Does supersymmetry resolve the GZK paradox? Is string theory relevant to the resolution of the GZK paradox? If X is to string theory as Kepler's laws are to Newton's gravitational theory, then what is X? Is the GZK paradox important for the foundations of physics?

In 1966 Greisen, Zatsepin, and Kuzmin predicted that cosmic rays that have energies above the threshold limit of 5 * 10^19 eV would interact with the cosmic microwave background radiation via pion production. Thus cosmic rays that travel a distance greater than the GZK horizon distance of 50 megaparsecs should always have energies below this GZK limit of energy. However, a few cosmic rays have been reported with energies above the GZK limit, thus creating a possible GZK paradox. Various ideas have been suggested to resolve the GZK paradox.

http://en.wikipedia.org/wiki/GZK_limit

According to Wikipedia, "In particle physics, supersymmetry (often abbreviated SUSY) is a symmetry that relates elementary particles of one spin to other particles that differ by half a unit of spin and are known as superpartner. In a theory with unbroken supersymmetry, for every type of boson there exists a corresponding type of fermion with the same mass and internal quantum numbers (other than spin), and vice-versa.

There is no direct evidence for the existence of supersymmetry. It is motivated by possible solutions to several theoretical problems. Since the superpartners of the Standard Model particles have not been observed, supersymmetry must be a broken symmetry if it is a true symmetry of nature. This would allow the superparticles to be heavier than the corresponding Standard Model particles."

http://en.wikipedia.org/wiki/Supersymmetry

None of the superpartners of Standard Model particles seem to be likely candidates for explaining the GZK paradox. For example, the photino and gravitino do not seem to be plausible candidates for explaining the GZK paradox.

http://en.wikipedia.org/wiki/Photino

http://en.wikipedia.org/wiki/Gravitino

Let us assume that nature is finite and superstring snapping brings gravitational energy from the boundary of the multiverse to the interior of the multiverse. In that case, one might expect that

superstring (via snapping process) —> (mystery particle(s)) + (gravitational energy transferred from the boundary to the interior of the multiverse).

Could mystery particle(s) in the superstring snapping process explain the GZK paradox? If nature is infinite, then the answer to the preceding question is almost certainly "No!". Is there a decisive way of testing the hypothesis that nature is finite?

According to Einstein, "… it is contrary to the mode of thinking in science to conceive of a thing (the space-time continuum) which acts upon itself but cannot be acted upon. This is the reason why E. Mach was led to make the attempt to eliminate space as an active cause in the system of mechanics. According to him, a material particle does not move in unaccelerated motion relatively to space, but relatively to the centre of all the other masses in the universe; in this way the series of mechanical causes was closed, in contrast to the mechanics of Newton and Galileo. In order to develop this idea within the limits of the modern theory of action through a medium, the properties of the space-time continuum which determine inertia must be regarded as field properties of space, analogous to the electromagnetic field. The concepts of classical mechanics afford no way of expressing this."

"The Meaning of Relativity", (pages 55-56) 5th edition, 1953, A. Einstein

In general relativity theory, the fundamental tensor and the energy tensor act upon each other in a deterministic fashion. In M-theory, the problem of the infinite self-energy of fundamental particles is given a geometric solution. However, because of the mathematical possibilities of the string landscape, fundamental particles have an ambiguous self-energy which might, or might not, be resolved by the anthropic principle. In quantum theory there is probabilistic Markov branching with determinism restored only as a statistical average. In Greek geometry, the squareroot of the area of a square is the length of the side of that square. In physics, does the squareroot of mass have some meaning in terms of the foundations of physics? The Koide formula suggests that the answer to the preceding question might be "Yes!".

http://en.wikipedia.org/wiki/Koide_formula

In quantum field theory, one might say (according to Professor M. Strassler) that the electron gets most of its mass from the Higgs field. If reverse engineering of Feynman diagrams is possible, then does the Higgs field get part of its energy from the electron mass? If physics is totally unified, then space-time-energy should act upon mass, and, equally, mass should act upon space-time-energy. Let us assume that SO(64) is a satisfactory group for unifying space-time-energy. If the preceding assumption is true, then there might be precisely 64 elementary particles that provide a basis for the reverse engineering of Feynman diagrams. The Standard Model of particle physics has 61 elementary particles so that the addition of graviton and two other particles might constitute the completion of the Standard Model in terms of gravitational theory. If the preceding idea is not completely wrong, then supersymmetry would perhaps be merely an approximation to some finite model with superstring determinism.

http://en.wikipedia.org/wiki/Standard_Model

't Hooft has stated, "… I want to stress as much as I can that I am striving at a sound and interesting mathematical basis to what I am doing; least of all would I be tempted to throw away any of the sound and elegant mathematics of quantum mechanics and string theory. Symmetries, representation theory, and more, will continue to be central themes.

I am disappointed about the reception of my paper on string, as I was hoping that it would open some people's eyes. Perhaps it will, if some of my friends would be prepared to put their deeply rooted scepsis against the notion of determinism on hold.

I think the mathematics I am using is interesting and helpful. I encounter elliptic theta functions, and hit upon an elegant relation between sets of non-commuting operators p and q on the one hand, with integer, commuting variables P and Q on the other. All important features of Quantum Mechanics are kept intact as they should.

I did not choose to side with Einstein on the issue of QM, it just came out that way, I can't help that. It is also not an aversion of any kind that I would have against Quantum Mechanics as it stands, it is only the interpretation where I think I have non-trivial observations."

http://www.math.columbia.edu/~woit/wordpress/?p=5022 " 't Hooft on Cellular Automata and String Theory" (comments section), blog "Not Even Wrong", Aug. 13, 2012

Has 't Hooft failed to take into account the Milgrom Denial Hypothesis, which states that the main problem with string theory is that string theorists fail to realize that Milgrom is the Kepler of contemporary cosmology? Is quantum mechanics now good as it stands? The various infinities are the gods of the mathematicians. According to Edward Fredkin, infinities and infinitesmals do not occur in nature. A complete infinity is incompatible with Fredkin's philosophy of information processing. A potential infinity is merely the poor man's version of the complete infinity. If Fredkin's idea that the multiverse is finite and digital is true, then what should be the decisive empirical test? If nature is infinite and if smooth geometry works below the Planck scale, then the equivalence principle should be 100% valid for both real and virtual mass-energy. If nature is finite and digital, then the equivalence principle should fail in some dramatic way. Physicists perform measurements that establish that the equivalence principle is accurate to 14 decimal places, and then conclude that the dark-matter-compensation-constant is effectively zero. This might be true, but the reasoning is unsound. I claim that measured mass-energy obeys 100% the equivalence principle and nonmeasured mass-energy disobeys 100% the equivalence. According to me, dark matter is virtual mass-energy that has positive gravitational mass-energy and zero inertial mass-energy. I claim that an easy scaling argument shows that the concept of the positive dark-matter-compensation-constant is approximately equivalent to Milgrom's acceleration law when gravitational accelerations are low. Is it possible that Milgrom's non-relativistic MOND is empirically wrong?

According to McGaugh, "… we are missing something fundamental about the nature of our universe".

http://astroweb.case.edu/ssm/mond/ "The Basic Issue", "The MOND pages" by Stacy McGaugh

Einstein found his 16 field equations involving the fundamental tensor and the energy tensor by using Poisson's equation as a guide. The appearance of the constant -1/2 in the field equations is based on the idea that for the left-hand side of the equations "Its divergence must vanish identically."

"The Meaning of Relativity", (pages 83-84) 5th edition, 1953, A. Einstein

Replacing the -1/2 by -1/2 + dark-matter-compensation-constant is, one might say, hypothesizing that weird forces from alternate universes somehow occur in the observable universe. Following Bohr, I might say that every statement that I make should be understood as ending in two question marks — one from Bohr and one from Fredkin.

If nature has a finite, deterministic model then supersymmetry should appear, if at all, in some fashion that flagrantly contradicts the smooth geometry of string theory together with the infinite nature hypothesis. If nature has a finite, deterministic model, then the equivalence principle should fail in some spectacular fashion. In other words, there should be spectacular evidence against the smooth geometry of general relativity theory together with the infinite theory hypothesis. If the hypothesis that nature is finite and digital is empirically valid, then nature should give a clear signal that something extremely weird is happening. If nature does not give such a signal, then Fredkin, Wolfram, and 't Hooft are either wrong or not even wrong.

For those who doubt that -1/2 should be replaced by -1/2 + dark-matter-compensation-constant, consider the following thought experiment: Construct a super-accurate gyroscope and send it near the sun. If you believed that dark-matter-compensation-constant equals zero, then you would find that your super-accurate gyroscope is "malfunctioning" in a remarkably regular and predictable way. Has the preceding thought experiment already been put into practice?

http://en.wikipedia.org/wiki/Gravity_Probe_B