DOWNLOAD PDF NEED FOR A NEW THEORY: GENERAL RELATIVITY VS. QUANTUM MECHANICS

Chapter 1 : Super Physics Smackdown: Relativity v Quantum MechanicsIn Space - MIT Technology Revie

Nov 04, Â· Since the late s, a group of physicists and mathematicians have been developing a framework called string theory to help reconcile general relativity with quantum mechanics; over the years, it.

Relativity v Quantum Mechanics In Space The only way to study the conflict between relativity and quantum mechanics is to test them over enormous distances in space. And physicists are already making plans June 25, One of the great puzzles of modern science is that the laws that govern the universe on the largest scale are entirely different from the ones that govern on the smallest scale. This is why physicists are inextricably wedded to the idea that relativity and quantum mechanics must be manifestations of a bigger and better idea that encompasses them both. The differences between general relativity and quantum mechanics are so great that every attempt to reconcile them has so far failed. However, these attempts have been entirely theoretical and that gives them limited utility. For example, physicists routinely measure the quantum phenomenon of entanglement by sending entangled pairs of photons from one location to another. In these experiments, the sender and receiver must both measure the polarisation of the photons, whether vertical or horizontal, for example. But that can only happen if both parties know which direction is up. But it becomes much harder if they are separated by distances over which the curvature of spacetime comes into play. The problem here is that the answer is ambiguous and depends on the path that each photon takes through spacetime. The experimenters can work this out by tracing the path of each photon back to their common source, if this is known. Theorists can only guess. Another problem arises when these kinds of experiments are done with the sender and receiver travelling at relativistic speeds. Here the measurement of one entangled photon instantly determines the result of a future measurement on the other, regardless of the distance between them. If special relativity ensures that the order of events is ambiguous, what gives? Once again, theorists are at a loss. Of course, the way to answer these questions is to test them and see. Two groups have already proposed to do these kinds of experiments in space. One group wants to put a package capable of producing entangled photons on the International Space Station, for beaming back to Earth. Another wants to keep the quantum equipment on the ground and bounce photons off a simple microsatellite in low Earth orbit, an option they say will be cheaper, easier and better. Neither group has a launch date in mind or even the guaranteed funds to built their gear. But that could change, given the increasing level of interest in this area and the possibility that Chinese work could leapfrog western efforts. Beyond this, there are longer term options to beam photons from further afieldâ€"from the Moon or interplanetary spacecraft, for example. The bigger picture is that to find new physics, scientists need to push experiments to new limits. However, efforts are now afoot to explore this scale using atom interferometers. And until now, physicists have not been able to test quantum mechanics on the scale of general relativity, because the distances over which the curvature of space time become significant are so large. We saw just a few weeks ago that the record for teleporting quantum objects is only km , which is too little for general relativity to work its magic. The paradoxes of quantum mechanics were first debated by Einstein, Bohr and others in the s and 30s. The paradoxes raised by the meeting of quantum mechanics and relativity are just as old and arguably more profound. And yet, physicists have yet to begin a concerted effort to explore them experimentally. High time to grip this nettle.

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Chapter 2 : The Final Contradiction

These two areas of cosmology are represented respectively by quantum mechanics and general relativity. In the case of quantum mechanics, we have a world that operates on uncertainty, probability, and complimentarity.

In this universe there are huge objects like planets and stars. There are also sub-atomic particles like protons and neutrons. You may note that at sub-atomic sizes, the wave nature of particles cannot be neglected and that the particles move at very high speeds. Which theory of Physics explains satisfactorily the behavior of both? Classical theory propounded by Issac Newton? Or General theory of relativity given by Einstein? This post is an introductory article before our in-depth analysis of Standard Particle Model of Quantum Mechanics. Classical Mechanics for Macroscopic Objects Classical mechanics describes the motion of macroscopic objects such as spacecraft, planets, stars, and galaxies. The classical mechanics as known as Newtonian mechanics provides extremely accurate results as long as the domain of study is restricted to large objects and the speeds involved do not approach the speed of light. Quantum Mechanics handles the wave-particle duality of atoms and molecules. Thus it can be said that General theory of relativity is a super set of Special theory of relativity. But still Classical Mechanics is preferred to General theory of relativity for particles of macroscopic sizes, just because of its simplicity. Standard Particle Model of Quantum Mechanics One of the surprises of modern science is that atoms and sub-atomic particles do not behave like anything we see in the everyday world. They have wave properties, which is not observable in macroscopic objects. To describe this particular behavior, characteristics and interactions, scientists have developed a mathematical model known as Standard Particle Model. This model proposed two major groups of elementary particles of matter, ie. The model also proposed elementary force carriers known as Gauge Bosons and one Higgs Boson. Defining particles in a fixed curved background space-time is not yet well-understood except in some special cases. Also, the proposed but not yet discovered particle Gravition, responsible for Gravitational force, does not come under the scope of Standard Particle Model. When both quantum mechanics and classical mechanics cannot apply, such as at the quantum level with many degrees of freedom, Quantum Field Theory QFT becomes applicable. QFT deals with small distances and large speeds with many degrees of freedom as well as the possibility of any change in the number of particles throughout the interaction. The scheme of Quantum Field Theory is that fermions interact by exchanging bosons. We will see more about Fermions and Bosons later. To deal with large degrees of freedom at the macroscopic level, statistical mechanics becomes valid. Statistical mechanics explores the large number of particles and their interactions as a whole in everyday life. Statistical mechanics is mainly used in thermodynamics. It provides a non-quantum mechanical description of a system of particles, or of a fluid, in cases where the velocities of moving objects are comparable to the speed of light c. As a result, classical mechanics is extended correctly to particles traveling at high velocities and energies, and provides a consistent inclusion of electromagnetism with the mechanics of particles. This was not possible in Galilean relativity, where it would be permitted for particles and light to travel at any speed, including faster than light. The foundations of relativistic mechanics are the postulates of special relativity and general relativity. The unification of SR with quantum mechanics is relativistic quantum mechanics, while attempts for that of GR is quantum gravity, an unsolved problem in physics.

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Chapter 3 : A new â€˜Einsteinâ€™ equation suggests wormholes hold key to quantum gravity | Science Ne

So, naturally, physicists are currently looking for a theory that is in some sense more general than both general relativity and quantum theory (meaning, in this context, quantum field theory, which is much more involved than quantum mechanics) within which the two are unified.

Rex Features Craig Hogan, a theoretical astrophysicist at the University of Chicago and the director of the Center for Particle Astrophysics at Fermilab, is reinterpreting the quantum side with a novel theory in which the quantum units of space itself might be large enough to be studied directly. To understand what is at stake, look back at the precedents. It provided the conceptual tools for the Large Hadron Collider , solar cells, all of modern microelectronics. What emerges from the dust-up could be nothing less than a third revolution in modern physics, with staggering implications. It could tell us where the laws of nature came from, and whether the cosmos is built on uncertainty or whether it is fundamentally deterministic, with every event linked definitively to a cause. Small is beautiful Hogan, champion of the quantum view, is what you might call a lamp-post physicist: The clash between relativity and quantum mechanics happens when you try to analyse what gravity is doing over extremely short distances, he notes, so he has decided to get a really good look at what is happening right there. But Hogan questions whether that is really true. Just as a pixel is the smallest unit of an image on your screen and a photon is the smallest unit of light, he argues, so there might be an unbreakable smallest unit of distance: There would be no way for gravity to function at the smallest scales because no such scale would exist. Or put another way, general relativity would be forced to make peace with quantum physics, because the space in which physicists measure the effects of relativity would itself be divided into unbreakable quantum units. The theatre of reality in which gravity acts would take place on a quantum stage. Hogan acknowledges that his concept sounds a bit odd, even to a lot of his colleagues on the quantum side of things. Since the late s, a group of physicists and mathematicians have been developing a framework called string theory to help reconcile general relativity with quantum mechanics; over the years, it has evolved into the default mainstream theory, even as it has failed to deliver on much of its early promise. Like the chunky-space solution, string theory assumes a fundamental structure to space, but from there the two diverge. String theory posits that every object in the universe consists of vibrating strings of energy. Like chunky space, string theory averts gravitational catastrophe by introducing a finite, smallest scale to the universe, although the unit strings are drastically smaller even than the spatial structures Hogan is trying to find. Chunky space does not neatly align with the ideas in string theory â€” or in any other proposed physics model, for that matter. It would suggest new ways to understand the inherent nature of space and time. And weirdest of all, perhaps, it would bolster the notion that our seemingly three-dimensional reality is composed of more basic, two-dimensional units. What makes them drastically different is that he plans to put them to a hard experimental test. As in, right now. A living thing in two places at once? This quantum quandary test is limited Read more Starting in , Hogan began thinking about how to build a device that could measure the exceedingly fine graininess of space. As it turns out, his colleagues had plenty of ideas about how to do that, drawing on technology developed to search for gravitational waves. The name is an esoteric pun, referencing both a 17th-century surveying instrument and the theory that 2D space could appear three-dimensional, analogous to a hologram. Beneath its layers of conceptual complexity, the holometer is technologically little more than a laser beam, a half-reflective mirror to split the laser into two perpendicular beams, and two other mirrors to bounce those beams back along a pair of 40m-long tunnels. The beams are calibrated to register the precise locations of the mirrors. If space is chunky, the locations of the mirrors would constantly wander about strictly speaking, space itself is doing the wandering , creating a constant, random variation in their separation. For the scale of chunkiness that Hogan hopes to find, he needs to measure distances to an accuracy of m, about m times smaller than a hydrogen atom, and collect data at a rate of about m readings per second. Amazingly, such an experiment is not only possible, but practical. Hogan has his share of fierce sceptics, including many within the theoretical physics community. The reason for the disagreement is easy to appreciate: Despite this superficial sparring, though, Hogan and most of his theorist colleagues share a deep core conviction: The other three laws of physics follow quantum rules, so it makes sense that gravity must as well. Chunky space certainly aligns with that worldview. Hogan likens his project to the landmark Michelson-Morley experiment of the 19th century, which searched for the aether â€" the hypothetical substance of space that, according to the leading theory of the time, transmitted light waves through a vacuum. It will show the right way or rule out the wrong way to understand the underlying quantum structure of space and how that affects the relativistic laws of gravity flowing through it. A bigger vision If you are looking for a totally different direction, Smolin of the Perimeter Institute is your man. Where Hogan goes gently against the grain, Smolin is a full-on dissenter: Smolin thinks the small-scale approach to physics is inherently incomplete. Current versions of quantum field theory do a fine job explaining how individual particles or small systems of particles behave, but they fail to take into account what is needed to have a sensible theory of the cosmos as a whole. A more fruitful path forward, he suggests, is to consider the universe as a single enormous system, and to build a new kind of theory that can apply to the whole thing. And we already have a theory that provides a framework for that approach: Instead, all of reality is described in terms of relationships between objects and between different regions of space. Even something as basic as inertia the resistance of your car to move until forced to by the engine, and its tendency to keep moving after you take your foot off the accelerator can be thought of as connected to the gravitational field of every other particle in the universe.

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Chapter 4 : Quantum Mechanics vs. Relativity? | Yahoo Answers

Taking a larger view, the real issue is not general relativity versus quantum field theory, Carroll explains, but classical dynamics versus quantum dynamics. Relativity, despite its perceived strangeness, is classical in how it regards cause and effect; quantum mechanics most definitely is not.

It is the biggest of problems, it is the smallest of problems. At present physicists have two separate rulebooks explaining how natureâ€¦By Corey S. Powell It is the biggest of problems, it is the smallest of problems. At present physicists have two separate rulebooks explaining how nature works. There is general relativity, which beautifully accounts for gravity and all of the things it dominates: Then there is quantum mechanics, which handles the other three forcesâ€"electromagnetism and the two nuclear forces. Quantum theory is extremely adept at describing what happens when a uranium atom decays, or when individual particles of light hit a solar cell. Now for the problem: Relativity and quantum mechanics are fundamentally different theories that have different formulations. It is not just a matter of scientific terminology; it is a clash of genuinely incompatible descriptions of reality. The conflict between the two halves of physics has been brewing for more than a centuryâ€"sparked by a pair of papers by Einstein, one outlining relativity and the other introducing the quantumâ€"but recently it has entered an intriguing, unpredictable new phase. Two notable physicists have staked out extreme positions in their camps, conducting experiments that could finally settle which approach is paramount. Just as a pixel is the smallest unit of an image on your screen, so there might be an unbreakable smallest unit of distance: Max Tegmark By Michael Segal Max Tegmark, professor of physics at MIT, strode into the room smiling and laughing, and stayed that way for all of the couple of hours we spent together. That he takes the keenest pleasure from peering into the world In quantum mechanics, events produced by the interaction of subatomic particles happen in jumps yes, quantum leaps , with probabilistic rather than definite outcomes. Quantum rules allow connections forbidden by classical physics. This was demonstrated in a much-discussed recent experiment , in which Dutch researchers defied the local effect. They showed two particlesâ€"in this case, electronsâ€"could influence each other instantly, even though they were a mile apart. When you try to interpret smooth relativistic laws in a chunky quantum style, or vice versa, things go dreadfully wrong. Relativity gives nonsensical answers when you try to scale it down to quantum size, eventually descending to infinite values in its description of gravity. Likewise, quantum mechanics runs into serious trouble when you blow it up to cosmic dimensions. Quantum fields carry a certain amount of energy, even in seemingly empty space, and the amount of energy gets bigger as the fields get bigger. Go big enough, and the amount of energy in the quantum fields becomes so great that it creates a black hole that causes the universe to fold in on itself. Craig Hogan, a theoretical astrophysicist at the University of Chicago and the director of the Center for Particle Astrophysics at Fermilab, is reinterpreting the quantum side with a novel theory in which the quantum units of space itself might be large enough to be studied directly. To understand what is at stake, look back at the precedents. It provided the conceptual tools for the Large Hadron Collider, solar cells, all of modern microelectronics. What emerges from the dustup could be nothing less than a third revolution in modern physics, with staggering implications. It could tell us where the laws of nature came from, and whether the cosmos is built on uncertainty or whether it is fundamentally deterministic, with every event linked definitively to a cause. Craig Hogan, a theoretical astrophysicist at Fermilab, has built a device to measure what he sees as the exceedingly fine graininess of space. The Department of Astronomy and Astrophysics, the University of Chicago A Chunky Cosmos Hogan, champion of the quantum view, is what you might call a lamp-post physicist: The clash between relativity and quantum mechanics happens when you try to analyze what gravity is doing over extremely short distances, he notes, so he has decided to get a really good look at what is happening right there. But Hogan questions whether that is really true. Just as a pixel is the smallest unit of an image on your screen and a photon is the smallest unit of light, he argues, so there might be an unbreakable smallest unit of distance: There would be no way for gravity to function at the smallest scales because no such scale would exist. Or put another way, general relativity would be forced to make peace with quantum physics, because the space in which physicists measure the effects of relativity would itself be divided into unbreakable quantum units. The theater of reality in which gravity acts would take place on a quantum stage. The holometer will show the right way or rule out the wrong way to understand the underlying quantum structure of space. Hogan acknowledges that his concept sounds a bit odd, even to a lot of his colleagues on the quantum side of things. Since the late s, a group of physicists and mathematicians have been developing a framework called string theory to help reconcile general relativity with quantum mechanics; over the years, it has evolved into the default mainstream theory, even as it has failed to deliver on much of its early promise. Like the chunky-space solution, string theory assumes a fundamental structure to space, but from there the two diverge. String theory posits that every object in the universe consists of vibrating strings of energy. Like chunky space, string theory averts gravitational catastrophe by introducing a finite, smallest scale to the universe, although the unit strings are drastically smaller even than the spatial structures Hogan is trying to find. Chunky space does not neatly align with the ideas in string theoryâ€”or in any other proposed physics model, for that matter. It would suggest new ways to understand the inherent nature of space and time. And weirdest of all, perhaps, it would bolster an au courant notion that our seemingly three-dimensional reality is composed of more basic, two-dimensional units. Just as a TV picture can create the impression of depth from a bunch of flat pixels, he suggests, so space itself might emerge from a collection of elements that act as if they inhabit only two dimensions. What makes them drastically different is that he plans to put them to a hard experimental test. As in, right now. Starting in , Hogan began thinking about how to build a device that could measure the exceedingly fine graininess of space. As it turns out, his colleagues had plenty of ideas about how to do that, drawing on technology developed to search for gravitational waves. Beneath its layers of conceptual complexity, the holometer is technologically little more than a laser beam, a half-reflective mirror to split the laser into two perpendicular beams, and two other mirrors to bounce those beams back along a pair of meter-long tunnels. The beams are calibrated to register the precise locations of the mirrors. If space is chunky, the locations of the mirrors would constantly wander about strictly speaking, space itself is doing the wandering , creating a constant, random variation in their separation. For the scale of chunkiness that Hogan hopes to find, he needs to measure distances to an accuracy of meters, about million times smaller than a hydrogen atom, and collect data at a rate of about million readings per second. Amazingly, such an experiment is not only possible, but practical. Hogan has his share of fierce skeptics, including many within the theoretical physics community. The reason for the disagreement is easy to appreciate: A success for the holometer would mean failure for a lot of the work being done in string theory. Despite this superficial sparring, though, Hogan and most of his theorist colleagues share a deep core conviction: They broadly agree that general relativity will ultimately prove subordinate to quantum mechanics. The other three laws of physics follow quantum rules, so it makes sense that gravity must as well. Chunky space certainly aligns with that worldview. Hogan likens his project to the landmark Michelson-Morley experiment of the 19th century, which searched for the aetherâ€”the hypothetical substance of space that, according to the leading theory of the time, transmitted light waves through a vacuum. It will show the right way or rule out the wrong way to understand the underlying quantum structure of space and how that affects the relativistic laws of gravity flowing through it. Here on Earth, the clash between the top-down and bottom-up views of physics is playing out in academic journals and in a handful of complicated experimental apparatuses. Theorists on both sides concede that neither pure thought nor technologically feasible tests may be enough to break the deadlock, however. Fortunately, there are other places to look for a more definitive resolution. One of the most improbable of these is also one of the most promisingâ€”an idea embraced by physicists almost regardless of where they stand ideologically. Granted, these objects are more commonly associated with questions than with answers. They are not things you can create in the laboratory, or poke and prod with instruments, or even study up close with a space probe. At the outer boundary of the black holeâ€”the event horizonâ€”gravity is so extreme that even light cannot escape, making it an extreme test of how general relativity behaves. At the event horizon, atomic-scale events become enormously stretched out and slowed down; the horizon also divides the physical world into two distinct zones, inside and outside. And there is a very interesting meeting place in terms of the size of a black hole. A stellar-mass black hole is about the size of Los Angeles; a black hole with the mass of the Earth would be roughly the size of a marble. Black holes literally bring the big-small problem in physics home to the human scale. The importance of black holes for resolving that problem is the reason why Stephen Hawking and his cohorts debate about them so often and so vigorously. Quantum theory implies that a single particle could potentially exist both inside and outside the event horizon, which makes no sense. There is also the question of what happens to information about things that fall into a black hole; the information seems to vanish, even though theory says that information cannot be destroyed. Addressing these contradictions is forcing theoretical physicists to grapple more vigorously than ever before with the interplay of quantum mechanics and general relativity. Best of all, the answers will not be confined to the world of theory. Astrophysicists have increasingly sophisticated ways to study the region just outside the event horizon by monitoring the hot, brilliant clouds of particles that swirl around some black holes. An even greater breakthrough is just around the corner: Soon, possibly by , the Event Horizon Telescope should deliver its first good portraits. What they show will help constrain the theories of black holes, and so offer telling clues about how to solve the big-small problem. Human researchers using football stadium-size radio telescopes, linked together into a planet-size instrument, to study a star-size black hole, to reconcile the subatomic-and-cosmic-level enigma at the heart of physics â€¦ if it works, the scale of the achievement will be truly unprecedented. Black holes are the only place where the whole of quantum physics collides with general relativity in a way that is impossible to ignore. Observations at a European Southern Observatory in Chile have revealed not only the torus of hot dust around the black hole but also a wind of cool material in the polar regions. Where Hogan goes gently against the grain, Smolin is a full-on dissenter: Smolin thinks the small-scale approach to physics is inherently incomplete. Current versions of quantum field theory do a fine job explaining how individual particles or small systems of particles behave, but they fail to take into account what is needed to have a sensible theory of the cosmos as a whole. A more fruitful path forward, he suggests, is to consider the universe as a single enormous system, and to build a new kind of theory that can apply to the whole thing. And we already have a theory that provides a framework for that approach: Even something as basic as inertia the resistance of your car to move until forced to by the engine, and its tendency to keep moving after you take your foot off the accelerator can be thought of as connected to the gravitational field of every other particle in the universe. Consider a thought problem, closely related to the one that originally led Einstein to this idea in What if the universe were entirely empty except for two astronauts. One of them is spinning, the other is stationary. The spinning one feels dizzy, doing cartwheels in space. But which one of the two is spinning?

Chapter 5 : Superstring theory - Wikiquote

This theory is relativistic because it takes into account Special Relativity; quantum because it is formulated based on the principles of Quantum Mechanics; and it is a field theory because it combines the quantum theory with the notion of a classical force field, in this case Maxwell's electromagnetic field.

Why does relativity require space to be continuous? Why is it necessary to distinguish between the right and left point? Where is the boarder between distinguishing 2 atoms and fusing them together? Or are the 2 points only meant for theoretical points that are infinatly small? Are there other problems between QM and relativity? That show some photons that have come from a pulsar â€¦these photons have been measured to show that there may be a quantised state of spaceâ€¦because some of the photons are a tiny fraction slower due to interaction of small peices of clumpy spaceâ€¦ Stephen Tuck August 22, at Since all matter and space is composed of photons, the discrete quanta makeup the smallest packets of energy. The Planck Units are the minimums and maximums of energy. Planck Mass is when all frequency-energy the Time-component has converted into wavelength the Space-component; photonic-string length. Photons are not massless, which is why they impart momentum when they strike the surface of an object. Space does not have discontinualities because it behaves as Discrete, Multivariate Linear Equations. Differential Equations are incomplete approximations because if they had all the variables, they would be Multivariate Calculus Equations. The c-constant is an energy-constant like a base unit since the speed-of-light depends upon the Parameters-of-Space. That is why Gravitational Lensing could most accurately be described as Gravitational Refraction. The Physics behind light slowing-down as it travels through a glass of water is the same behind the bending of light around a massive object such as the sun. You are probably looking for terms like Abelian and non-Abelian, but such formalisms are of no practical importance in the TOE since Space is commutative and Euclidian in nature. Also, throw out imaginary numbers because they are the product of light-cone mapping, which is due to the incorrect treatment of Time as a spatial coordinate rather than as kinetic energy. If you study my work on ToeQuest, you will find that the predominate mathematical framework of physics is incorrect Lorentz-Invariance, Guage-Invariance. The preferred frame of reference is the Aether Rest-Frame because if you measure the universe from a frame-of-motion, the speed-of-light would appear superluminal due to Time-Dilation meaning that it is Lorentz-variant. That is why the Gravitational-Constant has seasonal variation due to mass-increase and time-dilation of the Lorentz transformation since the earth is moving at a different speed along its elliptical-orbit. Of course, if the photonic-string manifold of a particle changes size due to photonic-string lengthening; mass-increase , it means that matter is not Guage-Invarient because physically-meaningful quantities like mass and fiber-bundle size do change. The Higgs Mechanism is an incorrect theoretical construct because Spontaneous Symmetry Breaking explains nothing. The Higgs Mechanism is actually the Lorentz Mechanism, which is the action of the Lorentz transformations. We draw lines in the sand, but Quantum Mechanics is just Vector Calculus where Tensors are useful tools for group operations. The subatomic particles simultaneously interact at the Quantum Level forming stable orbits as kinetic-energy bonds. Things like the Lorentz Force take part in this orbital-stabilization between atoms in the Electron Perihelion Spheres of molecular formation. Stephen Tuck August 23, at 8: I have given some further thought to Space being Eiclidean. With Euclidean Geometry, you have to admit certain exceptions because physical objects are not completely rigid since they expand or contract. Thermodynamics itself is adding or removing energy in the form of heat infrared photons , that changes the physical properties of matter or physically-meaningful properties in terms of Guage-Invariance. It causes phase-change and the increase or decrease in the mass of an object as well as affecting its kinetic energy. Interestingly, this naturally leads to the Lorentz transformations. However, it is a stationary form of increased kinetic energy in which heating generally leads to an expansion decrease in density and cooling leads to a contraction increase in density. Instead of the normal effect of Time-Dilation of an object-in-motion, there is a increase in the rate of Time from heating because the frequency kinetic-energy Time-component increases rather than decreases. That is why heat increases the rate of chemical reactions. A transformation of Space Rotational Motion into Matter bound Linear Motion should be possible just as matter falling into a black hole converts into Space, causing the accelerated expansion of the universe. I would rather refer to the geometry of the universe as Lorentzian after the Lorentz transformations rather than Euclidean. It seems that the universe has Lorentzian Space rather than Euclidean Space. At the center of every galaxy lies a black hole, which is a point of universal expansion. It looks like I will have to look into Differential Equations as a means of the functional variation of the rate of expansion of Space using deterministic Multivariate Calculus for a rate-varying, differential coordinate system rather than for approximating the missing variables of Multivariate Calculus Equations as it is most often incorrectly applied! Stephen Tuck August 23, at 1: Previously, I had thought that it would take different varients of the equation rather than an integrated approach, but all varient forms should work together as seemless extensions of Quantum Mechanics. The trick is that the mechanics of a photon does not merely vanish when it wraps-up into a particle manifold. The thing is that the string Tension or Rigidity will correlate to the vibrational frequency and wavelength. Imagine a guitar string where the diameter of the string and the tension on the string produce a specific audio frequency pitch based upon the amount of vibration applied by the guitarist affecting the amplitude or loudness of the waves.

Chapter 6 : What is the relation between General Relativity and Newtonian Mechanics? - Physics Stack Ex

Apr 13, Â· Do General Relativity and Quantum Mechanics even need to be unified? originally appeared on Quora: the place to gain and share knowledge, empowering people to learn from others and better.

Theoretical concepts of both General Relativity and Quantum Mechanics have allowed us to comprehend and, in some cases, even predict physical phenomena taking place on atomic and subatomic scales, and on the scales of the entire Universe, so to speak. This is truly a fundamental achievement. The fact that the civilization inhabiting a planet revolving about an ordinary star in quite an ordinary galaxy have managed to figure out such astonishing aspects of the physical world really impresses. But scientific institutions are built in such a way that scientists, and physicists in particular, are not going to stop until they have come to the deepest understanding and have figured out all the aspects of the physical world. There is a good bit of evidence that GR and QM do not allow us to achieve this deepest understanding. This is what we touched upon in the first article of this series, and here we are going to consider this in a bit of detail. But as we saw earlier, there are situations where both these theories are necessary to get a picture of what is going on. The centre of a black hole and the Universe as a whole in the moment of the Big Bang are a couple of such examples. But our attempts to combine the two lead to nothing but a catastrophe. For example, when we combine the equations of these theories together, a reasonable question leads to an answer which makes no sense at all, such as a probability equalling not 20 or 75 or percent but infinity! But what does a probability greater than one, let alone infinity, even mean? In this case we have to conclude that there is a flaw in our understanding of physics. The Uncertainty Principle When Heisenberg derived his uncertainty principle physics concepts hugely shifted in a way which had never been imagined before. Probabilities, wave functions, quanta and all that demanded a radical change from a previously deterministic point of view. The uncertainty principle unambiguously brings about an indeterministic aspect into the physical framework. We considered this principle in the latest article, but for those who have not seen it, I should briefly mention what it leads to. According to the uncertainty principle, the Universe becomes extremely outrageous when we investigate space and time on micro scales. In the previous article we showed that there are some pairs of characteristics of a particle, whose exact values could not be known at the same time. In order to define the exact position of a particle you have to light it up bring a photon in contact with it. And if we decrease the energy of a photon, its wavelength increases, which brings a high uncertainty in the position of a particle. What this tells us is that the world is essentially chaotic on its tiniest of scales. This short explanation could bring up a natural question: No, this is not the case! But this example does not uncover all the stunning aspects of the uncertainty principle either. What this principle shows is that even in the calmest situation which we can imagine â€” a completely empty space â€" there is miraculous activity on the subatomic scales. And this activity increases as we investigate the space-time fabric on smaller and smaller scales. This conclusion is based on the fact that another pair of characteristics â€" energy and time â€" is also tied by the uncertainty principle. If you have a financial problem you could borrow some money to solve it, and then return the quantity back. Similarly, a particle could borrow energy from the Universe and then return it back. In this case though, the energy can be borrowed for a very short period of time. And the amount of this energy depends on how fast it will be returned. Thus, if a particle borrows energy for an infinitesimally small period of time, the amount of energy could be quite large. The uncertainty principle shows that the exact energy and momentum values are uncertain on subatomic scales. These values fluctuate from one to another in a completely spontaneous manner. It seems like nothing an empty region of space borrows energy and momentum from the Universe and gives them back all the time. And here is a twist. For example, if the fluctuation of energy is sufficiently large, the borrowed energy could be transformed into matter, and a pair of particles with opposite electric charges e. But because the energy must be returned very shortly, these particles immediately meet and annihilate each other, giving the energy off, hence they are called virtual particles. To speak a little bit more precisely, we can say that a region of space is empty when the intensity of all fields in that region is zero. But according to the uncertainty principle the amplitude of a wave and its rate of change are inversely proportional to each other. And since the intensity equalling zero implies zero amplitude, there is a high uncertainty in the rate of change of that amplitude, which means that at the next moment the amplitude will not be equal to zero! On average though, the amplitude remains undisturbed since in some places it takes a positive value whereas in others the value is negative. Quantum Mechanical uncertainty clearly shows that the Universe is highly blusterous and chaotic on its micro scales. But because the amount of borrowed energy on average equals the amount of returned energy, this tempestuous activity is never observed on normal scales. And as we shall see later, this chaos is the main obstacle for GR and QT to be merged together. Quantum Field Theory Throughout the s and s a huge number of physicists were working on finding a robust mathematical apparatus that would have helped to becalm the microscopic chaos. So he decided to make the first step towards the unified theory leaving Special Relativity out of consideration but providing a mathematical apparatus that was consistent with the idea of wave-particle duality and other experimental data. But later, physicists realised that Special Relativity is essential for the description of the microworld, since otherwise they did not take into account the interchangeability of matter, energy and momentum. Initially physicists focused on the unification of Special Relativity and the part of Quantum Mechanics which describes the electromagnetic field and its interaction with matter. This was one of the theories dubbed relativistic quantum field theory. QED is, without doubt, the most precise theory which has ever been developed. Physicists had been using it to derive the predictions using the most powerful computers at a time which then were experimentally confirmed to the precision of more than one billionth! What this means is that the results of theoretical considerations match experimental results up to nine decimal places and even more. This accordance of abstract mathematics with real-world experimental data is simply astonishing to say the least. The details of QED are so subtle and its role in physics is so vast that there are entire books written about it, for example this brilliant book by Richard Feynman, who was one of the main contributors to the development of QED. The success of QED has led other physicists to try to describe other forces â€” strong, weak and gravitational â€" in a similar way, through a quantum field theory. This approach has proved very successful for strong and weak nuclear forces. Physicists have been able to describe these forces by the means of a quantum field theory; as a result Quantum Chromodynamics and Electroweak theories emerged. The former describes strong force with a fantastic precision, while the latter shows that both electromagnetic and weak nuclear forces have the same origin! With the conditions of unimaginably high temperatures and energies â€" which the Universe had a fraction of a second after the Big Bang â€" these two forces manifest themselves as one unified force. In a work, for which Sheldon Glashow, Abdus Salam and Steven Weinberg were jointly awarded with a Nobel Prize in physics in , they showed that those two forces naturally merge together into one force in quantum field description even though they seem to have no commonalities in our cold Universe. In a fraction of a second after the Big Bang the temperatures dropped enough for these two forces to be separated out due to the process known as the spontaneous symmetry breaking which we shall consider later. Then the Universe continued to cool down so that we now have both these forces having very distinct properties. So by s physicists had got a very accurate description of three out of four fundamental forces of Nature â€" strong, weak and electromagnetic â€" and also showed that at least two of them can be unified in our physical framework. There have been many attempts to put strong nuclear force into this picture, in which case this would become a Grand Unified Theory, but so far no one has been able to accomplish this. However, the predictions of both Electroweak theory and Quantum Chromodynamics have been thoroughly tested with all sorts of adjustments, and so far this model has been proven correct countless times. Because of that, we call it the Standard Model of particle physics. Likewise, as we saw in the first article of this series, gluons and weak gauge bosons W- and Z-bosons represent the smallest components of strong and weak interactions respectively. Standard Model says that each of these particles is elementary, which means that they do not have any internal structure, just like quarks, electrons and neutrinos. Photons, gluons and weak gauge bosons provide a microscopic mechanism for the transmission of interactions between matter particles. For example, two electrically charged particles with the same electric charge repel each other because they are surrounded by the swarm of photons whose interaction, in a sense, transfers the information to the particles that they must be repelled of each other. Likewise, strong interaction is transmitted by gluons and weak interaction by weak gauge bosons. Symmetries You might have noticed that the quantum field theory leaves gravitational interaction behind the scene. But since we know that physicists successfully used this theory for the description of other forces, you might expect that such attempts were made. In such a theory, a particle carrying gravitational interaction would be graviton; and the connection of gravity with other forces becomes even clearer if we look at the examples of what is known as gauge symmetries. Even those who move with acceleration could reconcile it by putting the appropriate gravitational interaction in. Thus, gravity provides a symmetry: Likewise, strong, weak and electromagnetic interactions are connected to other symmetries, even though these symmetries are far more abstract than that of gravitation. In order to get an idea of these subtle sorts of symmetry, let us consider strong nuclear force. Symmetry steps in when we consider the interaction of quarks with a particular colour. All interactions between quarks with the same colour red-red, green-green and blue-blue are identical. Similarly, all interactions between quarks with different colours red-green, green-blue, blue-red are also identical. A good analogy could be drawn with a perfect sphere. A sphere is an example of a body having rotational symmetry: In such a sense, we could say that our Universe has the strong interaction symmetry: This symmetry is the example of gauge symmetry, as was mentioned earlier. This means that if there was no strong interaction, physical framework would change with such a colour shift. This shows that even though strong and gravitational interactions are so different, they are connected, in the sense that each of them is essential for maintaining certain kinds of symmetry. Moreover, the existence of electromagnetic and weak nuclear force is also connected to a certain kind of gauge symmetry. Therefore, all four known fundamental forces are directly connected to the principles of symmetry. This searching has been continuously kept up by many physicists for decades, but so far nobody has been able to accomplish it. In the last part of this article we shall try to figure out why this route has been so complex. In order to combine the laws of GR with those of QM we have to investigate the properties of space and time on the microscopic scales. Let us see what happens in this case. You can see the successive diminishing of scales in the figure 1. The bottom in this figure represents an empty region of space on our everyday scales, and each next level shows the tiny areas of the same region investigated on smaller and smaller scales. As you can see, initially â€" on the first three steps of magnification â€" nothing happens at all, the structure of space keeps its initial guise. If we continued to magnify this structure taking into account only classical physics, we would expect to see the same picture with every successive magnification, irrespective of how small the investigated scales are. Quantum Mechanics, however, radically changes this picture.

Chapter 7 : Relativity vs Quantum Mechanics - How do they conflict? | Yahoo Answers

I read that the foundations of quantum mechanics and general relativity are mutually exclusive, meaning that the validity of one implies invalidity of the other. Resolution of this is one of the inspirations for pursuiting a theory of quantum gravity.

Dilaton The dilaton made its first appearance in Kaluzaâ€"Klein theory , a five-dimensional theory that combined gravitation and electromagnetism. It appears in string theory. The impetus arose from the fact that complete analytical solutions for the metric of a covariant N-body system have proven elusive in general relativity. This outcome revealed a previously unknown and already existing natural link between general relativity and quantum mechanics. The field equations are amenable to such a generalization, as shown with the inclusion of a one-graviton process, [23] and yield the correct Newtonian limit in d dimensions, but only with a dilaton. Furthermore, some speculate on the view of the apparent resemblance between the dilaton and the Higgs boson. Finally, since this theory can combine gravitational, electromagnetic, and quantum effects, their coupling could potentially lead to a means of testing the theory through cosmology and experimentation. Nonrenormalizability of gravity[edit] Further information: Renormalization General relativity, like electromagnetism , is a classical field theory. One might expect that, as with electromagnetism, the gravitational force should also have a corresponding quantum field theory. However, gravity is perturbatively nonrenormalizable. The theory must be characterized by a choice of finitely many parameters, which could, in principle, be set by experiment. For example, in quantum electrodynamics these parameters are the charge and mass of the electron, as measured at a particular energy scale. On the other hand, in quantizing gravity there are, in perturbation theory, infinitely many independent parameters counterterm coefficients needed to define the theory. For a given choice of those parameters, one could make sense of the theory, but since it is impossible to conduct infinite experiments to fix the values of every parameter, it has been argued that one does not, in perturbation theory, have a meaningful physical theory. At low energies, the logic of the renormalization group tells us that, despite the unknown choices of these infinitely many parameters, quantum gravity will reduce to the usual Einstein theory of general relativity. On the other hand, if we could probe very high energies where quantum effects take over, then every one of the infinitely many unknown parameters would begin to matter, and we could make no predictions at all. It is conceivable that, in the correct theory of quantum gravity, the infinitely many unknown parameters will reduce to a finite number that can then be measured. One possibility is that normal perturbation theory is not a reliable guide to the renormalizability of the theory, and that there really is a UV fixed point for gravity. Since this is a question of non-perturbative quantum field theory, it is difficult to find a reliable answer, but some people still pursue this option. Another possibility is that there are new, undiscovered symmetry principles that constrain the parameters and reduce them to a finite set. This is the route taken by string theory , where all of the excitations of the string essentially manifest themselves as new symmetries. Effective field theory In an effective field theory , all but the first few of the infinite set of parameters in a nonrenormalizable theory are suppressed by huge energy scales and hence can be neglected when computing low-energy effects. Thus, at least in the low-energy regime, the model is a predictive quantum field theory. An example is the well-known calculation of the tiny first-order quantum-mechanical correction to the classical Newtonian gravitational potential between two masses. Background independence A fundamental lesson of general relativity is that there is no fixed spacetime background, as found in Newtonian mechanics and special relativity ; the spacetime geometry is dynamic. While easy to grasp in principle, this is the hardest idea to understand about general relativity, and its consequences are profound and not fully explored, even at the classical level. To a certain extent, general relativity can be seen to be a relational theory , [29] in which the only physically relevant information is the relationship between different events in space-time. On the other hand, quantum mechanics has depended since its inception on a fixed background non-dynamic structure. In the case of quantum mechanics, it is time that is given and not dynamic, just as in Newtonian classical mechanics. In relativistic quantum field theory, just as in classical field theory, Minkowski spacetime is the fixed background of the theory. String theory[edit] Interaction in the subatomic world: Although string theory had its origins in the study of quark confinement and not of quantum gravity, it was soon discovered that the string spectrum contains the graviton , and that "condensation" of certain vibration modes of strings is equivalent to a modification of the original background. Background independent theories[edit] Loop quantum gravity is the fruit of an effort to formulate a background-independent quantum theory. Topological quantum field theory provided an example of background-independent quantum theory, but with no local degrees of freedom, and only finitely many degrees of freedom globally. Semi-classical quantum gravity[edit] Quantum field theory on curved non-Minkowskian backgrounds, while not a full quantum theory of gravity, has shown many promising early results. In an analogous way to the development of quantum electrodynamics in the early part of the 20th century when physicists considered quantum mechanics in classical electromagnetic fields , the consideration of quantum field theory on a curved background has led to predictions such as black hole radiation. Phenomena such as the Unruh effect , in which particles exist in certain accelerating frames but not in stationary ones, do not pose any difficulty when considered on a curved background the Unruh effect occurs even in flat Minkowskian backgrounds. The vacuum state is the state with the least energy and may or may not contain particles. See Quantum field theory in curved spacetime for a more complete discussion. Problem of Time[edit] Main article: Problem of Time A conceptual difficulty in combining quantum mechanics with general relativity arises from the contrasting role of time within these two frameworks. In quantum theories time acts as an independent background through which states evolve, with the Hamiltonian operator acting as the generator of infinitesimal translations of quantum states through time. Candidate theories[edit] There are a number of proposed quantum gravity theories. They also face the common problem that, as yet, there is no way to put quantum gravity predictions to experimental tests, although there is hope for this to change as future data from cosmological observations and particle physics experiments becomes available. String theory Projection of a Calabiâ€"Yau manifold , one of the ways of compactifying the extra dimensions posited by string theory One suggested starting point is ordinary quantum field theories which are successful in describing the other three basic fundamental forces in the context of the standard model of elementary particle physics. However, while this leads to an acceptable effective quantum field theory of gravity at low energies, [27] gravity turns out to be much more problematic at higher energies. For ordinary field theories such as quantum electrodynamics , a technique known as renormalization is an integral part of deriving predictions which take into account higher-energy contributions, [35] but gravity turns out to be nonrenormalizable: In this way, string theory promises to be a unified description of all particles and interactions. Sorting through this large family of solutions remains a major challenge. Loop quantum gravity[edit] Main article: Its second idea is that the quantum discreteness that determines the particle-like behavior of other field theories for instance, the photons of the electromagnetic field also affects the structure of space. The main result of loop quantum gravity is the derivation of a granular structure of space at the Planck length. This is derived from following considerations: In the case of electromagnetism, the quantum operator representing the energy of each frequency of the field has a discrete spectrum. Thus the energy of each frequency is quantized, and the quanta are the photons. In the case of gravity, the operators representing the area and the volume of each surface or space region likewise have discrete spectrum. Thus area and volume of any portion of space are also quantized, where the quanta are elementary quanta of space. It follows, then, that spacetime has an elementary quantum granular structure at the Planck scale, which cuts off the ultraviolet infinities of quantum field theory. The quantum state of spacetime is described in the theory by means of a mathematical structure called spin networks. Spin networks were initially introduced by Roger Penrose in abstract form, and later shown by Carlo Rovelli and Lee Smolin to derive naturally from a non-perturbative quantization of general relativity. Spin networks do not represent quantum states of a field in spacetime: The theory is based on the reformulation of general relativity known as Ashtekar variables , which represent geometric gravity using mathematical analogues of electric and magnetic fields. One version starts with the canonical quantization of general relativity. These represent histories of spin networks. Other approaches[edit] There are a number of other approaches to quantum gravity. The approaches differ depending on which features of general relativity and quantum theory are accepted unchanged, and which features are modified.

Chapter 8 : Relativity vs Quantum Mechanics | Physics Forums

General relativity, on the other hand, is known as a "tensor theory" because there are all sorts of sources related to the pressure and flow and density of an energy distribution.

Jump to navigation Jump to search Superstring theory or supersymmetric string theory is an attempt to explain all of the particles and fundamental forces of nature in one theory by modelling them as vibrations of tiny supersymmetric strings. Since the second superstring revolution , the five superstring theories are regarded as different limits of a single theory tentatively called M-theory , or simply string theory. This science article is a stub. You can help Wikiquote by expanding it. Quotes[edit] Scientifically speaking, a butterfly is at least as mysterious as a superstring. When something ceases to be mysterious it ceases to be of absorbing interest to scientists. Almost all things scientists think and dream about are mysterious. Butterflies and Superstrings, p. First, the entire universe. Second, the planet Earth. Third, the nucleus of an atom. The step in size from each of these things to the next is roughly the same We might conclude, as Sir James Jeans concluded long ago, that the Great Architect of the Universe now begins to appear as a Pure Mathematician , and that if we work hard enough at mathematics we shall be able to read his mind. Or we might conclude that our pursuit of abstractions is leading us far away from those parts of the creation which are most interesting from a human point of view. It is too early yet to come to conclusions. Now I know that other old men have been very foolish in saying things like this, and, therefore, I would be very foolish to say this is nonsense. I am going to be very foolish, because I do feel strongly that this is nonsense! So perhaps I could entertain future historians by saying I think all this superstring stuff is crazy and is in the wrong direction. For example, the theory requires ten dimensions. Richard Feynman , interview published in Superstrings: A Theory of Everything? Davies and Julian R. Brown The notion of a smooth spatial geometry, the central principle of general relativity, is destroyed by the violent fluctuations of the quantum world on short distance scales. The equations of general relativity cannot handle the rolling frenzy of the quantum foam. Physicists have made numerous attempts at modifying either general relativity or quantum mechanics in some manner so as to avoid the conflict, but the attempts That is, until the discovery of superstring theory. Superstring theory starts off by proposing a new answer to an old question: For many decades, the conventional answer has been that matter is composed of particles Conventional theory claims, and experiments confirm, that these particles combine in various ways to produce protons, neutrons, and a wide variety of atoms and molecules Superstring theory tells a different story. And just as a violin string can vibrate in different patterns, each of which produces a different musical tone, the filaments of superstring theory can also vibrate in different patterns. All species of particles are unified in superstring theory since each arises from a different vibrational pattern executed by the same underlying entity. Brian Greene , in The Fabric of the Cosmos: Space, Time, and the Texture of Reality , p.

DOWNLOAD PDF NEED FOR A NEW THEORY: GENERAL RELATIVITY VS. QUANTUM MECHANICS

Chapter 9 : Will we ever unite quantum mechanics with general relativity? | HowStuffWorks

General Theory of Relativity extended the notion of Inertia to Spacetime (the scale which was established in Special Theory of Relativity). Plus, it turned down Newton's Gravitational Theories saying Gravity isn't real force.

Are you sure you want to delete this answer? Yes Sorry, something has gone wrong. Great question, and lots of good responses. I want to point something out: Many physicists prefer the quantum view of the universe over the general relativistic view in the sense that one is "more right" than the other. But a lot of the black hole jocks Hawking, Penrose, etc. The QFT guys disagree. Keep that in mind. Black holes represent the limits of GR - as matter becomes more and more dense inside a blackhole and even in Neutron stars , the energy density gets high enough that QFT is needed to really understand the physics. A blackhole in GR is explained as a singularity - the highly dense matter of the BH shrinks to a infinitesimally small point. So black hole physicists deal with the Event Horizon of the blackhole, not the singularity. This is where QFT comes in. Does something stop the collapse or does a true singularity really exist in nature? Now QFT treats the forces of nature as an exchange of particles. Two electrons "feel each other" because they keep sending photons back and forth. Furthermore, the vaccuum of space is constantly "bubbling" with virtual particles that come into and out of existance according to the Uncertainty Principle. Since gravity is caused by this curvature, quantizing gravity to treat it with QFT causes some bad mathematical results - namely infinities. It is, technically speaking, a non-renormalizable theory. Furthermore, no one can explain why gravity is so much weaker than the other forces. Think about it, every massive particle has gravity, but it takes entire planet-size masses for gravity to become important. OK, all that long explanation boils down to this: It has to do with how space is so "rough" on the small scale in the sense that particles keep popping in and out, thus causing gravity to fluctuate. Also gravity is so much weaker than the other forces that it is hard to unify it with them extra dimensions might solve this.