need to read it and think about it, independent of social forces, to evaluate it honestly before it acquires enough political clout that it's correctness becomes evident simply by going by the socially mediated emotions of what feels right.

What is Ron Maimon's advice to the new generation of aspirants in mathematics,

computer science, physics, biology and his areas of interest?

Ok, that's nice of you, but I shouldn't be giving advice, because I don't have a career, and also, right now, I am working on mapping influenza, and although it is conceptually simple, the programming is frustrating me to the gills, so i don't feel particularly competent at this moment. I guess the only thing I know that's worth sharing is that the internet kills science politics. The politics that so dominated the 80s and 90s science is now as obsolete as the cassette tape. It is impossible to plagiarize today, so don't even try. It is impossible to bury good work anymore, so don't worry about getting attention. If the work is original and correct, it will get used and probably recognized, to the extent it deserves recognition. Online, it is so easy to expose the charlatanry of people in power, and to promote the good ideas of those out of power, so politlcal power is useless, so don't bother trying to acquire it. Just worry about getting good ideas, and developing them, and putting them somewhere where people can read them, and don't worry about screwing up a lot, everyone does. This democratization means that the whole of theoretical science is returning to what it was in the early days of the enlightenment--- a mass public project that anyone can join, so long as they have a good idea to contribute. So you should just focus on doing the best original work as quickly as possible. The area where this is most true is mathematics, because here the correctness of a proof is completely independent of politics. I think that mathematics right now is undergoing an unprecedented revolution, and I always wished I followed it more. Conjectures are falling left and right, it's because the mathematics literature has been opened up by the availability of definitions and basic theorems online. It is possible to become competent in all fields of mathematics again (not that this is true of me today, but it should definitely be true for a dedicated 15 year old). The only thing I do that other people usually don't, is anti-politics. I look for political bullshit, read it and evaluate it as best as I can, as neutrally as I can, to make sure that it actually is bullshit, and then, if it is bullshit with high enough confidence, I call it

out forcefully and bluntly, with explicit name-calling. The name calling is not for making mistakes, everybody makes mistakes. It's for doing politics. Politics is when you say something because you know people will believe you, even though you know it is inaccurate. This activity doesn't work when political people control the communications, like in journals, but it works on the internet. This means that the internet potentially completely straightens politics out. But I'm not particularly omniscient, even trying hard to be honest, you make mistakes. But each mistake is easy to fix if correct yourself when you see you are wrong. This is not something that comes naturally. Sometimes you might have to correct your correction too, and correct the correction to the correction, and this is both how you become more accurate, and also how you alienate all political supporters, I don't have some special insight here, and this is sort of embarrassing. these are more or less platitudes. The main problem is that the powerful folks today were brought up in the 70s, at a time where people put the rules of politics over the rules of science.

Why does Ron Maimon believe in God?

I don't believe in a supernatural God, but the concept of God is not at all supernatural. The supernatural idea is pushed so hard by denominations, that people say it is the only concept. And since it is obviously impossible for any sane scientifically minded person to actually believe in supernatural nonsense, it is then easy to get people to reject the sensible non-supernatural concept of God. The concept of God is simply the limiting conception of the behavior of complex systems over time, it is the end point of evolution. It makes a teleology, because it is defined to be a teleology. It is intelligent, because the system computes, and computes more and more, going to infinity in the future. It is desired, because you don't want your works to be wiped out, and it wins, because people who don't believe in God are

missing the most important teleological property of complex behavior, including the most complex behavior of all, human societies and histories. One way to state the concept of God is Gandhi's: bad things win a battle, good things win a war. This concept is important in game theory. The basic idea is Hofstadter's superrationality--- the solution to the prisoner's dilemma, and the first mathematically precise form of the Golden Rule. When you are playing a symmetric prisoner's dilemma, the concept of "rational play" is ambiguous, and the correct concept is the one that maximizes utility after taking into account that the play should have one correct answer, before calculating your payoff. This is explained in many places under "superrationality", but it appears in print for the first time in 1981, in a popular article in Scientific American written by Hofstadter, and it does not appear anywhere before, and it is ignored for over a decade afterwards. You asked for a personal answer, so here it is. At age 7, I was put in a religious school, because my parents moved from Israel to the US, and they wanted me to remember Hebrew. After a little while, I was refusing to drive on Sabbath and eat non-Kosher food, so they took me out of this school and put me in a normal school at around age 9. This school had a massive library, and the moment I read the books on biology and evolution I became an atheist, around age 10. But I remember telling myself at some point, at around this age, that as an atheist, I needed to understand the following things: 1. Physics 2. Biology 3. Ethics The physics is to understand the origin of the universe, the biology is to understand the origin of life, and the ethics is to decide how to behave without God's guidance. These are the 3 areas that religion fills up with supernatural answers. The physics was so interesting, that I read about mostly this for a long time, and the biology business, I thought Darwin answered completely satisfactorily back then, I didn't see the missing pieces until much much later. I was just interested in origin of life. Ultimately, 1 has nothing to do with God, but the proper answers to 2 and 3 involve teleological concepts that are parallel to the older notions of God, and simply extend them and make the ideas mathematically precise. So once I understood 2 and 3 satisfactorily from the atheist perspective, I couldn't really say I was an atheist anymore, because the answer to 3 is similar enough to

God (although not supernatural) that I could see that the religious people weren't really saying nonsense, but an incomplete picture from a different perspective of the non-superstitious answer. I was introduced to Kantian style rational ethics from schoolmates in Israel who were interested in philosophy (we moved bcck to Israel when I was 11 or so). We moved back to the US when I was 15. I was introduced to the prisoner's dilemma in sophomore year of high school, by a conservative History teacher. He had us play a four-person version of the prisoner's dillema in class, in four teams of two players against three other teams of two players, and everyone always promised to cooperate when discussing the problem, but when it came time to play, all the teams defected, including my own team! This was a very informative lesson, it was probably the best thing in high school. This was a precise distillation and idealization of the problem of ethics, so I thought about it sometimes. I read the communist manifesto, and learned about Marxist things, like the anti-colonial struggles and feminism, although all these books were holdovers from the 1970s in the libraries. I figured out superrationality in 1989, while I was bagging groceries, in high school. I then looked around for who had said this, and foud nobody said this, at least not anywhere in the game theory literature. I stumbled on Hofstadter's stuff in Metamagical Themas a year or two later, by accident, and of course, credited him from this point on (he also analyzed other games, like the Platonia dilemma--- this is important because it is a fixed symmetric determnistic game where the best superrational play is probablistic). Hofstadters definition defines superrational play, and the moment you figure this out, all the older mathematically imprecise notions of ethics, like Kant's stuff, is out the window. So I was sure superrationality solves 3 in a completely satisfying way. It is a compelling argument for how to behave which does not involve God, it is a precise form of Kant, and I could prove that it reduces to utilitarianism in circumstances which are symmetric. But there was still an issue: it is only mathematically precise for symmetric games, the idea doesn't extend to asymmetric games. This bothered me throughout the 90s. Around 2000, I figured out 2, as explained in answers to origin of life questions here, and switched fields from

physics to biology (the physicists answered 1 more or less completely and persuasively as far as I could see). The important notion was computation, which everyone in my generation knew like the back of their hands, because we grew up with the computer revolution. The complex cellular automata originate life spontaneously and without any external intervention, but they change the picture of evolution somewhat, to a more intelligent and computing thing, which has some teleology. But then, you could see how to generalize the superrational idea to asymmetric games. The way to do this is simply to postulate that all games have a unique superrational answer, and this answer, by Von-Neumann consistency, has a utility function. If you personify the utility function as an agent, you find that you are acting superrationally only if you are acting in accordance with the will of an invisible agent that isn't playing the game at all, an infinitely wise abstract agent that does or doesn't exist (this is a meaningless question in positivism), but which you should think about if you want to behave ideally superrationally. This idea was so parallel to God, that I was grappling with whether I was still an atheist. Then I read Sade, and from Sade's work, I had an epiphane regarding the nature of the monotheistic conception of God. It wasn't at all supernatural, it was just a picture of the perfect superrational strategy written in a mathematically illiterate way. This explained all the religious literature, and made it clear in the same way that calculus makes Newtonian mechanics clear, so I knew it was the main idea. But I could no longer say I was an atheist, because the resolution to the problem of ethics is a notion of God which is not supernatural, but parallel to the older notions. The superrational thing, even in the symmetric case, is close enough that it gets you to behave indistinguishably from a religious person in nearly all circumstances, you just add a little bit of Rawlsianism to symmetrize any asymmetric game. This is not exactly the same as full-blown self-consistent superrationality with a complete utility function for all asymmetric circumstances, but it's close enough to compel you to behave as selflessly as Tutu or Mandela, at least if you are brave enough to manage it, which I usually wasn't.

Is Greenpeace involved in terrorism?

Absolutely not. There has not been an actual, unambiguous, terrorist attack by any leftist groups since the early 1980s. Modern leftist groups sometimes hold protests and events which are falsely labelled terror in order to shut them down. This is a form of political intimidation, and it must stop.

Should terrorism drills involving simulation be permanently banned?

Yes, they must be banned. Israel has the most attacks of any country, and has never held a simulation of a terror attack. They hold normal scheduled siren/evacuation drills, not simulations involving building and defusing fake bombs, or pretending that a hijacking has taken place. The simulations give the coordinators undue power, and simply the threat of turning the simulation live means that people are clamoring to hold drills at all places, wasting money and time at best, and producing false attacks at worst. Banning this will have negligible consequences on public readiness, one can train for readiness without the simulated attack, and certainly no one in the government should be doing anything that can be made to go live, at least not without a massive conspiracy. Turning a drill live does not require conspiracy, since all aspects of an actual attack can be planned and carried out by subordinates with no awareness that their plans will be used for actual terror. This must end immediately.

Do you believe the 9/11 conspiracy theories that the attack on the WTC was carried out by the then government itself so as to gain access to the oil wealth of middle east countries by invading them?

I believe the 9/11 plan theory that the attack on the WTC was organized by a single individual, working alone, in charge of the drills of that day. This is how you stage an attack, by changing a little detail in a drill. The purpose was to gain personal power, through the fear that the attack would engender, and to further a pro-American policy drive. But since it was one person, you don't need a coherent motive.

If you believe that 9/11 was perpetrated by the government, what are you doing about it?

All you have to do is chat about it. It was perpetrated not by "the government", but by a few people, or even a single person, inside the government. This is not scary. There was no "illuminati", there were no "elders of Zion". This is a magic trick, a misdirection, turning a military drill into an attack without anyone knowing. If you tell people, they will lose all fear. They will not fear terrorists because there are no terrorists. The will not fear their government, because their government is composed of middle of the road decent people. They will not fear the "powers that be", because there are no powers that be. The only devil is a single person working alone, it is only

through the fear that there is a conspiracy of many others that such a person can make sure other people stay in line.

How many different people in how many different government offices would have had to have been involved in the 9/11 conspiracy?

Such an attack requires only one person--- the person coordinating the drills on 9/11. At the end, when it is successful, will produce at the minimum 5 people who are aware of something wrong with the official story, but they will only know one part of the story, and only 2 people will know something was wrong with the attacks themselves, the two people piloting the drones. If you have no compunction about blackmailing or murdering these people, you can do it alone, and kill your unwitting co-conspirators afterwards, or blackmail them, or pay them off. If you want everyone involved to be happy, you need approximately four friends willing to work with you, two of whom who know how to pilot a drone (this is a demanding skill for a pilot, drones are prone to crashes, which makes it more likely experienced non-conspirators were used, who were unaware of what they were doing), and two of whom know how to perform a demolition (they don't have to know the attacks are staged). The reason that you don't need a large conspiracy is because there were drills going on simultaneously, simulating every part of the attack. There was a drill simulating the hijacking of planes (which can be used to get false hijackers on the planes, so long as you have a bunch of Saudi agents), drills simulating intercepting hijacked planes, which can be used to supply the conspirator with drones, and drills simulating flying planes into buildings, which can be used to pilot the drones to their targets. The demolition of the World Trade Center can be arranged in secrecy for security reasons, with only the participation of the owner and a

small squad of as few as two people, working over months to install incendiary devices on the steel, using thermite. The secrecy is obviously necessary, and you can justify the whole thing by saying "imagine the destruction if these buildings toppled over." You can justify the secrecy by the fact that nobody will rent a building that's been rigged for demolition, and also, wouldn't the building make an attractive target if they knew the building would be demolished upon attack? Most importantly, such a justification works retroactively to ease your conscience, since even if you know the buildings were demolished, you can convince yourself that it was done for the public good, to prevent a worse catastrophe upon the buildings toppling over. You can also sleep quietly, thinking that the officials waited until the last possible moment before demolition, so that everyone who could be evacuated was evacuated, except for the firefighters, of course. That was an unavoidable tragedy. We can't have the terrorists know that highrises are rigged to go down, now can we, since then they would attack more highrises. On the day of 9/11, all the conspirator has to do is feed the fighter planes with the wrong coordinates, so that they shoot down the two civilian aircraft instead of the drones. This was possibly done over Stewart air-force base, so that any witnesses to the airplanes being shot down would assume they were watching the successful conclusion of the drill. Both airplanes happened to pass over the base at approximately the same time. The drones would take off from the base, and take over the flight path of the civilian airliners, perhaps leading to a small temporary glitch in air-traffic control, which can coincide with the scheduled drill glitches in air-traffic control. The simulation of crashing planes into the twin towers can be turned into a real attack, simply by having the folks doing the simulation pilot the drones supplied by the first drill to hit the World Trade Center. They wouldn't recognize what it is they are doing until they saw the results of their action on the news. Then you use the power of confusion: when nobody knows anything, they will accept any information. You can leak stories about hijackers, stories you can back up with intelligence documents inside the government, which you have placed there. Since no one has any better story, they will go along with anything you say. You can stage patriotic stories about passenger

revolts, and you can get unwitting participants to go along, because these fabrications are needed to commemorate the heroism of the passengers, which was unfortunately not caught on tape. You can fabricate everything related to the attack very easily, it's within the power of one person with high security clearance and a bunch of terrorism drills. A conspiracy of one person stops being a conspiracy. It's just a plan. This is what you allow when you allow secret drills. In order to win the war on terror, you simply have to forbid terrorism drills that involve simulated terror, because it is all too easy for one person, or a few people, to turn it into real terror. This video at the 7:00 mark has plausible but uncorroborated testimony which completes the story:

What changes have been made in government procedures that have made an attack like 9/11 (but using private planes) less likely today?

An attack like 9/11 is always infinitely unlikely, because no sane pilot would purposefully fly a plane into a building. They would die in the attack! Suicide bombers are rare, and they are lonely, and usually depressed and poor, and don't own planes. Only a remotely piloted airplane can hit a building, and the public can't buy drones. There is no less likely event than an impossible event, so making an impossible event less likely is impossible. So none of the steps taken have changed the probability of an attack like 9/11, it remains at 0%.

Why did the attacks on 9/11 happen?

Because there were drills simulating it at the same time. and such drills can be easily turned into real attacks. No drill, no attack. If you want to end the attacks, end the drills. This is the way to win the war on terror.

Was the United States government behind 9/11?

The plan was coordinated and executed within the US government, but this doesn't mean "the government" was behind it. It was almost surely not an official government plan. Bush almost certainly knew nothing about the plan, let alone authorize it. No documents detailing the plan were debated or discussed internally within the administration, it came as a surprise to everyone. Everyone, that is, except one person, the person who was behind the simulation drills coincident with the attacks. It is only by manipulating the details of such drills that you can pull off an attack such as this from the inside. It is impossible to make a large nefarious conspiracy within the government, you can hardly expect to persuade hundreds of top official people to go along with treason and murder. But you can make the event happen all by yourself, under two conditions. 1. You have to have the highest possible security clearance. 2. You have authority to stage a drill simulating the intended attack. Under these circumstances, to make a fake terrorist attack, all you have to do is pull a little switcheroo on the day of the drill, something one well placed person can easily manage. On the day of 9/11, there were a massive number of coordinated military drills, which simulated many aspects of the actual plot, and overlapped in time. This was noted by Bush, who called this an uncanny coincidence. It is uncanny, but it's not a coincidence. One of the drills of 9/11 involved a hijacking scenario, where planes were supposed to be hijacked and flown somewhere else. Someone designed computer equipment to muck

around with air-traffic control for the purpose of this drill, to test how they would respond to bad blips, stuff going wrong. There was another drill which sent military planes to ward off an imaginary Russian attack, leaving American airspace vulnerable, and another drill involving the agency that is responsible for space imaging, which sent them out of the building during the hours of the attack. There were about 46 separate drills on that day, more than any other day in American history. The most interesting and relevant drill in the attack was a flight simulation designed to see if airplanes can be piloted into the pentagon or world trade center. News of this drill leaked in 2002, much to the consternation of senior folks in the Bush administration. Putting the drills together, with the proper authority, it is a cinch to pull of 9/11. You simply give the fighters, who are supposed to be shooting drones out of the sky, the coordinates of real civilian aircraft instead, and have them shoot the civilian aircraft down unwittingly, using long-range missiles. They would never know what they did. Then you morph the path of these downed aircraft into the path of the drones, either by placing the drones near to where the airliners were shot down, and switching their identifying signals, or else by manipulating the air-traffic control radar, which was rigged for a hijacking drill on 9/11. Instead of running a flight simulation for planes crashing into the world trade center, you have the pilots in the simulation pilot the remaining drones into the real world trade center. You can justify the drones resembling civilian aircraft, because the drill is after all simulating civilian aircraft getting hijacked and flown into buildings. They won't be spot on, however, and witness testimony and photographs of that day are more consistent with a drone than with a civilian aircraft. Besides, no pilot in their right mind, including Al-Qaida jihadists, would pilot an airplane into an occupied building. That's the kind of comic-book villainy only novelists and military planners image. Real suicide bombers always come in groups of one, a suicide pact of 19 or 20 people is kind of a big conspiracy for people who are committing suicide, one of them might decide they don't want to die. The result is that you have pulled off an attack with no explicit co-conspirators necessary, and after the attack, the only people who suspect that they are responsible for something terrible are the few

pilots who were involved in the simulation, who would surely realize that they were piloting the planes into the World Trade Center. Considering their terrible guilt and horror, you can blackmail them, or have them killed using your security clearance to fabricate secret evidence against them. Or you could use co-conspirators, if you have them. (see minute 23 of this video for plausible but uncorroborated testimony) It would be a violation of security clearance to come forward with any information, so people who participate in the drills more peripherally, and have suspicions, would need to risk their jobs and jail time in order to testify. They would not be absolutely certain that the attack didn't happen as the government said, and these doubts would make coming forward difficult, considering the consequences. One requirement of this plan is that the evidence of the planes, that they are drones, be destroyed in the attack. This does not mean that we don't have plenty of witness evidence: But it means that any part of the World Trade Center which contains parts of the aircraft inside must be demolished as part of the attack. You can do this by contacting the owner and requesting permission for emergency demolition charges to be placed in the building. You don't need the building owner to be a co-conspirator for this, it makes sense to have the power to demolish tall buildings in case of emergency, to prevent property damage to other buildings in the dense area, from falling towers. It also makes sense to keep it secret, because, who the heck would rent space in a building that's rigged to go down? Such a system would also make the building a more attractive target for any actual terrorists, who would be guaranteed a spectacular result if the attack succeeds. Further, since no one knows about it, even if the owner were to say "Yes, there were charges in the building, it was demolished", he would be liable for wrongful death lawsuits totalling billions of dollars, for neglecting to disclose it to his tenants. So he keeps his mouth shut. (see the beginning of this video for more sincere sounding testimony) The owner doesn't need to know about the full plot, the point is that nobody really needs to know about the full plot, except for the person coordinating it. But there will be suspicious people. If the drill involved contacting American Airlines, for instance, and suggesting that there would be a simulated hijacking on this airlines, people

would figure "hey, either they have intelligence about this, or else people won't want to fly American, because of association with terrorism", and you could get a person placing put options on American, and their friends, and their friend's friends. The high volume of hedged short-selling on the Airlines does not necessarily indicate an enormous conspiracy of fully clued in conspirators, although it doesn't rule it out either of course. The illicit trading discovered on WTC computers might have all been done in the last few minutes, on lower floors, as people evacuated, betting that the building would be going down. It is not necessarily indicative of a huge conspiracy (although it's consistent with a large conspiracy). The fact that a simulation nearly exactly mirroring the events of 9/11 were being carried out as an exercise at the same time as the attacks occurred, is not just an implausibility, it is statistically impossible in the common meaning of the word (not in the scientific meaning, however, that requires more evidence). To match the year, day, time, and targets of a unique attack is a one-in-a-thousand coincidence, even assuming there were terrorists around interested in carrying out such a plot, which there weren't. So, given knowledge of the drills of 9/11, your prior confidence in the government being involved should be 999/1000. A statistical prior can modified with new information, if some group would have taken some responsibility, for example. But Al Qaida condemned the attacks, and claimed they had nothing to do with it. No other group claimed responsibility. The leadership of Al Qaida has never been tied to 9/11, except through alleged information acquired under torture, behind closed doors, and leaked to the press by people selected for their deference to authority. The Clinton administration also has a terrorist attack which matched and coincided with a drill, the first such event in my memory, which is the Oklahoma City bombing, which coincided with a planned drill as well. So Bush administration officials who knew, or figured it out, could blackmail Clinton officials with complicity in terrorism, preventing Democrats from exposing the plot. For political support, any Democratic insider would have a difficult time trying to tell the truth, since it would open a can of worms which would engulf both parties. Really, the whole thing tarnishes both parties so terribly, that it would

be a miracle if they can survive. What is required is legislation making it illegal, attempted murder really, to have any sort of anti-terrorism drill that involves a simulation of an attack. Israel has never held such a drill, they have more attacks than any other country. These drills are counterproductive, since the events they imagine never turn real. Except, of course, when they do. This is in the case of Oklahoma City, 9/11, The London Bombings of 2005, The Madrid bombings of 2004, the Oslo attacks, the Boston Marathon bombing, and essentially every terror attack in the last 19 years. When attacks coincide with drills, the drills aren't drills at all, but covers for the attacks. In this case, the coordinators of the drills should not be commended for their foresight in anticipating the exact time place and form of the attack, they should be tried for murder.

What happened on 9/11? How valid are the conspiracies about explosives, etc.?

I like to think of it as figuring out how to pull off a magic trick. Three building have airplanes smash into them, another airplane is shot down. How would you do it? The trick is, you can't tell anybody. You have to do it by yourself, or at most a handful of accomplices. Is it possible? The following is my fictional daydream. It is a solution as to how this magic trick is done. ### My daydream: What Happened on 9/11 ### In early 2001, George Bush is parcelling out the tasks in his new administration. A certain high-level government official gets the normally thankless job of "terrorism readiness". This consists of coordinating drills, and arranging for disaster preparedness, and so forth. But this fellow has an idea, perhaps cribbed from the Oklahoma City bombing, perhaps original. He is going to do something important with his position. He is not completely alone, he has a few colleagues in his skull-and-bones type society ready to go along with it, but there are not many people in the government he can trust. But

these three guys are going to pull of something enormous. ---- To NYC He goes to New York, and talks with the owner of the last major target of international terrorism, a certain fellow who owns two very tall buildings. The conversation goes something like this: "I am directing terrorism preparedness, and, I have to tell you, the government is really concerned that, in the event of a terrorist attack, your buildings will collapse onto the surrounding buildings. These buildings are extremely heavy, and can cause a great deal of damage." "What can I do to help?" "We would like to install an emergency demolition system in your building, which only we will know about, which can take them down in the case of a terrorist attack." "What? Are you mad? A demolition system? In a working office building?" "You never know when an attack might happen, and we have concluded that even a simple attack can lead to a catastrophe, for example, a hijacked airplane striking your building." "Oh, I see. But my tenants will freak out. They'll leave." "Your tenants will never know. We will install the charges in the middle of the night over several months. It's required for government security. Also, it is top secret, we do not want to make your building a more atractive target." So then the official authorizes, in the interest of public safety, a few folks to go to the buildings in the middle of the night, and rig them top to bottom with explosive charges made of thermite. They park their van outside the building every night for months, night after night, and work until 5AM. Only a few people notice the strange activity, and then it is over. This is Top Secret, nobody is to know about it, except at the highest security clearence level. The folks doing it know why it's being done, to demolish the buildings in case of an emergency. They rig several buildings in the complex, and they can detonate them at any time. The owner is spooked by these events, thinking to himself "They must have good intelligence that this building is a target, to go to all this trouble". He insures the buildings specifically against terrorism, just to be safe. --- At work back at work, our official asks folks to get together and brainstorm about various scenarios for terrorism, he would like to be prepared. The folks come up with all sorts of stories, nuclear plants attacked, anthrax letters, and so on. But the most intriguing idea is cribbed from a recent Tom Clancy novel, and involves crashing

hijacked airplanes into buildings, in a suicide mission. "I like it." He tells the staff. "Let's simulate it." So over the next few months, preparations are made to simulate airplanes hitting buidlings. Mock buildings are constructed, drones are built and commissioned that are the size and build of commercial airliners, and they are painted to look roughly like an airliner (although not with the detailed markings, of course). People work on the simulation all the time. Fighter pilots learn to scramble to intercept the jets. Other folks learn to fly the drones simulator. The official replaces two of the worse performing folks with senion people he knows from the old days, seasoned pilots, old chums of his. --- The Hijackers There are about six or eight lazy Saudi CIA agents, who aren't doing very much. They were recruited to spy on the Arab community, but the work is not very demanding, and they goof off and take drugs with the money the CIA pays them. They like strip clubs, cocaine, the works. They aren't particularly devout, although the pretend to be sufficiently devout to infiltrate the devout community. They are told to go to flight school, or they will lose funding. They take flight lessons. They are told to study flying, not landing, because they will be needed in a simulated hijacking. They are told it's top secret. Okey dokey. They take flight lessons, they do terrible, they aren't interested. But they are told that if they don't pass, they don't get paid, and they work harder. He tells the folks to be prepared to take a trip on specific flights, that the agency will get them a ticket, and to make sure they are on it. On 9/11, all but one of them is there, the last guy runs away, suspecting something is wrong. The remainder get on the flight. --- Air traffic control The official contacts air-traffic controllers, saying the following: "We are going to be conducting a drill tommorrow involving activities in airspace that pose a potential hazard to commercial air traffic. In order to keep the traffic safe, we need the precise coordinates of all commercial flights in our airpace." "Yes sir, we'll have them feed to you directly." "We would also like to rig your system so that you don't track our flight. Our flight path is confidential." "Ok no problem. We'll tell you the radio frequencies we are using." "Thanks." --- The day of the attack On 9/11, the drill begins early in the morning, around 7 AM. The drill involves intercepting and shooting down five drones headed for a

public building. The drones take off, and they are each at a different place, one over the midwest, another over the south, they're scattered about. Fighter jets scramble to intercept the drones using long-range heat seeking missiles, using shorter range missiles, using different types. The goal is to see which work best for interception. But the official goes over to the fellow with the flight coordinates of the drones, and does a little switcheroo. He relays the location of 4 nearby airliners, instead of the precise location of the 4 drones. They aren't too far away, just a few tens of miles ahead of the drones. The fighters make visual contact with the airliners: "I see the drone. Ok, fire. It's a hit!" The four actual jetliners are blown to smithereens. It's around 8:00AM. The drone pilots are dismissed and go join everyone else to celebrate, except for the old buddies that the official brought in. Everyone pops champaign--- the drill has been a total success. They were able to intercept all the drones. Everyone is laughing, that was a lot of work, it's all finished, now they can get some rest. As this is going on, the official switches the drones to tranmit their location in the same frequency as the airliners just destroyed, and then his buddies begin to steer them elsewhere. Air traffic control reports that 4 airplanes have lost radio contact, oh wait, we see them, they have deviated from their flight paths, and they are probably hijacked. They are headed towards several cities. These are the drones, alive and well, and piloted by the two remaining conspirators, the only people who will be aware of the nature of the attack, other than our official. ---- 45 minutes later In New York, a small plane crashes in the twin towers. It is a largish military drone, but still small compared to a typical airliner. Our conspirators are counting that nobody will have gotten a good look at it. One lady sees it and says "Oh my god, a small plane has hit the World Trade Center!" This is reported on the news, and people come to gawk, and film. While they are gawking, the second of the drones comes in and smashes into the World Trade Center, losing pieces that fall into WTC 7, across the street. Now, it is clear the the US is being attacked. A third drone smashes into the pentagon. The fourth drone is flying to Washington DC, going to who knows where. The president orders the shooting down of hijacked jets. The fourth drone is shot down at a distance using scrambled fighter jets. "It's

incredible", one fighter pilot radios the other, "We were just simulating this exact scenario this morning. It's the freakiest coincidence." --- The collapse As the buildings are smoldering, the owner is concerned. The demolitions folks trigger the collapse system. Lots of thermite begins to melt the steel, and it's only a matter of time before the building is collapsed. The owner is very concerned. He knows that several other buildings are rigged to implode, and he is worried about the people in the building. But before he is even there, the two towers collapse. Then he comes to the site, and seeing the damage, decides that building 7 has to go too. Our official encourages this, worried that pieces of the drone are in building 7. --- The aftermath The government begins to leak many completely fabricated phone calls from the planes. The nation discovers the incredible heroism of the passengers of flight 94, the cover story for the shooting down of the drone. The nation is rallied to go to war. The documents for the anti-terrorism drill are shredded. The documents ordering the demolition of the towers never existed. The only people that know about the demolition are the owner, the official, and two highly trusted explosives experts. The only people who know the attacks are not real are the official and two drone pilots, who take turns piloting the different drones in turn. The number of actual conspirators can be counted on one hand. --- The Moral? When there is a simultaneous exercise simulating the events, it is dead simple for a handful of people to turn the drill events into an actual terror act--- you just change a few teeny-tiny details in the execution. But it requires a simultaneous drill to work. Without a simultaneous drill supplying you with drones, and people working in good faith, cluelessly, on your attack, you can't do any such thing, you need an army of co-conspirators, and you're not going to find it. But this is the only example of such a coincidence. No other terror attacks have coincided with drills simulating their effects. Except for the following: 1. The 2005 London subway bombings coincided with a drill for a bombing taking place in the exact same stations, coinciding so closely, that the actual events merged with the drill. 2. The Boston Marathon bombings coincided with a scheduled drill to simulate an explosion near the Boston Marathon, coinciding so closely, that in fact they were merged events.

3. The Oklahoma city bombing occured on the same day as a scheduled ATF drill of an explosion in the same exacy building, coinciding so closely that bomb squads defused fake bombs planted for the drill in the building that day. (see here: Training Exercises Before "Terror Attacks") Actually, come to think of it, ALL but a couple of the recent terror attacks occuring in the West have coincided precisely with drills that mimic their effect, with the possible exception of the Madrid bombing, no sorry, there was a NATO drill in Madrid that day simulating a terror attack. Gosh. What a coinky-dink!

Why do 9/11 conspiracy theorists disbelieve the official story?

There are several reasons, most have been covered in other answers. I will give my own: 1. The transnational group you are talking about, Al Qaida, denied responsibility for the attack at first, and the then-current evidence that it claimed responsibility was obviously fabricated. 2. The physics of WTC towers collapsing is implausible, the physics of WTC building 7 collapse is just plain impossible. 3. The planes don't look like jetliners--- the first plane is small, the second plane looks more like a drone, both to eyewitnesses and also in video images. 4. There was a string of obvious fabrications, including the "let's roll" story, and the passports of the hijackers miraculously found in the debris. 5. There was a simultaneous exercise dealing with the same events on the same day. Point 5 is most important, because it allows a small conspiracy. To build drones that resemble jetliners and fly them around on the day of 9/11 would ordinarily take a bunch of people, and they can't all be in on the conspiracy, or else they would never go along with it, and someone would talk. But they would have no problem building such drones for an exercise, for the purpose of shooting them down, and they wouldn't even bat an eye if their exercise turned out to be so precient, that an actual attack just the

same as their simulation happened on the very day of the simulation. They would chaulk it up to synchronicity. The official story is not possible, it's ridiculous. But the requirement of a large conspiracy makes it difficult to believe anything else. The simultaneous exercises means that there is no large conspiracy required. The simultaneous drill has been a recurring feature of attacks since, repeating on the London bombing attacks (where the people involved were startled when their exercise suddenly turned into a real attack), and most recently in the Boston marathon bombing. The sheer statistical improbability of the coincidence is sufficient evidence of a conspiracy, and the coinciding drill is the mechanism that allows the attack to be staged from the inside. No drill, no attack. You can't get an army of inside people to attack their own country. But you can get them to pretend to, for a drill, and you can change this into reality with only a small number of people.

What do 9/11 conspiracy theorists believe was gained by blowing up the Twin Towers that wouldn't have been gained by just flying planes into them?

What is gained is that you can't investigate the actual plane wreckage and see that it wasn't a jetliner that crashed into the building.

Are there actually genuine Sandyhook Truthers who believe that the Newtown

massacre was staged? What do they believe?

One can believe that the government was involved in this, with the intention of disarming the public, as part of "terrorism prevention". The events coincided with a drill, which might plausibly require funding a bunch of people to simulate the events, including grieving parents and so on, and then you turn the drill "live", so to speak, just bring the fake drill-parents out in front of actual cameras. There seem to be children who actually died, so it requires an actual gunman or two to come into the school and shoot people. Aside from these gunmen, you do not need a large conspiracy, as the event happened to coincide with a drill to simulate the event. This doesn't mean that nobody died, but it means that it is easy to make the story fit whatever preplanned scenario the drill coordinators dreamed up ahead ot time. See my answer here: What do 9/11 truthers believe? I do not have a firm opinion on this (or anything else), I am simply suspicious of everything now. The way to prevent this kind of skepicism is simply to avoid drills altogether. No more drills. Done. Get rid of them. Nobody needs them. They seem to coincide with actual attacks far too often. To see a more complete list go here: http://www.examiner.com/article/...

What do 9/11 truthers believe?

There is no uniform answer to what truthers believe, but the general idea is that the 9/11 attacks involved a conspiracy of some sort, which allowed people within the government to perpetrate a hoax, a sham attack, the equivalent of the Riechstag fire, with the goal of advancing some agenda, involving removing civil liberties, advancing the interest of certain private parties, and expansionistic military adventures by the US. The main positive evidence in the case of 9/11 is the collapse of WTC7, which is inexplicable. A building which wasn't hit by airplanes

was demolished that day, in a collapse that resembled the WTC collapse, and this causes cognitive dissonance. But it is difficult to draw definitive conclusions from a single anomaly. ### Chomsky's Complaint ### There is a serious,superficially insurmountable, obstacle to any such conspiracy idea, explained also in other answers, which must be adressed first in order to become a truther. In order to proceed with this line, one must first answer Chomsky's question: How the HECK can you have a nefarious conspiracy of 3,000 officials and not have word leak out? It is simpy impossible to imagine such a thing, because you can't even trust a dozen people with a secret, somebody always opens their big mouth. To trust the thousands and thousands of people involved in faking such an attack is completely ludicrous, it is beyond preposterous, it is impossible. But the recent Boston bombing attacks have provided an answer to this. The main point is that there was a drill simulating the events, simultaneous with the events themselves. When you have a secret drill, coinciding with actual attacks, it is possible to do all the arrangements for the attack as part of the drill, without the people involved in the drill even suspecting that they are somehow coordinating the attack. In fact, afterwards, the people involved in the drill will feel like they are prophetic--- their predictions for the attack were SPOT ON! They did an excellent job in thinking like a terrorist! They deserve promotions, they predicted the attack to a tee. ### A Fictional Scenario ### A top official arranges a drill involving at least two tiers of secrecy. The lower level of the drill involves people with a low security clearence, the higher level of the drill involves people with high security clearence, and the nefarious plot is only known to the top official and a handful of other co-conspirators, who are not communicating through government channels at all. The drill is designed to "think like a terrorist" and figure out how to plant bombs, or hijack planes, or do some destruction. People with low security clearence sit around and think about how terrorists might do it. People get reports about it, they send them up, and they are each classified on the higher security level, so that only top level folks can see all of these. Then the conspirator picks out one of the plans produced, and puts them into operation. Sending the plan down to the bureaucracy again, he asks

people to build a simulation of this plan. For example, to produce a drone the size of a commercial airplane to hit a building, as part of a simulation. The work is done by people at a lower level of security clearence, and the thing is classified with a high security clearence. All that the conspirator has to do is manipulate security clearences. Nobody who is doing this remotely suspects that the drone they are working on is going to be used to do actual terrorism. Once the drones are built, they are painted to look "realistic" for the simulation, and the people involved are doing a terrorism drill, they don't suspect anything. As part of the drill, you have military planes shoot down the drill drones, to practice taking out commercial airliners. Except, unknown to them, they aren't shooting down the drill drones, you send the pilots the coordinates of actual commercial airliners, and they shoot these down, killing everyone on board (they don't know this, and they do this hours before any attacks). Then you fly your two drones (you have made two using a duplication of effort, each hidden from the other) into the twin towers. In the previous period, you have 1-2 people, private CIA explosives contractors, with coordination with the building owner (and nobody else) put explosives in the building, at each story, to knock it down once the drones hit the building. You promise the owner compensation in exchange for secrecy, and you say the following: Official: As part of terrorism awareness, knowing that your building has been a target of terrorism in the past, in case of a terrorist attack, we might have to demolish the buildings to ensure the safety of other buildings in the area from the collapse of certain part of your building. This means we should rig your building for demolition in case of attack. Owner: But who the heck would rent in a building which is rigged to collapse? Official; You can be assured that the buildings will be rigged in secrecy, only you will know about it, your tenets will be clueless. Please provide us with structural plans so we can do the rigging, to ensure safety in case of collapse. Owner: Ok, but I am afraid word will get out. Official: Don't worry about this, we will use a special secret squad consisting of 2 highly trained and highly reliable operatives, and they will do this in the middle of the night, into the early morning, every night, over several months. By the way, we also have suspicious intelligence that suggests an attack of this sort

might be brewing, and it is best for you to be careful. The owner then gets a shitload of insurance, because he is scared as heck of a potential terrorist attack. He cooperates with this, but keeps his mouth shut, because he doesn't think anyone would rent from him thinking his buildings are rigged to go down. They sit there, rigged to go down for months. Then the planes hit, and the controlled collapse is authorized by the official, and the 2 operatives bring the buildings down. The owner now DEFINITELY doesn't want to admit he allowed this, because he is now partly responsible for 3,000 deaths, and he feels both guilty and scared of being sued and imprisoned for allowing this. But he doesn't think "I am part of a conspiracy", because it is all done in secret, and he doesn't know about the other parts of the conspiracy. But he doesn't want anyone to die, and he tells people to get the hell out of the buildings before they come down, and then he kicks himself for using demolition language. The CIA folks doing the demolition think they are ensuring public safety, and have no reason to come forward. They only know one little part of the conspiracy. The number of people involved in the actual conspiracy, the people who know that the attack is fabricated from start to finish, could then be reduced to as small as four people--- one very high level official, who can control classification status and has decades of familiarity with the bureaucracy, and a few other people who know how to pilot drones. All the other people, the CIA explosive expert who plant the charges in the buildings, the building owner, only know a little bit, and think they are acting in the interest of public safety, or terrorism prevention. The people shooting down the airliners, or the ones building the commercial airliner drones, part of a terrorism drill. The people who arrange the drones, the people who shoot down the jetliners, the people who do whatever else, all are doing everything as part of the "scheduled drill". The people who demolish the building think they are doing so for the safety of the public, as the buildings are going to collapse anyway, due to the jeliner impact, causing more destruction Further, you get together 16 passports of Saudi people who are missing or killed by the CIA, without relatives, and you create paperwork about these terrorists, simply by bringing down documents from a higher to a lower level of secrecy. You also put your drill report as part

of the government paperwork, all this is done as part of terrorism awareness, and in each case you ask low-level people to supply information on a possible suspect, and you take whatever bullshit they give you back, and you make it part of the top-secret records. Then once the attack happens, you release information little by little, and manage the information. When the terrorists are needed, you supply passports and stories about these people. It really is not an enormous conspiracy, it's a tiny conspiracy. ### What the story requires ### But it absolutely requires ONE THING, a terrorism drill! You can't do it without having a drill around the whole event, which miraculously matches the event. This is the sine-qua-non, it can't be done any other way. You need to have people making plans for the event, building bombs, making drones, whatever, and they must be doing it for a terrorism drill which matches the event in complete miraculous, almost spooky, fidelity. It is a notable fact that each of the following events have precisely coincided, in uncanny ways, with a drill to simulate their consequences: 1. The 9/11/2001 attacks. 2. The 7/7/2005 London bombing 3. The Sandy Hook shooting 4. The Boston Marathon bombing. Each of these coincided with a drill, which spookily matched the exact nature of the events. The 9/11 attack coincided with a plan to simulate flying a plane into a building, as part of a terrorism prevention plot. The 2005 London bombing coincided with a drill that simulated bombs in 4 stations, the exact 4 stations where the bombs actually hit, on the same day. The Sandy-Hook shooting matched a plan to simulate a terrorist attack on children, and the Boston Marathon bombing coincided with drills to simulate an explosion in the Boston marathon. So it is precisely in these cases that we see that it is possible to produce the sham attack without a large conspiracy, and the attack matches the drill. That does not mean it happened according to the fiction story, but it does not require an enormous suspension of disbelief in the laws of human organization to see that it can happen. ### How to prevent such things ### Simple! No more secret terrorism drills. One is better of being unprepared for terrorism attacks, which happen rarely, and in and of themselves are extremely non-threatening to the social order, than to allow the potential for coordinating a real attack from within the government,

under the cover of a drill. You can live with a few terrorist attacks, you can't live with a government that takes over your life. Further, without the government instigating them, the number of terrorist attacks in the US would probably be close to the 1900-1990 average, which is approximately zero attacks per year. The US isn't Israel, it is not a very attractive terrorism target, nobody sane wants to attack it. In order to reassure the suspicious public, the secret societies in the government, the tiers of secret documents, must be completely opened up. ### How to disprove these scenarios ### You simply have to review the drill documents in detail, and interview every single person involved, to make sure that there was no way the drill could have been manipulated to turn live. At the moment, I can see a path for it to happen, and since the anomalies, which are especially serious in the case of the Boston bombing, are impossible to make sense of except for a drill which turns live, and the information is manipulated from inside the government, I am a truther. I am also happy, and have no intention of comitting suicide, now or ever, I have a lot to live for. But I AM thinking about finding another country in which to live, because the current situation in the US is absolutely intolerable. ### What can the public do? ### Simple! Ignore terrorist attacks, and focus on civil liberties. Elect people who promise to preserve civil liberties in the face of "terror", and open up secret documents as quickly as possible, to prevent such plots from even being possible in the first place. The most nefarious deeds of governments are conducted under the cover of secrecy. The genocides of the 20th century, the bombing of Cambodia, the CIA coups, the torture and rendition. It is important to remove the potential for misdeeds. There is no need for a CIA anymore. The cold war is over. Unfortunately, the public already tried this with Obama, and Obama has failed to open up the secrecy layers, instead inhabiting and promting the secret society he promised to kill. Perhaps Jesse Ventura would be a better president in this regard. At the moment, I feel that all social and economic policy should be secondary to this consideration, removing the power of individuals within the government to stage terror through secrecy and drills. See here: Another official drill goes live after Texas fertilizer plant explosion

Was the Boston bombing an inside job?

Sorry, but you have to be a complete idiot to not see through this one. I was on the fence regarding conspiracy ideas until today, but here, you can't avoid the conclusion. You just have to look at the photos here: Boston Truth Revealed and this video: see here: “Contractors” at Boston Marathon Stood Near Bomb, Left Before Detonation and here: Who's Investigating the FBI Investigators?: This was obviously a scheduled bomb-drill which suddenly turned live, what a coincidence. The evidence is overwhelming, there are people involved with the drill caught on photo, you can see Blackwater people, oh sorry, they're called something else now. The evidence is so overwhelming, it is a big mistake, since it clarifies the nature of the previous events of this nature--- they are always designed as drills, so that many people can be involved without any inside knowledge, and only a very small number of people are actually doing anything awful. It is likely that the majority of the people doing the work are each individually clueless as to their part in the attack, just doing their part for the "drill". This event also completely changes the balance of the evidence regarding 9/11 and the 2005 London bombings. Both of these happened to coincide with a scheduled exercise, and the events matched the exercise: see 7/7 Mock Terror Drill: What Relationship to the Real Time Terror Attacks? and Was the NRO's 9/11 Drill Just a Coincidence? A suggestion: if you wish to prevent future terrorist attacks, forbid all terrorist attack drills and mock simulations, they seem to mysteriously transmute into the real thing. That's three ridiculous 1 in a hundred coincidences, and that by itself constitutes 5 sigma evidence for a conspiracy, it's scientific certainty. It is a sad day when "Robbo da Yobbo" and 4chan can out-report all major US media outlets and out-investigate the FBI. Or perhaps a hopeful one, because they brought out the truth essentially instantly this time, being prepared. I suppose I should add, considering the content of this

post, that I have absolutely no intention of committing suicide in the next few months or years, or, come to think of it, ever. I am very happy, and have much to live for.

What do I do with a kindergartener who can do algebra?

You have a very curious son, and other people, not me, would say "boy is he talented", but I don't say this, because I remember vaguely what it was like to be in his shoes. The thing he is doing is impressing YOU with social tricks, by learning whatever rote button-pushing he needs to do to make you happy about him. This is not actual knowledge, because it is very easy to impress most adults by a simple act of original thinking, since most adults have forgotten how to do it, and how easy it is to do it. This type of creativity and talent, while statistically exceptional, is not particularly exceptional for CHILDREN, they are wired for doing this. Most children are in principle able to do what he does, as it is a simple formal structure. This is something that children are able to internalize by that age, since they are certainly able to internalize their native language grammar, to the point of understanding embedded sentences, at close to this age. The mathematical structure of language grammar is somewhat more elaborate than this level of algebra (as is learning to read). It is a waste of his time to learn "algebra" the way it is taught in school, as these formal rules are not real mathematical knowledge, or rather, they are extremely trivial mathematical knowledge which is taught by rote. Something that might get him excited is doing multiplications and discovering the laws of prime numbers, or doing multiplications base 2 or base 16, these are interesting to children at this age, or learning geometric proofs, something Gauss could handle. So you can draw a triangle, and imagine a man walking around the triangle, and counting how much he turns. He walks along one edge,

and then turns by an angle, then along another edge, and turns by an angle, then along another edge, and turns by an angle, and he is back to where he started. Since he got back to where he started, and he is pointing the same way, the angles he turned by add up to 360 degrees, which, after some of the algebra he's already learned, implies that the angles on the interior add up to 180 degrees. This is real mathematics. It can be extended to find the sum of angles of any polygon, and then he will notice that the turning number (the sum of exterior angles) come in integer clumps of 360 (obviously, you always come back to where you started), but this integer is also equal to the number of self intersections of the curve. Sort of. You have to count the intersections in a certain signed way, because sometimes there are pairs of intersections that sort of cancel out. This leads to the fruitful 19th century concept of winding number and turning number of a curve, which are appropriate geometrical concepts for children who have no formal mathematics. Another thing you can show him is that if you are "inside" a polygon and shoot out a line, the number of intersections of the line with the polygon is always an odd number. While if you are "outside" it's always an even number. Almost, you need to count the self-intersections in this signed way to make it work, but this introduces the concept of "generic" and "exceptional" lines. You can hone his mathematical skills by simply teaching him more formal things, like doing careful column decimal addition, and calculating a number like sqrt(2) to a certain distance by hand. This is a very difficult calculation at his age, but he might do it, and it will give him the satisfaction of having worked a long time for a tangible answer. Long decimal calculations can be done at his age, so long as the algorithm is understood and spelled out. Unfortunately, most algorithms require Taylor series to understand why they work, and some require continued fractions. These are both excellent topics for later, but this is probably too early. The puzzles in puzzle books are very useful here, and also the puzzles from IQ tests, and things like this. If he can master these, he will learn some new concepts and principles. From this point on, obviously, his IQ will be stratospheric, but this doesn't mean he knows anything about anything except IQ tests. But these are useful skills they are testing for, and you shouldn't deprive him of them just because they are misused by classist bigots. Other proofs from Euclid are also appropriate, the pythagorean theorem can be proved the chinese way, or Euclid's way. But doing it Euclid's way, you should introduce Cavalieri's principle, that the act of identifying equal areas is through sliding infinitesimal segments (Euclid doesn't do this, but it's easy to imagine if you look at the proof Euclid gives). A copy of Euclid would go a long way here, and you can find it online for free, I am sure. Cavalieri's ideas are explained on Wikipedia, and are a good motivation for calculus. The calculus of finite differences is good for children, as it is a half-way house to infinitesimal calculus. Once he understands the Euclid theorems (and he might not, I didn't get Euclid until I was relatively old, pooh-poohing it because I knew coordinate geometry from my exposure to computer graphics), you can move on to more sophisticated geometry, and real infinitesimal calculus. For calculus, it is important to explain the concept of infinitesimal clearly and cogently, and this is not done in modern rigorous books. But you can do it in a few minutes yourself. Then the rigorous epsilon-delta proofs can come, perhaps at around age 12-13, maybe later, they require familiarity with the notion of a formal proof. Another thing is to install a distribution of GNU/Linux on one of your home computers, and plonk him down in front of a terminal, and show him a simple language, like python. Children can easily and quickly absorb computer languages, since they are abstracted from natural language. If you go to another country, he will pick up a second language quickly, and this is equivalent mental training. This is not realistic for most people, of course, but exposing him to another language at this age can be done more easily than transplanting your family. Learning to use a computer will produce an infinite number of the most interesting kinds of mathematical problems in his head almost automatically, the moment he wants to write some nifty program for himself, they appear like cockroaches in your head, you can't avoid it except using the bug-spray they seem to have handy at school. None of this is intended as a knock on your son. He might be the world's greatest mathematician someday. But this has nothing to do with the abilities displayed on this video, which say more about that you are a good parent, and notice and hone his

mathematical skills. The ability to produce great mathematics can only be demonstrated by producing great mathematics (or first mediocre mathematics, which is all I have done personally, by the way). Great mathematicians, aside from producing great mathematics, are usually ordinary people, not superheroes. They just spend a hell of a lot of time on mathematics in the correct exploratory way. Gauss was a child prodigy, and also a great mathematician. Galois was a prodigy and also a great mathematician. Penrose was the opposite of a prodigy and a great mathematician. Einstein was not a prodigy at all, and was a great scientist. 99% of all children showing this kind of talent do not do anything with it. Again, not a knock on your son, but the mathematics is not a magic property of a person, it's something you painstakingly evolve in your head over years and decades. It also helps at some point to talk about the dangers of marijuana, and how it will prevent him from further growth in mathematics. Mathematics is the best anti-drug there is, since the act of doing it will reveal the mental confusion of drugs immediately and clearly. The most important thing, after the basics are laid down, is to expose him to mathematical resources which are written by actual researchers. Arxiv is very good for this, as you can find research papers which can be read at any level, if you know calculus, algebra, some geometry, and search dilligently. But it is best to read this stuff after learning the basics yourself, so that you have a good immune system for the political nonsense in the literature, and learn to identify the pure original work. It is also important to make sure he develops in freedom, so if he wants to be a novelist, or a professional soccer player, or a musician, or a plumber, or a stock-market analyst, you don't impose. Mathematics is so entrancing, that it doesn't need pushing, in fact, it is so addictive, that society needs to put negative motivators in place to prevent everyone from learning it.

Geology: Why do large quantities of heavy elements like uranium appear together?

This is one of the mysteries that is explained by abiogenic theory of oil. In order to segregate heavy metals, they should be carried in solution to their present location in a fluid. The fluid carrying the metals up to the crust from the mantle, where they are homogenous, is methane, within this theory, and the methane is permeating rocks, and constantly bubbling up from the mantle because it is light. It is replenished as continental shelves go into the mantle at the ocean ridges, bringing new carbon to the mantle, where it spontaneously forms methane. While in the mantle, the methane dissolves various heavy elements inside at different ratios. It then deposits these elements in the crust at different locations where the methane outgassing is largest. These deposits will follow the path of the methane flow to the atmosphere, and so the heavy metal veins run along channels. Further, the different elements precipitate out into the rock (replaced by different elements from the rock) at different temperatures and pressures, so that you expect the metals to come together, so that you expect to find different metal veins next to each other in the crust, as is observed. This requires you to first accept the Gold theory of petroleum origins, which is more properly called the Soviet theory, which is essentially conclusively established, but nobody in the west is listening right now. Gold expanded this idea to explain the concentration of elements such as gold and uranium, the mantle elements strangely concentrated in locations which correlate with hydrocarbon finds. This idea is explained in detail in later chapters of Gold's 1999 book "The Deep Hot Biosphere".

How is the vision of the universe as a computer simulation considered among modern physicists?

This paper is wrong, and the idea hopelessly old. Coleman and Glashow consider the idea in the 1990s, others considered the idea earlier, except with different conceptual decoration around the thing, they didn't say "the world is a computer simulation", they said something else, like "Lorentz violations" or "discrete space-time". The loop quantum gravity people too. The first problem with the idea is that the authors think that simulations of QCD on lattices are somehow simulations of QCD on lattices. The QCD simulations are in imaginary time, which make the quantum system into a statistical system, which can be simulated by Monte-Carlo, by equilibrating a statistical simulation. This trick, born from the path-integral, doesn't give you results in real time, it doesn't simulate the motion of particles, or nuclei, it gives you energy levels and correlation functions, and you can only extract the remaining physics by a process of analytic continuation and hard work. This allows you to get physical predictions for certain quantities, like the mass of the proton, relatively easily, but it doesn't work to produce a simulation of the macroscopic world, simply because it isn't really quantum mechanics, the analytic continuation is exponentially demanding. You can see this simply by thinking about simulating a quantum computer, or, if you want to stick to pure QCD, a highly excited heavy nucleus. Such a simulation can't be done in the Monte-Carlo way, at least not without exponential slowdown, where you have to simulate essentially forever to find the energy levels of the nucleus to ridiculous precision, just so that you can time-step the simulation forward with any reasonable accuracy at a later time. So the right test to see if the universe is a computer simulation, at least for a non-quantum computer simulation, is to look to see if quantum computers can be built. If we can build them, and factor some enormous number, than we know the universe is much bigger than any realistic classical computer to simulate. This

is really a test of quantum mechanics, not of space-time so much. But there are further issues with the idea. Their idea is not just that the world is discrete and simulatable, but that space-time is ultimately a lattice. This is ruled out simply by noting that the lattice would break rotational and Lorentz invariance unless it were ridiculously tiny. Using lattice QCD is misleading, because lattice QCD has a square lattice, and the square-lattice symmetries means that the surviving terms that respect the lattice symmetries are also accidentally rotationally invariant. In our universe we have gravity, so you can't have a square lattice, the notion of square doesn't make sense with curved space time. But it's more insidious than that--- in gravity, no lattice in space time is very naturally compatible, because the space-time peels off in an expanding way, during inflation, or near a black hole horizon. These things mean that it is difficult to imagine making a fixed lattice structure. The loop quantum gravity is the closest people have come to this, and there are issues with Lorentz violations on this, and it is very difficult to make precise. It is not clear that it can be made to work at all. But within string theory, when you renounce the bulk-spacetime as a holographic reconstruction, there are many cases where a finite approximation is as good as perfect when it comes to describing the dynamics of the spacetime. In this sense, certain discrete approximations reproduce an approximate space-time which breaks down at short distances WITHOUT being a lattice, and without introducing any gross violations of Lorentz invariance or rotational invariance. The lattice idea is wrong, it is ruled out. But the philosophical idea that the universe should be simulatable by a computer is fine, it is just the program of physics. The idea that this computer should be classical, and of a realistic size, is incompatible with quantum mechanics, and this is one of the motivations for recent proposals that quantum computers might not work.

Is Ed Witten really the world's greatest living theoretical physicist?

I think the greatest living theoretical physicist is Stanley Mandelstam. His thinking and insights (usually with Chew) are the only reason there is such a thing as string theory. But this is just a stupid opinion, like "what's your favorite pizza topping". Physics is not a sport, like chess, where you can be the best by winning. It is not a competition, or rather, the competition is against nature, and each discovery is a win where nobody loses. You discover stuff, and you tell people, and then you go discover something else. At the end of your life, if you're lucky, like Ed Witten, or any of the other folks, you have at best a handful of discoveries compared to the size of the field. Then to ask who is greater, it's a question of whether discovery X plus discovery Z is more important than discovery Y, which is completely inane. Witten is a great physicist, and never speak ill of a great physicist. However, his number one position has been granted by a corrupt and wrong political process, similar to the h-index, and this is not an acceptable way to go about doing science. It turns a discovery art into a contact sport where the main activity is citation sowing and reaping. The people who win at contact sports are the ones that trample over the field and hurt others. The physics h-index works like any other star-making procedure, you select a small basket of people to be famous, using early career competence as a test. Then you apply political selection on the famous folks after the fact to get the "best of the famous". This process is bankrupt, because the best most original ideas come from absolutely nowhere, from the bottom of the barrel, from complete nobodies, just by the laws of statistics, because there are more nobodies than famous people. Nobody listens to these nobodies. In the old days, you needed people on top to endorse them, otherwise, they were just thrown out, like Everett, or the string theorists. If you have famous people around, in the world before the internet, especially when hardly anybody could actually read the whole literature, like physics or mathematics in 1983, the famous people could sometimes get more famous by taking the work of a

complete nobody, and republishing it as their own. In the early 1980s, nobody could read the whole literature, and you could get away with it, because nobody would know except for the author, and the author wouldn't find a job, because people would assume that the nobody was plagiarizing the somebody, rather than the other way around. Of course this doesn't work today. This type of corruption became worse during the reign of Ed Witten's. Einstein, Feynman, Schwinger, 'tHooft, Susskind always did stuff that was unmistakably completely 100% original, they never ever stepped on anyone else's toes. Since the process of making Ed Witten leader was political, one should describe how it works for future generations, so they will see how fragile pre-internet science was: the way you got more famous is by making famous research buddies who you cite, and pull up, and they pull you back, in a corrosive feedback process that requires a feedback amplificaiton mechanism to select a few people for the top, this is the h-index. This process of feedback citation marginalizes all really good people, because a person with a new idea is not going to get cited, they are going to be laughed at, no citations , then the idea suddenly becomes obvious, no citations again (Einstein's Nobel prize winning photon paper has, like, 4 citations). This is not some weird exception, it is all the best work. Ed Witten was transformational, because Ed Witten, through intelligence, foresight, and political shrewdness, made this horrific crappy system work pretty ok, at least throughout the 1980s and 1990s, by first rising to the top (quickly) through making the right friends and doing a bunch of competent field theory research with the right people, then once he got to the top, quickly recognizing and pulling up the RIGHT PEOPLE, the completely original people who were stomped on through the 1970s, the string theory people, and at the same time, all the while doing his own completely original work, which was unusually heavily mathematical, and pushed the field forward also. Ed Witten became a leader essentially because he was the only baby boomer on the East Coast physics departments who actually could read. He became a superstar when he endorsed strings, thereby giving East Coast journal people a way to check whether string papers are correct (ask Ed to referee it), and suddenly the field boomed, and everyone needed to make friends with Ed, because he

was going to referee their string papers. Back then, people who weren't John Schwarz or Michael Green couldn't evaluate string papers. The baby boomers had a drug catastrophe in the 1970s, which played a role in this. When people are burned out, they needed someone to follow in order to know what to do. Ed Witten played this leadership role in physics, emulating and displacing 't Hooft somewhat, who was the previous leader. I am trying very hard not to insult Witten here, rather to insult everyone else of his generation instead.

Is there any proved relation between Weed Smoking and Brain Skills. Measurable skills like memory, IQ, etc and others like Creativity, problem solving, etc?

The problem with the clinical trials is that they use standardized tests for elementary schools to determine the damage, things like adding and subtracting simple fractions, and other things that any adult can do without thinking. I presume this is done so that they don't have to have their samples to consist entirely of mathematicians, physicists, computer scientists, because if they did, the percentage of marijuana smokers in the sample would decline to statistically indiistinguishable from zero (I doubt there is a single active mathematician in the whole world who takes marijuana, perhaps there are a few physicists, but they must be doing very rote things to be able to function). Marijuana is statistically correlated with class, so you need tests that are univesal competence among all social classes, and today, this consists of grade-school math only. There are many in the humanities and arts who smoke marijuana and who would resent the idea that they have been turned into a vegetable. But, at least as far as mathematics is

concerned, vegetable is the proper word. Even small amounts of marijuana, taken as infrequently as once a month, will produce a serious and debilitating decline on tests of mathematical competence which are not at the basic brain-stem level, and heavy marijuana smoking will even lead to a cognitive drop in the elementary school skills tested. For an example of the type of problems that become impossible after ingesting marijuana, just look at a typical Putnam mathematical competition. These problems are sophisticated, but they are undergraduate level, and can be done with ease by most practicing mathematicians. But marijuana smoking will damage other, less demanding skills, and I am sure that no marijuana smokers will be able to solve even the three extremely easy problems I have given here: Can any regular marijuana smoker solve any mathematical problems? I would be happy to be proved wrong, but I fear i will not be. Don't smoke pot, it's catastrophic to your mathematical mind. And despite what you may think, you will use it, and you will enjoy it, even if you think you are "bad at math".

What are the biggest misconceptions about recreational drugs?

That it is possible to take any of them, even in miniscule quantities, and remain productive in any activity that requires focused attention over long periods of time. This seems obvious, except everywhere I look on the internet people are saying it isn't true. Well, in this case, the obvious thing is also true. There is practically no substance that crosses the blood-brain barrier, legal or illegal, with the possible exception of extremely mild stimulants like caffeine, nicotine, and perhaps ritalin (Erdos took this with no apparent ill effects), and perhaps a tiny handful of other chemicals (I haven't tested them), which one can take and maintain focus on mathematical problems. Even alcohol in small doses will remove the ability to think

mathematically for a few hours, and in regular use, it will remove the ability altogether, while marijuana even in infinitesimal quantities will remove the ability for a few days, and in larger quantities, for weeks. Stronger drugs will do so for comparable periods of time, although I can't say for sure for all of them, because the amount of damage from marijuana itself was so terrifying that I never took any. Marijuana is fat soluble, and so is cleared extremely slowly from the body, and this makes it especially pernicious. Whether or not the cognitive damage registers on the simple tests used to test competence in clinical trials, the damage to creative mathematical work is debilitating, and can induce despair. It is long lasting, and can only be reversed with a long period of abstinance. If all you took is marijuana, however, you should not despair, because when the marijuana is cleared from your body, you will be able to think again.

Are there any famous mathematicians that smoked marijuana?

ABSOLUTELY NOT, it is CATASTROPHIC to mathematical thinking in no uncertain terms, even in miniscule doses that do not affect anything else. The damage lasts for days or weeks, depending on the usage, and the effect is to set a person back in their research longer than the time spent confused and debilitated, because the research is interrupted. The only illicit drug which comes with mathematician approval is ritalin, which was used by Erdos, in small nonaddicting doses, as a substitute for coffee in his old age.

What scientific evidence exists for abiogenesis?

I think the best evidence for this is the existence of complex computing autamata, spontaneously generated with no effort, from any combination of parts capable of storing memory and producing transformations on this memory. This was discovered by Nils Barricelli, John Conway, and really most strikingly driven home by Stephen Wolfram, following Barricelli's approach. The existence of natural computers from simple building blocks means that there are systems where Darwinian evolution begins to happen spontaneously, long before any precise self-replicating entity is even close to being produced. The evolution can proceed to produce life, and I would define the origin of life as the moment of production of the computing automaton, not the self-replicating stage, which is rather late in the game. I explained this in more detail in the answer here: How did life begin on Earth? .

What's an intuitive way to understand integration by parts?

The intuition is just the picture you drew, more or less, but it's in what looks like a special case, where the function "u(x)" is just x. This is not really a special case, as you'll see at the end, all other cases are related by change of variables. I'll explain it for the special case where x is integrated starting out at zero, it's just a tiny bit easier to picture in your head. If you integrate some function y(x) from 0 to x, [math] \int_0^x y(x') dx' = x y(x) - \int_{y(0)}^{y(x)} x(y) dy [/math] This means: the area under the curve y as a function of x is equal to the big box of width x and height y(x), minus the area under the complementary graph of x as a function of y, you know, tilting the picture and going up the y axis. It's completely obvious, the box is split into two "parts", hence the name. To turn this into the usual statement, you first change variables in the integral on the right, to use x instead of y as the variable in the second integration: [math] \int_0^x y(x') dx' = x y(x) - \int_{0}^{x} x' {dy\over dx}(x') dx' [/math] This is now the usual integration by parts, where "u(x)" is x, and "v(x)" is y(x). To get the general case, you just change variables again, imagine that x' is some function of some other variable, so that [math] x'= x(u) [/math] Then change the integrals to integrate du instead of dx, [\math] \int y(u) x'(u) du = xy | - \int x(u) y'(u) du [/math] where I have used the chain rule a few times. This is the usual textbook statement. The picture never really changes in all cases, it's always just a change of variables away from the obvious picture, but it becomes a little obscure once you change variables away from x. The Liebnitz style proof from the product rule is easier, so people never explain the reason for the name, which is a pity.

What is the role of causality in modern physics?

Causality, as philosophers understand the term, plays no role in modern physics, it is subsumed by the second law of thermodynamics. The philosophical notion of causality, that "action A produces consequence B" is simply a mental shorthand for describing properties of our experience, it's a construct of our minds, which observations go with which other observations in a reliable enough way to say "X is the reason for Y". The relation between the observations require focusing on certain aspects of the initial conditions as relevant, and calling them X, and focusing on certain aspects of the final condition as relevant and calling them Y. The notion distinguishes between past and future in a way that is not particularly important in physics. So you could say colloquially that the force of gravity makes an apple fall down, but the physicist only says that the Earth produces a gravitational field, and an apple placed in a gravitational field falls down, without making any direct philosophical causal claim (at least, in any way more than a figure of speech). This initial condition leads to that result. That's all that physicists have to say. The laws of physics simply tell you what happens when something is set up, they don't need to tell you about what is relevant to what, except as you can deduce this from the predictions. That's not physics, that's a meta-statement about physics (I would call it metaphysics, but that term is taken for something more useless). The only requirement is that you should be able to reproduce normal notion of human causality when you have big thermodynamic time-irreversible things. The distinction between future and past is the second law of thermodynamics, that entropy goes up into the future. Since we do computing, we need entropy to go up in the direction of our experience, so the usual notion of causality can only be extracted throwing in a little bit of statistical mechanics--- a bat impacts a ball made out of atoms, the ball goes out fast, but the direction in which time is going is the direction in which the atoms jiggle more at the end than at the beginning, so which causes which is dependent on whether the atoms are jiggling more. In one direction, it's a fast ball hitting a bat and stopping, in the other, it's a bat hitting a ball and making it go. The two situations are only distinguished by entropy. That's all I am going to say about the notion of forward in time causality. It's about thermodynamics and perception. The laws of microscopic physics as we know them do not care so much about the direction of time, and so we can't say in particle-terms that X causes Y, because the relationship is microscopically symmetric in time. But there are several useful notions in physics called causality. They are related to philosophical causality when you consider situations where you have thermodynamic large observers, the name is really justified. But they are fundamentally things that do not distinguish between the direction of time in and of themselves, so they are not themselves about causality as the word is understood day to day. One notion of causality is the no-CTC-conjecture. This says that you can't go back in time by going around in space. The reason is simply that then you could kill your grandfather. This is also related to thermodynamics, because if you have a loop that goes back in time, at some point on the loop, the entropy must be a maximum, and this means that any traversal of the loop violates the second law of thermodynamics. This notion of causality is very intuitive, and you need to make sure it isn't violated in your initial conditions, so that you can make sense of increasing entropy and observers on the space-time. A related notion is no-faster-than-light signalling. If you can violate this, you can use relativity to boost the faster-than-light device (assuming relativity is true) so that you can send signals back in time, using two boosted devices. Backward in time signaling will allow you to get rich on the stock market, but more importantly, it means that you can't make consistent thermodynamical observers, because as the observers compute, you can make a paradoxical loop, where you tell an observer to do the opposite of what the machine says, so if it says "Jump" to stand still, and if it says "stand still", then jump. Then you set up the machine to say what the observer actually did (using the back in time signalling), and no behavior of the observer is consistent. This suggests that such theories don't have a consistent thermodynamic computing limit, where you can identify sensible observers. The next notion is microcausality, which is abstracted from the previous notion. This is a more technical statement that quantum fields commute at space-like separations. The notion of space-like separation doesn't distinguish past from future, neither do quantum fields at points. So this notion is superficially not related to the philosophical notion. But if you introduce a big thermodynamic observer, and say that this observer can measure fields at arbitrarily localized position x, and also at arbitrarily localized position y. If these fields do not commute, in the quantum mechanical sense, than the measurement at position x will change the outcome at position y, and the two points are therefore signalling faster than light. So if you couple microcausality to macroscopic observers able to make measurements at local points, you get violations of philosophical causality. But it's called MICRO causality for a reason. This hypothesis is not controversial at all when you are talking about long distances and times, it is controversial only when the points become very very close so that x and y are not distinguishable without smashing energetic particles together. In this case, it isn't clear that you need microcausality, because perhaps any violations of microcausality exponentially die out as you go to larger distances, so that you can't actually signal faster than light. If you

abandon microcausality, then you don't need to have localized fields at points. But you still want to say that you can't send signals faster than light. How do you say that properly, in a way that doesn't refer to local points? This was understood in the late 1950s by Stanley Mandelstam. The right notion for fundamentla physics is Mandelstam analyticity. This says that the singularities of the S-matrix (the scattering amplitudes as a function of incoming momentum) must appear with a certain sign on the imaginary part. While this condition is very technical and superficially intimidating, it is derived from the idea that signals can't propagate faster than light in a medium with a wavelength dependent dielectric constant--- this is the Kramers Kronig relation. The Kramers Kronig relation says that as you integrate over frequency, you only can get singularities in one direction, because the out-signal can't precede the in-signal (when you do a Fourier transform to find the out-packet, you need to close the contour on one side of the complex plane for times earlier than the incoming time, and in the other direction for times later, so the condition of no singularities on one half of the plane means earlier in time scattering is zero. The Mandelstam condition is an elaboration of this for all asymptotic collision states, and it is tautalogically true in field theory, but it is extremely nontrivial if you are trying to go beyond field theory to a pure S-matrix theory. This condition replaces micro-causality in S-matrix theory (and string theory), it is saying that you don't need micro-causality in all the steps, you simply have to ensure that the causality is true asymptotically, so that, setting up asymptotic collisions, you can't send asymptotic signals backward in time. You still might have no notion of local causality, like micro-causality, you only need this weaker thing. This idea is an asymptotic kind of boundary micro-causality, because the boundary, meaning the scattering states, need to be correctly produced in a non-backward-in-time way from inputs and outputs, so that if you examine far-away scattering states nearly parallel on a light front, and you vary the momenta slightly from going along the light front, the perturbations have to commute along the light front if the scattering is not going to violate Mandelstam causality. This is probably the motivation behind the construction of the light-front gauge and the Mandelstam

formulation of string theory, which directly led to string field theory by Kiku and Kikkawa. In string theory, this turns into "horizon micro-causality" (I just made up this term), meaning that if you formulate it on asymptotic boundaries, the boundary theories are micro-causal. So it's really a minimal violation of the idea, and with the notion of holography, it allows ordinary physics to emerge, and there is no contradiction with thermodynamic observers doing measurements and not being able to macroscopically signal faster than light, because the observers can be thought of as living on the boundary, where their thermodynamics makes sense, and the spacetime is projected, so an asymptotic low-energy no-signalling must make sense in the low energy description they give for their reconstructed space time, even though it has no fundamental fields defined on it. Using boundary thermodynamic observers, meaning computations you make using boundary big computers, you should be able to turn a violation of Mandelstam causality into a violation of the intuitive notion of causality. But microcausality is making the statement that you can turn a failure at arbitrarily localized points into a failure of asymptotic states to be causal, and this is too restrictive for a fundamental theory including gravity. The dispute between micro-causality and S-matrix theory was unfairly resolved in favor of microcausality in the 1970s, and Mandelstam's pioneering work on the causality interpretation of dispersion relations, and the generalization to the correct S-matrix causality conditions has been widely and grossly unfairly overlooked.

What is the nature of the weak nuclear force?

The weak force can be approximated at ordinary energies by the Fermi theory of weak interactions, except using a fact that Fermi didn't know, namely that there are only left-handed neutrinos (this is the Sudarshan Marshak Feynman Gell-Mann model). This model is a

point interaction between four fermions--- meaning it is a fundamental interaction which turns two quarks in the same family into each other, at the same time as it turns two leptons into each other (or creates two leptons, with appropriate swap of particle to anti-particle). This is not quite precise, there is a bit of an angle between the different quark families, also it can lead to scattering without changing type, the so-called neutral current interaction, but what I said is good enough for a first approximation. So, for ordinary nuclear physics, where we only see protons and neutrons, the weak force is simply responsible for turning a free neutron into a proton, an electron, and an electron anti-neutrino after 8 minutes, or at other rates in neutron rich nuclei, or for the reverse process, seen in atoms with proton-rich nuclei, of taking a proton and an inner shell electron into a neutron and an electron neutrino. That's all it does outside of high energy physics. The fact that it's a contact interaction between four particles meant that it couldn't possibly stay a pointlike interaction, because the scaling law of a pointlike four-Fermion interaction is all wrong--- the strength would blow up at scales of some 10s of GeV. So it was clear that something else would replace the effective Fermi theory at some point. The details of what replaced it is described in the other answer, and were the most important step in formulating the standard model.

What is renormalization group theory?

Renormalization group theory is the theory of the continuum limit of certain physical systems that are hard to make a continuum limit for, because the parameters have to change as you get closer to the continuum. A continuum means continuous space, parametrized by real numbers in cartesian coordinates. This is always an idealization, so you can model it as a lattice of points, like a square grid which gets finer and finer, and limit means that the grid is disappearing by getting smaller, so you are approaching an idealized continuous space.

The continuum limit is difficult when the limit requires you to change the model as the lattice length becomes small. For a simple example, consider the idea of length of a rough curve, or area or a rough surface. A simple model for this is the Koch curve, or Koch snowflake (it's on Wikipedia). At each stage in the transformation defining the Koch curve, the length of the curve increases by a factor of 4/3. So you fix an atomic scale, at which the curve is resolved as a series of straight lines, and then the length is blowing up according to the law: L = C (4/3)^N Where N = 1/e, where e is the cutoff. The coefficient "C" is the size of the curve, the quantity 4/3 is the blowing-up exponent. The appropriate quantities to consider in the limit of small e is C, not L. The same parameter swap happens when you have a statistical phase transition. For the simplest example, consider the Ising model, where you have one bit at each point, and the probability of two neighbors being the same is enhanced by a factor of e^J. As the factor J gets bigger, there comes a point where there is a transition, on infinite size lattices of dimension 2 or more, where most the bits will have a tendency to be one, or minus one. You can simulate this as described on Wikipedia, and see the transition with your own eyes (there are also applets on the internet). When you are close to the transition, you can describe the Ising model using the average value of the bits (change the bit values to be -1,1 instead of 0,1 for convenience, because then there is a symmetry between the values on flipping sign). The average value can be defined on a very big ball, or using some smoothing function, like summing all the values with a Gaussian weight, it doesn't matter how you smooth it up very much. The resulting average field varies from point to point, and if you look at all Ising model configurations, it will have a tendency to want to be the same at neighboring points, but also a tendency to be pushed away from 0, and the two compete. You can make a grid-based model for this field, where the probability of every field configuration is the exponential of minus S, where [math] S = \sum_{\langle i,j\rangle} (\phi_i - \phi_j)^2 + \sum_i t \phi_i^2 + \lambda \phi_i^4 [/math] You can heuristically derive this approximation as Landau does, and this is done in many books, my favorite is Polyakov's "Gauge Fields and Strings". The derivation is relatively straightforward, and you can also try to do it yourself. This model is the workhorse of elementary renormalization theory. In the continuum limit (when you consider the ball large, or equivalently, the lattice small) the first term is the gradient, it makes ϕ want to be constant from point to point, and it comes from the fact that averages don't change very much on overlapping balls. The potential term, the quadratic-quartic term, is enforcing the tendency for the field to be two-valued like the Ising model is. You recover the Ising model by taking t to minus infinity at fixed lambda, where the field has two values at each point. There is a correlation length in this model, which means that at a generic value of t, the field [math]\phi[/math] at two points is independent of the precise field value at another point far away. The independence is not complete, but the correlation between the two falls off exponentially. The exponential rate is called the correlation length. The point of this theory is that as you tune t, at some negative value of t, there is a phase transition. At the phase transition, the correlations no longer drop off exponentially, you get a power law. At this magic point, you can take the limit of t getting closer and closer to the transition, but rescaling the lattice to keep the correlation length fixed. This limit is a continuum limit, because the lattice gets smaller. In this limit, you get a continuum theory. Define the coefficent t' to be the difference between t and the critical point. As the lattice gets smaller, the coefficient t' has to go to zero as a precise power law. This power law defines how you get the continuum theory. Renormalization group theory is the theory which allows you to calculate the exact law for the way the coefficient changes. Historically, it wasn't thought of this way. Historically, it was discovered in quantum field theory, where people thought of things in the continuum to begin with. The correlation length in the dictionary to quantum field theory is the mass of the particle described by the field. Since the mass is finite, and the lattice spacing is zero, the correlation length is infinitely larger than the lattice spacing. So you can see that, if you make a teeny tiny lattice, and you have a finite mass particle, you need to make the correlation length enormous compared to the lattice spacing to define the field theory, so that the theory is tuned to extremely close to the critical point. The scaling laws are funny, so when you take the limit of a pure

continuum, you have to change the parameters of the lattice theory as you make the lattice small, exactly according the scaling laws of the phase-transition theory. This relationship was understood in the 1970s. Before this, renormalization theory meant doing hokey things with perturbation expansions of continuum theories that gave infinities. The reason for the infinities is completely understood now---- you are expanding a theory with somewhat altered fractional scaling laws in a power series using a theory with different scaling laws. That's a little bit of a lie (at least in 4 dimensions). In 4 dimensional quantum field theory, you are expanding the theory with log-altered scaling laws, meaning that it's not quite a different power, but it's trying to be, because a log is like a power that is going to zero. The best introduction to renormalization group theory, in my opinion, is the Migdal Kadanoff transformation for the Ising model. This defined the modern field. In this transformation, you define a block of spins as a single spin, and you make up a majority-rule for deciding what the block spin is supposed to be. This is described in several books. It's a huge field, reviewed well in several places. Kenneth Wilson's 1974 Reviews of Modern Physics article is one of the best sources for learning the theory, and there he describes the transformations. It's a little old-fasioned today, and it is complemented by reading the high-energy theory of perturbative renormalization. I am not writing more, because it is possible to write a book. However, you asked about soft-condensed matter and simulation. In soft condensed matter, it is applied wherever you have a nontrivial continuum limit to take, with natural fractal shapes. Examples are depinning, certain sand-pile phenomena and other examples of self-organized criticality, disordered systems, any sort of statistical theory, really. It's easier to ask where it is NOT applied, because it is the general way of making a model at long distances where the atomic scale becomes unimportant, whatever that "atomic" scale might be (it might not be atoms). In some cases, like the tight-binding model reducing to the Schrodinger equation, or the analogous thing in high energy physics, of a free lattice field turning into a free continuum field, the theory is trivial--- it is just dimensional analysis. The simplest nontrivial example is the Ising model. http://en.wikipedia.org/wiki/Isi...

Is infinity ∞ the measure of human ignorance?

Yes, this is true in a precise and exact sense. The theory of this is called "ordinal analysis", and it was essentially started in 1936 by Gerhard Gentzen, building on earlier work in logic which culminated with Godel's completeness and incompleteness theorems. The theory was developed in Germany right before WWII, and the only people who were good at it back then were Gentzen and Hilbert. Hilbert died (of old age) in 1941, while Gentzen was resettled to Eastern Europe along with other Germans during the war, and was starved to death in an internment camp by the Russians in 1945. With the death of the founder, and the unfortunate political association with German positivism (which also took a beating) The field was neglected until the 1980s, when it begins to be investigated again. There is a good book describing the modern field by Rathjen at Leeds. The modern theory of infinity begins with Gerog Cantor, and this is where it stops in most descriptions, because the later developments are really a retrenchment of Cantor's more mystical ideas. Cantor was investigating mathematical analysis, he was looking to understand why concepts like "The real numbers" and "the complex numbers" allow you to prove theorems about arithmetic, like the prime number theorem more easily than pure arithmetic methods. He isolated the structure of certain collections of real numbers, which he called infinite ordinals. The modern construction of the infinite ordinals is within the modern elaboration of Cantor's set theory, but I'll describe Cantor's original way first: you consider points on a real number line which have the property that they are discrete to the right, meaning, given any point, there is a finite size gap until the next point to the right. Such a collection has the property that if you consider the points as ordered from left to right, if you go down, you always reach the lowest point in a finite number of steps. This means that if you prove a property is true for the first point, and you prove the property is inductively true,

which in this case, means that when it is true for all points to the left of a given point x, then it is true for x as well, then you know it is true for all the points in the collection. This is called "transfinite induction", and it was the first generalization of the notion of mathematical induction to the correct modern general form. The idea is that any theorem should be proved by transfinite induction using a large enough ordinal, and ordinal analysis makes this more precise. The simplest infinite ordinal is the collection of numbers 1-1/n for all integers n. This produces the ordinal "omega", it is equivalent in order to all the natural numbers in order. You can consider the ordinal .5 - 1/n and .5 too, this is the ordinal "omega plus 1". Cantor defined addition of ordinals by placing ordinals end to end, and multiplication of ordinals by expanding each point of one ordinal into a little copy of the other ordinal. Then exponentiation of ordinals, by iterating multiplication an ordinal number of times (the ordinals describe how you can iterate operations). These operations produce ordinals from ordinals, and allowed him to define the "Cantor Normal Form", which gives an explicit combinatorial description of all ordinals up to epsilon naught (this is described on Wikipedia), an ordinal which plays an important role for Gentzen and in metamathematics. The theory of ordinals immediately subsumed all previous notions of infinity, because they were a precise way to describe any collection which allows inductive proofs. These collections include the integers, but also these larger infinite structures, these branching hierarchical fractal-type ordinals. The structure was incredibly rich at the large end, you could make more and more complicated ordinal structures, and proofs by induction using the more complicated ordinals would produce combinatorial theorems that were difficult to imagine could be proved by ordinary arithmetic induction. These combinatorial theorems were heavily studied in the 20th century, and imply things like the Goodstein theorem, a result which requires for it's proof, in addition to Peano Arithmetic (the theory of induction on the integers) the statement of the consistency of Peano Arithmetic, and so for sure can't be proved using only the Peano Axioms. In addition, you need to assume the consistency of these axioms, but I am getting ahead of the story. This intuition, that ordinal structures and transfinite induction prove more and more powerful theorems, led Cantor to mystically identify the large ordinals with the theological notion of God, and to try and push the structure of the ordinals as far as it could logically be pushed. Since the ordinals for him defined the limits of mathematical reasoning, he felt that all mathematical objects should have an ordinal description. In order to do this, he investigated set theory. Within set theory, his next great idea was to consider the real numbers as a set. He then proved an important theorem--- the real numbers are uncountable, meaning that they are not matched one to one to the integers, like the rational numbers can, or the algebraic numbers, or any other collection defined by a list of text strings (like all real numbers you can precisely name, for example). This result was an infinitary leap beyond the ordinals he was describing earlier, because the ordinals he could draw on a real number line are all countable (the gap to the right means that the lengths have to add up in an infinite series to 1, and a convergent infinite series of positive numbers is always countable). But now that Cantor had an uncountable set, he could construct an uncountable ordinal, by proving that there is no "set of all ordinals", so that if you consider all possible well-orderings of subsets of the real numbers (all possible ways to embed ordinals into the real numbers, not necessarily in left-to-right order, but in arbitrary order, without using the same point twice), then it is impossible to embed all ordinals, so there must be an uncountable ordinal. This proof is non-constructive, the existence of an uncountable ordinal, is equivalent to the existence of an uncountable set, and this is given to you by the axiom that the real numbers are a set, which is one of the axioms of modern set theory. Cantor also had the intuition now that the real numbers should be well ordered, because you can consider the limit of all maps of ordinals into the reals, and the limit of the embeddings must exhaust the reals, to prevent the set of all ordinals from "fitting into" the set of all reals, which it can't, because the ordinals are not a set. This intuition was turned into a rigorous proof by Zermelo around 1910, who also formulated Cantor's set theory as a rigorous system for the first time in order to make this proof precise. This idea, that the real numbers can be well-ordered, was resisted by many mathematicians, including

Poincare and Dedekind, who accepted countable manipulations, but were wary of manipulations using the set of all real numbers. This led to a schism in mathematics, the foundations war, which never really healed, it was just forgotten. It has a resolution today, and this is ordinal analysis. I'll get to it. In order to place set theory on a logical foundation, to give what amounts to a precise countable description of set theory using symbols, Hilbert and others decided to make a theory of meta-mathematics and logic which would allow people to prove axiom systems are consistent. This program formulated modern logic, which had been stagnant due to the horrific influence of the pseudo-logic of Aristotle, which falsely claimed to solve the problem of logic using syllogisms. In addition to syllogisms, it was necessary to introduce variables, quantifiers, and precise rules of deduction on quantifiers and variables, which were codified by Frege, Russell, Whitehead, Hilbert, Godel and many others in the 1910s-1920s, making true modern systems of logic that actually could work for mechanical theorem proving, unlike Aristotle's vapid nonsense. In 1931, Godel proved that the resulting system of logic, now called "first order logic" for unimportant reasons, was complete, meaning it was able to prove the full consequences of any axioms. The notion of completeness of logic was extended to the notion of computers and computation by Turing, and the first result Turing proved was that there is an uncomputable real number, simply because the real numbers are uncountable, and computer programs are countable. Turing's method clarified the role of first-order logic. First order logic is like an instruction set for a computer to do deduction from axioms, and it is complete, in the sense that given a collection of symbols describing an axiom system, it can produce all the consequences of these, which include the result of all computations. But now there is a simple consequence: given any axiomatic system, there is a deduction algorithm. So given any axiomatic system S, strong enough to follow a computer, you can always write a computer program SPITE that does the following: 1. Prints its code into a variable R 2. Deduces all the consequences of S 3. if it finds the statement "R does not stop" in the consequences, it stops. The statement that this program doesn't stop is unprovable by S and constitutes a new axiom that allows you to extend

S. This is Godel's incompleteness theorem. It is easy to show that "SPITE does not stop" is equivalent logically to "S is consistent", since if S is inconsistent it will prove everything after the inconsistency, including "R does not stop", and if S is consistent, R cannot stop, because that would be an inconsistency (since S is strong enough follow R or any other finite computation). Godel's theorem was interpreted by many people' as killing Hilbert's program, because set theory could prove the consistency of Peano Arithmetic, and Peano Arithmetic could prove the consistency of simpler systems, so it was considered that it was hopeless to prove the consistency of set theory from computational arithmetic ideas. This interpretation became popular right before the war, and the war meant that Hilbert and Gentzen, who didn't accept this interpretation and in fact, disproved it explicitly, were marginalized. In 1936, Gentzen, Godel's theorem be damned, proved the consistency of Peano Arithmetic in a way that was completely satisfactory to Hilbert. What Gentzen did was show that any deduction path in Peano Arithmetic that ended in a contradiction, once all the lemmas are expanded (cut elimination) would imply a smaller contradiction, in a way ordered by an ordinal epsilon-naught. So the fact that epsilon-naught is an ordinal is equivalent to the consistency of Peano Arithmetic, and this ordinal is precisely equivalent to the complexity of Peano Arithmetic. To define epsilon-naught does not require any of the controversial parts of set theory--- it only requires the axiom of infinity, not the axiom of powerset. Epsilon naught is also a completely combinatorial object, which can be represented on a computer, it's not even difficult--- the obvious order on Cantor normal forms are exactly such a representation. So here was a complete satisfying combinatorial proof of the consistency of Peano Arithmetic. In analyzing Gentzen's proof, in a display of terrible intellectual dishonesty, Godel declared it was "infinitary", and from this point on, epsilon-naught was declared to be an infinitary object, unfairly and stupidly, by all subsequent generations of mathematicians. This is idiotic, epsilon naught is completely and explicitly representable on a computer, and so is finitary, no ifs ands or buts. So I will ignore Godel from this point on, although he went on to complete an important thread of Hilbert's program afterwards.

Hilbert had already had an idea for reconstructing all of set theory from the ordinals alone, he had an inductive idea of building up the universe algorithmically using the ordinals and logical operations on simpler sets iterated an ordinal number of times. Hilbert just didn't know which ordinals to admit, so they waited to clarify the ordinal structure before expanding it out to the full universe. Godel had no such compunctions, and just produced this construction in set theory, using the mystical ordinals of his vague intuition. This produced Godel's universe "L", which is the universe produced from starting with the empty set and iterating the objects produced by set theory an ordinal number of times, where the ordinal idea is from some surrounding mystical set theory that you accept without question. This procedure would have boiled Hilbert's blood, had he been alive, since it was just his program for set theory, except removing the most important unsolved problem--- namely which ordinals you need to explicity introduce in order to reconstruct the structure of the complicated set theory. Anyway, that's where set theory was stuck for 20 years, because Godel slammed the door on further investigation of Hilbert's program. The program was revitalized by a young New Yorker named Paul Cohen, working completely independently. What Cohen did was construct alternate models of set theory. This is far afield, so I won't describe it, but Cohen's reviving of all the old ideas was extremely depressing to the older Godel, who thought he had done a very good thing in killing them, and Godel was broken man. He died in a form of mathematical grief, after realizing the majority of his entire career was a backward step. This was all caused by his sell-out of taking the Hilbert school methods and results and applying them in traditional set theory, without clarifying the notion of ordinal properly first. Anyway, just like arithmetic has epsilon naught, it is certain in the every sense but proof (we haven't proved this yet, but people are working on it), that EVERY theory has a countable computable ordinal that describes it's strength, and you can describe these ordinals in a more or less explicit way, without ever using the real numbers, or uncountable sets, or uncountable ordinals, except as useful figures of speech. Kripke and Platek made a constructive set theory without powerset (no set of real numbers) which could be

described this way, and Rathjen extended this to larger set theories, and we might soon describe ZFC minus powerset in this way. Once this is done, the powerset axiom will take the undescribed countable ordinal X of countable ZFC, and sort of fractally replace each point of X with an image of X, to produce an even more enormous ordinal for ZFC plus powerset. This is the system of traditional mathematics. Describing larger and larger countable computable ordinals, you go on to describe stronger systems that were constructed in the 1940s-1980s, and there is no limit to this, it is describing more and more sophisticated computational structures. Such a program completes Hilbert's vision, and the roadblocks thrown in the path of this precise vision of God, suggested by Cantor, and clarified by Hilbert, roadblocks thrown by such great minds as Godel are a picture of the Devil himself. I am borrowing this religious imagery from Cantor, but I think it is appropriate.

What is it like to be high on marijuana or other sources of THC?

It depends on whether you do anything with your brain. If you don't, you will just get high, and then come down, and think nothing has changed. Perhaps your food will be tastier, or your lovemaking a little more potent than usual. If you do use your brain for demanding things, for example, if you are a professional chess player, or a physicist, or a mathematician, you will immediately notice that you can't work while high. Further, you will notice that you can't work even after you are no longer high, and for days afterwards. It takes an extraordinarily long time to recover the ability to think, mostly because marijuana is fat soluble. It depends on your fat metabolism cycle how the cannabinoids are released, but you will be stupid for 3,4,5,6 days, as long as a week. During this time, you will forget what you were working on, entire chunks of work will evaporate, at the end,

you will recover, but any work you were in the middle of is gone, you have to start from scratch. This effect sets in at tiny doses that are below the threshhold for making you high. If you don't do anything cognitively demanding, you will probably not notice. The basic effect is to turn you into a mindless idiot.

How bad is second hand marijuana smoke for you?

Secondhand marijuana smoke doesn't cause lung-cancer, even first-hand marijuana smoke doesn't cause lung-cancer (in studies, it seems to protect against lung cancer in pot smokers who are also tobacco smokers, in one of the quirks of biology). That's not what secondhand marijuana smoke does, this is not it's harm. It's harm is that it makes you STUPID beyond belief, in a way no other secondhand drug does. What secondhand marijuana smoke does is make people who inhale it slightly stoned, and this effect wrecks all mathematical thinking. It is a brutal form of assault, taking away the mathematical sense of people who have done nothing other than take a breath in the wrong place at the wrong time. The effects cannot be avoided, because with a strong joint, they set in at tiny doses that you acquire before you can even get away from the stuff, doses that don't work to get you high, only to confuse. The effect is terrible, it wrecks your cognition for days and days, wiping out any ideas you might have, and erasing chunks of your mathematical memory. This effect, the psychoactive property of secondhand marijuana, is so horrible because marijuana doesn't have an overdose cutoff, it is smoked by people at doses hundreds of times stronger than a threshhold dose. It can't be avoided, and the lingering secondhand smoke in certain places guarantee that people are going to be turned into mathematically stupid mindless slaves.

Should I quit smoking marijuana?

You MUST quit smoking marijuana, as it is debilitating your brain. If you don't believe me, pick up a math book and try to read it. No, it is not that confusing for other people. It wasn't that confusing to YOU before you started smoking. The effect of marijuana on technical thinking is enormous, and if you smoke it on a regular basis, it will be semi-permanent, in that you will have to relearn grade-school mathematics from scratch. This is just a sympton of a general stupidity, and the effect of marijuana is to turn you into a mindless idiot. Please, please, do yourself and bystanders a favor, and stop smoking that garbage. ERIC GRIFFITHS claims marijuana is harmless, so I left him some problems in a comment. He declined to solve the problems I posed, because he said I was a jerk (I was a little), so I leave them here, so that people can judge whether they should smoke pot. Each is an undergraduate exercise in Eric's self-proclaimed fields of expertise, low-level programming and financial trading, but they both require enough steps of reasoning, like two steps, that I feel it is impossible for a pot-smoker to solve them (and I made them up as an undergrad, so I know they aren't verbatim in books, although you can find them in the literature of course, and they really aren't "gotcha" problems, they both should not be very hard): 1. I have two integer values x and y in two registers. I want to swap the values in the registers, but I don't want to wipe out any other registers, and I don't want to access memory. Can you do this using ordinary arithmetic? How about using arithmetic and logical operations? 2. I have a stock with absolutely no tendency to grow or shrink in value, and I have decided to sell at $22.00 and buy more at $15.00. The current price is $20. What is the probability that I will buy before I sell, and vice versa? I doubt anyone exposed to marijuana can do either of them. Any reasonably competent studious undergrad will eventually solve these problems, and will keep this

ability throughout the rest of his or her life. If the person smokes marijuana, solving them will be like scaling mount Everest. If you want that to happen to you, go ahead and keep smoking. If you stop, and study, they will become easy again.

Why is marijuana illegal, even though there is no harm in smoking it?

Marijuana is illegal because of historical reasons, related to the Jazz age and immigrants from Mexico, in addition to it's association with native populations that are discriminated against. But that's not why it SHOULD be illegal. There are very good reasons why it should be illegal, namely that it turns a person into a mathematical zombie. It is impossible to do mathematical thinking after being exposed to marijuana, and as such, it is the worst barrier between the public and understanding the technical complexity of the modern world. Further, marijuana smoke annihilates thought at doses which are far too miniscule to feel high, doses which are forced on a person simply by inhaling the vapors off a strong joint. This effect makes marijuana an assault weapon which converts a mathematically trained person into a vegetable in 15 minutes. As such, smoking it in public must stay illegal, because it's the worst form of assault you can imagine. It is worse than robbery at gunpoint, perhaps not worse than rape, I have no experience, although I have been beaten, and it is worse than that (so long as they don't bang your head). The damage is to your brain, to your very self, and the mathematics is gone for days and days, wiping out every bit of research you were working on, every original idea, everything. It's a brutal thing to do to a person.

How does marijuana affect a person's memory?

The effect is catastrophic on precise thinking, and the memory of mathematical methods. You will not be able to do the simplest calculations that are a piece of cake while sober, and this is the main effect of the drug, it sets in immediately at much smaller doses than any high. The effect can be demonstrated in any smoker, even days after the last dose. It is simply impossible to follow a serious mathematics book, or construct a new proof, or do a novel calculation, in the days following a marijuana dose, even a tiny secondhand dose. This effect is so obvious and enormous, it does not require a clinical study--- any smoker can verify it by trying to read a math book in the 3 days after taking any amount of the drug. It is the reason one should avoid the stuff like the plague. The clinical studies show that very heavy use will damage short-term memory, but the scientific studies are not done on mathematically competent people. The effect on mathematically competent people is to immediately turn them into mathematically incompetent people, reversing years of training.

What are the advantages of smoking marijuana? Do the positive effects outweigh negatives in the long term?

There are no positive advantages, unless maybe you are suffering from serious depression when you smoke, and only smoke once in your life. If you smoke marijuana even as infrequently as once a month, in miniscule doses, it will annihilate any mathematical learning you have, and you will be incapable of thinking precisely at all. The effects take many days to reverse themselves, and the forgetting that happens

during those days is permanent. You will just annihilate your mind, and you will be left an a-mathematical zombie. This is not a side-effect of the drug, it is the main effect, and it sets in at infinitesimal doses, much smaller than those required to get you high.

Is marijuana safer than alcohol? Why?

Alchohol is FAR less harmful than marijuana on mathematical cognition, because it is water soluble and leaves your system quickly. If you drink small amounts every day, the effects are more severe, it will also prevent you from thinking, but they are nothing compared to the marijuana induced mathematical stupidity. Marijuana, even in infinitesimal doses, will erase your mathematical mind. You will not be able to do precise thinking, you will be stupid for days on end, as the cannabinoid residues work through your system. There is nothing to be done, and you won't feel particularly affected, but try to do some mathematics, and you will see the damage. You can see the effect immediately upon getting high, or even if you are around people who are smoking and you inhale the vapors. It lasts forever, and if you are not looking to get stoned, spreading the vapor around is a serious horrible assault. Alchohol only affects the drinker, and even a drunk person has most of the precise cognitive faculties intact--- you won't forget your calculus class from alchohol, but you are guaranteed to forget it from marijuana.

What are the health effects of using marijuana?

The long term effects of regular marijuana smoking is that you will lose every shred of mathematical or technical knowledge that you have, and you will be reduced to stuff you can find and regurgitate from rote memory. This is not just true of mathematics, but it is most obvious using mathematics as a test. You will lose the ability to create original works, you will be restricted to modifying other people's work in trivial ways, without the attendant ability to sense when something is wrong, except through socially mediated methods, which you will be good at, because marijuana tunes you in to all the social minutia at the same time as it robs you of the ability to generate original though. These things are catastrophic for anyone doing anything at all with their brain, and they are obvious and immediate consequences of marijuana use, you don't need a clinical study, it happens with 100% regularity to everyone exposed. If you don't believe me, try to read a mathematics book, even one you know (but haven't memorized) a day AFTER being stoned, when you are under the delusion that you're completely back to normal. There is nothing to be done about it, it's cognitive damage, and it reverses itself over a period of several days, as the cannabinoid residues work their way out of your fat. The effects on mathematical cognition are catastrophic, horrific, and they last far far longer than any high. Superficially similar damage can happen with other drugs, even with regular moderate alchohol use, but the alcohol damage is nowhere near as severe and complete as with marijuana. If you continue to smoke on a regular basis, the marijuana will erase your memory of mathematics permanently. This is probably just natural forgetting, coupled with the marijuana induced inability to reconstruct the stuff from scratch. So if you once knew, you will not rememer how to do calculus, how to do geometric proofs, how to do number theory, or algebraic topology. You will not be able to calculate Feynman integrals, or solve differential equations, nothing, the only thing left will be rote stuff you remember from books, and in patchy incomplete form. Forget about learning new stuff, even the old stuff will disappear, and quickly. This is the most obvious effect of marijuana, and it makes it incompatible with an informed citizenry, since mathematics is the basis of the entire modern world, and a person who is totally ignorant of all mathematics (this is

a set that includes every single stoner on the planet) is essentially a clueless slave. Further, the effects on mathematics set in at such miniscule dosages that even just being around someone smoking pot, or inhaling the direct vapors from a strong joint outdoors, will have this debilitating effect for days and days, even though you will not feel anything at all in the way of getting high. The reason I am writing this answer is because I was exposed to someone's marijuana smoke 54 hours ago, a girl was smoking a joint in a closed windowless bathroom I was intending to pee in, and I have yet to be able to think straight again, it will be a few days still. This is an assault of the worst kind, I am horrified, especially when I consider what that poor girl was doing to her own brain. This is a reproducible effect--- NOBODY who smokes marijuana, even small doses, on a monthly basis or more frequently will be able to do even elementary calculus competently. Heavy smokers will even fail tests aimed at 4th graders, and this is attested by clinical studies of heavy marijuana smokers, given aptitude tests from elementary grades. I don't like to cite clinical studies for effects that are this enormous and this OBVIOUS. It is impossible to find a mathematically competent stoner, and if you think you are one, you simply don't know what mathematical competence means, you think it's the trivial rote nonsense you learn in school. Mathematical competence means being able to understand another person's proof by working though all the tedious little calculations in a reasonable time frame, and creating your own proofs and solutions from scratch. This stuff goes away immediately, and with time, permanently. This damage can be seen in the long-term productions of regular marijuana smokers, which consistently become increasingly insipid and brain-dead as the years go by.

What is bad about marijuana?

The worst thing about marijuana, even in incidental or miniscule secondhand exposures that do absolutely nothing to get you high, is the complete annihilation of nontrivial precision thinking. Any original idea you have in the back of your head is gone, wiped out, and the only ideas you can get are those you absorb from others, which are by definition derivative ideas. This means you are reduced to a pawn of the social order, and are basically a slave to popular opinion. You have no independence of thought left, because marijuana has erased the stuff on your mental chalkboard. If you don't smoke regularly, you will recover in a week or so, and fill in all the stuff that was missing, but if you smoke regularly, it is gone for good, and when you stop smoking, you have to start building up knowledge from zero, like a first grader. This is especially obvious in fields which require low-level cognitive invention on a regular basis, and the most obvious example is mathematics. To do simple mathematics, like read other people's proofs, or come up with new ones, you need to constantly do little calculations, which each are individually easy, but when stoned, they are slowed down to a crawl, stopping the process dead in its tracks. You become confused on the most elementary transformations, every algorithm you have internalized is defective, and you have to laboriously start from scratch. The effect also lasts forever in relation to other drugs, and even in relation to how long you feel high. It takes DAYS AND DAYS to remember what was automatic knowledge before you were exposed. This mean that you are essentially incapable of doing real mathematical work, no physics, no mathematical science, no serious original computer programming, no long-term composition work. You are reduced to one-liners and throwaway compositions. What you CAN do is derivative work, by taking something else that's out there and modifying it slightly. And this process, as useless as it usually is, is actually rewarded more by society than work that is entirely original. So, insidiously, as you are annihilating your ability to think, you might at the same time do better socially, you might even superficially impress more people in school (for a short while, at least, until the damage is obvious) and give people a superficially better impression of your general intelligence. You will become a social superstar with slowly deteriorating cognitive ability. Here's how you

can tell when you are doing original thinking: original thinking sounds like a rambling of a delusional crazy person. It's good original thinking when it is correct, it always sounds like horseshit, regardless of accuracy. It impresses absolutely nobody, you sound like an idiot. Here's how you can tell when you are doing derivative thinking; derivative thinking sounds smart and persuasive. It's familiar and comforting. It's rewarded by society, and when you say it, people tell you "how observant!" Marijuana erases all original thinking and replaces it with derivative thinking. This means it is a tool of conservatism, because it will erase any new ideas and replace it with old socially sanctioned ideas, because these are the only ideas floating around the culture. New ideas are only in your head, and nowhere else, otherwise they wouldn't be new. It is hard to explain these things, and they do not persuade anybody. The effect of marijuana on society is serious and terrible, it means that the general public, which is usually exposed to both firsthand and secondhand marijuana at some stage, is incapable of learning the most elementary mathematics, and people on the street can't prove e is irrational or do a simple contous integral, even though these things are described in detail on wikipedia. This was not a problem in societies which had no marijuana, you could see reasonable mathematical competence in the general public in societies with hardly any drugs to speak of, like the former Soviet Union, or modern China. One of the great shocks of my life was explaining a simple original proof of mine (a version of the geometrical Pythagorean theorem for Minkowski space) to a Chinese person with no special mathematical training, and having her understand it immediately, and suggest (correct) improvements! I asked her "how do you know this stuff?" She said "We learned geometry in school!" Americans also learn geometry in school. But this NEVER happens with people who go through the US system, even people in engineering are usually perplexed by an original idea. I strongly suspect the major cause is marijuana exposure, since the only reliable determinant of mathematical stupidity is extent of drug exposure. People learn the stuff fine in early grades, but forget it later. Mathematics could be a universal skill, except for marijuana getting in the way. A mathematically literate public is a much more potent tool

for social advancement than even a universally literate public was in the enlightenment. The effect of marijuana smoking on intellectuals (they aren't immune from social fads) was to create the most mind-boggling stupefying consensus thinking. In the 1970s, entire fields of research were driven underground by the stoner brigade, including logical positivism, artificial intelligence, string theory, even certain traditional mathematics things like forcing were made obscure. This was a part of the general conservative tendency in academia to inhibit original creative work, and marijuana was one of the most significant tools in this retrenchment. The exposure to marijuana is worse than nearly any other drug in terms of length of stupefaction, because it is fat soluble and not water soluble. This means it sits in your fat making you stupid for days on end, and there is no recourse, except to wait, and do mental exercizes, and think hard, and wait, and do exercizes again. It's awful. I don't know why anyone would take it on purpose, it's bad enough to get dosed accidentally once in a while.

Why don't more people smoke marijuana?

The reason people don't smoke marijuana is because of the immediate debilitating effect of being stoned--- it immediately wipes out your technical knowledge, at any dosage, even a threshhold dose too small to notice except in the effect it has in wiping out your knowledge. If you smoke the teeniest amount of marijuana, you will not be able to do anything technical or demanding, because your brain will not be able to do all the little automatic things that you have internalized to make mathematics easier. You will no longer be able to integrate a new differential equation (even the old solutions will be difficult to reconstruct). You will not be able to understand someone else's unfamiliar proof, let alone come up with one of your own. Your scientific knowledge will be more or less intact, but you won't be able to expand it. You will also have to rely on rote memory, whatever is

left of it, because you won't be able to fill in any gaps which come from natural forgetting. In addition to the natural forgetting, marijuana will impose an artificial forgetting which will get rid of any new knowledge you might have in your head that nobody else has. This is the most terrible effect, because this knowledge you often don't have written down, it's embryonic and half-baked, and the marijuana wipes it out, and there is no source to acquire it from, because it's all in your head. This means it is a poison for anyone doing research, and the worst sort of poison, the kind that can wreck a career permanently forever. All your research is flushed into the toilet, and you have to rely on doing second-rate immitation of sober people.

Is marijuana an anarchistic drug?

The only way to avoid becoming a conservative is to avoid marijuana. It is a drug that is so debilitating mentally, it will rob your ability to reason and think logically, and it will turn you into a mindless slave, incapable of the simplest intellectually demanding tasks. You will not be able to follow the simplest arguments about mathematics, even elementary calculus will be out of reach. So you will be ignorant about economics. You will not be able to evaluate successful projects with a significant anarchic component, like the free software movement, because you will be too stoned and forgetful to program a computer, or follow the associated social ideas. The loss of precision thinking means that you will be dependent on other people, in some social group, for all your ideas, and this abject dependence on a group is the opposite of individual liberty. Your independence of thought will be hijacked by your social peers, and they will dictate what you can think. Unavoidably, these peers society will eventually be hijacked by conservatives, so as to promote the existing social order, because conservatives have money and power. Conservatives can get stoned without any problems, because all their ideas are reinforced by society,

they don't need rebellious individual thinking. So marijuana is a drain you pour liberals into, and at it's sink is conservativism. It's the worst assault on progressive politics that has ever been devised, and there is hardly any recognition of this, because people who are on their way down are usually happy about it, they don't know the damage. I have not taken marijuana purposefully since I was in college, yet I am still exposed every once in a while, so I remeber the damage. It is severe and irreparable, and only a conservative can smile at the pickling of individual thought. For the best example of the carnage of marijuana, in the 1960s, there was a thriving anarchic free-press movement, that was bought out and expanded by capitalists using a free-press immitation--- Rolling Stone. Rolling Stone, unlike the free-press of the 1960s, was pro-capitalism, and promoted big-name marijuana-abusing bands, like "The Rolling Stones" or "The Beatles" over lesser known drug free acts like "King Crimson". The promotion of drug acts and capitalist hedonism led to rampant drug abuse which took over the free press movement, until it flipped entirely and became a conservative movement in the late 1970s. Among the marijuana users, you will find the Thatcherites and Reaganites. Their only success was in dismantling Soviet communism, with mixed results--- it certainly gave people more political and economic freedom, but at the cost of driving Russia into poverty and misery, and at the further cost of robbing the Russian people of their thriving mathematics and science. In the US, science and mathematics became underground activities. Marijuana users just couldn't do them. People who took drugs, like Steve Jobs, hire technical people who didn't, like Steve Wozniak, and exploited them to no end. The result was a reversal of social class structure, a counterrevolution which put drug abusers with miniscule benefits in social cognition and horrible defects in precision cognition as overlords in a technical society. The result of marijuana is that idiotic new-age style things are lodged in the brain, as you become confused and incompetent, and you don't know why. You look to anything that will make the brain-fuzz go away, and this is religion, magic beads, meditation, anything. The only antidote to this brain-fuzz is precise thinking, and this is only provided by mathematics and mathematical sciences. But to do mathematics in this society is

frowned upon, it diminishes your social standing. But the mathematics is the only path to anarchism that exists. The mathematicians are far more anarchic than any marijuana users, they have constructed their own subculture which is completely egalitarian, and respectful of individual freedom of thought. I would recommend that you learn from them, not from the potheads. The pothead intellectuals are Newt Gingrich and Rush Limbaugh.

Is it possible to overdose on marijuana?

It is impossible to OD on marijuana, this is what makes it horrible---the amounts people can consume are enormously larger, hundreds and hundreds of times larger, than the threshhold dose. This means that just walking past a stoner with a joint, you can get a psychoactive dose before you can react, even though the stoner is exposed to hundreds of times more substance than you. The effects on cognition are immediate, and horrible, at least if you use your brain. These effects are pretty much independent of dose, they just last a few days longer for higher dosages. You will lose the ability to think precisely, or to create actual original ideas. This is the first thing that happens, at a dose much smaller than the one that produces any buzz or high. Then the buzz comes, then the high, during which time all your original ideas are replaced by half-baked derivative crap that you think is original, because you forgot where it comes from, because you are stoned. These ridiculous derivative ideas are what marijuana users call creativity.

Should marijuana be legalized?

Marijuana can be legalized for possession and consumption in private areas, that's not my beef. It must never be legal to smoke where others can walk by, or otherwise unintentionally inhale the vapors. Marijuana is psychoactive in second-hand doses, and it damages people's ability to think and solve mathematical problems from just incidental exposure. The damage lasts for DAYS and DAYS, it's like a cloud of fog that never lifts, and it is depressing assault on one's personal integrity to be forced to be stupid for a week by some stranger. If you are accidentally exposed to secondhand smoke, you don't even get buzzed or high, the dose is way too small. But you do get confused at calculations, and it is a horrible, horrible assault on another human being. So pot smokers, please be considerate, and smoke in places where nobody else will inhale your vapors, at least not someone who doesn't want to get even the slightest bit stoned.

Should marijuana be legalized? Is it time for a factual debate since our country cowers at this question?

Posession of marijuana can be decriminalized, I really don't care, but smoking marijuana in public must never be made legal, because marijuana smoke wrecks bystanders' brains. The effects of secondhand marijuana are unbelievable, it's like no other drug. You can't get a cigarette buzz from secondhand smoke, but if you are next to a pothead with a strong joint, you will be affected. You won't get seriously stoned unless you are in a closed room with no ventilation, but the confusion and annihilation of thought will start long before any buzz or high. The effect is not negligible either. Marijuana completely annihilates all nontrivial thinking, it rewires your brain completely, unlike alchohol, and any chain of thought or nontrivial original idea in your head, building on other ideas or methods, is

wiped out, gone, as if it never existed, at least until the cannabinoid residues are gone. You have to wait for the confusion to go away, there is nothing you can do, and this is three days lost, sometimes a week lost, and then laboriously reconstruct what you were thinking about, and if it was too long ago, sometimes it is impossible. The potheads don't actually do anything, so it doesn't affect them at all. It makes them more social, and allows them to appreciate their dippy music and have stronger orgasms, or whatever. But for people who are doing thinking, it's a catastrophe to be exposed to marijuana smoke, it is the worst kind of assault, it's a form of torture. If you live where people smoke pot, like by a university, or in a major city, you will be exposed to this stuff on a weekly basis. Although you will only occasionally get a psychoactive dose, when it happens is completely out of your control. By the time you smell that something, it is usually too late, especially if someone is smoking really strong pot which hardly smells skunky at all. By the time you smell anything, you are already dosed, and that's three days of horrible confusion, and there's no buzz, no pleasure, nothing, a secondhand dose is too small. All you get is temporary confusion, and you will stay confused for days. How can anyone even think of making such a thing legal? The only resolution is to confine the marijuana smoking to indoor areas, or to special pot-clubs, and to forbid smoking the stuff except in special designated areas, clearly labelled, that the public can easily avoid. And this has to be ENFORCED with serious draconian punishment, otherwise people will smoke it everywhere, like they do cigarettes.

What are the effects of marijuana on the brain?

The major effect, something which you will not notice if you don't do mathematics on a regular basis, is the complete annihilation of mathematical thought. You will not be able to go through a delicately

balanced train of thoughts using your well-prepared internal algorithms, you will have to agonizingly check and recheck each step, as if you were a first-grader. You will lose any shortcuts and mental tricks you developed, and you will be back to square one for everything. You will no longer be able to do integrals, you will not be able to work through mathematical proofs, calculations which seemed straightforward will confuse the heck out of you, and generally you will become as dumb as a post. Any research problems you were thinking about, poof, they're gone. Any sophisticated composition you were putting together, it will have to wait until all the marijuana is out of your system, and then some, as you catch up with where you were before you were exposed. If you keep smoking marijuana for a period of a few months, or are exposed to secondhand smoke day after day, this change will be permanent, in that you will never do anything technical again from previous skills. If you want to then learn technical skills, you have to start all over, like a high school student. This is both from observations of what it did to me (although I never smoked it regularly) and to others, both with and without technical skills. Thankfully, after it's all gone from your system, you're back to normal, except you'll have to scratch your head to remember what you were thinking about before the dose.

What is the cure for marijuana hangovers; that dull groggy stupid feeling one can get the next day?

There is no cure for marijuana hangover--- the damage will stick with you until the THC byproducts are out of your system. The effects are miserable (I am feeling them now). You will not be able to concentrate, you will not be able to think. Everything will be slow. You will be stupid, and irritable, you will have a headache. You will forget what

you were doing just a day before. And it will last FOREVER. You will have this horrible icky slowness for 2 days if you're lucky, but more likely 4-5 days, as you slowly remove the stuff from your fat.

Why should Marijuana be legalized?

Edible marijuana, like pot brownies, should be legal because it is people's right to do stupid things to themselves, and the power of the state is too total, current law ruins people's lives for something essentially recoverable and not so terrible. But smoking marijuana must never even be decriminalized, because it has a horrible effect on bystanders. Just from being exposed incidentally to strong fresh marijuana smoke, even a single breath, can lead you to absorb enough marijuana fumes to have an effect on cognition. A single inhalation of the fumes from a strong joint smoked in a closed room, or a few inhalations of the fumes from an immensely strong joint outdoors, a few feet away, will cause a miniscule alteration 15 minutes later (minscule only in comparison to what the poor pothead is doing to himself or herself), which will prevent you from doing any serious thinking for about two days, wiping out any train of thought you might have had previously. This is a brutal assault on almost anyone who is using their brain. If you are doing research, if you are in the middle of writing (or even reading) a novel and you want to finish it with the ability to read and visualize images intact, if you are composing music, or programming a computer, even a tiny secondhand marijuana exposure of the sort I am describing will set you back a non-negligible amount, even though such doses do not give you a buzz or get you significantly high. The confusion starts long before the high, and it persists long after the high is gone.

What is technically meaning of force?

A force is a current of momentum, it's momentum flowing from body to body. When a body gives a certain number of "Galieos" of momentum (there is no name for the unit of momentum) per second, that's a force. Since momentum is conserved, the other body gives an equal number of Galileos per second back to the first. This is Newton's third law. The notion of force is exactly analogous to the notion of "current", except the conserved quantitiy is momentum, which is a vector, while current is for charge, which is a scalar. In the old fasioned (and incorrect in precise details) Kaluza Klein theory, charge is just another component of momentum, in the 5th dimension, and "force" and "current" are unified.

What is the downside of legalizing marijuana?

The downside is that stoners will smoke in public, and people who do not want to will be exposed to the smoke. Marijuana smoke is psychoactive in secondhand doses, it's the only drug which is so smooth in its effects that the residual tiny secondhand dose will affect you in any noticible way. The noticible way is impairing precise thought and problem solving, and generally causing you to become more mathematically stupid. This is a form of assault, and it is really the worst type of assault you can imagine--- a stranger taking away the nicest part of your life for a few days without even meaning to, and without any way for you to avoid it. This is the effect of secondhand marijuana. If you legalize marijuana, at least if you legalize public smoking, without setting aside areas like marijuana clubs, everyone in any major city will be constantly exposed to it, and everyone will be slightly stoned all the time. This is a nightmare to contemplate. Already in NYC, you get inadvertently infiniteimally stoned on a semi-

regular basis, even if you live your life actively avoiding marijuana and marijuana users, as I do. It is an intolerable situation for people who happen to be using their brain, and it will only get worse upon legalization. The legalization must include a way to ensure the marijuana stays in private areas, not where it can affect other people who really, really, can't stand to be even the slightest bit stoned. It is a terrible thing, it's like allowing strangers to randomly walk up to you and bludgeon you whenever they feel like it.

What are the strongest arguments for legalization/decriminalization of drugs in the United States?

Strongest argument against: Marijuana gets bystanders stoned against their will. That means it is an assault weapon, and it should be made illegal to smoke anywhere other people could be. That means it's best left ILLEGAL, so people smoke it indoors, away from ME and everyone else who respects their brain. This is the worst type of assualt which is condoned and tolerated in our society, the fact that we allow stoners to go around damaging other people's brains and lives. Aside from marijuana, no other drug has this secondhand effect, so I don't give a crap whether other people use them, or whether they are legal or illegal. But marijuana users who smoke in public should be jailed for assault. They are fucking other people up. In case you are wondering, today, I committed the crime of entering into a windowless bathroom where a pot-smoker had smoked a joint. My punishment? Three days of lost research. Why didn't she just knife me in the arm? This is not the first time this has happened, I am exposed to marijuana once a week, but usully outdoors in situations that don't have any secondhand effect. Getting stoned against my will only happened a handful times, but it's a handful of times too many. Marijuana

smoking in public must never, ever, ever be decriminalized, it should come with a prison sentence that reflects the level of the assault. But most of all, marijuana smokers: keep your garbage out of my air! Edible marijuana, I don't care about. It can't affect me.

What are the pros and cons of decriminalizing marijuana?

I don't give a crap if other people pickle their brain. The biggest con of decriminalization is the effect on me, personally, through the secondhand smoke. Unlike other drugs, like heroin, cocaine, crack, amphetamines, which could all be legal without affecting anyone except users, the active dose and lethal dose in marijuana is separated by at least 3 orders of magnitude. This means that even a secondhand dose from a seasoned smoker will get you noticibly affected. The dose that makes a sober person stupid is much smaller than 1% of the dose that makes a veteran smoker high. These properties make marijuana a dangerous ASSAULT WEAPON which stoners use to make others as stupid as them, by blowing smoke in their faces. Making it legal to smoke marijuana in public is like making it legal to carry a bludgeon, and smack random people in the back of the head. If marijuana is decriminalized, it must be only in ways that protect bystanders, because unlike potheads, some people are actually using their brain. The second-hand stoning is not a hypothetical thing, it happens to me approximately once a year in New York City, even with pot illegal. That's not how often one is exposed to marijuana on the streets of Manhattan, you smell the stuff once a week or once a month, but most of the time it's in ways that don't get you stoned--- it's either stale smoke or it's too far away, or whatever, nothing happens. But today, I walked into a windowless toilet in a bookstore, right after a stoner had smoked a joint. I got out of there pretty fast once I figured out what was going on, but it was too late, and I got a dose. I am not high, but I

can't think properly. To call it an assault is an understatement. I would rather she had knifed me in the arm! This is the third or fourth time this has happened in the 4 years I have lived in NYC. It is the worst criminal assault that happens in NY, and I mean worse than robbery at gunpoint. You can't avoid it, you don't even know about it, until you smell something funny an then, fifteen minutes later, feel your brain tighten, and you know you will be foggy for a day and a half at least. The result of decriminalizing marijuana will be that lots of people, including me, will constantly be infinitesimally stoned against their will, with no protection and no recourse. The situation is already intolerable. Being infinitesimally stoned makes you stupid, nowhere near as stupid as being stoned-stoned, but there is no low dosage limit at which marijuana stops removing intelligence from brains, so the effect of this is to remove any mathematical or technical ability from folks, and make them into slaves. I cannot describe the levels of anger this induces. If marijuana is being smoked all over, it will be impossible for a technical person to live in the US. My head is tingling, and I can't think properly, I know it will last for a day and a half, at least. I don't mind legalizing edible forms, but anyone who smokes marijuana where others can inhale should be summarily shot. I would rather make heroin and cocaine legal than marijuana, because this never happens with these drugs, even if you were to stand next to a heavy crack smoker in a closed drug-den and inhale deeply. It's only marijuana which is a natural assault weapon, so it is only marijuana that should be tightly controlled.

Does oil have a biological origin?

(Note: I made long comments on Ryan Carlyle answers which have since been deleted. These explained why the so called "kerogen" in his answer is rubbish (it is shale oil, a long-chain hydrocarbon deposit with no relation to actual kerogen which is nitrogen and oxygen rich),

why the "source rock" theory is busted (they do not have sensible migration paths, and a million other things. he has deleted these comments, and blocked further comments from me. Interpret that as you will) There is consensus in the west, but it is a stupid one. The weight of the evidence is overwhelming, and it points to deep Earth origins for all hydrocarbons, especially oil. The weight of the evidence points to rock turning to coal under progressive dehydrogenation of the short-chain (light) oil coming from below. The refilling of oil fields shows that light oil is coming from below. And most damingly, the oil is associated with heavy metal deposits and helium. Helium has only deep Earth origin, where it is formed by alpha decay. It is not made in the crust, and it has nothing to do with life. The helium by itself is conclusive, not persuasive, conclusive, and this association is what made Thomas Gold persist in his ideas, despite heckling. To make a long story short--- there are oil fields in Vietnam, all over the former Soviet Union, and in many places elsewhere that I don't specifically remember, that are drilled in porous bedrock, they are not near any significant sedimentary deposits, and they have no connection to fossils. In the biogenic theory, any oil at these spots must be made elsewhere and migrate in ridiculous ways to get to the actual field. Thomas Gold chose a meteor crated in Sweden to drill for oil, specifically because this area has no sedimentary deposits to speak of, so there is no way for oil to get down there. He found oil on three separate drills (although not commercial quantities). The point of drilling there was to test the abiogenic hypothesis, he chose the spot because oil couldn't possibly migrate there from any biogenic source. His oil was found in bedrock, and it was contaminated with gunky residue which Gold identified as bacteria poop. He was able to culture two strains of thermophile bacteria which were previously unknown from the goop. Skeptics said he must have contaminated his dig with drilling oil, so he drilled with water. During the water drill, he found 80 barrels of oii! Still, people insist it must be contamination from the drill, although no oil was introduced into the borehole, and the stuff coming out has no relation to the stuff coming in. This is pathological skepticism. There is no real evidence for oil forming from any kind of biological deposit. Biological materials have never been turned into oil,

it is thermodynamically impossible except at ridiculous depth. So the theory is that first kerogen forms, then it gets buried, then it breaks down, then it floats up. This happens on the seabed. In this theory, coal forms from buried forests, and has nothing to do with oil. But the Soviets and everyone else drilling for oil were aware of Kudryavtsev rule--- hydrocarbon rich regions are hydrocarbon rich at many levels--- they have oil and coal both, and the concentration of hydrocarbons is light oil at the bottom, heavy oil on top, and coal above both. The association between coal and oil is completely mysterious in the biogenic view. The fossils in coal demonstrate conclusively that the rock turned to carbon, with fossils intact, due to an influx of fluid. It is imbecilic to assume that a whole forest turned to a homegenous black substance, preserving leaves and tree trunks. Further, the fossils can cross coal seams top to bottom. The coal seams also sometimes run perpendicular to geological strata. Yet scientists in oil companies persist in dating their coal using the geological strata it is found in, and using the fossils inside. This is deranged, so much so that I cannot believe they do not know it is deranged, and so it is also dishonest. There are heavy metals in coal, and near oil deposits, and these heavy metals make coal radioactive. There is no way that biological material can concentrate radiological elements, although a fluid forming from the mantle will do so, because there are lots of heavy radioactive elements down below. Heavy metal deposits in the crust are statistically found next to coal seams, and the association is sufficiently strong that it supports the idea that crustal heavy elements were brought up by upwelling oil. The biogenic theory has a two points in its favor. The first is that oil is contaminated with biological residues. This fact is explained by Gold: there are bacteria living at great depth. Now these bacteria have been found. The other point is elemental composition: the C12-C13 ratio is different from the elemental composition in other places. Gold also explains this phenomenon by the phenomenon of isotopic seperation during diffusion through small pores. This was used as an isotope separation method during the Manhatten project (and incidentally, the calculations for the isotope separation were the only contribution of Einstein's to the project). The isotopic separation only shows that the methane migrates a long way

in the crust. The evidence that oil is abiogenic has been conclusive in the Soviet Union for several generations of geologists. It was debated heavily in the 1950s, a scrutiny which the biogenic theory never had to endure. Well now it's the biogenic theory's turn. I'm busting it. It's busted. No going back, the Earth is not flat, the Earth does go around the sun, and oil is not made from squashed fish.

Is the "new" (Page on Arxiv) evidence for a cosmic origin of life on Earth convincing?

No, it is not convincing, because the genomes don't follow a straight line in complexity, nor are the last points correct--- the genome complexity is not meaured by "functional non-redundant genome", it is probably best measured by compressing the genome using bzip2. The dating of prokaryote divergence is busted, because we have no idea what the genomes 3bn years ago look like. This is comparing modern genome complexity. Further, there is no good model for how a self-replicating molecule can evolve to do anything other than become the most efficient self-replicator, let alone get longer, so the idea that genome complexity is linear in time is unsupported and ridiculous. The origin of life on Earth is described in an answer of mine here: Ron Maimon's answer to How did life on Earth begin? . It has nothing to do with self replicating molecules, it is a network of proteins in conjunction with petroleum energy resource.

Why do people dislike The Beatles (band)?

Why dislike the Beatles? Beginning with revolver, the LSD album, Sgt. Pepper, the marijuana album, the White album, including heroin references, and the solo careers of the members, which, with the exception of George Harrison, advertised cocaine, substance abuse threads the work, tainting it with the stench of thousands of corpses and millions of ruined lives. The biggest drug advocate among the four was shot down in confused rage by a drug casualty. While the fellow didn't have enough of a brain left to explain why he did what he did, from interviews, it seems that his main motivation was that he felt that it was morally bankrupt for a fellow to get rich advocating drug abuse, when others who annihilated their mind following his lead suffered ghastlier consequences. Of course I don't condone what he did, but I think I know why it happened, and what chain of chemical alterations in the brain preceded it. Let's be honest: the reason the Beatles were so enormous is that they had the best ideas in the advertising branch of a major booming industry which could not pay for advertising via usual channels. They weren't alone, other bands of the era served to advertise the clandestine industry, and the mechanism was a socially mediated collective deal--- where the drug culture and drug promoters would select a drug-promoting band for insane fame, and the drug promoting band would include easter eggs for drug abusers, little gimmicks that stand out by synesthesia when one's brain is altered. This made listening to music a strangely communal experience with other drug users, it wasn't the individual pleasure like listening to Beethoven's sixth symphony. It was a collective wink that showed you were in on the drug-altered synesthetic experience. You can hear these easter eggs all over albums of the era, and some bands today include such easter eggs still. The social feedback with drug-users was explicit, and the Beatles mastered it. They weren't the first to include these easter eggs, the Beach Boys were first, but the Beatles did it more thoroughly. Sgt Pepper is essentially one long stoner head movie, with a strangely short attention span. The goal was to spread a cheap idea of hedonism leading to a fulfilling life, the capitalist dream, which was able to seduce people away from the hard work of building and maintaining a progressive society. The result was a rejection of all the principles of the postwar

left, with the only real benefit of the whole thing getting rid of Russian and Eastern European communism. The Beatles helped there, the western music and rock-and-roll idea was a force in toppling the Soviet empire. The Beatles are also a commercial for capitalism, because they were very successful and yet innovative too. They showed how capitalism can produce innovation, despite what the dialectical materialists were saying. There was no way to deny that Soviet Russia was never going to produce anything like the White Album, partly because they had no LSD or Heroin. Now the Russians have everything and they have even invented worse. I can't say anything about substance abuse in Russia today, there are no words, it is a horror which can only compare to the Vietnam war. I must admit that the Beatle's song compositions are extremely good, even when damaged by drugs, driven as they were by the songwriting competition between the four members. The songs become more and more sophisticated until the drugs abuse took it's inevitable toll on the brain, but this only became obvious after 1970. George Harrison was least affected, since he gave up hard drugs in 1967, when he visited Haight Ashbury and saw what was going on. Other bands with less of a substance abuse issue, or who were younger, took over where the Beatles left off musically, when they lobotomized themselves. Many of those folks also abused drugs, so they lobotomized themselves in turn, and were replaced by another generation, and another, in a heart-wrenching cycle of slow televised suicide. When I was growing up, you would wake up and turn on the television and hear some immensely talented songwriters' brain cells popping. No matter how much money they made, I pity them, they live through anguish that a healthy mind cannot even conceive. There were exceptions: Robert Fripp avoided drugs altogether, and was able to push the sophistication of the music to the point (Lizard, Lark's Tongue in Aspic, Red, and many others) where it matched or surpassed the best avant-garde composers of the 1960s, and he is still active and producing challenging music of ever higher sophistication. Bill Bruford (a creative force on Lark's and Red) also avoided the drugs, and continued a marvelous creative career which is an endless delight--- the last thing he did, Earthworks, might also be the best. Others got off drugs early, and were able to

salvage some of their creative ability. But most of the folks were chasing the dragon. When they weren't chasing the dragon, they were chasing the money. So when capitalism rejected avante-garde (as happened when the audience lobotomized itself enough that it could no longer enjoy it), chasing the market meant making increasingly simple music. Some people were able to make artistic creations anyway within the new draconian commercial constraints, these were the punks, but most didn't manage, and instead went to a commercial place with no artistic merit and stayed there. So now we have a music industry which does not have any music, at least not in those genres where the drug cancer spread. There is thankfully hip-hop, which is more talk than action regarding drugs (and everything else), and the painful necessary process of rediscovery of all the drug stuff by drug-free folks, so you have a new generation of drug-free psychedelic music now. You can't easily separate the horror from the art. Even the masterpieces, like "You Know The Name, Look Up the Number", or "The Long and Winding Road" have impending destruction written all over them. The internet allows the discovery of brain non-toxic forms of mental exploration, and hopefully makes the drug taking obsolete. I still like the Beatles, though. Despite the tragedy hanging over the music. But today, I find that I only enjoy listening to Red, Larks, LIzard, and other drug free compositions.

Does the belief in gods diminish humans capacity to discover the complexities of life?

Religion doesn't make the world less complex, it is a statement about how to form a community from shared beliefs and shared traditions, and shared ethics. There is no threat to scientific understanding of complexity if the stories are not taken literally, and are used to guide ethics, and not to guide research.

What is your three word philosophy?

Philosophy is bunk.

When you ask someone what happened before the big bang, they say there was no time before that. What does that even mean?

You can believe it or not believe it at will, because the statement is meaningless. If time "was" or "was not" before the big bang only changes the "ontology", meaning the philosophical things you admit into your description. It doesn't change the observations we can make, at least not according to present theories. So you could say time "was" or "was not" at whim, because ontology is just a framework, it's something you use to make blah-blah words to communicate the ideas. The ideas themselves are about what you can observe. What we can observe is that the universe began from an inflating small deSitter like space, and this space had a ridiculously small entropy, most likely because it's horizon area was so small, and it was in thermal equilibrium for this horizon area, which is not a lot of entropy in the single patch. Then the deSitter space turned into a standard hot-big-bang, with low entropy initial conditions. Because the initial state is so low entropy, it doesn't give much information about anything "before", so it is very difficult to make sense of the idea that you can make measurements that reveal what came before. So a shorthand for this is that there was no time before the big bang. It is possible that future theories will give a way to make sense of time in a way that

crosses the big bang, and gives some sort of testable imprint on our universe, so that they aren't just an ontology. But don't hold your breath. When talking about theories, you always should use "Carnap's razor" and identify any two theories that make identical observable predictions as equivalent in every sense, so that you don't get hung up on ontology, or blah-blah philosophy nonsense. Philosophers used to accept this principle, but they don't anymore, damning their field to irrelevance.

A scalar field with a non-zero expectation value could explain Dark Energy - could it also explain Lepton number violation?

This is not necessary, as lepton number is an accidental global symmetry, meaning it has no gauge field associated to it, and it is not conserved for fundamental reasons: you can throw leptons into a black hole and get baryons and photons out. This means that lepton number is only approximately conserved fundamentally, and the only reason it is so well conserved at low energies is because the renormalizable low-energy approximation conserves it. The violation of Lepton number due to Neutrino masses can be explained simply from the next-order non-renormalizable correction to the standard model. Two lepton doublets (the left-handed-electron/neutrino joint field), together with two Higgs bosons, make a dimension 5 term which gives neutrinos a mass when the Higgs gets its vaccum value. This dimension 5 term is the neutrino mass term in the modification of the standard model which gives neutrinos a mass, and because it is not renormalizable, it is suppressed by the scale of new physics. So the mass scale of the neutrinos is the Higgs scale squared (from the H^2 term) divided by the scale of the high-energy place where the theory breaks down, so it's the Higgs scale (about 1TeV) times the ratio of the

Higgs scale to the GUT scale, or (1TeV/10^16GeV) which gives 1 TeV times 10^{-13} or .1 eV, which matches the observed neutrino masses in order of magnitude. The precise match in order of magnitude suggests extremely strongly that this is what is going on, so the neutrinos get their mass from the same Higgs mechanism as everything else, except that the relevant mass is dimension 5, and so involves two Higgs bosons. This mechanism occurs in an explicit model, the see-saw model of Gell-Mann and collaborators in the 1970s. In this model, the dimension 5 neutrino mass comes from integrating out a right handed neutrino, but you don't need a right handed neutrino, or even a high energy renormalizable GUT, a generic modification at 10^16 GeV will always produce the level of neutrino masses we see from the ordinary Higgs mechanism.

What will happen if String Theory is experimentally proven?

If string theory is proven by relatively good evidence, and we find our vacuum, and we demonstrate the quantum mechanics is exact by building a quantum computer and having it factor a 10,000 or 100,000 digit number, we have reasonable certainty that we are finished with fundamental physics, that we know all that there is to know about the laws of nature at the fundamental level. David Gross said it best, in 1985, after he and collaborators discovered the first realistic string theory: "Let's finish this thing and go home". He meant, let's find the proper vacuum configuration, check it matches standard model data, deduce the consequences for dark-matter/inflation, and then retire from fundamental physics because the project is finished. His program was fine, but he was a little optimistic about the pace of progress. A proper non-perturbative description of heterotic strings wasn't even constructed until 1996, when Horava and Witten figured out how it embeds in M-theory. Knowing the fundamental laws of nature doesn't

help at all with any other question, the other questions are about the properties of computations, not about the properties of the fundamental laws. It's precisely because the fundamental laws are not complex, they are not full computers in isolation (they are analogous to the instruction set, not to the behavior at arbitrarily long time), that we can discover them once and for all, and be done, and go home, as Gross puts it. The reason I mention quantum mechanics, is because it is possible that quantum mechanics fails, as 't Hooft sometimes suggests, and that the amount of computation our universe can do is not exponentially larger than classical. This is a reasonable principle, it might be true, it might be false, we have to check it. But if it is false, if quantum mechanics is accurate at the level of computers, it is reasonable to conclude it is exact.

Are systems of aesthetics, ethics, values and moral law Turing-computable?

Everything is Turing computable, as we understand it, because computers can simulate molecular and atomic systems with high fidelity, and reproduce their behavior to arbitrary time, including enough atoms to make a person (in principle-- the simulation becomes difficult for larger systems). For a good-enough classical approximation, the simulation isn't even hopelessly large, because you can model things in thermal equilibrium, like water, as thermal jitter on the stuff that isn't in thermal equilibrium, like bio-molecules. Further, not all the bio-molecule is doing computation, and you can simulate most of the effects using stochastic binding, unbinding, and diffusion-reaction, with a system size that is not much larger than the number of binding configurations. The main bottleneck information-wise is the number of conformations and bindings of biomolecules, not the space positions or the thermal stuff. This type of simulation is not impossible to actually do, it requires gigabytes for a cell, many

Terabytes for small multi-cellular animals, and 10^21 bytes for a human. These are not impossible computational sizes, although they are still many orders of magnitude bigger than current supercomputers. So not only can a computer do these things in principle, unless we are missing a law of nature, it can do it in practice, with achievable machines, although we are extremely far away right now, being about at the level of single-celled organisms. This is why Penrose, who denies computation is a good model of thought, is required to postulate new physics relevant to the brain. He is aware of the fact that simulations exist, and he uses this to make a testable prediction--- that a hypercomputing quantum gravity is relevant to the physics of certain brain structures, in his model, microtubules. This idea wil be tested as we simulate neurons, and we will know if it is true, but I think it is safe to presume it will be false, because it has no support other than the intuition that computations are not rich enough to model internal experience, and this intuition is false on closer inspection, because computations are just as sublime as you expect for a good model of internal experience.

Are most standard theories used in modern science absolute? Should alternate approaches be considered if they fit the data?

If they fit the data exactly the same, meaning they make the same predictions, they are equivalent theories, despite anything you might superficially think. This is one of the principles of positivism--- any two theories with identical predictions are considered absolutely identical theories, even if they use superficially different terms for the same thing. So the theory that the universe began as-is 10 minutes ago and the theory that it has been around for longer are positivistically equivalent, and they are not different. This is the major reason the

public can't come up with scientific ideas which are worthwhile--- they obsess over meaningless distinctions between equivalent theories, rather than finding new theories which make new, different, predictions for observable effects.

If realisation of self is nothing but a result of neurological action,then have there been any reported cases of person having two selfs within samebody,or is it biologically possible?

split brain patients have disagreements between the left and right hemisphere, which separate enough to have different opinions after the operation (see here:) . This is the closest example we have. Since infant brains are much more malleable and amenable to taking up functions of the lost hemisphere, if you were to split the brain at birth into two hemispheres, you are almost certain to develop two individuals in the same body, controlling the opposing halves. Needless to say, this experiment is unethical.

Common Misconceptions: What are some things nearly everyone believes that actually aren't true?

That petroleum and coal are formed from biology. This was conclusively established to be incorrect in the 1950s(!) in the Soviet Union, and yet, nobody in the west can say this, because oil-scientists

in the pocket of oil companies want to pretend that it is a scarce resource. It's not scarce, so we will probably cook ourselves in our own emissions. The evidence against this is listed in Thomas Gold's book "The Deep Hot Biosphere", and I have repeated it several times. The main points are that long chain hydrocarbons form from primordial methane in the mantle, under high pressure conditions, there are fluid gaps all the way down to the mantle, although methane is past it's critical point. The He content of petroleum is enormous, and points to deep Earth origin, because He is formed from alpha decay of heavy radioactive elements, and the petroleum has a large heavy metal content, and is deposited next to heavy metals. Coal is not formed from peat, peat is formed when vegetable matter is exposed to abiogenic methane. Coal is formed from dehydrogenation of long-chain hydrocarbons upwelling from the mantle. The fossils in coal were in the rock originally before it turned carbonacious, they have nothing to do with the formation of coal. The biomarkers in oil are due to bacteria living deep in the Earth's crust, the deep hot biosphere.

Why do people think the Earth orbits the Sun? Can geocentricity be disproved?

Every year, the stars in the sky do a little circle, due to the aberration caused by the change in momentum of the incoming light due to the directional motion of the Earth. This stellar aberration conclusively establishes the thing. There is also the stellar parallax, much harder to detect, that not only gives the motion of the Earth, but the distance to the stars. There are other effects measurable in principle, but they are negligible, like the coriolis forces due to the Earth's orbit.

Is there anything that says we aren't headed towards finding an infinite number of fundamental particles?

We are finding a finite number of fundamental particles, in the modern sense, of fundamental fields, there are only 3 generations, as we know from explicit counting of light neutrinos. There are two ways to count neutrinos--- cosmology and Z-decay. From Z-decay, we know the number of generations is exactly 3, from cosmology, it's 3.4 +/- .6, or something like that, so it's still exactly 3, maybe 4, but certainly not 17. There are not an infinite chain of quarks and gluons, at least not at accessible energies. The bound on the number of fundamental particles comes from string theory, where you can't have too many light fields in a high-energy compactification. There is a heuristic relation between the size of the compactification and the number of light fields, and for realistic string models, it's no more than a few hundred fundamental particles, meaning a few hundred fundamentally zero mass objects. The number of generations is the Euler characteristic of the compactification, and it can't be too big without the compactification getting very baroque and then having volume stabilized much larger, and then getting the unification scale wrong. This is to be contrasted with the number of S-matrix particles, the number of bound states, which is infinite. I am not counting the practically infinite number of hadron resonances, because these are unstable, and they smoothly wash out into a continuum at a hundred GeV. Unstable particles are neither a fundamental field or a fundamental S-matrix state. They are sort of nothing. But there are all the stable nuclei, and all the stable atoms, and all the stable molecules, and the stable molecular clusters at zero temperature, each is a particle state. These are only limited in size by the cosmological horizon. So there are a practically infinite number of bound states, but they are big and floppy, and they cause no distress. I am lying a little, because the proton is known to be unstable over cosmological time, so that all these cold states are really decaying, and the only real

completely stable particles in the universe are the electron/positron (the lightest charged particle), the lightest neutrino (the lightest uncharged fermion) the lightest magnetic monopole (if there are dyons, those too), the graviton, the photon, and probably the lightest dark-matter particle. If you are thinking of S-matrix--- everything described by asymptotic collisions--- these are the only asymptotic particle-type states you need to put in to describe everything else (although this is a ridiculously "in principle" description considering how hard it is to make a proton by reversing proton decay). Similarly, in string theory, there are an infinite number of highly excited string states, but these are smoothly linked with classical black hole states, and these are also big and floppy (and unstable). So the highly excited black holes are no more mysterious in this regard than other unstable bound states. The chain of particle composition is over, quarks and leptons are elementary with high confidence. The reason one can say this is because they fit in a GUT naturally, and the GUT is naturally emerging from strings. Even if you ignore strings, the GUT tells you that any substructure for quarks or leptons is close to the quantum gravity scale, at which point asking about further structure is meaningless, because gravity makes resolving constituents impossible.

What is physics?

Physics is the act of matching a computer program output to a natural system, so that aspects of the physical system are matched by the computer program. Any predictive program works, but the fundamental physics is ambitious, in that it wishes to be able to match a computer program to any concievable situation, so that it can reproduce the results of the situation as best possible. In this sense, the program of physics is matching programs, mathematical objects, to real world objects, and there is always this dictionary that tells you what mathematical thing in the program matches to what physical

measurement. This dictionary can end up impossibly counterintuitive, as in the many-worlds interpretation of quantum mechanics. Ultimately, it is not about life, or consciousness, at least not in any way greater than the amount which is required to identify the computational elements with observations. You don't need such a good model of the stuff in the head. But the philosophy which emerges from physics, which is positivism, allows you to even make progress in non-physics questions, like consciousness and so on, by simply focusing on the measurable attributes, and identifying computer programs to match these, and you know you are done when the program predicts all the measurable stuff. When the program is simulating something Turing complete, it isn't called physics anymore, it's called biology. Physics is the stuff that is amenable to a simple description, so nothing that is computationaly complex.

Why has Benoit Mandelbrot never won the Fields Medal?

Aside from being too old, which is correct, this is the main reason, he was also an extreme outsider. The fields medal is cliquey, it goes to politically in mathematicians. Perelman was hostile to the cliques also, and had the internet not advertized his work broadly, he might have been denied in the same way. Mandelbrot was extremely hostile to the formal tradition in mathematics in the 1960s, the Bourbaki stuff. He didn't like to hide results in walls of jargon. He was studying practical systems, and his work was essentially founding the modern renormalization group approach. The scaling laws of the modern renormalization group are found in Mandelbrot's work, and he pioneered the essence of this idea, along with Kadanoff, Migdal, Fisher, and Wilson. He was the only mathematician in the bunch, precisely because he was not interested in formalism, but rather in mathematical phenomena from nature. His starting point was Levy's

processes, Levy was his advisor. Paul Levy was also underrecognized, since he made a wrong statement or two in some papers, and he was considered a statistician, and therefore a second-rate mathematician (this is how people thought in the 1960s, it's hard to remember today). The result is that one of the central discoveries of the 20th century, the generalized central limit theorem, was not widely appreciated until the late 1990s. Mandelbrot analyzed many multi-particle systems to extract scaling laws, before the physicists did so. His work became mainstream in the 1980s, in large part due to his continuing insistence. He is a great mathematician, and his countercultural spirit is an inspiration.

Creationism: Did life on Earth happen as a series of random events?

It is impossible for something so sophisticated to form "randomly", but it was self-directed, in the sense that the material events did not require supernatural intervention. We know that, because there are no supernatural events. The origin of life is explained in my answer to this question: How did life begin on Earth? The events in a Turing complete soup can in no way be said to be purely random, they stop being random after the first events. As the soup becomes more sophisticated through time evolution (which is Darwinian evolution), it becomes more intelligent in the precise computational sense. The result is teleological, the structures evolve toward greater complexity, and they stay teleological and directed as long as the computing soup stays computing.

What is the statistical likelihood that modern man (Homo sapiens) would evolve from a single celled life form to what we are today over the last 500M years (from the Cambrian Period)?

It would take forever, it wouldn't happen, because the evolution people talk about using DNA, point mutations and so on accumulating favorable mutations, cannot proceed past a certain point--- it gets to the limit of evolvability very quickly. You can see this in simple evolving replicators, like viruses. The reason evolution happens anyway is because it is not a simple process of point random mutation. There are networks of computing RNA in animals which computationally munch the DNA, and insert new ideas in, to try, in each successive generation. These noncoding RNA networks are also required for embryogenesis, and are observed in oocytes (John Mattick postulated these, and put together the evidence for their occurence). Once you have a good mutation mechanism, the RNA networks providing the mechanism, the too-long-a-time paradox of modern-synthesis evolution evaporates. Then you can form a human from Cambrian animals in the alotted time frame, because the mutations are sensible and authorly. The paradox has been noted by Wolfgang Pauli already in the 1950s, he opposed the modern synthesis for this reason. It is not a flaw in Darwin, but in 20th century folks who made a stupid unintelligent model of evolution, with no basis in evidence, and no plausibility, as a way of denying intelligence in nature, in effect, to deny God.

Could viruses have been created by extraterrestrials?

The origin of viruses is actually somewhat mysterious, because they are extremely limited in their evolvability. Viruses can only speciate through cross-species infection and wandering around a little bit in genome-space, and they are not evolvable enough to cross types, so an RNA virus can never become a dsRNA virus, or a ssDNA virus, or a retrovirus, or anything other than a slightly different RNA virus. This is in stark contrast to eukaryotes, where there is a smooth evolvability path linking an oak tree to a baboon (through a single celled common ancestor). This is the limit of evolution of self-replicating entities with errors. It is very different from entities which are truly alive. Since viruses cannot really evolve, if new ones can't be formed, you would think they should all be extinct. As soon as one type is gone for good, nothing can replace it. One can make two hypotheses here: * There are on their way to going extinct, but it's taking forever, so the viruses are remnants of early viruses which were around at the origin of life. * There are new viruses produced from scratch from something else. I prefer hypothesis b, because I can't imagine that dinosaurs got influenza, or hepatitis. There must be a source. The source then is in self-packaging genetic material which can leave and enter cell bodies, which has nothing to do with virus infections. Such entities do exist (surprisingly), the endo-retroviruses are an example. Endoretroviruses form a significant fraction of the human genome, and they produce a coat, a reverse transcriptase, and they can even become virulent under certain conditions, such as cancer. There is a Koala endoretrovirus event underway right now, as Koalas are all getting a retroviral insertion in their genome. The retroviral properties make it natural to assume that they are serving an important role in the body, perhaps to communicate RNA from one cell to another, so as to link the different computations in different nuclei, and perhaps incorporate into the DNA. They might also be used to transfer RNA between different individuals for all we know. This is speculative, but it is a very easily tested hypothesis--- look for endoretroviral particles in the

bloodstream of a healthy animal, and see if they insert themselves into genomes of distant cells. If the retroviruses are used for intercellular communication, this case, one can postulate that new retroviruses form when endo-retroviruses are accidently virulent and replicating. This is not hard to imagine, and it allows new types of viruses to emerge, with no relation to previous viruses. This claim, as far as I know, is original, it is not present in the virology literature I have read. It might be false, but at least it's original (no, actually, it's not--- I just didn't know the relevant literature--- see Adriana Heguy's answer on this page) The source of RNA viruses is more difficult to see. It is possible that these evolve in special places, perhaps in bird genomes. If the viruses come from the complex animals, each virus, one must find the originating animal, and it must have homologous packaging proteins. I should point out that if this is true, AIDS did not have to result from somebody screwing a chimp (or eating a chimp). The chimps could have independently generated the same infection from their own endoretroviruses. I don't know if this is viable, although I could test this by myself, just by comparing the sequence of SIV and HIV to see if they differ by more or less than the ERVs of humans and chimps. I didn't test yet, I am just asking.

Evolutionary theory is based on the fact that life previously originated on Earth and we all evolved from a universal common ancestor. Where did life itself originate?

Life emerges whenever a system with bulk computation is Turing complete. This is not a rare or strange event, as Wolfram shows--- many random cellular automata are automatically Turing complete, it simply requires that they have semi-stable structures that store data

stably, and interact predictably. In addition, you need bulk noise, to evade complexity bounds. The theory is described here: Ron Maimon's answer to How did life on Earth begin? and nowhere else (with the exception of other quora answers linking this one).

Is it possible that life originated from protein and not RNA?

It is not only likely, it is impossible that life originated from RNA, because RNA cannot in any way plausibly form under prebiotic conditions. Further, a replicator doesn't work for the origin of life, you need a Turing complete soup. This is provided by random proteins in conjunction with petroleum, and RNA doesn't do anything metabolically and is useless in this regard. You can read more about it here: Ron Maimon's answer to How did life on Earth begin? .

What would be the minimum set of elements, particles, cells and rules, which if programmed to run indefinately by itself, will show life like behaviour and evolve into higher life forms?

This is the same as the question of what is the minimal Turing complete automaton. I will ignore 1d, because the Turing behavior there is very degenerate, requiring a very long time to do any meaningful computation. So the simplest such system is Conway's Game of Life, seeded with infinite random pattern, and provided with

a randomness source, either the random pattern, or a small probability of a cell flipping color. The minimal requirements are * Turing complete behavior * randomness * Potentially infinite memory, and fast enough processor speed. * Efficient local storage of information. * Sufficiently fast bulk processing. If Conway's system doesn't work well, it would only be because it is 2d. There might be obstacles to efficient shuttling of information long distances in a bounded size 2d cellular automaton (although I doubt it). Then the answer would be any simple 3d cellular automaton, or a polymer automaton in 3d.

Has anyone used information theory to study the origin of life, and if so what were the findings?

Yes, there is such a formalism, unique up to some silly details, described in this paper of mine: [q-bio/0503028] Computational Theory of Biological Function I . It is a way of describing the interactions in a complex molecular system, from a computational point of view. The computational point of view is describing the information in the molecules, it's what you mean when you say "information theory", although the precise usage of the term in the literature is not quite what you are talking about. This research is the outgrowth of an origins-of-life hypothesis I described for the first time here: How did life begin on Earth? The main point for the origin of life is that all you need is a Turing complete molecular soup, and you're done. This solves the problem permanently and persuasively. The hypothesis is amenable to test by both simulation and experiment. The simulations simply simulate Turing complete automata, like Wolfram's, except in 3d, and with a bulk computing capacity (so potentially infinite strings at each cell with rewrite rules according to

nearest neighbor or power-law decaying inteactions, modeling proteins). As Wolfram noted, every such system is Turing complete, unless it is random or trivial. The experimental test is simply to make an amino acid and petroleum/water mix under conditions where polypeptides spontaneously form. The system should, under certain conditions of salinity and Ph, form a computing system, and the result will then start evolving immediately, as described in the linked answer. This idea is original, so there are no references, other than the ones I linked here.

Could life evolve in space?

As explained here: Ron Maimon's answer to How did life on Earth begin? the only thing required to form life is the formation of a Turing complete system spontaneously, with bulk computing and essentially infinite memory. In space, it is hard to form such a system, but one cannot rule it out without a good survey of all the phenomena that happen in space. In order to store memory, you would need stable structures. If you are using molecules, they would have to withstand the harsh cosmic rays for long enough to impress their structure on other molecules before they are destroyed. This is not likely in dilute space. It you are in a dense cloud, you can use ripples in density to store data, but the transformations are usually either chaotic or regular, you either get a mess or a solar system. The chaotic systems tend to fall apart, and in any case, the amount of memory and processing in such a system is incredibly tiny in relation to the memory and processing in a watery soup of proteins and hydrocarbons. Other places are planetary atmospheres in gas giants, which do admit stable structures, like the red-spot in Jupiter. Is Jupiter's atmosphere Turing complete? Possibly, but it's not likely. The Navier Stokes equations generate a downward cascade which has a stable equilibrium structure in fully developed turbulence. Perhaps you can store data in

molecules other than water and carbon-chains. This can be investigated experimentally, since one can easily determine when a collection of molecules make a Turing complete set, and determine the memory and processing from experiments. So far, only a protein, water, hydrocarbon soup can make a big enough computer, but it is an open question to catalogue all Turing complete chemical systems. Perhaps life can evolve on the surface of a neutron star. Such life would be interesting, because it's time-scale would be as much faster than ours than ours is faster than geological scales.

Since amino acids have been found in meteorites, could a collision with a meteorite be a possible origin of life on Earth?

It is implausible that pan-spermia is the origin of life, both because the pan-sperm would have to be made, and also because the quantity of delivered life on the external thing would not be large, and would have to be magically adapted to Earth environment. There is a perfectly natural and completely reasonable explanation for life on Earth, which I have described on other answers. This makes pan-spermia kind of silly.

Origin of Life: What is some evidence in favor of an RNA world?

There is no evidence for a real RNA world, at least not an RNA world which is not the product of a functioning protein world. There is no

evidence, because it doesn't work as an origins theory, it's a just so story based on the idea of a self-replicating molecule. The simplest self-replicator is RNA, so people assumed it must have occured spontaneously. It doesn't. RNA is hard to make, outside of protein aided catalysis. RNA has a sugar in its backbone, and sugar has oxygen and hydrogen arranged in a C-O-C-O pattern with energetic bonds, this is why it is a good cellular fuel. To make this bond-pattern, you need some magic, a chemical energy source that can extract oxygen from its stable form in CO_2, or from its elemental form in O_2, or from rocks. The mechanisms can be dreamed up without biology, we can synthesize nucleic acids, but any such mechanisms are baroque, they involve strange and implausible steps. Once you make the sugar part, you have to weld it to the rest of the RNA molecule, which is produced in a different kind of chemical environment, and this means one part is made in a reducing environment, another part in an acidic environment, another part in salt, and so on and so on, and then they come together, with sparks and lighting, and you have nucleic acids. You can make it (barely), but it is clearly going to appear in trace amounts if at all. Even after it appears, it can't spontaneously polymerize into a chain, and even if it does, no RNA can autocatalyze it's own replication. Even if it does autocalyze it's own replication, a self-replicating RNA just eats up all the nucleotides in making copies of itself, and fills up the whole prebiotic space with junky RNA copies that don't evolve any further. The story doesn't work at all levels. But people cling to it because they can't think of anything else. There is something else, and it does work, but it turns the picture of evolution on it's head, bringing it closer to intelligent design (except without any supernatural intervention). Unlike RNA, protein is produced spontaneously in many environments, since it is formed from NH_3 (ammonia), CO_2 (carbon-dioxide), CH_4, and H_2O (water) under many natural circumstances. With petroleum around (petroleum is around on the ancient Earth, it is formed without any biology), you can easily form peptides that catalyze the formation of other peptides, without any replication. This system is easily and plausibly Turing complete in the sense of Von Neumann, Conway, and Wolfram--- it makes transformation of the information in the

polypeptides which are sufficiently complex to form a universal computer. When you have a computer, the system begins to evolve spontaneously, in the sense of Darwin, even before there is any precise replication. The evolution is of the patterns which are stable in the presence of the other proteins in the soup. Small peptides are digested or linked up with other peptides in a way that depends on sequence, and the resulting branched poly-peptides discriminate between different small peptides, and in an environment condusive to making peptide bonds, they will channel the new peptides to certain forms and away from others. The class of allowed forms becomes narrower and narrower with time, as the peptides act on each other, and this is automatic in any "class 4" Wolfram automaton, it is just the natural time-evolution in the system. The Darwinian evolution has competition, since the subpart of the full automaton which can impose it's order on the rest is the more successful one. The most successful molecular automaton will eventually learn to form RNA, as an aside, to make chains of it, and use those chains to make lots and lots of peptides of the form it wants. It will also learn to replicate RNA, and eventually make DNA, and store the RNA into DNA. All this from molecular evolution which precedes any replicating molecule. The picture that Turing completeness is the main ingredient in evolution, and the sort of self-non-self immunological suppression of molecules over others. This type of evolution makes a Turing complete system, a large computer, an intelligence, out of the molecules, and it is only this type of thing which admits Darwinian evolution. If you think that this sounds different from what is happening today in life, it is only because what is happening today is not what is described in biology textbooks. The evolution long ago shifted to act on RNA and DNA sequences in raw form rather than proteins, and sequence evolution is achieved by an authorly act of rewriting in large RNA networks in egg-cells in and in sperm producing cells. This is a prediction, since it is not yet observed how mutations get written into germ-line cells, but it is a safe prediction because current models of replicative evolution with random point mutations are sure not to work, since they get stuck in quick minimum-finding ruts, for instance, viruses are evolving this way, and they are all dead ends.

Nuclear Physics: Can atom-like nuclei without protons actually exist?

The reason nuclei with only neutrons are unstable is beta decay--- the neutron will turn into a proton. The proton doesn't have exclusion with the other neutrons in the cluster and has much lower energy, on the order of MeV's less than the neutron. This means the gap in energy between the proton state and the neutron state is about doubled as compared to a free neutron. The only reason the neutron is long lived is because the difference between proton and neutron mass is not much more than the electron mass, so there is very little phase space for the decay. In neutron clusters, the phase space is made much bigger, and the decay is quicker than 15 minutes. The same thing happens with neutron rich nuclei, they beta decay relatively quickly, because there is a large phase space for the decay. As Marc Eichenlaub has pointed out, neutron stars are the first stable neutron objects, but these are enormous and gravitationally bound. There were speculations that large enough neutral strange-matter configurations could have lower energy than nuclei, but it seems not to be so, since it would lead to a doomsday scenario, where a strangelet gobbles up a planet or a neutron star, collapsing it to a black hole eventually.

Is evolution still a theory?

There are several parts of the theory of evolution, and one must distinguish them because they have different degrees of support: 1. Creatures are descended from ancient common ancestors, so that people once looked more like monkeys, and previously like rats, and

earlier like yeast, and earlier less differentiated still. This is not a theory, but a fact. The reason it is a fact is because it makes enormous numbers of highly nontrivial predictions regarding life today. It predicts that living things form a tree, that the DNA sequences should show homology in the same way as that tree constructed from morphology, that fossils show convergence of genuses into one common ancestor, that the geological record and the fossil record conform to the DNA record, and all of these highly nontrivial tests are aced by the theory, with no real contradiction. It is impossible to sanely dispute this given the evidence, and neither the Pope, nor Behe, the father of intelligent design, dispute this. This is only disputed in certain political environments where scientific truth is put on the back burner. 2. The mechanism of evolution is a form of natural selection, meaning some living things pass on their forms preferentially, while others die out. This idea is less strongly supported than the first, but it is nearly certain too. The reason is that the selection pressure is observed in nature, we see that some animals pass on genes and others don't, and we can measure the degree of selection. We also have put animals under selection pressure of various strengths using artificial breeding, and the level of variation we have produced using artificial breeding, is comparable to the morphology change in the fossil record, and the natural changes proceed at roughly the rate one would expect from extrapolating the artificial selection to the levels of selection pressure we observe in nature. This means that natural selection fits the changes well, and one can be reasonably certain this is the major mechanism. This is as far as one has to accept the doctrine of evolution from empirical evidence. 3. The mechanism is by competition as to which animal lives longest. This is completely uncertain. The mechanism in animals might be predominantly sexual selection, as we can see that humans are still evolving relatively quickly, and the only mechanism in humans is sexual selection. But sexual selection in humans is very strong, selecting for height, big head, big penis, and wider hips (all are related for obvious physiological reasons), and more abstractly, for more efficient intelligence, social maneuvering, stuff like that. 4. The mechanism is through spot mutations of a DNA sequence which is replicated with mistakes. The mistakes are random

and caused by cosmic rays, or some other environmental noise. The genes reassort and evolve independently and selfishly. Although viruses work this way, for the most part, for actual living things, I think it is safe to say today that this is complete nonsense. The more we learn about mutation mechanisms, the more it is clear that they are not random and they are under the control of the gametes. Random error is not a way to evolve complex code, as there is a bottleneck in evolving algorithms if the algorithm mutation method doesn't co-increase in complexity along with the algorithms themselves. Selfish gene theory predicts that genes are going to be the major evolving things, the protein coding sequences, and this is not born out by sequencing data. The majority of evolution seems to be in noncoding regions of DNA, that are purely regulatory. Humans have essentially the same genes as nematodes, with some duplications, but vastly more noncoding regulatory DNA. So I think you don't have to accept selfish gene. In fact, you probably have to accept the exact opposite, although perhaps not certainly yet. 5. The evolution has no purpose or goal, and has nothing to do with religious doctrines. This is not a scientific question so much, but a philosophical one. When you look at natural systems, some of them, like yourself or your cat, have a purpose and a goal, and others, like a rock or a hurricane, don't. Since all biological systems are Turing complete and have a large store of memory and fast processing speeds, they are more like a brain than a rock, they have the computational spark. The collective phenomena in evolution produce a larger computation in the collective, so a larger intelligence, and there is no reason to think that this enormous natural computation doesn't have a goal. It is also possible to say it doesn't. But this is not a scientific question, so it isn't served well by the pontifications of scientists, most of whom have a sociological agenda when pontificating. 6. The doctrines of evolution should be emulated by society, to make a system which allows people to suffer and be weeded out mercilessly through unregulated exploitation through the result of competition. This is not a scientific question either, but this is the main issue religions have with evolution--- it looks like a self-serving way for people to reimpose the Darwinian society of the Roman empire on the modern world. The Christian religion worked

hard to topple this order, and this gain must not be reversed. Whether or not nature works by cutthroat competition with no mercy, and I don't think it does, it has no bearing on how compassionate humans should be to one another. There is no reason to immitate nature if nature is abhorrently cruel.

What are the chemical origins of life? How did non-living chemical compounds generate self-replicating, complex life forms?

The origin of life is from random proteins (amino-acid polymers, including branched polymers) near random hydrocarbons (petroleum). The hydrocarbons are common in the early Earth, they are still around today, we call them "petroleum". These things are called "fossil fuels" by moronic petroleum scientists in the pockets of oil companies, but it has long been understood that they have nothing to do with life, that they are ubiquitous in the solar system, and that they form under abiotic conditions. This was discovered in the Soviet Union, under the influence of Dmitry Mendeleev, and it was also patiently explained and promoted in the west by Thomas Gold, but it is not appreciated by the public or by scientists, despite the evidence being overwhelming. Their stupidity is not my responsibility. Simiarly, amino acids are ubiquitous in the universe, since they are naturally made by CO2, H20, and NH3. These are the most common small molecules on early Earth's atmosphere, as they are on Jupiter, and they produce amino acids in great quantities, and the hydrocarbons are always there. We are sure hydrocarbons and amino acids both form, and both mix, in proto-oceans of hydrocarbon and water. The life begins when proteins form under ocean conditions that favor peptide bonds between amino-acids to form spontaneously. Then you get a collection of proteins. The important thing is that this collection

is Turing complete, in the sense of Wolfram's automata: they produce any computation if you fiddle with them. They also have abundant and growing food (petrolium), so they can learn to extract energy from hydrocarbons. Once you have a Turing complete collection with a food source, this is sufficient to produce Darwinian evolution, and from this point, the system will engineer stronger and stronger mechanisms to store information spontaneously and retrieve it, producing an RNA-like molecule for denser information storage (it doesn't have to be RNA), a DNA-like molecule for permanent storage, and then producing ribosomes, and cells. The evolution starts at the moment you have a "class 4" Wolfram automaton. This process of Darwinian competition and high-level replication of properties begins long before there is any kind of exact replication of low-level molecules, it occurs much as in immunology, by weeding out thins that are incompatible with the environment. In fact, this is the correct definition of Darwinian evolution. Replication with modification is a bastardization which is appropriate only for systems which are barely alive like viruses, or for the parts of living things that are no longer being innovated on a regular basis, like proteins in the bodies of mammals. The idea is explained in more detail in my answer here: How did life begin on Earth? . The point of view invokes Turing computation, which in the common-sense computational view is the definition of intelligence, and the action of this collective intelligence to engineer the information molecules of life by trial and error and collective evolution of thought, meaning computation, in the soup, so it is a form of intelligent design. Except the intelligent designer is the molecular soup. This idea is kind of obvious since Wolfram noticed that automata are easily Turing complete, so it always amazes me that I was the first to think it up. Right now, Chaitin is going around South America making similar claims for origin of life from Wolfram, but this is an old idea, due exclusively to me (although I am surprised I was the first, it's completely obvious) and I put it on stackexchange before he wrote anything at all about this. It is also easy to test this idea in computer experiments, by simulating a Turing complete system of an enormous size, and watching it evolve. The predictions are that

you will produce Darwinian competition immediately, with absolutely no obvious replication.

If carbon, an abiotic thing, was the basis of life on earth, what's the fundamental difference between a biotic being and an abiotic thing? How did the first genes come into existence? How did they form?

A living system is Turing complete and embedded in a larger Turing complete system with an essentially infinite memory. The main difference is the difference between a computing cellular automaton and a non-computing one, except here the information is stored in the molecular bindings and configurations. The idea is not in the literature, but I described it here: How did life begin on Earth? . It's self-evident and it solves the problem, as it is both true that Turing complete systems evolve in the Darwinian sense, that other systems called "Darwinian" are not Darwinian, since they are not computing (for example, self-replicating molecules), and these systems are absolutely incapable of generating life. The resolution also clarifies what to look for regarding evolution in modern life, and I think every other answer to this question is obsolete now that I have explained this idea. Sorry, folks, I figured it out. You didn't. Nyah, nyah. I should also add that if you think of the big computer made of molecules as a gigantic disembodied mind forming, which is perfectly fine, since computation is essentially synonymous with mind, then this is basically saying "God did it", except in a testable way that has nothing to do with established religion.

Is Erik An' Theory of Everything Gyre paper genius or madness?

It is a parody, although of what exactly, I can't say. The terms are insane, the content is vacuous. There is nothing in the paper that is useful. To give a flavor of what the paper is doing, here is my own version: "Let Acranobapary represent the number seven and Acranabapory by the number eight and Acronobapairie represent the number 15 and acronaboparai be the operation of addition and acronobopaira be the identity mark. Then one can note that Acranabapory Acronaboparai Acranobapary acronoboparai Acronobapairie And also, one can deduce Acronobapairie Acronobipi Acronaboparai acronoboparai Acranobpary When Acronobipi represents the operation of subtraction." And so on and so on. Once you unravel the purposefully obscure language, it is trivial identities from undergraduate textbooks. There is no refutable content, there is only invented jargon over null content.

What mathematical or scientific principle have you discovered on your own only to later learn it was already known?

This is a daily or weekly occurrence for any decent practicing scientist, it happens so often you lose track. Usually the ideas are old, rarely they are more recent. You just keep reproducing, until you reproduce stuff that is new. This happens rather quickly.

How can Quora content improve Wikipedia?

Wikipedia has failed long ago in its mission, to provide all human knowledge. The reason it failed is because of the idea of sourcing, which was used to remove all content which contradicted somebody with a publication. Since most knowledge contradicts some published nonsense, this removed all the good stuff. Thankfully, it wasn't applied to stuff that was written before the rule-nazis took over, so there is good stuff that remains. The sourcing rules came late in the game, and they only wrecked the thing in 2008-2009. It can still be forked into a working project, all that it needs is anarchy, which was the rule until around 2009, codified in Jimmy Wales dictum, now ignored, that editors ignore all rules. Quora content improves on Wikipedia, because it serves as a non-authoritarian method to complete the content without undue burden. If there is a subject, the unsourced knowledge can be presented on quora, so that it is freely available in one venue.

What are some examples of elegant, beautiful theories that are incorrect? In a documentary, it was said that scientists search for a beautiful, elegant theory. He said history is littered with beautiful theory that's incorrect.

(This answer overlaps an earlier one due to Anonymous) Most of the most beautiful incorrect theories had a good idea that eventually gets

incorporated into a correct theory, but there is one example of a beautiful theory that failed entirely: the steady-state model of the universe. The idea here is that just as the universe is the same under translations in space, it should be the same under translations in time. This idea is a higher symmetry than a big-bang, it makes all eras equivalent to all other eras. The idea was that the expansion of the universe was due to a cosmological constant, and that as the universe expanded, new matter was created continuously from a negative energy field called the "C" field, to reproduce more galaxies and so on. The idea failed because of the microwave background, and none of it survived. The only idea which is sort-of preserved is the idea of a cosmological constant, which is observed now, and is believed to be higher during the early universe. Another beautiful failed theory was Kelvin vortex ether atoms. The idea here was that the ether could have topological defects, and that these defects would make flow-rings that can link into different types of links. Then the elementary atoms were knots, and the molecules are links. The theory was killed by Rutherford scattering, which revealed a non-topological point model of the atom as a solar-system, which was later made quantitatively precise. A modern version of this topological defect idea is the Skyrmion, which shows that unlike the atom, the proton and neutron can be viewed as topological defects in the pion condensate, the modern relativistically invariant version of the ether (which also has the virtue of being correct, unlike the old ether ideas). This idea can not only predict the nucleon pion cloud, it can predict the structure of some light nuclei qualitatively. In conjunction with string theory, it's accuracy can improve to semi-quantitative prediction of the structure of the nucleon, at scales larger than where you see individual quarks and gluons. This work is ongoing. Another beautiful failed theory is the LeSage ether. The idea here was that space is filled with fast moving particles, which hit matter and get absorbed, giving minute pushes in all directions. Then gravity is caused by the shadow in the LeSage ether, and leads to an attractive force as 1/r^2. This theory fails because of motion friction in the LeSage ether, but you could fix this today by making the ether relativistically invariant. The real reason it fails is because empty space is a pure quantum state, there is

no entropy carried away by the ether particles, so the explanation cannot work classically. But within quantum mechanics, in the Feynman description of forces through particle exchange, it's the exact same geometrical dilution of particles that leads to the 1/r^2 form of the force law. So the most beautiful part of the theory was incorporated into later developments. This is the general pattern of the failed beautiful theories--- the beautiful parts get incorporated into an even more beautiful successful theory. The one exception is steady state.

Is the value of a good idea in its origin or in its delivery?

In the print era, the people who came up with the ideas were isolated from the public by a requirement of getting into print. This barrier was constructed so that incompetent people who could not come up with their own ideas could gain academic positions by simply ripping off the new ideas and spreading them around with minor addenda. The second thing is much less important than the first thing, and usually the delivery of the person who has the idea originally is also better than the delivery of the secondary authors. So the value of the good idea is in the idea, not in the delivery, and the delivery is usually very simple for the person who has the idea. The internet fixes this in principle, by eliminating the barrier for communicating an idea to the public directly, without an intermediate who spreads your idea around.

Does the new black hole "firewall" theory really put quantum mechanics and general relativity at an impasse?

This problem is almost surely a fake, but it is superficially persuasive because it reveals a mistake that appears in the literature, and it is a true paradox given it's assumptions. The assumption that fails is the semiclassical behavior, the behavior is only semiclassical after coherence is lost, since the semiclassical notion of a spacetime with a horizon is fundamentally thermal and must be described by a density matrix, not by a pure state--- the very notion of a semiclassical geometry is not pure. Not all the surrounding literature has been fixed, but I the main points of the current understanding of horizons are pretty surely not going to be modified in any deep way, there is no firewall at the horizon, you go right through. The issue is simply how exactly you do the analysis of what is called the "Page time", the time at which half the information that fell into a black hole is reemitted in the Hawking radiation. What the group including Polchisky noticed is that the normal analysis of the page time is inconsistent with a normal horizon, because the information that comes in is almost all reemitted by the time the black hole is shrunk to a small one into patterns in outgoing radiation. This means that measurements on the early radiation determines the late radiation. But then, they say, if you measure the early radiation, you can determine the exact pattern of late radiation, and when you back-extrapolate any precisely defined known late radiation backwards, in the geometry of the horizon, the blueshifting at the horizon gives you a hard wall of very ultraviolet photons. So if the late radiation is determined, it comes from a firewall, not from a horizon. The mistake is simply in making a separation of radiation into early and late plus semiclassical spacetime background. The photons emitted by a black hole are entangled over the entire lifetime of the black hole, and they are entangled with the non-classical non-geometrical superposition geometry, and simply determining that the photons have been emitted early is already a

brutal measurement---- it wrecks the entanglement between the early and late radiation. When you have a horizon, the state of spacetime around this horizon is automatically thermal, it is a density matrix. When you are claiming that the density matrix is a pure state, you get the Polchiski paradox. The pure state is only the S-matrix thing from the far-past formation to the far-futre evaporation, and when you consider the quantum state without allowing an intermediate semiclassical space-time picture, you get no paradox, but consistent string scattering on the background. This is just another demonstration that the notion of space-time must be reconstructed from a holographic or S-matrix description, that it isn't there in the correct pure quantum description. The paradox also evaporates if you allow limits which are controlled, like allow the black hole to decay to an extremal end-state before performing the measurements on the radiation. In this case, the end result is a unique quantum state, and there is no hard wall, because the photons can be determined, and also the final black hole state, without any paradox about the black hole, because it settled down to a cold quantum state. This paradox is coming from the incompatibility of semiclassical black hole decay with pure information preservation, it's essentially a modern more precise variation of Hawking's information loss argument. The resolution as always is to pass to an S-matrix picture, where the emitted photons are spread out over the entire formation/evaporation and the paradox isn't real. But Susskind has made page-time arguments in the past to support the ideas of complementarity, and these arguments are busted by Polchinski, so it's good for doing that. But the principles of complementarity are still more or less ok, they just require a nonlocal reconstruction in time which doesn't allow you to separate outgoing photons into early and late and reconstruct what is going on behind the horizon at the same time.

What are the chemical consequences of having an element, with an atomic number above 137, whose 1s electrons must travel faster than the speed of light? Is "Feynmanium" the last chemical element that can physically exist?

This is not as much of a paradox as it sounds, the only thing that happens is that the ground state is heavily mixed with positron states, and knocking an electron out of the 1s state could lead to positron production in subsequent decays. The more interesting thing is that such a nucleus, if it were stable, would spontaneously produce electron-positron pairs from the vacuum, so the nucleus would shield it's charge. This is the phenomenon of "maximum nuclear charge" which Gribov thought about, and it's a form of the Schwinger effect, production of electrons and positrons by an electric field. Such nuclei, were they stable, would generate their own 1s electrons from the vacuum, to sheild their charge, ejecting positrons to infinity in the process. The problem here is not any of these electronic effects, but the spontaneous fission of these nuclei, due to their charge. The spontaneous fission bound on nuclear size is about atomic number 100, close to the point where you have positrons produced, but smaller. This is just a coincidence, there is no fundamental reason the two numbers should be close, but it's an annoying coincidence, because it means we can't easily experimentally study high charge nuclei where the positron creation would be important.

Presuming that life appeared as a result of a natural event, what could have been this

event?

It is my opinion, I think shared by nobody else with the possible recent exception of Chaitin, that this event is the formation of a soup of molecules which together make a Turing complete system, with a potentially infinite memory due to the large size and processing distributed over the whole volume, and with random chance introducing random disorder into the system. The model for this is the cellular automata of Von-Neumann, Conway, and Wolfram. These model Turing complete systems which appear in simple simulations of information flows based on rules. The processes of catalytic transformation of random proteins are exactly analogous, and certainly form a system of the automaton type, and when these proteins form a computing automaton, as opposed to a stable, periodic, or random automaton, they begin to evolve spontaneously, and they will eventually generate some form of stable information storage and modern life, though a not-yet-replicating form of biological evolution. I should point out that the replicating parts of modern biology are generally things that were evolutionarily sorted out long ago, and modern evolution bears more of a resemblence to this pre-biotic automaton evolution than to the modern synthesis idea of SNPs and fixation. The process of evolution must never be separated from the idea of computation, because the two go hand in hand. The natural event, forming a Turing complete system out of molecules, can occur in many chemical contexts, and is possible even in gaseuous systems, and perhaps on non-molecular substrates, like neutron-star surfaces or interiors. The only requirement is that information can be stably stored without randomizing, and that some clumps of information can reliably transform other clumps of information with a rate that is not too slow and that is uniform in a volume. The randomness required for evading complexity bounds on the computation always comes for free in physical systems, since they always have some thermal jitter.

What are some theories/ideas that sounded extremely silly to most people before they finally proved their merits to most?

All of them. There is no idea which is nontrivial which doesn't sound silly when it is new, since if it was natural, it wouldn't be new, but it would have been discovered earlier. This is why research requires people to feel free to say silly things without feeling shame, and not to worry too much about being wrong. And it also requires that they be given credit for when they are right, with all the silly missteps ignored, because the silly stuff is part of the process of discovery. This is exactly the opposite of politics, where every wrong thing you say costs you support and credibility. It's the opposite of chess, where every wrong move costs you the game. So to have science, you have to abolish traditional human politics, turning it from a game of chess into a game of chess-analysis, and making sure that ideas are considered and rejected or accepted based on exploring it fully in light of the evidence, not based on who ends up looking silly at the end, not based on winning and losing. This is difficult for humans, who often like to play games instead. I will reverse the question: are there any correct theories or ideas which did not sound silly to people before they proved their merits? Such an idea would have to have some other barrier to discovery, other than politics. It would have to be very difficult to think up mathematically, or philosophically, because of some barrier other than sounding silly. An example might be Heisenberg's quantum mechanics. The matrix formalism and the operator calculus was difficult mathematically, and the deductive paths from the older quantum theory of Bohr and Sommerfeld were not completely persuasive. Heisenberg's ideas sounded wrong to Einstein and Schrodinger, but I don't think they sounded silly. Another example in physics is the mathematical discovery of the BCS

theory. People argued that it was incorrect, but nobody argued it was silly. This is similar to new ideas in mathematics, which are often necessarily complicated to explain and internalize, and so don't sound silly, but sometimes sound wrong. The discovery of anomalies by Adler, Bell, Jackiw didn't sound silly. Similarly, the discovery of asymptotic freedom by Khriplovich, 't Hooft, et al didn't sound silly at all--- it sounded important. The Bethe ansatz was never silly, neither was the Onsager solution. This was generally true of the work in quantum mechanics and quantum field theory. Unlike these, the path integral did sound silly to people, and also the renormalization program, and the S-matrix program, the many-worlds interpretation of quantum mechanics, Regge theory and string theory, quarks, skyrmions, even though these ideas were relatively mathematically sophisticated. So not all mathematically sophisticated proposals are immune from sounding silly--- it depends on whether they are visualizable. If you can make a picture of the mathematics, then it will sound more silly. This unfortunately provides political pressure to make mathematical presentations more obscure than they need to be, because if you are too clear, you sound like a fool. But the best ideas are often simple, and the simple ideas necessarily sound silly. Are there any simple ideas that didn't sound silly at first? I think the examples here are few--- perhaps natural selection is an example. The idea of natural selection didn't seem silly right from the start, although it seemed wrong to a lot of people. I think the mechanism that causes new ideas to sound silly is this: most new ideas are not completely new, they are discovered when they are ripe for discovery. This means that along with the person who thinks up and publishes the idea, taking it seriously, there are also a whole bunch of people who also thought up the idea, but didn't dare publish it, because they were sure it was wrong. These people are annoyed that someone else is publishing this obviously wrong idea they also briefly considered, and they form a political opposition to the idea. This might also explain why wrong original ideas usually always have an easier time politically than correct original ideas. The wrong ideas are wrong, so they are usually only discovered by one person. The correct ideas were likely thought of by other people too, who rejected it. So the correct ideas come with

a pre-made opposition, and have to fight harder. It is easier if you are really and truly the absolutely first person to have even considered a correct original idea, but that only happens once in a blue moon.

What are some famous ideas that ruined people's lives?

The idea that psychoactive drugs are a method to open the mind and unleash latent creativity.

How did life on Earth begin?

There is a reasonable answer to this question, which is a synthesis and extension of some ideas of Stewart Kauffman (1969), Stephen Wolfram (1981), and other stuff that is not in the literature. These ideas are essentially updating the cybernetic approach due to Turing, Von-Neumann, and Wiener, which was marginalized and suppressed in biology once DNA was discovered. The reason the computational ideas were put on the back burner is because DNA has an obvious replication mechanism, and the molecule gave people a picture of the origin of life immediately--- a nucleic acid formed, and began to replicate, and then evolution proceeded. This idea is seductive, but I believe it is completely incorrect, and many others who thought about this, including Francis Crick, eventually came to the same conclusion--- self replicating nucleic acids are not the likeliest candidate for the origin of life. Crick was mystified, and proposed half-jokingly that it was pan-spermia. I don't think this is a reasonable answer either, since it just pushes the question to the origin of pan-sperm. * Computations

in modern cells The main characteristic that distinguishes living from nonliving systems is the ability to do Turing complete computation, in a finite approximation, with an essentially limitless memory capacity, and a processing quantity per unit volume. Each cell has an enormous store of stable memory, dwarfing the best solid-state memory chip in bit-density, and the processing speeds are on the molecular scale. An RNA read and write can be done at thousands of bases per second, with error correction, and you can stuff millions of these things in a cell volume. So the potential RAM of a cell is 10s of gigabytes, and the processing speeds for this data is the rate at which the data can be copied and transformed, which can happen at rates of megabytes per second. These are comparable to a modern artificial home computer. To see that modern life is potentially Turing complete is not very hard--- you can easily engineer a Turing complete system using bio-molecules, and it is easy to see that the storage capacity of DNA and RNA is sufficient for running software of the kind you have on a modern laptop. Further, we have a system capable of computing in biological systems for sure--- our brain. The computer itself was originally defined to abstract out the information processing done by the brain of a mathematician. So biological systems can compute, and do compute. But the processes that biologists recognize as happening in a cell are not always sufficient to produce a full computation. at least not one of a significant size. If all that happens in a cell is the central dogma, then DNA produces RNA and the RNA produces proteins, and then only the proteins are computing anything. The proteins compute with a random access memory which is determined by their potential different chemical bonds to each other, and this is only a few kilobytes of RAM at the most. It's still computing, but it's a very small computation, compared to the amount of frozen data stored in the DNA. It is unreasonable that a system that has gigabytes of ROM should only have kilobytes of RAM, especially that the DNA has to get written and proofread in the process of evolution. I will argue later that the proper computational ideas demand that there are exceedingly complex RNA networks active in modern cells, which compute at the gigabyte/teraflop rate. This idea that RNA networks are required and appear in modern cells in a way that can do gigabyte

computations is implicit in recent work of John Mattick. It is experimentally more and more certain every year, as new functions for RNA are discovered. I take this idea for granted, as it is the only way I can see to make sense of the computational capacity of modern cells. * Computations in non-living systems If you start with a pre-biotic soup of molecules, it is very simple to make a naturally computing system. This became clear after Wolfram's work in 1981. The basic idea of a cellular automaton is that it is a model for information transformation in a system which can store stable discrete data. An example is molecules, which store data in the pattern with which they are bound to one another. These molecular patterns are transformed by catalysis, using other molecules, and the result is that certain bit-patterns rewrite other bit patterns in a rule basd way. Bit rewrite rules were studied by Von-Neumann, Coway, and Wolfram, and it was discovered in each of these cases that a relatively simple system will produce full Turing computation. Von-Neumann had a many-state one-dimensional automaton, with relatively complicated rules, but it was proved Turing complete relatively easily. Conway used a two-dimensional automaton with very simple rules, and this was proved Turing complete in the 1990s (although it was pretty clear that it should be Turing complete in the 1970s too). Wolfram found a very simple nearest neighbor automaton which was proved Turing complete around 2000 by Cook, a Wolfram employee. The proofs are relatively difficult, because they require building a computer from the information transformations in the cellular automata, but the general program makes it clear that as long as an automaton has "complex behavior", which means that the system doesn't die out to a stable pattern, doesn't devolve to a simple fractal pattern, and doesn't wash out to completely random noise, as long as there are identifiable structures that persist long enough to impress their data on other structures, then you have Turing completeness. This is not a theorem, it is a principle, and the principle was called the "Principle of Computational Equivalence" by Wolfram. It generally says that whenever an automaton looks complex, when it isn't trivial, then it is going to be Turing complete. I will accept this, because it is true in simple examples, and it is difficult to construct something complex which is intermediate in Turing degree of

complexity, Friedman and Muchnik needed to work hard, starting from something that is already a universal computer. So in order to make a computer, all you need is a system with information stored in molecules, with rewrite-rules in the form of allowed catalysis. The peptides produces on the early earth from the atmosphere, together with primordial hydrocarbons from the Earth's formation, can produce polymers at the interface of the primordial oil and water which have these properties, simply by joining peptides into polypeptides. This is the computing soup. I believe that a sufficiently large and sufficiently fast computing soup is necessary and sufficient to explain the origin of life, there is nothing more and nothing less required. * Self and non-self A computing soup is seeded random data, but the data doesn't stay random. It gets reworked depending on the local environment to acquire the characteristics of the molecules surrounding it. These characteristics build up progressively, because the system does not reach any sort of statistical steady state, and different regions of the large computation produce a different ecosystem of interacting molecules. None of these molecules are self-replicating, but they are all self-replicating in a certain sense, in that they weed out and digest molecules which do not conform to the pattern that is compatible with the other molecules. This is a collective sort of replication. Collective replication was proposed by Stuart Kauffman as an alternative to the self-replicating molecule idea, back in 1969. The idea was that a collection of independent molecules can each catalyze part of each other, so that together they autocatalyze the whole set. Kauffman argued that such an autocatalytic set is inevitable given a large enough diversity of molecular species. This is probably true, to a certain extent, but one must keep in mind that this is also true in a computing soup, and without a computing soup. But a simple autocatalytic set suffers in general from the same problem as other replicators--- getting stuck in a rut. In order for evolution to proceed, it is not enough to be replicating, you need to make sure there is a path for further evolution into ever more complex systems. The simplest replicators have the property that all they do is replicate themselves, and then the only evolution is a quick minimum-finding where they find the quickest and stablest replicator. An example of such a

parasitic replicator is fire, fire metabolizes and reproduces itself, but it is incapable of evolution. Similarly, small self-replicating computer programs with noise are capable of filling up the computer memory with copies of themselves, but they don't evolve past this point. The systems that are capable of further evolution are those that are not precisely replicaitng, but that are precisely computing. The recognition of self and non-self by computing automata means that if you divide an automaton in two, and wait, the two halves do not mix together well after a while, because they acquired different characteristics. The result is that if you allow the two halves to touch, they will compete, and the best one at spreading will take oer the computing volume. This produces Darwinian competition long before any precise replication. The Darwinian competition allows for selection of traits that are favorable to spread throughout the computing soup. * Emergence of life It is likely sufficient for life to have a computing soup of molecules, as these will then compete locally to make better and better synthesis systems, and eventually they will make compartments to localize the molecules into cells, long after developing nucleic acids, ribosomes, and all the other ideas we see in modern cells. The stable replicating DNA molecule, in this view, is the last to form. It evolves when there is a need to store RNA in a more permament fasion. This idea is proteins and hydrocarbons first, RNA and genetic code second, DNA and cells last. It is hard to test the later stages, but early stages can be tested using cellular automata, which is something I did about a decade ago. It was hard to interpret what was going on in the cellular automata, even when they looked like they were computing, because the patterns are not obvious a-priori, but that was only because I did it half-heartedly, being more excited at the time about the computational patterns in modern cells. * Criticism of other ideas The idea of RNA world assumes RNA can form. RNA has a sugar in it's backbone, and it has different bases, and it's much much too complicated to make RNA abiotically. By contrast, proteins are dead-simple to make, you can't avoid making amino acids from methane, carbon dioxide, and water. So it is obvious chemically that proteins are earlier than RNA. Further, RNA can't self-replicate. That's really good, because if it could, it would kill the computation

like a cancer, but this is what is assumed in RNA world--- some sort of self-replicating RNA. The ideas of Dyson on cells-first suffer from the problem of no-computation. If you don't start with a computing automaton, you have no computing automaton inside the cells--- they are too small. They are unlikely to have a diverse enough collection of species to make a computation, and even if they did, it's potential for evolution is too small, becaue it is isolated, so it has a limited memory. These ideas are reasonable for the emergence of cells once the computing soup has evolve to a good enough point to package the machinary in isolated compartments. The ideas of Thomas Gold on the importance of petrolium and deep-vents, archaea first if you like, I think are ok, but they are completely compatible with the view I am pushing here.

What would happen to atheists if God, heaven, and hell were real?

God only admits atheists to heaven, the believers are sent to hell.

What are the arguments for and against the Higgs field being the inflaton field that caused inflation shortly after the big bang?

Jay Wacker says correctly that the Higgs field doesn't have a flat enough potential to be an inflaton with the terms that we can measure. The problem is that we can't probe the potential at Planckian field values, where the subleading renormalization-suppressed corrections

become important. At those scales, it is possible the Higgs potential becomes flat, but of course, it is also possible that the Higgs potential becomes meaningless, because other fields mix together with the Higgs to make the effective degrees of freedom different, so you wouldn't be able to say "oh, this field is the inflaton, and it's the same as the Higgs", because the fields at high energy make a different collection. The Higgs potential is, to leading order, a quadratic and quartic contribution. The only realistic way to answer the question of what the Higgs potential looks like at enormous values of the Higgs field is to make a string model for our vacuum, where all the scalar fields involved get a clear interpretation, and have completions at the Planck scale, so that all questions can be answered. An example of a string inflation mechanism is the so-called brane-inflation--- where the scalar field is the displacement of certain branes from each other. When the branes are very far apart, the potential becomes flat, but at the minimum, when the branes are on top of each other, the potential is approximated by a quadratic and quartic piece, as is always true at low energies, from renormalization. But there are many more scalar fields, and the notion of Higgs is only relevant far below the supersymmetry breaking scale, at our energies, where there is only one scalar left. As it stands, we don't even know what the Higgs is exactly, or whether there are low-lying superpartners of any kind, or whether there are other particles at the Higgs scale which are not predicted by any current model. So I would say we don't know, but it's probably not the Higgs, since the Higgs is a low-energy field, and the inflaton is a high energy field, and the two collection don't have to be related, except that the high-energy stuff has to reproduce the low-energy approximation. This is repeating Jay Wacker.

Is there any aspect of string theory that is verifiable?

The question could go the other way--- is there anything in string theory that is not verifiable? The answer is no, because string theory only tells you about observable things--- in the case of an asymptotically flat space, the scattering of particles to infinity. It never talks about things that cannot be directly measured (outside of approximations, or intermediate steps in the calculations), like fields at arbitrarily localized space-time points, or the topology behind the black hole horizon (to the extent that this doesn't show up in a measurement), or stuff in the volume of eternal inflation. All this stuff occurs in classical ideas that approximate the theory, but not in the theory itself. The predictions of string theory are ridiculously precise and extremely nontrivial, at ridiculous energies we will never be able to attain. If we could build a Planck scale accelerator, string theory would relate the high-energy scattering to the structure of our vacuum, which is also what gives us the low-energy matter, and all the couplings. So with a certain finite number of measurements, about as many as you need to fix the structure of the solar system, you can predict the results absolutely every experiment you can ever do. This is more predictive power than any theory has ever had. But unfortunately, we can't build a Planck scale accelerator, so the verifiability which is always there in principle, is out of reach. But when people say a theory is "not verifiable", they mean it is vague nonsense that you can fiddle with arbitrarily to make anything you want come out. String theory is not like that at all, it is not vague, it is not nonsense, and you can't fiddle with it, it is uniquely determined, and so it must never be confused as "not verifiable in principle". There is a kind of string theory which does allow you to do whatever you want, and this is the "large extra dimensions" string theory which was popular last decade. In this theory, you can put a ton of things in by hand, and fiddle with the things to reproduce experimental results. But these theories are not only falsifiable, they are falsified! They were ruled out by generic predictions they make about the size of the non-renormalizable corrections to the standard model, and they were ruled out before they were proposed, since the neutrino masses alone are far too small to have large extra dimensions and a small Planck scale. Ignoring large extra dimensions with ridiculous fine tuning, string

theory is eminently falsifiable in principle. But this is "in principle". When you are talking "in practice", we are for the forseeable future limited to collisions at less than 100-1000TeV CM energy. At these scales, string theory reduces to field theory with a few non-renormalizable corrections, like masses for the neutrinos, and a small amount of potential proton decay. And then, any prediction of string theory is also a prediction of the field theory, aside from perhaps some new predictions about the non-renormalizable corrections, which are always a finite number of terms, so they can always be reproduced by making a more complicated field theory at very high energies, with enough free parameters to match the new data. There are general predictions about the field theories that come from string theory (the traditional kind of string theory, with a high Planck scale, not the large extra dimensions nonsense). You can't have too big gauge groups, so you can't have a new sector with gauge group SU(1000), and you can't have too many fields, so eight hundred scalar fields are ruled out. This is a prediction, but it's a truly crappy one, considering how far we are from this bound with the stuff we know about today. You also can't have tiny gauge charges, you can't have particles which attract gravitationally more than they repel electrostatically through their gauge charge, so that there are certain models which violate string theory simply because the couplings are too small. For example, if you say the proton has a new gauge charge because the quarks are charged and the leptons are not, you violate this bound just from experimental constraints on the repulsion of nuclei. But this prediction on the size of charges is essentially a consequence of only the holographic principle, it doesn't require the full machinary of strings to work out, so if there is another holographic theory of gravity, as unlikely as this looks right now, it would also predict the same thing. This prediction is also terrible, in that there is nothing that even comes close to violating it. But it is still a prediction. Even a crappy prediction is a prediction. So when people say "string theory has not made predictions", that's not true. What they should say "stirng theory has not made good quantitative predictions". That is true. There are verifiable aspects that show you that string theory is mathematically consistent, like AdS/CFT predictions for the

interactions of strongly interacting particles. These give demosntration that the theory is mathematically consistent, but they don't give you evidence that it is describing out universe. Similarly, calculations in different limits give you confidence the theory is consistent within itself, and that's no small feat. But it's not enough for a scientific theory to be established, you want a good quantitative prediction about actual observations that you couldn't make any other way. One way out of this impasse is to note that there are only a finite number of string vacua when the Planck scale is large. Using the types of compactifications which look like the standard model, there is an estimate of 10^500 vacua. This might look like an enormous number, but it's a combinatorial number, it's the product of 500 things that can be arranged in 10 different ways. You can think of it as 500 digits of experimental data. But most of these 10^500 vacua look nothing like our universe, they have the wrong collection of fields, they are unstable to vacuum decay, and so on. Using the qualitative constraints, we might have 10^20 vacua that look more or less like ours (maybe it's 10^100, maybe it's 10^4, who knows, we didn't sample the space enough to know). Let's say it's 10^20. Then 20 decimal places of data will be enough to fix the vacuum uniquely, and from this point on, the theory tells you everything else. If this sounds like looking for a needle in a haystack, it's not quite like that, because the search isn't blind, and the properties of vacua can be worked out from general principles, and you can get a sense of what can work and what can't work, it's similar to determining the Solar System structure--- you need 20 decimal places of data, the qualitative notion of what moon orbits what planet, the radii of the orbits, their eccentricities and phases, and then everything else is determined. It's the same sort of thing--- there are certain things that require us to know what came out of the big bang. There is one potentially excellent source of many decimal places of data--- the cosmological constant. If we know what vacua have a tiny cosmological constant, much smaller than the supersymmetry breaking scale, maybe this one piece of data alone will reduce the number of vacua from 10^20 to 10, or 1. If not, then knowing the 20 decimal places of the standard model parameters (we already know about 60 decimal places of these numbers,

corresponding to 3 decimal place data on 20 numbers) can resolve 10^60 different vacua that are qualitatively identical to the standard model (it doesn't seem at all likely that there are this many, considering how hard a time we have coming up with one). Once you know the vacuum, string theory is insanely predictive--- it will predict every other decimal place of data after this, and also the structure of the dark matter, it's interactions, it's impact with known matter, the types of monopoles we have, the rate of proton decay, and so on, without any adjustments or freedom. Since finding our vacuum looks like it might not happen in my lifetime, in my opinion, the best place to test string theory realistically is using spinning black holes. Nature has already provided such things for us at the center of galaxies, there are some galactic center anomalies, like the anomalous positron annihilation signal from our galactic center, and string theory unambiguously and more or less vacuum-independently can tell us what comes out of near extremal black holes. The only issue is that we haven't really worked it out. If the answer is "thermal Hawking radiation", like it is for spherical thermal black holes, then this is no further clue. But this is not what is suggested by AdS/CFT, the near-extremal black holes look like they don't thermalize things very efficiently, so there is a potential for a good prediction for astrophysics about black hole emissions, a prediction which doesn't require the exact details of the vacuum, which we don't know. The black holes might produce all sorts of things in their emissions, if classical General Relativistic solutions are a good guide. If the stuff makes a finite-time transit through intermediate regions, which is something I personally suspect (although I never can definitively calculate how long it takes, so I can't say I know it's true), then there are a slew of predictions which might give good models of certain active galactic nuclei, and might explain the anomalous antimatter signal. It requires further development to be sure. So in practice, it is just extremely difficult to verify the theory, and this is only because quantum field theory is guaranteed to be correct at low energies from renormalizability. Aside from reproducing quantum fields and General Relativity at low energies from a consistent framework, the other predictions of string theory are remote and extremely difficult to verify. But for the in-

principle question, string theory is absolutely verifiable in the philosophical sense, as any scientific theory must be, it just is teasing us by being so hard to verify with the money we can realistically spend.

Is Stack Exchange a digital space which could be repurposed to create an open peer review system?

Alas, no, but only because of the moderation on the site--- if you criticize something too severely, you will be suspended by moderators, for "rudeness", "incivility" and so on. The peer review system requires this kind of rudeness, since it is pointing out when something is full of crap. The other problem is the creeping requirement of sourcing--- if you are required to source, you cannot do open peer review, since review is criticizing what is said in sources. These two issues have made it that there are perfectly easy legitimate criticisms of common literature claims that could have a home on stackexchange, but are summarily deleted by moderators who have a vendetta against these opinions, and then block the content from being reintroduced, and block the user for introducing it. For example, one cannot place a fair review of Thomas Gold's book "The Deep Hot Biosphere", because it is contradicting a literature consensus. An open peer review system requires that people must never be given powers of censorship, beyond removing spam, gibberish, things like that. The ideas that go against a literature consensus require the most protection, and this is not provided on stackexchange, much the opposite, these things are removed. Aside from these two flaws, it would be ideal for peer review, vastly better than any existing system. If you would like to make such a site, I would love to join. I would like to do so, but I am busy at the moment, and it is a bit of work.

Classical Conditioning: Why were Pavlov's dogs so significant?

I don't think it was so significant, it was more era-defining, it was an experiment which showcased the way people thought about things in the 1950s, and how different this thinking was from the earlier centuries, where mystical unknowables like the soul always interposed themselves between the stimulus input and the behavioral output. The idea here is scientific behaviorism, the idea that we should describe things in terms of observable inputs and observable outputs, without postulating too many things in the middle, like mental states, unless we have to, to describe the inputs and outputs. This idea is associated with Pavlov and Skinner, and it is a materialistic no-nonsense minimalist scientific description which is in line with Marxist ideology, and with logical positivist ideas about how to describe nature. Pavlov's dogs showed that if you make a particular stimulus, the dogs will respond in a certain way, reliably. It gave the description of the dog's behavior without making postulates about the interior experience of the dog, or any intermediate states that the dog has. It didn't say "now the dogs expect food", or "now the dog is fantasizing in it's head", it said to look for a signal in response to an input, and this is a complete description of what is going on. This philosophy of behaviorism and logical positivism defined the scientific outlook of the 1950s and 1960s, but it went out of fasion in the 1970s and 1980s. It disappeared along with Marxism, materialism, logical positivism, the no-nonsense scientific outlook, in a puff of marijuana smoke. There were several legitimate reasons for this, other than the marijuana smoke. Some people associated the ideas of behaviorism with the much more radical (and obviously false) idea that the dog just didn't have an internal experience, that there was nothing sophisticated going on in the dog's head at all, that it was all a relatively simple association between input

and output that could be modelled with a small stimulus/response table. This idea is clearly false, because the dog has a big computer inside its head, and people have an even bigger and more sophisticated computer, and the computations are involved, and can lead to unpredictable results. But people were trying to squeeze as much juice as they could from the simplest models, so they tried to make the input-output relation as simple as it could possibly be, which was usually too simple to model anything at all. For example, behaviorist inspired models of language were too primitive--- the language models of behaviorism were the regular languages, the languages that could be processed by finite-state automata. This was a state-transition model of human language processing, where you have a finite relatively small number of possible internal modes, like "I got a noun, now I am waiting for an adjective phrase" or "I completed the adjective phrase, now I am waiting for a verb", and as you process a sentence, you make transitions between these states, and process the words into sentences. One source of opposition to behaviorism came from Chomsky, who noticed along with Schutzenberger and the computer scientists that human sentences can have embedding arbitrarily deep in principle, so you can make the sentence: "I walked to the place that was behind the place that was in front of the place that was behind the place that was in front of te place that was behind of the place that was in front of my father's house." and there is no obstacle to going arbitrarily deep. So the processing must be potentially infinite. Chomsky and Schutzenberger identified the proper model for these types of things, which is the context-free grammars, the languages that can be understood by a finite state machine with an infinite stack. Human stacks are not really infinite, but the model was better at describing what is going on in recursive language processing, and so it was considered a refutation of behaviorism--- it gave an infinite model of the transitions which was sort of "idealistic", rather than "materialistic". These disputes are kind of dated. Sure, the stack grammars are more correct for modern languages, but you can obviously turn a stack grammar with a finite stack into a regular grammar, just because there are only finitely many things you can store on a finite stack, and a stack of not-too-

deep depth can model the sentences that human beings will realistically encounter, and you can always add a little bit. The dispute here was really over the materialist conception that the world can be understood from relations between inputs and outputs, so that all you need are the observations to deduce what is happening, you don't need to postulate metaphysical entities, like God, or the invisible hand, or the notion of human-rights, or some abstraction. Just focus on the practical stuff. This was what Marxism kept on trying to do. The resolution to this dispute is to simply point out that the input and outputs might be small, but the internal computations which are required to produce these outputs still are enormous. Hamlet may be only a few kilobytes when encoded efficiently, but to produce it required unimaginably large computations in the author's head, visualizing the scenes, understanding the nuances of the phrases, making the language sonorous by hearing it in the head, and so on. These things are not directly in the output, they are in the interaction of this output with sophisticated computations in the reader and author. So while the only evidence of these computations is the small input and output, the computations themselves required to relate the inputs to the outputs are immense, mind-bogglingly large. Pavlov's dogs were significant because they were reducing the behaviors of dogs to the behaviors of switches, to an insignificantly tiny computation, and the implication was that the behavior of people is not much more sophisticated. In this sense it was false, but it was already clear that these models were far too primitive. Not because computations are the wrong language, but because the size of the computations involved in the behaviorist descriptions is too small by many many orders of magnitude.

Can signal detection theory help us distinguish the signal from the noise in science?

This is known from experience, and it's just common sense: you make a prediction for a correlation on an existing data set, but you verify it with new data which is not using the same data, but new data specifically taken to test the hypothesis you found. The problem of large-data sets, people finding spurious correlations by statistical accident, happens all the time in high-energy physics--- these are the "3-sigma events" which show up every few years, where there is a bump in the cross section that superficially has a 1 in a thousand chance of being random chance. The problem is that you are sifting through thousands of data points to find these exceptional events, so it isn't really 1 in a thousand, more like 1 in 1, and when the experiments are repeated to check whether there is something there, 9 times out of 10, there's nothing there. So when you are data mining, you can say "look what I found", but you shouldn't be so sure it is real until someone tests it on new data, unless the statistics are 1 in a million certain, or 1 in a billion if you are going through millions of points. If you can't take new data realistically, you should split your data set in two ahead of time, look for effects in one half, and then verify these effects on the second half. If you are automating the search on the first half, make sure you are not finding thousands of examples in the first half and then "validating" a handful on the second half with 3-sigma confidence, since this is likely just a statistical fluke. Going to 5-sigma confidence, one in a million chance of a fluke, gets rid of these in most practical circumstances, when there are only thousands of seach positions. This is why high-energy physicists wait until they have 5-sigma evidence before annoncing, even though a 1-in-1000 would normally be good enough to never get burned, because 1 in a 1000 is really 1 in 1 when you are sifting through thousands of positions. The basic result is the common sense dictum that your confidence should be 1 in 1000 times the number of trials you make, if it isn't, you aren't finding something significant.

Why do we need economic growth? What would be so bad about keeping our economy the same size year to year?

Economic growth is the statement that people are able to do more things for each other. If you have economic growth, it is a statement that people are helping each other more, in whatever way other people deem useful enough to pay money for. It doesn't necessarily mean more environmental damage, because the growth can be in clean industries, or even in environmental clean-up industries, if people wish to pay for clean-up. It doesn't mean more exploitation, because it can occur uniformly, with everybody becoming better off. It doesn't mean anything except that you have rearranged your economy so that people's labor is more efficient, and each person is able to do more things for other people with the same amount of labor. The purpose of money is to make sure that people who dislike each other can still help each other. If I am hungry, and my neighbor has wheat, and I am a painter and I have some paintings, and I come to my neighbor and say, "Look, I can paint, give me some wheat and I'll give you a painting." My neighbor has to like me in order to do the transaction, and he has to like my paintings. If money is involved, you help each other by exchanging peices of paper, which allow me to eat if someone likes my paintings, anyone, and the farmer will sell me the wheat at a fixed market price, whether he likes me or not, he doesn't even have to know me. So exchange ideally becomes completely detached from politics, so everyone can hate each other and still they help each other. I am bemuzed that whenever I walk into a coffee shop, the people behind the counter give me coffee, just because I hand them some slips of paper. They would never do it without the paper, some of them dislike me! But they give me coffee. And all I give them is paper. The purpose of the money system is to ensure that everyone's labor is efficiently distributed, and this is guaranteed under certain economic assumptions, of free efficient trading, and perfect competition for everything. In these conditions, with perfectly rational actors, you can

show that the economic equilibrium coincides with the ideal perfectly planned economy by an infinitely wise agent. So it's a reasonable idea to implement such a thing, as closely as possible. Such a thing is an idealization, so it always requires some sort of intervention to implement, because it doesn't happen by itself. Some people are incapacitated and cannot do useful labor, other people have formed little cliques which possess monopoly power over certain position, and you can tell because they are renumerated at much higher than market rates. Other commodities are not sold at a market price, you can tell because their price ends in a string of "9"'s. Generally, the 9's begin where the market ends. But there aren't so many disabled people, there aren't so many people with a monopoly position, and there aren't so many 9's in prices, so the market is more or less functioning. Under these circumstances, growth is the statement that we have rearranged things so that people are able to provide more value to each other through trading and labor, by building more efficient machines, or by helping each other in new ways that we didn't know about before. So no economic growth means no new ideas for how people can do things for one another, and that's a terrible thing. Some modern ways people help each other are not renumerated with money, things like free software and quora answers. This is a different sort of economic activity which is not linked to the main economy, and so depends on goodwill and good politics to function at the moment. But having these things around still is a form of growth, except not measured in monetary terms.

Is there a difference between condensed matter theory and high energy theory in terms of beauty?

This is a very hard question, because the two fields have very different types of aesthetic considerations. In my biased opinion, the condensed matter theory is much more beautiful than the high-energy theory, except where they overlap, and with the conclusion-flipping exception of string theory, which is the most beautiful thing human beings have ever conceived. The aesthetics of high-energy physics is due to the prettiness of the laws themselves, they are a manifestation of the order of the universe itself, and how it works. The theories there try very hard to give a perfect model of the phenomenon, and so they want to include everything there is. When you are including everything in the theory, any prettiness in the theory is a prettiness of the thing itself, not of your model. The issue of model-prettiness comes up in a sort of phony way in early approaches to quantum field theories, where there was a folklore fetish that the simplest theory was always correct. For example, you can take minimal coupling for quantum electrodynamics, or you can add a Pauli term to give the electron a different magnetic moment. Experiment shows there is no Pauli term, which is also what makes the simplest equation, so Dirac was able to predict the magnetic moment of the electron from the principle that the equation should be pretty, without an extraneous Pauli term. The same reasoning allowed Einstein to deduce the equations of General Relativity, and Klein and Gordon to deduce the scalar equation, and so on. This heuristic at the time was considered an extreme form of Occam's razor (although a ridiculously over-stringent form, since the second-simplest theory is just as good in the sense of Occam's razor as the simplest one). The reason why this fetish works was understood in the 1970s, it is a property of renormalization. In renormalization, even if you put in a Pauli term, at low energies, it goes away. The same for corrections to General Relativity, or to Yang-Mills theory. So it is renormalizability that demands that the equations of field theory be "simple", and it does this through scaling. In the modern theory of gravity, it is clear that all the non-renormalizable terms appear at the string scale (or the quantum gravity scale), and they are just suppressed by the distance between the energy scale of gravity and the energy scale of our elemetary particles, almost 20 orders of magnitude. The small corrections give next-to-prettiest theories, like including a

neutrino mass in the standard model, or a certain amount of proton decay. So this type of aesthetic reasoning is now seen to be a sort of embarassing mysticism in the early 20th century physicists---- they thought "it must be the simplest equation!" instead of asking what principle demands that higher order terms are suppressed. This wasn't really their fault, the principles of Occam's razor and renormalizability sort of coincided in this case. But this over-radical Occam's razor fails for the standard model. The simplest model of the electro-weak interactions in Schwinger's SU(2) model. The Glashow-Weinberg-Salam model is next simplest, it has an extra U(1). But it is the correct theory. Similarly, the simplest GUT is probably SO(10), but the correct GUT might be SU(5) or E6, or SU(5)xU(1) with some flipping, or maybe even (horror) the Pati-Salam SU(4)xSU(4). We can't say for sure for sure, because we don't know our string vacuum. It's one of these, almost surely, though, because these possibilities are selected by a proper use of Occam's razor. Although it might also fail to unify at all, the group might be SU(3)xSU(2)xU(1) all the way up to the string scale, although this seems unlikely considering the breaking patterns work well, the couplings approximately unify, and all the grand unified groups have been embedded in semi-realistic string theory constructions. The modern prettiness of the theory is now replaced by the principle of uniqueness and completeness, the non-deformable property of string theory that you can't add new stuff without wrecking the theory. This principle is demanded by the holographic idea, the consistency of reconstructing a space-time from a world-volume theory demands a very specific form for the theory. The "simplest" theories of this sort are incredibly supersymmetric and do not resemble our universe, but some of the next-simplest models work well, and describe universes resembling ours. Our quantum field theories then are just the phenomenological description of the string vacuum at low energies, and they are a sort of condensed matter theory in relation to string theory, which is a fundamental theory. The criteria of holographic consistency, together with uniqueness, non-deformability, and so on, really form the aesthetics of string theory. But the aesthetics are secondary here, you really don't have any choice. Once you accept the holographic principle, which is derived by

rather solid deductive paths from accepted theories, you are really forced to accept string theory, or something very much like it, as the correct description. In condensed matter system, it's a completely different problem. You know the fundamental laws, and you are trying to understand a phenomenon you see in the laboratory, or to predict a new phenomenon. In this case, the prettiness comes not from what you put in, but from what you leave out. The models of condensed matter physics are constructed to remove as much as possible of the irrelevant crap, and to leave only the stuff you are interested in. In this sense, they are mathematical idealizations of the phenomenon, which give you the most insight into what is giving the effect. For example, take the Ising model of magnetism. It only leaves one direction of electron spin, and it removes all quantum aspects except the discreteness. It includes only nearest-neighbor aligning forces, these are a stand-in for any collection of local forces, and then it shows how the magnetic phase transition can emerge. The beautiful thing here is that the same principles of renormalization that make the high-energy theories pretty also make the phase-transition theories pretty in the same way, and show that the Ising model is a good model for the critical behavior in any system with a one-dimensional phase transition. This insight is from the 1970s, and is associated with the names of Kadanoff, Fisher, Wilson. Similarly, every model of condensed matter is beautiful for what it leaves out rather than what it puts in. The Anderson model of a disordered metal leaves only a random potential, and an electron hopping from atom to atom. The tight-binding models leave out the electronic orbitals, and leave only an electron hopping on a lattice. The Pieirls model for charge density waves leaves out all the dimensions of space, and explains the phenomenon from phonon condensation. The Landau theory of superconductivity leaves out everything except the behavior of a charged condensate. The models of condensed matter physics don't stay in condensed matter, they go back and infect high energy physics. The Higgs mechanism was a relativistic version of Landau's superconductivity model. The quark-condensate of pion physics was an electrically uncharged version of the Bardeen-Cooper-Schriefer condensate responsible for actual superconductivity in materials. The phase transitions of the early universe were back-

cribbed from the renormalization inspired work on phase transitions in condensed matter. The two fields are completely intertwined in this way. It is only string theory that distinguishes high energy, because it has no real condensed matter analogs, although that is not quite true, as the topological fields of the fractional quantum hall effect are similar in their boundary-bulk relation, and there are analogs of the quantum hall effect in brane-physics, as described by Susskind and Hellerman in the late 1990s. But because condensed matter leaves things out, the models are mathematical constructions requiring human ingenuity, they bear the stamp of their human creator. Feynman's model of He4, the hard-disk repulsion model, and his ansatz for the ground state, bear the mark of his path-integral thinking, and would not have been made the same way by anyone else. The models of statistical physics, like the sand-pile model or the forest-fire model, carry Per-Bak's fingerprints, as do the cellular automata of Wolfram, or Parisi's replicas. This doesn't mean they are less beautiful, they are beautiful in the same way that Michaelangelo's David is beautiful, they are beautiful as works of art with an application--- they are impressionistic painting of a physical phenomenon. Because of this, I think that condensed matter models are more beautiful, because they display high human artistry. The high energy physics is more constrained, at least when it is trying to describe everything precisely. When it is trying to understand particular phenomena of particles, like quark confinement or diffractive scattering, it becomes just as human and artisinal as condensed matter. These special-phenomenon things do bear the fingerprints of their creators. The Lee model is Lee's, the Reggeon calculus is Gribov's, the parton model is Feynman, the Shifman Vainshtein Zakharov method is Shifman, Vainshtein and Zakharov. The topological string theory is whoever's (Vafa? Witten?). These high-energy things are human constructions of great beauty also. But I think condensed matter has more of these, simply because there are more people involved, and they have more experiments to inspire them. By contrast, string theory bears no human fingerprints, the theory is uniquely determined, and would have come out pretty much

the same no matter what anyone did. But this does not mean the creators deserve less credit. I think it means they deserve even more.

What is the relationship between black hole physics and fluid dynamics?

The relationship is through AdS/CFT: a black hole in AdS space is holographically described by a constant thermal background in the conformal field theory. This background breaks the conformal symmetry, and this is the same as breaking the translation symmetry on the gravitational side (the black hole has a center). The constant thermal background means that there is an energy density, lots of of stuff, at every point in space, and this stuff is bouncing off other stuff, making a fluid. It's a fluid because all colliding particle systems make a fluid at long distances, this is just from conservation laws--- a fluid is something where momentum flows along with the stuff as the stuff flows, only changing direction through pressure, and otherwise only diffusing to neighboring positions. So to lowest order, the holographic fluid describing the black hole flows according to the Navier stokes equations with a certain viscosity, determined from the CFT. So the the long-wavelength low energy deformations of the boundary theory are slow incompressible fluid flows in the background, with a certain viscosity. This is what it looks like if you stir the CFT fluid a little bit. By the holographic correspondence, this means that the near-equlibrium behavior of the black hole, the normal mode oscillations and decays, are also described at lowest energy by the Navier Stokes equations. To each solution of the Navier stokes equations decaying by viscosity on the CFT side, you can associate a decaying solution of the normal mode perturbed black hole. The main results here (that I heard about) are the universal viscosity bound for the conformal field theory, and the conjecture that this is the lowest achievable viscosity, the relation of the classical membrane-paradigm black hole motion to

Navier Stokes equations, and the relation to nucleus/nucleus collisions with the prediction of jet-quenching and fluid-like behavior at RHIC. This field is big, and my contribution to it is a goose-egg zero, I just read the papers more or less superficially, without sitting down to reproduce all the results for myself, so I might have made a technical mistake in describing the ideas, and I have no idea who did what, aside from saying that I liked Yaron Oz's papers. But it's on my need-to-learn list. There is a potential for deep insight into turbulence, because the scaling in AdS/CFT has an analog in gravity, with translations away from the boundary corresponding to scale transformations, so it is possible that the turbulent scaling laws will have some comprehensible gravitational analogs. Right now, this is a dream, but who knows, this is a completely new point of view.

Why are there no major breakthrough theories in physics since the 1940s?

A question of the form "why X" usually X is true. This X is absolutely preposterous. There has been more physics done since 1970 than all the physics done before put together, and in terms of fundamental physics, the biggest major advances came in the 1990s, which wasn't so long ago. I think the major issue is that you are looking for "gee whiz" physics, the kind where you suddenly start to think of the universe in a whole new way. The gee whiz physics of the early 20th century was Relativity and Quantum Mechanics, and it had a good propaganda team and solid experimental results. The Gee Whiz physics of our time is String Theory, which has no experimental results to guide it, and so it has a lot of annoying wrong stuff attached (large extra dimensions and Randall Sundrum) and this stuff gets all the propaganda. String theory is more theoretically subtle than quantum mechanics and relativity, and it is a culmination of both, in the sense that it makes a consistent theory of quantum gravity that

turns the conception of space-time upside down in ways that are so far past relativity, it is hard to explain what they are in clear language to laypeople. It reveals the fundamental description is on horizons, not in space-time, and it implements Mach's principle in a precise way, after a century of speculation and half-way measures. The universe suddenly becomes a projection from asymptotic boudaries, and we stop thinking of unobservable sectors and global solutions of General Relativity, and make a consistent observable picture. I will ignore gee-whiz physics (even though there has been more of it in the 1980s and 1990s than at any other time), and focus on three other revolutionary developments: 1. Nambu's Vacuum physics: the vacuum is full of stuff! In the 1950s, Heisenberg was going on and on about a theory of everything where there was only a fermionic field, and yet somehow everything else was supposed to be built up of fermionic bilinears. It was hard to figure out what he was talking about and it mostly was nonsense, but the core of the idea was spontaneous symmetry breaking in the vacuum which produces fermionic bilinear effective excitations that we see as actual particles. This idea is true, and never revealed to the public. In the 1950s, Landau showed that a Bose-Einstein condensate of a charged scalar field make superconductivity. This was a phenomenological model, because we don't have spinless charged bosons in materials, but it was the essential insight as to what was going on. In 1957, Bardeen Cooper and Schriefer showed how a fermionic condensate can produce a bosonic condensate from Fermion pairs, even when the attractive force is too weak to make actual bound pairs which condense. Nambu studied this stuff, and wished to apply it to high energy physics. In 1960, Nambu proposed that the vacuum is full of fermionic stuff, and that the manifestation of this stuff in the vaccuum is that we have light pions. This idea explained the mass and nature of the interactions of the pions, and the fermionic bilinear was revealed to be quark-pairs. The theory of spontaneous symmetry breaking in the QCD vacuum was refined into a quantitative theory in the Shifman-Vainshtein-Zakharov sum-rules of 1978, which showed how to quantitatively determine the vacuum glue condensates. Wilson developed lattice QCD, which gave a picture of these condensates. The non-empty vacuum also led to the Higgs mechanism, and this is

superconductivity in a vacuum. It is a central insight that is not propery advertized, frankly because a lot of people didn't understand it in the 1960s, didn't believe it in the 1970s and 1980s, and suppressed it hoping Nambu would go away in the 1990s. Finally they gave him the Nobel prize. Other than Nambu, there was also Goldstone, Gell-Mann and Levy, Brout and all the Higgs folks, who contributed to this idea, along with others. 2. Disorder physics: Anderson localization. In 1957, Anderson discovered the phenomenon of localization--- with enough disorder, a quantum particle will not delocalize over a metal, but localize in bound states at various points, in a fractal way. The phenomenon of localization is not only relevant for quantum electrons, it has analogs in diffusion in disorder, and it is a discovery with enormous implications over all fields of science. To give a relevant example--- the quasispecies of virus evolution is an example of Anderson localization, it is Anderson localization in DNA sequence space--- the sequences keep mutating (diffusion) in a disordered potential (selection fitness) and the high mutation rate produce a completely stable average sequence (the center of the bound state) despite this being completely counterintuitive. The physics of disorder is associated also with revolutionary work of Parisi. This field did not exist and was not even imagined in 1940. 3. Renormalization physics: Wilson, Kadanoff, Fisher, Mandelbrot The idea of scale invariance with corrections from nonlinearity emerged from the renormalization program of Bethe, Stueckelberg, Schwinger, Feynman, Tomonaga, Dyson. Elaboration of this by Zimmerman showed that you have a new algebra of local fields. The result was a complete reimagining of geometry, as explained by Mandelbrot, where scale invariance is revealed to be the central parameter that describes how irregular things are. The emergent shapes of physical things were most naturally revealed to be those things that reproduce themselves on a larger scale. The geometrical insights regarding ordinary things were enormous--- you look at blood vessels and clouds, and see them as fitting an orderly framework, whereas before they look like a tangled mess. This program got most of the attention of academic physicists in the 1970s and 1980s. it includes the breathtaking analysis of Belavin,Polyakov, Zamolodchikov, of two dimensional theories which

revealed all the possible fixed points with a finite number of degrees of freedom, and gave predictions for the fractal scaling dimensions in the two dimensional case, which turned out to be rational numbers. There are lots more discoveries that have not taken up the attention of the whole field the way these three did. The amount of physics discovered since 1940 absolutely dwarfs the physics discovered before, but it just can't be explained to the public until they get with the ball and learn the mathematical stuff from before 1940, because all the later stuff builds upon it. Since the public has refused to keep up, the popularizations are stuck with the simple stuff of the earlier era.

What could be the stronger points in favor of the Anthropic Principle?

The only real evidence for this is that now, and only now, is the cosmological constant energy density the same as matter density. In the past, the matter dominated, and in the future, the cosmological constant will dominate. There is nothing particularly special about 14 billion years, except that this is how long it took us to evolve. If the cosmological constant were much larger, then we wouldn't have time to evolve, the universe would rip itself apart before our galaxy and sun would form. So the cosmological constant seems to be just as small as it needs to be for us to evolve, and no smaller. Since there is no principle controlling the cosmological constant except supersymmetry, and supersymmetry is broken in our universe at a scale much large than the cosmological constant scale, it seems that the cosmological constant is accidentally small by anthropic tuning. Weinberg used this argument to predict the size of the cosmological constant decades before it was observed, at a time when everyone else thought it was exactly zero. Within positivism, it isn't clear how much power the anthropic principle has. We are here, and any description of the laws of nature needs to be conditioned on this data. An example of this is

Hoyle's prediction of a particular resonance in the C12 nucleus from the fact that heavier elements must be synthesizable in stars, because we are around and we are made from heavy elements. I don't think the anthropic argument in this form is controversial. What the anthropic principle does is simply reduce the options for our universe to those consistent with the observation that we are here, and this is not a major thing. But the idea behind the anthropic principle is that we are somehow supposed to be in a generic region of possibilities consistent with the emergence of intelligent life. In order to make this precise, one must know exactly what is the requirements for intelligent life. It is not clear what you need for this, as it is possible that all that is required is some kind of primordial soup that can be described as a computing cellular automaton, and then evolution begins, and here we are. In this case, it is likely that there are a large number of possibilities consistent with intelligent life, and it is hard to make sense of saying what it means that we are in a generic position in the space of possibilities. Perhaps it is a way of deciding between different string vacua, but aside from tuning the cosmological constant, the constraints of the anthropic principle are much milder than knowing the standard model, so I don't know what it gives you exactly.

What is the holographic principle? Does it mean that "our universe is a hologram"?

The holographic principle is the statement that the spacetime we see around us is not a fundamental thing you put into a physical theory, but is reconstructed from the behavior of "matter". If you say it like this, it is a modernized souped up version of Mach's principle, which is something which motivated Einstein during the early years of General Relativity. But in the modern understanding, the word "matter" is identified with horizons, black holes. All the matter we think of as matter is either already a big black hole, like the black holes in the

center of galaxies, or else it is a little quantum black hole, like the strings in string theory. The horizons of these objects form boundaries or edges to space time, and the holographic principle states that the right way to formulate the theory is on the boundary, on the horizons, not in the interior space-time. The principle is extremely revolutionary, and I mean Copernicus, Heisenberg revolutionary, I don't think it can be compared to anything else in history, it is the most recent and arguably the most important single step that we have made towards the fundamental laws of nature. The holographic theories are the right way to describe quantum gravity, beyond any reasonable doubt, and this makes all older approaches obsolete, including ones that are still kicking around the literature. It essentially picks out string theory as the unique correct theory of quantum gravity, and for this reason, it has made some enemies among the politicians. Before the 1990s, you formulated physics using space-time positions as the logically fundamental objects underlying your description (with one exception in the 1960s, which is related to string theory). Points in space-time were thought of as mathematical idealizations, like the real numbers, and the theories lived on top of spacetime, telling you what was going on at different points and the relation between these different events. The result of a quantum mechanical description of stuff going on at logically independent points is quantum field theory--- there is a collection of fields at every point which tell you what is the physical state of this point, and the dynamical laws give you the behavior of the quantum field in a background space-time. The classical limit of quantum field theory is classical field theory, or classical point particle dynamics (depending on the details of how you take the limit exactly). But already within classical field theory, there was a hint that the physical description using fields was somehow limited, or incomplete. This is the following observation of Mach's: we can stand in an open field, and notice that our arms hang limply at our side. If we swirl around, the stars swirl around in our field of vision, and our arms get pulled out by centrifugal force. Then we stop swirling, and our arms are limp. Why should the distant stars and the local centrifugal force agree on what constitutes the non-rotating state? Mach proposed that the reason is

because the distant stars somehow had a role in defining what it meant for a local object to be non-rotating. The idea was primitive,but inspirational--- it meant that the local space-time was somehow related to the global configuration of matter. After relativity was discovered, Einstein reworked Mach's principle into the statement that the local notion of rotating/non-rotating (which is encoded in the metric tensor field) was the proper generalization of the Newtonian gravitational field, and Einstein hoped that classical General Relativity would give enough constraints on the gravitational field so that it would be determined from the matter configuration, and fix the local notion of inertial frames from the global configuration of matter. General Relativity did do something like this--- if you look at an object surrounded by a rotating sphere of matter, the object will feel no centrifugal force when it is slightly rotating in the same direction as the sphere. The effect becomes more pronounced as the sphere gets heavier, and the inertia idea of no-rotation inside is asymptotically matched better and better to the rotation of the sphere when the sphere is just about to collapse to a black hole. This effect is called "frame-dragging", and it was an indication that there was some sort of Mach's principle in General Relativity. But in General Relativity, this isn't really completely true. The issue is that there is another boundary--- the boundary far away--- determining what's the rest-frame, because there could be matter infinitely far away, thrown to infinity in the limit. So you can zoom into a point with a rotating black hole, and make the black hole smaller and smaller, then the rotation looks like it is relative to nothing, because everything else has been pushed out to infinity. So you must have a solution which is asymptotically flat with a rotating object in the middle, and indeed you do, this is the Kerr black hole. Einstein's response to this objection was that the universe should be closed on itself, like a sphere, and this motivated his spherical cosmology. In a spherical universe, you can't have a single rotating black hole, you need to balance it out with something else on the other side rotating too (although whether you call it "the same" or "opposite" direction depends on your perspective of how the rotations should be labeled). Einstein's universe is not stable--- the matter in this universe will collapse into black holes, and eventually, one of these black holes grows big and becomes the cosmological horizon, and swallows everything else, and the Einstein universe turns into deSitter space. This is important, because the deSitter space has as only matter the cosmological horizon (remember, this used to be a black hole). This means that you should not think of black holes and cosmological horizons as somehow second-class matter--- these things are matter like anything else. Godel found a more weighty counterexample, the Godel universe. In this universe, the distant matter is rotating faster and faster as you go away from the center. The issue is that eventually the rotation is faster than light, and you can make closed timelike curves in the space. So this example wasn't so physical, but it was very strange, and it made it seem that Mach's principle was just a vague heuristic without a precise formulation. In the 1960s, the development of S-matrix theory suggested that it was possible to make a quantum theory without using space-time notions. The idea was to use asymptotic plane-waves and their scattering to describe everything in terms of quantum transitions between asymptotic states. This idea was the first real method of making a theory without direct reference to space time, but when Feynman tried to do it, he ended up with another form of quantum field theory. Similarly, when Chew tried to do it for pions, he ended up with an effective field theory of the form of the modern chiral models, as understood by Weinberg. But the S-matrix theory of Regge trajectories, unlike the theory of finite number of particles, did produce a new thing, and this new thing, string theory, included General Relativistic gravity in an approximation of low energies and small strings. In this theory, the string objects can be identified with black holes in the classical limit (it's hard to make them classical, because this requires that you leave the regime where they are perturbative, but there are tricks--- you can use duality to relate strings to D-strings in type IIB string theory, and the IIB strings can be T-dualized to branes of different dimensions and then stacked to become black holes). So in the string theory version, all matter is horizon stuff, it's a quantum black hole. The holographic principle is then the statement that the oscillations of this black hole reconstructs the space-time around the black hole, so that the entire theory is

formulated on the boundary, not the interior. This is the precise version of Mach's principle, and in this form it is correct. The understanding of the holographic principle is made precise in AdS/CFT, which gives precise examples of space-times reconstructed from black hole surface dynamics. It is a very strange duality, and it is a-priori impossible except that string theory does it. This is strong evidence that string theory is the only possible way to formulate a theory of quantum gravity. The holographic principle for string theory is much like the equivalence principle for GR, it explains why the theory must look the way it does. To see why holography is important--- we now suspect that the N=8 supergravity theory is perturbatively renormalizable. Does this mean it is a possible complete theory of gravity as Dixon sometimes suggests? The answer is no, because it is s a field theory, it suffers from the usual paradox of field theory that when you form a black hole, it has infinite entropy. This is reflected in the fact that the N=8 theory looks like an inconsistent truncation of a string theory, but where the extra stringy stuff is pushed out to be very massive, so it doesn't influence the perturbation theory at any finite order. So the principle of renormalizability is not really what is selecting string theory, it is the holographic principle, and only the holographic principle. The S-matrix idea of the 1960s was a primitive version of this, because in the AdS/CFT correspondence, the CFT turns into the S-matrix in the limit that the space-time becomes flat.

Is it true that if we are able to unify gravity with other forces with the help of quantum mechanics, we would be able to solve the mystery of the black hole?

It is annoying to answer a question which asks "if we did X could we do Y", when we did X and it did Y. We already unified quantum mechanics and gravity to a great enough extent that it solved the mystery of black hole formation and evaporation, and this happened in the 1990s, with the development of modern string theory and AdS/CFT. This resolved the major paradox of black holes, namely: how can black hole formation and evaporation be unitary, when the outgoing Hawking radiation doesn't seem to give a hoot about what it was that formed the black hole? The resolution to this was painstakingly peaced together by 't Hooft, Susskind, Maldacena, Witten, Polakov, Gubser, Klebanov, and many others. The answer was already implicit in the formulation of string theory--- the black hole formation and evaporation process is the same as the process of string scattering, and it reconstructs space time from surface degrees of freedom, like the worldsheed fields are the space-time coordinates in string theory. The result is that today we can calculate the complete formation and annihilation of any finite-size black hole on an AdS or flat space time, and answer all the questions you can ask about this black hole in principle. But since this is computationally very demanding, we still haven't answered all the questions about black holes. For me, the most pressing question is what are the emissions from near-extremal black holes. This is important both because there is a paradox there that is never stated in the modern literature, and also because it is experimentally relevant, because we have rotating black holes in galactic centers that might be close to extremality. The main remaining paradox of black holes is that classical extremal or near-extremal black holes don't have infalling matter get close to a singularity. If you drop a weight near an extremal black hole, The matter bobs in and out in it's own proper time, making harmonic oscillations in the radial coordinate "r" that carry it in and out of the horizon again and again. How this happens is through the different regions of the maximal extension--- the object crosses the outer event horizon, then the Cauchy horizon, then the Cauchy horizon going the other way, then the event horizon, and these oscillations go on forever. In the classical theory, all these oscillations are into separete universes. This cannot be true physically, because there is a backreaction

paradox: when the object enters the black hole, the black hole gets bigger, but when it comes out the black hole becomes smaller. But if the object is entering a black hole in our universe and exiting another black hole in another universe, the two black holes after the transit are of slightly different size, and this contradicts the statement that they are continuations of each other, because all the black holes in a continuation have the same size on all the sheets. This also contradicts black hole unitarity, the object seems to be carrying information irreversibly to another universe. There are two resolutions, 1. The object enters the black hole and thermalizes at the Cauchy horizon. 2. You just have some identification between the sheets so that the object comes out again in our universe. The entire literature thinks it's 1, but I think this is completely absurd, because the thermalization must happen in a fixed proper time no matter how cold the black hole. A cold black hole can't thermalize a coherent thing falling in so efficiently, it contradicts what we know about thermalization times in any other physical system. But number 2 is not worked out. If you think the stuff comes out in this universe, you need to figure out exactly how long this takes, and this requires a string description. This requires quantum gravity, because the transit takes an infinite amount of time classically. It cannot happen in finite time because an object coming out of a black hole it earlier fell into always means it crosses it's own path, leading to closed timelike loops and grandfather paradoxes. But the grandfather paradoxes occur right in the region which was shown to be unphysical by 't Hooft while formulating the holographic principle--- if you come out sufficiently later than when you fell in, you can only meet yourself in a thin skin right near the horizon which is asymptotically exponentially skinnier than the Planck length, and is clearly not leading to any physical paradox. It doesn't exist in a stringy reconstruction of spacetime. The idea that stuff falling into a black hole comes out non-thermalized might mean that galactic centers can produce anomalous antimatter signals, because the process of coming out of a black hole can allow you to come out in the wrong direction of "T", and the only consistent identification which is possible reversing T is CPT identification, which requires an object to come out antimatter. This is speculative,

but plausible, and it doesn't matter, because we have the full theory, we can calculate this in principle on a computer, and we can trace what happens in the formation of a highly spinning black holes. This is something I think about when I get the chance, but I feel like I am the only one. People in the literature have a consensus that it's option 1, paradoxes be damned.

In string theory, what is AdS/CFT? Is there a better explanation than the wiki article?

AdS/CFT is the completion of the program of string theory to the general situation, generalizing from 1-dimensional strings, which are just a special case in special limits (although a particularly interesting special case, because long strings can't stay put--- they are required to be delocalized through the world-sheet Mermin-Wagner theorem) to all the branes in all possible world-volume dimensions. AdS/CFT unifies string physics and black hole physics, in a consistent quantum mechanical framework, and gives a full description of the string-theoretic S-matrix (actually, the analog of the S-matrix in AdS-space, which is just the "CFT" of the correspondence), so that you can calculate everything that happens in any situation for certain types of spaces on a computer, in principle, with the caveat that we still don't know exactly how to read out the computer output and turn it into what's going on in the reconstructed space and time very well (but we know how to do it for certain things, enough to be sure it is possible, and we will know eventually, it's not hard in comparison with previous advances, it's just one of the things people are thinking about actively now). To really understand how it works, it is best to read the original papers. These are 'tHooft's papers from the late 1980s in Nuclear Physics B, introducing the modern holographic principle (although some of the content is slightly wrong, because he is dealing with normal thermal black holes, just ignore the parts that don't work

100%), Susskind's papers on the holographic interpretation of strings as quantum black holes, these showed that 't Hooft's concept is realized in string theory. The first real example was the Banks, Fischler, Schenker, Susskind Matrix theory of 1995, although this case is the most difficult to understand intuitively, because the whole of space is reconstructed holographically, and then the famous 1997 paper of Maldacena which demonstrated a 4 dimensional form of the idea, and papers citing this one. The old ideas of 'tHooft on large-N gauge theories are important, and you need to know the background on D-branes, which comes from Chan-Paton in the 1970s, and Polchinski in the 1980s and 1990s, and it is described best in Polchinski's book on String theory. The basic idea is very simple to state qualitatively: the holographic principle states that the description of the space-time near a black hole is completely described by the shaking of the black hole horizon. The reason to believe this is that this is the only way to make sense of the fact that the black hole entropy scales as area, and yet the quantum mechanical process of forming and evaporating a black hole is unitary. Hawking correctly understood that these two ideas are contradictory, and this tension is the main conflict between GR and QM, it is what forbids gravity from being described by a local theory. 't Hooft understood that the main conflict is the infinite entropy in thermal fields outside a black hole--- if physics stays local, if field theory is correct, then a black hole would have an infinite entropy, just from the entropy of the local fields very very close to the horizon (but still outside). You can understand the infinite entropy from the classical "frozen star" picture--- the outside region, when you look very very close to the horizon, contains all the information about everything that ever fell in to the black hole. This information is not really there, the black hole has only a finite amount of information capacity, given by Hawking's entropy. So the black hole has to somehow inform the outgoing radiation from the incoming stuff. How does that happen? The only imprint on the Hawking radiation from incoming stuff is through the gravitational force. Not the gravitational force of the infalling stuff on the photons, that's negligible for a big black hole, rather, the gravitational field of something that falls into a black hole has a nonlocal effect on the

horizon. The horizon is defined as the place where light just can't escape to infinity, and when there is something nearby, this location moves around in a global way, you have to do complicated back-tracing on all the rays to figure out where it is. For the special case of a fast moving object, the deformation of a large horizon is of a special form discovered by 't Hooft--- the black hole horizon piles up at the location of the impact, to make a strange funnel-shape with a logarithmic spike. This spike tells you where the object is going to hit, and if the object is very close to the black hole, it traces the location of the object in a strange non-local way, so that it looks like this spike on the horizon is also a description of the object. The emissions of Hawking radiation in the far-future is only influenced by these spikes on the horizon, and since the Hawking radiation has to tell you all the information about the infalling matter, these on-the-surface spikes must by a complete description of the infalling matter, at least if it is very close to the black hole horizon. This is the holographic principle---- the dynamics of the black hole surface produce a complete description of the surrounding space-time close to the black hole. The holographic principle also demands that anything going on in the interior of the black hole is encoded in a similar nonlocal way on these surface oscillations. So it's really the whole space-time that is produced from a completely different kind of theory, the theory of oscillations of the surface, which is in a different number of dimensions. From the form of the spike, 't Hooft realizes that the black hole theory is some sort of string theory, although it looked strange because his black holes were four-dimensional and thermal, rather than stringy and extremal. Still, and his considerations lead him to propose that gravity is described by S-matrix theory, something which was proposed in the 1960s for the strong interactions, but later replaced by the gauge field theories that 't Hooft pioneered in the 1970s. The space-time near a cold black hole is an AdS space. An AdS space is a space of constant negative curvature, like a saddle. The reason the curvatures become constant is because you as zooming in on the horizon, so that the scale of curvature variation becomes negligible. For a thermal black hole, the near horizon geometry is flat, except in accelerated coordinates. For extremal black holes, the near-horizon geometry is AdS. You can

see it by looking at the Reissner Nordstrom solution and expanding near the horizon, the expansion is the same in higher dimensions, and it always gives an AdS space in the directions going away from the black hole, and in the directions which are not going away from the black hole are like the sphere in polar coordinates, they make a sphere. This is AdSn cross Sn, an AdS space in the radial directions and the sphere in the polar angle directions. Further, when you have black holes within a string theory, at weak coupling, when the strings are weakly interacting, and when the black holes are extremal for certain charges, the black holes themselves only add endpoints to the string, they are D-branes. The D-brane description is by Chan-Paton factors, meaning that the string carries a variable that tells you which hole it ends on, and these factors make a gauge field theory, in the way open-strings are understood to behave since the 1970s. The open-string description shows that at low energies, if the strings are always attached to the branes, the theory is the low-energy limit of string theory near a brane, which is just the SU(N) gauge theory with a lot of supersymmetry, a theory which is already known to be conformally invariant (meaning you can do local scale transformations). From the holographic principle, you conclude that the stuff which is going on in the full string theory near the brane must be described entirely by the SU(N) gauge theory. So the string theory on AdSn cross Sn is described by a conformal theory of the SU(N) gauge theory type in n-1 space-time dimensions. This argument was presented by Maldacena, and it finally showed how string theory is related to gauge theory in a nontrivial way. All the older ideas of the 1970s, 't Hooft's large-N, string theory as a theory of hadrons, and of the 1980s, Polyakov's extra field for noncritical strings, the D-branes of Polchinski, these were all understood from the correspondence. The basic principle extends to all black holes which are extremal, and there are holographic descriptions of many of the black holes we know occur in string theory, although the list is not exhausted yet. Just a year or two ago, the holographic description of the M2 brane was discovered, for instance. The AdS/CFT correspondence means that you can describe all the dynamics of things stuck to an extremal black hole completely and quantitatively, using a mathematically well-defined field theory,

the supersymmetric SU(N) gauge theory. The limiting procedure allows you to give a precise definition of quantum gravity on an AdS space entirely from the dynamics of the gauge theory. You describe the geometry from nonlocal reconstructions starting from the boundary field theory.

Physics challenge. Solve it if you can !

The Higgs mechanism doesn't bind massless particles together to make a massive particle--- it gives mass by reversing the helicity of a Fermionic particle constantly. The Higgs mechanism is not a case of massless particles making bound states which are massive, but QCD is. Even with massless quarks, the QCD particles, the proton for instance, would be massive. This is a purely quantum effect, it is due to the vacuum in the strong interaction making the strong gauge field random at long distances, and it also has no classical picture which is not statistical fields in imaginary time. So I would say, please don't think of it as little classical points held together with forces, the right pictures are quantum mechanical, and there are resources to learn quantum mechanics.

What reservations do you have about how math is taught to young students and what alternatives do you suggest in light of these?

The computer is under-utilized. With a simple course on programming, first in a simle high level language, then in assembly,

then in C, then in Lisp, and a graphical library capable of plotting points for the student, you automatically force a person to learn a big chunk of practical mathematics simply because it is needed for programming the computer--- if you want to draw a circle, you must know the equation of a circle, or a parametrization. If you want to simulate a planet orbiting the sun, you must know how to turn the equations of motion into an algorithm, you have to understand differential equations. If you wish to compute an integral numerically, you must know what it means. Some of the problems are subtle. if you want to do a flood-fill algorithm, you will find out how to decide if a point is interior to a region algorithmically. The methods in this case were discovered only in the early 20th century. In order to represent manifolds on a computer, you need to use various discrete forms which were each important--- combinatorial simplicial complexes, algebraic equations, wavelets. The introduction of formal logic to computer-trained people is relatively effortless, because people use logical operations in computers all the time, and become familiar with boolean algebras. The quantifier calculus is the only new thing which is not common to other computing tasks, and it's not so hard. The logical deduction algoritms can be used to do mechanical reasoning, which is the main point of computers, and the proof of the elementary logical theorems are so trivial given a computer, they are self-evident and hardly need proving. The other astonishment is how easy it is to find unsolved problems using a computer. Kleene Algebras, Cellular automata, Collatz conjecture, these are all extremely difficult problems where it is trivial to see the content on a computer. There are certain superficial problems with this approach, because it is essentially an approach to what is called "constructive mathematics" or "formalist mathematics", in the sense that all the mathematical objects are concrete and representable. This is not a restriction, as we know how to make a concrete model of any axiom system algorithmically, step by step, in principle, using Godel's completeness theorem, but philosophically, people generally don't think of this model as being exactly what the axioms are describing--- we tend to think of the universe of enormous sets and real numbers, rather than the universe of formal symbols for sets and real numbers, since the

second thing is intrinsically countable, while our intuition for mathematical real numbers is that they are intrinsically uncountable. But the only thing we can manipulate on the computer is the computational representations, the symbols. So with computers, a young person is basically made to learn Hilbert's point of view, the formalist point of view. This then makes certain results difficult to accept, the ones that have stood in the way of Hilbert's program. It also sounds Soviet, it is in opposition to what is thought of as the transcendent view of the Platonic universe. But I believe this philosophy is correct, and equally transcendent as the usual philosophy, except having the advantage of being absolute, it is not riddled with undecidable questions about the continuum as the usual view is. We have a good understanding of what the use of infinity in mathematics is all about today, it's about introducing bigger and bigger ordinals, to allow more and more complex axiomatic methods. There is no need to have a mystical view of it, because these ordinals never need to be uncountable, and in fact, it is likely that they never need to even be non-computable, the ordinals less than Church-Kleene ordinals are probably sufficient to prove the consistency of any system, no matter how strong (although this is not yet a theorem). The non-computable and uncountable ordinals are simply tricks for extending the naming convention for ordinals to higher places than you can do by ordinary naming conventions, because the new ordinals which are uncountable just collapse in a countable model to larger countable ordinals than what you could represent originally. I think it is important to learn how to use a formal system of reasoning early. It really doesn't matter which one, so that you know what a rigorous proof is supposed to look like when you see it. The computer is not a panacea--- there are aspects of mathematics that are difficult to express in the primitive computational languages we have today, things like ordinals, uncountable sets, abstract groups and algebras, geometrical arguments that involve homotopies that need to be visualized, basically everything mathematicians find interesting. The formalisms can be put on a computer (everything can), it just hasn't been done in an efficient way. A computational education can spur the development of these computational tools. For grade-school math, the

computer, especially if augmented by some higher level languages with support for advanced functions, is extremely useful for providing both motivation and intuition. So much so, that with a computer, a child will basically learn all of grade school math independently in a very short time, and will just be bored in school. I agree that calculators are not useful. Calculators are not computers, they provide only a limited amount of intuition, because they perform only the most basic tasks, with a human bias as to which tasks are most intereting. The computer is universal. Generally, I don't think education is so much of a problem anymore, because young students can learn mathematics by themselves with an internet connection. If there is something missing today, it certainly won't be missing in a decade or two.

What steps should I take before deciding whether something is science or not?

The only way is to read the related literature, and evaluate the claim yourself. If you are not competent to do this, if you do not trust that your understanding is complete, you can post it to an open internet forum, and ask if someone knows whether it is ok. You will get a bunch of technical feedback, and then you just ignore the political parts, and look at the technical content. This usually takes only a few hours, and it is generally spot-on. If you are pressed for time, you can use political measures to determine whether an idea is true or false, but then you should say "I believe this idea for political reasons, I don't have any real evidence". This way, people don't get a false sense that you have somehow done a technical analysis. The methods of the "crackpot index" fail precisely at the point where you have an innovative discovery. The last item: "50 points for claiming you have a revolutionary theory but giving no concrete testable predictions." is an undisguised attack on string theory, which, as a gravitational theory, hasn't made new predictions of high quality. The theory is correct and

highly nontrivial, so they will come, one must have patience. The theory already makes predictions as a mathematical tool to understand the strong interactions, and these predictions are often swept under the rug. Only for string theory as a gravitational theory, are the predictions meager for the energies we can directly probe, but even there, there is no chance this will remain so forever, since there are paradoxes about spinning black holes which can only be resolved with string theory, and there are spinning black holes all over the universe. There are statements which are "widely agreed to be false" which are revealed to be true when the evidence is evaluated impartially with statistics, to determine actual likelihoods rather than socially mediated consensus. For example, the claim that Marlowe wrote Shakespeare is widely agreed to be false, but the statistical analysis of the stylometry by Peter Farey (and also, the more subjective method of "read it and see") shows it is very likely, and with the added evidence from Mendenhall and Ehmoda, Charniak et al stylometries, it reaches the point of certainty for me. The claim that nuclear reactions happn in deuterated palladium was widely agreed to be false last time I checked, but it is overwhelmingly supported by the actual evidence, which is compiled at lenr-canr dot org. Conversely, there are statements which are widely agreed to be true which are revealed to be false when the evidence is evaluated impartially, for example, that oil and coal come from ancient living things (this was shown to be false in the Soviet Union, and later by Thomas Gold in the west). There are statements which are widely agreed to be vacuous which are revealed not to be vacuous when examined more closely or with additional assumptions, for example, the statement that the S-matrix must obey relativistic dispersion relations, a statement which was considered vacuous in the 1980s but which becomes very contentful when you add the assumption of narrow-resonances and parallel Regge trajectores, or "survival of the fittest", since fitness is defined by survival, but this is very predictive in real life. There are statements which appear logically inconsistent, for example, "The axiom of choice is true, the well ordering theorem is false", but which are not inconsistent when examined more closely, because of implicit assumptions that are rejected (in this case, that the collection of real

numbers form a set, rather than a proper class). There are statements that sound logically inconsistent because the author is trying to explain new ideas, and states things slightly wrong, but the author is not really confused. Every person with a new idea sounds like they are full of crap. Saying "you are contradicting yourself" is the most common attack on any new proposal, true or false. There are thought experiments which contradicted real experiments, for example, Einstein's thought experiments on relativity contradicted the early experimental results which supported Max Abraham's theory. Sometimes it's the experimentalist that makes a mistake. YOU CAN TELL THE TRUTH IN CAPITAL LETTERS, you can tell it in small, it makes no difference to the content. I think it is more important to read Einstien and Hawkins attentively than to spell their names right. Quantum mechanics might be fundamentally misguided. We haven't built a quantum computer yet, and it is possible that the positivist contortions forced on us by the interpretation are a sign its an approximation to something else. It might also be just hunky-dory. I don't know. If you asked me to bet, I would only take even odds right now. The crackpot index is just an attack on original thinking, pure and simple. There is no political metric which effectively separates nonsense from an important new discovery. You need to read the stuff, and evaluate it impartially, even if it is written by the self-proclaimed next Isaac Newton who worked on it for 10 years in complete isolation, and says she has been robbed of the Nobel prize by a conspiracy of buffoon-like academics. None of that matters. All that matters is the content. This is why science depends on rejecting politics. I therefore like to use the crackpot index as a "how to". Try to get as many points as you can possibly get, and then you know that if you persuade somebody, it's because you are actually right, not because you sound right.

Was Reagan a bad president? Why? If you think Reagan was a bad President, what were his failures and shortcomings?

Reagan was criminally negligent during the cold war with his stupid militaristic rhetoric, and needlessly escalated nuclear tensions at a time when the Soviet Union was very paranoid. This led to nuclear panics and inched the world closer to war in 1983, and personally, as a 10 year old, it caused me endless nightmares. The Soviets had a scare in 1983 during the ridiculously provocative NATO maneuvers, their radar malfunctioned. If that meteorite that landed in Siberia this year had instead landed in 1983, we wouldn't be chatting online, we would be hairless and vomiting over our rat stew. This stuff is a joke now, it's hard to remember that 30 years ago, everyone day to day had to factor into their calculations a non-negligible probability for complete annihilation. I was 10, but I knew what kind of bullshit he was doing, and this is unforgivable. For this alone, reversing Carter's detente, he qualifies as a terrible president, since increasing the chance of that kind of catastrophe by even 1% outweighs everything else. Reagan changed course in 1985, after a slew of nuclear-war films and warnings, but does a person really need that much of a kick in the pants just to not stir up trouble? Reagan often gets credit for market-oriented reforms that are entirely due to Carter, airline deregulation and austerity to curb inflation. The monetary policy of the early 80s which ended the inflationary 1970s was due to Volcker, who was a Carter appointee. The inflation was a relic of Nixonian hyperstimulation of the economy when all the big industrial production sucked up by the war in Vietnam. What Reagan added to Carter's modern policies was a nonsensical tax-cut and anti-union component that decimated working wages in the 1980s, leading to the modern polarized economy. The idea here was to reverse Keynsian policies and make a flat tax. The extreme of Reaganomics was the 1987 budget deal, where top brackets were slashed to 28%. That's as flat as the tax system ever got, and Reaganites like Jack Kemp, wanted

to take it further, and make a pure 25% flat tax. The idea of a flat tax flies in the face of modern economics. The purpose of taxation in a post-depression economy is to redistribute incomes, which are always distributed completely lopsidedly, to come closer to economic equilibrium, so that economic demand can keep up with industrial capacity. Without tax and spend redistribution, the spontaneous segregation of wealth in the economy makes all the income go to certain people in certain social classes. This segregation of wealth is theoretically forbidden in economic textbooks, it should be reversed by competition, but experience shows that it happens anyway. In every free-market economy ever formed, people who control capital can turn capital into income, despite the fact that other people are willing to do the same job for less, they just don't accept bids from those people. This siphoning off of income means that the workers do not make as much as they would in a competitive equilibrium, which means they can't purchase all the goods the economy can theoretically produce, and this means people working for dropping wages, only controlled by minimum wage and working-day limits, without the benefits of economic growth. Reagan encouraged this polarization in incomes, since he thought it would improve economic activity. The idea was "whatever happens in an unregulated market is getting you closer to equilibrium", and this is a farce. Reagan's economy was bracketed by two immense recessions, in 1981 and in 1991, and a minor stock-market crash in 1987. The era saw a rise in homelessness and childhood poverty, and an increase in racial tensions, things which subsided in the 1970s. The market changed when the tax rates went back up under Bush then Clinton, and especially when Clinton expanded the Earned Income Tax Credit to make it a true income redistribution program. Clinton's economy ran circles around Reagan's, in fact, it produced levels of growth and employment which had been declared to be impossible in a modern economy. The US was growing at 5-6% a year during this era, and unemployment was at 4% by the time Clinton left office. The income redistribution allowed the economy to function at full capacity, for the first time since the 1960s. Entirely new industries, like internet sales, and telecommunications companies, took root and prosper in conditions where consumers had

enough money to demand the services these companies provided. These economic policies were explicitly redistributive, and hated by the Reaganites, who considered Clinton's economy a lucky streak. or attributed it to Reagan's policies. I have no doubt that if Clinton's tax rates were kept, and increased somewhat at the high end, and the EITC was doubled again, the economy would have grown proportionately. It is also not clear to me that if Gore was elected, that the internet growth would have ever stopped. The internet boom of the 1990s is essentially repeated today, more slowly, and it was not really a bubble as much as an actual reconfiguration of the economy. Inflation is the marker of when the government is doing too much redistribution, and there was no hint of inflation in the 1990s. Unemployment and falling wages are the sign of the government doing too little redistribution, and these could be seen in spades in Reagan's economy, and Bush's. It is obvious to anyone who knows anything about the functioning of markets that income redistribution is necessary in markets with inequality on a vast scale, so as to allow the market to produce at peak capacity. This was advocated by conservatives as a substitute for government spending in Nixon's day---- the negative income tax was a replacement for unnecessary spending on military contracts, or onerous bureaucratic social spending with strings attached. With a negative income tax, all you are doing is removing income from people who have a monopoly on their labor and can charge exhorbitant rates for this labor, and redistributing to people who are not laboring in a closed position, and who deal with competition from others. In other words, you are taking undeserved monopolistic income, and distributing to those who work hard and efficiently under competition from others, and so deserve it. Reagan was the first modern conservative to oppose redistribution of income. He opposed Keynsianism, replacing it with his own brand of voodoo nonsense. Keynes is about demand, so Reagan called his vision "supply side economics", meaning, you have to make the climate nice for the suppliers. This is only true in those cases where the suppliers are somehow inhibited because there are not sufficient incentives for people to join their ranks. If you asked random people whether they would like to run a company, at any time in the 1950s-1990s, I don't

think at any point they would say "no, it's not enough reward for the work". There has never been a supply-side incentive loss. Reagan's appointees gutted anti-trust law. In the 1980s, the definition of "competitor" was relaxed so that even very distant companies which offer a vaguely similar product suddenly became "competitors", and the requirements for a competitive industry was that only 1 or 2 other large firms compete. This was a retrenchement of Teddy Roosevelt's hard-won gains. So Reagan was appealing to big pockets, saying, "look, we can reverse the Roosevelts, finally!" And they did. The growth with Reaganite policies has been tepid and lopsided, the incomes of working people do not suffice to purchase all the goods that the US economy could be producing today. You can see it, because there are people sleeping on the streets who could be making golfballs instead, but their labor is not needed, because consumers have too little money. Reagan also came to power with a religious socially conservative coalition that opposed the social advances of the late 1960s. The only thing they were right on was the drugs, but the left figured that out without their help.

What were the most accurate predictions of all time?

Here is a marvellous prediction, decades ahead of its time. In 1960, Pomaranchuk predicted that at high enough energies, the total number of collisions in a proton-proton and proton-antiproton beam would become equal. So that smashing a proton-proton beam would have the same total number of collisions as a proton-anti-proton beam, asymptotically, at energies much larger than the mass of the proton. At the time, the cross-sections were not even close, the anti-proton would annihilate with the proton, while the proton just bounced off. Further, the discrepency seemed to increase with increasing energy, the two curves for the total cross-section of the collision were going

away from each other as the energy increased (with energies available in the 1960s). The prediction was based on the assumed opacity of the proton, and the properties of scattering amplitudes in quantum mechanics under analytic continuation. it was surprising as all heck, but despite being not very rigorous, and counterintuitive, the theoretical argument was accepted as correct in the 1960s, and continued to be accepted and taught until 1974. In the early 1960s Gribov turned this predicition into a mathematical theory, the object that is exchanged in the scattering was described by Chew and Frautschi in the west, and called a Pomeron by Gell-Mann in honor of Pomeranchuk. In 1996, the cross sections of the proton-antiproton and proton-proton collisions were finally shown to converge, they become equal at energies of hundreds of GeV. Further, the scattering showed the so-called "rapidity gaps" predicted by Gribov, Chew and Frautschi, in the 1960s, and the pomeron was shown to be neutral to all charges, as Pomeranchuk postulated and Gribov explained. This prediction was part of the program of S-matrix theory, which stood in opposition to quantum field theory as the fundamental theory of physics. S-matrix theory was not the correct fundamental theory of the strong interactions, the strong interactions are described by field theory, but it made a good theory of gravity, and in this context, it is now called string theory. Because the field theorists were right, they buried the S-matrix theory in 1974, leading to a lot of problems for string theorists, who had a theory, but no political support, because it wasn't working so well for the domain they applied it to. But some of the predictions were accurate, because string theory is also an approximate description of the strong interactions, through the AdS/CFT correspondence, and in the modern literature, the pomeron is now partly understood as the strong-interaction analog of the closed string. The universality of the pomeron interaction is related to the universality of gravity as a force. The pomeron was not mentioned in high-energy physics from the end of the 1970s until the early 2000s, when it began to be discussed again by Polchinski and Tan, expanding on work of Gribov's student Lipatov and collaborators. The prediction of the Pomeron is one of the great unsung triumphs of physics in the

20th century, and it is only today that the work is getting fully recognized.

Is it true that science cannot promise eternal truths but only eliminate false hypotheses?

Science only produces eternal truth, that's what survives after you eliminate the false hypotheses. All truths are eternal, by the way, otherwise they aren't truths. Eternal truth: if you run electricity through water, you will always produce hydrogen and oxygen in molar ratio 2;1, and never any titanium. Eternal truth: Newton's gravitation works in a domain where hbar and c are small, and the scales are much much less than cosmological, to such and so accuracy. Eternal truth: human beings are descended from rat-like things. The truths of science are still true even after the theory is superseded by completely new ideas. The old ideas just have to be qualified a little bit. The eternal truth about human beings is really a prediction about the future: it's telling you what you will find if you sequence DNA or dig in the ground. You are confusing the process of science with it's output. The process allows you to challenge anything, and produce evidence, and debate in as much of an anti-authoritarian environment as you can muster up. That means no ideas are held up as sacred, but are challenged without the help of being politically called "absolute truths". But just because something can be challenged politically doesn't mean it's not true, the challenge and withstanding scrutiny is just how it demonstrates that it is actually true, rather than some political bullshit. If you don't subject ideas to harsh open scrutiny, bogus crap wins out. For example, Aristotlism. There is nothing that Aristotle says that was simultaneously verifiable and true. But his ridiculous blather beat out the scientists of his age. To prevent this, you allow all ideas to be challenged. But that doesn't mean they aren't

true, it just means you have to check openly and honestly if they are, so that you don't get trapped in bogosity traps, like Aristotlism.

How is Ron Maimon able to be at the cutting edge in multiple fields ranging from theoretical biology to string theory?

I AM NOT AT THE CUTTING EDGE. I have a few dinky discoveries. I worked out some stuff in biology that is significant, but that's only because biologists had no theory until recently, most of them still don't, so it's all low-hanging fruit. In physics, I discovered something now called the "weakest force principle", but I didn't publish due to my own incompetence at publishing, and the fact that I didn't believe string theory was consistent until Simeon Hellerman demonstrated with examples that it obeys weakest force. Lubos Motl and Cumrun Vafa figured it out for themselves a few years later. This is a minor result, because I wasn't able to prove it is true (neither did they). I have contributed nothing spectacular to string theory, and I don't even have time to work on it anymore, and I suspect I am all washed up there, because I haven't discovered anything stringy in years. The major thing I did in physics is explain cold fusion, that was a year or two ago. I put it on stackexchange, which allows you to edit your answer and expand it as you find new stuff. I am certain the mechanism is correct, because it is consistent with the wacky transmutation results, and it requires no new physics, and actually, if you were clever, you could have predicted the effect before it was observed. But I am also certain that nobody will take it seriously for a long long time, because I know how mentally defective scientific politics is, and who knows when the physicists will get serious about scientific honesty again regarding cold fusion. I have some nice papers in statistical physics in close collaboration with Jen Schwarz, and one

of them gives an explanation for static friction which is certainly correct, but again, good luck getting anyone to pay attention. It also needs an extension to the situation where the forces are nonlocal, which is a real solid-solid interface with power-law interior-mediated tensions, but the basic mechanism for the static-friction effect is what we called "phony hysteresis", but what PRL's editors decided to call "An Unusual Hysteresis Effect". PRL editors, go fuck yourselves. The only difference is that I can read stuff online, and I don't waste time trying to get ahead in life, you know, accruing money, or social charisma, or stupid things like that, so it is easy to learn everything, but of course, you end up starving to death. I always saw it as a race against time: do you starve first, or discover something first? After you discover something, you can still starve, but at least you die having discovered something. The current era is just like the enlightenment take 2. In the enlightenment you had people who knew everything, because the printing press made blah-blah humanities knowledge widely available. The internet is 10 times better for that, and it even makes the mathematically intricate knowledge widely available. I ran into usenet in 1992, and I spent a lot of time there, and it was manifestly obvious after about a week that this was going to take over the world, and that the new generation after me would have access to 100 times more knowledge then me, and they wouldn't have to scrounge around libraries and hope to chance on things by flipping open books and reading at random (which is what I did to learn, it's better than going to school, but it's not as good as having a search engine to help out). They would actually have resources, and they would run circles around the previous generation, and I was scared to death of these unborn future intellectual supermen (they aren't around yet, but they're coming). I always felt completely inadequate. Praise and financial reward is the mechanism society uses to make sure people who have some study inside them don't discover anything, so please don't praise me. It was also obvious that the internet would fix the attention-deficit, the distance between the monumental work of the 1950s-1970s and the scant attention given to it because nobody had time to learn it all in the dead-tree era. I don't just mean physics here, I mean all that humanities stuff that was produced in the brief

flowering of 1968-1974 that was gradually reversed in the 1980s because neither capitalist or communist media would advertise it. The internet meant that in 1994, no matter how much I had already studied, I was already incredibly stupid and far behind, and the education I was getting was already worthless, because it was delivered without an internet and it would be trivial crap in 2013 (so it is). So I needed to sit down and learn everything that had ever been published, even if it isn't online yet, because it will be soon. So I tried my best to do that, with my average brain. It was easy in grad school, they don't push you to do anything, and I spent a long time there, really superannuated, and really disliked, because I obviously wasn't ever going to put together any thesis, and I obviously was never going to have any political power, and I was probably going to starve to death (I didn't mind, I figured most physicists do their best work before the age of 40, and I calculated that I probably wouldn't be homeless and starving until I was around 45-50.) I also became depressed around 2000, as I gradually realized Leonard Susskind had solved the central problem of physics, so I started thinking about biology, which was because I understood the origin of life from Wolfram's stuff, and reading Darwin. Then I figured out something in biology in a small company that some friends of mine had started (they wanted me around at first, but then when the culture turned corporate, they fired me. They also fired Virkrum Periwal, a guy who contributed to string theory but was denied tenure at Princeton and took a chance in the private sector. It didn't pay off, and now there is yet another brilliant string theory guy vegetating in a low position. After the biology work was out, I became depressed again. This was a combination of the fact that my country was turning into a fascist police state, after you publish something you always get depressed (I didn't know that then), I had ridiculous romantic trouble, and I was trying to do programming that was just beyond my abilities at the time, and also I had turned 32, and I figured that all my best work is behind me, which is Dirac's depression, all physicists go through it. After I was fired from my job (which was just a matter of time, corporate culture is incompatible with science), I would just go to seminars and live off my parents. This was depressing. Then I got

married and lived off my wife. This was also depressing, but I did some reasonable work during this time. Now I got a job through a friend of my brother, so I spend most of my time programming bio stuff, and it's interesting good science, but academia is much more bureaucratic than I remember, and the politics in biology are even worse than in physics. My knowledge is still extremely defective. I don't know anything about Algebraic Geometry, in mathematical logic I don't know the real results, the stuff from the 1970s and 1980s, because I'm annoyed that the forcing stuff is not presented in it's full potential, so I have to translate all the stuff from logic-ese. I don't follow mathematics in general as much as I should, mostly because I never have time to read the literature. So dude, it's not that I'm so smart, it's really, what the heck is wrong with all the rest of you? There's no excuse for ignorance today.

How did string theory begin?

String theory is the culmination of a particularly radical program of physics which has it's roots in the period 1938-1941, when Wheeler formulated the concept of the S-matrix, or scattering matrix, and Heisenberg was very taken with this concept, and proposed that it is the fundamental quantity underlying all relativistic physics. Wheeler's S-matrix is a quantity that tells you how incoming particles are turned into outgoing particles. The incoming free particles are energy-eigenstates, meaning they are enormous long plane waves with definite energy, and after scattering, they turn into a superposition of other plane waves. There are annoying intricacies in doing the limit for the S-matrix, because two infinite plane-waves never scatter (the particles are spread out over all space, and so never find each other). The S-matrix is defined as the limit or scattering amplitude density per unit momentum on the mass shell per appropriately scaled unit area of the incoming plane waves. The mathematical intricacies are not so

important, the S-matrix is a definition of how particles come in turn into particles coming out. The basic idea Heisenberg had was that Wheeler's S-matrix doesn't require following the details of what's going on in-between the input and output, it can describe the whole process without knowing what is going on in the middle. By employing logical positivism, Heisenberg became convinced that the S-matrix was sufficient to reconstruct the whole theory, so that only scattering was necessary to know what was going on in any situation. He then proposed that one should formulate rules for the S-matrix directly, without using quantum field theory to find a series for this. All this was in 1941, in Nazi Germany, and this means nobody paid attention, because everyone else had fled. Heisenberg proposed that one should use the principle of unitarity to reconstruct the S-matrix from some postulates. The idea here is that unitarity is the statement that SS*=1, and this condition relates higher orders of scattering to lower orders. Unitarity is a restrictive non-linear condition, and Heisenberg hoped that there would be a unique finite unitary theory, but he had no idea how to formulate it. The reason Heisenberg was interested in this is because, unlike the electron, the proton was discovered to be a big blob in space, it wasn't described well by Dirac theory. It's magnetic moment was more than 4 times bigger than what it should have been for a Dirac particle, and it's charge radius was about a femtometer, it wasn't pointlike like the electron. Non-pointlike particles are a problem in relativity, because you need to have consistent communication between the parts of the particle. The idea of space-time points in positivism requires local probes, elementary fields which represent localizable particles. If your particles are blobs, space and time might not be reliable notions. But if you use a unitary S-matrix, you are only referring to asymptotic things--- free cold particles in plane waves coming in and going out, so you aren't making any assumptions about space-time, whatever space-time is doing at short distances, the S-matrix is stable to these phenomena, since it is describing the relation between asymptotic things. Wheeler also emphasized the S-matrix (naturally, he discovered the thing, one of the first major natively American discoveries), and he was interested in reconstructing theories of particle interactions from S-matrix alone,

without a detailed space-time picture of fields. When Feynman became his student, they made an acausal formulation of classical electrodynamics, and he had Feynman work on the S-matrix for quantum electrodynamics from this classical foundation, and Feynman never learned or used local fields. He constructed the perturbation theory for quantum electrodynamics from pure S-matrix particle considerations, and, in heroic inspirational work, he derived consistent and correct Feynman rules from free-particle propagators, primitive interaction vertices (determined from the classical limit and minimal coupling), and the restriction of unitarity on higher orders, which determines the way loops have to work. His intuition was from the particle path-integral, which he formulated in order to tackle this problem. The results gave consistent scattering formulas, but they didn't mention any local fields, so Feynman thought he had an amazing new kind of physical theory. Not quite. Feynman got a rude shock--- other people like Schwinger had derived the exact same rules from local field theory! They didn't use S-matrix, and they got the exact same propagators and vertices, with no herculean efforts. Feynman had to work 10 times harder, and yet the result was equivalent. Dyson showed how to derive Feynman's diagram series from field theory, as Feynman did in the early 1950s, and Schwinger too, each in their own way. Candlin completed the thing by showing how to do path-integrals for local fields. This experience soured Feynman at Wheeler's S-matrix, and gave up the idea that this was something radical and new, and became a field theorist. Feynman was one of the critics of string theory when it was prominent, probably because he was already burned once by S-matrix. He heckled proto-string-theory in the 1960s, and his opposition was possibly a reason for the marginalization of the ideas in the 1970s (also, some mistakes made by S-matrixers in the 1960s--- I'll get to those). Aside from Wheeler, who came up with the S-matrix, postwar, the S-matrix idea was ignored until the around 1956, when Murray Gell-Mann, Stanley Mandelstam, Tullio Regge, Vladimir Gribov, and Lev Landau started to get interested, really under the influence of Feynman's magic looking derivation of the Feynman rules. In this case, it is Wheeler's ghost, once Feynman gets away from Wheeler, the S-matrix is out the

window. Anyway, the main results from this era were Tullio Regge's discovery of the fact that particles come in families which have to be scattered together in families with the scattering of all of these together reconstructing the true scattering, which is softer (meaning less divergent at high energies) than the scattering of the particles individually. Mandelstam and Gell-Mann were studying dispersion relations, integral laws which determine the scattering from the singularities of the amplitude. Landau discovered the correct physical interpretation of these singularities (from thinking about Feynman diagrams), they are places where you have just the right kind of energy in a subset of the incoming particles to produce a physical particle of another type. The dispersion relations allowed you to compute the amplitude from experimental data on physical scattering, and you would never have to work with a field theory! You could reconstruct the S-matrix from some simple considerations, and experiment. Mandelstam realizes that Regge's idea for families of particles with different angular momentum has a more physical interpretation in relativity, where you find that the asymptotic scattering at high energy is related to Regge's prediction for the unphysical scattering at values of "cosine theta" much bigger than 1. These predictions were mathematical curiosities until Mandelstam's interpretation came along, now they turned into experimental predictions: knowing the Regge trajectory function (the rate of increase of mass-squared with angular momentum) you could predict the rate at which the scattering amplitude fell off at high energies at any fixed "t" (meaning angle normalized by a power of energy). These relations were all S-matrix, meaning you didn't need a Lagrangian. At the same time, Froissart proved the Froissart bound in S-matrix, showing that there is a strict bound on the amount of scattering you can have in a theory with a mass gap. The scattering can't grow faster than logarithmically. There were many other more minor results in this era, relating S-matrix quantities to physical observables. This is where Geoffrey Chew comes in. He was a phenomenological guy, not like the big-shot theorists, and he at some point realizes that the strongly interacting particles, the proton, the pions, the Kaons, are all lying on these Regge trajectories. He says that this means that they are

not fundamental, and further, he says that the correct way to describe them is using the dispersion relations of Gell-Mann and Mandelstam, without postulating that there is a quantum field theory underneath. He calls this "nuclear democracy", meaning none of the strongly interacting particles are fundamental, they are all composite, and further, they don't have constituents, they are made up of each other in a self-consistent way. Chew and Frautschi showed that the basic law of the strong interactions is that the particles lie on straight-line Regge trajectories (meaning the mass-squared is linear plus offset function of the spin) and the slope is the same for all the mesons. Simultaneously, Gribov formulated the Pomeron trajectory, to explain why cross sections in the strong interaction were maximal--- they saturate the Froissart bound (actually, in experimental data, the cross-sections grow as a small power until now, meaning that they more than saturate the bound, they violate it! This behavior can't go on forever, the scattering has to fall back to logarithmic, and this is called "Pomeron unitarization" in the literature. The mechanism of Pomeron unitarization is not understood, nor is it heavily studied for reasons that will become clear soon) Chew went on to develop methods of extracting S-matrix predictions from a few particle interactions and experiment, while Mandelstam continued to press on with the idea of a fundamental theory using only dispersion relations and S-matrix. Feynman thought that the theory should be a field theory, Gell-Mann wasn't sure, and hedged his bets. In the 1960s, people were heavily split, with half the community working on S-matrix and hard mathematical stuff related to dispersion relations, and the other half secretly working on field theory, and nobody knew whether the strong interactions were a field theory or an S-matrix thing. In 1968 was the major triumph for the S-matrix folks. Dolen Horn and Schmidt had shown in 1967 that scattering in the strong interaction had a strange property--- normally when you exchange particles, you have a broad background and peaks on top of this background at places where you have particle exchange. But DHS showed that where you have a peak, the background is depressed, as if the background were a sum of broad peaks! This means that the particles you are exchanging that give you peaks (S-channel exchange in Mandelstam jargon) are really

responsible for the background (t-channel exchange). In quantum field theory, the two things are completely separate things. So people pondered what this meant--- they drew "fishnet" Feynman diagrams. In 1968, without knowing what this meant, Veneziano proposed a scattering amplitude that had the Dolen-Horn-Schmidt property. This property is so ridiculously restrictive that there were essentially only two solutions (modulo some assumptions, like straight line trajectories with parallel slope), Veneziano's and a later amplitude by Shapiro. These results were wind in the sails of S-matrix theory. People were confident that there would be a theory, that it would be unique, and it would solve the problem of the strong interactions. This meant that most physicists were working on S-matrix from 1968-1974, and field theory was marginalized. The S-matrix people were saying stupid things, like the fact that field theory has perturbative infinities meant that it was inconsistent, and that there would be one unique S-matrix consistent with relativity, things like that. During this time, people like Feynman and Bjorken were still trying to describe the strong interactions with field theory, that is, with point particle constituents. Experimental data from electron-proton scattering showed that there were charged points inside the proton, and this meant quantum field theory, not S-matrix theory (which predicts soft scattering from a diffuse blob). But nobody could figure out how the points were stuck inside the proton, so that we don't see free quarks or gluons. Also, Gell-Mann was dithering, because maybe the quarks are points, and the glue is S-matrix blob. Feynman in 1972 book "Photon Hadron interactions" demonstrates that if quantum electrodynamics is a field theory at the proton scale (something well supported by experiment by then), then the things in the proton that are charged should also be described by a locally commuting field theory. This was a strong argument for field theory, rather than S-matrix theory. Schwinger had given a toy field theory model with this property in the mid 1960s--- the Schwinger model of 1+1 dimensional electrodynamics. He showed that in this model, the electrons and positrons formed mesons and are permanently confined, because the electric field doesn't die away with distance. Nambu had postulated that the vacuum of the strong interaction was like a superconducting pair-condensate of fermions,

and this model was successful in predicting the interactions of pions, as shown by Weinberg. Weinberg also was becoming skeptical of S-matrix theory, because he was able to show that the predictions of Chew for pion scattering could be derived more simply from effective field theory. The finite-number-of-particles form of S-matrix theory was turning into field theory in another form, people were getting burned the same way Feynman got burned. But unlike Feynman's quantum electrodynamics S-matrix, or the S-matrix of pion-pion models which turned into the effective field theories of Weinberg, Veneziano's theory was clearly not turning into a field theory--- the scattering was always soft, things were completely composed of Regge trajectories, there was no notion of quantum field, in fact, there was no notion of space and time. The theory was clearly new and different from field theory, and it required infinitely many particles to be consistent. It was also very hard to make work, it demanded all sorts of things that nobody ordered. In the early 1970s, there was tremendous progress on what this theory was, and as the theory became fleshed out, it looked less and less correct for the strong interactions. Nambu proposed that the thing described by Veneziano's theory is a string. Susskind also proposed this, and understood how the string modes were Veneziano's things, as did Nielson from fishnet diagrams (good picture), and analogy with vortex lines (not 100% accurate, but whatever). By 1974, Lovelace had shown the Veneziano theory needs to live in 26 dimensions, Ramond incorporated fermions, and showed it needs supersymmetry on the world sheet (and the critical dimension shrunk to 10), Scherk showed the theory includes electrodynamics and Yang-Mills theory in low-energy limits, and Yoneya had shown that string theory includes gravity (work which was reproduced and extended in groundbreaking reinterpretation of Schwarz and Scherk). String theory was also predicting soft scattering at large angles, which was conflicting with the experimental data from Bjorken scattering, showing partons, little points. The more it was fiddled with, the less it looked like experimental data, and because it was a self-consistent S-matrix, you couldn't add stuff to fix the contradiction with data, it was determining itself by self-consistency. Then in 1974, when the Charm quark was discovered, the whole field

realized that the correct theory of the strong interactions was SU(3) gauge theory, with Nambu's color idea, and Gell-Mann and Zweig's quarks being the point particles. Field theory won, and S-matrix theory, including string theory, was thrown out as wrong garbage, and a lot of people lost reputation and jobs. The result was a complete counter-revolution in physics. S-matrix theory was mathematically and physically demanding, the stuff was incredibly difficult to understand, in comparison, field theory is kind of trivial (no offense to field theorists). It was easy for field theorists to think that the S-matrix people were engaged in horseshit, publishing garbage that didn't make any sense, and making up stuff by groupthink and consensus thinking, without any mathematically consistent thing underneath. This was especially true when field theory was shown to be correct for the strong interactions, all the motivation dropped out of the S-matrix program. I personally read a lot of the 1960s literature in the late 1980s and early 1990s, and I couldn't understand how all these people could be chasing after such obvious bunk. It is very hard to build intuition for string theory, because it is a scattering theory, so it doesn't tell a story in space-time (although this is improved with Mandelstam's 1974 light-cone formulation and Kaku and Kikkawa's string field theory, it is only true that you get a picture in a light-cone coordinates, and the picture is not really local in space-time when you consider the coordinate perpendicular to the light-front). The counterrevolution was a terrible thing, although a lot of good physics was done. It was essentially a conservative thing, like the politically conservative reagan movement, or the dismissal of progressive rock in favor of simple commercial rock, or the rejection of Marxism in favor of older ideas. These things were necessary, there was a lot of bunk in communism, progressive rock, and S-matrix theory, and this bunk needed to be purged, but the manner in which these things were purged threw out legitimate stuff along with the overreaching nonsense, and caused a lot of good people a lot of pain. Anyway, not everyone gave up on string theory. Scherk and Schwarz understood that this was really a fully consistent S-matrix including gravity, and it is probably uniquely determined, so it would be a theory of everything. The 1976 work of Gliozzi, Scherk, and Olive showed that

string theory was supersymmetric in space-time, and the construction of supergravity explained what string theory was predicting to alter General Relativity. These supersymmetry things were very fruitful to study, even within field theory, but string theory remained out. In the 1980s, there was a new young superstar, Edward Witten, who was a mathematics powerhouse with stunning physical intuition. He was following string theory, as were all the young people, and he was never sure if it was bunk or not. But he was very good with General Relativity, and he discovered a bunch of annoying things for traditional approaches to quantum gravity: * Kaluza Klein theory is unstable: this was a disaster, the space-time falls apart semi classically, due to a weird instanton you would never guess in a million years, and you would never see this instability in perturbation theory. You need to stabilize the vacuum. * Gravitational anomalies: you can't introduce chiral matter in gravity theories arbitrarily, there are insanely stringent consistency conditions on chiral stuff, and nearly all field theories of gravity are inconsistent. Further, it was clear that the path-integral for gravity was no good, the sum was over topologies, and included parts that diverge in ways that can't be fixed by going to imaginary time. Also, Hawking had made progress in quantum gravity, the first real progress, by showing that black holes were thermal. This meant that you needed to formulate the theory somewhat differently. There couldn't be any global conservation laws (you can't have Baryon number conservations, because you can make a black hole out of neutrons, and have it decay to gravitons and photons). The theory had to have an infrared ultraviolet link, because high energies produce big black holes, not small localized collisions. Now string theory was shown to solve all these problems. It was soft at high energies, and it was shown to have ultraviolet-infrared duality, and also T-duality by Schwarz and collaborators like Green. String theory makes every global symmetry a gauge symmetry, something which was known since the early days, from Scherk's work. So it was consistent with post-Hawking expectations, in a way no field theory could be. Further the supersymmetry in string theory showed that there is no process which would destroy a supersymmetric Kaluza Klein vacuum, so Witten's instability was also fixed. Then in 1984

Michael Green and John Schwarz showed that the gravity theories which come out of string theories, in those cases where they have chiral fermions, are magically just the ones that cancel all the anomalies. This was the last straw for Witten--- there is absolutely no reason that an inconsistent theory would produce anomaly-free low energy limits, especially that the cancellation was magic, relying on a conspiracy of certain bosonic fields and chiral fermions together. This kind of thing absolutely demanded that string theory makes sense mathematically. Further, the anomaly cancellation mechanism suggested there should be an E8xE8 string theory, which was duly found in 1985 by Rohm, Gross, Martinek, Harvey. The heterotic string was sort of "het" (different) and "erotic" (sexy) because it could immediately produce realistic physics with gravity. The main problem in string theory is because it was constructed as a self-consistent theory, you couldn't be sure if it was the right theory, because there was no data to support it specifically, and there was no physical principle to derive the theory. In the 1990s, Susskind, following 'tHooft's prescient analysis of Hawking's information loss argument, formulated the string-theoretic holographic principle. The principle Susskind gave explained why string theory had to look the way it looks, and explained what the strings are: they are little extremally charged black holes. The black hole oscillations have to describe all the matter that can fall in, and further, any one black hole can oscillate to reproduce any other, because anything can fall into a black hole. So in the 1990s, string theory was explained in a deep sense, through the holographic principle: it's the theory of black holes with just enough charge to be extremal. Then their shaking tells you how to reproduce the behavior of stuff near the black hole, and any one black hole can be made a constituent for any other, in the sense that the other black hole (if it is localized, like by closing the sheet into a compact shape) can fall into a big black hole of any other type. This led to the golden age in the mid 1990s, when string theory was extended to the AdS/CFT correspondence. The results of this era showed that string theory was definitely unique, definitely consistent, and almost certainly the only possibility consistent with the holographic idea, because it is a-priori impossible to construct a holographic theory,

except that string theory does it. This evidence is persuasive. Further, string theory now has regimes where it can be calculated to arbitrary accuracy on a computer, in principle, so we know it is well defined, at least on certain backgrounds. This means that we have actually solved the problem of quantum gravity in principle, although we have not solved the problem of the quantum gravity in our universe. The main barriers to string theory are that you can't predict anything at low energies yet, because we don't know our vacuum. This problem will be solved at some point when an exhaustive search of vacua is complete (this is not an insurmountable problem--- it's about the same as the classification of finite simple groups in complexity). The more fundamental problem is that the theory doesn't describe finite-area cosmological horizons, like the one surrounding us, and so there is still a domain which needs to be understood theoretically. I am optimistic that the theory will make predictions about black hole emissions in our universe, relatively independently of the high-energy details. The reason is that there are still mysteries in big black hole emissions, in the charged and rotating case, which we definitely know how to calculate in principle in string theory, but we haven't figured out what the general prediction is. String theory is the only way to be sure we understand black hole physics. This is not a review, and I have told a mostly personal story. Apologies to anyone I neglected, these were just what I thought of at this moment. Wikipedia has a reasonable history in the page on "String Theory" (which I wrote after thinking a little, and a few things were fixed up later).

Is it common for particle physicists to pull more all-nighters than other scientists? If so, why?

Of course yes, because at night no one bothers you, and you can do a long calculation in complete isolation while thinking through things. In the day time, there are people around bothering you, and doing theoretical physics requires complete and total isolation.

Is it possible to have a unified theory of everything?

String theory is a cold theory of everything, meaning it describes everything in a cold universe, like an AdS space of a flat space. Our universe is not cold, it's thermal, and it will stay thermal because we have a cosmological constant. Thermal string theory is not yet formulated, so we can't describe our universe just yet, but we can describe cold universes well. The consistency conditions on string theory make it pretty clear that there is probably no other theory consistent with quantum mechanics, General Relativty, and the holographic principle (the holographic principle is a precise, souped up version of Mach's principle). This means we already know a lot about what the theory of everything looks like.

If Higgs boson and Higgs field are the reason why mass exists, then what is the reason for the existence of spin?

The Higgs field is not the reason that mass exists. It is the way in which the elementary particles in the standard model acquire their masses. The mass of the dark matter particles is almost certainly

independent of the Higgs, the mass of the proton is nearly independent of the Higgs, and the mass of the lightest magnetic monopole (a stable particle which we haven't detected yet, perhaps it is too heavy to realistically make on Earth) is also independent of the Higgs. The Higgs mechanism is a special thing in the vacuum that allows particles to flip their helicity. Without the Higgs mechanism, electrons and quarks would not have fundamental mass in the Lagrangian. But the dirty secret is that they would still be massive, by a different, but similar, mechanism. The standard model without the Higgs still has a QCD symmetry breaking, which makes condensates in the vacuum. There would be 6 massless quarks, and SU(6) worth of massless pions, making a quark-antiquark condensate with 35 massless pions. The coupling of this condensate to the W's and Z's would give the W's and Z's masses much as if there is a real Higgs around. We would have MeV range W's and Z's, instead of GeV range and 32 massless pions, three pions would be eaten to give the W's and Z's mass. The result would be very different from what we are used to, but there would still be massive particles. So it is just wrong to think that mass is caused by the Higgs. Mass is a fundamental property of observed particles, and it is what it is, it doesn't require a mechanism. The Higgs is only required to give mass to elementary fermions and spin-1 bosons in the standard model. The Higgs mass itself is not generated by the Higgs mechanism, it is an effective parameter. Spin is a fundamental property of elementary particles too, it is the amount they spin around their axis. This is also not something which requires an explanation, or rather, the explanation is from the symmetry of rotations and relativistic boosts.

What is an intuitive explanation of measure theory?

Measure theory is the extension of the notion of length/area/volume/probability so that it is countably additive, meaning that if you have an infinite list of separate regions with a size that shrinks to zero appropriately fast as you go along the list, the size of all the pieces adds up in an infinite series to the size of the whole thing. This is the defining propery of Lebesgue measure--- countable additivity. So for example, a point has measure zero, and so does a countable set of points, because of countable additivity. So the set of all algebraic real numbers has zero length inside the real numbers, and a randomly picked real number will be non-algebraic (although one must make the notion of random-picking precise to make this rigorous). The intuitive explanation of measure is by probability, although traditionally in mathematics the definition goes the other way--- the measure of a set tells you the probability that a randomly chosen point in a big box containing the set lands inside the set. Since we can choose points at random in a box by flipping coins for the binary digits, there is a strong intuition that every set is measurable, meaning every set has volume, because if you pick a real at random, it has some probability of being in every previously defined set. But unfortunately, there is an issue here. In the early 20th century, when set theory made the notion of a set precise, Cantor's intuition was that every set corresponded to an ordinal, meaning that you could map any set one to one to a particular sort of list which allows induction proofs to work on the list. If the continuum of points on a line can be well-ordered, then there are necessarily sets that don't have a measure, because you can't find the location of a randomly chosen point in a well ordering consistently (when there is translation invariance in the measure, so that you can define a Vitali set--- you can pick a random point this in a "measurable cardinal", which is probably a consistent notion). You don't even need to well order the reals to do make a non-measurable set, all you need to be able to do is make a continuum number of arbitrary choices, this is the axiom of choice applied to the continuum (the well ordering of the continuum requires the axiom of choice applied to the set of all subsets of the continuum, the powerset of the continuum, so it is a stronger application of choice). Using the axiom of choice applied to the continuum, Vitali made a non-

measurable set. For this set, it is clear that the notion of length does not make sense. So measure theory becomes complicated, because people became worried about non-measurable sets. To fix measure theory, in traditional mathematics, you don't apply it to all sets, but only to measurable sets. But every set is really measurable, it is impossible to define a non-measurable set by any algorithm, the only definitions require doing an operation for every point of a continuum! So the measurable sets are really everything, but you need to prove this in each special case, and it gets annoying. The measurable sets are defined by a process of countable unions and intersections of intervals and points, and the result is a sigma-algebra, a collection of sets closed under complements, countable unions, intersections, but which exclude collections which are formed using uncountable choice and transformations of these by the axiom of replacement. In the 1960s, the notion of picking a real number at random was made rigorous in logic by Cohen and Solovay. For random picking to make logical sense, the notion of measure must extend to all sets of real numbers. This was proved in the self-consistent sense, meaning you can always extend a model of set theory in such a way that all the sets in the model get a consistent measure, by Solovay in 1972. The theorem guarantees that there are no actual non-measurable sense, and can be thought of as the completion of Lebesgue's program for a universal integration. The notion of measure shows that every geometric subset has volume, even very irregular subsets. So measure theory can now be defined as a universal thing, as applying to all sets of real numbers, saving effort in proving sets are measurable. Then you can make mathematical arguments using the notion of picking a real number at random, and you don't have to work to make this rigorous. Unfortunately, the transition has been resisted by a century of inertia, because mathematicians have grown used to the universe with choice and non-measurable sets.

Which deep insights, life-lessons, ethical principles and pearls of wisdom do you think should form part of a viable, non-partisan philosophy of life for the 21st century?

Here are some new ethical principles: 1. Use free software, preferrably viral. 2. Your dollar is your vote. Give to many little companies. 3. No patents on abstractions or genes. 4. Evaluate ideas without regard to the source. 5. Never cite a secondary source without citing and reading the original. 6. Be obnoxious, insult wrong crap. 7. Insist on honesty at all times.. These principles will hurt. Regardless, they are ethical principles, you don't do them because they benefit you.

Is intelligence hereditary or environmental? Why are some people smarter than others?

It's not nature and it's not nurture. It's evolution. The thing going on in the head is evolution, competing little algorithms for doing stuff. The end result of this evolution has very little to do with the starting point (the DNA), or with the input of others (the nurture), because it is mostly going on within itself. The ideas are competing in the collective of other ideas, and the strongest algorithms survive, and make new thinking in the head. You can guide it some from the outside, but the inputs and outputs are always vastly smaller than the thing itself. We only get a few kilobytes of data in text we read of talking we are exposed to, and the internal stuff is enormously larger. So the internal stuff has very little to do with either. It is self-generated, and the nurture (or nature) is just guiding the thing. That doesn't mean you can't have a genetic defect screw it up, or complete social isolation, or

cultural impact which directs some ideas to become prominent and others to fade away, but the thing itself has little to do with either. If you toss away all nurture and ignore your nature, you can think whatever the heck you want. To see that there is something else, other than nature or nurture, use this analogy: try to predict the outcome of evolution on Earth from the Earth's nature (the primordial soup) plus it's nurture (the sunlight, occasional meteor impacts). You will not be able to predict what dinosaurs look like from this data. With humans, because we have language, we can transfer some blocks of thought from person to person. This stuff has to hit good local flora and fauna to have an impact on the person, and there's no way to make that happen except by encouraging the evolutionary process and throwing it the idea again and again. But it gets easier with good communication technology. The idea of IQ is nonsense, it's measuring the biodiversity of life on Earth using the height of the tallest animal. Sure, tall animals come later, but it's a bad measure.

Why do some believe that computers could possess consciousness and emotions?

Because a computer can simulate you. That means it can talk, and it can make ideas, and it can produce all the outputs you can from your inputs. That's what it means to think. In response to a comment, nothing other than a computer can simulate you or anything else, the word "simulate" does not mean "make a recording". A television image of yourself is not simulating you, because if you ask the television image "what did you have for breakfast", it won't answer. The computer simulation will answer the same as you. That's what simulate means, it means reproduce the behavior in response to arbitrary input. A computer simulates you, and nothing else does. In fact, it's so stupidly blindingly obvious that computers can think, that one must ask "Why do some morons in philosophy departments still

continue to deny that computers could possess consciousness and emotions?" Because it's self-evidently true that, with sufficient complexity, they can, if only by simulating the things that do.

What role do Lie groups and/or Lie algebras play in physics?

Lie algebras describe continuous symmetries in infinitesimal form--- so if you have a geometrical continuous group, the Lie algebra describes the transformations near the identity. If G is a transformation near the identity, G=I + A where A is infinitesimal, then A is part of the Lie algebra, when you think of it as a concrete object, as a matrix you compute things with. But the lie algebra abstracts out the notion of group multiplication and leaves only the abstract properties of the infinitesimal parts. The product of G and G' is to first order (I+ A)(I+A') = 1 + A + A', and to second order there's an AA' term which depends on details of the parametrization (for example, you might have A^2/2 term if you use an exponential). The group commutator of G and G' is GG'G^{-1}G'^{-1}, and to first order, this gives zero first order term, and the second order infinitesimal term is then AA' - A'A independent of parametrization. This quantity defines the Lie Bracket, it's the commutator of the A's, which are called the infinitesimal generators. [A,A'] = AA' - A'A Sophus Lie abstracted out the properties of the bracket which guarantee that an abstract bracket can be interpreted as a commutator. These are three properties--- they only refer to the bracket itself, not to the enveloping algebra that the objects live in: [A'.A] = - [A,A'] [a A + b B , C] = a [A,C] + b [B,C] [[A,B],C] = [B,[A,C]] - [A,[B,C]] Where capital letters are generators, and little letters are constants. you can check these properties are all true when the bracket is a commutator. The third relation is the Jacobi identity, and it has a word interpretation when you think of the quantity A as

acting on other things by commutation, it says that acting [A,B] is acting A then acting B and subtracting acting B then acting A. This gives intuition for this thing. The idea of the bracket is that it is the natural way that a generator can act on another generator. There are more applications in physics than one can count, and it is too broad a question, but here are some highlights: == Canonical Transformations == Every vector field on a manifold defines an infinitesimal motion, by moving all the points along the vector field. This is a subgroup of the group of all differential maps from the manifold to itself, if the vector field is differentiable it is an infinitesimal diffeomorphism (it is always invertible, because it is infinitesimally close to the identity). So you can define the commutator of these transformations, and this defines the Lie bracket of two vector fields: [math]\{U,V\}^j = V^i \partial_i U^j - U^i \partial_i V^j [/math] This quantity doesn't depend on any connection, since it is an abstract commutator of diffeomorphisms. You can also explicitly see that the connection cancels out, so you can replace the derivative with a covariant derivative at will. For Hamiltonian manifolds (symplectic manifolds), that is, for classical phase space with position and momentum, every function on the phase space defines a vector field by taking the gradient and using the symplectic form. This is really just Hamilton's equations: dq = H_p dt dp = - H_q dt These equations tell you how to move a point in phase space infinitesimally given a scalar function H on the phase space. Such a transformation is an infinitesimal canonical transformation. So you can define the commutator of two different scalar functions H,G: first move p's and q's forward in time by dt as if H is the hamiltonian, then move them by dt as if G is the Hamiltonian, then move back using H for dt, then move back by dt using G, and divide the resulting motion by dt^2. This is the Lie bracket of the vector fields that tell you how p and q move in response to a Hamiltonian which is H or G. This Lie bracket is called the Poisson Bracket. == Quantum Mechanics == In quantum mechanics, the canonical transformations turn into unitary maps. The unitary maps have infinitesimal generators which are the Hermitian operators (actually anti-Hermitian, but it's conventional to multiply by i). So in quantum mechanics, the Poisson bracket is reinterpreted as an actual commutator of matrices. This is

Dirac's transformation theory. In Dirac's version of quantum mechanics, the reason that commutation is how operators act on operators becomes obvious--- this is the Heisenberg equation of motion, it is just saying that when you make an infinitesimal unitrary transformaton, operators transform as the commutator. == Symmetries == For symmetries, there is an abstract group that you are representing, like abstract rotations. The Lie algebra structure of the rotations turns into the Poisson bracket structure of the rotation generators, and in quantum mechanics, to the commutator of the generators. The Lie algebra of the operators in quantum mechanics, or generator functions on phase space in classical mechanics coincides with the Lie algebra of the symmetry group. This is the most obvious application. == ADE classification == One of the great classifications of classical mathematics is the classification of the compact Lie groups into infinite families, and a few sporadic exceptions. The three families are all variations on rotations. There are rotations of real valued vectors in n dimensions which preserve length. These make the group SO(n). The case n even and the case n odd are distinguished because of the details of the Dirac algebra in the two cases. Then there are the rotations of n complex numbers, which preserve complex multiplication and complex length. These form a subgroup of SO(2n), since a complex number can be thought of as made up of a real and imaginary part. This special subgroup is the part which commutes with complex multiplication by scalars. This is the group SU(n). Then there are rotations of n quaternions. These are a subgroup of SU(2n) which preserve the quaternionic structure, and this is called Sp(n) (actually, it is most often called Sp(2n), but I think it's better to call it Sp(n), in analogy with SU(n), and I think a lot of modern people agree). These are the three infinite families. Then there are the exceptional groups too: G2, F4, E6, E7, E8, which can be thought of as arising from octonions and Jordan algebras, but they crap out after a finite number of examples, because the octonions are not associative. Each of these are useful in physics: SO(n) and it's relativistic analog SO(1,n) define symmetries of space time. SU(n) defines fundamental quantum mechanical phase space symmetries. Sp(n) defines symmetries in cases where there is a quaternionic structure. All of the

infinite families, and the special groups, arise in string theory. == Particles == In the 1960s, Gell-Mann made an industry from classifying the symmetries of the low-lying hadrons, the particles called elementary then, using SU(3). This gave relations between particle masses which are ultimately a consequence of the quark model--- the SU(3) is quantum mechanical rotations of the three flavors of quarks into each other. The main buzzword here is "current algebra", and what it means is that you use the symmetry of the theory to make predictions about the spectrum and about scattering which don't rely on the field theory which is right. The same Lie groups then became useful in formulating the fundamental theory, when it was realized by Nambu that the quarks carry color, and the color group is coincidentally also SU(3). The modern particle physics theories use the representations of SU(2),SU(3), SU(5) and SO(10). The last two because the standard model fits inside SU(5), and therefore inside SO(10) in the most obvious way (by thinking of the 5 complex numbers as 10 real numbers). The SO(10) extends to E6 and this embeds into E8 in an interesting way in string theory E6 x SU(3) sits inside E8 in a similar way to how the standard model sits inside SU(5). Since E8 emerges from heterotic strings, this is the easiest path from strings to the standard model. == Kac Moody Algebras == In addition to the finite dimensional Lie algebras, the ones arising from compact groups, or complexifications of these, as appropriate for Minkowski space, there are also infinite dimensional Lie algebras that arise in 2 dimensional conformal theories. The Kac-Moody algebras are the symmetries of certain models of 2 dimensional physics, where there is a natural group acting on the space of configurations. The simplest example is to imagine a sheet of rigid rotators at every point in 2d (one dimension of space, one of time), with a spring making the nearby rotators want to be oriented in the same direction, and the generators are the motions which rotate the rotators at each point separately. This defines a Wess-Zumion-Witten model, or a chiral model in Polyakov's terminology. This is not really a symmetry, because the action relates orientations at nearby points, but the algebra of these transformations is useful for constructing the conformal symmetry by the Sugawara construction. I have given buzzwords, because writing more about it

takes effort and time, and I think other people do a very good job on all these topics, better than what I can do right now.

Does talking to smart people make you smarter?

Only up to a point, because "smart" people are just as blind to where progress will come from, and have their own mental blocks preventing them from finding new ideas. I have talked to great physicists, and while they are very competent on the work that they have done themselves, they are usually no more competent than anyone else regarding history, meaning work that predates them, or where the future good work is supposed to come from, except that furture work that they are involved with themselves. The way to improve your own thinking is to sit down and solve puzzles, then old mathematics problems, then unsolved problems, then difficult unsolved problems. This is also the way to become a mathematical scientist, a musician, or any other cognitively demanding task. It is important for this to not be intimidated by the idea that there are "smart people" out there who are intrinsically better at this than you are (there are no such people), and to persist even when the social structure decides to punish you for it, which will come at the precise moment when you first have an actually original correct idea.

When did physicists start using the term "information"?

Physicists started using the word information soon after Shannon's paper on information theory came out in the late 1940s, so that information as a concept was mathematically precise. A little bit later, in the 1950s, Jaynes explicitly used Shannon's information to give a justification and generalization of thermodynamic reasoning, and Shannon's information is, for thermodynamic equilibrium, just the negative of the entropy. By the late 1950s, Everett made an information theoretic analysis of quantum mechanics, and Hirschfeld and Everett found the information theoretic uncertainty principle (I am confused on the priority here). The entropy was introduced in the early part of the 19th century from an analysis of Carnot's ideas on heat engines, and was given it's statistical interpretation in the 1870s by Ludwig Boltzmann. This was negative information, although historically, the definition went backwards. The (log base 2) entropy is defined as the number of bits we need to specify to fully define the exact precise microscopic state of a given macroscopic system. The use expanded with Landauer, who coined the phrase "information is physical". The theory of reversible computation and the later introduction of "quantum information" expands the term to include non-classical non-Shannon things. The basic idea though is really Boltzmann's, at least for the classical information, and when people talk about "information loss" in a black hole, they mean fundamental entropy increase, and this is something that Boltzmann already understood should not happen in the 1870s. The theorem here is Liouville's theorem, which was proved earlier in the 19th century, and allowed one to say what it means that "information is preserved" within classical mechanics. In quantum mechanics, the analog is unitary evolution. This stuff is what the black hole information paradox is about, it doesn't require Shannon or Jaynes.

Does being extremely smart make you lonely?

You got the cause and effect chain wrong: it's being lonely that makes you smart, because you need to be alone to think. People talking to you have these these little thetans they carry, collective myths, and stupid consensus thinking they are infected with, and these will stick to you like barnacles, and prevent you from getting any original idea (if you could get it by talking to people, it would already have been discovered). To get rid of the thetans, you have to isolate yourself and scrape off the thetans over a period of months and years, and then some ideas come. But always very few, and it takes more months and years to carry them out to fruition. So you need to be lonely to make yourself smart. Sometimes you are blessed with being ugly, and then you can study, but other times you need to cultivate being an ass, so that people will leave you alone. This is true of Richard Feynman as well. Although he tells a lot of stories about social adventures, these are usually a product of sitting for hours alone in bars or in anti-social places in Las Vegas, doing thinking and doing calculations, and occasionally running into interesting people, once every four days. He reports the three days of calculations in his research papers, and the fourth day of social adventuring in popular books. Comment on upvoted answer: I cannot add a comment below his answer, Dan Holliday blocked me, so I will add it as part of my answer: I am pretty sure that Eli does not exist, Dan Holliday made him up. The people in the camps were mistreated slaves, and their education was truncated. For example, my maternal grandparents never finished high school. Former camp inmates suffered from cognitive defects due to malnourishment and camp paranoia, and these things lingered for years and decades. There is next to no chance that any of them subsequently completed a PhD (although some had PhD's going in). None of them supported forgiveness of perpetrators, they wanted to see those bastards brought to justice, far too few of them were brought to justice. None of the camp SS staff suffered, with the exception of a few high-ranking officers, who were tried after the war and served ridiculously short prison terms (most of them were released by 1956). The camp survivors were paranoid of authority, and would not collaborate with government officials of any kind--- they knew the horrors of governmental authority. Eli is a lie, and I would

recommend reversing the up votes and down voting that answer to oblivion.

We teach children it is right to share, so why is this ethic not followed as adults by voting for a Socialist Party?

Socialism is not usually about sharing, it's about telling people what to do. When socialists get in power, they often give their cronies and friends high positions on powerful committees that then restrict the direction of economic development through democratic voting and collective decision making. The committee mentality makes it impossible to do anything new or anything well. The truth is insulting to people who are wrong, so people who speak the truth are never popular. So under socialism, outspoken people are purged from the committees, first the incompetent outspoken people because they are a nuisance, then the competent outspoken people, because they are a threat. Next, anyone who might vote against the consensus, until finally all you have is a committee of shitheads and their yes-men. So choosing socialism is most often choosing rule by shitheads. If you want to see socialism at work, go to Wikipedia. Wikipedia used to be an anarchy, now it's ruled by an Arbcom composed of shitheads. The process was through sanctions, first on annoying eccentric folks, then on outspoken competent editors, finally on the most prolific and dedicated people, until, just as in the Soviet Union, everyone was purged, except a few shitheads. So if you want collective decision making, you need a way to allow good new ideas to prevail in collective decision making, without purges and without committee voting, and without shutting outspoken people up. One not-so-great way to do this is by markets, to let people amass wealth, and build businesses in which they are little dictators. Then the best ideas among the little

group of dictators tend to win. But this restricts decision making to these little dictators, and they tend to not see past their own nose. Further, among the dictators, there are also shitheads, and these shitheads make gigantic agglomerations of wealth, and then buy out their competitors. The market shitheads are usually a little more outspoken than the socialist shitheads. So if you want a form of socialism, you need to fix human politics. The Buddhists have an interesting idea here--- random leadership. You go to the countryside, take a random baby, see if it is inquisitive enough to select some objects from a pile, then select one of the inquisitive babies, who are probably mentally competent, and declare that they are the reincarnation of the previous leader. A random pick is, 9 times out of 10, better than rising through endless ranks. On the other hand, there's always the 1 in 10. Free-software is a very interesting way that preserves individuality and social benefit, without allowing shitheads to dominate, The way it does this is by allowing all individuals to contribute ideas, judging entirely by technical merit, and the collective of all users votes on the outcome by deciding which version to use. Nobody can stop you from writing your own version of free-software. In capitalism, the consumer choice is supposed to function this way, but most often doesn't. There are lots of experiments with different political systems on different websites now. Wikipedia is terrible, but there is also stackexchange, and quora. Quora seems to be unique in that it doesn't shut people up, and so far, this seems to lead to a lot of annoying noise, but it allows reasonable discussion without shutting it up or directing it by committee. Stackexchange gives people administrative power to shut others up, and fails for the same reason as Wikipedia--- the shitheads gradually take over. So if you can find a good way to keep the shitheads from taking over, so that committee decisions are at least as good as the decisions of a group of fat cigar-smoking rich oligarchs, then you can say you have a chance for a reasonable socialism. Until then, you're kinda stuck with what we have. This is about fixing politics. To achieve sharing is much easier and doesn't require any new idea, all you need is moderately high taxes on the wealthier folks, redistribution of income by negative income tax to poorer folks, and generous social welfare policies to

people who are incapacitated in some way. You can do this under capitalism just the same as under socialism, it is usually good for capitalism anyway (so long as you don't make so much demand that the producers can't keep up and you get hyperinflation), because redistribution of income usually makes markets function better--- it produces the maximum demand that the economy can support, and gets you as close as you can come to an ideal efficient market equilibrium. This type of thing is not socialism, because entrepreneurial people can still do what they feel is best without a committee telling them that they can't.

What are the most important papers in STEM disciplines renowned for their brevity?

Rarita and Schwinger "On a Theory of Particles with Half-Integral Spins" is a two paragraph letter, rewriting the results of Pauli and Fierz for the spin 3/2 field in the natural intrinsic form, as a vector of Dirac spinors. This work is the foundation of supergravity, although Schwinger didn't follow up on this to show that the source must be a conserved spinor, and therefore requires supersymmetry, and therefore supergravity. This all follows from the assumption of a spin-3/2 field, and it naturally leads to all the nice modern supergravity physics, and the results are only clear in the natural Rarita-Schwinger formulation, not in the cumbersome and overly-general Pauli-Fierz formalism. Schwinger "facepalmed" in the late 1970s for missing this. Maybe if the paper was longer?

When you're in a sticky situation with another person, what is your go-to thought process?

It depends on a few things: * Is there any threat of bodily harm? If so, run away! If you can't run away, crouch down in a submissive position, allowing the thug to ritually mount you. A violent person is a pigeon in a skinner box: give it submissive behavior and it leaves you alone. Assuming one is dealing with a nonviolent situation: * Is there a positively meaningful distinction between the two positions? If the answer is no, you are not having an argument. * Is the other person objectively right? If yes, change your mind! No? Then they have to change their mind. This might be hard for two reasons: * They don't know enough. Then explain. * There is a political reason for the disagreement. Then insult the other person's politics to their face, by explicitly and pointedly pointing out the political organization, the political reasoning, and so on (if they become violent, go to step 1). This procedure is called "being a coward and an asshole". Coward: A person who won't fight to enforce the will of the gods. Asshole: A person who will fight the enforcement of the gods' will. The result of being a cowardly asshole is that you end up isolated, alone, hated, out of a job, homeless, and eventually dead.Nevertheless, as in earlier times, it is ethically required to martyr yourself. The one nice thing about fighting the gods is that, if you have an internet, you sometimes win.

When have you most successfully hacked a non-computer system to your advantage?

.The greatest non-computer hack is the couponing methods for drug stores. The essential policy is that coupons add, and coupons may be

applied simultaneously with no limit, in any order, so long as at each stage a coupon applies to the purchase, and so long as the total doesn't become negative. So in a Rite-Aid, if you have the following coupons: * Brand X razor: buy one get one free (store coupon) * Brand X razor: buy one get one free (manufacturer's coupon) You get 2 razors for free, each coupon buys the other razor. You can buy any even number of razors, totaling, say $20.30 Further, you can get a Rite-Aid coupon for "Buy $25 or more get $5 off". So if you purchase $5.01 of anything else, you get a total of $25.31. Apply the $5 off, reducing he total to $20.31, then use the buy-one-get-one coupons to reduce your total to $.01. You can buy anything at any drug-store for the cost of the tax, and hauling a bunch of razors. The buy-one-get-one store coupons are purposefully matched with the manufacturer's coupons by the drug store, so they may be exploited this way. Why do the stores allow this hack? They probably use it to distribute a lot of free samples of the razors quickly to lots of people, through an army of couponers.

What can Christians learn from the Muslim concept of "Jihad"?

The term is "crusade" and it is used in the exact same way in Christianity as Jihad is used in Islam. It is probably a borrowed term, created to parallel Jihad. The concept appears obliquely in the Bible, when Jesus says "I bring not peace but the sword". He isn't talking about a literal sword, but the coming battle to convert people to the new religion, but the concept is not very literal in Islam either.

What has been the reception to Zeraoulia Elhadj's proposed solution to the Riemann Hypothesis?

This is nonsense, although it is wrong to dismiss it for political reasons. It is also badly written, although it is wrong to dismiss it for these reasons either. The first two pages are fluff, the third page does a component decomposition of complex numbers which is very clear, but drowns it in a soup of symbols for no good reason. The only thing that is going on there is that he is expressing the functional equation in component form. The common place where people make mistakes in "proving" the Riemann hypothesis by formal manipulations is using the functional equation. The functional equation relates s to 1-s, so that if you do formal manipulations, you can often erronously conclude that the real part of s has to equal the real part of 1-s, or that the zeros is on the critical line. This is the original motivation for the hypothesis! Back to the paper: the thing called "theorem 1" is ridiculous (but correct, although written in a way that is completely insane)--- the quantities are all zero! It's not good enough to say "this equals this and that equals minus that", all four quantities are exactly zero! It's like saying, I will prove to you that at a zero of the Riemann zeta function, the real part is equal to 4 times the imaginary part! Of course, because they are zero. There is no content to this theorem. The ridiculous hemming and hawing about the nonzero value of the phi function is irrelevant--- if there is one zero on one side of the critical line, there is another zero on the other side. The rest of the page rewrites the functional equation in components, replacing complex multiplication with matrices, for absolutely no good reason. The determinant of the linear action of multiplying by a complex number is the length squared of this complex number. This is again a ton of formalism disguising empty content. The contentless statements are correct, modulo possible typos, I didn't check carefully. The first nontrivial statements appear at the bottom of page 4, starting with equation 10, which is rewriting what it means to have two zeros of the

eta-function on opposite sides of the strip. The equation is fine (modulo typos or stupid errors--- what I mean is it is easy to write an equation of this form which is correct), it is an equation for the sum of infinitely many terms, which is saying that there are two zeros on opposite sides of the critical strip. But the next equations deducing theorem 2 from this are nonsense--- they are assuming that a series whose sum is zero has to vanish term by term! This requires that the two parts of each term must cancel individually, and this can obviously only happen on the critical line, where there is no nontrivial multiplication relating the two terms to each other. So from this he deduces that the zero is on the critical line. There is something to say about form--- from the type of formal manipulations being done, and the obfuscatory way they are written, you can sense that the author doesn't see the mathematical picture, so this doesn't give confidence in the proof. Also, you know from a quick glance that all that is known here is the functional equation and nothing more, no estimates, nothing, so it is impossible that there is a proof. But one should point out the explicit error, since this doesn't take long, it is just refereeing a paper.

How did eukaryotic cells come into existence?

It is not clear that prokaryotic cells were first, all that is clear is that the eukaryotic cells and prokaryotic cells diverged from a more primitive system which gave rise to both. The membrane bound organisms have an evolutionary tree which is very hard to ferret out, because the prokaryotic branch consists of organisms with very limited genomes, with promiscuous gene sharing, and so it's hard to firmly date the major events. The general consensus is murky, and it is possible the eukaryotes came first. There is nothing extraordinary about different organelles evolving in symbiosis, it is no different than

symbiosis in more sophisticated organisms, like you and the bacteria in your gut, or your dog.

What is it that makes Noether's Theorem so beautiful?

It's beautiful because it's links the two most fundamental things in physics: the conservation laws and the symmetry principles. It relates the oldest kinds of physical arguments, symmetry arguments, to the oldest kind of physical laws, conservation laws. It's also impossible to discover outside of Lagrangian or Hamiltonian formalisms, or the quantum mechanics that underlies this, because it isn't true without this stuff. The theorem is true in both classical and quantum mechanics, in either Lagrangian or Hamiltonian formalism, and the proof is parallel in all cases. It is true in General Relativity, either for coordinate symmetries which have a nontrivial effect on the boundaries, or for physical symmetries which are symmetries of the geometry of the space (giving two distinct notions of energy and momentum). It has become a foundation for the physical sciences, in the same way as E=mc^2, it's so fundamental, people forget there was a time when it was surprising and new. Einstein immediately applied Noether's theorem (fresh off the presses) to the (also fresh off the presses) General Relativity in 1917 to get the stress-energy pseudo-tensor, work which was so forward-looking that Schrodinger and everyone else called it crazy from 1917 until well into the 1990s, when York's work on the nonlocal stress energy tensor and the holographic principle clarified what gravitational stress energy is supposed to look like (Einstein comes out looking good in the end). Noether's theorem in gauge theories in general was still giving surprises until relatively recent times, because in the case of a gauge symmetry, the conserved current is a perfect derivative, it is tautologically conserved, so the conserved quantities are only boundary sorts of things. There are

several ways to state the proof, all equivalent. I like the Hamiltonian way. In the Hamiltonian formalism, the time derivative of a quantity is: dA/dt = [A,H] Where the bracket is the Poisson bracket, and if this is zero, then transformations using H as a generator don't change A, so going a little bit into the future keeps A constant. But then also transformations with A as a generator don't change H (since [H,A] is also zero), so A generates a symmetry (this proof doesn't work well for transformations which change time). The Lagrangian proof is also intuitive: suppose you have a trajectory x(t) which is the minimum of S. Then you can perform an infinitesimal symmetry transformation on the trajectory, and you get S(x+dx), which is S(x) plus an integral over time of dS/dx times dx, where d is the variational change in S, the variational derivative. The bulk path is an infinitesimal variation of the bulk path, so there is no change in action, by the principle that the variations of S are zero on the true trajectory. So the variational change can only depend on the endpoints, because the path is a minimum, so you get that there is a quantity A(x_i)dx - A(x_f) dx which is zero summed over the two endpoints, which means there is a constant quantity along the trajectory. Feynman explains the theorem this way in "The Character of Physical Law". In Hamiltonian quantum mechanics, the argument is exactly the same as in Hamiltonian classical mechanics. In the Lagrangian formulation of quantum mechanics, the argument is a little different, because the trajectory itself is summed over, but the proof is easy to reconstruct once you know how the equations of motion are derived, and this is explained on Wikipedia's page on "path integral formulation" among other places.

How would Karl Marx agree and/or disagree with John Keynes criticisms of Capitalism? and why?

Karl Marx would be pissed off that this guy was stealing his ideas, watering them down for general consumption, and getting famous for this sell-out. Keynes declining demand theory comes straight out of Marx, except he pretended for political reasons that this type of depressionary decline is only temporary. This is horseshit and everyone at the time knew it, because they knew their Marx, but it was politically necessary, because the classical economics literature did not accept anything related to Marx. In order to get published, you had to assume that the Pareto ideal economic equilibrium was where markets were always going. Market equilibrium is the situation where all production is competitive, all salaries are competitive, and there is more or less full employment and full production, and all the people working can collectively purchase all the goods they collectively manufacture. This ideal means that all corporations are making zero profits (beyond the amount they need to pay to insure their risk, pay their debts, and provide return on their capital investment), all employees are making roughly the same salary (or else they would switch jobs), and all entrepreneurs and sporadic workers are only making as much more than regular employees as would justify their risk or lean years (or else more people would become entrepreneurs). In equilibrium, the mean salary is just the amount required to purchase all industrial output, at peak capacity. This market equilibrium is a hopeless fantasy when you look at real markets. Even allowing for corrections to ideality, you predict slight fluctuations, a Gaussian distribution. But it's always a huge tail. This means that there is never market equilibrium in industrial economies. But people don't usually care about how much the market looks like a textbook market, so long as there is growth. I care. The textbook ideal efficient market is like a dream. From 1929-1933, the intrinsic industrial capacity of the US didn't change a whole lot, but industrial output collapsed, and factories were sitting idle. Somebody had to address the obvious facts. Marx had already noted that when there is a pool of unemployed workers, the market wage can collapse from the ideal equilibrium value, where the workers can purchase all industrial output, to subsistence level, due to competition from unemployed workers. The reason is simply that the workers are supposed to be

charging a competitive price at full employment to have market equilibrium, and when there is a pool of unemployed, they are instead forced to take the minimum wage which will keep them better off than the unemployed, which is subsistence. Drastically low wages mean that the workers can't purchase the full industrial output, and industrial production collapses. Contrary to what Keynes says, this is a stable situation, it never corrects itself. The reason is that the industrial capacity already exists to absorb the workers, they are not idle because their labor cannot be used, but simply because the demand has slackened due to the symmetry breaking in the market--- there is a spontaneous segregation which produces workers which compete with the unemployed and earn little more than subsistence (in the absence of government intervention, like minimum wage and maximum working time), and other workers who can siphon off large swaths of industrial profit into their pockets. You can see this symmetry breaking in extremely simple models of economic production, which appear nowhere in the economics literature, where this is considered crazy-talk. You can make up an economy of 10 firms with 10,000 workers in equilibrium, and suddenly perturb this economy by adding 100 unemployed workers. The correct equilibrium market response is to expand capacity to absorb the 100 workers, but if there is a time delay to expand the capacity, there is an instability: the 100 unemployed workers drive the 10,000 workers salary down to subsistence by competition, the workers can't buy the output of the factories anymore, and the factories close or sit idle, because you broke the equilibrium. The unemployment grows to huge levels, and it stays that way forever, because there is no capital for expansion, nor would anyone expand, because there are no consumers to purchase the output of the expansion, they can't even purchase all the goods you could be making now! This instability model is the basis of the classic Marxist prediction for the collapse of capitalism, and it matches the great depression. One should conclude that Marx's model is accurate, the economic equilibrium is not stable to unemployment rising, and the system can fail to find the classical equilibrium permanently. Economists wanted to match the real world, but they didn't want to agree with Marx. So Keynes made the following bullshitty but

plausible sounding explanation for the observations, which kept the main idea: during deflationary times, the workers salaries, for some reason, can't reach proper equilibrium, because they psychologically won't accept wage-cuts, which he claimed would fix the unemployment problem. So the market temporarily contracts because the unemployment rises, and the too-few employed workers have too little money to produce the apprорpriate demand. The part of this that is correct is just the same as what Marx said. The part that is wrong is where it differs from Marx. This is not a temporary glitch--- the market will never ever find equilibrium again in these circumstances (you can do the experiment, it has been done in certain parts of the third world, and in the presence of an underclass, the underclass is stable, and the economy develops among a separate class which can charge prices for labor on an entirely different scale). Keynes's argument for taking action anyway, despite the fact that this problem would ostensibly fix itself, was that "in the long run, we're all dead". The fix that follows from this watered down hogwash is basically a milder form of the fix proposed by Marxism, government intervention to prop up demand, so as to increase the purchasing power of workers to buy the products the industrial economy can produce. This is what was done, and the situation improved--- economic growth is restored when the government expenditures compensate for the loss of demand. But the reason for the low wages is not properly understood in Keynsianism. The real reason is Marx's: in the presence of a pool of unemployed people, there is class separation, and for the lowest classes, wages are driven to subsistence by competition. The only people making money are those that have some sort of leverage to charge monopolist's prices for their labor, and these form a distinct social class from the workers, and the class structure keeps market equilibrium permanently, not temporarily, out of reach. This doesn't mean that the traditional fix that Marxists advocated is a good one.

Why were there so few revolutions in Europe between 1850 and 1917?

This was the period after Marx, and the target was no longer the relics of old feudal structures which stood in the way of business expansion, but business itself. So the merchants become the target. Before this point, the working class and the merchant class were usually on the same page regarding government reform. In this new climate, merchants became fearful of revolutions, and would lend their economic might to suppressing the revolts. Even so, there was still an extremely notable revolution in Europe during this period, the Paris Commune of 1871. It lasted only a few months, but it established the general character of the later socialist revolutions of the 20th century. Workers committees took over all the businesses.

How can the Banach-Tarski paradox make sense to mathematical laymen?

The Banach Tarsky result is not absolutely true, it is true or false depending on which axioms you like to use. Before you say "but isn't that true of everything?" No, not really. There are things that are computationally absolute, so that once you define the terms in a computational sense, they are just true or false, things like the twin-primes conjecture, or the Riemann hypothesis, or the volume of the sphere in terms of its radius. The Banach Tarski paradox is not like these other things, because it is not only intuitively false, it is also mathematically false in the most natural axiomatizations of the real numbers. It just happens to be true in the axiomatization of the real numbers that mathematicians have standardized upon, and that's not something to explain, it's something to lament. Suppose I draw a big

box around the sphere, and then choose a point at random inside the box. Since this is important, I will specify exactly how I choose a point at random--- by this I mean that I flip an infinite number of coins, to determine the binary digits of a real number between 0 and 1 one by one, then I rescale this number to the length of the box, and choose another random number and another, and together I get three random real numbers that pick a point uniformly inside the box. It seems intuitively reasonable that I should be able to do this, since I can do the finite process, and the result is certain to converge. If I can do this, pick a random point in the box, then this point has some probability of landing inside one of the Banach-Tarski pieces. This probability defines the measure of each of the pieces, it can be determined semi-empirically by choosing the points again and again, and then the fraction of the time I land in the set is the ratio of the measure of the set to the measure of the box (this is not quite empirical, because determining if a given real number is in a given set might not be decidable by objective means, but what I mean is that it is consistent to imagine this probability). This measure, the probability of landing in the set, is unchanged by rotation and translation. So when you rotate and translate these sphere pieces, you just can't make two spheres, because the proability of landing inside the two spheres is greater, the two spheres together have a bigger measure. That is a disproof of the Banach Tarski theorem. But since you can prove the Banach Tarski theorem in ZFC, you learn that in the standard axiomatization of mathematics it is simply false that every subset is measurable. In other words. This means that the disproof above doesn't work. Why doesn't it work? The reason is that it is simply false that you can choose a real number at random in ZFC! The concept "pick a real number uniformly at random between 0 and 1" is inconsistent in the standard axiomatization of set theory, and we are supposed to be ok with that. I am not ok with that. To see the contradiction between infinite random choice and axiom of choice, there is an illustrative puzzle. Suppose I place infinitely many hats, either black or white, on infinitely many heads. I ask the people to guess the color on their head from looking at all the other colors. The people win if only finitely many guess wrong. Can the people win? If I am allowed to place the hat colors at random,

the people can't win. The hat colors are independent, and knowing all the other colors gives you no information about your own. So the answer, in a universe where randomness behaves as it's supposed to, is no. You can't have finitely many guess right. But in ZFC, the people can win. Define equivalence classes of hat-choices, where two hat-choices are equivalent if they differ in finitely many places. Now "choose" one representative of each class. Then have all the people answer according to the representative that agrees with the infinitely many hats they see. This allows the people to win. So the concept "an infinite list of independent random bits" is incoherent in set theory, it is just incompatible with the axiom of choice. That means I can't choose a real number at random in the standard axiomatization. But mathematicians need this concept of a random real number. Probabilists talk about random reals all the time, and also random paths, random walks, and so on. So how do they deal with it? What they do is sidestep the issue, by defining what is called a sigma-algebra of sets, a collection of sets closed under countable union and intersection, and defining measures only on a sigma algebra. Then they never speak about the random real number itself, rather they speak about the probability that this real number is contained in any given set. By doing this, they define the "random variable" as this collection of probabilities on a restricted universe of sets, which are in the sigma-algebra, so that they never talk about the random real itself, just about the measures of various sets. This makes probability theory very counterintuitive and onerous--- every statement about "a random variable r" is never a statement about an actual real number, but about a collection of measures on subsets, and then you have to prove a lot of niggling technical theorems that establish that the sets you are determining are always measurable, theorems that are always obvious and annoying. The only point of these theorems is to avoid the non-measurable sets, the things constructed using the axiom of choice. However, all this rigamarole is completely unnecessary. It is very easy to define the notion of a random real number, if you use modern logic, in particular, forcing. In this case, starting with any countable model of ZFC, you can adjoin a random real number to the model, essentially by just picking the digits one by one at random. That this

concept makes formal sense is extremely easy to prove, and the result is called "random forcing", and once you do random forcing, you learn that an adjoined random real will assign a measure to all the subsets of [0,1] in the old model. Further, the whole R of the old model is revealed to be measure zero in the new model--- there is zero chance that the random real was already in the old model (you have to be careful here to talk about the dust of points in the old model, because intervals extend to intervals in the new model, blah blah blah, all this is explained by Solovay). Using random forcing, Solovay went further, and defined an extension of any given model of ZFC which has the property that every subset of R is Lebesgue measurable! These models have completely normal probability, you can speak about picking real numbers at random with no fear of contradiction. In fact, that is what it means to say you can pick real numbers at random--- it means every subset is measurable. In these Solovay models, the Banach Tarski theorem becomes false. The old decomposition is just mapping a measure zero dust in the sphere to a measure zero dust in the new spheres, but this measure zero dust just happens to be all the real numbers in the old model, so the old model is under the delusion that it has succesfully mapped all the points in a sphere to all the points in two spheres. So now you see what the proper intuition for the Banach Tarski theorem is--- it's a theorem about models of the real numbers obeying ZFC. It is consistent to say that the real numbers in one sphere can be matched by rotation and translation to two spheres, because in a particular countable model, all that happens is that the countably many points in the original sphere are matched to the countably many points in the new spheres by rotation and translation. But it is also manifest that this is not an invariant statement about subsets of R, it is a statement about your particular axiomatization of the real numbers, about the particular way that powerset and choice axioms play together. So the Banach Tarski paradox is a fake. It can be proved true in ZFC, and it can also be proved false in restrictions of a forcing extension of any model of ZFC. So it's really one of the results that have been overthrown by the forcing revolution, although in the particular axiomatization mathematicians like the most (for stupid historical reasons) it stays true. So in this case, the layman's

intuition is more correct than the mathematician's intuition, and you should not make the theorem make sense, because it really does not make sense. The negation of the theorem is the only thing that makes sense.

Belief and Beliefs: Can the existence of a god be proven or disproven?

I'll prove both directions. Not a contradiction, just meaning one kind of thing does exist (or rather, aught exist, and one can take it to exist with no contradiction, and you should), and another kind of thing does not exist, but has nothing to do with the other kind of thing, except as a way of illustrating it. The main point of religion is that there is an infinitely wise and infinitely good intelligence that is aware of everything that we do, and wants us to act in certain ways and not in others. I think one can explain this idea sufficiently that it is shown to be more or less evidently true. At the same time, you can also prove in the scientific sense there are no supernatural events. The main thing is to just that the supernatural stuff is not required for the infinitely wise/infinitely good abstract intelligence thing. Whether that counts as proving or disproving God depends on your definition of God, but I think it completely clears up the question, in that I personally have no more confusion on this, and from reading the other answers, I feel like I'm the only one. First, you definitely can prove that there are have been no supernatural events just by normal scientific reasoning, it doesn't require any more effort than proving that my breakfast did not come from outer space, rather from the grocery store. You can't PROVE that it didn't come from outer space, except you can, at least with the normal day-to-day sense of the word "prove". The word "prove" in normal day-to-day speech, means this scientific concept, including scientific induction, not the logical mathematical concept which is completely sterile when applied to the natural world. But the

induction is enough to conclude that nothing supernatural has ever ocurred, nobody dead ever came back to life, no enemies in battle were ever defeated by magic, no magic events at all. This is the atheists' spaghetti-monster, it's old, and the atheists are right, it rules out supernatural stuff. But the atheists are not aware that this argument won't change anything at all, because it isn't the main debate. This stuff a side-show. You can't focus on it, because you don't win the debate, even though you are right, because there is something else that you are wrong about that will keep the politics from aligning on your side. For the creation of the universe, it's even weaker argument, because you don't even need science really to see that this is nonsense, all you need is philosophy. You can see that creating the universe is a meaningless bit of rhetoric, just from the definition of words. The statement "X created the universe" is ultimately meaningless, in the sense of Mach, and the logical positivists, as first argued correctly by Rudolph Carnap in the 1940s (but he might as well have been farting in the wind). So that's it, done with creator and meddler. But neither of these are really God, because the same argument that shows you they are false also shows you that there is absoluely no path through which anyone would ever think they were true, except if motivated by something else. The goal of the rest of this answer is to explain what this something else is, and that it is actually true. The something else is the notion of superrational decision making, which is a concept which is about 30 years old. In 1980, Douglas Hofstadter noticed that the traditional idea of game-theoretic rationality is not completely uniquely defined, because there is an implicit assumption. When you are playing a prisoner's dilemma, the standard game-theoretic argument is that it is rational to defect, because this is a Nash-equilibrium, meaning this is the point where nobody unilaterally changing course will improve their outcome. Hofstadter pointed out that you don't have to unilaterally change course. When playing a prisoner's dilemma, you know that you and your opponent are both studying the same problem, and it makes sense that you should find the same answer. The hypothesis that there is a unique answer makes your decisions perfectly correlated, and when they are perfectly correlated, changing the decision doesn't change just your decision,

but all the decisions of those you are correlated with. So the decision to cooperate can be rational, under the assumption that there is a unique answer to the problem of the game, and that there is a community of players that recognizes this correlation, and plays according to the superrational strategy. Hofstadters articles "Irrationality is the Square-Root of All Evil" and others in the series, explain this concept clearly, with verbose examples, and give nontrivial predictions for how to play in symmetric "Luring Lotteries" where the outcomes are lopsided, so that the superrational players want to use a randomizing device. But how does one generalize the concept to asymmetric games? This question is one that I was confused about, because the notion of correlation only obviously tells you the outcome in the case where symmetry allows you to figure out the other player's play from your own. But there is a simple way to generalize superrationality to arbitrary games. You simply postulate that there is a universal strategy for all games, symmetric or asymmetric, that this strategy is self-consistent in the sense of the Von-Neumann Morgenstern utility theorem, and that the idealized perfectly superrational players will find and play according to this strategy. The Von-Neumann Morgenstern theorem associates to each situation a utility function, a will, so that by making a universal superrational strategy, you are making an abstract utility function encoding the will of an agent which isn't playing the game. The agent can judge things in an abstract sense, it has a desire. This agent is all-knowing, because it needs to know the answer to all games in order to give a self-consistent answer for any one particular game. It is all good, because the ultimate utility is bound up with the utility of the players, and the goal is to maximize the utility of the superrational players in some collective sense. It is abstract but completely reasonable concept. This is nothing other than the religious notion of God. So to make a superrational strategy for all games, you have to introduce a monotheistic concept of God, and then if you want it to work, you need to tell people to play according to this will, the abstract will of the superrational agent, the tippy-top consistent extension of superrational play to all concievable games and circumstances, to the best that they can intuit this desire or reason it out, from other games and other circumstances. So you want to

produce stories and cultural traditions that will make people figure out that this is how they are supposed to behave as quickly as possible. To this end, you construct and defend supernatural fables about whatever, it doesn't matter, so long as it makes people believe in an all-knowing all-good entity that cares about what they do in their day-to-day decisions. It's just a way of making superrationality happen in real life, even when you don't have the concept around, because this concept didn't exist before 1980, except in the religious approximation. To actually replace the religious institutions, you must have the superrational conception in place, and since it is essentially equivalent in the logical postive sense to the meddlesome personal God (minus the miracles and creating the universe), it is not clear to me whether I believe in God or not. I believe in the universal superrational strategy. I should point out that it is not possible to noncircularly prove that there is a universal superrational strategy noncircularly, since you need to assume it exists to figure out what it is. So this is not exactly a proof of God, rather it's an explanation of God with no anti-scientific assumptions, a demonstration that the concept is not anti-science or supernatural, that it is actually true in the self-consistent sense of the word, and in the ethical sense, we are duty bound to do what God says we should do, whatever that is exactly, because the religious texts are not super-reliable guides to this. Since this is so important, I think it is better to say one does believe in God if one believes in this, even if one does not believe in miracles or in meddling or in creating the universe.

Do photons interact with the nucleus?

Yes, protons are charged, and they interact with photons. Neutrons are neutral, but they have a magnetic moment, so they also interact with photons, but less so when the wavelength is longer than MeV's, free neutrons aren't shiny, free protons are. The main interactions of note for larger nuclei is electrostatic interactions, so that a free nucleus,

stripped of electrons, will scatter long-wavelength light much like a free electron, except much more massive. For higher frequency light, you start to see nuclear energy levels. These involve the nucleus charge distribution shaking in response to the light, and the main phenomenon (in larger nuclei) is the giant electromagnetic resonance, a relatively low energy mode where the protons and the neutrons slosh in opposite directions relative to the center of mass in response to a KeV level electromagnetic photon. At even higher frequencies, at 100s of MeVs, the nucleus starts to be opaque to photons, they scatter as if they were strongly interacting. The reason is that the nuclear effective strong field leads to photon-rho mixing, the effect where a photon behaves as if it were the strongly interacting particle rho 760 part of the time. This was discussed experimentally and theoretically by Gottfried in the 1972 Cornell conference on photon-hadron interactions, and the main phenomenon is called "shadowing", the effect where large nuclei have photon scattering cross sections that don't scale as "Z" but as "Z" to a fractional power, because the photon gets completely attenuated inside the nucleus. This is also discussed in Feynman's book "Photon Hadron Interactions". The interactions of photons with nuclei is simply the same as with any charged particle, made more complicated because of the fact that the nucleus has a moderately large number of charged particles, and also because the QCD vacuum is full of quark condensate, and quarks are charged. It's pretty well understood in a phenomenological way, although the fundamental understanding is limited by our limited method to describe QCD.

How might a theist explain his or her personal religious belief (see question details) to an atheist in plain language and without Bible verses or other proof texts?

The first tenet of thought is logical positivism, the statement that one must only make statements meaningful by attaching them to observations. So the creation of the universe is not a meaningful thing to discuss, and I won't discuss it. Neither is the metaphysics of life after death (at least in the unobservable realm, there's always a person's legacy), so I won't discuss that either. But now you can ask about what it means to behave ethically. For this purpose, consider a two-player symmetric prisoner's dilemma, and ask, should I defect or cooperate? The rational answer is ostensibly to defect, and economists and game theorists generally agree that this is the correct answer. But the argument that leads to defecting involves an implicit assumption---that my decision is uncorrelated and independent of the other player. But if the two players are solving the same problem, should they not get the same answer? Should they not have a perfectly correlated outcome? Considering perfectly correlated players who know that they will be perfectly correlated, creates the system of decision making known as superrationality. Douglas Hofstadter considered these types of strategies in Metamagical Themas. Superrational players will cooperate with superrational opponents. But the theory only works for symmetric games. How do you generalize to the asymmetric situation? In order to do this, you maintain the property of perfect agreement of the players. You assume that all the players are playing according to a unique strategy that can be determined by these players, if they assume that the unique strategy exists for them to find. This is circular, but not paradoxical, and doing this defines what it means to behave ethically. You can assume there is no such strategy, that there is no universal ethical standard, and then you end up defecting. But since superrationality is much better, don't do that. A unique strategy for all games is a utility function, which tells all the players how to behave in every game. In order to be consistent in the Von-Neumann sense, it must be the desire of a rational agent. In order to be unique and universal for all games, you should think of this agent as infinitely rational, all knowing, and all good. This is God. The statement that one believes in God is then, in logical positive terms, tantamount to the statement that one will behave according to one's best determination of the will of the superrational strategy in all circumstances. This is

hard to determine--- you need to make a model for this, to consider other people's model for this, to look at literature and history, to meditate and consider different circumstances, to make the belief self-consistent, and in general to go through all the different practices that are standard in religious practice for determining the will of God. So it is, in my opinion, impossible to sanely reject this kind of God, the non-supernatural kind, at least not without destroying the ability of society to repel prisoner-dillemma challenges to human ethical behavior, dilemmas which have produced nightmarish societies in the past, and which we must avoid in the future. But to a certain extent, the belief is a free choice, since even if one concedes that one can make a superrational strategy, nothing compels one to act in this way. It is actually literally impossible to act according to this strategy, simply because we are finite beings, and the model is abstract and infinite. But even if you choose not to act according to this strategy, you can still believe that it is possible to formulate such a strategy. I identify this strategy with the concept of God, and since I believe one can formulate such a strategy, I suppose that I believe in this sort of God. The reason is simply that one can see that it is possible to do this explicitly in many simple situations, and the extension to the limit is not much more of an act of faith than believing in any other limiting mathematical conception, such as the Church Kleene ordinal, or the number pi. I also feel compelled to act according to my best determination of this strategy (although I of course fall short, and I am never sure what that strategy is supposed to be with any kind of certainty). I think that this is the logically positive definite content of the statement "I believe in God", and that the evidence that there is such a system is reasonably overwhelming. There is no consequence on the physical universe from this idea, it is simply a way of organizing the decision making of players in games so that they come together to make a coherent whole. This is all that religions ask people to believe when they ask them to believe in God. Everything else is secondary.

How can you be an atheist or a theist, and be confident in your belief if you have not read a lot of philosophy?

Philosophy texts are a stupid and pointless waste of time, since they are just mouthing off with an attempt to appeal to powerful people. There texts are selected by a purely political process, they have no measure of truth, or even of logical reasoning, since they are not bound to rigor or to experiment. Therefore it is better to just sort this out for yourself, ignoring all previous writing, as there is nothing of value that has been said in the philosophy literature that can't be reproduced in about 10 minutes of thinking.

What is the best way to convert an atheist to Christianity? What are the best appeals Christians can use to persuade and save atheists?

Ask the atheist to consider a hypothetical society where people are nailed to sticks and fed to lions on a regular basis. Now ask this atheist to consider what possible story you can tell people which will simultaneously stop them from getting entertainment by watching people being eaten lions, comfort those that end up being fed to lions so they are calm and peaceful in their deaths, and allow those being fed to lions to win over those who are feeding them to lions over a long period of time, even while they are each individually jeered and scorned. This story will have to make it clear to folks that their acts of martyrdom will have impact, that each of them are valued and important despite the jeers, and that the future triumph is coming.

Further, it should make it clear that those who jeer are damned, that they evoke emotions of pity and shame, not terror and respect. For this, an uber-martyr will help, a prototype for all future martyrs, and if you celebrate this figure as a divine presence among humanity, people will be encouraged to emulate this figure, and willingly go to their death for the sake of an uncertain future triumph. Since this system of belief is pretty much the only reliable way to reform a horrific political system of this type, it is therefore a true system of belief in the ethical sense, it is a system of belief which one ought to hold if one is living in such a society. Is it a true belief in the scientific or material sense? Heck no. But it's one that you should believe, at least under those circumstances. That's what Christianity is about. Christianity is about placing a buffer between human society and the appaling carnage of Romans and Nazis and all other political orders unchecked by ethics. The Christian ideal is simply the recognition that martyrdom is essential for progress under these circumstances, it is an ethical order that celebrates martyrdom, because the martyred spirit is stronger than the wretched lives of those jeering. It makes it plain that the suffering of the martyrs is ultimately small compared to that of those who oppose him or her, simply because those crimes will not endure, their legacy will be lost, and they will be forever enslaved to their local best interest. They are divorced from God. They are damned. This collective ethics is what Christianity is about, and it is the same small voice that tells you what is right and what is wrong, that ultimately makes an appeal to an infinite future and an infinitely wise intelligence to judge the actions of others, and determine what ethics says. It is the requirement to follow this voice, even when it is inconvenient, and even when doing so requires you to do things that are uncomfortable. I think that nearly all atheists understand this appeal. Then you ask them "which is more important? That the maximum number of people accept this difficult and counterintuitive principle of self-sacrifice? Or the exact scientific and material details of what exacly happened in some small town in Palestine 2000 years ago?" I think they would agree that, under most circumstances, the principle is more important. In that case, no matter what their belief about what materially happened, chances are good that they will go

along with the story, simply to preserve the ethical heritage, to prevent a return of Roman barbarism. So you say this: I know it makes you uncomfortable to say that these ridiculous supernatural things happened. It makes everybody uncomfortable. So what. Deal with your discomfort, because the discomfort of being eaten by lions is greater, and that is what you are trying to prevent. That's a conversion right there. I don't think that it's a good idea today, simply because the issue of material truth about history, and scientific accuracy, are much more important now than preventing people from feeding other people to lions. If this were to change, and people started feeding people to lions again, I might start lying. But since it's not happening anymore, this battle has been won, and other battles, involving scientific and historical accuracy are more pressing. So you can adhere to material truth and at the same time meet your ethical requirements today, in a way that you really couldn't as recently as 60 years ago, when Nazis were running around Europe, or 20 years ago, when Balkan folks and Tutsis were rounded up and killed.

Given a continuous function f, (how) can you find a non-zero continuous function g such that integral fg from -infi to +infi is 0?

Start with any continuous function g which is compactly supported, for example, $g=1-|x|$ for x between -1 and 1, zero elsewhere, and then make a continuous interpolation from g to $-g$ so that at no point is the interpolating function 0 everywhere. For example, if t going from 0 to 1 is the interpolation parameter, $g_t = 1 - |x|$ for $1<|x|$

Why is Theist vs Atheist debate given so much importance? Why is so much energy, time (and credits, in my case) spent on debating this age-old issue?

The reason is the internet. Can't lie online, someone will catch it. The most obvious lie which is told in society is that there were supernatural events in the past, and so it is natural to believe that the internet is going to get rid of this. This was one of the first thoughts I had when I saw usenet, this thing is going to kill religion for good. People thought the same thing in the enlightenment, where the printing press was going to kill religion. In the 19th century and 20th century, where cheap science books and later paperbacks were going to kill religion. The idea here is that religion is on its last legs, because the supernatural stuff is so obviously false. But it's just not true. The supernatural stuff was always obviously false. It was obviously false in the 2nd century AD too. People knew that people don't get up from the dead, and they knew that water doesn't turn to wine. The miraculous claims served a social function--- they created a narrative which allowed you to see which people you could trust in a social revolution in a hostile environment. It was like a code: do you believe in the resurrection of Christ? If so, you're on our side, and we can trust you. In order for this code to work, it helps if it is preposterous. So revealing that religious miracles are lies is not news, it wasn't news to begin with, and it doesn't help in reducing the influence of religion. But since people are mystified by religion and it's persistence, they are constantly thinking "This nonsense can't survive this technical innovation, can it?" But it can, because the idea isn't nonsense. It's a sensible idea with some nonsense hair sticking out of it. You can cut the hair all you want, but it will just grow back. The point of religion is to make it clear that the ethics of human beings are derived from an infinitely intelligent, infinitely wise, and infinitely good limiting conception, where you idealize collectives to be infinitely large, and

everyone behaving in a superrational way. The limiting conception is the monotheistic notion of God, and accepting this as the ethical standard sort of trumps a lot of other considerations. Rejecting superrational behavior leads to colloseums and concentration camps, so you really want to make sure people accept this. So if you need to tell some obviously false stories about dead people walking around or animals on a boat, you live with it, so long as the alternative is Nashian or Kantian rational ethics. The rational ethics is susceptible to prisoner's dilemmas, on either the individual or collective level, and without the ability to intuit the notion of God from the notion of idealized superrationality, you can't sort out the ethical stuff properly. So the atheism debate flares up whenever communication technology improves, and the atheists always lose. But it is possible that this time they might not lose, because there is a way to incorporate all the insights of religion, including the insights of divinity, prayer, self-sacrifices, meditation, spirtual growth, eternal life, ethical good, sanctity of social functions, and so on, without having to accept any supernatural foundation. In previous eras, it was hard to keep all that stuff without a supernatural backbone to prop it up. But the supernatual stuff is false, everone knows it is false, even secretly most religious folks, they are just afraid that if they let go of it, the superrationality they constructed will collapse. One has to assure them that this is not so, and then the atheists and the theists can come to an agreement, I am sure, and there will be no more debate, and everyone will believe in God, or no one, I am not sure how you call this.

We know space and time form a continuum with no physical borders between its dimensions. Why is it assumed that the Big Bang expanded in one direction in time only

(asymmetrically in "3.5D"), instead of both directions in time (symmetrically in 4D spacetime)?

First, this idea is meaningless in logical positivism. Aside from "explaining" the anti-matter asymmetry (I'll get to that), it doesn't make any new predictions regarding the universe, so the other branch, the past branch, is not needed by Occam's razor--- you can just delete the past and be left with an equivalent theory. That means you are free to accept it or to reject it, as you feel, it doesn't mean anything. The reason this idea doesn't work to explain antimatter asymmetry is that the production of matter and antimatter is all going into the future! If you produce an electron and a positron, you produce both going into the future. The positron can be viewed as an electron going back in time along it's worldline, but the event itself looks like pair production, where both are going into the future. So your event where antimatter is produced going backwards into the past, and the matter is going forward into the future is really tantamount to matter going right through the big bang, since antimatter going backward is the same as matter going forward. So what you are describing is a big bounce, the worldlines are just continuous through the big bang. This is not consistent with what we know about the big bang--- the universe at the very beginning was all scalar field, and otherwise empty, it wasn't full of protons and electrons. A big bounce in general has a hard time making predictions that are not made by a big bang, because of the logical positivism issue.

Is it possible to prove that a proof for a given proposition does not exist?

This is not really possible, because there are infinitely many axiom systems, increasing in strength. So while it is possible to prove that something is unprovable in a weak system, generally this is done by using a stronger system to establish the result is true and false in a given model of the weaker system, and so to establish it is unprovable. If the result is an objective result, meaning it is a computational statement about the existence of tangible computable objects, then you can't show that it is unprovable in a uniform way, meaning that it stays unprovable in higher axiom systems. So for example, the consistency of set theory cannot be proven in set theory, but it is easily proved if you assume the existence of an inaccessible cardinal, and in fact, the existence of an inaccessible cardinal, in a computational interpretation of mathematics, is not much more than the assumption of the consistency of set theory! Technically, it's a little bit more, because it tells you that the model of set theory makes a set in the usual sense, so it gives you some more information about the growth rates of provable computable functions in set theory, but this is a technicality--- the basic principle is that you can always make axiom systems stronger. It is an article of faith in matheamtics that all propositions which are absolute, which are statements about computer programs or integers, acquire a proof in a strong enough axiom system. While this is not a theorem, and cannot be, because it is a meta-statement about an infinite tower of theories indexed by ordinals which have a limit that cannot be described computationally, so cannot be modelled by axiom system of finite complexity, it is probably a good heuristic, and it corresponds to the religious idea that by making stronger arguments we will learn all truths. You don't have to believe this, but I do. The P!=NP conjecture is absolute, it is a statement about computer programs, and therefore cannot qualify as an absolutely unprovable statement. If it is unprovable in an absolute sense, we won't know it. But it is probably provable by a relatively simple argument that nobody has thought up yet.

Is there an infinite amount of information in the universe?

From the holographic principle, a bound on the information in the universe is probably the area of the cosmological horizon in Planck units, since this is likely to be the maximum information in bits that we can pack ideally into a computer using all the stuff we could ever arrange in the universe. This is about 10^137 bits, which is a lot of bits, but it's not infinite. The bound is also growing, but not too much, because the area of the cosmological horizon can't grow too far before the accelerating expansion (the cosmological constant) fixes the horizon area at something like 60 billion light years squared.

Are Von Neumann–Bernays–Gödel set theory and Zermelo-Fraenkel Set Theory equivalent?

They are equivalent in terms of their mathematical content, meaning any theorem of BG which only talks about sets is a theorem of ZF, but the axiomatization is different because BG has class axioms, so it has both sets and classes, and it has theorems about classes too. The classes are just abstractions of logical predicates, so you can form predicates by steps from simple operations, corresponding to "and" "or" etc. The difference is not important in any real way, the only point was to have a finite axiomatization, so you can prove theorems more easily, because you don't have to check an infinite axiom schema is satisfied. This is the fastest way to verify that L is a model of ZF, by verifying it's a model of BG. If you restrict yourself purely to sets, you don't have a finite axiomatization of ZF. The reason is that there is an axiom schema--- the axiom schema of replacement, and you can't form all the replacement axioms from a finite subset of these. This is a stupid

technical property---- the replacement axiom is computational, it says that for every unique-image mapping from sets to sets, the image of the map on any pre-given set is also set. In terms of the completeness theorem, it's an algorithm for producing new sets from previous sets in the model. The collection of possible functions is like the collection of computer programs--- it is infinitely rich. So to make a finite axiomatization, you have to axiomatize the possible unique-image objects which represent functions from sets to sets. Since these "functions" have as a domain the class of all sets (the set of all sets is not a set), you need class axioms. It's not deep, and it's not a paradox, it's just a technical hurdle to a finite axiomatization and BG shows how to surmount it, and it's relatively straightforward.

Should most young people learn to code?

Of course everyone should learn how to code, and it is ridiculous that they don't know already, although if schools start to teach it, they will botch it up. I learned how to write BASIC in a few months in the early eighties, and 6502 assembly in a few months in the mid 1980s on an Apple II clone, from crappy xeroxed instruction manuals, with no internet. It was dead easy compared to other intellectually demanding tasks, like learning to read or talk. Learning to program immediately introduces you to all the deep ideas of the 20th century, ideas which took great minds like Leibnitz a lot of effort, because he didn't have a computer. You immediately understand the concepts of: * A universal machine: A computer can simulate nature just by updating particle positions. You begin to think of the world as a gigantic computer simulation, as some sort of cellular automaton. * physics: You want to simulate natural systems on the computer, so you learn some physics. And I don't mean far-out physics, like quantum mechanics or string theory, although that comes eventually, I mean balls bouncing on tables, planets orbiting the sun physics. * A thinking machine: since

the computer can simulate you! * Turing test/logical positivism: this is obvious once you try to think about simulating thought seriously. You realize all the little things your brain does which are impossible to formalize. You don't need to read Turing, it's obvious once you program for a week or two. * Traditional notions of intelligence and cognitive difficulty are crap: recognizing a face from pixel data, interpreting a slang sentence with complex imagery, identifying a commercial jingle in a different key and timbre, breaking apart speech into words, these are revealed to be the enormous mysterious powers of the brain, not the things traditionally thought of as intellectually demanding. * Formal logic: mechanical reasoning is obviously possible, so that mathematical deduction can be encoded in simple rules. The boolean algebras of logic are hard-wired into the computer, so you learn this stuff by osmosis. * Constructive mathematics: it defined what parts of mathematics are real (the ones you can see on a computer) and which parts are merely useful figures of speech (the metaphysics of uncountable sets). * Bullshit: programming a computer shows you all the bullshit. If you can't make a computer understand it, it's most often bullshit. To program a computer today is a simple matter of installing Linux and typing "python" at a terminal. I prefer to start with "if/goto" language. You have two commands, "if" and "goto", and a block of memory. Then you write code only with these two constructions and arithmetic. This shows you how little you need for Turing universality.

What do physicists think of Michio Kaku?

Michio Kaku made a fundamental and significant advance in physics, he created light-cone string field theory, following Mandelstam's light-cone formulation of string theory, along with Kikkawa. This contribution was central, because it was the first definition of string theory which was Hamiltonian, meaning it could tell you a detailed

story of how strings split and join in space time. It also allowed you to produce a detailed description of the Hilbert space of string theory which is not a scattering space. The thing about physics is that it has become annoyingly politicized, with two branches--- the technical branch which produces all the results, and the popularization branch which gets all the political clout. This division is extremely unfortunate, but it is a byproduct of the fact that nobody in the general public reads the technical literature. So people with immense technical clout, like Georgio Parisi, are incomparably less politically relevant than those with popular books, like Brian Greene. This is a plea to the general public: please read the technical literature. I mean it. Please read it. It is a precious production of our culture, it is the main thing we will be leaving to future generations. The 20th century physics literature is our Shakespeare, it is our Homer, it is the thing that defines our cultural legacy to the largest extent. It is not acceptable to have this literature be the domain of an elite, it must be universally appreciated. Under these circumstances, there will be no need for Michio Kaku to go around selling himself to mass media, he would have been appreciated for his technical contributions, without any need for him to become a publicity hound. But since we don't live in such a world, he has become a publicity hound. I think it is a bit of a shame, but it will never take away his earlier achievements. String field theory has receded somewhat from the main focus, now that we have AdS/CFT, since string field theory is not the most fundamental way to view string theory. But it is a valid technique, and it has led to many insights, and it is still the most economical formuation of string theory, and it is still something to celebrate. Michio Kaku might not have written Shakespeare's works all by himself, but he wrote "Macbeth", and I don't know how anyone can speak ill of a person who made such a contribution. To explain why the other answer here is wrong: while Kaku's contribution to string theory was not as enormous as Mandelstam's, Venziano's, Schwartz's or Scherk's, he did do something important in an important field, at a time when nobody took the field seriously. The people in the field were hounded and rejected, and it is impossible for him to have become a leader of physics based on his string field theory work, because people laughed

at string theory in the 1970s. The "leaders" of the field, Schwarz, Green, these folks were isolated in small departments and had no influence. The other "leaders", like Yoneya, and I'm talking about a whole generation of physicists, were just purged from the field. They were heckled for being crazy, and for denying quarks. Scherk took it to heart, and actually went crazy. It's a terrible story. You can't fault Kaku for being political in late life. While it would be nice if Mandelstam got the public recognition, Mandelstam is a very old man now. Somebody has to be a face for early string theory, and Kaku is as good a choice as any, he made a great contribution. In terms of technical achievement, string field theory is still useful and relevant, although it is less central than AdS/CFT and holography. So what. It's important.

Are Republicans or their political operatives attempting to suppress the votes of American citizens? Are these methods, when successful, reversible?

The main concern is that in three of the last four presidential elections, in 2000, 2004, 2012, with the single exception of the 2008 election, there was reason to suspect widespread vote distortion, since exit polls and official results were not aligned to the degree that historically they used to be aligned. This leads one to suspect that there was vote distortion through shady means, and in all cases in recent elections, it has favored the Republicans. In 2000, the vote skewing in Florida was large enough that a network had to reverse it's Gore victory, predicted by exit polling, to match the uncertain result that came out of the official tally. Still, even with all the uncertainty, the suppression of African American votes, the butterfly ballot, the skewed election

commission, the result would still have come out in Gore's favor had the supreme court not stopped the recount. One could say the 2000 election was a one-off event, but the problem was that one of the shadiest stars of that shady election, Kathleen Harris, was immediately rewarded with a Congressional seat. When a political party rewards operatives who distort the vote, the predictable result is that more operatives will strive to gain power by distorting the vote. So I consider the selection of Kathleen Harris to higher office the indication that the Republican party rewarded efforts at vote distortion. This is tantamount to the party sanctioning vote fraud, since vote fraud does not need to be coordinated at the highest level, it happens on the local level, county by county. From this point on, you get several unsettling events, at least they were unsettling to me: In 2004, electronic voting machines with no paper trail gave Ohio to Bush. The results of polling and the results of voting were not in line, and did not settle the mind of a suspicious person. This doesn't mean fraud occured, but I am not confident that it didn't. You need an auditable election to give people confidence in the fairness of the vote. The 2008 election wasn't close, and fraud would have been impossible given the lopsided outcome. I am sure that there was no vote fraud, as it would have been a waste of time. In 2012, however, the Republicans were under the impression that the vote was going to be closer than it actually was. In this case, you had the suspicious end of tallying in Florida, when the results looked like they were going to favor Obama as the vote count proceeded. The election talliers took a holiday until the next day! This is unprecendented, and it suggests that there was politcal pressure there to make the results favor Romney. The results from other states were sufficiently overwhelmingly for Obama that it didn't matter in the end, but I am very disturbed by what was going on in Florida in 2012. Thankfully Obama was also disturbed by this, and made straightening out the election process a priority after reelection. From this suspicious pattern, although it doesn't prove anything, it seems that there has been some minor movement in the lower ranks of the Republican party to skew voting. This is in both voter ID laws, and in voting machines and tallying procedures that are susceptible to political meddling. This used to happen in the other

direction in the 1950s and 1960s, to favor democrats, with several suspicious elections at the time being influenced by mystery ballot boxes and strange activities by unions and democrats. I think that these types of things must be eliminated, and can be, with a good exit polling institution, and with careful independent poll-monitoring and public release of exit poll and county-by-county and ballot-location by ballot-location voting tabulation data. I don't want the voting process to unfairly favor either party, as it produces terrible consequences, because of the rewarding ot shady operatives, and the consequence can be corruption which engulfs the whole government.

What advice would you give to a Physics major student that you wish you were given when you started Physics?

The general advice is simply to read the original literature, the research papers of the 20th century, not just rely on the secondary literature. You should read the secondary literature too, but as an exegesis, to make the primary literature more accessible when you don't have a lot of experience. There is no substitute for reading the masters. Everything else I say follows, although I am ashamed to admit that I don't listen to my own advice enough. One insight you will get from reading primary literature is that String theory is not bullshit, and it isn't something that people believe out of deference to authority, but for very very good reasons, originally the S-matrix philosophy and later the holographic principle. That doesn't mean it is certainly right, you need experimental evidence to come to that conclusion, and we don't have this evidence today, but it does mean that string theory is a huge step forward in physics, and it is possibly the largest single step to a theory of everything that has ever been made. Every other path to quantum gravity is somewhat bullshitty.

That doesn't mean you can ignore all the non-string quantum gravity literature, the loop stuff has some interesting and perhaps relevant mathematics, but it means that only the string theory path gives you a good theory at the end of the day. The loop stuff has problems with reproducing the entropy law But it's very hard to learn string theory, because it's ultimately a strange Italian theory, with enormous contributions from Berkeley, Syracuse NY, and various smaller centers, but it owes little to the main centers of physics: Moscow and Princeton, at least not until the 1980s. In the 1980s, Polyakov and Witten take it up, moving it to the big time, so that by the 1990s, every university has research on the subject. String theory is hard to learn because it is so much a grass-roots theory. The original literature is Berkeley's bootstrap program, and reading Gribov's "The Theory of Comples Angular Momentum", together with Tullion Regge's articles on Regge theory, and various not so well-known 1960s phenomenological literature on Regge theory is the only way to gain intuition for the theory. Feynman's book "Photon Hadron Interactions" also has some insights here, but this is more for the QCD light-cone stuff that is done in the 1970s by Gribov and in the 1980s more by Kenneth Wilson and later taken up by Rajeev. This stuff is fascinating, but outside the main line of development. The main line is through the work of Veneziano, Mandelstam, Schwarz, Scherk and all their coworkers in the 1970s who develop the formalism and show it describes gravity consistently. The literature is daunting because without reading the original literature, you can't understand any of it. So I would advise the young person to read the original literature on strings in the 1970s, until he or she is thoroughly familiar with it, and then to move on to the 1980s and 1990s. To do this, it helps to read a modern string theory textbook first, and Polchinski's is without peer, it is the best. Even so, Polchinski's book is not enough, you need to read the original literature to really get it. The other piece of advice is simply to keep an open scientific mind, and to remember that experiments are important. So reading condensed matter literature will keep you grounded, and reading about cold fusion will let you see how terribly political physics can become, and how easy it is to dismiss solid experimental evidence in a bad political climate. This happened

to string theory too--- it was politically out from 1974-1984. It was only kept alive through the effort of Gell Mann and a handful of other supporters, and this type of political effort is important, and needs to be lauded too. I agree with the other answers here, especially on the importance of learning to program and do computations. I wanted to give a perspective on some other things that I think are important, but more controversial.

What's the funniest thing a kid has said or done?

While doing laundry, with my 3yr old daughter: She: "Do we take it for mommy?" Me: "We will take it TO mommy." She: "Take it ... for ... mommy?" Me: "take it TO mommy." after a long confused pause She: NO! Not TWO mommy. ONE mommy! She was very upset.

What is the wisest/smartest thing you've ever heard a child say?

A physicist I met once told me he asked his 6 year old son to imagine standing on top of a big ball in outer space. Then, he told his son, he looks over the edge, and there is a person on the other side of the ball, upside down, with feet on the bottom of the ball. He asked his son: will that upside-down person fall off the ball? His son thought about it, and said "If the other person looks at me, he sees my feet, and I'm upside down to him. I'm not falling off, so he doesn't fall off".

Why do so many people hate Anne Hathaway? I have heard several people complain that she's annoying, but I haven't seen any evidence of that. Did she have an interview or scandal that makes people dislike her?

Because she forced Shakespeare to marry her, even though he was clearly in love with another woman. So he abandons his family for an acting career in London, and then come the Shakespeare works. The issue here is similar to Yoko Ono and John Lennon, nobody likes it when a woman stands next to an artist. But in the case of Shakespeare, there is no need to hate on Anne, since he was just fronting for Marlowe.

In your opinion, what is holding back the companies 'Apple' and 'Microsoft' from joining forces for technological progress?

Neither of these large corporations are capable of producing technological progress, because they aren't producing open systems which can be developed by anyone and the collective progress shared by all. The main story of the computer revolution is not Apple or Microsoft, it is Richard Stallman and the Free Software Foundation, who were able to produce free systems which surpass anything that Microsoft or Apple can make, even thought they had no large

corporate sponsorship for the first two decades (IBM develops free software now to a certain extent, and some Linux companies are reasonably large today). The development of GCC, the Linux Kernel, and the free-software tools of the modern day are the worthwhile things of permanent value, the large corporate bodies consistently oppose these developments, and so have served only as a terrible impediment to the adoption of universal computing and ubiquitous programming. In this sense, the monopolistic and intellectually closed constructions of modern corporate capitalism are not friendly to technological development, and Apple and Microsoft (who work together more than they work apart) were neither willing or capable to deliver true progress, rather they held it back by suppressing free software.

What were the worst SCIENCE ideas to ever hold back scientific or technological progress?

The worst idea is the authority structure of society, the idea that the opinion of people matter by a weighted average using their social position as an indicator of reliability. This is the only thing that holds science back. Unfortunately, it is deeply embedded in human society, and only a completely egalitarian distribution method for ideas, together with a debate mechanism with an anti-authoritarian evidence based evaluation of accuracy, can counter this. Fortunately here we are, we have such a system on the internet. The idea of truth by authority is dangerous whether it is secular political authority, established religious authority, or even scientific authority, although the authority structures of modern science are more accurate than the previous authority structures by a large measure. But, even with modern scientific authority, as long as the truth of an assertion is determined by counting how many people support it and how many people oppose it, and making some sort of average of opinions, science

cannot progress. Science progresses when individuals speak what the evidence compels them to believe, and argue their positions openly, with an open mind, until the weight of the evidence persuades them of what's what. This is something which is time-consuming and difficult, and requires internal honesty to tell you when you screwed up, but there is no royal road to geometry.

Since nothing can travel faster than light, can't events in the so called past, such as those from stars billions of light years away, be said to happening in the present scientifically speaking?

I like this point of view very much--- and to some extent it makes modern physics a lot more intuitive, but it is intuitively different from the standard idea, and presents some intuitive glitches that you need to get used to. This idea is that you define "now" along a past light cone from a given point. If you move far away from this point, the cone looks like a flat light-sheet locally, and the propagation forward in time is by pushing the sheet-cone outward by a normal null coordinate, and this is a standard technique in modern physics known as "light cone coordinates" or "light front coordinates". Light cone coordinates were introduced by Dirac in the 1940s, and they are more physical for gauge field theory and string theory, because they allow you to formulate the theory without ghosts, meaning that all the excitations in these coordinates are physical. It is less convenient mathematically for field theory than standard definitions of "now", because it makes rotational invariance and Lorentz invariance not obvious, rotations which change the light front are hard to describe. But for string theory and for quantum gravity in general, the light cone is in some sense the right definition, as I will try to explain below. The main issue is that cones are not sheets, so that the definition of "now" has the property that if A sees B happening "now" and B sees C happening "now", then C is in the past for A (except if A B and C are collinear, with B between A and C). This is because cones are not isotropic--- they have a special point. This problem dissapears in light-front coordinates, the light front is a sheet, and the light-front sheet has all the symmetries of every other sheet, it has translation invariance on the sheet. But it also has an extra symmetry--- boosts along the sheet, and this enhanced symmetry is what attracted Dirac to the formalism. Light front methods were taken over by Mandelstam in the 1970s, who developed the technique to make sense of string theory in the off-shell formalism, meaning away from pure scattering theory, Mandelstam showed that in the light cone formalism, you can make string theory into a Hamiltonian theory, and this was the only precise definition of the state-space of string theory which did not rely on scattering states, which actually allowed you to say in detail how the strings join and split in detail as they move through space-time. So in string theory, the definition of now is best done along a light-front, and Mandelstam's collaborators Kaku and Kikkawa made this into light-cone string field theory. Because string theory is an S-matrix theory fundamentally, the definition of light-front string theory was the only way to make sense of the state-space for a long time. It was a little embarassing, because it didn't make rotational invariance obvious. The 1980s formulations of superstring theory, by Schwarz and Green were also done in the light-cone coordinates, and had the same problem. I don't see it as a problem, I think this is the correct idea, and the reason is the holographic principle. The original formulations of string theory were for cases where the background space-time was flat, and in this case, light-cone coordinates seem unnatural. But when you have a black hole, or a cosmological situation, the light-cones bend in such a way that they cannot penetrate through the horizon, and this makes the light-cones a strictly outside description of black holes (when the horizon is a future horizon and the cone a past-cone), or a strictly interior description of cosmology (when you interpret the cosmological horizon as a future

horizon, which is not the usual picture). So the light-cone definition of "now" doesn't have the unphysical extension of space-time into regions where we cannot get signals. When you look at the universe in this perspective, the cosmological horizon is the boundary where the big bang is still happening "now", the horizon was smaller in the past, meaning when you look at the "now" for our past position in space-time, the horizon had a smaller area. The ancient horizon at inflation times was just a little sphere surrounding us, and this picture makes no reference to exterior places, it doesn't have the extended universe of eternal inflation, or of classical General Relativity, in the usual slicing into a 3-d space and a 1-d time. This perspective is more in accord with the holographic principle, which demands that the interior of black holes (in established formalisms) and the exterior of the cosmological horizon (in ill understood extensions) should be reconstructed from a pure interior description. So I think this is a better definition in light of the holographic principle, although this is ultimately quibbling over words, the meaning of the formalisms is in the mathematics, independent of which way you interpret human statements like "now" which become ambiguous in relativity.

What are the implications of a court banning Bayesian probability?

The court is probably doing something useful. While Bayesian methods are the foundation of thinking and reasoning about the world, we do these types of inferences intuitively. Paradoxically, because our intuition for this is so developed, the mathematically untrained person can do it better without any math than with! So for example, suppose I see find on a murder scene a red cap, a Camel cigarette, a shoe-print of size 14, and a blurry picture which shows the guy is 6'4. I can say in court, as a prosecuter: 4% of people smoke Camels. Only 8% of men have size 14 shoes, only .1% own a red cap,

and only .1% of men are 6'4! Multiply, and you see the probability is 1 in a million. This is your guy! It's very hard for a defense attorney to argue with this, even though we all know in our gut that this crap, that the evidence above is ridiculously weak. It is hard to explain why it is ridiculously weak without a long explanation of the selection process, the biases for keeping certain evidence and not others, and the ability of police to attach irrelevant stuff to the event that match, after finding the suspect. All these things render the 1 in a million more like 1 in 2, or 1 in 3. Here is you see the main problem with Baysian reasoning in a courtroom (rather than a science laboratory), the method is being applied with a political end, and so it is not done honestly. The right way is to say how you selected the evidence you are presenting, and how you found your suspect. If you found your suspect from a million follks, by matching these traits, you have no evidence at all. This is exactly what a jury's intuition is from seeing this ridiculous evidence: you don't know anything. But using Baysian multiplication (inappropriately) a lawyer can try to persuade the jury that the evidence is much much better, since only about 5 pieces of evidence each with 10% prevalence and which match to the suspect are required for scientific certainty, or certainty beyond reasonable doubt. Yet precisely these kinds of vague-evidence are the easiest to spuriously attach to a case. So the use of Bayesian probability in courtrooms is almost always a way of lying with statistics, a way of making weak evidence seem stronger by multiplying likelihoods inappropriately. It's another version of the conspiracy theorist's "What are the chances of THAT??" Often the chances are very good, because THAT is very fungible, it could be a billion coincidences. The fact is that these probabilities are very hard to estimate by folks unskilled at statistics, and the manipulation of the statistics by attorneys is easy to do and hard to counter. So I would argue that if you have good evidence, present it in such a way that the evidence looks good intuitively as well. I agree with this judge's judgement, or rather, I defer to their experience.

Do fields really exist? Could it not be that the field emerges after we put the particle—just like in quantum mechanics, where particles act like they have well-defined positions only when they are observed?

This is one of the cases where logical positivism is positive rather than negative: when you can give a procedure to test something, then you know it exists. That's what "exists" means in physics. In this case, you place a charge somewhere, and you see it move, and that's what it means to say that electric fields exist. The definition of field is that it is defined by the effects it has, and this question you ask was the motivation for logical positivism to get formulated.

Who is the most badass physicist ever? Why?

The most badass was, without a doubt, Ettore Majorana. (Ettore Majorana) He was a young Italian fellow who disappeared mysteriously, and was rumored to be involved with the mafia. He discovered a bunch of things, but his name is associated to one in particular, the class of real Fermions, the kind which are their own antiparticles. The stories Fermi tells about him reveal his character. He is the Galois of Physics.

If you travel through a wormhole and end up millions of light years away instantaneously, would physics deem that to be time travel (since you're technically breaking and re-entering the fabric of spacetime), faster-than-light travel, or both?

A worm-hole that allows for faster-than-light travel also automatically allows for backward in time travel, under the assumptions that you have more than one of these around, and that relativity works, so you can boost them to be moving at a relative speed. Then by using the two boosted wormholes, you will go back in time, simply by going far away "instantly" in one frame, and coming back "instantly" in another frame. This means that superluminal connections lead to causality violations, and this is a reason to forbid making wormholes in nature.

Should industry regulations be analyzed by game theory experts to avoid motivating self destruction behavior?

Although you won't hear this from any game theorists, the game theory models are not likely to work well in any case other than enormous markets with essentially infinite number of players, such as is the case in small business. For large businesses, game theory predictions are often useless. Game theory presumes a very unsophisticated form of rational decision making as its fundamental premise, and this is the rationality of Nash and Von-Neumann. This rationality states that each actor will play according to a Nash

equilibrium, if there is a position where any unilateral action will decrease the payoff to any actor, that's where play will stagnate. So that in prisoner's dilemma, you will find people playing in economic equilibrium, meaning they will always defect. This is a false prediction for large firms, and it fails more and more dramatically the fewer the players involved, and the more political connections there are between them. An example of this, if there are two firms manufacturing light-bulbs, and one can gain an economic advantage by making their light-bulbs longer lasting and cheaper, then the laws of economic competition, the laws of game-theory, dictate that the firm will do so, and even with only two firms, the competition will drive the light-bulbs to be the longest lasting and cheapest they can possibly be, undercutting both firms profits until the profits just sustain the rate of capital returns, and the owner is making no more profit than if he retired and opened a shoe-store. But in fact, light bulb manufacturers made large profits, and at the same time, they reduced the life-time of bulbs, so as to increase collective profits. Initially, in the 1930s, this was done through an explicit cartel, but later it wasn't necessary. The force of convention in the industry was enough to make it clear that one does not manufacture light-bulbs which last too long. Similar industry-wide conventions enforce planned obselescence in other manufacturing areas. Such a thing would be predicted to be impossible in game theory analysis, it contradicts the fundamental assumption of competitive economic game-play. The phenomenon is a superrational decision making, where the players recognize themselves to be part of a collective, and part of their loyalty lies with the collective. So that certain actions which harm the collective become unthinkable and unethical to these folks, even if these actions would increase short-term profit in isolation. These actions are also not profitable, because of the retribution which will follow from other players in other firms. In order to be stable to defection, the retribution mechanism must operate even when it is irrational in the traditional sense. If you are a new small manufacturer of light bulbs, and you make a long-lasting cheap bulb, you are a dangerous price-warrior, and then the other companies, without collusion, can see this all at once, without communication, and they can bankrupt you by making special contracts with your suppliers to prevent materials from getting to you, or engage in some punitive action like collectively undercutting your price temporarily, below their cost of manufacture, just to drive you out of business. These collective measures don't have to take the form of illegal action, they can involve simple propaganda that states your products are inferior in some way. These actions can be taken even in the case where it costs the firms involved more money to enforce the sanctions than the extra money that they make directly from the action, so it would normally be considered irrational. But since it serves to enforce a superrational equilibrium where both purchases and prices are above the market equilibrium, it can stay stable forever, so long as there aren't too many players. No new entrant to the market wants to upset the balance, and so they play along with the conventions established by previous players. This is a competitive muti-monopoly, a monopoly-like pricing established by firms which would be considered uncoordinated, since they do not need to explicitly collude. Is the punitive behavior of firms irrational? A game theorist would say yes. But in the real world, we have politics and collectives, and the gain from staying on the good-side of the political organizations is greater than the loss from a small financial setback from a punitive measure. This only fails when there are so many players, that it is impossible to find and punish all the folks who violate the rules. Economists and game-theorists don't accept that collective entities with their own decision making power can form, and that these can produce seemingly locally irrational behavior through shared values and punitive political actions, and use these locally irrational actions to enforce the monopolist's pricing. Partly, this is because these behaviors make it impossible to effectively model anything mathematically--- you need to know the common values of the collective. Partly this is also because such hypotheses were for the longest time taboo--- the mechanism of collective entities is like a corporate level class structure, and such things were postulated by Marx, and there was a polarization of the world, pro and anti Marx, which prevented anything which smelled of Marx from gaining traction in the economics or policy departments where game-theory was developed. But when analyzing policy using game theory, one

must take into account the ability of collective agencies to form, and to the extent that this harms market production, to kill these collectives. The result of such things is that markets don't work the way textbooks describe them, corporate profits aren't driven to zero by competition, and old industries with no innovations can produce enormous profits not through risk, or through expansion, but simply through political deals among an oligarchy to produce monopolist's behavior even when there is no actual monopoly. The distance between textbook rational behavior and real world economic behavior is too unacceptably large to take the game-theory models seriously.

According to string theory, there are 10 dimensions and that's it. Why are there no more than 10?

The string is a black hole, and the number of degrees of freedom of a black hole are constrained. The string black hole can shake in any one of the dimensions of space, and when there are more than 10 dimensions (and Fermionic currents on the worldsheet), the black hole has too much entropy. You can see that there is a strict mass bound because the number of oscillation directions gives a new scalar field, and each one contributes to the entropy of the string. The dimension can go up to 26 for a string, if you give up on Fermions and allow a non-stable vacuum. The 26 dimensional bosonic string is not viable by itself, but it can perhaps be given a cosmological interpretation, as Simeon Hellerman has done in the last decade. The limit is just that the number of degrees of freedom of the string can't grow without bound (or shrink either), because there is a self-consistency requirement that the string describe a surrounding spacetime holographically, with the right entropy relation for a black hole in the classical limit. This argument does not appear in the literature in

exactly this form, and it is not 100% clear it can be made mathematically precise, so take it with a grain of salt. It's a framework for giving a more physical interpretation to the mathematical calculations in the existing formalisms that pick out a certain fixed amount of degrees of freedom as required by the duality between world-sheet and space-time to work.

According to String Theory, why did only 4 dimensions expand from the Big Bang?

This is an open question. There are models in the literature which I think are no good, like the Brandenburger Vafa idea that strings meet generically in 4d and no higher, so it was an annihilation effect. There is an older idea in 11d supergravity which is that the 3-form gauge field can pick out a 4d-7d compactification as natural, where 7 dimensions are curled small and 4 are large, because if you give a 4-form field (the d of the 3-form field, the gauge invariant field strength) an expectation value, you can produce a negative cosmological constant for 4 dimesions (3+1 actually), and a positive cosmological constant for 7 dimensions, so the 7 dimensions curl up and the 4 dimensions become big. But all these ideas are primitive, because we don't know the details of the string vacuum we live in. These details will give you dynamics for inflation, from brane motion, from orbifold stabilization, from radial excitations dying out, and so on, and nobody knows exactly how the 4 dimensions are stabilized with a net small cosmological constant, and the 7 with a net large cosmological constant, but it's completely plausible that it happens. So it's something people think about, but not so much anymore, because there are too little clues, we know too little about our vacuum.

What are the differences between a black hole singularity and the Big Bang singularity?

The black hole singularity is completely different. The singularity in the center of a black hole is modified to a much milder time-like singularity if you set the black hole spinning or give it a small charge. The singularity at the big-bang disappears if you add a cosmological constant. The big-bang singularity doesn't disappear if the universe has a net charge density, and it doesn't disappear under other perturbations than a large cosmological constant at the beginning. The black hole singularity is stable to cosmological constant perturbations. The two arguments showing that the singularities occur are mathematically similar, they are both due to the convergence properties of geodesics. The main difference is that the black hole result requires only condition on the behavior of null geodesics (light rays), and in general, for spinning and neutral black holes, Penrose's theorem is consistent with the idea that only light-rays hit the singularity, everything else misses. That's good, because this is exactly what happens in charged or spinning black holes, so the theorem doesn't prove more than what is correct in the exact solutions. The big-bang singularity result requires a stronger condition on the energy, namely that the stress-energy-tensor has an energy component bigger than the pressure along all frames which follow any massive particle trajectory. This stronger energy condition is due to Hawking, and it is violated by a scalar field with an expectation value (by a cosmological constant). This is the only violation which is significant and non-quantum, and this is the reason that inflation can smooth out the initial singularity, depending on the details of the inflaton dynamics. Instead of a singular bang, you match to a smooth deSitter initial conditions. To see the argument for both, you should learn this answer: .http://physics.stackexchange.com... . Penrose's argument is then very simple--- if geodesics from a closed-trapped surface are all converging, the boundary of the future must be compact, because all the generators of the boundary end after a finite affine parameter (time along a null geodesic). This means that the future either ends, or

new null geodesics are generated from nowhere. The first option is what happens in Schwarzschild solution, the second option is what happens in the charged/spinning case, and in the generic black hole exact solutions. People debate which is the right generic description, the charged/spinning case, or the neutral case, I tend to think it's the charged/spinning case, as suggested strongly by AdS/CFT.

Is there any theory for what may be the ultimate beginning(If big bang started with a speck of particle with size less than an atom and density higher than anything we know, how did that come in the first place)?

It is important to note that the bottleneck of a small initial cosmological horizon makes the information about our universe generated long past the intial inflationary period. This means that we only have a certain small amount of information coming from the big bang, an amount limited by the small entropy in the big bang. The initial state was hot in terms of temperature, so it was maximally random, but it was cold in terms of entropy (this is a minor paradox--- it's the small cosmological horizon that allows this seemingly conflicting properties to coexist, as argued persuasively by Davies. Cosmologists for some inexplicable reason didn't buy Davies's explanation of low entropy initial conditions from small horizon size. I buy it) so it randomized any information about "earlier" states, so the degree to which we can meaningfully speak about these states is limited by the information we can acquire at the present moment. The best answer one can give is that to the extent you can make a prediction that agrees with the data, so you can describe the big bang evolution from a small cosmological horizon (low in entropy---

explaining the low entropy of the intial conditions of the universe entirely from the cosmological constant), and the entropy is too low, essentially zero, so it is difficult to say how you can give a meaningful explanation in terms of earlier stuff, since that earlier stuff would necessarily have a higher information content than the big bang. That earlier stuff is more information than is required to specify the initial state, whatever it might be. So even if you have a compelling model which describes the emergence of low-entropy initial states, like a tunnelling model, or a scenario that randomizes something else leaves only a small amount of entropy behind, I think it is enough to describe our vacuum precisely, and show how to describe high temperature/low-entropy states in string theory (the cosmological initial state), and then you can say this is the initial statistical state with no further information required, since this is all that is logically positivistically meaningful to determine. The hypothesis you make about the previous stuff usually involves more information than what is coming out of the big bang, and unless it can make some predictive statement about the statistics of the big bang (predictions which will be hard to confirm, since the big bang is unique), I don't know how you give meaning to such theories. This means that most of the literature designed to explain the big bang is not necessarily wrong, but possibly meaningless, in that positivism does not give it a meaning. So you have to be careful in this field to make sure you are making a prediction regarding observations which are stronger than current knowledge. Since the current model has such a low-entropy initial state naturally, using only cosmological holography, I don't know if further explanations can be given (beyond working out what vaccum we are in, what the inflaton was, and exactly what the evolution of the inflaton was during the inflationary and pre-inflationary period).

Thermodynamics: In the case of a porous and movable wall connecting two physical systems

A and B, on solving for maximal microstates to get equilibrium state, we see that P/T and mu/T are constant, but why does the total combined system not come to same temperature?

It's just an assumption, you are assuming the wall does not exchange energy between the two sides, even though the particles can diffuse. This is not necessarily a paradox--- you can imagine that the particles diffuse through a long batch of wall, and that the heat diffuses slower. One way to arrange this is for the diffusion to be of Hydrogen, the wall strips the electron from the proton, and then there's an electric field which leads to bulk flow of the protons, while the heat still has to diffuse from one end to the other, so the bulk material flow is faster. If you have two such diffusors with opposite electric fields, you can make a wall of this sort. But it's just an abstraction--- the wall allows particles to move from one side to the other, but doesn't allow energy to move from one side to the other.

What are some concepts that were difficult for people to grasp in the past but are now commonplace?

I don't know about the too-distant past, but the compactness theorem of logic was very difficult for mathematicians to use until the 1950s. The compactness theorem states that if any finite collection of statements is logically consistent, the infinite collection of statements is logically consistent. The proof is trivial--- any contradiction is finitely

long, so it only uses finitely many of the assumptions. You can see that this trivial idea was difficult to grasp, because it's most immediate consequences were not widely understood until the 1950s. * Infinitesimals are consistent. If you have a theory of the real numbers, the infinite list of statements: * I have a positive real number x. * It is smaller than 1/2 * It is smaller than 1/3 * It is smaller than 1/4 etc, this infinite list is clearly consistent with any finite truncation, but the implication that the full list is consistent means that you can extend any axiom system for the real numbers to include infinitesimals. The same argument shows you can introduce infinite integers, or infinitely large real numbers. This was considred surprising when Abraham Robinson used it to construct infinitesimal calculus. There were many arguments made in the past which were given involved proofs that become trivial when compactness was invoked. It is a little embarassing now to read these things, because they show that logical compactness is not as trivial as it seems today.

What cognitive tasks/ideas/ways of thinking were once considered complex and now are considered normal/not prodigious?

Programming a computer used to be an arcane task, but children learn to do it today, and since the 1980s. Everything in mathematics has this nature, as every hard theorem of the distant past is easy today, and there are no exceptions.

What are some examples of wrong scientific beliefs that were held for long periods?

The easiest examples, excluding ones from before modern science existed: Phlogiston: the fluid of heat. This was debunked by Joule, who showed that you can get as much heat as you do work while boring a canon. Lumineferous ether: This idea was debunked by Einstein. Blending inheritence: The idea that traits mix by blending during sex. This was disproved in Darwin's day, because it was incompatible with evolution, but it is more thoroughly disproved from the molecular basis of heredity, which shows that genetic information is stored in discrete bits, mutable individually. Plum pudding: This was the idea that the electrons were embedded in a postively charged ball, and the spectral lines were resonance frequencies of the electrons. It was disproved by Rutherford's alpha-particle scattering experiment. Nuclear electrons: the idea that there are electrons in the nucleus was disproved by the advent of modern quantum mechanics, and the discovery of the neutron. Energy non-conservation during beta-decay: this was disproved by the neutrino, which was directly observed in the 1950s. Drude model of metals: the idea that electrons carry curent ballistically. This was disproved and refined into the Fermi theory of collective currents, after modern quantum mechanics. Specific heat measurements showed that the electrons were mostly immobilized, and anomalous currents (hole conduction) was established to occur by measurements of the hall effect showing positive charge carriers (electron holes) in p-type materials. Viruses have a fixed sequence: This was considered established from the stability of viral sequence, but it was challenged theoretically by Eigen in the 1970s, and experimentally by the observed mutation rate of RNA polymerase in the 1980s and 1990s. Now sequencing establishes the Eigen quasispecies model is correct. Electrons delocalize when there is no band-gap: This was shown to be false in three different ways: Mott showed it could be made false in certain conditions by electron-electron repulsion, so that the electrons crystallize on top of the lattice, independent of the lattice, Anderson showed it could be

made false by strong enough disorder, and Pieierls showed it can be made false by introducing new band-gaps due to crystal motion, these are the charge-density wave materials. Boulware vacuum described black holes: there is a non-radiating vacuum for black holes, which was shown to be the wrong description when Hawking calculated the thermal radiation from black holes in the 1970s. The Boulware vacuum is the solution for a black hole surrounded by an infinitely cold mirror right next to the horizon, reflecting all the radiation back. It is mathematically confusing, because you would think that the black hole has a cold solution, because it looks like a static situation. Path integral for quantum gravity: this was a mainstream idea until the 1990s, that you describe gravity by path integrals over metrics. It was uncomfortable theoretically, since if the path-integral included different topologies, the sum on topologies for four dimensional manifolds is uncomputable, as proved in the 1980s. But it was 'tHooft and Susskind that showed that this doesn't work, because it produces an infinite black hole entropy, so it is inconsistent with black hole thermodynamics. There are too many more examples to list, I got tired. The number of examples is comparable to the number of scientific discoveries, since each new idea displaces an old idea. That there are wrong ideas is not a problem, so long as they are not held dogmatically.

What are some things that science firmly denied or rejected as myth, which were later found to be true?

Meteorites: the idea that rocks fall from the sky was considered pseudo-science or superstition, but was demonstrated when a meterorite landed just outside the Academy of Science in Paris in the 18th century. Continental drift: this was considered a pseudoscience,

even though the evidence was compelling from the moment Wegener compared fossils at correpsonding locations on the African and South American coastlines. Abiogenic methane: This was considered crackpot stuff, that hydrocarbons are made from natural processes, but is now mainstream. The broader idea that all hydrocarbons, oil, coal, and so on, are made without any biology intervening, is still considered off the wall, but as Thomas Gold explained, it is indisputably supported by the available evidence, and the biogenic theory is not. Hypnosis: That people could be suggested to do things while in a trance was once considered a pseudoscience. Mesmer was doing pseudoscience, he said he was controlling people using magnetic fields, and animal magnetism. The idea was quietly absorbed into modern psychology in the early 20th century, because the effect is widely reproducible, and is widely reproduced. You can see street hypnosis in many videos on youtube, for example, and hypnosis is used today by many psychologists. Radioactivity: Bequerel's discovery, that materials can produce heat and energy indefinitely, with no observable change in their chemical or physical state was considered pseudoscience for more than a decade, because it seemed to conflict with principles of conservation of energy. It stopped being pseudoscience once the nucleus was discovered by Rutherford. Epigenetics: The idea that heredity can be transmitted through mechanism other than genes, this was considered a dangerous pseudoscience. It is now established conclusively through many studies, although the array of mechanisms involved is still obscured. Microorganisms: That there are little animals that cause disease was considered pseusocience until Pasteur. Antimatter is matter going back in time: This is a funny one, because it was proposed by Stueckelberg, made stick by Feynman, accepted in the 1960s, but it is now considered wacky by people who should know better. The problem is that the formalism of particle path quantum mechanics is not fully understood, and can be subsumed into a quantum field theory, which in the Hamiltonian formulation, only has forward in time evolution. That's true in the Hamiltonian formulation, but that's why the particle formulation is interesting and different. Lesage ether: the idea that gravity's 1/r^2 force is through geometrical dilution of

particle propagation was wacky, but half-mainstream until the field theories of the 19th century made it non-mainstream. It was revived in a different way by Feynman, and this made it stick. Quarks: The idea that there are fractionally charged constituents of hadrons was proposed by Gell-Mann (also by Zweig, but Gell-Mann did much more of the associated work), and it was considered screwy until 1974, whem it was confirmed by observations of the Charm quark mesons. DeBroglie Bohm theory: The idea that you could have hidden variable theory reproduce quantum mechanics was so screwy, that Von-Neumann claimed to prove it was impossible. Bohm showed it was possible, although the results are necessarily nonlocal, due to Bell's theorem. Black holes: This idea was screwy until the 1960s, because Einstein didn't see how matter could pass the horizon, where time stops, as measured from infinitely far away. Regge theory and S-matrix theory: This was considered "wacky", not pseudoscience, but it was discredited in the 1970s-1980s, when the evidence for a Regge theory was already overwhelming. Vacuum fields: Nambu's idea of vacuum fields leading to light pion pseudoscalars, also developed by Gell-Mann and Levy, was considered off the wall, because it would lead to a cosmological constant. It is accepted fact today, since lattice QCD shows that these condensates do form. BCS theory: The idea that there could be a charged condensate was considered wacky, because the condensate would not be gauge invariant. The list is essentially infinite, I got tired. The political structure of humanity makes it that every new idea is initially opposed, because the defenders are few and the deniers are powerful. The internet mitigates this to a large extent, because you can evaluate the theories on their merits in open discussion, so this problem might disappear in the current media climate. Within physics, scientists such as Pauli made open discussions of all ideas reasonably accepted, so that the problem was not so pronounced. But the physics culture was isolated from the larger world, where authority is still the main arbiter of right and wrong.

Why can't we emulate dreams when we are awake?

You can do this in several ways. The worst way is through the abuse of opiates, opium, morphine, heroin. This is the "pipe dream" the dream induced by smoking an opium pipe. This class of drugs can produce vivid waking dreams, where you begin to hallucinate vivid scenes while you are not asleep. When this happens, the user will nod, you can see people nodding on the street in any big city. If you ask heroin addicts what keeps them addicted, for many of them, it is this waking dream, rather than any euphoria, that is the source of the psychological addiction. Drug euphoria is silly, you know it's not real. There were several poets and authors in the 19th century, like Coleridge and DeQuincy (see here Opium and Romanticism) , that dabbled in opium, but opiates were also abused by some rock musicians. The goal was to write down the dreamscape while they were still inside the dream. Opiate abuse is a terrible thing, and it is completely unnecessary to do that to your brain. I have never taken opiates, and I have had the same exact type of waking dream. This was after sex (so perhaps just natural opiates substituting), when the eyes are closed, and you are tired and content, but not sleepy. You can begin to dream without sleep. It is also certainly possible to do this through meditation, and this is sometimes called "astral travel" by practitioners, with the false implication that it's more than a particularly lucid dream. You dream while awake, with eyes closed, in a trance, enhancing the visualization process through practice. Richard Feynman reports these types of waking-dreams in a sensory deprivation chamber in his autobiographical book, so that's another way. It's not an uncommon experience. I think that in order to stop opiate abuse, the natural methods of achieving the results need to be advertised better. It is hard to stop people from taking a drug when you give them no alternative. There are certainly healthier alternatives to opiates.

Can we make sure we are dreaming while we are dreaming?

I developed a way to tell if I was dreaming when I was ten, and I used it for a few years to lucid-dream. It might have stopped working after a while, I don't remember exactly, I stopped lucid dreaming at about the age of 15. The method was inspired by Descartes' question, can we tell if we are dreaming? I suspected there must be some aspects of the dream world which are only imperfectly reconstructed by the sleeping brain, and can be used as clues. Then one night, I had a vivid dream where I was wondering around an apartment, and I noticed an incandescent light bulb. I stared at the filament of the light bulb, for no good reason, and it looked off, it wasn't as painfully annoyingly bright as I remembered it should have been, and when I looked closely at it, and focused on it intensely, so that it filled my field of vision, it never became painfully bright. It got dimmer and dimmer, and I realized it wasn't glowing at all, the filament turned black! That was an immediate clue, there was something wrong with this environment, and I realized I must be dreaming, and I woke up. So I decided that this is a good way to test if one is dreaming, to look at an intense light source. If you are outside, you have the sun, staring at the sun is uncomfortable, and you can immediately tell it's not a dream, because your eyes will quickly get annoyed at you. In most rooms, at least in those days when you had incandescent light sources, you can find something painfully bright. In a dream, your brain won't be able to reconstruct the painful intense light accurately. But the problem is that most of the time you don't go around staring at light bulbs, or the sun, and in the limited mental state you have in your dreams, it is very hard to remember to do this to check. So I decided that the way to do this is to make it a daily habit, even when you know you aren't dreaming, just a habit, so that you do it unconsciously all the time.

Every time I would enter a room, or when I was bored or distracted, I would look for a bright light source (usually by quick glance at the ceiling) and find the brightest light, and stare for a bit. If I walked outside, I would quickly check out the sun. It only takes a second or two, it wasn't intrusive, but I would do it ten to twenty times a day, every day, for a few weeks and months, until it was a habit. I started doing it in my dreams after a few weeks, and the first time I did it, I knew immediately I was dreaming. The light would turn dark, and it never glowed right. This would happen in nice dreams, in nightmares, anywhere I had a bright light source. Once I was lucid dreaming, I could do anything. I remember one particular anxiety dream, where a man was attacking me, and moved his hand to strike me. I glanced at a light at that moment, reflexively, and then the nightmare anxiety immediately left, because the light was dark. So I smiled, and the man's hand passed right through my body, without striking anything. Then I jumped out the window, so as to fly somewhere. But I could also just change the scenery, just by closing my eyes in the dream and commanding the scenery to change. It wasn't possible to accurately produce things I had never seen before, but I could reasonably wander through places or see things which were similar to ones I had seen. It was a strange thing, to hallucinate like this every night. I remember the method stopped working (after many, many years), because I had stared at so many lights that I began to reconstruct them more accurately in the dreams. This might be a false memory, or a rationalization, it might have just been a change in the brain induced by puberty, I really don't know. But I believe that with an appropriate device, like a portable flashlight you glance at every half hour every day, making it a habit, you can easily tell when you are dreaming, and begin lucid dreaming. It is a very interesting thing to do, although I haven't done it on a regular basis since I was 15.

What's wrong with the theory of evolution by natural selection?

There is nothing wrong with the idea that all life came from a common ancestor over a few billion years of descent and modification, and there is almost surely nothing wrong with the theory of evolution by some form of selection, but the theory of evolution by natural selection, meaning that the selection process is predominantly through the action of early death by predation or disease, has some uncertainty. There is a serious issue for testing this idea, in that by itself, it does not give an estimate for the time-scale for speciation for advanced forms of life (meaning, eukaryotes, not viruses or bacteria or archaea) from the basic mechanism alone. You need a theory of mutation genesis and selection landscapes. Darwin gave a theory that tells us that if you have a bunch of rats, they will turn into elephants over a period of about 10 million years, but the only reliable estimate for how long this takes is from observing how long it took, which means that we don't have a test of the detailed mechanism, and the mutation genesis mechanism and selection landscape are generally taken to be primitive. I am actually lying a little in the above. Darwin did give a method for estimating the time scale for evolution by natural selection, which was simply the time scale for evolution by artificial selection, by human breeding. He observed that over 6000 years, we could take a wolf to a chihuahua, a crab-apple to a farm apple, and a zebra-like animal to a pony. So this gave him an upper bound for the rate of change of morphology, and this estimate was more than enough to account for the changes in the fossil record. You can't argue with Darwin's argument about artificial selection, this does produce very fast changes that go about a hundred times faster than natural evolution, and if you consider the morphological changes in anatomy over geological time, they are consistent with a slower version of artificial selection, a process Darwin identified as natural selection. But this estimate is not very quantitative. The estimate from artificial breeding is given under extremely harsh selection pressure, essentially perfect selection. Selection by predators is imperfect, and

selection by disease and early death is also imperfect. But the natural process takes longer than the artificial process too, so it works out, more or less, enough to give good confidence that some sort of selection is at work. But the fit is not particularly quantitative, so you don't know exactly what kind of selection is operating. In the 20th century, the introduction of Mendelian genetics made the modern synthesis, which modelled evolution as a process which begins with a set of genes, which mutate by random deletions and insertions, or occasional duplications, and then the most fit gene fixates in the population independently of other genes. This gene-individualistic model was supported by the observation that crossing over shuffles genes arond, so you can think of the fitness of each gene in isolation to a certain extent, because it will wander about at random through the organisms. This individualistic model of gene selection is clearly false, it doesn't work to explain macro-evolution, because the amount of morphological evolution between distantly related animals has no counterpart in the selection of the genes involved. We have almost the same gene set as simple worms with only a dozen tissue types, and the difference in coding genes between humans and chimps is essentially zero. Further, the mutations in genes accumulate at a steady rate, in an apparently rather uncoordinated manner that seems to have no selection pressure at all controlling it, that is called "neutral evolution", and the neutral model gives an accurate molecular clock that can track species divergence. Further, there is a theoretical problem with the idea that genes evolve randomly and independently to produce evolution, in that the time-scale for any sort of functional change goes to zero in such a model very quickly--- there is no chance of producing long term evolvability. This is on general principles--- when you have a computational program, and you evolve it by a given fixed collection of mutations, there is a quick saturation where you find the best local minimum, and then you stay there, until the selection landscape changes. This kind of stuff, the primitive kind of minimum-finding evolution, is not consistent with producing new structures and new tissues of advanced collective genetic function, it doesn't make any more sense than saying that books are written by a process of copying previous authors, with occasional errors introduced

by careless scribes. That's not how new books are written, they are authored by an intelligent process. There are exceptions to the neutral mutation rule--- some single nucleotide mutations in protein coding regions are lethal, and some are very deleterious, like the mutation for sickle-cell anemia. But the general rule is that you don't find a difference in coding regions which is at all consistent with the morphological difference you see in higher animals, and also, you see a tremendous amount of non-coding region variation which is much more difficult to account for, and the total length of non-coding RNA does correlate with the morphological complexity of the animal, so that animals with a large number of tissue types, like human, have a gigabyte of genome, while animals with a small number of tissue types, like worm, have tens of megabytes of genome, even though the genes are largely homologous. The clear inference is that the non-coding genome is the part that is relevant for evolution, and it is functioning to control gene expression and activity in much the same way your brain controls your body, so that it is computing at a reasonably high level of complexity, and is therefore intelligent to some extent. Many of these RNA mechanisms have been discovered in the last decade, and the RNA-brain hypothesis, usually associated with John Mattick, although I don't want to put words in his mouth, is now not as controversial as it used to be. Knowing about the noncoding RNA regulation, and given the much higher bit-density of RNA as compared to protein, it is manifest that evolution proceeds in an authorly way by rewriting non-coding RNA during replication. This is the low level mechanism, and it co-evolves with the high level stuff, so that the mutations RNA cleavage and insertion introduces in a complex genome are sensible, and compatible with the already existing complex program encoded by the genome. This mutation mechanism is required, and it is sufficiently different from the textbook picture of blind mutation that I think it is closer to intelligent design than to the modern synthesis. It is not yet accepted that such a thing is required, because biologists associate complex mutation mechanism with a rejection of the blind, mechanical, idea of the modern synthesis, ideas which were ruled out when they were first proposed, by the absurd time scale in estimates to go from mouse to human by blind mutation.

But now that we can see the genomes, the modern synthesis is completely busted. You can see retrotransposons, endoretroviruses, copy-number variations in non-coding regions, general complex non-coding templates with unknown functions, gene-like silenced sections, and all sorts of stuff that is obviously showing that the standard story is a tall tale. The other problem with evolution by natural selection was already pointed out by Darwin--- this is sexual selection. Once you have sex and brains, there is a new mechanism of selection by mate choice, and this selection can produce peacock tails, things that reduce the predator fitness of the organism. The existence of sexual selection allows things which are forbidden by ordinary natural selection. Mate choice is itself evolved, so that if a subspecies of a given species of rabbit decides to sexually select for fast running, and another subspecies decides to select for fluffier tails, the group that selects for fast running will outcompete the group that selects for fluffier tails as they diverge and speciate, and can drive the other group to extinction. This type of thing is called "group selection", and sexual selection allows you to have group selection, because the basket of sexually selected traits is the group-selected through competition with other groups which have a different basket of sexually selected traits. Group selection is completely forbidden by ordinary natural selection, because traits which are beneficial to the group, but harmful to the individual, will be weeded out. Sexual selection allows you to compensate for this, by sexually preferring traits which are beneficial to the group. The existence of group selection through sexual selection is not recognized in mainstream evolutionary biology, but it explains certain mysteries. In prarie moles, there is an observed scouting behavior, where the animal will raise its head to look for predators, and alert the group if it found a predator. This trait puts the animal at risk individually, by a quantifiable amount (you can see how often the predator gets the risk-taker) and by an amount which makes it difficult to see how this behavior could have possibly evolved. Kin-selection was proposed as an idea which can account for this in principle, but the kin-relatedness of the pack is not sufficient to account for the scouting behavior by itself, because the pack is too big, the genetic relatedness is not enough to explain the amount of risk.

The idea I am proposing is then that this behavior must be sexually selected. The evolution of animals might be entirely through sexual selection, and hardly at all through natural selection. The natural selection would then only operate on a higher level, selecting between different groups that have evolved different traits to a great degree very fast through sexual selection. This requires that cheetahs sexually select for speed, that skunks sexually select for smell, that giraffes sexually select for long-necks, and in general that every trait we associate with natural selection could be a product purely of sexual selection, with natural selection operating on the group level only. The only case I have any experience with is that of humans, which is because I happen to be a human. In our case, it's our extraordinary brain which is the most distinctive trait, and language which is the most extraordinary behavior, and these are insanely strongly sexually selected. It is difficult for humans to reproduce without a long bout of talking first, and the talking is not necessary for reproduction. The brains don't protect you from predators at all. So I can see with my own eyes that humans evolve brains by sexual selection, and not by natural selection. Whether this is true for everything other species, you need data to say that. This idea is also not in the evolutionary biology literature. In evolutionary biology, the consensus is, by blind authority, that group selection is forbidden, because without a sexual selection mechanism, it is impossible (aside from the small correction provided by kin selection).

How is it that the Speed of Light was calculated in Rigveda many years before Romer?

It wasn't.

Why do people believe in God and how can they say he/she exists?

Because the idea of God isn't nonsense, it's a perfectly reasonable way to explain how ethics works in collectives of people. In order to behave as a cohesive group, people must work according to the will of an invisible agent, which is encoding the communal will. This agent is a god. Then the gods themselves working with each other, if they behave ethically, meaning superrationally, behave in accordence with a higher god. The notion of God is the limiting conception of this idea, where the collectives are all super-ethical and all super-intelligent, because they have become infinite. It is an idealization, but without this idealization, you can't formulate a consistent superrational behavior algorithm for all situations.

What is an intuitive explanation behind why group velocity is defined as the partial derivative of angular frequency over the partial derivative of wavenumber?

This is because when you superpose waves, this is the rate at which the beats go in and out of sync, translated into a spatial location variation. If you have a pure sinusoidal wave with a wavenumber k and a frequency w, and it is superposed with another pure sinusoidal wave of wavenumber k+dk with frequency w+dw, then the beat frequency is the difference in the two frequencies, or dw, and this tells you how

quickly the two waves dephase. The rate of dephasing per unit time is dw. Then the dephasing due to the frequency cancels out if you shift the position where you are looking at, and the dephasing in position is according to the difference dk in the wavenumbers. So the location where you have the same kind of superposition of the two waves travels at a rate of dw/dk, and this is the group velocity.

Why is velocity the derivative of energy over momentum?

This is one of Hamilton's laws, and it is a consequence of the existence of a Lagrangian/Hamiltonian formalism--- it is really a consequence of the fact that there is quantum mechanics underneath. This law is more general than just Newton's mechanics. It is universal to all classical mechanical systems. For example, in relativity, the energy is [math] E =\sqrt{p^2 + m^2} [/math] and the derivative is [math] v= {p\over \sqrt{p^2 + m^2}} [/math] and v is the correct relativistic velocity, as you can see by solving for p in terms of v. It's true in any Lagrangian system, where, by definition [math] p = {\partial L \over \partial v} [/math] and (the negative of) the Hamiltonian is defined as the Legendre transform of the Lagrangian: [math] - H = L - p v [/math] But considered now as a function of x and p, not as a function of x and v. Then, differentiating H with respect to p, you always get v, that's what Legendre transforms are designed to do. This relation then becomes one of Hamilton's laws, and the other one is the restatement that the equations of motion of satisfied, that the Lagrangian is extremized. These things are mathematical, and that's as good as you can do in classical mechanics. Ultimately, there is a physical explanation, but only through quantum mechanics. In quantum mechanics, the energy is the frequency of the wave, and the momentum the wavenumber (up to factors of hbar, which you can set to one using natural units). The derivative of the energy with respect

to the wavenumber is the group velocity of a wavepacket, so this is the velocity of a classical particle, which is what happens in the limit where the wavepacket size and the wavelength, and every other wave scale, goes to zero. So this observation is a major clue (and historically was a major clue) that classical mechanics is a limiting description of a wave mechanics where the energy is the frequency and the momentum the wavenumber. It was this that motivated Schrodinger to find his equation.

Why should I believe in God?

It depends on what you mean by God. If you mean an intelligent agent that created the universe in some way by acting from outside the universe, this statement is positvistically meaningless, and you should not believe in it, or rather, you should be able to turn the belief this way or that, on a whim, without any effect on anything. It makes no difference to any observation, so it makes no difference what you believe. If you are asking if you should believe in supernatural miracles, the answer is just no. There are no supernatural miracles. So if you want to believe that all the animals were packed on a boat or that such and so died and physically came back to life, no one can stop you, but it's a nonsense belief. This stuff just doesn't happen, and did not happen, and anyone who says they actually did happen is just lying. They might be lying for what they think is a good cause, and I might agree, but they're still lying. God is a subtle ethical idea which is abstract. One can make a case for accepting this idea is correct, because it make positivistic predictions about the order of the world, and these predictions are correct. For example, one prediction is that over the long term, good people will prevail over evil systems, and there is really no reason for this to happen, other than through a collective phenomenon which is the positivistic manifestation of the action of God. So for me, you should accept God because of the

following astonishing facts: * We used to have slaves. * We used to kill people for amusement. * We used to accept that our leaders would be polygamous. * We used to select people to privilege based on ancestry or race. * We used to burn people at the stake for denying miracles. In effect, the ethical progress of humanity is dependent on a compact between all good people to push forward for progress, despite the long odds, and despite the fact that there is no guarantee of success. And yet there is progress anyway, as if something is guaranteeing success. This something is God. To understand why this is God, you need to look at the Roman empire, before Christianity, to see what was going on in the civilized world. The empire had material progress to a certain extent, they managed to build aquaducts. But they tortured slaves in arenas, they had a horrific class and caste system which made only a small class of people free citizens, and even those free citizens, with time, lost their freedoms to political intrigue and an imperial order which abolished all civil liberties. Politics didn't work to make ethical progress, the people who dominated the politics were self-serving asses who only cared about their own power. The culture didn't make ethical progress, because the caste hierarchies were fixed in place by cultural convention, and they only got worse with time. Nothing worked to make things better, and when you look at a stable empire over many hundreds of years, and they still feed slaves to wild animals and crucify folks for speaking out against their barbarity, you could lose hope. But the slaves toppled the empire, with no army, with no power. Using only the message of Jesus and the message of God in the Jewish Bible. It was only religious reform that was able to check the power of the political orders, and make the imperial state ethical, and then it collapsed. But out of this collapse came the modern world, in which we do not do those terrible things the Romans did. We do other terrible things, but they are less terrible, and using the same religious ideas, we make them less terrible every day. So there is an important idea here, that justice will triumph, despite there being no real mechanical reason for it to be so. Once you accept this idea, you might even go around telling other people that such and so died and physically came back, I mean lie to them, because justice for a group of illiterate slaves sometimes demands that you behave in accordance

with a higher truth than physical truth, if it serves the main ethical purpose. But I think you don't need to lie today. The basic principle of religion is that ethical action is through collectives, and the collectives are more intelligent than the individual. These collectives are bound through a concept of superrationality, the idea that when playing in games, one does not play for your own maximum gain, but for your own maximum gain, assuming everyone else uses the same algorithm that you do. To make this idea precise, you have to say what "same algorithm" means, and the algorithm for playing games is a utility function, a desire, a will, and it isn't your desire, so you call it the will of a god. If you and others behave according to the will of a god, the will of this god will have influence in the world. But your community is not the only community, and other communities also behave according to the will of their god, and all these gods have to come together and interact with each other, as their members interact. These interactions, if they are to be properly superrational, must be in accordance with the will of a higher god, and the highest god is God. The ultimate in superrational strategies is this tippy-top limit of ethical systems, in the limit of infinite knowledge and infinite wisdom, and with a desire for absolute good. People then personify this concept in illustrations of a super-duper person who comes down and smites the wicked, but it's not a person. Or they use a humble saint who continues to do the right thing, even though the result is terrible persecution. The point here is that there is a source of ethics, a superrational limit for collective behavior, which is more powerful than the politics of Rome. The politics of Rome are a forgotten long-gone joke today, we have moved past it. But the idea of God is still around. The basic point is simply that we are agents whose behaviors should aspire to be consistent with an all-knowing, all-good intelligence, which we can become aware of, the same way a cell in your liver can become aware of you. The cell might not see all the reasons why you had that drink, and now they have to work double-time to process all that alcohol, but that cell can see that it is in an environment which provides for it, and has concern with its welfare, and is striving in some way to ensure that its relatives will fare well in a larger world that it cannot see or feel directly. This is all that God

means. It is not supernatural, and it has nothing to do with science. It's also very important. I think that the reason to believe in God is simply that superrationality is a consistent system of ethics, and it makes sense, while non-superrational systems fail miserably with prisoner's dilemmas, and it is these prisoner's dilemmas that made life in Rome a hell for those who weren't Caesar, and even, when you look at history, for Caesar too.

What am I missing out on in life if I don't drink, smoke, or do drugs?

regarding smoking, nicotine is a mild stimulant, like caffeine, except it can keep you awake a little longer, and it also has some side effects, like altering the reward mechanism in your brain, so that you control exactly under what circumstances you feel a very slight dopamine rush. This allows you to choose the activities you wish to be addicted to, simply by associating them with smoking. The only truly harmless delivery method is electronic cigarettes, and with these, I think you can have a nice experience of nicotine which is no more harmful than drinking some coffee. Regarding other drugs, alchohol, marijuana, hallucinogens, you are missing out mostly cognitive damage. The damage is immediate and severe, at least in my experience. I can't do any serious thinking after even a glass of wine, and this damage lasts a day or so. The damage from marijuana, even from second-hand doses that don't get me high at all and that I don't notice until I try to work, lasts longer, it's gone only after three or four days. For other drugs, although I don't have much experience, it's like a concussion--- it takes months to recover. I notice the onset of confusion long before any buzz. If you don't do anything mentally demanding, you might not even notice the damage until it is enormous. The hallucinogenic drugs do have something to say about how fungible the world is, and to what extent our reality is a construction of our senses. But I think that every

single one of these insights, including the hallucinations, can be obtained through deep regular meditation, accompanied by a few days of sleep deprivation or fasting. Sleep deprivation and fasting are also completely safe in moderation.

What geometric meaning does the equation f(x)=(1/2)sin(x)cos(x) f(x)=(1/2)sin(x)cos(x) hold?

This is a stupid question. The intended answer is probably the area of the defining triangle, but it's also sin(2x)/4, so it's the size of the square made by bending the height of the triangle made by bisecting the angle into a square. it's also tan(x)*cos(x)*cos(x), so you can interpret it as a particular volume, and so on, for infinitely many interpretation, and the area interpretation is not simplest in any metric other than "my teacher says so". This type of thing is a defect in your teacher, and you should not give in, but resist. Say "I refuse to answer", and get no credit.

Is there an explanation for the symmetry of the series f(x) = 9x, 1 ≤ x ≤ 10 and x is an integer: 09 18 27 36 45 54 63 72 81 90?

For a number to be divisible by 9, the sum of the digits must be divisible by 9 (the proof is that 10 mod 9 is 1), so given the first digit, the second is determined. The first digit goes up by 1 each time, so the

other digit is determined to be the complement 9-x. The same palindrome happens in any other base for multiples of N-1 base N, for the same reason.

If science explains that the world was created naturally via the Big Bang, how do we explain where the original matter and energy came from?

The concept "cause" does not appear in physics, it is a human construction, related to information we have in our brains. We say "A causes B" when we find out that A is true, some bits of information about the environment, then we know B is true later, with no other information required. This concept doesn't appear in the laws of physics. In physics, you describe the evolution of states, and the states that appear, without invoking any notion of cause. So when you ask "what caused the big bang?", you are asking a meaningless question, one that cannot be answered, because it makes no sense. It's just your brain fooling you. This is the position of logical positivism, and it is essential for physics, at least since the 20th century.

What reasons do we have for thinking that an intelligent designer is not the cause of the Big Bang?

Because the concept is nonsense within the usage of words as defined by the philosophy of logical positivism. The statement "A causes B" means that when you see A, you later see B, regardless of any other information. The definition is about observable consequences, coming from the relation between observations. The notion of cause can't be applied to the big bang, because there is no sense impression you can associate to a cause of the big bang. It doesn't make any sense to say X caused the big bang, because there is no meaningful sense impression one can use to make the statement meaningful. So you can say I caused the big bang, or you did, or whatever you want, the statements are equally meaningful, which is, not at all. So the question here is not a question, it is nonsense fooling your brain into thinking you have a question when you don't. You can ask "what temperature was the universe 8 minutes past the big bang?" You can ask "What proportion was He and what proportion neutrons?" But you can't ask "What caused it?" because this utterance makes no sense, it is applying a colloquial notion of cause in a domain where it does not apply.

What has science gotten wrong since the 1980s?

Every discovery in science is an upset, I will list the most obvious ones in the period past 1980: * The cosmological constant is zero: This was common wisdom in physics from the day Hubble convinced Einstein that the universe is expanding. There were a bunch of explanations for why it is zero, including some arguments from the quantum gravity path integral, due to Hawking and Coleman. Now we know it's not zero. * Ulcers are caused by stomach acid: This was disproved in the 1990s, ulcers are caused by a particular type of bacteria. * Genes don't jump: Yes they do. That's Barbara McClintock. * Quantum field theories in four dimensions always have ultraviolet divergences: This was common wisdom, until 1984, when Mandelstam and others

proved the N=4 SUSY gauge theory in 4 dimensions has no surviving ultraviolet divergences that aren't cancelled by supersymmetry. * Quantum gravity in four dimensions always has perturbative ultraviolet divergences: this is likely false, due to the recent work of Dixon and others, which shows that N=8 supergravity is likely perturbatively finite. We know it doesn't work as a theory of gravity because of nonperturbative problems, thanks to string theory insight about the necessary nonperturbative breaking of the relevant symmetry groups, but it's probably perturbatively renormalizable. This came as a shock to everyone. * Quantum gravity can be described by a path integral over local fields: This was understood to be wrong in the 1980s by t'Hooft, the entropy in the local fields would be infinite if it were so, not finite and proportional to the area. This observation was developed by Susskind into the holographic principle throughout the 1990s, and made string theory work. * String theory is a theory of strings: this was also completely clarified by holography, there are branes, and the brane descriptions are equally fundamental. * Black holes lose information: This was also completely understood through holography. * You can't have crystal order with five-fold symmetry: This was disproved in the 1990s with quasicrystals. * The central dogma: DNA makes RNA (never the other way around), RNA (only) makes protein. This is totally busted by modern biology, which shows that noncoding RNA is the major computational component of the cell, that the genome has active retrotransposons, and generally the information flows are very complex. This scientific revolution is ongoing. * There are four kingdoms of life, animals, plants, fungi, bacteria: Archaea are a new kingdom, confined to unimaginable depths and hostile conditions. * The quantum hall effect is restricted to integer plateaus: Nope. The fractional quantum hall effect was discovered in the late 1980s. I could go on forever. If you read any science journal, every decent article is challenging some opinion in some way, using experimental data, by simulation or calculation, or by synthesis of previous work. This means that you have nearly as many examples as there are papers in any field, and it is pointless to list. The question is what are the current wrong dogmas. Here, one can give two egregious examples only from synthesis of previous work: * Oil/Coal

comes from ancient life: This is not so, the western consensus is false. In this case, the Soviet Union had the abiogenic theory, which was further developed in the west along parallel lines by Thomas Gold. The only real evidence to support this is that oil is contaminated with biological residues, and Gold explained this through the activity of deep Earth bacteria. For the catalog of evidence, I defer to Gold's book, "The Deep Hot Biosphere", but I want to point out that even a rudimentary knowledge of chemistry makes the assertion that fossil fuels are fossils extremely suspicious, since you can't make simple hydrocarbons from sugars or proteins, you need to get rid of oxygen to do this, and getting rid of oxygen is very very hard. It's like un-burning fuel. * Modern synthesis evolution: That evolution of complex organisms happens by random single-nucleotide errors caused by cosmic rays or thermal jitter is just false, and this is obvious from the types of mutations people see. The process is clearly more complex than this, involving rewriting of noncoding regions of the genome during crossing over and during oogenesis and spermatogenesis. The mechanisms are murky, but the SNP hypothesis is ruled out by the fact that the observed SNPs in coding regions are mostly neutral, they form a molecular clock.

If an early hominid were to be born into our society, would it have the capability to learn at the same proficiency of a modern human?

Almost certainly not, since you see a huge difference in the artifacts of modern humans and the artifacts of all previous hominids. Previous hominids made hand-axes, fires, and some primitive tools, but modern humans made combs, needles (so clothing), delicate jewelry, decorative arts, and primitive markings consistent with tallying (and therefore abstract thinking) as far back as 100,000 years ago, and these artifacts

are pretty much the same wherever modern humans spread. So it is likely that language, at least sophisticated language, evolved 100,000 years ago, and the modern human just made that cognitive leap. It is very difficult to imagine how, if the early hominids would be capable of surviving in our world, they didn't manage to make a comb in 4 million years of what one can presume is urgent need.

Why are some women so reluctant to admit that they want hot guys? Don't women want really hot men, just as men want hot women?

Physical attractiveness is similar in men and women, but the social and psychological components are different in a very simple way. You don't get a good answer from either men or women about any of this, because it operates on a subconscious level, and the net result is simply "oh, s/he's hot", or "s/he's not my type". This main invisible factor is the social hierarchy, and sexual attractiveness is through a socially transmitted dominance hierarchy, and the male is required to be socially higher up on the totem-pole than the woman. This power imbalance is absolutely required for sexual attractiveness in men, and it subordinates every other factor. So that if David Beckham sleeps with a woman, and then calls her incessantly the next day, asking how she is doing, then, no matter how attractive he was to begin with, he loses all attractiveness completely. The reason is that he is demonstrating a neediness for companionship which is inconsistent with a powerful social position. Likewise, paying too much attention or giving too much respect to what a woman is saying will lower the man's relative position, and thereby diminish his attractiveness. This is why feminism is necessary, to correct the imbalance of power which comes from letting these silly sex-games run amok. Conversely, if an ugly guy dominates a bunch of hot guys socially, then this guy is by

definition more attractive, period, and he is paradoxically even more attractive than if he were good looking. This is because by dominating the sexy dudes, he is flaunting his display of social skills, thereby demonstrating his ability to rise up the social hierarchy even with the handicap of being ugly. The euphamism for this is "sense of humor" and "nice personality", two things that really mean "can dominate a social gathering, producing admiration and subservience in others". These are the most important factors, they are strongly sexually selected in humans. It is probably through this absurdly powerful sexual selection that we evolved brains. Women know this more or less universally, they are aware to what extent attractiveness depends on this social factor, so women are circumspect about the source of attraction, because they know from experience that they can keep changing their minds as they acquire more evidence about the man's status through new cues. For men, it's not hard to attract them, because all you have to do is fall down the social hierarchy, and then you are desirable. Going down is really easy compared to going up, you just make yourself more vulnerable and needy, or get more slutty. But the side effect of going down too far is that the man, if he is conscious of his own position on the social hierarchy, will not want to have you around, because you will diminish his own sense of social standing. So as a female, you become not worthy of companionship, because your social status is too low. So people try very hard to strike a balance, where the woman gives a certain number of low-status cues, alterating with a few high-status cues and the man gives a certain number of high-status cues, with an occasional low-status cue, until the proper balance is achieved, and then you can go have a sexual relationship. I find all these social status things kind of distasteful and silly, since the social hierarchy is kind of stupid and seems counterproductive today. It is also very time consuming and spiritually corrosive to seek status, so thankfully most societies institute draconian regulation of sex through marriage and customs. It is also why monks and nuns are celibate. It's not the sex that hurts the monk, it's the vying for status.

If a man has a baby with his wife, and then starts body building and has another baby with his wife 2 years later, would the second baby grow up to be more muscular than the first?

This is Lamarckian evolution, and there is no conclusive evidence that this ever occurs. All the evidence for this comes from a few experiments which are easily explained through other mechanisms. For instance, Lysenko observed that to make crops hardy for a cold environment, you expose the seeds to cold temperatures, and then they are cold-adjusted and their offspring too. This can be easily explained through non-hereditary temperature adjustment, or perhaps epigenetics. There is evidence for epigenetic factors being heritable, but this is almost exclusively maternal--- aside perhaps from some methyllation of DNA in the sperm. It is concievable that hormonal changes from exercize, like testosterone release, will lead to some methyllation of DNA in the gonads of the man which will then be passed on through the sperm, but this is not going to transmit a huge amount of information, and it isn't the same as a permanent change in sequence. So the main question here is whether a long bout of exercize can change the father's main DNA sequence in such a way to make the baby more muscular. The main evidence against this is mostly propaganda--- experiments were conducted on rats, whose tails were cut for 20 generations. The rats at the end of the experiment had exactly the same length distribution for tails as at the beginning. But cutting a tail removes tissue, and so removes possibility of signalling from the tissue to the gonads. It is clear you need signalling mechanism to have an effect like this. There is absolutely no evidence for such a signalling mechanism but one needs imagination in science.

I will imagine such a mechanism, but it is entirely hypothetical. It also relies on several ideas which are not established, and in each one has successively less confidence of it being true: * There is RNA active in all cells in a computational sense, acting like a cellular nervous system, directing genetic expression. This is not so controversial anymore. People accept that it is possible, even likely, given that there are noncoding RNA segments in nuclei doing mysterious things. It used to be laughable hypothesis. The idea is associated with John Mattick in Australia, although others proposed this too indepently throughout the last decade. I think this is a very safe bet, nearly certain. * This RNA controls crossing over and mutagenesis. This is compleply plausible, as it is required for evolution to work properly from a theoretical point of view. * This RNA can insert itself back into DNA People used to say this is impossible, because the human genome does not have a reverse-transcriptase. But this is false! There are various disabled or shut-off reverse-transcriptase proteins in the human genome, and they are normally not expressed. They are endoretrovirus-like, in that they allow RNA to go back and insert itself into DNA, and these polymerases are directly related to viral polymerases. These polymerases allow retrotransposon activity, which has been found to work in tissues like brain, and might work in muscle too. This means RNA is made from DNA, and then reinserted elsewhere in the genome. This reinserted stuff looks like it makes up a fifth to a third of the human genome. * The RNA can transport itself from muscle tissue to other cells This is supported by the existence of ERVs (endoretrovirus) with coat proteins, not just with a polymerase. ERVs look just like viral infections, except the polymerase is disabled. The majority opinion today, without evidence, just because they look like viruses, is that these ERVs are relic fossils of ancient viral infections, but this is not compatible with their function--- the ERV proteins are often expressed and do useful things. I believe it is plausible that the body manufactures virus-like particles for transporting RNA segments long distances for the purpose of inserting into the genome elsewhere. These have their own coat proteins, and their own packaging. We have no evidence for this, but also none against it, because unlike viruses, these particles would not be replicating, so they would occur only in

miniscule concentrations. If this is so, then HERVs would be capable of altering genetic material by transporting genetic innovations from somatic tissue to other tissues. If this is so, then it is reasonable to believe that retroviruses are ERVs that go out of control, replicating themselves, rather than the other way around. This means that you expect to find new retroviruses produced in nature, from animal cells, and that you can evolutionarily trace back every retrovirus to an active endoretrovirus. The evolutionary tree is usually interpreted in the other direction. If all of these unsupported claims are true (I think they are likely true), then there is a path for Lamarckian evolution--- you can imagine that muscle training will produce ERVs which travel to the gonads, and modify the DNA of the sperm-producing machinery to change the genetic content of the offspring. But even with all of this, I don't think that it is true that the baby will be more muscular, because even though the mechanism might be there, it is probably not useful to use it for this particular purpose. I think that cases where large numbers of genomic alterations through retrotransposon activity are observed, namely in brain tissue, these might be transmitted back through ERVs to the gonads. For muscles, probably not. But you need to test, because it's just something that is not known given the primitive state of today's biology. It is not so easy to test this idea with current biological techniques, but to rule it out in principle is not hard, it relies on many things: you can rule out ERVs produced by healthy humans by just looking for HERV particles in healthy blood, although at minute concentrations, without amplification by replication, you might not see anything. But I don't think it is easy to motivate anyone to do the experiment. You can't rule this kind of stuff out on general principle, because in cancers, there are occasions where ERVs become infectious and replicating, and HERV-K and other HERVs have been observed to become fully functional viruses, with the whole enchilada---- reverse transcriptase, coat protein, matrix proteins, transporting ERV RNA from cell to cell. This might be isolated to cancer, but it might be only in cancer that the mechanism breaks down and allows the virus to become virulent. Take all this with a grain of salt--- none of this is supported. But in the absence of evidence against something, one must investigate it, not reject it a-priori. It is possible that

Lamarckian evolution does exist to a certain extent, although it is not required given present knowledge.

If a cell inside human body had consciousness, would it be aware of the larger consciousness inside which it is living?

This is essentially the same question as how a human being can become aware of the gods. You could ask the same question about ants--- if you are an ant, can you become aware that there is a colony? Consciousness is a vague term, and it is hard to know what to make of it. I don't know what "self-aware" means exactly, because it's hard to imagine an objective test for it, but if you have one, give it, and then you can say if cells pass it. On the other hand, we do have a good model for computation, and computation of a certain type is what is going on in the brain, since it is the most that is allowed by physics, or even by general philosophy, as to what a natural system can do. Computation is rather mystical and unknowable (despite the common perception, which is due to the rather primitive types of computations people see their laptop doing), it is the definition of complexity when it gets large, and the existence of computation in the brain is rather obvious, since computation was defined as the simplest abstraction of the operations a human being can do which still contained the ability to do all logical deductions, and therefore do mathematics. There is a certain complexity limitation in computation, in that the complexity of a fixed computer program means it can never do certain things which are of a higher complexity, like prove the Kolmogorov complexity of a string whose Kolmogorov complexity is larger than the program. But the real computations in nature have access to a random number generator, and there is no bound on the complexity of a computation with a random oracle, the random oracle, the random number

generator, will produce an uncomputable sequence of arbitrarily large Kolmogorov complexity. So using randomness, you have no obvious complexity limits, and when I say "computation", I mean "computation with access to randomness", which is slightly different than "computation with a fixed program". The issue with cells is that we know how many bits of data can fit in a typical cell, about 1-10 gigabytes, and that's certainly not enough for a human-style consciousness. There is no way this computation is sufficient to read "Hamlet" or to compose, or even listen to, a Beethoven symphony. But let's pretend. Under these circumstances, the cell can become aware of the larger organism by noticing the constraints on its behavior, and providential action. For example, imagine this dialog between two cells in my liver: Liver-cell Louie: I am sick of being a liver cell. I want to be cancer. Liver-cell Lisa: No! don't become cancer. It's dangerous. I heard a liver cell became cancer last year, and Immune-cell Ingmar ate her! Louie: I know ingmar. He has a crappy antigen set, I can evade him. Lisa: But you know you're not going to be a tumor. No one has ever been a tumor before. Louie: I am sure I can make it. Here I go.(transmute) RAWR! From now on, you call me CANCER CELL CARL! Carl: I'm replicating already. FEEL THE POWER! Lisa: I don't know about this Louie, uh, I mean Carl. I have a bad feeling you will be punished by Ron. Carl: Ron! Ron! That stupid superstition? Have you ever seen Ron? I don't believe in Ron. Lisa: But look at the blood stream supplying us with nutrients, the nerve cells supplying us with signals. Is that not evidence of Ron? Carl: It is nothing of the sort, that's Harry the Heart cell and his friends, supplying us with blood, and he won't stop just because I'm cancer. In fact, I have assurances from Stem-cell Stanley and his buddies that they will make a whole new set of blood vessels in case I make a big tumor, and we'll have more nutrients than ever! Even you. Lisa: I still think this is a bad idea. Ron is going to punish you somehow. I don't know how. a few months later, Carl is a big tumor. Carl: Look at me now! I made it, I am a huge tumor, I have vast influence. Blood cells come to me from new vessels specially constructed. Aren't you feeling stupid now for being a liver cell? Lisa: I still think it's not right. What if everyone became cancer? Wouldn't the whole blood system collapse? Wouldn't

we stop getting nerve signals and the bile production would drop... it doesn't feel right. Carl: Forget about the other cells. I am unique! I have always known it. I always knew I was meant to be cancer. Then I go to the doctor, and he tells me I have liver cancer. So I have an operation, where the tumor is removed. Carl: Oh no! What's happening? We are being severed from the blood stream! All is lost. Lisa: I told you it wasn't a good idea to become cancer, we are being punished by Ron. Carl: I don't believe in Ron! It's just bad luck. So the sign of being embedded in a larger collective with consciousness is the traditional religious notion of providence and punishment, that events which seem uncoordinated will provide evidence of a larger intelligence which serves to correct actions which harm the collective. It is not clear to what extent human collectives are more intelligent than individuals, and the notion of God is even more subtle still, since it imagines a limit of ethical behavior extending upwards through even larger collectives. These stories I am telling about Lisa, Carl and so on, are parallel to some of Jesus's parables.

How do I believe that the humans around me actually possess consciousness, and it's not just me who is conscious? What if the people around me are merely programmed to act that way?

This question is meaningless in logical positivism, it makes no difference to observation, and you could ask the same question of yourself--- how do you know if you are not just programmed to delude yourself into thinking you are conscious? Your perspective makes it that it is difficult for you to imagine this possibility, but you can't make objective evidence for it, except by throwing your hands in the

air and saying "but I AM conscious!" So you should trust other people when they throw their hands up in the air and say "but I AM conscious!", and so you should trust any other programmed agent that sufficiently resembles a human being in responses, and where you can sense a complicated evolving internal computation, and where you can talk to it, and when you ask it "how do I know you are conscious?" it throws it metaphorical hands in the air and says "but I AM conscious!". This is the insight of Mach and the logical positivists. It is the ability to decipher and respond to your words, which requires a massive amount of computing on top of computing, with evolving algorithms, with the attendant ability to sense the connotations and subtle implications, and compute the consequences of those, that is the logical positive deinition of what it means to be conscious. There is no reason to suppose that the quality of consciousness is anything more than this computation, that's what it "feels like" to have such a massive computation. The size of the computation required to simulate consciousness is staggering, it is on the order of 10 gigabyte per cell, or for a human brain, with order 100 billion cells, it's 1 trillion gigabytes, 10^21 bytes. This is simply the total weight of RNA in the brain times 2 bits per base. This is a staggeringly huge amount of random access memory, it dwarfs every computer we have, it is comparable, but slightly larger, that the total data on all the hard drives on earth. This is the information content of a single brain. This is assuming the not-at-all mainstream hypothesis that I take for granted, that the computation in the brain is intracellular and done by RNA. Some arguments supporting this position have been compiled by Mattick, but I don't want to put words in his mouth, this position is not really in the recent literature. The reason to believe this is simply that it gives the right model for the level of computation in the brain, and it is evolvable from cellular mechanisms, it provides a mechanism for memory and learning, and it is the right order of magnitude for the computation we can do, unlike other models which might be more popular, but which fail at accounting for even the simplest cognitive tasks human beings do, like recognizing a bicycle at a glance, and remembering the recognition for some minutes. A computation of the sort the brain does, when it consists of 10^21 bytes networked together in 10^11 clumps of 10^10 bytes, when it is active and responding to stimuli, is the definition of consciosness, as far as a logical positivist is concerned. It makes no more sense to say that it is there without consciousness than it is to say: "How do I know my computer is running Microsoft Windows, or simply simulating Microsoft Windows?" Simulating Microsoft Windows is the same as running it, and simulating consciousness through programming is equivalent to consciousness. The reason that this is not intuitive is that the actual data we get from people which gives us evidence of their humongous internal computation is always vastly smaller than the 10^21 bytes in their heads. When we talk or type, we get a few bits per word, so that even a long communication is only a few kilobytes of information. Because of this gap in information between the few kilobytes we see and the unimaginable amount of data inside, we can easily imagine a preprogrammed computer, with only a few kilobytes, that stores the answer to the questions we ask our friends, and feed these pre-prepared answers to us. Such a computation would be trivial, and such a computer is a zombie. This is what it would mean to be "preprogrammed and not conscious", the computation would be tiny. But the problem with this perspective is that you can't predict in advance what the interaction is going to be! If you want to fool someone, you need to have pre-prepared kilobyte answers to any of the possible kilobyte questions, and the number of kilobyte questions is 2^8000, a number which is close enough to infinity. To make a database of all possible questions and all possible responses might be imaginable, but then the next question depends on the answer to the previous one. For example: > What do you think of Shakespeare's Hamlet? > He's a whiner! (preprogrammed) > Why? > ??? (can't respond--- need an even bigger database) So even a very short interaction with a person is evidence of a computation vastly larger than the size of the communication overhead, because it comes out coherent, no matter what the question! To gain evidence of a computation of large size, you don't need more than a little communication with the computation, to see that there is internal processing going on. It is just plain statistically impossible to get a zombie computation with a table-base lookup to do an interaction over

any length of time, and that length is ridiculously short, even a few questions will trip it up: > Wazzup? > Not much. Hanging. > doing what? > Chilling watching TV. > What's on? > It's stupid, it's some talk show with this guy that thinks he's an alien. > What does he think aliens look like? > You know, green, big eyes. Already the unpredictable nature of the questions makes it that any stupid program will fail. This type of thing is a Turing test, and we do it all the time online. You can't be fooled by a bot. This is the essence of the Turing test, and why it is controversial. The Turing test says that to verify consciousness, you only need a few kilobytes of interaction which verify coherent responses to arbitrary questions. This is counterintuitive, because the questions and answers are relatively short amount of data compared to the richness of internal experience, a few kilobytes compared to 10^21 bytes, so our intuition is that a computer can be pre-programmed by a trick to respond to these without having 10^21 bytes inside. But it's not true, as even a few kilobytes is enough variability to be essentially infinite.

Who assassinated President John F. Kennedy?

This page may help you: Roscoe White Materials . Here is the official accepted debunking: Roscoe White . The documentary you link involves speculation, in particular, episode 2 supports a very implausible story by this French convict which is an obvious fantasy for self-serving ends. Even though I found and checked this stuff in an hour of searching online, I am ashamed to say that I became extremely paranoid about even posting the link! See here: Jack White: "The Roscoe White curse" - JFK Assassination Debate .

Are there any structures in the brain completely unique to homo sapiens?

No there aren't any that we know of. The main differences in human brain tissue is the larger size relative to the body, and the noncoding RNA expressed. Mammals have retrotransposons which are active in brain tissue, and humans have a different set of retrotransposons than chimps, as these are very quickly evolving unstable genomic features, and they are likely dynamically changing during the lifetime of an individual. The molecular signatures don't show up as anatomy, but they change the character of the computation involved, if that computation is intracellular, as I am sure it is. This is where one should look for the source of the extraordinary cognitive abilities of humans.

What are some not well known facts about famous scientists?

The darkest secret in recent history is the occasional use of drugs, in particular LSD by several well known scientists. LSD is very cognitively strange, and it can damage your mind, so people did not want to admit that they used it. Kary Mullis is an obvious example---he always advocated ingesting LSD as a souce of scientific creativity, but I think his career is more of a warning against it, since he has been extremely mentally unstable. There are credible stories regarding Francis Crick and Richard Feynman. Crick was rumored to have dabbled in LSD during the period where he and Watson discovered DNA's structure, and Crick refused to deny these rumors, but also refused to have them published. Feynman was rumored to have used LSD in the late 1960s a handful of times. Feynman denied using

hallucinogens, saying he was too scared to damage his brain, but there are credible reports that he did take LSD at least once around 1970. For marijuana, there are several well known physicists who were outspoken advocates, like Sidney Coleman. Having known him, Sidney Coleman showed symptoms of occasional marijuana use, he was more scatterbrained than usual, he would persistently forget your name, and he would get confused occasionally at the chalkboard while teaching. A paper he wrote with Glashow while they were both admittedly stoned "the vector dominance model", is both annoyingly derivative without citing it's sources (they probably couldn't remember) and also not very good. This is the symptom of drug use, inappropriate citation together with often false claims of originality. You don't remember where it comes from, because the ideas come when you are not coherent. This means that the druggier work can often take credit away from the sober hard working people that did their work in obscurity. Drug use was a part of the conservative social transformation of the late 1970s, it was a sign of independence of thought, and the people who used drugs were considered some sort of supermen, like David Bowie. Since the drugs lead to alienation and big ego, and also quickly lead a person outside the mainstream, where the work is necessarily original sounding, if not truly original, it can be a self-reinforcing feedback loop. The results of these experiments with drugs is simply that a lot of scientists were incapacitated when they thought they were being creative, and they ended up unwittingly plagiarizing others or doing what for them was substandard work. Feynman for example, in his extremely brief drug era, wrote a forgettable paper on the quark model which was probably his worst, it was essentially ignoring and repeating all the work of others on quarks with no correct dynamical idea. But it was still pretty good, because of the attempt to grapple with relativistic bound states. Feynman's later papers in the 1980s when he was sober (and dying), on the gauge vacuum, on quantum computing, were much much more creative, although they were dismissed in their time. Feynman did not admit LSD use, but he did admit using small doses of ketamine. Crick never admitted to using LSD either. But it seems that there is a dark secret here, and this has caused the literature to become somewhat

dismissive and forgetful of the people that did the bulk of the actual work, who were necessarily completely sober.

Why do Kennedy assassination conspiracy theorists dismiss the fact that the President was suffering from Addison's disease when any discussion of his assassination occurs?

Addison's disease is understood and treatable, it can be controlled by administering drugs like cortisol which substitute for the adrenal gland. It is extremely unlikely that Kennedy would have died from it, or even suffered any adverse effects, considering his access to medical care.

What should everyone know about Shakespeare?

The most important thing is to know is that the work of Shakespeare was written by Christopher Marlowe. This is important for several reasons, not least of all that it gives an accessible way to get into Shakespeare's work: simply start with Dido, then Tambourlaine, Faustus, Jew of Malta, The Massacre at Paris, Edward II, Hero and Leander, then go on to Venus and Adonis, Edward III (Kyd and Marlowe), Richard III, Henry VI part I,II,III, Titus Andronicus, Taming of the Shrew, Merchant of Venice, Romeo and Juliet, and so on in chronological order. This produces a graceful path of

development, which allows young people to appreciate the mature works, building as they do off the less mature works. The evidence for this is both historical and stylometric. I will ignore the historical evidence, which is inconclusive but well known, and rather, point to the stylometric evidence, which is compiled by Peter Farey. I don't want to link it again, so I will just link this answer which contains links to all the original data: Did William Shakespeare ever visit Italy? . The earliest stylometry is Mendenhall's letter distribution. As Peter Farey shows in his computerized replication of the test, linked above, Marlowe's later works and Shakespeare's tragedies have indistinguishable Mendenhall graphs, and their correlation is higher than any two authors by a large margin. I consider this a factor of 10 evidence at least, meaning it should change your confidence by a factor of 10, since the probability of the two graphs matching this closely even under attempt at immitation can't be more than 1 in 10 by any reasonable meaure, even for authors who are similar in style. The next stylometries are taken from Farey's page on Marlowe, where he considers stylometries which were specifically found to distinguish Shakespeare from Marlowe in the past, which was a very difficult thing to do. But people found a few stylometries that did this. In every case of such a stylometry, when you plot the Shakespeare works by date (or even just clump them into Marlowe/Early/Late) the Early works and the later works make a smooth line with the Marlowe works. This is an extremely unlikely event--- the coincidence for each stylometry is at least 1 in 3 improbable and in actual fact much less than this, and Farey has 5 graphs, so the confidence goes to 1/3^5, or 1 part in 200 confidence--- meaning that whatever likelihood you had before, you should reduce your probability that they are different authors by a factor of 200. Next we have the Charniak stylometries. These were rigorously constructed to separate Marlowe from Shakespeare, and had a ton of controls. They failed miserably to separate Marlowe from Shakespeare, their program misclassified the majority of Marlowe's work as Early Shakespeare, and one of Shakespeare's works as Marlowe's. This is another 1/100 coincidence, at best, it's more like one in a thousand or one in ten-thousand. Putting these failures together, it's a ridiculous chance, it's close to 5-

sigma certainty, which is scientific certainty. Under these circumstances, you can only say "Enough! They are the same writer." This is important because it is independent of the historical evidence, and it allows you to now assert with confidence that all that intrigue regarding Marlowe spirited away, and faking his death, and writing in exile, and Shakespeare acting as a front, that all this stuff really did happen. It begins to reveal what kind of backroom deals and conspiracies were going on in the early modern era--- it is amazing and revealing. This is the era where freemasons and freethinkers challenge the church, and produce shadowy networks capable of conspiracies such as this. In previous eras, Marlowe would have just been burned at the stake, and we would still be living in darkness. The interesting thing about Marlowe that he is not at all impressed with magic as an adult, meaning past the age of 30, after he starts using Shakespeare as a front, than when he is a young guy. So as a young guy, he's into all this occult stuff you see in Faustus, he is not impressed with the human stories of ordinary people, but as Shakespeare, he is impressed with all the little characters as much as with the big ones, and his thinking expands much in the same way as James Joyce's expands in Ulysses, to show an interest in the inner life of folks who are very different from himself.

What are some positive points or concepts to learn from E8 Theory (Exceptionally Simple Theory of Everything)?

There is no "E8 theory", unless you mean the exceptionally simple theory of everything, which is bunk. The Lie Group E8 is important in string theory, it is described in a simple way in Green Schwarz Witten, and it is useful because it emerges naturally in heterotic strings as a gauge group, in two independent copies. The gauge group E8 then can

break to E6 by having nontrivial embedding of the SU(3) of the holonomy of the manifold into E8 and having that kind of gauge flux in the E8 field. The residual unbroken group E6 is important, because it includes SO(10) and SU(5) in a natural way, and this means it includes the standard model after breaking. This, and modifications of this idea, is still the most natural and plausible path from string theory to observed physics. Starting with heterotic strings with an E8 gauge group, you can easily produce many different standard model like theories, with a bunch of matter in the right representations, including some that match the matter content of the MSSM almost exactly, with 3 generations and everything. The problem is that there are several alternatives, which would predict different couplings and so on, but we can't calculate those in great detail, and also the supersymmetry breaking mechanism is obscure, since we have no data on the supersymmetry in nature, and formulating non-supersymmetric string theories is difficult.

Did William Shakespeare really write his plays? What evidence is there that could be used to support the theory Shakespeare was not the author of his plays?

There are two kinds of evidence, historical and stylometric. The first is sort of wishy washy, but by the standards of historical evidence, it is pretty good to establish that Shakespeare was not a writer. The second is fantastic, because it is precise and mathematical, and it establishes with reasonable certainty who the writer was. The evidence for Shakespeare not being a writer is historical, and it is the following: * Shakespeare owned no books. We have his will, he doesn't mention books, manuscripts, or anything other than various possessions.

People searched for his books approximately a century after his death, and found nothing at all. The fellow who was looking gave up and concluded that Shakespeare was not a writer. * Shakespeare's daughters and granddaughters were illiterate, as was his father. Shakespeare could probably read and write to a certain extent, but from his four surviving signatures, which are very variable, he didn't do it very often or very carefully. Shakespeare's granddaughter is interviewed during that book-search in the 17th century, she signs her name with a mark, and she says her grandfather was not a man of letters. * He doesn't have a rich literary heritage, no letters, no correspondence with other writers, no known collaborations (except the ones in the plays, which are collaborations of the author). * He has no evidence of education, no rich stories of his intellectual youth, nothing at all. He might not have even gone to school. The evidence that he is not a writer is relatively strong by the standards of historical evidence. The only evidence on the other side is that he put his names on the plays, and that people said he was a writer in the first folio of 1623. The evidence that he didn't write the canon is greater: * The plots for the plays have sources which are largely identified, and there are sources which are in continental Europe, in Spanish, Italian, Latin, all of which Shakespeare probably couldn't read. * Shakesepeare's settings in Italy are very vivid, and correspond to real locations (despite the ridiculously incompetent claims you read that Shakespeare's Italy doesn't resemble early 17th century Italy). Shakespeare wasn't travelling in continental Europe--- he came to London, stayed there, then retired to the countryside. * Shakespeare has no early immature works. He appears fully formed in 1593, writing mature poetry of great difficulty. * Shakespeare put his name on other works too, the Shakespeare apochrypha, which a cursory reading shows are not at all by the same author as the one that wrote the canon. * Shakespeare's life doesn't match the information in the autobiographical sounding sonnets at all. The academic consensus is that he made up a character for the sonnets, but they don't read that way, they are correspondence with actual living people, talking about the author in the first person. * Shakespeare's works are entirely derivative: they are in the same micro-style as the works of

Christopher Marlowe, only differing in big-picture things, like subtlety of characterization. This is just not consistent with literary genius--- no other author of genius has stolen so much from someone else. It is not so simple to say this, considering how many people have historically got it wrong, but if you read the works of Marlowe, in order of date of composition, then read the works of Shakespeare, in order of date of composition, and you do not come to see that they are the same person, you are basically an idiot. This is manifestly obvious, and it is only disguised by the fact that people don't read the works composed at approximately the same date, but read one Marlowe play from 1588 or 1590, and one Shakespeare play from 1606, and conclude that they are very different. Even the 1606 and the 1588 stuff is not so different, it is still clearly by the same person, but the comparison by date is even more striking. It is very difficult, if not impossible to distinguish Marlowe's Edward II from Shakespeare's Richard III, Titus Andronicus, Henry VI parts 1,2,3, and fully half the Shakespeare canon was conjectured to be a rewrite of a lost Marlowe manuscript by someone or other at some point. The scientific evidence, however, is the only kind of evidence that I accept as conclusive, and this is stylometry. This is comparing the statistical characteristics of the texts, those characteristics which are impossible to fake or immitate consciously, except by verbatim copying. The stylometric evidence I have listed here: Did William Shakespeare ever visit Italy? , I copied it to make this answer self-contained: You can find the quantitative stylometric graphs by following the red links on this page: A Deception in Deptford , and two more on this page: Peter Farey's Marlowe Page , in the linked Hoffman prize winning essay "Hoffman and the Authorship". This evidence comes on top of the original monumentally surprising word-length stylometry of Mendenhall (the plots are reproduced with computers here: On Mendenhall and compelling evidence of Marlowe authorship by Daryl Pinsken), which shows that Marlowe's later work (tragedies) and Shakespeare's tragedies are stylometrically identical, even more so than Shakespeare's own tragedies and comedies, and, as Farey shows by comparing p values, Marlowe and Shakespeare are closer than any two authors compared, you only get this close as comparing authors

to themselves. And the straw that broke this camel's back is the latest stylometry: http://www.cs.brown.edu/research... , which depite the mealy-mouthed introduction and conclusion, showed that two completely new stylometries still continue to confuse Marlowe and Shakespeare, despite the author's best attempts to weasel around this fact. The author of the plays is Christopher Marlowe, who was therefore necessarily alive to write them in 1593-1610, and was possibly alive as late as the publication of the first folio in 1623. The stylometric evidence is conclusive. That's that. End of story.

What are some of the silliest mistakes made by famous scientists?

With Einstein, the following mistakes qualify as silly, in that they are immediately obviously false to a modern person, and should have been clear to Einstein, although this is probably hindsight speaking: * The hole argument: this was the idea that general covariance is impossible, because it doesn't allow you to predict the future, because you could change coordinates in the future. * The anti-black-hole arguments: Einstein believed that black holes couldn't form, because the Schwarzschild solution had time stop at the horizon. He published one of his arguments late in life, the idea was that an incipient black hole would have to spin-up faster and faster to stay stable, the surface going at the speed of light at the moment of collapse. The resolution was already clear to Chandrashekhar, Oppenheimer & Sneider, and many others, the collapse simply happens. Einstein has a few other mistakes, but I wouldn't call them silly. These two are just silly. Past the 1950s, in the peer review system, silly mistakes don't usually make it into print, unless they are universally made, in which case it's hard to call them silly.

Do you believe in IQ tests? Do you think your IQ Score reflects on that belief?

IQ tests work to measure generic problem solving ability, and general mental agility. They are useful for identifying mental retardation, environmental toxin exposure, genetic deficits, learning disabilities of certain types, and various other sources of cognitive damage. But they are useless at the high end, because the tests do not measure a trait which is out there to be measured. Further, I do not consider anything but perfect performance on these tests, answering all the questions correctly, acceptable. One should train on a sample problem set which includes all of the dozen or so different puzzles that IQ testers like to test, until one can do them all. This is not prohibitively difficult for most people, it is harder to learn a real skill. The historical point of IQ tests is to take the diversity of human intellectual achievement and produce a number for "intelligence" which will have a mean and a standard deviation, like "height". In order to do this, you need to produce a list of questions where the number of correct answers is roughly Gaussian distributed. For cognitive tasks, this is extremely difficult, because people vary too much! For example, if one gives a person chess problems, and uses the size of the search space as a measure, the number of chess problems solved by different people will have a massive tail on the distribution. It is not just familiarity with the game that is important--- there will be variance even among children and among people who have been exposed to the game for equal amounts of time. The differences are due to the internalized search algorithms that are produced unconsciously in the brain, and these are very difficult to understand, because they are not done by the conscious mind. So if you use chess as an IQ-test, you will find that there is a massive difference in the time taken to solve problems and find best-moves between people at all levels. But now, if you are an IQ

tester, you need to make a bell-curve, a Gaussian distribution. So what do you do? You put a list of 20 very simple problems gradually getting harder, then a list of 20 ever harder problems growing exponentially fast in difficulty. In this way, you produce a measure of chess-performance which looks like a bell-curve. This is why IQ tests always have this ridiculous break-point where the problems go from super-easy to very very difficult. It is the only way to shoehorn a massive tail into a bell curve. The result is designed to produce a bell curve for the number of answers, and it does. But by studying chess for a long time, with the correct approach, meaning training your unconscious search algorithm, and learning from the moves found by the great masters of the past, you can improve your ability to the point where you can ace any such chess IQ test. IQ testers use other puzzles, not chess, but the principles are the same. The puzzles become exponentially harder, so that different people will break at different points on the high end. The reason these tests are useful for identifying cognitive deficits is because the low-level questions are very finely grained--- they discriminate very well between people with even minute toxin exposure. If you are tired, or confused, or feeling weak, or mentally debilitated by some factor, you will have a drop in your performance on the test, and this can be detected. The same reason makes it so that the tests are useless for testing for exceptional talent--- they are not at all finely grained at the high end. The high end parts of the test consist of extremely challenging tasks that get exponentially harder, and depends very strongly on which types of cognitive search algorithms you have internalized. The original point of these tests, the reason they were introduced, was to give a scientific reason to allow you to discriminate between people and ethnic groups. This is why they were introduced, and they were used to select people for high positions throughout the 20th century, with not so great results (although better than hereditary aristocracy, for sure, because anyone could learn to do well on IQ type tests). I think that the proper use of these tests is as a personal challenge. When you see an IQ test, try to do all the problems, then when you fail to so some, learn to do all the problems, and practice with enough sample tests (only the difficult problems), until you can do all of the problems instantly. This is great training for the mind so

long as you don't waste too much time. Once you do this, you are well prepared for other challenges.

What are some famous scientists who had excellent intuition, but who weren't analytically exceptional?

I think the best example in the 20th century is Geoffrey Chew. He was a phenomenological theorist who was interested in formulating a theory of the strong interactions, but he wasn't an analytic superstar, his mathematical skills weren't extraordinary. In 1960, he realized that the families of particles in the strong interactions requires a different kind of theory, an S-matrix theory, and he formulated many concepts of S-matrix theory in a series of brilliant intuitive papers and explanatory lectures that inspired a whole generation to work on this. These papers introduced many techniques, which were made more formal through the efforts of more formal collaborators at Berkeley, most notably Mandelstam. Mandelstam's views were less radical than Chew's. Mandelstam believed that the S-matrix was not quite the only observable, but one could push the S-matrix off-shell in any theory (this means calculate properties of detailed space-time behavior too, not just scattering experiments). But in his papers, he only managed to do this in a certain technique, which is light-cone coordinates, so that the extension wasn't complete. This was a source of embarassment for many decades. Geoffrey Chew wasn't just jabbering. He introduced techniques for calculating pion-nucleon scattering, mostly forgotten, and he also had various techniques for estimating the inter-nuclear potential, also mostly forgotten. I don't know these techniques very well, I didn't read all his papers. But among his students is David Gross, who became a famous field theorist, and later string theorist. The S-matrix theory of Regge trajectories that Chew advocated was

eventually constructed, and is nowadays called String Theory. By now, the holographic principle is known to hold within String Theory, and it explains why Chew was right about the S-matrix, at least for the gravitational theories people are concerned about today. Chew's contribution to the development of string theory is not recognized, probably because he and followers made certain false statements in the 1960s disparaging the consistency of quantum field theory. I think that these mistakes should be forgiven, because it is very easy to disparage the old stuff when one is proposing something radically new. Geoffrey Chew is one of the great intuitive minds of physics, and he deserves recognition for his marvellous legacy. String theory is not going away. If the goal of this question is because you have this vague idea, but you can't give it mathematical form, you should just say what the idea is. Then one can see how to make a mathematical formulation, if this is possible, or test if the idea is correct. It's not hard to learn mathematics today anyway.

Who are some famous scientists who scored low (anything below 135-140) on IQ tests?

The top scientists generally score about 1-2 sigma above the mean in IQ tests, the same as mediocre scientists. Feynman scored in the 120s for example. Any higher score requires specific test preparation in IQ test specific tasks, like training your short term memory, training your visual imagination specifically for the test, training your permutation search algorithm for demanding search, and identifying the types of analogy that are considered most correct by the test makers (these are not obvious in advance). I did such things as a child, after getting the gist of the idea in the test, so as to score a little higher. Some people train harder, and they can score as high as they want, including getting every answer right, and so being "off the charts". There is no limit to your performance on an IQ if you do not happen to have some

obvious cognitive deficit. IQ is just not a measure of any intrinsic intelligence, it is very difficult to identify a meaure of intrinsic intelligence, and the concept is of no value at the high end. It is useful for identifying cognitive deficits, caused by lead exposure, or genetic abnormality, but it is not useful for identifying exceptional talent. You can see this from the distribution of performance on cognitive tasks. For genetic traits, like height, you see a bell-curve where all people are more-or-less the same, with a certain small spread. But for complex cognitive tasks, people just do not fall on any sort of bell-curve. The people who are good at mathematics or chess are way, way, better at mathematics or chess than the people who are mediocre at mathematics or chess, and the best of them are better than the average by a similar amount than the average are better than the bad. These differences are due to internal training of the mind to store and search for patterns, and it is extremely time consuming to do this, and it produces gains which are qualitative. If you show a chess master a chess problem that takes a person who just learned the rules several days to solve, they can see it instantly, with no effort, and there are other problems they can solve which the neophyte is just plain unable to do, it is just too big a search space. But the test-makers decided to shoehorn such a distribution into a bell curve, so that "intelligence" looks like "height", so that it looks like a genetic trait. Given the completely huge tail on performance on any sort of mental task, in order to get a bell curve, you need to pose questions of an especially ridiculous sort--- they have to get exponentially harder, so that the number of right answers go on a bell-curve. So IQ tests generally consist of a list of 30 ridiculously simple questions getting only slightly harder and then a dozen hard questions, of which you get about 3, and maybe 6 with good preparation. To get all 12, you need to study and think very hard, but if you study with 300 example questions, you will have seen all the possibilities before, and you will easily get all of the questions right. This is how you get Mensa members, they compete with each other to score higher on these tests, training in these cognitive tasks. So why do we have these tests? The point of IQ tests, why they were introduced, was to codify a social hierarchy, with explicitly racist and classist motivations. The goal of American IQ

testers in the 19th century was to find a criterion by which they could justify oppressing black people and poor white people, and the easiest way was to produce a test which would test for types of knowledge which slaves and poor freemen did not have, but which were common in the mathematical cultures which the upper southern gentility admired. Those tests from the 19th century are ridiculous today, the culture has transmitted this knowledge to everone. Even the IQ tests of the 1940s are ridiculous, everyone can do exceptionally well on them today. This phenomenon is known as the "Flynn effect", that if you give people out-of-date IQ tests, they score higher than people did back when the tests were formulated. It is due to the rapid dissemination of knowledge through culture, and remember that the questions are getting exponentially harder, so it's a big, big effect we're talking about. If anything, with an internet around, the Flynn effect should be more pronounced today, and IQ tests from the 80s already look kind of stupid today. You can informally see a version of the Flynn effect simply by going back and doing old mathematical competition problems. The level of these just steadily keeps going up, as does the level of mathematical writing in the literature. The rate of growth is kind of extraordinary. The same is true in chess, where objective tests are now possible. Evaluating the chess play of grandmasters and ordinary folks over time using engines, the players just keep getting better, and more so now that they have engines! The association of IQ testing with eugenics and racism never went away--- this is "The Bell Curve" in the 1990s, and other IQ-race and IQ-class associations that are used to justify discriminatory policies. The IQ business is used in every culture to justify the oppression of other classes, even in cases like in Europe or Israel, where the genetic background of the folks doing well and the folks doing badly on the tests are extremely similar. Nowadays, in the US, some people have an inferiority complex regarding IQ, and make it their business to study IQ test problems, and become very good at them. That's good up to a point, because it is useful for everyone to learn memory tricks and puzzles, this is the seed of mathematical thinking. But it is depressing to see some person struggling to get their IQ test performance from 160 to 180, because beyond the point of becoming familiar with the

general ideas and methods methods (and there aren't very many, the IQ testers are not very creative), the attempt to raise one's IQ is really just waste of time. The effort expended in going from 160 to 180 is getting about 3 more questions right, which, because of the exponentially rising difficulty of the questions requires much more intellectual effort than getting the first 30 questions right. The point of these tests, from the beginning, was to discriminate between people, it was not to learn something useful. The goal was to produce a test for the natural aristocracy, those who deserve to tell others what to do. By the 1960s, you have an IQ aristocracy, the meritocracy, the "best and brightest", like McNamara, that took over in the Kennedy administration. These people in their hubris were responsible for some of the worst catastrophes in American policy, like the war in Vietnam. In response to this, the modern conservatives became hostile to the idea of IQ as a test of competence, they called the meritocracy the "out of touch elites". In this particular case, they were right. Nobody should be telling others what to do. The proper goal is to make sure that all people can do as many intellectually demanding tasks as possible, that means, learn to do every question on every IQ test, it doesn't take that long, then go do something useful.

Given that smoking tobacco causes more deaths per year than any other drug, should it be made illegal? Why?

There is no need to make it illegal. Simply allow civil suits against the manufacturers of cigarettes for damages caused. Nicotine is a mild stimulant which is associated with creativity, it shouldn't be banned, there is a safe nicotine delivery device now: the electronic cigarettes. Smokers will switch or die. The only downside of the electronic cigarettes is thirstiness from thel propellant.

Why passive smoking is said to be more injurious than actual smoking?

It is not more injurious, it is more injurious in proportion to the amount of smoke inhaled. The second hand smoker is only getting a minute quantity of smoke compared to the firsthand smoker, at most 1%, and if you do a linear extrapolation of the risk of lung-cancer or other diseases, you would conclude that it's negligible risk. But the statistics show a non-negligible effect, so that means the risk doesn't go linearly, it's worse than linear at small doses, either that or else the statistical studies are biased. I don't know which, but I tend to believe the studies, because the number of different carcinogens in cigarette smoke is large, and they might each have a different dose-response curve.

In layman's terms, how is the Banach-Tarski paradox possible?

The Banach-Tarski paradox cannot be explained in layman's terms very well, because in layman's terms every set of real numbers is measurable. You can say it as follows: if you can pick a real number between 0 and 1 at random (this can be any interval by rescaling), then you can determine the volume of any set by Monte-Carlo--- pick a random real number again and again, and the fraction of time you land in any set S is the measure of that set. This "definition" is circular in set-theoretic mathematics--- the measure of a set is the way mathematicians talk about probability--- but it isn't circular

intuitively. Our intuition says we can pick a random real, because we can pick finite approximations by picking random digits, and these approximations converge. You can therefore, as a layman, pick uniform reals in a box containing the sphere, and the partition of the sphere into whatever sets, the sum of the measure of the sets must add up to the measure of the ball. So when probability works as you expect, the theorem is false, and it should be considered just plain false. The reason it works in ordinary ZFC is because the real numbers are only modelled by the theory. When you have a model of the real numbers produced by axioms, you can list out all the real numbers that will ever be defined by the axioms, using the symbols in the theory. This listing is what is produced by Godel's completeness theorem, and it produces a countable collection of points which have the hubris of thinking that they are all the real numbers, because they are all the real numbers in the model you are considering. This is how Godel's completeness theorem constructs a countable model for any set theory. But the result is known as "Skolem's theorem", or "Skolem's paradox", because Skolem did it first, using a model theoretic reduction using sentences in the theory, instead of a general completeness proof for logic. The fact that there are only countably many reals in a countable model of ZFC doesn't contradict the statement that the reals are uncountable, because there is no map within the model from the reals to the integers. You only see that the reals are countable "from the outside" so to speak, by considering the model itself. ZFC doesn't even know that it has a model, since it can't prove itself consistent by Godel's incompleteness theorem. Once you understand that theorems of ZFC are not necessarily talking about all the real numbers we can imagine, rather it is talking about the real numbers in some model it has in mind, the paradox evaporates. What this theorem is saying is that you can partition the countably many real numbers which are in the model and in the sphere into a finite number of collections in the model, so that when you suitably translate and rotate, they lie on top of the countably many real numbers in the model in two spheres of the same size. The result is now not particularly counterintuitive, because the countable model makes it obvious that all these sets are measure zero, and the theorem is still

obviously false when thinking about all the real numbers, in normal day-to-day intuition, where you aren't considering a model of some axiom systems. The proper formulation of the intuitive idea that probability always makes sense, is that every subset of R is Lebesgue measurable. This is consistent with ZF with dependent (countable) choice, and the axiom of determinacy, but not with the axiom of choice as applied to all the real numbers. Then the Banach Tarski thing doesn't work. This is what is more intuitive and also more convenient for mathematics, so I believe it is only a matter of (a short) time before people stop believing this joke of a theorem as in any sense absolutely true. But as a statement about countable models of the reals produced from set-theories with the axiom of choice, it is true, but it is also not particularly counterintuitive.

What are some of the best scientific discoveries made by laypeople?

usually, when someone makes a discovery, they aren't called a lay-person anymore. But there is a major exception: the big bang. Penzias and Wilson noticed noise in thier radio antenna, which didn't go away, and turned out to be the microwave background radiation from the big-bang. There are others, depending on your definition of the laity. If you include students, there are many. If you include people from other disciplines, the list is essentially infinite.

What is the difference between accepting a mathematical axiom and accepting a statement

on faith?

For the axioms which people care about, namely the ones that prove new theorems, there is a philosophical justification, which is provided by Godel's completeness and incompleteness theorems. The basic axioms in a mathematical system describe finite computations. For the case of set theories, these are the axioms that build up finite sets, starting with empty-set and applying pairing and (finite) union in different ways. For arithmetic, it is addition and multiplication. So long as the axioms allow you to calculate the behavior of some computer, you are fine, because any computer is equivalent to any other. This is true both of arithmetic and of set theory, as Godel embedded a computer into the integers with addition and multiplication (it's not hard). Then the other axioms can be seen as various sophisticated forms of mathematical induction, which allow you to prove theorems. The simplest induction is that of Peano Arithmetic, this is the induction you learn in school. But now you want to prove that Peano Arithmetic is consistent. You can't prove this within Peano Arithmetic, by the incompleteness theorem. So to show this, you want to give a symbol model of Peano Arithmetic, where all the axioms can be shown to hold. For this purpose, you pass to set theory, and admit the axiom of infinity, which allows you to form the set of all integers. Along with the other axioms of ZF, replacement/separation, unions, makes a stronger system. Then you go further, you want to prove the consistency of the resulting theory. To do this, you admit an axiom of uncountability--- there exists an uncountable set. This allows you to prove the consistency of countable set theory, by considering the collection of all countable sets. That's not what mathematicians did, actually. What they did is to make the axiom of powerset, which states that for every set, there exists a power-set, the set of all subsets of this set. This axiom is like the axiom of uncountability on steroids--- it allows you to give a set of higher cardinality from every set of any given cardinality, and to iterate this process. So you have a second kind of axiom--- the powerset axiom--- which turns out to be equivalent to just a tower of uncountablity

axioms, because the generalized continuum hypothesis is consistent with ZF. The powerset axiom allows you to prove the consistency of all the truncations of ZF to size less than a given aleph-omega (assuming GCH). But now you want to prove consistency of ZF, and this means an inaccessible cardinal, or rather, you can make an inaccessibility operation like you made a power-set operation, and get another super-duper tower above ZF. The point of these axioms is that each one proves the consistency of a previous system. They are tantamount to statements "S, S + consis(S) == S is consistent, S+consis(S+consis(S))", and going up the tower is equivalent to doing induction up to some ordinal. So the main mathematical axioms are those that produce descriptions of new ordinals, and to be significant, one should recast them as axioms which produce descriptions of new countable computable ordinals.

What is the minimal set of axioms needed as a basis for the mathematics used to express current physical theories?

All you need are the axioms of Peano Arithmetic, as these can be used to model a computer. Then you give physical theories are computations that match a particular set up to a given precision. You may not be able to prove all the results you want to prove using Peano Arithmetic, since it isn't the strongest system in the world, but you will be able to formulate the physical laws. You don't need anything else, except to define certain idealizations, which are convenient. So you might want to talk about an infinite Hilbert space, or a function space, but they only show up in physics in a way that admits finite truncations and finite computation when you are talking about a physical theory in a given situation. This is important to keep in mind--- mathematics is only physical to the extent it describes the behavior

of computations. The idealizations involved are not particularly important except to the extent that they give you a way of showing why the behavior of computations comes out the way it does from a larger framework.

Why are there so many questions on Quora about the Axiom of Choice when AC is largely irrelevant in mathematics?

The Axiom of choice is a political problem in mathematics, in that it has been a thorn in the side of a sensible measure theory for 100 years, and there is very little progress is getting rid of it, even though the alternative has been clear for decades: every subset of R is measurable. When every subset of R is measurable, the following is a rigorous definition: I construct the free quantum field on a bounded subset of R^n by choosing a random function whose Fourier transform is Gaussian random real number with width 1/q^2. This is just not allowed today, because the concept of "choosing at random" conflicts with a universe with the axiom of choice. The definition of Wiener measure becomes trivial, as does the definition of the path-integral measure for certain interacting quantum feild theories, namely those with an explicit Nicolai map. These gains are enormous, and they were already clear to Lebesgue and others at the turn of the 20th century. These ideas led to the development of forcing, which formalized the notion that random picking is consistent logically (well, duh), and provided a proof that you can make every subset Lebesgue measurable without contradiction with anything except choice. It is ridiculous to keep the old conventions, they are absurd, and they are an obstacle to giving rigorous proofs of things that have been long known in physics, but which are difficult to make rigorous, due to the

difficulty of explicitly constructing the sigma-algebras and measures involved in path-integrals.

How can I, a non-mathematician, wrap my mind around the Axiom of Choice?

The problem is that people are using examples where the sets involved are countable, and in this case, the axiom of choice is intuitive. What the axiom of choice, in the domain where it is controversial, says is that one can find a nonempty representative of uncountably many different sets at the same time. To give an example, consider the hat-head problem. I put a hat on the head of infinitely many people, either black or white. People can see everyone else's hat-color, but not their own. They are asked to guess their own color, and if only finitely many people guess wrong, then they win. The axiom of choice is the statement that one can do the following: define equivalence classes of hat-choices where hat-choice A and hat-choice B are equivalent if A and B are only different in finitely many places (this doesn't require choice). Now "choose" one representative from each class (this requires choice). Then have the people answer according to the (necessarily unique) representative consistent with everyone else's hat choice. The result is that necessarily only finitely many people guess wrong, since they are guessing according to the "best fit" representative, and this representative only differs from the true hat-choice in finitely many places. The problem is that this is obviously not true! If you flip a coin and place a hat on everone's head by random chance, seeing everone else's hat doesn't give you any information about your own. So when you accept uncountable axiom of choice, you are denying that the concept of placing an infinite number of random hats on an infinite number of heads makes sense. This contradiction is formalized in mathematics by saying that the axiom of choice allows you to construct non-measurable sets. Non-measurable sets are those

for which probability doesn't work the way it's supposed to. If you pick the hats at random, you are supposed to have a certain probability of differing from the best-fit choice representative in 1,2,3... places. But these sets are non-measurable, so you can't make probability arguments. The real problem with choice is that it is using constructions of set-theory which are only intuitive and clear for countable or finite collections and extending them to collections as big as the real numbers. This is the main problem. The correct intuition for the real numbers is that they allow you to pick at random, not that they admit choice functions. Not making this convention has cost mathematics dearly in terms of the complications involved in setting up measure theory.

Do we really need the Axiom of Choice?

The axiom of choice is a total red herring--- it's proved consistent in either direction, and knowing the proofs, due to Godel and Cohen, you lose fear of the axiom. It's really not the important thing in set theory. The axiom of choice is used in practical mathematics only for countable collections, and it is replaced by the axiom of dependent choice for all practical purposes of working mathematicians. The theorems that are proved are the qualified by having "countable" attached to the hypothesis: a countable product of compact spaces is compact, a vector space with a countable spanning set has a countable basis, a countable ring has a maximal ideal, a countable infinite product of nonempty sets is nonempty. The countable version is sufficient for everything mathematicians do. Further, the uncountable choice leads to horrible paradoxes with intuition: 1. There exists a non-measurable subset of [0,1] This is counterintuitive, because we think we can pick real numbers at random in [0,1] by flipping coins, and the result converges, so it should be possible to assign set-membership to these real numbers. If there is a non-measurable set,

you can't assign set-membership consistently to random-reals. To speak about random things, you then need sigma algebras and you need to do induction up to the first uncountable ordinal to establish the stupidest most elementary stuff. This is the main counterintuitive property, I will use it to give intuitive counterexamples to other choice things. These are not true counterexamples, they don't work in ZFC of course, they just show you how uncountable choice makes intuitive probability fail. But together, they make a compelling argument for denying choice at the level of the continuum, and replacing it with "all sets of reals are Lebesgue measurable", which makes all the arguments below rigorous proofs of the converse of the numbered statements. 2. If you place an infinite number of hats, either black or white, on an infinite number of heads, the people can, from looking at the other hats, guess the color on their heads so that only finitely many are wrong. This is clearly false if you can put a random color on every head. If you allow the axiom of choice, you declare equivalence classes of hat-choices so that two hat-choices are equivalent if they differ on only finitely many heads. Then choose one representative from each equivalence class (choice) and have everyone answer according to the unique representative that matches what they see. This is the starkest formulation of the contradiction between choice and probability that I know of. It became popular after a relatively recent blog post. 3. The reals have a basis as a vector space over the field of rational numbers. If this is so, then pick a gaussian random real x with variance 1. This gaussian random real is a linear combination of the basis elements. So there is some integer n--- the basis-number, which tells you how many basis elements it is made of. Call the probability of having basis-number n, p(n), so there is a probability p(n) of this real being made up of n=1,2,3 basis elements. Multiplying by 4 doesn't change the basis number, neither does dividing by 5. Pick another gaussian random real y with variance 1, it also has a basis number with the same distribution p(n). But now (4x+3y)/5 is again a gaussian random real with unit variance. But by construction, it is made up of more basis elements than either x or y (there is zero chance of x and y sharing basis elements)! So it has to have distribution for it's basis number which is both p(n) and p(n)*p(n) where the * means convolution, and

this is impossible, there is no such distribution p. This proves that the reals don't have a basis over the field of rational numbers, assuming only that probability is consistent, so that the words "pick a gaussian random real" makes sense. In traditional set theory, these words don't make sense. The sets involved, the sets of reals with basis number 1,2,3, etc, are all non-measurable, so I can't speak about the probability of having basis-number 1,2,3, and the argument above demonstrates this. But then the consistency of the Solovay universe, where randomness is intuitive, demonstrates that there is no basis for R as a vector space over Q in any meaningful way. A person who knows probability says "pick a gaussian random real" all the time. So we have decided to live in a universe where intuitive probability statements are not consistent. That's not reasonable, in fact, one might go so far as to say it's totally fucked up. One can make up intuitive probabilistic disproofs of all the standard theorems which are proved using choice in the case where choice is controversial, namely for sets of size continuum or higher. The real problem here is using the set-conception for real numbers, they are a richer kind of collection, one which does not admit induction, rather it is one that admits random-picking.

Is the Axiom of Choice critical for the mathematical basis of any physical theory?

It is not. The physical laws are always formulated as an algorithmic computation for producing an answer to what happens in a physical setup with a finite computation, if perhaps you need more computating to get better accuracy. The computations in ZF and ZFC are the same, the computational aspects are absolute, and you could use Peano Arithmetic for formulating physics, except you might not have as elegant a formulation, since you would have to represent real numbers in finite approximation. It is further true that if you start

with ZF, no choice, and just look at Godel's minimal model containing the ordinals, L, then choice holds in the model. This means that whatever model you want to use for set theory, there is a submodel obeying choice. So you won't prove anything wrong by assuming choice. But the reason choice is wrong is because it contradicts probabilistic intuition in ways that are unnecessary and stifling. So in physics, you are better off denying choice, and assuming every subset of R is Lebesgue measurable. This makes defining certain path-integrals, like those for a free field, or for Brownian motion, or for supersymmetric theories with an explicit Nicolai map, a piece of cake. In physics mathematics, you don't bother with worrying that probability is inconsistent with choice, and you allow theorems whose proof involves random picks, something which is not possible in the presence of choice. In fact, using random picks, it is easy to see that every subset of R is measurable (this is the formal definition of saying random-picks make sense), that R does not have a basis as a vector space over Q, and that there are equivalence classes of real numbers that do not admit a choice function. It is always better to have probability than axiom of choice, so one will not get progress in measure theory without rejecting choice.

Should Einstein have won more than one Nobel Prize?

I would have given him a solo Nobel prize for General Relativity, and a separate solo Nobel prize for predicting photons. You could make the following cases for a shared Nobel: 1. Einstein and Perrin 1909 for Brownian motion theory and experiment 2. Einstein, Poincare, and Lorentz for special relativity. 3. Einstein and Schrodinger for the Schrodinger equation. 4. Bohr, Einstein and Sommerfeld for the old quantum theory. 5. Einstein and Bose for the Bose-Einstein condensation. 6. Einstein Podolski and Rosen, for entangled particle

pairs. But really, the Nobel prize is a political thing, and getting it multiple times is not important, it is just for visibility.

How long would it take for the all of the oil in the reservoir tapped by the Deepwater Horizon to leak into the gulf at its current rate?

You are assuming that the oil in the reservoir is a fixed quantity, that new oil doesn't seep in from the deep Earth. This assumption is a consequence of the idea that the oil is formed from biological residues, an idea which has very little evidence supporting it, a few biomarkers, and the biomarker evidence is much more easily and cogently explained through the action of deep-Earth bacteria that produce the biomarkers. The balance of the evidence is that the oil is not formed from biological residues, but is cooked in the deep Earth as primordial carbon seeps up through the heavier elements in the molten parts of the Earth. If you accept that oil is cooked in the mantle, and that the small amount of biomarkers is due to contamination with biological residues from deep Earth bacteria as it rises up, there is no reason to suppose the reservoir will ever fully run out. The pressure will fall as the reservoir is emptied, but the pressure will rise again as new oil comes in from below, and it will just continue leaking oil over geological time-scales. The phenomenon of oil-well refilling is one of the many pieces of evidence Thomas Gold cites in his book "The Deep Hot Biosphere", which is a presentation of the rediscovery in the west of the Soviet theory of abiogenic oil. In my opinion, it is just a stupid unsupported political consensus that stands opposed to this theory, and this political consensus doesn't stand a chance in the modern media climate.

If Albert Einstein had never existed at all in the world, would relativity theory have been found and proposed by others by now?

If Einstein never existed, special relativity would have been found, more or less as we understand it today, but possibly it would have been an ether theory for a long long time, before people would have recognized that the ether is unnecessary. Mach's positivism was essential for this recognition, and some follower of Mach might have done it, but it might have happened only in the 1940s. For General Relativity, it is even harder to say. If Einstein published the equivalence principle, and did all the work up to 1914, then the equations of General Relativity would have been soon discovered by someone else, like Hilbert or Schwarzschild (but Einstein would still deserve the bulk of the credit, just for the pre-1915 work which laid the foundations). We know this, because after some lectures by Einstein, Hilbert began working on General Relativity, and he eventually found the correct field equations after guessing the correct action (it's not hard to guess--- it's the simplest invariant scalar). Einstein derived the same equation by a more laborious route, since he wanted to make sure that the equation reduced to Newton's it made a sensible wave equation, and that it predicted correct physical consequences. Nevertheless, despite doing a ton more work, Einstein still found the correct field equations first, as his correspondence with Hilbert makes plain. But you asked if Einstein never lived. In this case, there would not have been a photon paper, there would not have been the quick recognition of adiabatic invariance, quantum mechanical wave-particle duality would not have been proposed in 1909, Bohr would not have had a champion for his atomic model and he might have languished in obscurity, Schrodinger would not have had a champion or the inspiring 1924 Einstein paper, DeBroglie would not

have had a champion or wave-particle duality, Heisenberg would not have had the A/B coefficients, and even if he could have produced quantum mechanics without this, he would not have been nominated for the Nobel prize. Dirac would be an electrical engineer. Wigner would have been an electrical engineer. The general inspiration of Einstein would have been absent. It is not clear that we would not be only slightly further along today than we were in the 1940s. Of all Einstein's 1905 work, only the Brownian motion and special relativity were ripe for discovery. But even with Brownian motion, it didn't become mathematics until the 1940s, when Wiener gave a formal definition of the measure. Smoulochowski's work and Perrin's were inspired by Einstein. So I think we would have had Brownian motion and special relativity by the 1910s, perhaps a rudimentary quantum mechanics at some point before 1930, but I am not sure at all that we would have the proper culture to advance physics. Because one of Einstein's greatest contributions was political. He made it ok to do complicated mathematical theory that nobody but you understands, and this in the print era, before the internet, when you could be heckled into oblivion for it by ignorant people, and you couldn't respond in a timely fasion. This insistence on continuing despite heckling served as a motivation for others, the many physicists starting with Bohr, continuing with Heisenberg, and Lee and Yang, and Schwinger, and Wheeler, and Stueckelberg, and Mandelstam, and all the modern folks who still make mathematical theory even when experiment is an uncertain guide. This tradition continues, and I think all the modern folks would be tempted to give up and sell out without the example of Einstein lighting the way. The special theory of relativity inspired group theory and representation theory in physics, and if these would have developed at a similar pace absent Einstein, then the general theory of relativity would have been discovered some time in the late 1960s, from considerations of the spin-2 field. This was when people rederived general relativity from special relativity plus the assumption of a massless spin-2 field. But by this point, Yang and Mills had discovered Yang-Mills theory inspired directly by General Relativity, and without the previous development, we would probably have muddled with a scalar theory of gravity for a long time, Yang

Mills theory would have been formulated in the 1990s, and we would not have understood the principles of gauge invariance fully, perhaps even today. It is possible that another person would have filled the gap in some way, providing the necessary culture for physics to progress, perhaps Pauli. But since Einstein was so transformative, it is like asking "What would the Linux kernel look like today without Richard Stallman?" The answer is that it probably wouldn't exist.

Are there any scientists out there who can or do make a 'good' case against Evolution and can anyone also make a case for a younger earth (i.e. not billions of years old)?

You can't make a case for a younger Earth, because we have mountains of evidence that the Earth is about 5 billion years old, for example, the amount of radioactive decay products we find in naturally occurring Uranium. Uranium has several decay channels, and they are all consistent with an old Earth. The picture from different radioactive elements is consistent, and consistent with the fossil record. You could say the Earth was created 6000 years ago with fossils in the ground and radioactive elements in strange proportions in rocks, designed to look like an old earth, but you can equally say that the Earth was created 10 minutes ago, for that matter, or will only be created 10 minutes from now. This type of thing, creating an Earth which looks ancient, is logically positivistically meaningless, you would be abusing the word "created". You also can't make a case against the thesis that all life on Earth comes from an ancient common ancestor by descent, modification, and selection, because this is completely obvious when you look at the common genetic heritage of life. Just looking at genetic data, it is obvious that the organisms are related in a

tree, and that the tree matches a fossil record of species splitting from each other by decent and modification. You can also identify the process of separation of species as selection pressure, due to different rates of success of different lineages in the background of other life and other things, because we have artificial breeding, and we can get a sense of the time-scale required from the rate of artificial breeding, and it's consistent with the fossil record being a product of a form of natural selection. This point is Darwin's and it is also unassailable. But the motivation for such questions are religious--- can you make a case that life on Earth is the product of a deep intelligence, which can be thought of as analogous to the infinite intelligence which religious people intuitively identify as the source of ethics? Can you make a case for the concept of God in the Bible, that thing that tells people how to behave as historical agents, as being somehow relevant to both biology and to human social organization? And can you rule out certain forms of evolution from these ideas, not just the vague Darwinian concept of natural selection, but more specific mechanisms which lack in intelligence? In this case, I think the answer is yes, although nobody makes such a case today. So I will make such a case below. The main issue is that scientists often present the view that evolution completely lacks intelligence, that it is a blind process. This is the thesis Dawkins promotes, and one can identify this with the modern synthesis. Evolution is clearly a natural process, it doesn't require supernatural intervention, nothing we observe requires supernatural intervention. But that doesn't mean evolution is an unintelligent process, or that it doesn't have a goal. Your brain also doesn't require supernatural intervention, but it is intelligent, and your brain can formulate goals. It is difficult to clearly say which natural processes are intelligent and which are not in such a way that brains come out on one side and everything else goes on the other. Alan Turing distilled the essence of the notion of intelligence into the mathematical notion of computation, and I will accept this: the intelligence of a naturally occurring computer, like a brain, (technically, this requires a random number generator, a random oracle in Turing's way of stating things, but the notion of a random oracle is predicated on a consistent notion of probability, or working in a Solovay universe, but forget these

technical considerations--- a random number generator is what you intuitively think it is) is the total number of megabytes and processor cycles required to simulate the process in the most-efficient possible representation. When the number is small, then the thing is not intelligent, and when the number is big, then its intelligent. Not everything requires a big computation to simulate the outcome. For regular deterministic systems, the computation doesn't grow linearly with time as is required to predict a computation, to predict the far-future of a regular system requires only logarithmically growing computational effort. For a chaotic system, you don't need growing computation either--- at some point you switch out to a random number generator choosing a point at random from the attractor according to the stable measure. Both these kinds of dynamical systems are relatively stupid. To simulate the atmosphere of the entire Earth to best-possible precision requires no more than a few gigabytes of velocity data, none of which is stable enough to compute anything at all, the bits randomize each other and forget their initial state within a few weeks. To simulate the moons of jupiter (to the extent that the motion is regular) requires a lot of data, but the data is not interacting to make a full computer. But for other natural systems, like protein networks in cells, you can have complex computational interactions that form an actual computer, with dozens of kilobytes of data in each cell. Likewise, RNA networks in cells can have gigabytes of data, all interacting in that way identified by Turing as leading to full computation--- with switching behavior and stable memory. This is sometimes given a proof, but I prefer to baldly state it, because if you are familiar with how little is required to produce Turing computation, you can see that it is obvious. Given this computational behavior, it is difficult to say whether the process of evolution is intelligent or unintelligent. It all depends on how much of the RNA and protein computation is relevant to the process of producing new genomes. Within a widespread view of evolution, the modern synthesis, evolution is not very intelligent. In the modern synthesis, mutations are produced by random SNPs, duplications, and deletions, and then selection works as usual. This process is very difficult to make work, because it is unintelligent. Scientific consensus for a long time was that

this is the entire story in evolution, but this consensus was not strongly supported by any evidence, because we didn't have enough genetic data to see what was going on in detail. It was also very strange to imagine that this is what is going on, because it seems like it would take eons and eons to make evolution go from a rat to a human by SNPs, deletions, and duplications, but it only took a few tens of millions of years in nature, which is a very short time to SNP/delete/duplicate mutate a gigabyte genome between distant forms. This idea, the idea that evolution is guided by unintelligent processes, is to my mind completely busted by modern biology. The proper hypothesis is that there are large networks of RNA in the cell, that these networks make a computation of many gigabytes size, and that this computation is important for creating mutations and crossing over in egg cells. The intelligence is not enormous--- it is small compared to a brain--- but it is not negligible, and it shows that the evolutionary process is far more sophisticated than the blind process Dawkins imagines. The networking of these genomic computations through their interactions in the wild then produces an even larger system, which is hopeless to simulate except using an enormous computer, with trillions and trillions of genomic gigabytes interacting in complex ways. This is the size of the intelligence in life on Earth, and it is pretty darn close to infinite, at least by comparison to a laptop, or even to a human brain. So it is perfectly sensible to ascribe intelligence to the process of evolution, and even to abstract away the limiting intelligence and call it God, and then the process of natural evolution, the processes of social evolution, and the processes in your own head that lead to deciding between different actions are all consistently thought of as the product of the limiting conception of computation of infinite size, with all the goals, aspirations, dreams, and more that our brains, which are of finite size, can be seen to possess. Then the Biblical texts are simply an expression of this intuition regarding computation, in an era where all computation was seen as a supernatural phenomenon. It is important to keep this intuition because it is not a false intuition, but it is also important to understand how it is realized in nature.

Why are so many Christians politically conservative?

The Bible and Jesus's teachings are anti-capitalist to an extent, because they oppose the Roman heirarchy of class, and they are about social justice for the slaves. The focus on social justice and economic equality is still important in the Catholic tradition, and Catholic christians tend to be more economically left-leaning that other denominations. But the US is a protestant country, and the protestant denominations are economically conservative. The protestant reformation was made by a banker (Calvin) and it's main practical effect was to reverse the ban on usury in protestant nations, and allow a modern banking system to form. The ideals of protestantism are those of modern American capitalism--- emphasizing self-reliance and individual accomplishment. Protestant Christianity generally doesn't submit the individual to the community of Christ to the same extent that Catholicism does. That's not to say that there aren't Catholic conservatives, or protestant leftists, but the philosophy of Catholicism is more community oriented than the philosophy of the major Protestant denominations.

Did Albert Einstein steal the idea for the relativity theory? There are rumors that various scientists published the basic ideas of the relativity theory earlier and Einstein did

not cite them at all in his publications. Is this true?

In the case of general relativity the answer is just plain no. Einstein did all the work, and he did nearly all the work in complete isolation, except for the last months of 1915, when he was competing very intensely with Hilbert and Noether to make the final form of the theory. By Nov 1915, he had the vacuum equations, certainly without any input from Hilbert, and he used these to calculate the perihelion advance of mercury (getting the right answer) and the deflection of light from the sun (doubling his earlier answer). These equations he already considered in 1914, but rejected, because of the infamous "hole argument". Einstein realized the hole argument was wrong in 1915, but Hilbert's letters to Einstein still repeat the hole argument nonsense, so Hilbert wasn't further along. That was kind of surprising to me, because I thought the mathematicians would see the hole argument was nonsense immediately. Hilbert in Nov 1915 was rushing to follow, sending Einstein pre-prints with his ideas. The preprints annoy Einstein, who feels that Hilbert has done nothing significantly new. Einstein gets the field equations with sources at the end of 1915, with the term that is controversial, and Hilbert gets the same equation with the same term in a paper at the start of 1916 (in pre-print with Einstein's paper), except Hilbert has the action principle, and Einstein does it from the field equations. Both methods work, but it seems Hilbert made a mistake in the trace term, which wouldn't be significant, except people sometimes say Einstein stole the trace term from Hilbert. This is completely ridiculous--- Einstein found the coefficient of the trace term by insisting that the Bianci identity enforce the conservation of stress-energy in a free-falling frame, while Hilbert found the trace term (with supposedly a wrong coefficient, which he fixed in draft) using the action. So the convention today is that it's Einstein's field equations and it's the Einstein Hilbert action, and this is as it should be. Noether did something else during this competitive phase, she did Noether's theorem. So she wasn't interested in stepping over other people's research, she went and did something

new. Which is also as it should be. But one must remember in this particular priority row that Hilbert was coming into the game in 1915, after Einstein had toiled on the equivalence principle and the weak field approximation, after rejecting Nordstrom's scalar theory, after formulating the Entwurf theory (a gauge-fixed crappy version of General Relativity with no elegance and wrong perihelion precession), and after Einstein had already calculated a billion things, with all the physicists thinking he had gone mad. It was only in 1916-1917 that people started to realize his stuff works, and by then, Einstein had moved on the the A/B coefficients and cosmology. Hilbert didn't do much, except find the action (it's not that hard) and try to take over the theory for the mathematicians. He then went on to do a bunch of silly unified theories that didn't work. For special relativity, it's a different story. Here the claims of plagiarism are somewhat more justified. Einstein cited absolutely nobody in his 1905 paper, because he did everything from first principles, so he didn't need to. But he was familiar with Poincare, he read Poincare's 1902 book, which contains some of the rudiments of special relativity. This is a lapse in academic honesty, he should have cited Poincare. He does cite Poincare in 1906 and in later life, he gives most of the credit for the special theory to Lorentz and Poincare. He might be forgiven for this lapse, because Poincare was confused on certain issues, like mass-energy equivalence, and Einstein sorted that out quickly. Also Poincare had a wrong philosophy, and I suppose Einstein didn't want to endorse Poincare's philosophy. Also, Poincare was already famous. But Poincare and Lorentz deserve co-credit for special relativity, as Einstein always acknowledged at the end of his life. Regarding all the other claimants, it's a joke. It's either anti-semitism or just professional jealousy. The idea that Einstein was stealing his main ideas is a joke, because his main ideas were laughed at for decades. Photons were laughed at, even by Niels Bohr, until 1919, when Milliken set out to disprove them, and instead showed the theory works. This was also when Compton scattering was discovered. General Relativity was laughed at until 1919, and even then, it wasn't fully accepted within physics until the 1960s. Einstein also contributed to quantum mechanics in this period, but it wasn't until the 1920s that

his wave-particle duality was considered serious. He promoted Bose and DeBroglie, both of whom were outside the mainstream. This stuff was also laughed at. In the 1920s, Einstein was a reputable respected fellow, but then came modern quantum mechanics, and he rejected the interpretation, and became a pariah again. His stance on quantum mechanics cost him other physicists' respect, but it really is a reasonable position, and it was shared to some extent by deBroglie. Schrodinger also jumped on the bandwagon because Schrodinger was deeply in awe of Einstein, but later regretted he didn't follow Bohr. Bohm showed in the 1950 s that deBroglie's interpretation was viable in a mathematical sense, but the jury is out on hidden variables. Bell showed that hidden variables must be nonlocal, but in light of holography, that's doesn't sound as crazy as it used to. Quantum mechanics could be fundamental and exact, or it could be a statistical description of some deeper thing, we just don't know. We'll find out when a quantum computer works, or doesn't.

What's your nomination for the best movies of all time?

The Steamroller and the Violin, (1961 movie)

What if time stopped suddenly for 5 seconds?

Paul Baruch's answer is fine, but I want to point out something more, namely that your question is not meaningful at all. Since we define the description of nature in terms of experience, and since there is no second "philosophical time" relative to which "physical time" passes,

it makes no sense to say "physics time stops for 5 philosophical seconds". This statement cannot be tested by experiment, and in the logical positivistic conception, it is a meaningless utterance. This is important: there are classes of statements your brain makes and your hand types that sound superficially meaningful, but are meaningless on closer examination. This is the central insight of logical positivism, that we can identify the meaningless statements by the fact that they have no impact on anything we can observe. The tenets of logical positivism are essential for understanding science, especially physics past 1900. The basic idea is that the meaning of terms like "5 seconds" are defined by operations that measure those abstractions and turn them into sense-experience, like by looking at the hands of a watch. Further, any two ideas that coincide in terms of the measurements are identified as ideas, they are the same idea. So philosophical time could stop every second for 5 seconds. It could turn around and go backwards, then go forwards again, it could be going backwards all the time, it could have started 10 seconds ago, it could start 10 seconds in the future, and it could never start at all. All these ideas are identical, because the concept of philosophical time never enters the physical description. You can then jettison the concept of philosophical time as unneeded extra baggage, using occam's razor. So there is no meaning to your question, although it seems to have meaning at first glance. There are many other such questions: * How did the universe come to be? * Are we discovering mathematics, or does it exist in a Platonic realm? * does an electron have a position before it is measured? And so on and so on. The collection of meaningful questions is not obvious a-priori, but becomes clear as one formulates the physical laws. There is a nontrivial equivalence between ideas, which is that two ideas are the same if they predict the same sense-experiences and observations. This identifies several classically distinguished positions as really equivalent. These points were made by Carnap in the 1940s, and then willfully forgotten by philosophers because they didn't like losing all those nonsense questions from their field. Anyway, logical positivism is important, as 90% of the "deep questions" people ask are really meaningless when formulated positivistically. This is an example.

How do you tackle "show that..." problems?

Consider the difference of the two sides: [math]X^p -1 - p(x-1) = 0[/math] This is zero at x=1. The first derivative is zero at x=1, explicitly, the derivative is [math]p x^{p-1} - p[/math] and the second derivative is positive for x positive and p>1 or p<0, [math] p(p-1) x^{p-2}[/math] which is positive for x>0. So the function curves up everywhere and it's unique minumum is at x=1. The further away you are from 1 in either direction, the more strongly the inequality is obeyed. This is convexity, and it is generally useful.

How big is a number with 280 million zeroes?

To put a number like this in context, you need to think about entropy. Entropy is a logarithmic measure of the number of possible states, and the number you give is comparable to the number of states corresponding to the entropy in a grain of dust at room temperature. It is much smaller. Even a few billion atoms in a solid will have a greater number of states, that is, a greater entropy than 280 million times ln(10). A more tangible combinatorial example is that this is the number of possible 100 megabyte files. 100 megabytes is a reasonably large amount of data, it is comparable to the size of the genome, so the number you give is roughly the number of possible genomes (without constraint for these genomes making sense, but also genomes can be longer than 100 megabytes, especially plant genomes, so it is probably roughly the right order). So this is more or less the number of different imaginable species of life on Earth, according to the current design of cells. Another comparison is to text. Text has an entropy of about 1 bit

per character, so to get 100 megabytes, you need 800 million words, or 4 million pages, give or take, or about 10,000 books, or a small library. This is the number of possible small libraries. It is impossible to give this number an interpretation in terms of realized states, because there aren't this many realized states in the visible universe. So it can only represents number of possible states, or entropy.

What is the scariest situation you've been in?

I have been held up at gunpoint, and I've been threatened with bodily harm, but it's no contest: the time I was most terrified was just being alive during the last crisis of the cold war, in 1983. At some point, one becomes aware that there are 20,000 hydrogen bombs pointed at you, and that in any particular twenty-minute interval, with absolutely no warning, a stupid nutcase, by which I mean Ronald Reagan, could decide to snuff out everyone. This wasn't abstract--- there was a serious possibility of all-out war until Gorbachev took power, and many people were worried. 1983 was a particular low point, being both the time of maximum Soviet paranoia and well before the point Reagan became convinced that nuclear war was not something one could reasonably win. This fear was shared by everyone, except those in power. One had constant low level dread. And nightmares. Everyone growing up then had nuclear nightmares. It was just a normal part of life--- you dreamt the world would end. At various points in your subconscious life, you were burned, starved, radiation sick, or just vaguely alone in a desolate landscape. Kurasawa's "Dreams" is a record of this, also Tarkovsky's "Sacrifice", but just as much "Mad Max", the Minutemen, and every other aspect of the culture of that era is a product of the expectation of a finite short time to armageddon. I remember a sense of tremendous relief in 1989, when the cold war ended. People growing up today don't understand this situation, as it really was unique in history, the type of fear is

beyond the realm of comprehension. It was a permanent low-grade existential terror the kind of which we probably won't see again until the sun blows up in 5 billion years.

William Shakespeare: What are your thoughts on The Merchant of Venice's anti-Semitism?

This answer presupposes you understand that the author of the Merchant of Venice is Christopher Marlowe. To understand why this is the correct attribution, look at the stylometry linked in this answer: Did William Shakespeare ever visit Italy? The Merchant of Venice is a complete rewrite of the earlier Jew of Malta, and the differences illuminate the anti-semitic sentiments. The Jew was a stock villain, he was scheming to produce evil, and this was his motivation and this was his delight. As a result, he is killed barbarically in the final act, and this is something that audiences are supposed to cheer. The reason is that the theology of Judaism was often viewed within Christianity as being the primitive eye-for-an-eye nonsense that you can read in the Pentateuch. But Jewish theology became very similar to Christian theology in the 2nd century, after the Bar-Kochva revolt inaugurated the diaspora. The Jewish religion had its martyrs and it incorporated the spirituality of other-worldly conceptions of future punishment and reward in the olam-ha-ba, the world to come, which plays a parallel role to heaven. But Marlowe while living in England had never met a Jew, and for him, the Jews were simply a foreign collection of heretics from whom he could choose a stock villain. This changed in 1593, when Marlowe became a heretic himself and then an exile. In sympathy with those on the outside, and encountering actual living Jews in Italy, Marlowe became dissatisfied with the Jew of Malta, and rewrote it as the Jew of Venice, then the Merchant of Venice to shift focus again. The rewrite fixed the play of it's anti-semitism, and the Jew of Malta was not even published until the 1630s, long after

Marlowe's death (and Shakespeare's). The final rewrite shows remarkable growth and maturity. It keeps Jew's villainy, but it removes his inhuman indifference to others' lives. He becomes an evil character one can sympathize with, in fact, he is a little bit parallel to Marlowe himself. Shylock is a completely human villain, he is not a stock villain, and this makes it difficult to find anti-semitism in the work. Still, in early performances until the 19th century, Shylock was treated no differently than Barabas, he was performed in fright wig as a stock villain. This only changed as actors found humanity in Shylock, and the deepening of the characterization made this play one of the most popular. The mistakes in staging are a sign that Shakespeare didn't really understand what Marlowe was writing. I don't think one should call the play anti-semitic at all, unlike the Jew of Malta, which is. But one should realize they are the work of one man, not of two.

Did William Shakespeare ever visit Italy?

The "Shakespeare Guide to Italy" demonstrates conclusively that the author of Shakespeare's plays was intimately familiar with Italy as it was in 1600, including many surprising true details of the locations involved, and no false ones. The inland canal-travel depicted is spot-on accurate (including canals that were verified in the Shakespeare guide, but which were not commonly known outside the region), this canal travel between inland cities involved boat docks in inland cities, at the exact embarkation locations depicted in the plays. The actual locations mentioned in Shakespeare's works include obscure local references, to an actual Sycamore grove in Romeo and Juliet, to a "St. Gregory's Well" in the Two Gentlemen of Veron (not a well at all, a plague pit, another thing reavealed in the Guide for the first time), various churches with the correct names, and more generally dozens of actual locations in many towns, all in the correct location for the plots, none

of which would possibly appear in any way in any account available in England. The name "Caliban" and "Ariel" are derived from the local mythology in the local dialect. The "Shakespeare's Guide to Italy" is a very well researched work, contrasting with the willful ignorance of traditional Shakespeare scholars on this issue, who seem to just make up whatever for whatever purpose. But it is nearly certain that William Shakespeare, the man from Stratford, never left England, being occupied as he was with a family and business ventures, in addition to acting and claiming authorship for a bunch of plays in London (including some by authors other than the one that wrote Hamlet). Shakespeare was not a writer, this much has been solidly known since the 19th century. The evidence of modern stylometry establishes with what is to my mind reasonable scientific certainty that the works were written by Christopher Marlowe. You can find the quantitative stylometric graphs linked in the red links here: A Deception in Deptford , and two more on this page, in the linked Hoffman prize winning essay "Hoffman and the Authorship": Peter Farey's Marlowe Page. This evidence comes on top of the original monumentally surprising word-length stylometry of Mendenhall (the plots are reproduced with computers here: On Mendenhall and compelling evidence of Marlowe authorship by Daryl Pinsken), which shows that Marlowe's later work (tragedies) and Shakespeare's tragedies are stylometrically identical, even more so than Shakespeare's own tragedies and comedies, and, as Farey shows by comparing p values, Marlowe and Shakespeare are closer than any two authors compared, you only get this close as comparing authors to themselves. And the straw that broke this camel's back is the latest stylometry: http://www.cs.brown.edu/research... , which depite the mealy-mouthed introduction and conclusion, showed that two completely new stylometries still continue to confuse Marlowe and Shakespeare, despite the author's best attempts to weasel around this fact. This kind of evidence is absolutely airtight, except that the implications are so bizzare. What it means is that Marlowe then didn't die in 1593, but faked his death with the collaboration of Walsingham and fled somewhere, and continued writing. Then the works were copied by another hand, transmitted to William Shakespeare, and

registered under Shakespeare's name, who went on to stage them, and perform in them. When you have this kind of story, you have to check that the historical evidence is compatible with it. It would be very easy to disprove this kind of thing under ordinary circumstances: for example, if you find an overlap of Marlowe and Shakespeare as writers. But the first mention of Shakespeare as a writer is a few weeks after Marlowe dies in 1593, registering "Venus and Adonis" as "The first fruit of his labor". The poem Venus and Adonis is a companion peice to the unpublished Marlowe "Hero and Leander". There are no mentions of Shakespeare as author before this. If you have read a biography of Shakespeare, you will see that in the Groatsworth of Wit, Greene calls someone a "shakescene" and an "upstart crowe", who thinks he can "bombast a pentameter" better than his contemporaries. As Farey shows, independent of what you think about the authorship, the target of this attack is almost surely a famous actor named Allyn not Shakespeare, and this is not through Marlovian thinking, it comes just from the best interpretation of the Groatsworth itself. It is monumentally shoddy scholarship to identify the target as William Shakespeare, and this kind of farcical wishful thinking is common in Shakespeare biography literature, which is always beset by the problem of too little documentation of Shakespeare's life, so they grasp at any straw. There are no good documents to demonstrate Shakespeare's literary skill, and there are many pieces of circumstantial evidence that show he is not a writer. His signature is a scrawl, never the same twice, his daughters and graddaughters are illiterate, and there are no books of his provenance found after a diligent search a century later, and no books mentioned in his will. The only evidence that says he is a writer is his name on the plays, a name which appears on a bunch of other plays too, the Shakespeare apocrypha, which everyone agrees have nothing to do with the great classics. Marlowe's death inquest document does not rule out that his death was staged. The witnesses were three employees of Walsingham, and the story is very suspicious. So, since there is no firm historical evidence to contradict the overwhelming stylometric evidence, one can do nothing but take the stylometry at face value, and just say Marlowe wrote the works. This means Marlowe survived,

exiled himself, and wrote a bunch of works that distance himself from his youthful bombast, and give himself another shot at literary immortality without the dead-weight of his atheism and heresy holding him down. The stylometric results about the inseperability of Marlowe and Shakespeare are all recent, the consensus up til a few years ago was that a few stylometries conclusively separate the two authors. What Farey did was to take these stylometries that claim to separate the bulk of Shakespeare from the bulk of Marlowe, and plot them against date. These plots showed that all of these stylometries drift in time, and the two works run a smooth curve with no jump and no forced interpolation. It is extremely easy for this to fail--- any of these stylometries could have been constant for Shakespeare, or shown no trend, or the trend could have gone the other way, so that Marlowe didnt fit. I should add that Marlovian authorship makes the canon of Marlowe and Shakespeare together fit into a unified whole, and allows the sonnets to get their straightforward natural interpretation as biographical statements. The result is a solution to the vexing problems of Shakespeare interpretation, problems which have long been recognised---- namely that the Sonnets tell the story of a disgraced and exiled author, who will be remembered as the "coward conquest of a wretch's knife", they don't fit with Shakespeare's biography at all. The Marlovian reading solved these problems long ago. So not only is it scientifically supported, it is also literature coherent, and really, it makes me breathe a sigh of relief, because I didn't use to be a Marlovian, and at that time, I just thought Shakespeare was a worthless no-good rip-off, stealing Marlowe's voice and inventions, except I couldn't understand how he managed to exceed Marlowe while ripping him off. It was an impossible mystery. Anyway, seeing the stylometry, problem solved. From the strange choice of setting of the next non-historical plays: "Two Gentlemen of Verona", "Romeo and Juliet", "Taming of A Shrew" are all set in Italy, one can plausibly conjecture that Marlowe went to Italy. This is also compatible with the source material for the plots of the plays, which can be identified as certain stories floating around Italy at that time. Marlowe knew Latin and French, and it is likely that he was either ok or fluent in Italian and Spanish, since these also Latin

derived. Marlowe's Italian exile is not something one can be 100% sure about, but it is a reasonable idea. That Marlowe wrote the plays, I think one can be 99.99% sure about, and you get more 9s the more stylometries you use, as many as you like. In response to the other answer: Richard Roe has written ‘Shakespeare's Guide to Italy', which demonstrates that the "historical inaccuracies" that Shakespeare scholars have incompetently identified in Shakespeare's description of Italy are not historically inaccurate, but reflect how Italy was in the late 16th century. There were canals linking inland cities, so that the type of boat travel Shakespeare depicted was accurate. This strongly suggests that Marlowe was exiled in Italy for the period immediately following the 1593 incident.

Is the dark matter hypothesis, which posits force from a weakly or non-interacting class of particles, falsifiable?

The term "falsifiable" is misunderstood in a lot of these discussions. The idea of "falsifiability" is really an attempt by a philosopher of science to separate scientific hypotheses, like "The Earth's core is made of a Uranium/Lithium alloy" from unscientific hypotheses, like "The Earth's core is made out of fairies pushing the crust away from the center". The distinction, according to Popper, is that the first you can falsify, because it makes a specific prediction about what happens when you shine neutrinos through the center of the Earth (or dig), while the second is unscientific, because if you shine neutrinos and see that it doesn't reflect off fairies, the fairy supporter would say "but the fairies are fooling you." And if you dig, and find no fairies, the fairy supporter would say "The fairies replaced the center with other stuff at the last minute". The hypothesis of falsifiability is to get rid of the fairy theories, not of hypotheses which can be tested in some precise

pre-specified way. Dark matter interacts gravitationally, so by making a beam of high energy gravitons, and scanning the sky, you can find all the dark matter particles--- they'll scatter the gravitons. That's it. That's a method to falsify. The fact that we can't make such a beam is neither here nor there, we can't dig to the center of the Earth either, or shine neutrinos through it in a controlled enough way to test the fairy theory either. The concept of falsifiability is not enough to rule out certain nonsense, like Russell's teapot. My theory is that there is a teapot on the other side of the sun, orbiting the sun just along with the Earth, so it's always on the other side of the sun. This idea is falsifiable nonsense--- you can test if the teapot is there, although, it's never gonna happen. The Russell teapot is ruled out by Occam's razor, the idea that one must make a minimal model for the data, without extraneous unwarranted assumptions. In fact, Occam's razor alone, without the notion of falsifiability, is enough to get rid of the fairies too. If you also take the positivist approach, that two ideas which are the same in terms of their experimental consequences are really to be identified, fairies which fool you to seing a Uranium Nickel alloy, and which replace the center with Uranium Nickel alloy when you dig, these fairies are logically positivistically equivalent to just the Uranium Nickel alloy theory, and there is no meaningful distinction to be made between the two ideas. Then the fairies can be removed from the model using Occam's razor. So the real point of "falsifiability" is just another brain-damaged philosopher attacking logical positivism. The ideas of positivism subsume those of falsifiability, and are more correct and subtle a way to justify induction. But for dark matter, it's not only falsifiable by graviton beams, it's also falsifiable from cosmology, from the detailed flows of dark matter in colliding galaxies measured by gravitational lensing, from rotation curves, from the pioneer anomaly (which can be attributed to the extra gravitational potential of dark matter in the solar system, as Adler showed), and from direct detection (which has not found anything yet). The compatibility of these observations (minus direct detection, but maybe soon) with the simple idea of heavy particles that interact only gravitationally is sound scientific evidence for saying that there is dark matter. This is what the other answers are saying. I wanted to clarify

that this is not in-principle falsifiability (which is what Popper meant), rather in practice falsifiability. String theory is in principle falsifiable, and in practice maybe not (although probably yes). So it is falsifiable in the Popper sense, you can build a Planck scale accelerator in principle, but we aren't going to do that, it's too expensive. Other theories the purport to explain aspects of dark matter, like MOND, are ad-hoc and hard to reconcile with relativity and quantum mechanics, and further, don't explain all the data. For example, MOND has a hard time explaining why gravitational lensing experiments show that the dark matter clouds of colliding galaxies are deformed.

Is it true that Albert Einstein failed in mathematics many times during his school days?

Einstein was a good student in mathematics as a child, but as a young adult, he was not a star in higher mathematics, and his mathematics professor Hermann Minkowski called him a "lazy dog". The reason is that Einstein was interested in physics, and he saw higher mathematics as a distraction. He was under the impression that any mathematics he needed he could create from scratch, and this hubris has been an inspiration for physicists since. When Minkowski saw the special theory of relativity, he was astonished that such an incredible theory could come from such a bad student. It is Einstein's weakness in mathematics as a young adult which is the real source of the idea that Einstein was a mediocre mathematics student. Einstein studied mathematics seriously starting in 1909, when, motivated by the equivalence principle, he realized he needed to learn differential geometry. It took him several years, but by 1915, he was as good at it as Hilbert, or Noether, two leading mathematicians of his day. His tutor and sounding board was Marcel Grossman, with whom he

developed the early sketches of General Relativity. But the final theory Einstein did by himself. In his later life, Einstein was comfortable with mathematics, so much so that his work was paid more attention in mathematics departments than in physics departments. This changed in the 1960s, as General Relativity became incorporated into mainstream physics, because it was rederived as the theory of the self-interacting spin-2 field. Today, General Relativity is quaint as physics, it's old enough to be classical. But in mathematics, it is yeilding nice results, because proving certain extremely physically intuitive facts is more difficult than would appear at first glance. Some of the more modern results are the positive mass theorem, and the local stability theorem for Minkowski space.

What are some subjects one should self-study that can be applicable and helpful in the fields of economics, finance, business, and computer science?

You should study statistical mechanics as applied to finance, which is really just statistics with more of a focus on the central results and less obfuscation than in the math department. You should also strangely enough quantum mechanics, to the point that you are comfortable with path integrals. This requires dedicated effort spanning at least several months, and more realistically, a year or two, but the payoff in finance is enormous. The only reason to study the path integral is that you immediately become comfortable with Brownian motion, which is the simplest path integral there is. The result is that you understand the main non-commutativity result of Brownian motion--- the position and time derivative of a Brownian motion have a nonzero time-ordered commutator. This is called "Ito's Lemma" in finance or stochastic equation books, but I guarantee you that if you read this in finance books, you will not understand it. The authors of these books do not understand it themselves. The result is easy to state once you know path integrals: X(t+ dt) = X + dX and dX is a random quantity, going up and going down, with an average width which goes as [math]\sqrt{dt}[/math]. So dX^2/dt is nonzero, meaning [math]{(X(t+dt) - X(t))(X(t+dt)-X(t)) \over dt}=1[/math] If you expand out the first term, it says [math]X(t+) \dot{X}(t) - \dot{X}(t) X(t-)[/math] Where t+ means t a little forward in time, and t- means t a little backward in time. This is the Euclidean commutation relation. The infinitesimal identity that dX squared is same order as dt for a random walk is the basis of Ito calculus, but it is very elementary in physics path-integrals, where you don't waste time with measure theory nonsense, like in mathematics. The measure theory is nonsense because mathematicians made the stupid choice 100 years ago to allow non-measurable sets into their universe, Solovay following Cohen, showed that this was not necessary. Non-measurable sets do not exist in any real sense of the word. In comments to the original answer, Minhaz Mishnu found three excellent references. This one is exactly right, it is first principles: http://www.amazon.com/Statistica... The next two are more physics oriented, but are both very good. The Kleinert reference has a lot of very important material, and Kleinert knows his stuff. Techniques and Applications of Path Integration (Dover Books on Physics): L. S. Schulman, Physics: 9780486445281: Amazon.com: Books http://www.amazon.com/Integrals-...

Why do we square when we can use fourth, sixth...powers when calculating variance and standard deviation?

Because there is an implicit Gaussian error model--- in a Gaussian error model the probability of being a distance delta away from a mean value goes as the exponential of minus delta squared. Probabilities multiply, so the log-probability adds, and the log probability of a given error is the sum of the squares of the distances. This is why "sum-squares" is a good quantity to minimize in a fit. It's also mathematically convenient, because when you minimize, you take a derivative, and the derivative of squares is linear, and linear equations are easy to solve.

Is intelligence the root cause for inequality? If yes, how to fix it?

It is not exactly intelligence that you are talking about, rather what people call social-intelligence, the ability to manipulate your social environment by making deals with other people and getting them to do what you want. This is the intelligence of "Survivor", not "Nova". Devoting your efforts to learning this activity is what separates the middle-class from the working class, and it is both useless to society and anti-correlated with real intelligence. Mathematical intelligence requires ignoring social cues to get at the truth. Politeness gets in the way, being social gets in the way, and the socially intelligent generally suck at any activity where the test of success is objective: like mathematics, or science, or chess. The middle class is at a disadvantage in such things because they train to be circumspect and indirect, for the purposes of social politics. The thing that separates the super-rich from the middle-class is not just social intelligence, it is also the ability to embrace tremendous inequality and be willing to get ahead even when this involves pushing others down. This requires the belief that one is special and deserves special compensation for one's own uniqueness. This idea is both statistically stupid, there are a lot of people in the world, and kind of evil. So to become super-rich you

generally have to be stupid at statistics and be completely amoral. This tendency doesn't come naturally, so you need people like nietzsche and Ayn Rand to say it's ok. There is always a paucity of philosophers willing to promote inequality, so the super-rich are always on the lookout for someone who says "inequality is good", and then they reward this person with money and prominence. Since neither evil nor social intelligence is particularly useful for humanity, the real problem is that one lives in a society where social political games can let you get ahead in the first place. The solution to this has been known for decades, and it was implemented in the middle decades of the 20th century: you tax individuals at punitive rates and make wage supplements for poorer people, and then you get rough equality. This is not harmful to economic growth, because income equality gets you closer to the ideal efficient market of economics textbooks, where all incomes are equal through competition. But there is a problem with government imposed equality, in that it can interfere with certain business activity. Not through loss of incentive, that never happens--- even if the richest person only makes 10% more money, people strive to be this person--- but through loss of capital for ventures. If there are no wealthy people, ventures become much more conservative, becuase you need to finance ventures by committee of many people, since no one person has enough money to finance the venture. Committees are always slightly stupider than their stupidest member, so you get no bold ideas financed. There are probably good ways to ensure equality while at the same time ensuring that capital for venture is available. One way is to have a probabilistic component for venture: so your bank rolls a die for each proposal and picks a "venture king" at random, and then the venture king determines whether the venture lives or dies, after discussing it with everyone, and getting input on the proper financing and so on.

Special Relativity: Where is the energy in a boosted capacitor?

This is a stress-energy tensor puzzle--- you need to understand that this is not a static situation all by itself, the two plates of the capacitor will collapse on each other in the absence of extra stresses, and the collapse is time-dilated in the moving frame making everything consistent. You want to model a static capacitor, so you need two infinite charged plates separated by a springy material that is under stress pushing them apart. The springy material is required to keep the situation static, and if you don't include it, you get your paradox. This is a simple example of "Poincare stresses"--- to do an electromagnetic energy balance, you always need to include any non-electromagnetic stresses going on too. To understand everything, first consider a much simpler analogous paradox in Newtonian mechanics. I am standing on a subway, and it's not moving, and I lean on the pole. I am pushing the pole forward with 20 Newtons of force, but the pole isn't moving, so I am doing no work. Now the subway starts to move. I am still leaning on the pole, but now I am doing work! The push on the pole is in the direction of motion. But, by Galilean invariance, nothing is changed. I am not suddenly getting tired because the subway is moving. The resolution is that there is a momentum flow through the pole, to the floor, and back into me. The horizontal momentum is flowing into the pole (because I am pushing on it) flowing to the floor (because the pole is attached to the floor), and then flowing back to me through my feet (because my feet are on a floor with friction). This closed circuit of momentum turns into a closed circuit of energy when you boost, so that in the moving subway, there is an energy flow through me into the pole and back into my feet through the floor. The energy and momentum flows are mixed up. The same is true in relativity. You have a stress energy tensor, which transforms under boosts as a relativistic tensor. The stress in the electromagnetic field includes an energy density [math]E^2/2[/math] in the time-time component but also a stress, a negative pressure, in the space-space component, which represents the local transfer of

momentum from the top plate to the bottom plate, which tells you that they are pulled together. When you add a mechanical stress and a mechanical energy to keep it in equilibrium, you have a sum of an electromagnetic stress and a mechanical stress, and each part separately transforms correctly. The net stress for a static capacitor is zero, meaning that the flow of momentum from top to bottom plate in the EM field is balanced by the flow of momentum back through the springy material, and when you boost the pieces separately you get apparent paradoxes, because it is only the total stress that has the property that you get a nice transformation which is intuitive. The problem is 2 dimensional 1 space, 1 time (you can reduce the dimensions of the plate, nothing is going on in those dimensions), and the electromagnetic field tensor in 2d is just E times the two-dimensional epsilon tensor, and this is invariant to boosts, so as you said, E is invariant. The 2-dimensional electromagnetic stress tensor is invariant too, so it is proportional to the metric tensor, on-diagonal u,-u, meaning there is a negative stress in the field, a flow of momentum between the two plates, equal to the energy density u, representing the pulling of the plates together. There is an additional mechanical stress tensor is on-diagonal A,u, cancelling the stress, which closes the momentum circuit, so that everything stays static, and A represents the mass density of the compressed springy dielectric material between the plates. So that the net stress tensor in the rest frame is just pure energy--- A+u, 0 on-diagonal. When you boost this, you get $\gamma^2(A+u)$ in the time-time component, $\gamma^2 v(A+u)$ in the time-space component, and stress equal to the square of the time-space component, which, when you integrate over the reduced volume, gives you volume times $1/\gamma$ and the correct total energy and momentum you expect. This is a nice puzzle, it is motivates learning the stress-tensor very well. Nothing in mechanics makes sense without stress-tensor. A good source for this is Schutz General Relativity book, where the concept of momentum flows is made very clear with diagrams and so on, appropriate for any level.

How do you convince an adolescent that just because something is older than they are doesn't mean it's rubbish?

The internet makes it that anything from before the year 2000 is rendered largely worthless. So they are probably right. This presents a dilemma, because one has to modernize the past works for the current environment, whatever is worth salvaging. From about 1955-1990, one has the additional problem that most people were under the somewhat justified impression that the world was about to end horribly. So they ignore long-term value in favor of short-term impact. So you get pop art, punk rock, druggy stuff. This means that the artistic creations of the period 1955-1990 are doubly dated--- they are obsoleted by the internet, and the world didn't blow up. So you can listen to King Crimson's "Epitaph" or Rolling Stone's "Gimme Shelter", but it probably won't work with no epitaph and when you don't need any shelter. I think the only really worthwhile thing that needs to be preserved is stuff that didn't make it to the internet, like Soviet culture, the culture of the Eastern block. The Soviet Union broke up too early for the internet could preserve their heritage, and the closed society made it that all the good stuff was hidden away. This is a pity, becuase they had some fantastic things, that were a product of the forward-looking leftists, but these guys paradoxically were suppressed by the heavy-handed government communism. So maybe you can show them the films of Tarkovsky, introduce them to Shostakovich, the mathematical books of Khinchin and Manin, the chess games of Mikhail Tal, and so on. The Western culture, they'll get by themselves.

What two things about forces are important when forces are combined?

The force-vector for force 1, meaning it's x,y,z component, and the force vector for force 2. This is not an objectively meaninful quesiton, because "things" are vague. this is a question produced by bad pedagogy.

Are people from India good at Mathematics?

Creative mathematics comes from God, and by God I mean the supremum of large countable computable ordinals. You can't appreciate these ordinal structures without a culture that transmits infinitary thinking to you, so to produce creative mathematics, you need to have a theology, and you absolutely need someone to introduce you to infinity. The reason India produced mathematicians is largely because India has an original locally developed theology, Hinduism, and an independently created mathematical tradition of infinity, the Kerala school, dating back to the 14th century, which developed results on infinite series well before Europeans did. They produced their own theology of infinity, roughly analogous to the infinite theology that developed in Europe in the 17th century, this is the theology of calculus. The modern theology of infinity is Cantor's ordinals, which is superior in every way to the previous calculus theology, but it is more abstract. Cantor knew he was doing theology--- he explicitly recognized the concept of ordinals as corresponding to the religious concept of God. He was also criticized by theologens for introducing countable and uncountable infinity, which seemed to contradict the unity of God (two different kinds of infinity, at least). But Cantor's ordinals are the essence of mathematical theology, and they contain the fundamental logical thing that makes infinity important, and it became clear relatively quickly. It is senseless to cling to the old notion of infinity when there's a better one, so mathematicians threw out the calculus theology in the late 19th century. But the infinite series thinking includes a lot of the ordinal

thinking inside it, except disguised a little. You can think of a convergent infinite sum of positive terms as generating a sequence of points, the partial sums, and the various ordinals as corresponding to various orders of points on a line. So you can rearrange the sum to be a sum of sums, and ordinals just abstract out the logical thing in this scheme, the rearrangement of infinite sums of sums, which is the thing that produces new math. Ramanujan achieved his original results entirely within the pre-ordinal theology. To do this, he first learning some 18th and 19th century European mathematics, and he incorporated the local Kerala style calculus-type infinite series manipulations which he picked up by osmosis from the surrounding culture. He then produced a bunch of new results from his own tremendous creative effort. So he did a lot of infinite series manipulations, and infinite continued fractions, stuff that produces new mathematics, but which was out of fasion in Europe in the early 20th century, because ordinals were introduced and people were going in another direction, towards logic and computers. Modern mathematicians call unjustified manipulations of infinite series "analytic function theory", and this justifies the manipulations within a rigorous framework, and Ramanujan was quickly brought up to to speed on analytic functions by Hardy. The other thing Ramanujan liked, continued fractions, is now called "SL(2,Z)" and "modular forms", and this just took over mathematics in the late 20th century, making Ramanujan more relevant than ever. So when Ramanujan died, Hardy thought he was a great talent, but out of touch with modern mathematics, meaning Ramanujan's theology was old-fasioned infinite series and continued fractions, not ordinals. But now people think of him as at least a century ahead of his time, because the modular ideas became so important for proving Fermat's last theorem. People do not appreciate what it means to grow up in a culture with an embedded mathematical tradition, the theology is essential. As a child, one is given puzzles and games, one is encouraged to think about these puzzles, and one is exposed to various formal manipulations and philosophical conjectures regarding infinity which are just not presented in books. In American culture, you just don't get exposed to this stuff, and if you try to think about it, you are

heckled. But American culture encourages people to go off on their own, so there are individuals who pick up a lot of mathematics anyway, despite the culture. Often they immerse themselves in a foreign mathematical culture which has an independent history of mathematics. Since new mathematics is a product of individuals or very small teams of individuals, culture becomes irrelevant now. We have an internet, there's no need to squirrel knowledge away.

Who would you consider the most influential mathematicians of all time and what were their major contributions?

I think the answer has to be Georg Cantor. He reformulated an ancient field, mathematics, so that a completely new field, set theory, became it's foundation, and set theory is the most radical refounding of mathematics one can imagine. It replaced the ideas of geometry and algebra with a strange vision of infinite sets. This vision is so crazy, it isn't completely true as Cantor envisioned it, but even the reactions to Cantor are influences, and these reactions basically clarified the concepts Cantor laid down. His main idea was that the ordinals capture the notion of mathematical complexity. The real numbers have big ordinals sitting inside them, so they are stronger than the integers in terms of the complexity of theorems they can prove, and the biggest ordinals are like a vision of God. This is how Cantor viewed his theory, and his ideas were considered heretical at the time, because he imagined different orders of infinity, and this was considered a blasphemy against the unity of God. I think this idea, the ordinals, is the greatest idea of the 19th century, perhaps of all time. The idea that one should consider ordered sets as a form of theology, this is due to Cantor, and it is now formalized in the program of consistency of higher theories, Gentzen's program, the modern

descendent of Hilbert's program. You can prove the consistency of Peano Arithmetic from a simple theory plus a simple explicit ordinal Cantor could write down. You should be able to do the same for any theory, although this has only been done up to a certain ordinal limit. Really, the ordinals order the mathematical universe, and explain how mathematics works in its deepest essence. I think because of this, no mathematician has completely changed the focus of mathematics more than Cantor, and therefore he is the most influential. Even though it seems his work is very narrow, it underlies the whole field. Cantor had weird intuitions, but these turned out to be consistent weird intuitions. He believed that uncountable ordinals existed, that all sets could be well ordered, and that the real numbers were one-to-one matched to the first uncountable cardinal. These intuitions are crazy given what we know today, after Paul Cohen, but they are remarkably consistent with each other and with the structure of set theory, and this was proved by Godel in the 1940s. Not only are they consistent, they are true in the smallest model you can make for ZF set theory, so in some sense, they make the smallest most ordered universe, and you can understand why Cantor was so sure these things were true. It's really amazing what came out of Cantor's head, it really is impossible to imagine mathematics today without ordinals, and the theory of ordinals led to computers, to powerful systems of logic, and generally to the entire field of modern mathematics. So I think it's Cantor, even though in terms of direct influence, it doesn't look like it.

What are the best books to start on Recursion Theory?

For surreal numbers, you don't need to read anything other than "On Numbers and Games" by Conway, and "Winning Ways" by Berkelcamp, Conway, Guy. I don't know why this is recursion theory--- it's not very recursion theory heavy. For pure computation theory,

there is a superb book: Yuri Manin's "A Course in Mathematical Logic for Mathematicians". It is written in the traditional sensible Russian computational point of view, and makes even stuff like Matyasevich's theorem that people say is difficult extremely clear. But it's not about the priority method. All the priority method books are purposefully obfuscated by not writing out the algorithms in clear pseudocode. This unfortunately includes Soare and Odifreddi, and all of them. I am not sure that there is a good solution now, but if you could post the exposition in Soare for each priority proof one by one, as a question, one can figure out how to make the proof completely obvious--- the proof in the book is simply obfuscated by bad notation for the programs Soare constructs, the unreadable turing tape notation, and the refusal to use any readable formal algorithm language when describing the algorithms, or even just natural language. This is not a problem in some of the original literature, Spector's papers are especially clear. To understand what I mean by clear exposition, without the jargon holding the field down, you can read this math overflow answer, which proves the elementary theorems the right way: What are some proofs of Godel's Theorem which are *essentially different* from the original proof? . The answer there gives proofs for Godel's theorem, Lob's theorem, the simple things like that, and an original theorem that isn't very difficult for embedding a full infinite boolean algebra of consistent omega-consistent theories inside the consistent omega-consistent theories between a theory T and T+consis(T), using normal computer programs, like the kind you write, with no obfuscatory Turingese. The same exposition method can be used to similarly de-obfuscate all the priority proofs, and I did this half-heartedly to the theorems one by one, while reading Soare's book, but I was terribly annoyed that Soare didn't do it for me already, so I stopped reading it at some point, and wrote off the whole field as dominated by incompetent political people.

What is a good list of inconsistencies in physics that forced us to develop much more mathematically advanced theories to explain the inconsistencies?

Here are the most famous historical paradoxes in field theory: 1. the Klein paradox: When you scatter a Dirac equation electron off a barrier which is high enough, the reflection and transmission probabilities add up to more than one! This paradox and it's resolution can be explained simply today as follows: if you look at the positive frequency solutions to the Klein Gordon equation, these travel faster than light, they can't be restricted to be slower than light. This means that you need antiparticle creation if you have a potential, because anything that can make something go faster than light can make it go back in time too. The greater-than-1 probabilities in the Klein paradox are due to unaccounted for pair-creation in the step-potential. This was also the historical resolution--- going to a field theory for the Dirac equation. 2. The Dirac equation quantizes wrong: If you use commutators to quantize the Dirac field, you get an energy which is negative infinity. This was resolved by the Jordan/Fermi resolution--- you use anticommutation relations instead of commutation relations for the Fermionic equation. This was equivalent to the exclusion principle (antisymmetric wavefunctions) and the filled Dirac sea proposed by Dirac, which was a slightly more intuitive picture, but less formally mathematically elegant. The general result is the spin/statistics theorem of Fierz, Pauli. Later Schwinger gave a nice demonstration that explained why it is true using intuitive rotations in imaginary time (Wikipedia explains this). 3. The infinities of higher order perturbations: when you calculate the probability amplitude contribution of any process involving an electron emitting and later absorbing the same photon, you get an infinite result, coming from very short times. This was resolved by renormalization, by Stueckelberg, Bethe, Schwinger, Feynman,

Tomonaga and Dyson. 4. Landau's paradox for critical exponents: Lev Landau, using a simple version of what later came to be called "catastrophe theory", predicted that all critical exponents should be simple rational numbers, and gave specific values for what they should be. So he predicted that the magnetization in a magnet cooled below it's Curie point (when it becomes spontaneously magnetized) should, once you get past the critical point, always go up from zero as the square root of the temperature change from the critical point. But it wasn't true experimentally, and it wasn't true in the exactly solvable Ising model. So there was something strange going on. This inconsistency led to the development of modern renormalization. 5. Mass wrecks renormalization (except in QED): If you introduce a mass into quantum electrodynamics, you break a principle of gauge invariance, so you think that renormalizability will fail (because you will introduce all sorts of new terms), but it doesn't fail. This was noted by Feynman and Schwinger, and explained by Stueckelberg. The idea that mass doesn't change renormalization properties of theories of this sort was widely believed after that, but it was explicitly disproved by 't Hooft, who showed that the mass does wreck renormalizability in theories where photons self-interact with other photons, the nonabelian gauge theories. This led to the development of the classic techniques of Veltman and 't Hooft, including dimensional regularization and minimal subtraction, which automated calculations in standard field theory. 6. Anomaly I: The decay of the neutral pion/Missing eta-prime: The neutral pion decays into two photons, but it isn't allowed to decay into two photons by the Sutherland-Veltman theorem. The reason is because there was the principle that the axial vector current is conserved (we would say today that the quarks keep their helicity, in those days it wasn't said in terms of quarks). This theorem was contradicted by an explicit calculation, and this means it's not a theorem, but the algebraic manipulations in the proof looked correct. The resolution to this paradox is that there is an anomaly in the axial current, that means that when you differentiate the axial current, you get an extra term, and this extra term comes from renormalization. For the missing eta-prime: There are three pions, but there naively should be four, because the lightest quarks have that

many ways to rotate into each other. This was resolved by the t'Hooft anomaly, he showed that the fourth chiral current was violated by the strong interactions. Later Venziano and Witten showed how much heavier the fourth particle should be than the other pions, this is the eta-prime. 7. Anomaly II: The missing charm quark: Glashow Iliapulous and Miaini showed that the standard model was inconsistent unless there was a charm quark. This prediction was verified in November 1974, when two groups discovered the charm quark mesons. 8. Anomaly III: Trace anomaly: This was the observation that the scale invariance was busted, which led to the Callan Symanzik relation. 9. Hawking radiation: This was the observation that quantum field theory on a black hole background will produce particles in thermal equilibrium, even though the background looks static, and there's a theorem that static backgrounds don't make radiation. The theorem doesn't work because the background is only fake-static, the horizon is a place where time changes character from space, and you can't really call it static--- the space-time is peeling apart constantly there. This result was surprising. 10. Weird renormalizability of SUGRA: people expected N=8 supergravity to fail to be renormalizable at a certain order, but explicit calculations show that it keeps being finite well past the point it should start to diverge. This is not resolved today, and it a major focus of research, associated with Lance Dixon. I tried to stick to out and out paradoxes in field theory. There are a ton I left out--- like the SU(6) theorems--- that you can't mix spacetime and internal symmetries, this was the O'Raifertaigh Coleman Mandula result, and there's lots more. Field theory was full of paradoxes for decades, although they are sorted out now in physics, as mathematics it's a different story.

Is it logically possible for a universe like ours to have decreasing entropy?

You have misunderstood that in such a universe, the perception of beings would be that time is going in the other direction, so all you have done is made a recoordinatization of our universe replacing the words "future" and "past". The psychological arrow of time is the same as the thermodynamic arrow of time.

Why is mathematics so hard?

Mathematics requires an ability to study in complete isolation without getting lonely and without getting discouraged or distracted. There is a self-esteem issue, when you read something and don't understand, you feel worthless and stupid, and these blows to the ego must be shrugged off, and you just try again. It's catastrophic to the ego, because the set of stuff you can prove and other people can't is empty nearly all of the time. So irrationally inflated ego is psychologically useful, because you are going to be constantly confronting your own undeniable, quantifiable, stupidity. Irrationally inflated ego is generally associated with young males. Mathematics is also anti-rewarded by society, in that the more you study it, past a certain point, the less competent you will be at social stuff, like getting a date, because your brain will just keep getting rewired by the math, and you just get objectively smarter, and pretty soon you can't talk to anybody except other math people, because people don't understand you or find you boring, except for a small contingent of mostly young males. So by studying math, you are basically making the decision to work very hard to earn less money and be more socially awkward. So all the people who want political power just don't study it. But why would anyone study it? It's because with mathematics, there is permanent and irreversible progress--- it's been a long continuous punctuated revolution since the 1350s with no equal, except perhaps in the sciences. So you see that progress is possible in an objective way--- it is now easy to prove things that were hard or impossible even 50 years

ago, and there's nothing people did 100 years ago that we don't find ridiculously easy to do today. This will go on forever. There is something else that is hard about the mathematics, which is that the pedagogy is terrible. You just can't learn it well in school, because the folks teaching you don't know the history of the field so well. There are also sticking points where mathematics contradicts intuition, and there are exactly two of these, both related: * Godel's theorem: people get discouraged by the idea that there are "unprovable theorems". The resolution to this is to understand the theorem, and know that it isn't saying that there are objectively "unprovable theorems", rather it is giving you a procedure to make axiom systems stronger, and it is perfectly reasonable to assume that all reasonable theorems become provable at some point. This is mathematician's theology--- all arithmetic conjectures will be resolved by a sufficiently large ordinal. * Continuum issues: these are the continuum hypothesis, and well-ordering the reals, and the non-measurable sets. These things are resolved by learning forcing, and by understanding the computational perspective that denies these questions having objective meaning, unlike arithmetic statements. These things were the critical issues for me. There was also some resistance to categories, but the theory there is sufficiently straightforward that you can learn it even if you hate it, and after you learn it you stop hating it. There is another issue of nonuniqueness. There are always many ways to prove something, and people have their own favorite way. So you try to prove things your own way, and you might fail, and someone else does it another way. Maybe your way is better. But sometimes people lose their own creative spark by reading too much about other people's ways. But sometimes people lose their focus by not reading other people's proofs. So who knows what's best here. Generally it's easier to learn mathematics than it has ever been, and it is much better today than 20 years ago, thanks to plentiful internet resources. In a little while it should be easy enough to make mathematical literacy (like understanding everything up to the 1950s) a reasonably universal adult skill. That will make certain progress in society, since there are certain logical fallacies, like gambling, that mathematically trained people don't make.

Why are most Americans so ill-equipped to talk about race?

Americans do a better job discussing racial issues than most other places. Americans are advanced on this stuff, compared to many other places. But there is a wall they cannot breach in their discussion regarding this stuff, there is a hard limit to the egalitarian ideas that are allowed. The reason is the philosophy of human inequality that the country is founded on. The American revolution was designed to replace rule of a hereditary elite by rule of a merchant elite. Instead of people selected to rule by their class position, they would compete for money, which would give them power, and those that rise to the top will be the rulers. To explain why this would be better, Jefferson made a philosophy that says some men (he meant males) were born leaders. The leaders are the ones who accumulate wealth for themselves, or persuade a lot of people to do what they want. Having lived in this Jeffersonian society, I can tell you exactly what these leadership traits are all about. The born leaders, the "natural aristocracy", consist of men who are: * perceptually attentive to cadences of speech, extremely sensitive to social cues * hypnotically persuasive * sexually attractive. * can judge talents in others, and use this to build a team. Notice that these traits don't include any actual skills at doing anything. That is not required. A natural aristocrat doesn't do stuff, he hires other people to do stuff. We have a name for these people in science. We call them "idiots". These are the ignorant pointy-haired bosses, the politician type people, who think that talking persuasively and wearing the right clothes gives them the right to boss around the people who have the actual knowledge. The social skills listed above are very time consuming to acquire, and if you decide you want them, you will have no time to learn anything else, in particular, you will be ignorant. This is why some science fields enforce a draconian code of

slovenly dress and required rudeness. If you want to be a physicist, don't wear a suit, and learn to curse, otherwise you are revealing yourself to be a natural aristocrat or a wannabe natural aristocrat, and such people are not needed. So a class of political idiots with no actual knowledge run society, and generally, everyone knows it, except for people who are part of this class, and those that aspire to join it, who purposefully blind themselves to this. But in America, this is considered a good thing. So the traits of the natural aristocracy are considered God-given talents that make a person deserving of power and privilege and wealth. When you think such traits are parcelled out by nature, you have no reason to think that they will be statistically distributed equally. Like blue eyes, or upper body strength, or a long penis, different ethnic groups will have a somewhat different distribution of these traits (not just different ethnic groups, but even different families). This means that, taking this view, a certain amount of ethnic power-segregation is expected, simply from the different distribution of natural-aristocrat traits. The Americans expect this segregation, and always worry they will undo it by overly egalitarian wealth-sharing measures. This idea is self-reinforcing, because it is only those groups which are shut out of political power that comes to disvalue these social traits, because they are worthless in and of themselves, they only acquire value in a society that puts people with these skills in power. Those groups who are allowed to have power rely on honing these social traits so they cannot disvalue them--- they want individuals to spend all their time trying to acquire these skills! So white people spend an awful lot of time learning to talk nice, and how to look a person in the eye, they learn how to hypnotically suggest things to people, how to project confidence, how to schmooze. These people learn everything there is to learn, except how to do something actually productive, like write a program or fix a sink. This situation makes it that there is a racial gap in American society. Among blacks, hispanics, native Americans, socialists and also scientists, there is no sympathy for the natural Aristocracy, they are looked down upon. This means these cultures actively dissuade you from joining the natural Aristocracy, and call you a "sell out" if you do. This is why scientists don't like popularizers of science. It's why black culture has

little sympathy for the grade A student who speaks white English and listens to classic rock. These activities reveal that a person is vying to join the natural Aristocracy. But if you think the natural aristocracy is a God-selected group of great people, the true talented folks, and this is the general myth of American society--- that people with well-honed social skills are the ones who deserve to be in power--- then you are generally hostile to the racial egalitarian idea, or even to the equality of different families from the same ethnic background. Because you see that there is a huge cultural gap between different ethnic and family groups in acquiring these social skills. This racial gap means that White Americans, who view the social skills of the natural aristocracy as God given gifts, rather than anti-social acquired skills, they end up believing that these gifts are just unequally distributed among humanity, because it seems that mostly white people have them, and even among white people, strangely enough, they are anti-correlated with being a scientist or a computer person, or having any technical skill, or with being poor. You might be thinking, what's the problem with acquiring these skills? One problem is that to acquire them, you need to do social drinking and occasional drug-taking which will, as an unavoidable side effect, completely wipe out any mathematical or technical skills you might have. The drugs will erase your mathematical knowledge, and you will need months and years of study to reacquire it. This is not a worthwhile trade-off. This is why Americans have a hard time fully rejecting racism. It's because they want the natural Aristocracy to come out on top, and the natural aristocracy idea is fundamentally wrong. But, wrong or not, among black people, there is a tradition that has developed in the U.S., starting with DuBois, of creating and nurturing and tolerating the antics of a black natural aristocracy. So you can have a black media figure, a black CEO, or a black president, since you can now sample the pool of black natural aristocrat dipshits. It is in reaction to this rule by the natural aristocracy that many scientists were generally sympathetic to socialists. But the socialist solution, making the government run everything, is so terrible, that it must be rejected even more strongly than the rule of the natural aristocracy. So you are

basically left with this impasse, which requires a new idea of social organization.

Shakespeare was around presumably better educated contemporaries, like Marlowe and aristocrats at Court. What books might he have discussed with them?

Shakespeare didn't discuss anything with anybody. He kept a low profile, put his names on the plays when they came to him, got well paid for it, and kept mum. William Shakespeare, the dude from Stratford, is just not the author of these plays. You can say this with confidence today, because we have enough quantitative stylometric evidence to see that these plays are indistinguishable from Marlowe's writing, despite a lot of effort expended in trying to distinguish these two guys. As far as I'm concerned, if you want to claim they are different people, you need to find at least one consistent stable stylometric difference between them. People tried many times, and Peter Farey showed that they failed in each case, and that means that Marlowe wrote the stuff, and that's that, no matter what scholars say. That means Marlowe didn't die in 1593, but just went away into exile, and kept on writing under the protection of Walsingham, and he probably kept on doing this until 1624. This explains several things: there are a bunch of new plays in 1624 which appear in the folio for the first time. There are also edits to the older quarto versions of the plays that are clearly by the author--- they are good. It also explains the Shakespeare apocrypha--- the plays with Shakespeare's name on them that are clearly not by the same author as the canon. That's just Shakespeare putting his name on some other person's work, not Marlowe. It also explains Shakespeare's mysterious retirement in

1610, that's just when he couldn't keep up the scam in public, and had to go hide out in the country. It explains his great wealth, and it explains his enigmatic will. It also relaxes the ridiculously compressed timescale usually used for dating of the plays, because you don't have to fit them into Shakespeare's pre-retirement life. So it's not a frantic 3 plays a year, it's more like 1.5 plays a year, 1593-1624, not 1593-1610. The main sources for the plays, aside from Marlowe's classical training and his Ovid translations, are Italian and Spanish texts which appear at the end of the 16th and beginning of the 17th century in continental Europe which are not available in England. This suggests strongly that Marlowe, who knew French, was wandering around Italy, possibly later going to Spain (the later thing is from vague references to Marlowe in Spain at around this time), and possibly back to England by the end. The early locations of his exile are probably in the locations used as settings in the early plays, and he either already knew or became fluent in Italian and Spanish, which would be easy for him since we know he was fluent in Latin and French. But there is no point in these autobiographical speculation about Shakespeare. Even without knowing who wrote them, it is clear that Shakespeare didn't do it, and this was pointed out by many long before the stylometric evidence became convincing enough to say it's Marlowe's.

Is "The Tempest" Shakespeare's answer to "Dr. Faustus"?

The Tempest is just the elder Marlowe revisiting the themes of Faustus with new maturity, and renouncing the anti-divinity stance of his youth. Writers revisit themes in their work, and there is nothing particularly exceptional in this echo, except that it is misinterpreted as a rip-off by Shakespeare of Marlowe, because Shakespeare scholars still stupidly and pigheadedly refuse to accept that the work of

Shakespeare and the work of Marlowe are the output of a single individual, no matter what the stylometric evidence says.

Does peer review crush novel innovation?

I think the answer is absolutely definitely. Peer review quashes science, and generally it is an outdated system that serves no useful purpose. The worst aspects of peer review: 1. It rewards obscurity: the referee is looking for something difficult, and if you are too clear, the paper can be rejected politically because you made it sound too easy. This makes it that scientific publications are always vastly harder to read than they need to be, since clarity only works against you. 2. It punishes honest criticism: If you say X and Y are wrong, and X and Y happen to be referees on any of your future work, you are going to get punished. This produces a bias for conformity in science, which makes it next to impossible to find criticism of anything, no matter how ridiculous. For an outrageous example, the theory that the word "ok" is an acronym for "Old Kinderhook" or "oll korrect", rather than frontier Choctaw, was the pet-theory of a prominent journal editor in the 1960s, so it is now accepted as true, even though there are mountains of evidence against it. 3. It rejects innovation: this is the main problem--- if you are completely original, you didn't cite anybody, which means no one has an incentive to let you publish. Further, you probably said a whole bunch of other people are wrong, and now they are annoyed with you. This is not always true, but it requires some benevolent dictators, like Einstein or Witten, to keep the process working. If something is radically new, you send it to Einstein, and he tells you if it's ok. 4. It allows intellectual theft: If you put up an idea in a non-peer reviewed form, personal conversations, a website, blog, it is likely that the first person to pass peer review with your idea will be credited with the invention, even if there is no significant improvement to the idea other than additional obscurity,

removal of criticism, and some citation to previous work to allow it to pass muster with the editor. In my opinion, there is no point in peer review today--- just put everything up, and allow comments on it, to establish the correctness. This can be automated on a quora-like site, but it requires a focus on science, not so much minutia. The list of things quashed by peer review is enormous. Just in physics, you have quarks, string theory, quasicrystals, cold fusion, and these are just the most egregious cases. In other fields, its 10 times worse.

What are some mind-blowing ways that Probability and Statistics are relevant to the real world?

Here are some mind-blowing predictions (the answers are in a comment, to avoid giving things away): 1. You have a collection of uniform random weights ranging from 1 gram to 1000000 g (1 metric ton), how many do you need so that you are likely to be able to find two disjoint subcollections with equal total weight (possibly leaving some out)? 2. You have two envelopes, and a demon writes down two real numbers in the envelope by some method you don't know. You are given access to whatever random numbers and whatever algorithm, and you can look inside one of the envelopes, but not the other. You can then choose to keep the envelope you looked inside, or you can switch, according to some method. Can you guarantee a better than 50% chance of picking the bigger number? 3. You have a particle diffusing between an enormous number of identical black boxes all touching each other, just hopping from one box to the others, and you don't know where it is. There are also an equal number of white boxes, and you know it's not in any of these. You are allowed to take the black boxes (without looking inside) and separate them so that the particle can't go between the boxes anymore, then touch the boxes

together to each other, and perhaps to some white boxes, and let the particle diffuse until it has equal probability to be found in any of the touching boxes. Then you can split the collection up again and make a new collection, as many times as you want. If you arrange it best, and the number of boxes is very large, with what probability can you transfer the particle into a white box at the end of the process? 4. You make a graph on the integers by putting an edge between each pair of integers with probability 1/1000. You make another graph on by randomly putting an edge between each pair with probability 99.9%. What is the probability that the two graphs are isomorphic, meaning, they are the same graph after relabling the vertices? These each have real-world applications: 1. you have a bunch of gold peices of random weights that you don't control, and you want to produce any given sum. 2. you are asked to predict something you know nothing about, better than chance, 3. You are asked to make a stochastic system behave as close to deterministically as you can. 4. To explain why it is important gives away the answer.

What is the coolest thing DARPA is working on?

By far the coolest, at least until recently, was the SPAWAR LENR experiments, involving Pamela Mosier-Boss and collaborators. This is stretching the question a bit, because a few months ago this happened: Navy Commander Halts SPAWAR LENR Research , now all members of the group are forbidden from doing any more research. LENR is another name for cold fusion. The fact that they are muzzled doesn't stop me from telling you what they did. After Pons and Fleischmann announced their results, many people tried to replicate by running electrolysis. A few were patient enough to see the effect, at Los Alamos, at Bhabha, at McKubre's lab, and at a handful of other places, but most gave up after the politics changed, and MIT made up their mind well before their experiment was concluded. The electrolysis experiments are flaky, and don't always work with regularity, and people were already skeptical for theoretical reasons, because they didn't have any clue how to bridge the gap between chemical and nuclear energy scales. But SPAWAR decided to codeposit Palladium and deuterium from solution directly together onto a cathode, so they didn't need to load metal with deuterium. The nice thing about their experiments is that in the codeposition, the effects were 100% reliable. They saw nuclear processes and heat release with regularity, whenever they did the deposition. Over the next years, Mosier-Boss placed X-ray film next to the cathode, and detected X-ray activity, and CR-39 plastic particle detectors, and detected tracks of charged particles. This evidence allowed the first significant clues as to what was going on. The X-rays were in the KeV range, the emitted particles were always charged, with an occasional multiple MeV neutron that is consistent, but slightly different in energy, than what would be emitted during normal hot fusion producing He3. These experimental clues allowed one to figure out the mechanism. The X-rays and charged particle imply that there are tracks produced by the charged particles in the metal, which means there is an ionization trail of excited shells inside the metal when the nuclear stuff is going on. The process of Auger excitation allows the inner shells to transfer energy to charged particles (usually electrons), but in deuterated metals, the best place to dump the energy of an excited inner shell is in a deuteron, because it is more massive. The Auger deuterons produced by the K-shells then fill up bands, and they have wavefunctions that concentrate near the nuclei at a distance of about 100 fermis from the nucleus (this is the distance of closest approach--- also the radius of the K-shell). This allows ~20KeV deuterons to fuse near the nucleus, and transfer the fusion energy to the nucleus through electrostatic interactions. The result is an alpha particle and a fragmented nucleus moving at 10s of MeV through the lattice, 24 MeV altogether, and all these products are charged, so they just produce heat, occasional transmutations, and lots and lots more holes to keep the reaction going. In order for there to be a self-sustaining reaction, about 1 in 100 deuterons accelerated need to fuse, and this is certainly plausible when there is a strong field to herd the accelerated deuterons onto tips of metal surface, or just if there is a region where there is a lot of fusion. The process is multiplicatively unstable, but it requires an initial seed. The seed is provided by natural radioactivity or cosmic rays, and the absence of a seed might account for some of the irreproducibility. The reproducibility is not so important anymore, because the theory is understood. The signature of the theory is production of elements of mass 1,2,3,4,8,12,16 mass units in trace amounts, from electrostatic disintegration of Pd from the nearby fusion, and equal amount of Pd reduced by mass by the same amount, and an occasional Pd fission into heavier products. These products are going at MeV energies, and this produces completely mysterious +4 +8 +12 transmutations in Pd, as the electrostatic barrier. These mysterious things were all observed by Mizuno in Japan, as detailed on the cold fusion website A library of papers about cold fusion. The fact that there is a plausible theory of the phenomenon means that the rejections were airheaded. The Navy work was instrumental in arriving at this theory (What I mean by that is that I read it, and it gave me confidence the theory is right), and it is a shame that political forces have suppressed it. The funny thing is that the Navy work was published in peer review journals throughout, probably because the editors were too stupid to recognize that this is cold fusion that they are seeing, probably because the system was codeposition, rather than electrolysis.

Theatre: Why are the works of great Elizabethan playwrights such as Christopher Marlowe overlooked?

In the case of authors other than Marlowe, it's because the plays are not of the same caliber as those of Shakespeare--- the writing doesn't rise up to the same level. For Marlowe, this is not true, as at least

Faustus, Edward II, and Hero and Leander, are the equal of nearly anything with Shakespeare's name on it, and in some ways Faustus and Hero can be said to exceed Shakespeare in certain artistic measures of quality, although not in the linguistic sophistication which is characteristic of the later Shakespeare canon. So for Marlowe, and Marlowe alone, it's a complicated story. There are two reasons here, but these must be qualified--- the quality of Marlowe's work is commonly accepted, but what follows is not. The main problem is that Marlowe's work is stylistically so closely reminiscent of Shakespeare, that it is impossible to read without getting a nagging feeling that Shakespeare is a total rip-off. This is especially true if you compare Marlowe to Kyd, Lyly, or Johnson. I personally only read a few pages of Tambourlaine before getting profoundly unsettled, because I immediately recognized Shakespeare's distinctive voice, and I am not alone. Many in the 19th century, when Marlowe's plays resurfaced, suggested that Marlowe was just Shakespeare's pen-name before 1593, the stylistic echoes, even without a quantitative analysis, were just too obvious. By the 1950s, there was a serious Marlovian authorship movement, which ascribed the works of Shakespeare to Marlowe's authorship. This movement was always marginalized, because people refused to believe that such a conspiracy is possible. I would be remiss if I didn't mention that computerized stylometries have only made the case of common authorship stronger, and some, including me, would say it is airtight today. The original stylometry of Mendenhall compared word-length distribution, and to Mendenhall's surprise (he wasn't interested in Marlowe, rather he was checking Bacon, Marlowe was just one of the controls), this stylometry showed that Marlowe agreed with Shakespeare about as well as Shakespeare agreed with himself. This agreement must be qualified in two ways; Mendenhall compared selected works with selected works, the exact quantitative agreement is between later Marlowe, Faustus, The Jew of Malta, The Massacre at Paris, Edward II, and all of Shakespeare's tragedies--- the comedies have a slightly different distribution of word lengths, probably due to the greater number of short prose sentences in the dialog. The agreement is surprising and distinctive, because both graphs show a peak at 4 letter words, meaning that 4 letter words are

more common than 3 letter words, something that is not true of any contemporaries or of nearly any other writer at any other time. Mendenhall's stylometry could not be definitive by itself because the prior confidence in common authorship was so low, essentially nobody before Mendenhall seriously proposed the works were written by one person. But now this is a well-known idea, and modern stylometries continue to confuse the two authors. After Mendenhall, people looked hard for stylometries that separate Shakespeare from Marlowe, this was a famous test-case for the stylometric method, and they found some---- run on line and feminine endings are more common in Shakespeare, so are enjambments. These stylometries were analyzed using the estimated date of the Shakespeare plays by Peter Farey, and he found, to my great surprise, that none of these stylometries are consistent across Shakespeare's career, that all of them have a drift with time, and if you plot the stylometric signature with time, Marlowe fits exactly on the extrapolation of the curve to years before 1593! Further, none of them is conclusive in separating the earliest Shakepeare from the latest Marlowe. This puts stylometry in the unprecedented position of being completely unable to distinguish the two authors by any quantitative metric. Some of the stylometries are ridiculously formal--- like counting the number of times the letter "e" is used versus the number of times the letter "x" is used--- in all cases where you can draw a graph, the stylometry, where it is consistent for the author, makes a smooth curve, and places Marlowe and Shakespeare on the same curve. These are ridiculously implausible coincidences considering that these stylometries are impossible to consciously fake. Further stylometries were examined by Charniak et al, and these were based on rare vocabulary and the use of function workds, like "the", "is". The stylometries compared a dozen authors, and excluded one play at a time, then tried to assign authorship based on best match to the list. It was 100% accurate on everybody except Marlowe and Shakespeare (I must qualify this--- if you read the paper, you will see two failures among the 40 or so plays, in both cases in disputed works "The Case is Altered", and another one, but these are historically extremely uncertain authorship, and I am sure their program gets it right, the historical guess of authorship is just wrong).

The vocabulary stylometry confused all of Marlowe's work, with the exception of Tambourlaine I and II and "The Massacre at Paris" with Shakespeare. Tambourlaine I and II are clear outliers, because they are comparing these to each other--- the method is "exclude one and compare to the rest", so the fact that these are classified as Marlowe is not at all surprising. The four remaining works, Dido, Faustus, Jew of Malta, Edward II were identified as Early Shakespeare, except for "The Jew of Malta", which was identified for some reason as "Late Shakespeare" (this is kind of funny considering the date, there must be a lot of coincidence in the vocabulary of Jew which matches some late works). Among the Shakespeare works, the vocabulary of Henry IV identifies the play as Marlowe's. This is very significant, because the method excludes one play and matches to the remaining corpus, and Shakespeare has a lot more words, so it is much easier to identify as Shakespeare than it is to identify as Marlowe. Henry IV (along with Richard III, Titus Andronicus, and other plays) have long been considered of clear Marlovian influence, if not co-authorship by mainstream scholars. The function-word stylometry confused the same plays as Early Shakespeare too! This means that not only does the vocabulary match, the function words match in the same way, meaning the sentence structure is the same. This is completely ridiculous--- two new stylometries, specially constructed to resolve the authorship dispute between Marlowe and Shakespeare, not only failed to resolve the dispute, they confused Marlowe and Shakespeare more definitively than Mendenhall's. Under these circumstances, I am willing to say that it is pretty certain the two authors are the same, and the Marlovian idea is just established to be true with some scientific confidence. I would put it at 4-5 sigma, meaning 99.99% likely, but my prior on this was around 50/50. If your prior on this is that it is only 1% likely, perhaps you would only end up at 2.5 sigma confidence, meaning 99% certainty. If your prior is that it is .01% likely, then you end up at only 50% confidence. But how the heck can you end up with a prior of .01% from historical evidence? Since I feel the stylometry is definitive, so that Marlowe wrote the work, one can explain why Marlowe's work is neglected. It was purposely suppressed so that Shakespeare could become the well-respected national author without

Marlowe baggage holding him down. This brings me to the second reason Marlowe is neglected. This is Faustus, which is a dark, semi-satanic work, which is embedded in a corpus that is very heretical, rather violent, and has anti-semitic and homosexual themed stuff that made it difficult to conform to mainstream Christian culture. Marlowe's work was suppressed until the 19th century, it wasn't even circulating in any serious way, until people took an interest in other playwrights of the Elizebethan era. Marlowe's work is more modern in a certain sense, because it is completely unbeholden to traditional authority or ethical structures imposed by state and church. The Shakespeare canon is much more conformist in this sense, although it is just as non-dogmatic and just as pagan influenced as Marlowe. But Marlowe's work goes out further into the modern era, it is more 20th century taboo busting style, and for this reason, many people consider it the equal of Shakespeare (or, rather, later Marlowe), or even greater than the later stuff because it is more forward looking. But in terms of literary sophistication, Shakespeare's canon is greater than Marlowe's. Further, it is clear from the Sonnets, reading them within the Marlovian framework, that Marlowe is no longer the wild-eyed youthful heretic once he is exiled, and he willingly agrees to allow his work to become national literature, and not be held down by the heretical blasphemous violent works of his youth. Because of this dynamic, Marlowe's actual plays were not even registered and published except posthumously. It is not clear when exactly Marlowe died, but I would guess it was between 1624 and 1630. It should be around 1624, because this is when the folio comes out with Shakespeare's work on it, including new plays not seen in 1616 (when the Stratford Shakespeare died), and revisions to old plays which are considered definitive, and definitely look like they were made past 1616. It can't be too far after that, because there are no more plays. So I would guess Marlowe died in 1624. But he might have had a lingering diseases, or a long retirement, so 1630. Most of Marlowe's plays are only registered under his name after this point, and my guess is that it's probably because the author didn't want that early crap floating around, he was a little embarassed by it, and worried it would cost him his literary immortality.

What is the most frustrating thing about being a scientist?

The most frustrating thing is the politics. There are situations where you are expected to state and believe obvious falsehoods in order to get published. If it were not so, science would be a blast. But as it is, you are expected to state at least one thing you personally know to be false as a precondition on getting a PhD in any field. I think it is better to starve to death. I can state a few of these political lies you have to go along with: 1. In theoretical physics, at least in high energy physics for the past decade, you were supposed to pretend that large extra dimensions were theoretically possible. This was not only sold to scientists (although, thankfully in Europe they didn't buy it), it was sold to the general public too, by Brian Green. The extra dimensions of string theory cannot be large, as this implies a low Planck scale, and this is excluded by simple renormalizability estimates: neutrino masses, strong CP, electroweak corrections, and proton decay (although the last can be fixed, but only at the cost of crazy electroweak running at a lower scale, running which is experimentally excluded). This was clear to everyone in 1999, but the politics stacked up in favor of large extra dimensions, because it gave string theorists something to do. This is the worst political contamination of theoretical physics in a century. It was a complete travesty, and the people involved sold their souls for tenure, and I am glad I am not one of them. 2. In experimental physics, for the past two decades, you could not say that cold fusion is an actual phenomenon, despite undeniable and mounting evidence. This was a clear political coup: within 2 months of the initial announcement, before there was time for replications, all the experimental groups that saw nuclear reactions were tarred and feathered. If all those that did the tarring and feathering were themselves tarred and feathered, it would be good for

the field. To be specific, John Huizenga, Richard Garwin, Steven Koonin, these folks should not be doing science. It's not just that they were wrong, it's that Galileo gave them the telescope, and they refused to look through it, because they already knew what they were supposed to see. It's good to have a scientific surprise like this, because it exposes the idiots. 3. In geology, you are not allowed to say that there is absolutely no evidence that fossil fuels are actually fossils, or have anything to do with surface biology, and the evidence in the other direction is conclusive. Oil, coal, and natural gas are produced in the deep Earth from primordial carbon left over from the Earth's formation, not from living things. You can see this just from the chemistry--- animals are sugar--- carbon plus water, they are oxidized. They are proteins, carbon plus Nitrogen. It is only the lipid parts that are hydrocarbon. There is no path of molecular deoxidation for these which ends in oil, but there is a path for dehydrogenation of deep-produced hydrocarbons into longer chains, and finally into coal. This was discovered in the Soviet Union in the 1950s, this theoretical insight played a major role in allowing the Soviets to become the worlds largest producer of oil, since they were willing to dig for oil in places like bedrock, where other nations were not because fossils couldn't get down there. Modern Russia and Ukraine still accept the abiogenic idea of course, but you are not allowed to mention it in the US, because it has been dogmatically and moronically rejected by too many powerful people. The evidence for abiogenic oil was compiled by the late Thomas Gold, who was able to explain the last mystery, the contamination of oil with biological residues, by deep Earth bacteria, the "deep hot biosphere". The deep biosphere and the abiogenic origin of methane are both accepted now, because people had no choice--- archaea are real and the methane seeping out of continental plates was clearly abiogenic, there was way too much of it. But the "fossil fuel" idea is still in textbooks and articles, it just can't be challenged. This is unacceptable. 4. Modern Synthesis Evolution: Modern synthesis says that genes evolve in population genetics fasion through SNPs and small random mutations, and then the best allele fixates, and that's evolution, there's nothing else. The modern synthesis is clearly false since the evolution rates in this picture go to zero quickly as genes

find their local minimum stable point, so this type of random-walk evolution can't reproduce the type of ongoing creative network-level creative modifications we see in natural evolution. This was already clear to Pauli in the 1950s, and to many religious folks, who keep challenging this because they can't believe that such a dumb process works to produce such intricate molecular networks with such definite function. While the dumb process doesn't work, so they are right in this regard, it is wrong to make up supernatural explanations when there is a perfectly sensible natural explanation. In particular, the intelligent design obvious in the genome is clearly due to intelligent RNA mediated computation rather than to some supernatural intervention. The case that random SNP mutation plus natural selection doesn't work to produce evolution, that RNA computation is required, is made clearly by a Leslie Valiant, in his 2011 Turing award lecture: The Turing Lecture . I won't repeat his points, but I will say that less precise versions of his argument were made by other people too, but fell on deaf ears. 5. Neural net brain: Distributed neural net computation cannot be the way the brain works, as it confuses the parallel communication overhead with the bulk of the computation, and the cost per bit for neural net computation is ridiculous. It doesn't account for short term memory, and it can't account for instinctive algorithms or memories. It is theoretically obvious that the source of computation in the brain is intracellular, it is the same networked RNA computation that is required for germ-line evolution, although in a different place, not in the nucleus, but in dendrites and cell-body axon-stems. One can see this from simple memory and processing considerations, but this is just not accepted by neuroscientists, even as a plausible hypothesis. 6. Endoretroviruses are frozen germ-cell infections: This is a load of hokum, as it is incompatible with the known function of some of these ERVs, for example, a HERV coat protein is used to bind the placenta to the embryo, so people say, with no further evidence, that an ancient viral infection led to placental mammals. This idea that these are frozen infections is kind of silly, a retrovirally infected egg is not going to produce offspring, let alone find a way to produce these proteins in a network to create new functions. This hypothesis is also clearly incompatible with the sheer

amount of retrotransposons in the genome and thei functional relevance. It is more likely that viruses come from ERVs, rather than the other way around. You can't even suggest this to (senior) virologists, they don't listen, since they have read about "frozen viruses" too many times. 7. Fever kills germs: I believe the role of fever is to speed up RNA computation in immune cells, since RNA has a phase transition at around 40 degrees, and the complimentary binding is the source of the data-recognition in the computation. But regardless if this is true, the idea that fever affects the bacteria is kind of nutty, since these creatures live in the real world with a much larger range of temperature variations. It makes a little more sense for viruses, since fever can disrupt viral replication, but not really, because the virus acts through transcription and translation, which is not as sensitive to detailed temperature as large networks of interacting RNA networks. The default hypothesis should be that the thermoregulation of RNA networks, but it isn't, probably because nobody suggested it before now. I believe that this is also the reason that birds and mammals thermoregulate to around 40 degrees. 8. In linguistics, you were not allowed to say that Chomsky's idea of recursion being ancient and universal is just wrong. This is clear now, from Everett's work on Piraha, but it was clear since the 1970s at least, because the native Australian and American languages were deficient in recursive structures. The modern realization that linguistic recursion is an old-world thing, that it started in Greece and spread horizontally from language to language, is something that is still not universally accepted, due to the politics. The politics are due to the fact that Schutzenberger and Chomsky's idea of stack grammar describing modern Greek-style language recursion is true, and this also was politically rejected for a long time, so the politics went both ways here. This political nonsense is both the worst and best thing about science. As Mark Twain said, what gets us in trouble is not the things we don't know, but the things we know that just ain't so. Each of these things are things that just ain't so. But since it is easy enough to explain why today on public websites, they have no chance of surviving. So this presents an opportunity for progress, since you don't have to kowtow to the politicians, you can beat them. Since they can do the political

calculation and see they can't win, there is a potential for a complete revolution in science, made possible by public honest disclosure and open criticism and debate that fora such as this one provide.

Is the movie Anonymous based on a plausible interpretation of history? What are the best arguments for and against the theory that Shakespeare's plays and sonnets were written by Edward de Vere, 17th Earl of Oxford?

No, Anonymous is not plausible, because DeVere dies in 1604, before the source for the Tempest is available. In addition, it has to be someone wandering around Italy and Spain, because this is where the almost certainly untranslated source material for the plays come from. The authorship question is completely settled today, but nobody seems to have noticed. The modern computer stylometries are unequivocal in confusing the works of Marlowe and Shakespeare in many different ways. The easiest way to check for yourself is using Mendenhall's stylometry, which is the frequency of 2 letter, 3 letter, 4 letter , 5 letter words. In both Shakespeare tragedies and later Marlowe works, you find the exact same distribution, including an odd feature of 4 letter works being more common than 3 letter words. This stylometry is not conclusive by itself, but there are later stylometries which look at the distribution of function words and rare vocabulary. These assign Marlowe's work in nearly its entirety (exclusing the distinctive "Massacre at Paris") to the same author as Shakespeare. Having three separate stylometries confuse two authors is unheard of, it has never happened before, and it gives strong confidence, perhaps certainty, although this is possibly still debatable at this point, to the conclusion that Marlowe's work is by the same author as Shakepeare's work. The

only reasonable conclusion from this is that Marlowe is alive in 1593-1624 (past Shakespeare's death), writing these plays. This is consistent with the existing historical evidence, which is more friendly to the idea that Marlowe faked his death to avoid execution than to the idea that he was murdered or died in a fight. But it doesn't matter--- the stylometric evidence in the plays is evidence enough for me that Marlowe wrote them, because there is no serious dispute that Marlowe wrote his own stuff. Given the to my mind undisputable fact that Marlowe's work and Shakespeare are authored by the same person, it is ridiculous to ascribe the works to another author. The attempts to do so are simply smoke-screens from Marlowe, at least since Marlovian ideas became mainstream in the 1950s, and there is no point in talking about them further. The modern Marlovian case is made stylometrically convincing by Peter Farey, and is made airtight to my mind by Charniak et al's stylometric comparison of authors from the era. Their method confuses Marlowe and Shakespeare consistently across two different methodologies with completely different statistial tests. You have to be blinded by authority to deny this evidence, or mathematically illiterate, and unfortunately this described nearly all academic Shakespeare scholars.

How would one begin self-studying Shakespeare? Start with the tragedies? Comedies? Sonnets? Chronologically? Suggestions for outside reading?

No matter what you claim to think about the authorship, the way to start with Shakespeare is to read Marlowe. He develops the style, and unlike the later Shakespeare works, you can see the development of the style step by step. It also is more immediately accessible. I would

see a staging of Faustus, which is available online, and then you can understand all the later material. Faustus is explicitly anti-clerical, and explicitly occult and pagan. The later stuff is more muted in these sentiments, and renounces the more bombastic early stance of the Marlowe era.

How would today's world be different if William Shakespeare had never been born?

Usually hypothetical questions are difficult, but in this case it's easy. If Shakespeare the man had never been born, someone else of the same approximate age and qualifications would have fronted the exiled Marlowe, and the literature would be published under another name. The person would likely have been just as much an upstanding citizen, and just as much a petty burgher, and just as unconcerned with their literary merit. It would probably have been another actor at the same company, who would have been made just as wealthy by the front act, and would have had a similar low profile. But perhaps it would have been easier to discover the subterfuge, it would not have required modern computers and modern stylometry.

British Literature: Are literary scholars agreed on the legitimacy of the Shakespeare authorship question?

Academics are generally united on this issue, they believe Shakespeare wrote Shakespeare. There are just as united as they were regarding

geocentrism and phlogiston, and they are just as wrong. This is the Copernican revolution of English literature, made possible by the internet. While previous generations were left to argue using circumstantial evidence, and guess at the answer, we are lucky because we have stylometry. The author is Christopher Marlowe. Shakespeare's plays have a distinctive style, and we find the author which matches this style, and by quantitating the match, you get certainty. It's done, and Shakespeare scholars, you're just cooked. In my opinion, the latest stylometries have raised the certainty to close to the 5 sigma confidence one requires for scientific certainty. I was 70-80% sure before the latest stuff came out, having looked at Peter Farey's stylometries, and having read Marlowe and Shakespeare, and compared them myself. There is no way to tell late Marlowe (Edward II, Jew of Malta) from early Shakespeare (Richard III, Merchant of Venice, Titus Andronicus), and the qualitative match is confirmed by statistical tests--- they are the same person with as near to scientific certainty as stylometry can provide, and more certainty the more stylometries you use. Stylometry is stuff like counting the number of "if"s and "and"s in a work and dividing by the number of "is" and "or". This stuff is not consciously controlled, and it generally identified authors with certainty. I think that the only reason this is not more widely advertized is because stylometry fails to distinguish Marlowe from Shakespeare, and this bothered people who thought they were different. The reason it didn't work is only because they are the same person. Christopher Marlowe has a shady story: he supposedly died in a knife fight in 1593, a week or two after he is arrested for atheism and counterfeiting, and is threatened with certain execution. He and three associates of his patron rent a private residence near the sea, they talk about something for 8 hours violating Marlowe's parole conditions in the process, then he is supposed to have grabbed Ingram Fritzer's knife and tried to stab him, and then Fritzer grabbed Marlowe's hand and stabbed him in the eye, and Marlowe died instantly. The inquest was held the next day (we have the document), and it is a shady thing--- the coroner is the queen's coroner, not the local coroner, the body is mangled in the face, and the only witnesses are the three men with Marlowe. Marlowe is declared

dead, his body is thrown into an unmarked grave, possibly a mass plague grave, and the atheism case against him is closed due to him being dead, which puts a bit of a damper on the prosecution. A few weeks later, Shakespeare starts to put his name on writing for the first time. He registers the anonymous "Venus and Adonis", a poem in Marlowe's style. This is the first of a series of blatant rip-offs of Marlowe by Shakespeare, rip-offs that are so good, they are better than the original. "Venus and Adonis" is inspired by Marlowe's unpublished "Hero and Leander". Then more Marlowe-souding works come out with the name Shakespeare on them, and these are all set in Italy. They read just like Marlowe, only a little better, they have the same pacing, characterizations, and themes, except with a load more maturity and experience. Two Gentleman of Verona, Romeo and Juliet, The Merchant of Venice. The last of these is a rewrite of Marlowe's "The Jew of Malta", fixing that flawed play. The rest are full of Marlowe echoes. There's also Titus Andronicus, Richard III, Henry IV part 1, which lots of people said must be due in part to Marlowe, because they are unmistakably in his voice. This is mainstream folks here. This front business keeps going for decades, until 1616, when Shakespeare dies. But it doesn't stop there---Shakespeare's folio comes out in 1624, with lots of new work appearing for the first time, at least in historical documents that survive. Further, there are revisions to works that appear in earlier quartos, revisions which scholars take as definitive, because they are better than the quarto stuff. So it looks like the author is still alive in 1624, although not certainly, because the documents don't all survive. This kind of thing is historical evidence, and it's hard to be certain. The clear hypothesis to test is then that Marlowe faked his death to avoid execution, and fled to Italy, and kept on writing with Shakespeare putting his name on the finished works. This is a perfectly reasonable thing, similar stuff happened in the 1950s during the McCarthy era. Dalton Trumbo was blacklisted, and his front won the Oscar for Roman Holiday. One is simply saying this happened in 1593. The source for the Tempest appears in Spain in 1600 or so, and is not translated to English. Marlowe was fluent in Spanish, Italian, French, and Latin, and Shakespeare wasn't. The source for the

Tempest is strong evidence that Shakespeare did not write the Tempest, and that someone living in Spain did. There are vague references to Marlowe in Europe, and Shakespeare's sonnets, in their natural interpretation, tell us of a disgraced author in exile. The best way to test authorship is using stylometry. The stylometric evidence is by comparing the plays to other candidate authors. This comparison fails abysmally for Bacon, DeVere, and all other candidates, ruling them out with scientific certainty. Done with all those. The first person to do the stylometric comparison was Mendenhall, and among his controls for checking Bacon and disproving Bacon, Mendenhall had Marlowe. So here's this control, and it turned out the control was ndistinguishable from Shakespeare! Mendenhall makes a big deal out of this, and he clearly thinks he discovered the author. This was the first time it became clear that Marlowe wrote the plays, or at least that both the Shakespeare and Marlowe plays were written by one person. The history is unambiguous about Marlowe's work being Marlowe's. Mendenhall's stylometry is pretty good--- he counted the lengths of words, the relative frequency of 4 letter words, 3 letter words, and so on. The result is a fingerprint of the author, and it's high enough dimension to distinguish two voices, and it's easy enough to do the comparison by eye without computers. The evidence that Marlowe wrote the plays is made much more certain by modern stylometries, which are summarized on Peter Farey's Marlowe page (Peter Farey's Marlowe Page), and in a recent paper Neal Fox, Omran Ehmoda and Eugene Charniak, Statistical Stylometries and the Shakespeare Authorship Debate. Regarding the last paper, you have to actually read the contents, not the intro and conclusion, to see that the stylometries confuse Marlowe and Shakespeare in damning ways. The authors backpedal and fudge their data by making up new methods to hide the obvious conclusion (don't take my word for it, read the paper). This wasn't suggested earlier simply because people didn't know Marlowe's stuff so well--- it was suppressed for most of the 18th century, surfacing in the 19th century, as more taboo authors became more accepted. Marlowe's "Faustus" which was controversial due to it's satanic heavy-metal freemason style story, made the author heretical and unacceptable to the church. It is probably to fight this

stain that Marlowe never wanted his name on the later works. He wanted his immortality, and he knew Faustus put it in danger. His later work, published with Shakespeare as a front, is just as atheistic, and just as pagan-inspired (look at Midsummer's Night Dream, or The Tempest), but it is not openly critical of the church, and it doesn't feel like a dog-collar wearing studded heavy-eyeliner teenager's diary anymore. I already accepted Marlovian authorship many years ago, so I don't bother with evidence anymore. It's now just become another self-evident truth that is denied by authority figures, and one just has to ignore those idiots and get on with understanding the implications. The implications for Shakespeare scholarship are rather enormous, despite the superficial idea that the works can be read without knowing the author. The reason the author is important, is because here you have an author with a sharp transition in his life story, at the age of 29, at the peak of his career, from a celebrated enfant-terrible to a sad man with no friends, no associations, wandering from country to country, exiled in continental Europe, having to hide his authorship of works of exquisite genius. This sadness is the sadness of Hamlet, it's the sadness in King Lear, it's the mature sadness in the later plays, it contrasts with the exuberance in the early plays, where Marlowe portrays characters that sit on top of the world, scheming in individualistic self-emancipation, like Tambourlaine, or Barabas. The transformation is not just maturity, it is also a capitulation to secular and spiritual authority, a submission to the divine order, and a humble repentance for the sins of his youth. It's the submission of Katherine in Taming of the Shrew, which is easy enough to read as an allegory for Marlowe. One can't read Taming of the Shrew as a sexist rant when you understand that the author sees himself as Katherine. The plot to get her to accept that the sun is the moon is an allegory of the plot to get Marlowe to accept the authority of Church, which asks him to believe more impossible things, it is the plot to force him to accept the authority of the English state, and make him a servant of these orders, rather than lashing out in complete individualist freedom, as he did in his youth. So, when writing with Shakespeare as front, he becomes the national poet, while in his youth, he's just a censored overly dark satanic tinged writer with severe empathy problems and unsubtle

overly violent antisemtism. There is a nice essay on the framing story of Taming of the Shrew, by the Marlovian scholar A.D Wright (it was she who got Peter Farey up to speed) which unlike the body, is a not-so-subtle description of the author's fate. You can read her work here: A.D. Wraight Helm II . Shakespeare the man is a nice front man, because he's a totally bourgeoise character. That's why people like him to be the author, despite this being totally ridiculous, even absent the knowledge that Marlowe wrote the stuff. Shakespeare doesn't speak the languages of the source material, he has no evidence of schooling and is not clearly literate, his daughters and granddaughters are clearly illiterate, he doesn't leave any books in his will, no books of his provenance are found a century later despite books being expensive and despite a diligent search, he is recalled by his living granddaughter as not being a man of letters, he appears fully formed, without immature works, and he is ripping off Marlowe left and right, without any shame, and in a way that no other writer has ever ripped off another, even ones with similar style. But what he is, is a successful businessman. He gets rich as an actor staging the plays with his name on it, and he gets lots of money to go to the countryside and stay in low-profile. It should be noted that he didn't just put his name on Marlowe works--- there are many other works with Shakespeare's name on them that are clearly not by the same person that wrote Macbeth, These other plays are possibly Shakespeare expanding his front business, as other fronts did in the McCarthy era--- several fronted for more than one suppressed writer. People love the fact that Shakespeare the man was such an ordinary guy. He was so normal, he didn't have any problem doing business stuff, he didn't mind suing people, he didn't mind hoarding grain, or engaging in usury, or being a total oaf. He was so normal, not at all the flaky artist-type, but a solid no-nonsense businessman who put pen to paper to maximize profit from the play, not due to spiritual guidance. He was a commercial guy, they say. Not an soul-tortured artist. This horrifying lie is just the bourgeoisie's way of mocking artists, pretending that commercial motivations can produce masterpieces. They can't. I sometimes fantasize that this is an open secret among Shakespeare scholars, because it is so obvious once you've got even passing

acquaintance with the writers of the era. So I imagine they can't be so stupid. I imagine them secretly getting together in rooms filled with cigar smoke, slapping their knee, and saying "What a gas! They still buy that Shakespeare bloke!" But the sad truth is that the Shakespeare scholars are probably just as stupid in private as they are in public. You can read further about this here: http://skeptics.stackexchange.co...

How would the world be different if everyone was a genius? How would good and evil change and what role would that play in the human condition? What changes in human behavior can be expected? Would technology have developed differently?

Genius is not a property of a person, it's a property of the things that they do. It means a great deal of originality plus an impact due to fitting in with the greater story they are a part of. Aside from doing the genius thing, there is nothing otherwise special about that person. People generally think that there is some sort of "capacity" for doing something new, which is absolutely demented. If you have a normal brain and some time on your hands, you're about as qualified to discover General Relativity as Einstein, or to do whatever else. You just have to sit down and force yourself to do it, especially when it becomes hard. And that takes thousands of hours of single-minded effort, and it requires a sense of what exactly needs to be done, and it requires tolerance of a great deal of failure along the way, without taking this as an indication that you are somehow defective. So we already live in this world you think is so improbable. Everone around

you is roughly as competent as the best people at about any intellectual task, at least if they avoid hard drugs, aren't handicapped in some obvious way, and weren't raised by wolves.

What are some unsolved problems in mathematics?

Nearly all real numbers are normal, meaning all the digits in their expansion are equally frequent. But not a single one of the ordinary numbers, pi, e, sqrt(2), have been proved normal. I think this is the major unsolved problem of mathematics, and it is considered so difficult, that nobody works on it. It might not be difficult at all.

What are some unsolved problems in math that seem easy at first glance (e.g., the Collatz conjecture)?

This is the most maddening example: consider any reasonable transcendental function, exp(x), sin(x), sin(x)+exp(x)+sqrt(x), whatever you want. then its value at all algebraic integers (excluding a tiny finite set of points where the function is rational) is clearly going to be normal, meaning all the digits in its expansion base 10 (or in any other base) are equally likely eventually. This is also true of square root of 2, of pi, of Euler's constant, of all algebraic irrational values, of everything really, except for certain sequences which are specially made to be counterexamples. But not a single value of anything has been proved normal! The only numbers which have been proved

normal are either uncomputable sequences like Chaitin's number, or specially constructed examples like the number .12345678910111213 which is made up just to be normal. This is not a tolerable situation, the facts are too obvious. I think this is the central issue in modern mathematics, that certain statistical facts become obvious from experience, and providing a rigorous proof for these facts is just not clear, because the method by which we acquire certainty of these is not the same as any method by which we would prove it. The Collatz conjecture belongs in this class, it is clear statistically that 3n+1/2 produces on average an equal number of even and odd numbers for large enough odd n. If we had a general way to turn statistical arguments into proofs, even if it only worked 1% of the time, it would solve most of the hardest conjectures. This is how most conjectures are made--- you notice statistical regularities in calculations that you just can't prove, because the statistics is only true of "most cases", and you want to prove it in one special case.

What was your mathematical wall where you just couldn’t understand the concept?

There is no "mathematical wall", this concept is faulty, mathematics is easy because it is precise and rigorous, so you can internalize it without limit, depending only on your time-commitment and preparation. But it is true that there is the experience of a mathematical wall, and this is always just a product of bad pedagogy, usually a bad presentation in textbooks or lectures by authors who misunderstand the idea, and so present it with a wrong philosophy. In this case, you can follow the steps one by one, but the reason behind these steps, the motivation, becomes obscure. At this point, you will hit a wall, it is only a matter of time, because there are only so many unmotivated steps you can memorize. The number of motivated steps you can understand is essentially infinite. The original author always

has the right motivation, because they came up with it, so they must have been properly motivated. So the solution to any mathematical wall is to read the original literature, and literature from around the time period. Sometimes you find that the original literature is obscure regarding the motivation too. This is almost always an indication that it isn't really the original literature regarding this, but there is prior work you need to learn. So you keep looking at literature, until you find someone who does understand it, motivation and all. It's easy today, because the articles are avialable online, and there are motivations and examples for all the elementary stuff online somewhere. The original literature is better, because the secondary authors sometimes only understand the steps, and write those up, without understanding the motivating philosophy at all. There are good secondary sources, but good luck finding them if you don't already know the stuff. It helps to read famous people, because usually they got famous for doing something, and this means they know how important proper motivation is. I have hit many "walls" in the past which were completely surmounted when I read the original literature, or even just old books with some repeating of the original motivation. So you can hit a wall in algebraic topology if you don't know combinatorial simplicial complexes, you can hit a wall in analysis or point-set topology if you don't know enough set theory and forcing to make sense of the nonsense, you can hit a wall anywhere, even in arithmetic. The solution is simply to read another presentation, closer to the original discovery, until the wall melts.

Who was most ahead of their time?

The person most ahead of his time, in all time, was certainly Archimedes. Nobody else even comes close. He discovered a form of integral calculus in the second century BC, described in the manuscript of the method of mechanical theorems. He explained the

method to colleages, and used it to calculate the volume of the sphere and cylinder, and also proved these results rigorously, but still, nobody extended it, or even fully understood it for the following centuries. His results and theorems on this were reproduced, sometimes in verbatim copies, by Cavalieri in the 16-7th century. Kepler also describes the two-cylinder volume problem in his work, something solved by Archimedes. So you can see that he was exactly 1800 years ahead, and with documented evidence. The other folks are Aristarchus, and Appolonius. Aristarchus had the heliocentric model, and I strongly suspect that Appolonius had elliptical planetary orbits. One can't be positive about Appolonius, but if it is true, he is equal to Archimedes in this respect. The evidence for Appolonius having elliptical orbits is Ptolmey. He reports that the deferent/epicycle/equant system is due to Appolonius, and that Appolonius uses it as an Earth centered approximation to something else (which is obviously a reference to the censored heliocentric model). This allows you to conclude that Appolonius had off-centered circular orbits, with the sun at the center, and with some sort of equal area law. This was Kepler's preliminary model. But it is a slight leap from this to an ellipse, and it is possible that Appolonius made this leap, since he started in Astronomy, and ended up studying conic sections for reasons he doesn't disclose. He knew all about the ellipse, and the distance between the off-center circle and the ellipse is miniscule. Both would generated equant/deferent/epicycle models of the same quality. The fact that Ptolmey ripped off heliocentrists to keep their fit to the data but reject their principles is telling. This is the kind of stupidity that made such a huge gap between the ancient discoveries and their modern rediscoveries. If you allow apochryphal stuff, there's democritus. His arguments for atoms were reportedly sharp phase transitions and the random motion of small particles, things that were only shown to be a consequence of atomism in the early 20th century. But here one isn't even as sure as in the case of Appolonius, while for Archimedes, the discoveries are certain, because we have the text.

What are some examples of mathematical theorems that were commonly accepted at one point but have since been shown to be false?

There is only one real example here, the clarification of the concept of set produced by the method of forcing. This showed that the following theorems, which are true in the standard axiomatization, are false in a very precise and literal sense, they produce objects which can be consistently excluded in other axiomatizations which agree on the result of all computations. That means that these theorems assert the existence of objects which are at the same time impossible to demonstrate in any concrete form and are consistent to reject. When you have a theorem that tells you that a certain object exists, you expect that the object exists, so that if you deny that it exists, you'll get into trouble in some literal, computational, sense. Cohen showed that these theorem can be denied without contradiction with any computation, so that whether you believe them or not is up to you. But for theorems that assert the existence of something, being free to deny the existence of this thing is tantamount to a refutation. So these existence proofs were simply refuted by Paul Cohen, and this coup was carried out without showing any problem with the proof, rather by showing problems with the axiomatic conception underlying the proof. Here are the theorems that used to be true but are now either dubious or false (depending on who you ask), They are still true in standard axiomatizations, of course: * The real numbers (or any other set) can be well ordered. This theorem was proved in axiomatic set theory around the turn of the 20th century, and was considered just plain true until 1963. In 1963, Paul Cohen demonstrated that starting with any model in which this is true, one could easily add new symbols for new real numbers which make this statement false. So it's status becomes nebulous. I would consider it obviously false, but most mathematicians just relegate it to the category of neither false nor true, rather, false or true according to convenience, and according to which model you feel like looking at. This category is always present

when you consider models of set theories with uncountable collections as large as the real numbers or larger. The method was sufficiently general and sufficiently independent of the axiomatization to show that it is always better to think of the result as false, at least when you are considering the idealization of the collection of all real numbers, rather than some specific model of the real numbers in some specific set theory. So that today, we know that there is no way to produce a well ordering of the reals by any procedure, nor to define what it means to have a well ordering of the real numbers using any method that can be evaluated on more than a countable subset of the reals. * There exists a non-measurable set This was also a theorem, and again, Cohen's method allowed Solovay to show that it was not true in any reasonable meaning of the word "true", as applied to the collection of all real numbers. This example subsumed the previous one, because if the reals are well orderable, then they have a nonmeasurable set. The sets which you produce which are non-measurable, when interpreted in a specific model, like Godel's L, are really measure zero in this view, because the well-orderable parts of the real number are always little dinky measure zero peices, and ultimately, in the objective computational sense, countable pieces. There are many consequences of this theorem which are either true or false according to how you decide to make a model of set theory: * You can cut up the sphere into a finite number of parts and rearrange them by rotation and translation into a sphere of twice the size. This is false when every subset of R is measurable, I consider it false. It is a theorem that every part of the sphere that can be defined in any reasonable sense has measure, only if you start doing induction on the reals can you partition the sphere in this way. * Every vector space has a basis this is false when every subset of R is measurable, I consider it false. * The double-dual of an infinite vector space is always larger than the vector space. This is surprisingly false for the example of the vector space of infinite terminating sequences when every subset of R is measurable. * The dual of L_p is L_q for all but one pair of dual values p and q. When every subset is measurable, it's true for all dual pairs, even L_0 and L_infty. In standard axiomatizations, it's not true for that pair. * There exists a nonprincipal ultrafilter on the integers false when every subset is measurable. In addition to these theorems, which, if you are honest, were simply overturned by Paul Cohen, there were proposed axioms or higher constructions which were shown to be inconsistent, or incongruent with intuition. * The existence of an elementary embedding from the set theoretic universe to itself. This was shown to be inconsistent with the axiom of choice by Kunen. Whether it is consistent in schemes without choice, like in the measurable universe is an open question. This was a proposed axiom, so it was really a conjecture that it was consistent, and this conjecture was disproved. So I don't think it counts as an example. The forcing examples are the only real examples.

Why is dy/dx = (dy/du)(du/dx) an insufficient proof of the Chain Rule? A more rigorous proof is needed, since du can't equal 0. But if both du's approach 0 at the same rate since they're the same quantity, what's the problem with canceling them?

du can be zero if the function u does not depend on x. In this special case, the cancellation is a little obscure. But you are right, this is a fine sketch of a proof, it is made rigorous very easily, and it is not gong to go wrong. The symbols "dy", "du" are infinitesimals, they are thought of as quantities which represent the infinitesimal change in a function when you make an infinitesimal change in the argument. This is the original interpretation, and Abraham Robinson showed that it can be just as easily made rigorous as standard calculus (in fact, it's a little easier in some respects). The nonstandard analysis is made obscure today, because people pretend it has something to do with ultrafilters,

which is nonsense--- you only use such things to embed the nonstandard models inside standard models. The original construction is much easier--- you just add the axioms: I have a real number q. q is not zero. q is less than 1/2, q is less than 1/3. q is less than 1/4, ... and so on. Any finite number of these axioms is consistent, so the infinite collection is consistent, and describes a real number system with an adjoined infinitesimal. This is what is called a conservative extension, meaning this new model of the real numbers is indistinguishable from the standard model without q, at least in terms of the properties you can write down as predicates. Every property is the same as for the usual real numbers, you just have a new symbol there. The only thing the new symbol does is to allow you to make formal infiniteismal quantities. Now you have a standard model inside the q model, and define a projection from the nonstandard numbers to the usual ones. This defines the map "the standard part" of an expression involving q, which is just the closest standard real to the nonstandard real you defined. This is logically precise, you can axiomatize the extension process, and show that there is a unique closest standard real to each nonstandard real. Then you say, when "dx" is equal to "q", meaning you look at nonstandard values near a given standard value x, what is the standard part of dy/dx? This is the derivative in Abraham Robinson style, and also in Leibnitz style. In this framework of nonstandard analysis, the cancelling infinitesimals is a fine way to prove the chain rule. But there is that catch that "du" can be zero (if u is not changing with x), but this is a silly catch, because then "dy" is zero too (since if u isn't changing, neither is y), and then the derivative is 0. Further, the standard proofs of the chain rule just dot the i's and cross the t's on this cancellation, so there is really nothing wrong with it, it's just a little sketchy, you need to fill it out.

Who is your favorite Fields Medal winner?

For me, it's Paul Cohen. The reason is the insanely radical nature of the mathematics itself. While several of the mathematicians on this list, Groethendieck, Smale, Perelman, are politically very radical about social organization, their mathematics fits within the established frameworks. Paul Cohen's mathematics stood in complete opposition to the entire working philosophy of nearly all working mathematicians, and although it was rigorous, and so must be accepted, it came from so far in left field, that it is still not completely internalized outside of the field of logic. Paul Cohen's work it tore down the conception of the absolute Platonic universe of Cantorian sets. The Platonic ideal is that there was such a thing as an absolute idea of the set of real numbers, or the set of all subsets of the real numbers, and that these uncountable infinite sets have definite properties that are just true or false independent of how we choose to model them. This means that you were supposed to believe that there really was a choice function on the set of all nonempty subsets of the reals (or maybe that there wasn't), even though to believe this taxed the imagination with a task that is impossible to meet. You were supposed to believe that there really is a basis for R as a vector space over Q, again, something impossible to imagine in any concrete way, and there really is a non-measurable set, another intuitive impossibility. These things were debated in the 1920s, but they were set in stone in 1963, they were theorems, they were true, and their proofs did not contain a mistake, so they could not be challenged. Yet Paul Cohen was able to remove the truth from these assertions, to unprove the theorems that were proven, without challenging the correctness of the proofs, without finding any mistake in the proof. Rather, he showed a different way of constructing mathematical objects in uncountable collections, by shoehorning in new elements that avoided the restrictions imposed by any countable collection of statements. He called this "forcing", which I am pretty sure comes from "forcing in new real number symbols into a model", and he showed that a logical system of any sort can't stop him from doing this, because he has uncountable freedom in choosing digits of real numbers, while the axiom system has only countably many conditions to impose, because there are only countably many theorems it can

deduce. This revealed the true nature of uncountable collections, as idealizations which are free to be readjusted according to the preferences of practitioners, which do not have the same kind of absolute truth as the integers and their relations are supposed to have (although this is also debated, here you can't demonstrate first-order absolutely undecidable propositions). Paul Cohen worked within standard first order logic, using standard set theoretic axioms. But his insight came from a view of mathematics from his upbringing as an analyst. He viewed the results of mathematics in the formal way, as a computation over symbols, and the uncountable set of reals to him was obviously much grander than these countable computations can productively enumerate. So his intuition coming in was that the continuum hypothesis is manifestly false, and that the axiom of choice is manifestly independent, because there are just too many real numbers to make these statements absolutely true. Since Godel had already shown they were consistently true, in some sense, he had the easier task of showing they were consistently false. This is what he did. He made this precise by defining a way of adjoining new symbols representing real numbers to any set theory model, and allowing these real numbers to match one-to-one to any ordinal, or to pick an otherwise indescribable path through an infinite branching tree. These generic objects made it obvious, right from the start, that the questions about the real numbers as a set-theoretic collection with an ordinal, were just ridiculous. You could shoehorn (nearly) any uncountable ordinal in a given model into the reals, just by matching it to new generic reals, essentially by picking a real number at random for each element of the ordinal. He didn't use the word "random", he left that for Solovay, but he created the more logical concept of "generic" real, which is a real which is specified to finite precision, ever growing. This is a mathematical revolution, in the sense of an overturning of established precedent, because mathematics had already debated these things, and decided on Cantorian sets, with the axiom of choice (but possibly without the continuum hypothesis), and had settled the issue for good in the 1940s. Cohen liberated human beings from the tyranny the fixed ordinal conception of the real numbers, and replaced this view with a much more transcendent view

of these. It allowed one more freedom in adjusting models of the mathematical universe than was even considered remotely imaginable before, in the pre-Cohen days when people viewed questions about transfinite uncountable numbers as either true or false. The thing that makes Paul Cohen's work amazing is that once you get the philosophical transformation, the results are not that hard--- they were easy results in terms of the number of steps of mathematical reasoning involved. But they were impossible to concieve because of the radical philosophical shift. You had to start thinking about statements in set theory as simply statements about the countable models that the theory can describe, and the range of possible statements as defined by the range of possible generic maps that you can shoehorn into the model, by choosing generic elements of uncountable collections. This turned the uncountable collections into playgrounds of the imagination, where many statements became true or false, depending in which way you introduced generic elements. This point of view has still not penetrated fully throughout matheatics. There are many mathematicians today who still harbor the hope that one day we will have an answer to the continuum hypothesis, and that it will be shown to be false. There are some others, although fewer, who are sure that it is going to come out true. The work of Paul Cohen made it clear that the question is manifestly undecidable, because you can always make it false in any theory by adding a generic 1-1 map from a large cardinal to some new generic reals, and you can equally make it true by adding a generic map (the set of all maps is also uncountable) from the countably many reals to aleph-1. You could do it again and again, making maps to big alephs, and then collapsing the reals back to aleph1. It's like a game, and the freedom is the demonstration of the richness of the uncountable set collection. I have never read more transgressive mathematics than Cohen's, and I doubt I ever will. It is a revolution without precedent, and it is a revolution that still has not ended. I believe this insight is the major irreversible change in 20th century mathematics, and that it was made by a mathematician who is not an insider, makes it all the more remarkable. It is a testament to mathematicians that they accepted and recognized the rather cryptic 1963 papers as correct. This type of

thing could have been dismissed as crank stuff in a more political climate.

If you had 15 minutes to educate a doctor about anything, what would it be, and why?

I would educate them about the stupidity of the traditional social authority structures in light of the internet. The field of medicine is full of nonsense authority structures, which places the doctor above the nurse and orderly, and above the intern and the resident, and far above the ignorant patient. The doctor is supposed to have some special insight, because they are given decision making power in life-and-death stuff, and the lower order people aren't, and the patient has no power at all because the patient doesn't have training. This is complete nonsense. With a computer, a modern search engine, and a hospital with journal access, everyone has an approximately equal amount of expertise, namely access to the whole of human knowledge. The doctor's training is mostly in learning greek and latin names, and various extremely rare diseases, so, beyond basic biology, this training is worthless nowadays. It is simply a method of social accreditation to erect a barrier to entry into the field. The patient, if scientifically literate and actively researching the condition, has more knowledge than the doctor, because you can be sure they are spending all their time trying to figure out what is wrong with themselves. So the doctor has no legitimate claim to special knowledge, and should just stop pretending. The patient knows more, and the doctor should accept the patient's knowledge and stop being intimidated by it, and consider their interaction as a way of using their experience and prescription/treatment power to engage in an informed debate with the patient regarding the best options for treatment. The doctor really doesn't know anything you can't learn in about a week of intensive research, beyond the precise clinical appearence of certain vaguely

described symptoms, something that can be communicated in 10 seconds. This will take away the mystical witch-doctor social power that doctors have, which helps people heal by placebo, and this is a little bit of a loss, but it will allow doctors to get on the ball and make scientifically accurate diagnoses, which is a far more significant gain. If you want the placebo power, hire a guy to put on a big headdress and shake a magic stick at the patient, this is the tried and true way to induce placebo healing. Today, a patient with a search engine makes nearly all doctors look like total clowns. For example, when my father had a kidney transplant, his blood pressure afterwards was very low, and his cortisol levels were extremely low, and the doctors had no clue why he was on the verge of passing out all the time. They gave him a blood transfusion, which helped a little, but that wasn't the problem, because his blood pressure only improved a little. So, my father googled his symptoms, and after a few days found out that the problem was likely that his adrenal gland was damaged by the transplant, because kidneys are stripped of glands during transplant, and his old kidneys were removed. He explained this to the doctors, and immediately, they started treating him for Addison's disease (low adrenal gland function), but they pretended that they knew this before he told them, which of course is ridiculous. Despite their experience with transplants, it was rare for them to remove both kidneys during a transplant, and they did not take into account the loss of adrenal function. In hospital treatments for other members of my family, two of them became completely mentally gone, even though there was nothing wrong with the brain. A simple google search revealed that the antibiotic they were given, distributed under the brand name "Flagyl" is very psychoactive, and can induce severe brain fatigue, which induces temporary memory loss, and causes patients to go completely nuts. The doctors are aware of this of course, they had seen it many times, but they choose not to inform the patient of the psychological effects before prescribing. It is important to remember that the doctor's interest in killing bacteria and keeping a patient sedated is not always the same as the patient's interest in being treated with a drug that won't cause them to completely lose their mind. Generally, the loss of expertise is a sign that medicine should be opened up and

deregulated, so that anyone can practice after a short period of training, and licensing no more restrictive than that of a cab-driver. This will have the effect of lowering medical costs too, and it has been tried with reported success in South Africa, where the doctor shortage was alleviated by allowing traditional tribal doctors access to antibiotics and medical equipment. If you allow this to everyone who shows some scientific literacy and can pass a minimal competency test, you can reduce medical costs by an order of magnitude, and increase competence and safety at the same time, because you will lower the authority barriers in hospitals, allowing honest open debate between people at all social levels on the best treatment. This tends to produce honest results when the discussion is open, and the patient is usually competent enough to know what treatment will be best for them. The goal here is to make medicine look like any other service-for-fee practice, regulated by market forces, like getting a hamburger. It shouldn't feel like going to the church of medicine, with special priests in robes pretending to have access to special knowledge, because they don't now, and I doubt they ever did.

"If all the empty space in an atom were taken out, the Empire State building would reduce to the size of a grain!": What exactly is this 'empty space' in an atom?

It is political bullshit that Rutherford used to advertize his solar-system atom, which took over, because the solar-system atom is the best classical analogy. So Rutherford imagined the atom was like a solar system, and the nucleus is the non-empty space, and the electron is orbiting classically. This was Rutherford's way of saying "the nucleus has most of the mass, and the nucleus is small", and this is

true. Compressing the empire state building so that the nuclei touch you make it the size of a grain. But it's the electron's wavefunction that tells you the size of "matter" and where space isn't empty, and the region with appreciable amount of electron wavefunction are by definition the "non-emptiness of the space". If you ask what's the smallest you can compress the Empire State building and have it have the same mass, that's it's Schwarzschild radius. The size of elementary particles, quarks and gluons, if the concept makes sense as an experimental statement, is about 10-100 times the Planck length, assuming some heterotic-like string theory, which is insanely tiny. For the Empire state building, the Schwarzschild radius is about 10000 times smaller than a single proton.

Why are some philosophers famous when their work doesn't even make sense in summary?

Philosophy is evaluated by poltical standards, about whether it helps a political movement succeed. For this purpose, it is not important to make sense. It is more important to be vague and inspiring, so that different people can get whatever they want out of your writing. Then when the movement succeeds, you become famous. But you don't start making any more sense. For philosophy, it is also important to sound precise, so that it sounds like you have an argument, and these are two conflicting requirements. You can't be vague and inspiring and precise at the same time. Or can't you? You can! Hegel showed you how. You can make up gibberish jargon, and write in a way that sounds precise, because you have created a web of semantic relations between completely abstract and useless terms that only you know. Then you can be as precise as you like, but the obscurity of the terms allows the political forces that come after you to interpret them as they like. For example, if I were a philosopher, I would take the following terms: * Numinous * Prereactionary * Optipessimism And I would write the

following essay: It is characteristic of the prereactionary to reduce the numinous to the concrete. While the concrete has no substratum which can unite with the super-numinous, it has substrata which serve as a counterpoint to these. The resolvent of the conflict gives meaning to the action which opposes the prereaction, even as yet the state of being which it has produced has not yet commenced. And the pre-reactionary is left mute, speechless at his own impotence, and at what has been wrought in his absence. This state of mind, the conflicted desire for both the pre-reaction and the precluded optimal which constitutes the negation of the pre-reacted, is one which I denote "optipessimism". Does it denote the optimist who is pessimistic about the conclusion? More accurately, it denote the pessimist who is optimistic about the conclusion of the pessimist. To be precise, one cannot be an optipessimist, and be happy about it, at the same time. And this rambling gibberish would sound coherent to people, because in my mind, I have created a semantic web of relations between the terms, and I am staying consistent with this semantic web, but I have not anchored this semantic web in any phenomena of the senses, so that one is free to take the abstract relations and anchor them in any sensory objects one likes. Hegel was writing for aristocratic courts, but he wanted to sound good to progressive advocates, so he made a philosophy in which the only nontrivial sentiment is progress and evolution, essentially the following trite idea: our thoughts struggle in the public sphere, and the struggle produces progressive change. Marx liked the trite idea, and liked that Hegel was vague, so he expanded the idea into a class struggle, but Marx was writing to be understood, and he was not vague or obscure. This is why he isn't taken seriously as a philosopher. The tradition of imprecise language and semantic webs without reference to the world was fought in the 20th century, by Russell, who was the first to produce a mechanical reasoning process, and developed mathematics within it, along with Whitehead. The mechanical reasoning was able to give the semantic web, while the logical positivist could anchor this web in a bedrock of sense-perception, and scientific fact, so we could make sense of what people were saying, at least those that were saying something, not rambling about made up semantic webs with no referent in the real world.

Principia Mathematica is now superseded by modern computational theorem provers, but it was the first mechanical system in which you could do reasoning, and for this reason alone, it made a revolution. It had antecedents in Hilbert's deductive schemes, and others contemporary with and even before Hilbert, but it was a 20th century development--- for the first time, there was a real logical system. This allowed computers, and then precise descriptions of language. This was a revolution in thinking which has no precedent, and it renders all previous philosophy obsolete. Except for Leibnitz, who was groping toward a computer, and liked mechanical reasoning, and a few 19th century visionaries around the Analytical Engine, nobody concieved of a mechanical reasoning device until the early 1900s, and it culminated in the demonstration of universality by Turing, and the birth of computer science. The only worthwhile non-mathematical blah-blah-blah philosophers are Russell, Carnap, and Dennett, these guys understand and appreciate Turing universality. The remainder of the field pretends that it is an open question whether machines can think, or even worse, gives arguments that take us back to the pre-computer era. The political evaluation in philosophy is made worse by the fact that the philosophers need to have at least one representative for each political movement of significance. So they have their fascist representatives: neitzsche and heidegger. These clowns are mentally defective, and make it difficult or impossible for a self-respecting person of color or a sincere leftist to study the field, since you are forced to pretend these racist pompous high-class total idiots are worth engaging. So you have now an entire academic field, which, aside from the three exceptions I listed (and, excluding mathematical philosophers, among the blah-blah-blah folks, the list is exhaustive), is dominated by charlatans and frauds, and which sits on the sideline of academia, throwing ineffectual punches at other disciplines, and ripping off their work, while at the same time trying to reverse the irreversible progress of the 1920s and 1930s.

How would you explain Levy distributions to your mom?

If you take a lot of uniform random real numbers between -1 and 1, and average them up, you eventually make a Gaussian. This is because adding random variables does an operation called "convolution" to their probability distribution, and if you convolve a lot of things together, you get a Gaussian. The easiest way to see why this is true is also the best proof of this: you look at the Fourier transform of the distribution (mom, please learn about Fourier transforms). The Fourier transform of the convolution of two distributions is just the product of the two Fourier transforms. So if you have identically distributed variables, and you add them up, you just multiply the Fourier transform of the distribution by itself many times, and this gives you the n-th power. The Fourier transform of a probability distribution has the value 1 at 0 (because the total integral of the distribution is 1), and is everywhere else strictly less than 1 (because sines and cosines oscillate in sign, while probability distributions are always positive). So you know that there is a strict maximum at 0. You would expect then that the Fourier transform near 0 has a shape like an upside-down parabola: $p(k) = (1- a k^2)$ and then, raising it to the N-th power, you get $p(k)^N = (1 - ak^2)^N$ and this looks more and more like a Gaussian, because raising a small number to a large power gives an exponential. The formal way to say it is: $p(k)^N = (1 - ak^2)^N \approx \exp(-ak^2)^N = \exp(- N a k^2)$ So that the Fourier transform turns into a Gaussian near zero, and the inverse-Fourier transform of a Gaussian is another Gaussian. Also, you can absorb the N into rescaling k by sqrt(N), and this means that if you rescale the original variable by 1/sqrt(N) you recover a standard width Gaussian, and this proves the central limit theorem, when you dot the i's and cross the t's. There is another possibility, however, namely that the Fourier transform has a maximum with a cusp at 0. $p(k) = (1 - a k^b)$ where b is between 0 and 2. You can't make b bigger than 2, because then the Fourier transform would end up being negative somewhere, contradicting the fact that it's a probability distribution, but you're fine if b is between 0 and 2. Then the limiting distribution, following the same formal argument (but it's just as good) ends up being $p(k) = \exp(- Nak^b)$ and you can see it behaves differently, because you need to scale k by N to the 1/b power, so that the distribution spreads faster than usual, as 1/b power. This is a Levy distribution. When b is 2, it's a Gaussian. In other cases, it's a new central limit theorem, and it's a different continuous limit of many random variables.   You can do the inverse fourier transform in one other case, namely b=1. In this case, $p(x) = {1\over 1 + x^2}$ is the Levy distribution for b=1, and this is known as the Cauchy distribution. You can see that it falls off as a power law at large x, and it has an infinite second moment. Since the second moment is the curvature of the Fourier transform at the origin, and since a kink has infinite curvature, this infinite second moment is the defining feature of the Levy distribution.

Why was the axiom of choice controversial when it was first formulated?

The axiom of choice was controversial because it proved things that were obviously false, in most people's intuition, namely the well-ordering theorem and the existence of non-measurable sets. In analyzing the arguments, this axiom was the only culprit making the proof possible that people were willing to agree to possibly reject. The real culprit is somewhat different--- it's the powerset axiom--- but people at the turn of the 20th century wanted to keep Cantor's proof of the uncountability of the real numbers as a true provable statement about sets, which required a power-set axiom, so they could only reject choice. ---- What choice proves Consider the unit circle under rational translations, meaning, the real numbers [0,1), where you can take x to x+p/q where p,q are integers, and then take the fractional part. There are numbers which can be mapped to each other under these translations, for example, 0 maps to any rational number, and other numbers are distinct, you can't map sqrt 2 to the fractional part of sqrt 3 because their difference is irrational. Now "choose" one element from each equivalence class, and make it into a set S. The set S has the property that if you shift it by all the rational numbers (and project back to the interval by taking the rational part), and take a union, you end up disjointly making the whole interval again. This is Vitali's construction. But this means S can't have a notion of Lebesgue measure. If you assign S a Lebesgue measure of .00001, each of the translates of S have the same measure, so the union you end up with infinity times .00001 being the measure of the interval, which is infinity. You can't give S Lebesgue measure 0 either, because then the interval would have countable-infinity times 0 Lebesgue measure, and this is 0, since Lebesgue measure is countably additive (the measure of a countable disjoint union is the infinite sum of the measures of the pieces). So the set S is not measurable. Why is this a paradox? Because it is intuitively obvious (and also now known to be consistently correct to say) that every set has Lebesgue measure! Consider picking a real number r at random between 0 and 1, for example, by flipping a coin to determine each successive binary digit of r. You can then ask, once r is generated, is r in the set S, or is it not? If you keep doing this, generating random numbers and asking if they are in S or not, you get an infinite sequence of yes-no answers, each one probalistically independent of the previous one. Then it follows that there is a unique limit of the fraction of times the random real number landed in S, the limit of the number of times r is in S over the total number of throws, as the number of throws goes to infinity. And this necessarily has to converge, according to the laws of probability, it can't oscillate (at least, with certain probability it doesn't oscillate). So you could just go ahead and define the measure of S to be this probability. But this means all sets are measurable! What gives? What gives is that the notion of choosing a random number must be inconsistent if you accept the axiom of choice. You just can't define the limiting notion of picking a random infinite sequence as the limit of picking finite sequences, even though you know that these certainly converge. That's the trade-off. If you can choose a number at random between 0 and 1, then it must have a consistent probability of landing in any given set.

So set theorists rejected the notion of a random number, and instead allowed non-measurable sets by choosing in this other way, choosing one element from each equivalence class. This was extremely galling to many mathematicians. It was galling to Lebesgue, who was extremely annoyed that people gave up on the universality of Lebesgue measure, which was something he worked hard to establish in the early years of the 20th century. So mathematicians admitted non-measurable sets, and then worked hard to show that all "reasonable" sets are measurable. To do this, they defined "Borel sets" and "Sigma algebras", which were sets which you constructed by countable unions and intersections of intervals. The result was that you could axiomatize probability over the real numbers, in such a way that you could have non-measurable sets, and at the same time make most of the intuitive statements of probability meaningful without having to talk about instances of infinitely precise random picks. The trick was to show that you didn't leave the world of measurable sets just by taking countable intersections, or unions, or any normal operation. I should point out that the non-measurable set "constructed" above using the axiom of choice can't be written down in any reasonable way--- you would need to specify an uncountable list of unique choices, one from each class. This is not a procedure in any sense of the word, unless you have a way of producing an uncountable list. The method for producing uncountable lists is by well-ordering uncountable sets, and this was something else that the axiom of choice allowed you to do. But then there was the forcing revolution. --- Forcing The notion of sigma-algebra only fixed up the Lebesgue measure for sets which are produced from intervals by procedures of countable union and intersection, it wasn't clear if the method worked to give Lebesgue measure when you did axiom of replacement, or separation, using well-defined predicates. The development of Cohen forcing fixed this gap, by showing how you could make a set-theoretic universe consistent which had the property "all sets are Lebesgue measurable". The method is very simple to describe as follows. First, you need to make a countable model of ZF set theory, this is done by following Godel's completeness theorem, or using Skolem's theorem. Then in this countable model, if you don't introduce extra elements, you have

the axiom of choice is true, because all the elements are "constructible" in Godel's sense--- they are produced by an ordinal process of definition starting from the empty set. Now you can adjoin to this countable universe random real numbers. These numbers are not already in the universe, because the universe has only countably many numbers. Further, you can decide which properties are true or false for these random numbers, from only their digit sequence--- a property becomes true if is proved from finitely many digits, and a property is false when the probability that it is true is 0, which means these new real numbers avoid all measure zero sets of the old model. By adjoining random reals, you get a measure for all the sets of the old model, because you can just define the measure of a set in the old model as the fraction of the time the real numbers land in the set, like in the intuitive construction. But now you have new real numbers in the new model, and you can make sets from these, and you need to define the measure of those additional sets. You can do this by just picking more random numbers and defining the measure to be the fraction of the time the new numbers land in the old sets, but you need to know that there is a consistent place to stop. In 1972 Solovay figured out how to project out the sets in these new models so that all the sets remain measurable, and the axioms of ZF hold. This was nice, because it showed that ZF is consistent with the axiom "all sets are measurable", even though it has axiom of powerset and axiom of replacement. So it really is only choice that is leading to non-measurable sets. So this means that no matter how you define sets in set theory, even using separation or replacement, you never produce a non-measurable set. It formalizes the intuition that non-measurable sets are impossible. --- Newer paradoxes Some new paradoxes made the notion of choice and non-measurable set starker. Somebody gave the following problem: An infinite number of people are standing in a row, and you put a hat on their heads, either black or white. Each person can see all the other colors on everyone else's head, and has to guess the color on their own head. The people "win" if only finitely many people guess wrong. Can the people win? It is intuitively obvious that the people can't win, just put a random color on each of their heads. But the axiom of choice doesn't work with intuitive probability,

so using choice, you can allow the people to win. What you do is you declare equivalence classes of the hat-choices, so that two hat-sequences are equivalent if they differ only in finitely many places. Then you "choose" an element of each equivalence class. Then you give this choice to all the people ahead of time, and they look at all the other hats, and find the unique representative of this equivalence class which matches all the other hats. Then they answer according to what this representative says is on their own head. This allows the people to win. The randomness is conflicting with choice as always. The rejection of choice in favor of "all sets are Lebesgue measurable" is a foregone conclusion in my opinion--- the measurability axiom is useful for defining probability spaces on infinite systems, and makes it easier to define the Feynman path integral rigorously (although it doesn't solve the main problem, it gets rid of one major headache of constructing sigma-algebras on distributions). The axiom "all sets are Lebesgue measurable" is also implied by other interesting schemes logicians like, like the axiom of determinacy. So people are becoming more comfortable with this universe. In order to allow people to do this, without changing their model of set theory, people define "topoi", which are just a modern mathematican's replacement for a set-theory model which does not require learning any modern logic, where you can take whatever set-theoretic model property you want and make it true for a "topos" (it's like a universe) and then people have to take you seriously, since your construction sits inside usual mathematics, it doesn't change the model. But I think all this pussyfooting is dangerous--- you should just say "We goofed"! It was a mistake, we should have rejected powerset/choice in favor of some other convention which works well with probability. --- Pro-choice propaganda people who like choice usually trot out some theorems that they say are "absolutely necessary for mathematics", which are equivalent to choice: * Tychonoff's theorem: the product of compact sets is compact. The solution is to make it a countable product, or a product of size less than the continuum. Then you can keep choice and keep probability. * Maximal ideals: All ideas are contained in a maximal ideal again, you make your ring have ideals which are countable generated or generated by an ordinal of size less than the

continuum, and it stays true even if the continuum doesn't allow choice. * Functional analysis theorems up the wazoo All the functional analysis choice business stay true (with the same proof) if you remove choice on the continuum and keep all the spaces with a countable (or ordinal less than the continuum) basis. The reason it's easy to de-choice theorems is the same reason choice was accepted in the first place--- it's because choice is true in Godel's model of set theory. So if you have a theorem using choice, you just interpret it as true in the constructible universe, and then just think the constructible universe is either countable or tiny part of the real universe, much smaller than the real numbers. That's it. It's relativizing to L, and it causes no problems, and it makes the theorems intuitive. The reason that L gets confused about probability is that if you pick a real number at random, it has zero chance of being in L, and L delusionally thinks it's got all the real numbers, so it produces paradoxical sets. I don't like to speak in such terms, because for a positivist, the question of the "real" real numbers is meaningless. You should just stick to statements about computers and computations, as these don't care about such things as choice. But precisely because of this, one should have the freedom to work in whatever axiomatization you feel like, and I think everyone should feel like working in an axiomatization where probability arguments work without paradox. --- Today The axiom of choice is still controversial in a certain sense, except that it is used without question by most working mathematicians. So why is it controversial? Because when it is used, the mathematicians secretly know that it is supposed to be applied to countable collections, and they just allow themselves to extend it to uncountable collection self-consistently, since Godel showed this can do no harm in any real sense. So they pretend it's true for uncountable collections, they know it won't cause outright contradictions, and they live with whatever suboptimal properties the universe ends up having. They also don't want to deal with it, so if you start to jabber about it, they shut you up. It's not wrong, it's the quickest way to shelve the philosophical stuff and get to real mathematics. But I think it's causing real problems today. I think that most modern mathematicians understand that choice+powerset is nonsense, they just know enough consistency results to move the

intuitive paradoxes to the side. So they can believe it is "true" (meaning true as a statement about their model of set theory) and "false" (meaning false as an absolute statement about the collection of all real numbers) at the same time. This is not a true paradox, because true and false for these sort of things is only relative to a given formal axiomatic system, and one can be equally comfortable in different systems. So, for example, I have no problem with the axiom of choice as a statement about Godel's constructible universe, and I just interpret all the theorems which are proved with choice as statements about Godel's universe, and not as statements about the "actual" universe, with all its real numbers. There are many contemporary mathematicians who simply reject the axiom of choice, and have no trouble doing so. It's not hard, because you can imagine all choice theorems as conditional. Bill Thurston is a very notable example. Logicians by and large are very comfortable in choiceless universes nowadays, and the contradiction between choice and experience has been distilled into a clear paradox already, since the 1960s.

What are the real primary colours?

The real additive primaries are red green and blue, since these are the wavelength in your eyes. So when you make colors by adding light to other light, you want to use RGB, because then you can mix any color additively (except there is also rhodopsin, but ignore that, since the rhodopsin response is usually the sum of the RGB values, except in very dim light, in which case you can have only rhodopsin excited, and no other pigment). When you have pigments, like paint, they remove light from the light incident on them. So you want to mix pure negative numbers, and the true pigment primary colors, subtractive primaries, are cyan magneta and yellow. But cyan and magenta can be taken to be red and blue and it doesn't make much of a difference to the mixing properties. The reason is that blue receptors are kind of

broad and weak compared to the red and green ones, and you have more lattitude in mixing to match those. In fact, a pure red-green monitor can give people the illusion of a full color scene, even though there is no blue. People can extrapolate the degree of blue they should be seeing just from the red and green cues. So blue is very weak, and magneta (red plus blue) can be replaced with red, while cyan (green plus blue) can be replaced with painter's-blue, because what we call sky blue is actually a large amount of green too, not just blue, the blue-tinged-green is percieved as what we call blue. Mixing yellow (red plus green reflected, blue absorbed) with a pure blue pigment (red and green absorbed, blue reflected, like cobalt blue), would give a muddy black if the pigments were ideal, but for standard paint pigments, the blue removes red more than green, since the green-blue combo is what we tend to call aquamarine, or sky blue. So an aquamarine/sky plus yellow leaves a green reflected residual. So you can mix green from blue and yellow, but it's a rough approximation to what is really going on. Artists know that there are limitations to the mixing of red-yellow-blue, that these are only approximate primaries, so they give different reds and different blue pigments, to allow the full range, the hot and cold colors. There are also earthy pigments, which are not exactly primary, but they allow you to find nice tones easily which would get all muddy if you tried to mix them from primaries. They also give green pigments which are hard to replicate precisely from yellow-blue mixtures, because these tend to muddy up in cases when the blue pigment absorbs some green. Generally artists will mix green from a sky-blue and a yellow, which is really a cyan-yellow combo, not a blue-yellow combo. The nice thing about painting is that you can also additively mix colors, by putting the two pigments very close to each other, side by side, so they reflect separately and do addition when they hit the eye. For example, if you make a red and green alternating grid, even in a painting, you can make yellow if you look at it very far away. So you can make both additive and subtractive mixing with appropriate pigment alternation or mixing. By imperfectly mixing the paints, and streaking them together, side by side, you can suggest additive mixing to the eye. If you mix the paint thoroughly, it will mix subtractively, so there's this artistic freedom to mix the paints coarsely

or roughly, and to make the brush-stroke homogenous or heterogenous. It gets complicated, but the basic idea is that the eye sees RGB, and all other primary schemes are historical artifacts of the fact that we had subtractive pigments for much longer than light-generating systems, so we had to construct a color theory appropriate to the technology of the time, which meant a subtractive theory.

Colors (vision): Could a different model besides RGB be used popularly? Why is it more popular than CYMK?

Because the receptors in your eye are tuned to a red, green, and blue wavelength. If you give a wavelength that stimulates exactly one of the color sensitive pigments and the others none at all, it will allow you to produce all the different stimulation patterns by adding stimulation in each of the three channels. This requires RGB. Y stimulates R and G, so if you wanted to mix R from CMY, you would need a Y plus M minus C, and you can't make a monitor make negative amounts of light. So if you want purely additive color mixing, you need to match to human retinal pigments, and you are stuck with RGB. Having said that, there is also rhodopsin, and it is very broad, so that you can stimulate rhodopsin with any of the color wavelengths. If you had a magical rhodopsin stimulating wavelength that stimulated none of the color pigments, you could make magical looking scenes. The closest you get to this is very very dim light, like moonlight. The moonlight is not bright enough to stimulate any of the color receptors, so you get a pure rhodopsin response, and this gives a weird purply-bluey feeling to moonlight that gives it a sense of magic, since it is a pure rhodopsin color. You can't really simulate moonlight on a computer monitor, because it is always bright enough to knock your color receptors.

What is the method to calculate a square root by hand?

The easiest way, in this special case, is to Taylor expand, because 25 is special in decimal, allowing a quick evaluation. I will write the Taylor expansion of square root this way: sqrt(1 - 2x) = 1 - x - x^2/2! - 3x^3/3! - 3*5*x^4/4! - 3*5*7*x^5/5! - 3*5*7*9*x^6/6! - 3*5*7*9*11*x^7/7! - 3*5*7*9*11*x^8/8! - 3*4*7*9*11*13*x^9/9! + sqrt(25 -3) = 5 * sqrt(1 - 3/25) so that x= 3/50 In this special case, of expanding square roots near 25, the Taylor series evaluates extremely easily term by term in decimal (if you do it term by term you will see, after cancelling small prime factors, you are left with beautiful terms up to very high order, with denominators of powers of 10). The first three terms are 5- 3/10 - 9/1000 = 4.69 The next terms are (negative) 5.4/10000 + 81/1000000 + 340.2/100000000 you can go up to 10th order by hand easily, which is sure to be more accurate than a calculator. This is a special case. In general for quick calculation, you carry a handful of natural logs around in your head--- ln(2)=.693, ln(10)=2.305, so that log(22)=log(2)+log(10) + log(1.1) = .693 + 2.305 + (.1 - .01/2 + .001/3 + ...) log(22) = 2.998 + .095 = 3.093 now divide by 2, to get 1.546 which is .693 + .693 + .16, so it exponentiates to e^(.693 + .693 + .16) = 2*2*e^(.16) = 4*(1+ .16 + .0128 + .0007..) = 4.694 usually good enough.

What do mathematicians and physicists think of each other?

The main issue dividing the physicists from all other academic fields (including mathematics) is the philosophy of positivism, that physicists accept and everyone else stupidly rejects. This positivism is the thing that allows physicists to make progress. Mathematicians have rejected positivism in favor of certain types of idealism, since they needed transfinite ordinals, and they weren't sure where to stop, and one is still not sure where to stop, regarding these. Positivism is the philosophical position that in order to give meaning to something, you need to reduce it to sense perceptions, or primitive impressions about the world, like "I see a blue patch of this and so size", or primitive concepts about numbers, like "three is bigger than two". The idea is that certain questions, like "Where did the universe come from?", when turned into a question about sense perception, have no meaning. There is no sense-perception which is different depending on the putatively different answer to "Where did the universe come from?" so the question is just meaningless blather, as is most of philosophy. This is important, because in physics, you don't know exactly a-priori what the primary concepts are in the description of nature, and the positivism allows you to identify these, because only the ones you can measure are the ones you can be certain are important to include. "Where exactly is the electron in the ground state of Hydrogen?" sounds like a reasonable question, but when you formulate it experimentally, whenever you make a way to test exactly where it is, the experiments conflict with the requirement of staying in the ground state, so the positivism does not allow you to say that there is a definite position in the ground state, the ideas are "complementary" in Bohr's way of saying it. The physicists refined positivism a lot in the 20th century, and made it completely coherent, at the same time as academics outside of physics, at least in the West, were busy rejecting the idea. Positivism confuses people endlessly, but it's one of the pillars of modern physics, the thing that allowed relativity, quantum mechanics, and string theory to get formulated. The idea of "reduction to sense impressions and primitive mathematics" was not made formal and precise by Mach. The tools weren't available. But by the 1930s, you could make the idea precise using a computer. To say "I see a blue patch" can mean "My mental model can be considered to

contain the same computational structure as when it is given this presentation of pixels in a png." Similarly, the number 3 can be axiomatized or represented internally in a computer's memory. The computational representation of nature, and of our sense impressions, allows you to give the fundamental ideas of positivism: * You have a computational model of the ideas in minds * You have a computational description of natural law. * You have an embedding that shows you how the top one sits inside the second one. For a trivial example, you can take a Newtonian world, and imagine a being made of atoms doing some computation, then the abstract computation sits inside the Newtonian model, and the computation is just embedded in the Newtonian world. A nontrivial example is Everett's many worlds. In this case, the computer is doing classical (probabilistic) computation, the world is quantum mechanical, and the embedding is into a particular branch of the wavefunction, which branch is selected according to the data that ends up on the computer at the end. If the probabilities are close to 1, you reproduce the Newtonian model, but it requires this branch selection, which is a nontrivial embedding, because quantum mechanics is not a model which computes anything, it gives you superpositions of possible computations, not definite answers. A nontrivial non-quantum example is duplicated observers. This asks "If I make an atom-by-atom copy of you, which way does your consciousness go?" Philosophers started thinking about this in the 1980s starting with Dennett's "Where Am I?" But this is just the classical analog of the stuff going on in Everett's many-worlds model, and the answer is ambiguous, and this bothers philosophers. This problem, like all philosophical problems, vanishes once you formulate it positivistically. The issue in all this is that there is extra information in the embedding of the computation in the world, and this extra information is not in the physics. In the case of duplicated Newtonian observers, you get a new bit which answers the question "which copy am I?" after the duplication which wasn't there before. The introduction of new bits of information to describe observations is one issue people have with quantum mechanics--- these bits, they feel, should be present in the physics. This was Einstein's "realism" postulate. When logic and computers are involved, positivism becomes

logical positivism, and in this form, it dominated European thinking until World War II, and continued in the Soviet Union until 1991. The impact of logical positivism was trememdous, since it gave a way to separate bullshit from thinking: if you can write a computer program to see what you are modeling, it's thinking. If you can't, not even in principle, then it's bullshit. In mathematics, the main schism is the fact that mathematicians still have a little bit of bullshit left. The bullshit is theorems that cannot be given a straightforward computational interpretation at all. These theorems are all about the idealization of the real numbers as a set, meaning a collection of discrete elements which can be well ordered (matched to an ordinal number). It is manifestly obvious to any schoolchild that the real numbers cannot be well ordered in any sense of the word, they are vastly too big, yet, in order to enter mathematical discourse, you are forced to reject this obvious fact. To make this precise took until the 1960s, and because it was positivism, and Soviet sounding, it was not properly advertized in the west. This was Paul Cohen's forcing. The ideological battles of the cold war had a terrible negative impact here, suppressing the full power of forcing. that the mathematicians have a requirement in their field, which is that "a result" is something which has an embedding in a particular formal system, something like ZF. This is fine. The problem is that they also standardized on an idealistic interpretation of these axioms that includes an idea that there is a definite "set of real numbers", with a definite "ordinal number", and so on, and this is what modern mathematicians call Platonism. The Platonism is fine for integers, countable ordinals up to Chuch Kleene, but it stops making positivistic sense for uncountable ordinals, or for real number ordinals. The rejection of positivism by mathematicians led to obfuscations in certain areas: * probability is formulated over measurable sets, and one spends time constructing measures to demonstrate their consistency with the well-orderable universe of sets. This is complete crap from the positivist point of view. It is clear since 1972 at least that all sets constructed in the usual sense are measurable, and that it is only impredicatively defined collections which give anything "nonmeasurable". This means that measure theory is screwed up, and the screw up is completely rejected within

physics. In physics-math, all sets are measurable. So physicists are allowed to say the following: * consider a random configuration of the Ising model on an infinite lattice... This makes no sense in standard mathematics, since a random infinite collection of bits is incompatible with the existence of a non-measurable set. Further, physicists can say * consider the limiting distribution of a measure on fields defined on a lattice, where you adjust the constants appropriately to allow the lattice to become fine... this is renormalization. The mathematicians have a hard time with this, partly because the randomness aspect is obfuscated. There is no time to waste on this nonsense in physics, and this is not something one should ask the physicists to fix. Instead you must demand of the mathematicians: please adopt positivism, and allow people to work in a universe where all sets are measurable, and they don't need to work to establish measure theory exists.

Is it possible to be an entirely self-taught theoretical physicist?

It was possible from 1900-1960 for sure, since Einstein was self-taught (although he went to school, his schooling was a joke), as were Dirac, Bose, Pauli, Wigner, Schwinger and tons of others. This was the norm for theorists until the 1960s, before peer reviewed literature becomes a little politically obscure through in-politics. Some important particle-physics literature becomes really opaque in the late 1950s, through the 1980s, and it is hard to follow the following threads: * S-matrix theory: This is the king of obscurity. The Rosetta stone for this is Gribov's classic "The Theory of Complex Angular Momentum", together with Landau-Lifschits Quantum Mechanics, or any other introduction to nonrelativistic Regge theory. You need this to understand real particle physics. * Nambu physics: The vacuum structure of QCD used to be obscure, but this can be fixed by reading about the chiral models, and this is covered in modern lattice QCD literature and in the European literature. There is not a great review, but Wikiepedia can fill in some gaps, and the rest are easy enough. * String theory: you need to be conversant in S-matrix theory to read the early string literature. The key here are Veneziano, Mandelstam, and Scherk, who review the field in the mid 1970s, before it died for a decade. * Path integrals: You can read about this in an appendix to Polchinsky's string theory books. Yourgrau and Mandelstam is also good. The issue is fixing itself, it was simply that the canonical commutation relation is not explained well, because people other than Feynman were confused on this. * Grassman integration: for this you need David John Candlin's original 1956 article, or else a good review of Fermionic coherent states from after the 1980s. You can find a treatment in Berezin's Quantum Mechanics book from the 1960s, in Negele/Orland, and in a few online sources. Condensed matter literature is generally much clearer, because it had practical braches, and people were encouraged to study this field. You should know the condensed matter literature, but I think there is no deliberate obscurity here. The particle literature improves again in the late 1990s, as the internet de-obscurified everything. It is now as clear as it has ever been, the online arxiv papers are really well written. If you can get past the hump, 1960-1990, you are golden, and this just requires studying the topics above intensely for a few months each. Among the modern physicists, Edward Witten is notoriously self-taught. His father was a physicist, so he had an early start, but in his undergraduate years, he dabbled in history and politics, only studying physics on the side (although he was dedicated, and switched immediately in his early 20s when 'tHooft made it clear the field was still wide open). He then got accredited through David Gross, but his output of the era makes it clear he was already aware of everything. Other self-taught (or mostly self-taught) folks are Vadim Knizhnik, Leonard Susskind, and Lubos Motl (although he might disagree with this description, I think it's pretty clear from his self-description). But this is an underestimate, since essentially all physicists are self-taught, because the curriculum is brain dead and so far behind the research frontiers. The education system is basically systematically designed to

not teach, since they want the physicists to go do something else other than academic physics, where there are always too many people.

What are some of the most ridiculous proofs in mathematics, especially for easier concepts?

The only ridiculous proofs are those that prove things that are false. In this case, there is only one real example in modern mathematics: the existence of a non-measurable set. But the proof that started this nonsense is the proof that the real numbers can be well-ordered, a "fact" which is obviously false, and which required a long time to clarify, basically until Paul Cohen showed that you can make it false as easily as you make it true, so that it is more correctly false than true (that's not exactly correct, it took several years after Paul Cohen, but the main idea is Cohen's). The proof that the real numbers can be well-ordered (put into an uncountable ordered list, so that each real number is at one and only one position, and the list has the property that it is discrete and finite when counting down, meaning that every subset has a least element) is as follows: 1. choose an element from every nonempty subset of R. 2. consider the entire set R, you chose an element (it's a nonempty subset of R), so call that the "first" element of R. 3. Now consider R excluding your first element. This is nonempty, so you chose something from it. Let this be the second element. 4. Now consider R exluding the first two elements. This is nonempty, so you chose an element from it. Let this be the third element. This is an inductive procedure, so it extends to all integers, and then to all ordinals, which are linearly ordered collections which are inductive, like the integers. For the countable ordinals, this is not an intuitive paradox--- you can embed any countable ordinal in R. But when you admit uncountable ordinals, and R as a set, then you can show that there is an ordinal which exhausts R in this way. The reason is that the union of all the ordinal maps that go into R in this way has

to crap out somehow, or else the set R bounds all ordinals. But no set can bound all the ordinals, because then you can define the set of ordinals as a subset of R with certain conditions (and then use replacement to map back to the ordinals). But there is no set of all ordinals, because such a set would be an ordinal, and then taking this ordinal plus 1 would give a contradiction. So the result is that, if R is a set in the usual sense, you must have well ordered it. This is an obvious lie, ordinals can't map to R in any normal sense, there are no non-measurable sets, and this ridiculous mentally defective lie presented in undergraduate classes made me stop studying mathematics for about 10 years, because I was sure the deductive system was completely defective. In case someone thinks the same way, I encourage these people to not give up, but to study Paul Cohen's work, which will make everything clear, and will explain why this theorem is both true in models of set theory, and false for the real R we know and love. This proof, the well ordering of R, is what gave birth to the famous statement "This is not mathematics, this is theology" (although you find this statement repeated about other things to which it was not applied as far as I know). In fact, it is not mathematics, it is theology. In modern set theories, you know from the Skolem theorem that you might as well work with a countable model, and then the theorem is simply showing you that the countably many elements of R in the model map 1-1 to an "uncountable ordinal" (which is countable in the model, just the model doesn't know it). That's the resolution. The other paradoxes where you inductively partition R into dusty collections that violate intuition all basically rely on this enumeration of R into an ordinal list, something which works in axiomatizations of set theory only because these axiomatizations are secretly countable, and describe only countably many real numbers in some philosophical sense of minimal models. The proper perspective is that the real numbers are not well-orderable, and there are no non-measurable sets. This is the property of many modern set theoretic systems, all of which are rejected, because mathematicians have grown too used to choice and powerset. The real problem in the proof is not the choice step, it's the powerset step, assuming R is a set. This is the central mistake, and it is very deeply imbedded in modern mathematical

practice, no matter what results set theorists come up with. To read more about this, look up Solovay model and modern models of the Axiom of Determinacy.

Who are some of the most underrated physicists?

The most underrated are those that contributed enormous things, but are not fully recognized for their contributions. This means, you probably never heard of them. I will focus on those theorists I know are shafted: 1. Ernst Stueckelberg: This fellow invented relativistic perturbation theory in 1934, almost 2 decades before Feynman and Schwinger. He discovered that positrons are back-in-time electrons in 1938 (and Feynman got the idea through Wheeler indirectly from him). Stueckelberg proposed renormalizable electrodynamics in 1941 but his paper was rejected from physical review, it took Hans Bethe's 1947 Lamb-Shift estimate to reintroduce the subject. Stueckelberg should have received the 1965 Nobel prize along with Schwinger and Feynman, while Tomonaga could have shared his with Luttinger for 1d liquids (which is a bigger contribution of Tomonaga's anyway). Stueckelberg didn't rest on his laurels, he went on to discover the Abelian Higgs mechanism and the renormalization group too. Each of these are major discoveries in themselves, but to have one person discover all of them raises him to Bohr-Einstein status. He died insane and neglected, although he received some awards late in life. He is the godfather of underrecognized physicists, and he must be at the top of any list. Why was he underrecognized? He was antisocial. 2. Alexei Starobinsky: This Russian fellow discovered inflation, Alan Guth was second. There is a lot of chauvinism in physics, and the great Soviet scientists were often neglected for no good reason. The mechanism was somewhat different, but the main predictions were the same, and the Soviet school calculated the fluctuations in CMB long before the

famous inflation conference in 1983 reproduced their results (in a more primitive approximation, and with mistakes). Why was he underrecognized? He was Soviet. 3. David John Candlin: this guy invented the Fermionic path integral, but credit accrued to Berezin, who wrote about it in a book a decade later. There is no dispute that David John Candlin is the inventor, his paper is a clear description of the anticommuting variables, reconstructing the state space, and producing the integral for them with the modern definition. Berezin was no slouch either, but he didn't invent the thing. This is not an attempt to steal credit from Berezin, but to attribute the result properly: David John Candlin is the sole inventor. Everyone else in 1956 had the wrong idea, including Feynman, Schwinger, and Salam. David John Candlin is still alive, and lives in Edinburgh, so there might be time to get his historical perspective on those events. Why was he underrecognized? He didn't publish a lot. 4. Stanley Mandelstam: This guy is certainly the greatest living physicist, although he is very old. In 1957, he discovered the double-dispersion relations, and essentially refounded S-matrix theory, which was proposed by Heisenberg in 1941, but lay dormant for nearly 20 years. This theory became string theory, after many twists and turns, and Mandelstam is the original formulator of 2-d conformal fields, fermionic correlation functions, string field theory, and the arguments for finiteness of string perturbation theory which convinced the world that the theory had no ultraviolet divergences. He also made pioneering contributions to field theory, and really, he deserves a major overdue Nobel Prize, but he'll never get it. Why was he underrecognized? He was too advanced for people to understand. 5. You can't say Mandelstam without Geoffrey Chew. This fellow prosalytized for S-matrix theory so effectively, it dominated high energy physics from 1964 to 1974. He proposed that Regge trajectories describe hadronic physics, along with Frautshi, and Mandelstam's theory of cross-channel high-energy/unphysical-angle relations gave the theory mathematical form. This is the birth of string theory. The string description of hadrons is underrecognized today. Why was he underrecognized? He was not a formal wizard (unlike his collaborator Mandelstam), and people characterized him as a dimwit, ridiculously, since his physical intuition was spot on and now known to be more correct than that of Gell-Mann, Mandelstam, Weinberg, and other formal wizards. His phenomenological calculations were also sound and competent. 6. Vladimir Gribov: Another S-matrix giant. This fellow gave form to Pomaranchuk's idea that proton-proton and proton-antiproton collisions have equal cross sections at high energy, and predicted the Pomeron trajectory (attributed to Chew and Frautschi in the west, wrongly, although possibly independently). This prediction is stunning, and it is completely verified in the 1990s when proton anti-proton collisions at hundreds of GeVs showed that the cross sections do become equal. Did the S-matrix folks who predicted this in the early 1960s get a Nobel prize? No, they were booted out of academia, and mostly had to scrounge around in accelerators. Why was he underrecognized? He was Soviet. 7. Tamiaki Yoneya: This obscure Japanese physicist was first to discover that string theory includes a graviton, a real graviton, not just a spin-2 particle that could be a graviton. He made the argument exceedingly elegant throughout the 1970s. He is still active in string theory today, and his underrecognition seems to be fixing itself. Why was he underrecognized? He was a string theorist in the 1970s. 8. Joel Scherk: This guy is the godfather of modern physics. Although he is well known to string theorists, he is not well known enough, and he was driven to madness and possible suicide just before 1980, His death is mysterious, there are several conflicting reports, but his mental deterioration is well attested, and it is perhaps due to the fact that string theory was so thoroughly neglected in the 1970s. Why was he underrecognized? He was insane. Also, string theorist in the 1970s. 9. Shoichi Sakata: Sakata proposed that hadrons are made of the proton, neutron and lambda. While this is incorrect in the details, the model works well, because these three particles are stand-ins for the up, down, and strange quarks, except with integer electric charges. His model was the direct precurser of the quark model, and is the reason that Gell-Mann and Zweig were able to formulate the correct theory independently. But he was first, and made a major contribution, if not the major contribution, to this idea. Why was he neglected? He was a Marxist. 10. Pasqual Jordan: This guy co-discovered quantum

mechanics, discovered Fermionic fields independently of Fermi, and made major contributions to early field theory. Why was he neglected? He joined the Nazi party. This one I can sort of understand. 11. Iosif Khriplovich: This physicist discovered the negative beta function (asymptotic freedom) in nonabelian gauge theory in 1968-1969, three years before 'tHooft discovered it (but Veltman did not allow him to publish), and five years before the pioneering papers by Coleman/Politzer and Gross/Wilczek that established the result for good. The Nobel prize to Gross Politzer and Wilczek should have gone to Khriplovich, who had a much more physical argument than a direct calculation with a finicky sign, he showed why the effect happens physically, that it is due to gluon polarization. David Gross is no slouch, he could have won for greater contributions, such as the heterotic strings, or the Gross Neveu model, or a host of things (he is really great), while Wilczek could have won for condensed matter anyons or the superconducting strong-matter high-pressure state (he also has great discoveries). The beta function was not the only great contribution Khriplovich made, he also discovered parity violating effects due to the weak interactions in atomic physics, and explained them as due to nuclear anisotropies interacting with the electron fluid. This research continues, and it is truly remarkable, considering the amount of speculation on P-violation in atomic physics in the 1980s, speculation which post-dated both Khriplovich's theories and the experiments which verified them. Why was he neglected? He was Soviet. 12. Robert Kraichnan: He is responsible for modern turbulence theory, including the inverse cascade in 2d. The inverse cascade is the prediction that turbulence in 2d takes small scale disturbances up to large scales, violating decades of physical intuition from 3d turbulence and the statistical ultraviolet catastrophe, it is truly a remarkable prediction. He is also responsible for many statistical physics models of turbulence, including the first "large N" approximation, something which took over physics when 'tHooft discovered a more central high-energy version (although one can see Wigner and Dyson's random matrix theory as another precursor to this). Anyway, he was working for decades on this, and received adequate support, so you can't complain too much. But nobody read

him. Why was he neglected? He was not in academia. 13. Tony Skyrme: Tony Skyrme discovered his eponymous model in 1960. It took a full 2 decades for this model to be rediscovered in large N QCD by Rajeev, Nair, Balachandran and then by Witten, and then he got some recognition, but promptly died. While trying to get a better handle on 4d Skyrmions in the 1960s, he also discovered the interpretation of 2d solitons like those in the sine-Gordon model as Fermions in a dual description, something which was refined by Coleman and Mandelstam in the mid 1970s into an exact identity of two dimensional field theories, the two dimensional bosonization/fermionization which is so central to physics today. Why was he underrecognized? He was doing unfashionable unified field theoretical physics when simple particle models were in vogue. 14. Leo Kadanoff: He discovered the modern renormalization group, and the operator product relations which are central to determining critical exponents, work which was turned into an elegant 2d theory by Belavin, Polyakov, Zomolodchikov. He isn't neglected anymore, but he was not awarded the Nobel prize with Kenneth Wilson (much to Wilson's surprise), and he should have been (along with Wolfhardt Zimmermann, another neglected giant whose 1950s work was the true source of the operator product expansion, and which is now active mathematics, thanks to Connes and Kreimer). Kadanoff still keeps plugging away, and his stature keeps growing, so this is fixing itself. Why was he negelected? Damned if I know. Perhaps that's why he is neglected less and less with time. And finally, I must end this list with a choice that is sure to be controversial, and is the most scandalous: 15. Martin Fleischmann: Having discovered the most suprising thing in the universe, namely that deuterated palladium sustains nuclear reactions, almost certainly of the deuteron-deuteron fusion sort, his reputation was scandalously blackened, and his great work diminished, until his name became synonymous with fraudulent or delusional science. It is clear now, two decades later, than he was not delusional, but this realization came too late for Fleischmann, who was suffering from Parkinson's disease at the end of his life. His memory drives one to work harder, with no hope of compensation, every day. Why was he neglected? He was a chemist. Chemists are not allowed to

discover fundamental challenges to all known nuclear physics, and his discovery stepped on well financed hot-fusion toes. That's the end for now. I could go on, because so many of the major discoveries in physics are scandalously underrecognized, Many of the physicists on the list who got some credit for the discoveries of others were still underrecognized for their own original contributions. There is not so much bad-faith--- a lot of things were discovered simultaneously in ignorance of prior work--- and the mechanism of credit accrual is mysterious and capricious, very rarely accruing credit to the proper author (but it happened: Einstein, Bohr, Heisenberg, Dirac, Feynman, Schwinger, Dyson, these folks got credit for their own original work) Attention to research was a scarce quantity in pre-internet times because it took decades to understand what the people were talking about. The Feynmans and Schwingers of the world are an exception, not the rule. I hope people try to emulate the people on this list, not those that suppressed and heckled them. I edited this for typos, included an extra neglected fellow, and added information on David John Candlin status.

Are skeptics more intelligent than religious believers?

People who are trying to preserve a status quo do not need or acquire the same level of intelligence as those trying to shake it. The reason is that intelligence is useful for making new things, and if all you want to do is keep the same-old, you don't need to be smart. This is why liberals are on average more intelligent, and atheists on average more intelligent. This has no bearing on whether they are right. I find that often the stupid people are right, despite having weak arguments, simply because the stupid person is speaking for a long tradition, while being ignorant of the true reason it was put in place. When it was first put in place, the people who put it in place were not ignorant,

at the time they were doing it, they were doing something new. This is especially true of religion, where we are displaced in time and space from the original outrages that led modern religion to form. Atheists in my opinion are statistically more knowledgable than believers, simply because to become an atheist requires an act of intellectual revolt, to shed off the fetters of authority. To become a theist again after being an atheist requires a second layer of intellectual revolt. Perhaps there is a third layer, but I don't think so. Generally, it is not worthwhile to debate whether ideas are right or wrong based on the perceived intelligence of those that hold them. For examples, in physics. The "intelligent" folks in Galileo's time were opposed to pure heliocentrism and to pure geocentrism both--- they opposed geocentrism because Venus and Mercury obviously go around the sun, and they opposed heliocentrism because a moving Earth would lead to huge winds and people flying into the air (they didn't understand inertia). Needless to say, the stupid folks were right. Similarly, in Columbus's day, people who were intelligent thought that he was doomed, because the Earth was too big. Columbus's stupidity is particularly well attested--- until his death he refused to believe that he hadn't gotten to India. He was also morally bankrupt, a slaver, a bigot, and his great contribution to the world was institutionalized colonialism and genocidal atrocity. But, stupid or not, he found America roughly where he thought it should be. I guess that his certainty was based on maritime intuitions of the Pacific sailing community about the patterns of waves and wind, which indicated to someone that there was a land mass relatively nearby to the west. This is just a guess. There might also have been legends of Viking voyages floating around. Likewise, in the 1950s, every intelligent person (at least every academic) advocated a mixed economy, half communist, half capitalist, for newly independent third-world countries, so as to have the best of both worlds. Only stupid people advocated a pure market economy. The pure-marketeers, had their way in Japan, while the academics had their way in India. India became a mixed economy, with both private and large public sectors, while Japan became a pure market economy similar to the US. I don't have to tell you how that turned out. Again, the stupid people were right, even though their

arguments were weak. Generally, the intelligence of the person is measured by how original an idea is, not how correct it is. Very smart people are often very wrong. Einstein believed black holes would not form due to rotational instability. Pauli believed time on a particle's path could not be a quantum property like position. Feynman dismissed S-matrix theory as a dead end, and later string theory. Everyone makes mistakes. The real issue here is authority--- atheists have a lot of secular authority in the US, as the wealthiest people who run large businesses tend to be Ayn Rand style atheists. Likewise, religious people have a popular majority and dominate politics. Neither side can claim any paucity of intelligence, but both sides are annoyed at the authority of the other But it is true that there are some forms of religious belief which are just not very smart, like believing that Darwin's evolution is fake, or that praying for something will get you something. This type of religious belief, the supernatural and superstitious kind, is on the wane.

Do atheists have a standard definition of "God"? If not, what is it that they disbelieve?

God is a personification of the universal superrational strategy for asymmetric games. This is "ethical God", and it is what religions are pushing predominantly. In addition to this notion, which is interesting, important, and true, there are other notions which are ridiculous: 1. Creator God: created the universe, set it in motion. 2. Snoopy God: snoops on you while you have sex, and waggles his finger. 3. Supernatural God: looks at the list of daily prayers, and comes down and rearranges atoms to make things better for religious folks. These things are ridiculous to anyone who has any sort of scientific sense. The creation of the universe from outside (as opposed to its evolution from inside) is not something which can be probed by instruments of tests, and you can believe whatever you want about it, including that

the universe was created 3 minutes ago, or it hasn't been created yet, we are just in the "false memory" stage right now. These questions are meaningless in the sense of Carnap, and this debate is just ridiculous, nobody needs to worry about it, because there is no sense in it. Snoopy God is sort of like saying that when you hand-calculate pi to 20 digits, and you get the last 6 digits wrong (this happened to me), you have somehow tried to change the value of pi, and pi gets angry and comes to haunt you in your dreams, then banishes you to mathematician's hell. It doesn't. But you still made a mistake. The problem is that the ethical God baby, the self-consistent entity whose desire is absolute good, is thrown out with the superstitious bath. If these concepts are separated clearly, I think there will be no more debate, or rather, the debate will be about the best course of human action in various circumstances, given circumstances of tradition and history, rather than about superstitious or positivistically meaningless nonsense. The debate on ethical behavior is informed by the knowledge that there is a self-consistent notion of superrational ethics extending to all games, and that some 3rd century saints and martyrs had an inkling of this, and made all sorts of arguments about how to determine the universal ethical good which one should not ignore. A related concept is the concept of eventual determination of the truth or falsity of every arithmetic statement from a strong enough axiom of higher infinity. This is tantamount to the idea that by approximating ordinals closer and closer to the Church-Kleene ordinal, one creates mathematical systems which are ever closer to the otherwise hard-to-define concept of arithmetical truth. The concept of Arithmetical truth is generally an article of faith of mathematicians, and the idea that one can approach it by evolutionarily producing bigger ordinal names is parallel to the idea that one can approach an understanding of God by debating ethics within historical time, while reading and accepting/rejecting the opinions in religious texts. Evolution is required, because no fixed system is going to produce all arithmetic truths.

Committed theists find the existence of God to be evident and deeply compelling. How do theists account for the fact that some people are not convinced by the same evidence?

The real problem is that atheists and theists are talking at cross purposes. The concept of God is not what atheists think it is, and it isn't exactly what theists make it out to be either. God is not a supernatural magic being that can do whatever to make your cancer go away. That's not what the word means, and when people use it in this sense, they are delusional, or engaged in magical thinking, and the atheists are right to heckle them out of their delusion. What God is all about is the ethical order of the universe, and usually we obtain this knowledge through intuitions and vague feelings, because it's not like we have a successful rational system of ethics, that can tell us how we are supposed to behave in all circumstances. The problem with the rational ethical systems is that they are not very consistent. The illustration of this comes with the prisoner's dilemma, where two people are in a room, and if they both cooperate with each other and don't talk, they both get off scott free. But if one rats out the other, he gets a reward, like say, 100 dollars, and the other goes to jail for 20 years. But if both rat out each other, they both go to jail for 15 years. So do they rat? Rational ethics, at least as normally defined in economics books, says they should rat, because whatever the other person does, you're better off ratting. If he doesn't rat, you get an extra $100, and if he does rat, by ratting, you reduce your sentence by 5 years. The Nash-equilibrium in this case is both ratting each other out, and that this type of thing can be used to railroad people into confessing to crimes they didn't commit, as the case of the central park five illustrates. The resolution to the symmetric prisoner's dilemma was given by Douglas Hofstadter in 1980. The key point is that when making a decision, one should consider that one's decision is correlated with the other person's decision, through the fact that both

decisions are coming from a universal algorithm--- namely they are both figuring out the answer to a well defined problem. If we assume this is a well defined problem (and it certainly looks like one), then one ends up with the conclusion that both folks should find the same answer. The thing is, once you know the answer is going to be the same, then it is a simple matter of asking yourself "which is better for me, if we both rat, or if we both don't?" This resolution is satisfying, but it leaves an article of faith--- namely, we need to assume there is a unique answer in order to find out what it is! If we assume that the answer is not unique, or if the answer is somehow uncorrelated, or if you start with some other assumption, the economic answer always comes out as the right one. Hofstandter's superrationality solves the ethics problem for symmetric games. There is nothing more to say. It is mathematically precise, and it defines what it means to behave ethically in a prisoner's dilemma type situation. The main issue with this is the requirement of symmetry. You are assuming that the outcomes are the same for both participants to derive the answer for one from the answer for the other. What do you do when the situation is not symmetrical? In this case, the proper generalization is to assume there is a unique answer to all games, to every collection of outcomes. This unique answer for play should be self-consistent in the Von-Neumann Morgenstern sense. You should not get into contradictions when you play probabilistic games with various weights, and the results should be continuous. This implies, through the Von-Neumann Morgenstern theorem that there is a utility function associated with this universal strategy, and this utility function can be defined to be the will of God. God is simply the entity whose desire is the universal strategy. Since it is useful for collectives to behave superrationally, human beings are capable of sensing the superrational universal ethics instinctively, without conscious awareness that this is what is going on. This is the voice of God. The ethical thing doesn't give any material substance to God, it isn't made of atoms, nor does it have weight. It's an abstraction, like pi. While pi can't smite you for measuring the circumference of a circle wrong, it still, in some abstract way, guarantees that the circumference is what it is, and that if you don't get pi times the diameter, you did something wrong. God is a similar

construction for mathematical ethics. Whether you say God "exists" or "does not exist" to me is unimportant, because it is meaningless in the sense of Carnap, in the sense of logical positivism. I don't even know if I "exist" for goodness sake. Or you. Or anything. It's not a question I can assign sense-perceptions to, so I can't make it meaningful. But the idea that there is a consistent universal superrational strategy for asymmetric games, this I find plausible. Further, that Christianity and the teachings of Christ are important guidelines for finding this strategy, I also find compelling. So in the end, the atheist and the theist are arguing over peripheral issues. On the peripheral issues, I agree with the atheist. There are no miracles, there never were, the world is ancient, we come from monkeys, and religious texts are written by humans. But on the central message--- that the religious texts are written by humans who are aware of what God is, of the fact that there is a universal superrational strategy--- on this I agree with the theists. I think that this is the resolution to this question, and we can move on to more pressing things now. I wrote a more detailed explanation here: http://christianity.stackexchang.... The idea of nonsymmetric superrationality coinciding with monotheistic religion is original to me, but it is just obvious once you understand Douglas Hofstadter's superrationality well.

If God doesn't exist, why did He talk to me last night?

This is a reply to the question, embedded as a reply to both atheists and theists. I also had the experience of God talking to me, and I would like to say right off the bat that I was a confirmed and practicing atheist for all my life, until the age of 30, when this happened. I would no longer describe myself as an atheist, but the funny thing about this is that none of my factual knowledge about the world has changed in the transition. I didn't start believing that the

world was created in 6 days, or that there were any supernatural events in its past, or that anyone came from the dead (in the material sense), or a virgin birth, or anything like that. But I understood why people would find it important to lie through their teeth and say that this stuff happened, and keep lying in the face of overwhelming evidence to the contrary. God is important, and to some, it is more important than scientific truth. I don't believe the two concepts are contradictory, because I think both are true, and truth doesn't contradict other truth. So although I get the concept of God, I don't believe in any of the dogmas of religious authorities. I support gay marriage, and I like religious rebellion, people finding new ways in response to new circumstances. I will not accept a religious authority telling me what God thinks, or that any text is infallible, because I don't believe in infallible things in this world. But I get the whole God business now, where I didn't before, so I feel I can speak to atheists in a way to make the whole thing make sense to them, in a way that other people of faith cannot. Because I know what the problem is--- the problem is not God, it is the supernatural picture of God painted in the fairy tales in the Bible. God is not supernatural. Nor is God even particularly counterintuitive. it is a description of the universal ethics, as (correctly) personified in a super-smart individual, which makes decisions on right and wrong. God is described as omnipotent, omniscient and omnipresent. It is more precise to say God is impotent, unchanging, and abstract. But, though the actions of people who have faith, God can work certain types of miracles. Miracles like toppling the Roman empire and getting rid of human sacrifice. Miracles like abolishing slavery, and instituting charity. The world with religion is slightly better than the world without, although the world with a future religion, I hope, is better than the world with the present religions, which are authoritative, and generally require you to check your brain at the door. First, I must pause to say how my religious experience came about. I read The 120 Days of Sodom, by Marquis de Sade. The reason I read this work is because I read a longish short story by Sade, which was, to my mind, the first transgender story ever written, and I became compulsively interested in the how the 1790s allowed a story like this to get written, a story which better belongs in

the 1970s. Sade is a fantastic and engaging writer, writing full-blown 19th century style at the end of the 18th century, except he is more taboo-busting than any of the Brontes. He is more subversive than any literature before or since, with the possible exception of some pamphlets in the 1960s (like the SCUM manifesto, or the Discordianism documents), which lived on in the 1990s, on usenet. The general pattern of taboo eradication on usenet was what led me to Sade. I needed to know how someone could be writing usenet at the turn of the 19th century. Sade is writing during the pamphleteering era, the French Revolution, and his writing is in a society where free speech is new and celebrated, the more free the better. In this sense, he is writing on his era's usenet. Anyway, while reading Sade, one has a disorienting psychological experience. He tells you of debauchery, sexual stuff, and horrific crimes, side by side, and mixes it with the most authoritarian of totalitarian power. He links the sex impulse and the authority impulse, and enhances the link. The sexual things become more and more depraved with each page, and the authority becomes more and more totalitarian, until he is describing outright sex murders, and complete and total dehumanization of both victim and perpetrator. The funny thing is that you don't become titillated (at least, I found it impossible to find it sexy), because Sade engages in authorly tricks. He has a bowl of human feces, which, whenever something the least bit titilating is happening, somebody grabs a turd from the bowl and eats it. It's like the treatment in the movie "A Clockwork Orange". Every time something sexy is happening, it is mixed in with a crime, and with the eating of a turd, and you get this nausiating mixture of sexual thoughts and revulsion. By the end of Part I of the book (the only part fully written), I was physically sick. I had a headache and a stomacheache. Reading Parts II,III,IV took a very short time (they are only sketches), and it didn't help, the nausea and headache just got worse. The problem for my atheist mind was that the absurdly cartoonishly abhorrent ethically behavior of the villains is combined with insanely long rationalizations, which individually are not enough to persuade, but which in their self-consistency and length, are genuinely persuasive and get you to think the way the villains do, so that you understand exactly why they think

they should continue to behave in this terrible way. I will give an example, although I can't do justice to Sade: Innocent: But if you kill a person, you will feel guilty. You will have pangs of guilt and suffer from your conscience. Villain: Ah, that is true for the first murder. This is why you must not stop at one. You must continue to murder, and murder more, because with each victim, the voice of conscience diminishes in amplitude, until it is thoroughly suppressed, and then you can continue to murder with no feelings whatsoever. Innocent: But surely your victims desire to live outweighs your desire for amusement? Villain: This is only so from a false point of view. Why should my amusement be beholden to any restrictions from my victim? My victim is but a plaything, and has no power to manipulate me, except to the extent that I grant this right. Why should I, the strong, grant this right, to this weak unworthy creature? Why should I not take what is rightfully mine, as the strong, and amuse myself with this creature's death? It is only superstition that prevents you from doing so. Innocent: But what about the voice of God, that calls to you to respect your fellow brother? Villain: What is this voice but superstition? It is just a fable made up by the priests to amuse themselves by gaining their powerful position. They will just amuse themselves with their own crimes, and let us amuse ourselves with ours. The only justice is that of strength--- let the strong rule. And so on and so on. The same sort of thing is done in "Philosophy in the Bedroom", and "Justine"/"Misfortune of Virtue", and in many of Sade's short stories. The problem is that the arguments are reasonable, and they carry force of logic, in that it is consistent to believe these awful things. And yet, as a human being, it is impossible to believe these things. Your mind rebels, and the rebellion makes reading Sade (at least for the atheist) a torture, it feels like your soul is being murdered by the logic of the villains. When I went to bed that night, and I tossed and turned, horrified. Could the world be like this? How could the world be this way? And yet, it seems that it is. This state is what Christians describe as Hell, although I would have called it moral anguish, it is the same thing. Sade is writing science fiction of a sort. He is describing a world without God. I woke up in the middle of the night with the feeling of a comforting presence, which was

assuring me that the descriptions in Sade are just not so, that this is not the order of the world, that it is just a lie. This feeling was that an external agent was calling me, telling me it would be ok. I am not delusional--- I know that there was nothing there in any physical sense, that anything I felt or percieved came from my own psychology. But this thing is universal human psychology. We all have a little antenna inside our head that can hear the word of God. It has nothing to do with creating the universe, or putting animals on a boat (although these are nicer kid-friendly illustrations of the concept than Sade's dugeons). I am not talking about a literal antenna, it doesn't work by radio waves, it's a moral antenna, and it derives it's wisdom from experience and collective memory, shared through our cultural stories. But the guidance comes nonetheless, and it comes with a force, and it is only when you _really_ reject this guidance, if you are a _real_ atheist, if you are one of Sade's villains, that you understand what God means, and what it means to reject it. In human history, only nietzsche attempted to reject God for real. I don't like nietzsche, because he is ripping off Sade. Except unlike Sade, he takes this contemptible world-view of the villain seriously, nietzsche isn't trying to show you the absurdity of the philosophy. This is why Sade was considered "The Holy Marquis" in his time. He was recognized as a writer of secular religious texts. If you want to know what God is, there is no better way than through reading Sade. Sade's influence is immense. He essentially invented the psychology of the modern villain, the 19th century Gothic story, the horror genre, and he was an important precurser to psychopathia sexualis, the study of sexual fetishes that eventually led to the Kinsey report and the sexual liberalization of the 20th century. The 20th century genre of film-noir also ows him a great debt, as noir also is the science fiction which asks "what would it be like in a world without God?" The feeling of God is distinct from the reality of God, and it is not enough to say one feels something to explain why it is true. You can feel a lot of things that just aren't so. I will argue that God is not one of these false intuitions. But as this window is unbearably slow, I will do so in another answer.