AN INFINITE NUMBER OF PARALLEL UNIVERSES pdf

1: Scientists may have found evidence of a parallel universe â€“ BGR

An Infinite Number of Parallel Universes is a beautiful story about love, acceptance, and what it means to have real friends that will be there for you no matter what. "The point is how you live, not how you die.

The second multiverse theory arises from our best ideas about how our own Universe began. According to the predominant view of the Big Bang, the Universe began as an infinitesimally tiny point and then expanded incredibly fast in a super-heated fireball. A fraction of a second after this expansion began, it may have fleetingly accelerated at a truly enormous rate, far faster than the speed of light. This burst is called "inflation". There are many, perhaps infinitely many, universes appearing and growing all the time Inflationary theory explains why the Universe is relatively uniform everywhere we look. Inflation blew up the fireball to a cosmic scale before it had a chance to get too clumpy. However, that primordial state would have been ruffled by tiny chance variations, which also got blown up by inflation. These fluctuations are now preserved in the cosmic microwave background radiation, the faint afterglow of the Big Bang. This radiation pervades the Universe, but it is not perfectly uniform. Several satellite-based telescopes have mapped out these variations in fine detail, and compared them to those predicted by inflationary theory. The match is almost unbelievably good, suggesting that inflation really did happen. View image of Just after the Big Bang Credit: The current view is that the Big Bang happened when a patch of ordinary space, containing no matter but filled with energy, appeared within a different kind of space called the "false vacuum". It then grew like an expanding bubble. Perhaps our Universe is simply one of a crowd But according to this theory, the false vacuum should also experience a kind of inflation, causing it to expand at fantastic speed. Meanwhile, other bubble universes of "true vacuum" can appear within it â€” and not just, like our Universe, This scenario is called "eternal inflation". It suggests there are many, perhaps infinitely many, universes appearing and growing all the time. But we can never reach them, even if we travel at the speed of light forever, because they are receding too fast for us ever to catch up. After Copernicus suggested Earth was just one planet among others, we realized that our Sun is just one star in our galaxy, and that other stars might have planets. Then we discovered that our galaxy is just one among countless more in an expanding Universe. And now perhaps our Universe is simply one of a crowd. View image of Credit: However, if eternal inflation does create a multiverse from an endless series of Big Bangs, it could help to resolve one of the biggest problems in modern physics. The fundamental constants of the laws of physics seem bizarrely fine-tuned to the values needed for life to exist Some physicists have long been searching for a " theory of everything ": But they have found there are more alternatives to choose from than there are fundamental particles in the known universe. Many physicists who delve into these waters believe that an idea called string theory is the best candidate for a "final theory". But the latest version offers a huge number of distinct solutions: Each solution yields its own set of physical laws, and we have no obvious reason to prefer one over any other. The inflationary multiverse relieves us of the need to choose at all. If parallel universes have been popping up in an inflating false vacuum for billions of years, each could have different physical laws, determined by one of these many solutions to string theory. If that is true, it could help us explain a strange property of our own Universe. View image of Bubble universes Credit: Things have to be the way we find them: Similarly, there is a delicate balance between gravity, which pulls matter towards itself, and so-called dark energy, which does the opposite and makes the Universe expand ever faster. This is just what is needed to make stars possible while not collapsing the Universe on itself. In this and several other ways, the Universe seems fine-tuned to host us. This has made some people suspect the hand of God. Yet an inflationary multiverse, in which all conceivable physical laws operate somewhere, offers an alternative explanation. View image of Other universes might be different to ours Credit: In the far more numerous universes that are set up differently, there is no one to ask the question. For many physicists and philosophers, this argument is a cheat: How can we test these assertions, they ask? Surely it is defeatist to accept that there is no reason why the laws of nature are what they are, and simply say that in other universes they are different? The trouble is, unless you have some other explanation for fine-tuning, someone will assert that God must have set things up this way. The astrophysicist Bernard Carr has put it bluntly: View image of

Two branes collide, creating a new universe Credit: In he proposed that universes might reproduce and evolve rather like living things do. On Earth, natural selection favours the emergence of "useful" traits such as fast running or opposable thumbs. In the multiverse, Smolin argues, there might be some pressure that favours universes like ours. He calls this "cosmological natural selection". The mother universe can do this if it contains black holes. View image of A black hole Credit: It is a neat idea, because our Universe then does not have to be the product of pure chance In the s, Stephen Hawking and Roger Penrose pointed out that this collapse is like a mini-Big Bang in reverse. This suggested to Smolin that a black hole could become a Big Bang, spawning an entire new universe within itself. If that is so, then the new universe might have slightly different physical properties from the one that made the black hole. This is like the random genetic mutations that mean baby organisms are different from their parents. If a baby universe has physical laws that permit the formation of atoms, stars and life, it will also inevitably contain black holes. That will mean it can have more baby universes of its own. Over time, universes like this will become more common than those without black holes, which cannot reproduce. View image of Could one universe create others? If a fine-tuned universe arose at random, surrounded by many other universes that were not fine-tuned, cosmic natural selection would mean that fine-tuned universes subsequently became the norm. So far, there is no evidence that this is the case The details of the idea are a little woolly, but Smolin points out that it has one big advantage: For example, if Smolin is right we should expect our Universe to be especially suited to making black holes. This is a rather more demanding criterion than simply saying it should support the existence of atoms. But so far, there is no evidence that this is the case â€" let alone proof that a black hole really can spawn an entirely new universe. View image of Extra dimensions could be curled up Credit: What might be in there? A hidden universe, maybe? Perhaps the fifth dimension was curled up into an unimaginably small distance This was nonsense. Einstein was not proposing a new dimension. What he was saying was that time is a dimension, similar to the three dimensions of space. All four are woven into a single fabric called space-time, which matter distorts to produce gravity. Even so, other physicists were already starting to speculate about genuinely new dimensions in space. The first intimation of hidden dimensions began with the work of the theoretical physicist Theodor Kaluza. But where, then, was this extra dimension? The Swedish physicist Oskar Klein offered an answer in Perhaps the fifth dimension was curled up into an unimaginably small distance: In the modern version of string theory, known as M-theory, there are up to seven hidden dimensions The idea of a dimension being curled may seem strange, but it is actually a familiar phenomenon. A garden hose is a three-dimensional object, but from far enough away it looks like a one-dimensional line, because the other two dimensions are so small. This seeks to explain fundamental particles as the vibrations of even smaller entities called strings. When string theory was developed in the s, it turned out that it could only work if there were extra dimensions. In the modern version of string theory, known as M-theory, there are up to seven hidden dimensions. They can be extended regions called branes short for "membranes" , which may be multi-dimensional. If branes collide, the results could be monumental A brane might be a perfectly adequate hiding place for an entire universe. M-theory postulates a multiverse of branes of various dimensions, coexisting rather like a stack of papers. If this is true, there should be a new class of particles called Kaluza-Klein particles. In theory we could make them, perhaps in a particle accelerator like the Large Hadron Collider. They would have distinctive signatures, because some of their momentum is carried in the hidden dimensions. These brane worlds should remain quite distinct and separate from each other, because forces like gravity do not pass between them. But if branes collide, the results could be monumental. Conceivably, such a collision could have triggered our own Big Bang. It has also been proposed that gravity, uniquely among the fundamental forces, might "leak" between branes. This leakage could explain why gravity is so weak compared to the other fundamental forces. If their idea is true, there is an awful lot of space out there for other universes As Lisa Randall of Harvard University puts it: In effect this means that a brane "concentrates" gravity, so that it looks weak in a second brane nearby. This could also explain why we could live on a brane with infinite extra dimensions without noticing them. If their idea is true, there is an awful lot of space out there for other universes. View image of This cat is both dead and alive Credit:

AN INFINITE NUMBER OF PARALLEL UNIVERSES pdf

2: An Infinite Number of Parallel Universes by Randy Ribay

The concept of parallel universes is an idea that arises from the multiverse theory, suggesting that our universe is one of many existing universes that, in a manner of speaking, lie parallel to.

Pocket The challenge that the multiverse poses for the idea of an all-good, all-powerful God is often focused on fine-tuning. If there areâ€¦By Dean Zimmerman The challenge that the multiverse poses for the idea of an all-good, all-powerful God is often focused on fine-tuning. But some kinds of multiverse pose a more direct threat. The many-worlds interpretation of quantum physicist Hugh Everett III and the modal realism of cosmologist Max Tegmark include worlds that no sane, good God would ever tolerate. The theories are very different, but each predicts the existence of worlds filled with horror and misery. Of course, plenty of thoughtful people argue that the Earth alone contains too much pain and suffering to be the work of a good God. For example, there is no forgiveness, courage, or fortitude without at least the perception of wrongs, danger, and difficulty. The most impressive human moral achievements seem to require such obstacles. Still, many horrifying things happen with nothing seemingly gained from them. Someone like myself, who remains attracted to the traditional picture of God as loving creator, is bound to find such consequences shocking, and will wonder just how strong the evidence is for these theories. According to Tegmark, for every possible way in which mathematical models dictate that matter can be consistently arranged to fill a spacetime universe, there exists such a universe. But in the s, Everett proposed a bold alternative. There are some complete copies of the universe in which the coin lands heads, and in others tails. And this applies to all other physical statesâ€”not just flipping coins. These slight differences create multiple overlapping universes, all branching off from some initial state in a great world-tree. Old-fashioned quantum theory assigns a tiny likelihood to things going really badly in the future. It also implies that, from any point in our actual past, things could have gone much worse than they actually did. Since the many worlds interpretation takes these possibilities as actual occurrences, it predicts that there are branching universes in which things do go as awfully as possible. For example, whenever there is a minute chance of a catastrophe that leaves all human beings utterly miserable but just barely healthy enough to reproduce, there is a branch in the world-tree in which this sorry state of affairs actually happens, generation after generation. So there are worlds in which the emergence of the human race proves to be an unmitigated tragedyâ€”or so it seems. How many Harvard professors have you heard of who have their own restaurant, much less one with a gastronomy manifesto? Once you get to know David Edwards, a biomedical engineer and If God prevents the worst universes from emerging on the world-tree, then the deterministic law would not truly describe the evolution of the multiverse. And so, even the worst parts of an Everettian multiverse are just particularly ugly versions of planet Earth. If an afterlife helps to explain our seemingly pointless suffering, then it would help explain the seemingly pointless suffering in even the worst of these Everett worlds, if we suppose that everyone in every branch, shows up in an afterlife. Although beloved by Oxford philosophers and accepted by a growing number of theoretical physicists, the theory remains highly controversial, and there are fundamental problems still being hashed out by the experts. Most philosophers talk about possible worlds as abstract things, like numbers, located outside of space and time, and as if they are very different from the actual world, which is substantial and made out of good old-fashioned matter. Tegmark agrees that other merely possible universes are abstract like numbers. But he denies that this makes them less real than the physical world. He thinks our universe is itself fundamentally a mathematical structure. Every physicist agrees that there is a set of mathematical entities standing in relations that perfectly models the distribution of fields and particles which a perfect physics would ascribe to our world. But Tegmark argues that our universe is identical to those mathematical things. If the world we inhabit is a purely mathematical structure, then all the other possible worlds we can imagine are equally real, their existence a necessary result of slightly different mathematical structures. For every possible way in which mathematical models dictate that matter can be consistently arranged to fill a spacetime universe, there exists such a universe. These possible arrangements of matter are bound to include ones corresponding to miserable universes full of pointless sufferingâ€”universes like all of the worst branches in the Everettian world-tree, and infinitely many more just as bad. But there would also be worlds that are worse. Jacopo Werther According to Tegmark, every possible story about living creatures that can be told by means of a mathematical model of the underlying physical facts is a true story. And, infinitely many of these worlds will not last long enough for their inhabitants to enjoy an afterlife. Adding insult to injury, since the horrifying worlds are consequences of pure mathematics, they exist as a matter of absolute necessityâ€”so there is nothing God can do about it! The resulting picture will remain offensive to pious ears: A God who loved all creatures, but was forced to watch infinitely many of them endure lives of inconsolable suffering, would be a God embroiled in a tragedy. But there is still hope for the theist. Take, for example, his claim that the physical universe is a purely mathematical structure: Why should we accept this? Ordinarily, physicists use mathematical structures as models for how the physical world might work, but they do not identify the mathematical model with the world itself. But why think that the only objective descriptions that can truly apply to things as they are in themselves are mathematical descriptions? So far as I can see, he never justifies this assumption. Every theist should take seriously the possibility that there might exist more universes, simply on the grounds that God would have reason to create more good stuff. Indeed, an infinitely ingenious, resourceful, and creative Being might be expected to work on canvases the size of worldsâ€”some filled with frenetic activity, others more like vast minimalist paintings, many maybe even featuring intelligent beings like ourselves. And the theories of physicists such as Alan Guth and Andrei Lindeâ€—whose multiverse is an eternally inflating field that spins off baby universesâ€—or Paul Steinhardt and Neil Turokâ€—whose multiverse amounts to an endless cyclical universe punctuated by big bangs and big crunchesâ€—are arguably compatible with this theological vision. It may turn out that our world is fairly middling, one among the many universes that were good enough for God to create. And the idea of a multiverse consisting of disconnected spacetime universes may make it easier to believe that our worldâ€—our universeâ€—is a part of a larger one that is on balance very good and created by a perfectly benevolent deity. Follow him on Twitter deanwallyz.

3: 5 Reasons We May Live in a Multiverse

Accordingly, an infinite universe will contain an infinite number of Hubble volumes, all having the same physical laws and physical constants. In regard to configurations such as the distribution of matter, almost all will differ from our Hubble volume.

History of the concept[edit] In his book, Opticks , Isaac Newton suggested the idea of a multiverse: At least, I see nothing of Contradiction in all this. He said that when his equations seemed to describe several different histories, these were "not alternatives, but all really happen simultaneously". Multiple universes have been hypothesized in cosmology , physics , astronomy , religion , philosophy , transpersonal psychology , and literature , particularly in science fiction and fantasy. In these contexts, parallel universes are also called "alternate universes", "quantum universes", "interpenetrating dimensions", "parallel dimensions", "parallel worlds", "parallel realities", "quantum realities", "alternate realities", " alternate timelines ", "alternate dimensions" and "dimensional planes". The physics community has debated the various multiverse theories over time. Prominent physicists are divided about whether any other universes exist outside of our own. Some physicists say the multiverse is not a legitimate topic of scientific inquiry. The ability to disprove a theory by means of scientific experiment has always been part of the accepted scientific method. Feeney analyzed Wilkinson Microwave Anisotropy Probe WMAP data and claimed to find evidence suggesting that our universe collided with other parallel universes in the distant past. To be sure, all cosmologists accept that there are some regions of the universe that lie beyond the reach of our telescopes, but somewhere on the slippery slope between that and the idea that there are an infinite number of universes, credibility reaches a limit. As one slips down that slope, more and more must be accepted on faith, and less and less is open to scientific verification. Extreme multiverse explanations are therefore reminiscent of theological discussions. Indeed, invoking an infinity of unseen universes to explain the unusual features of the one we do see is just as ad hoc as invoking an unseen Creator. The multiverse theory may be dressed up in scientific language, but in essence it requires the same leap of faith. He accepts that the multiverse is thought to exist far beyond the cosmological horizon. He emphasized that it is theorized to be so far away that it is unlikely any evidence will ever be found. Ellis also explained that some theorists do not believe the lack of empirical testability falsifiability is a major concern, but he is opposed to that line of thinking: Many physicists who talk about the multiverse, especially advocates of the string landscape , do not care much about parallel universes per se. For them, objections to the multiverse as a concept are unimportant. Their theories live or die based on internal consistency and, one hopes, eventual laboratory testing. Ellis says that scientists have proposed the idea of the multiverse as a way of explaining the nature of existence. He points out that it ultimately leaves those questions unresolved because it is a metaphysical issue that cannot be resolved by empirical science. He argues that observational testing is at the core of science and should not be abandoned: In looking at this concept, we need an open mind, though not too open. It is a delicate path to tread. Parallel universes may or may not exist; the case is unproved. We are going to have to live with that uncertainty. Nothing is wrong with scientifically based philosophical speculation, which is what multiverse proposals are. But we should name it for what it is. They are briefly described below. An extension of our Universe[edit] A prediction of chaotic inflation is the existence of an infinite ergodic universe, which, being infinite, must contain Hubble volumes realizing all initial conditions. Accordingly, an infinite universe will contain an infinite number of Hubble volumes, all having the same physical laws and physical constants. In regard to configurations such as the distribution of matter , almost all will differ from our Hubble volume. However, because there are infinitely many, far beyond the cosmological horizon , there will eventually be Hubble volumes with similar, and even identical, configurations. Tegmark estimates that an identical volume to ours should be about meters away from us. Universes with different physical constants[edit] Bubble universes â€" every disk represents a bubble universe. Our universe is represented by one of the disks. Universe 1 to Universe 6 represent bubble universes. Five of them have different physical constants than our universe has. In the chaotic inflation theory, which is a variant of the cosmic inflation theory, the multiverse or space as a whole is stretching and will continue doing so forever, [61] but some regions of space stop stretching and form distinct bubbles like gas pockets in a loaf of rising bread. Such bubbles are embryonic level I multiverses. Different bubbles may experience different spontaneous symmetry breaking , which results in different properties, such as different physical constants. In brief, one aspect of quantum mechanics is that certain observations cannot be predicted absolutely. Instead, there is a range of possible observations, each with a different probability. According to the MWI, each of these possible observations corresponds to a different universe. Suppose a six-sided die is thrown and that the result of the throw corresponds to a quantum mechanics observable. All six possible ways the die can fall correspond to six different universes. In effect, all the different "worlds" created by "splits" in a Level III multiverse with the same physical constants can be found in some Hubble volume in a Level I multiverse. In Level I they live elsewhere in good old three-dimensional space. Abstract mathematics is so general that any Theory Of Everything TOE which is definable in purely formal terms independent of vague human terminology is also a mathematical structure. For instance, a TOE involving a set of different types of entities denoted by words, say and relations between them denoted by additional words is nothing but what mathematicians call a set-theoretical model, and one can generally find a formal system that it is a model of. He argues that this "implies that any conceivable parallel universe theory can be described at Level IV" and "subsumes all other ensembles, therefore brings closure to the hierarchy of multiverses, and there cannot be, say, a Level V. Schmidhuber explicitly includes universe representations describable by non-halting programs whose output bits converge after finite time, although the convergence time itself may not be predictable by a halting program, due to the undecidability of the halting problem. With an infinite amount of space, every possible event will occur an infinite number of times. However, the speed of light prevents us from being aware of these other identical areas. Inflationary[edit] The inflationary multiverse is composed of various pockets in which inflation fields collapse and form new universes. Brane[edit] The brane multiverse version postulates that our entire universe exists on a membrane brane which floats in a higher dimension or "bulk". In this bulk, there are other membranes with their own universes. These universes can interact with one another, and when they collide, the violence and energy produced is more than enough to give rise to a big bang. The branes float or drift near each other in the bulk, and every few trillion years, attracted by gravity or some other force we do not understand, collide and bang into each other. This repeated contact gives rise to multiple or "cyclic" big bangs. This particular hypothesis falls under the string theory umbrella as it requires extra spatial dimensions. Cyclic[edit] The cyclic multiverse has multiple branes that have collided, causing Big Bangs. The universes bounce back and pass through time until they are pulled back together and again collide, destroying the old contents and creating them anew. Quantum fluctuations drop the shapes to a lower energy level, creating a pocket with a set of laws different from that of the surrounding space. Quantum[edit] The quantum multiverse creates a new universe when a diversion in events occurs, as in the many-worlds interpretation of quantum mechanics. Holographic[edit] The holographic multiverse is derived from the theory that the surface area of a space can simulate the volume of the region.

4: Multiverse | Definition of Multiverse by Merriam-Webster

There actually is quite a bit of evidence out there for a multiverse â€” an infinite number of other universes as a "parallel universe," and is a of parallel universes in fiction is at the.

May 9, Sandy MacKenzie Shutterstock Is our universe unique? From science fiction to science fact, there is a concept that suggests that there could be other universes besides our own, where all the choices you made in this life played out in alternate realities. The concept is known as a "parallel universe," and is a facet of the astronomical theory of the multiverse. The idea is pervasive in comic books, video games, television and movies. A fuller list of parallel universes in fiction is at the bottom of the article. There actually is quite a bit of evidence out there for a multiverse. First, it is useful to understand how our universe is believed to have come to be. Arguing for a multiverse Around Then, according to the Big Bang theory , some unknown trigger caused it to expand and inflate in three-dimensional space. As the immense energy of this initial expansion cooled, light began to shine through. Eventually, the small particles began to form into the larger pieces of matter we know today, such as galaxies, stars and planets. One big question with this theory is: With our current technology, we are limited to observations within this universe because the universe is curved and we are inside the fishbowl, unable to see the outside of it if there is an outside. There are at least five theories why a multiverse is possible , as a Space. One prominent theory is that it is flat and goes on forever. This would present the possibility of many universes being out there. More about that in a moment. Another theory for multiple universes comes from "eternal inflation. Others, however, will keep getting larger. So if we picture our own universe as a bubble, it is sitting in a network of bubble universes of space. Or perhaps multiple universes can follow the theory of quantum mechanics how subatomic particles behave , as part of the "daughter universe" theory. If you follow the laws of probability, it suggests that for every outcome that could come from one of your decisions, there would be a range of universes â€” each of which saw one outcome come to be. So in one universe, you took that job to China. In another, perhaps you were on your way and your plane landed somewhere different, and you decided to stay. Another possible avenue is exploring mathematical universes, which, simply put, explain that the structure of mathematics may change depending in which universe you reside. And last but not least as the idea of parallel universes. So, with an infinite number of cosmic patches, the particle arrangements within them must repeat â€” infinitely many times over. This means there are infinitely many "parallel universes": About the theory, he told Cambridge University in an interview published in The Washington Post , "We are not down to a single, unique universe, but our findings imply a significant reduction of the multiverse to a much smaller range of possible universes. A article on Medium by astrophysicist Ethan Siegal agreed that space-time could go on forever in theory , but said that there are some limitations with that idea. The key problem is the universe is just under 14 billion years old. This would simply put limit the number of possibilities for particles to rearrange themselves, and sadly make it less possible that your alternate self did get on that plane after all to see China. Also, the expansion at the beginning of the universe took place exponentially because there was so much "energy inherent to space itself," he said. But over time, that inflation obviously slowed â€” those particles of matter created at the Big Bang are not continuing to expand, he pointed out. This decreases the possibilities of universes similar to our own. He advises to make the choices that work for you, which "leave you with no regrets. Parallel universes in science fiction Here are some of the more prominent uses of parallel universes in science fiction. This is by no means a complete list, but a sampling of some of the more-quoted examples. Marvel Comics and DC Comics feature stories set in parallel universes that are part of the multiverse. Many anime series, such as "Digimon," "Dragon Ball" and "Sonic the Hedgehog" feature alternate versions of their characters from other universes. Abbott, is a story about a two-dimensional world that includes living geometric figures such as circles, triangles and squares. The novel also includes other universes such as Lineland, Spaceland and Pointland. This book was adapted into a feature film in Wells novel, included a "paratime" machine and explored the multiverse. Lewis book series, features several children who move between our world and the world of Narnia, where there are talking animals. Some of these books were released as feature films earlier in the s. An episode of "Star Trek" featured a "mirror universe" in which the characters were more ruthless and warlike. The concept was repeated in nearly every subsequent "Star Trek" series. In , the "Star Trek" universe got a reboot in a movie that put the characters from the s original series in an alternate universe. In "The Dark Tower," a Stephen King series that began in , travellers go through portals to different levels of the titular tower in other words, parallel Earths. Part of the series was adapted into a feature film in The "Back to the Future" movie series which began in follows the adventures of the McFly family, including visits to , and The second film in particular shows the drawbacks of an alternate reality, when one character uses it to get rich by nefarious means. The series starred Michael J. The first book, "The Golden Compass," was adapted into a film in in It starred Gwyneth Paltrow and John Hannah. While the book is mostly a time travel book, the multiverse is used in it as well. A film based on the book was released in It starred Jake Gyllenhaal. The series includes discussion of an alternate dimension called the Upside Down.

5: Parallel Universes: Theories & Evidence

And if the Universes are all the same as one another as far as physical laws go, and if the number of these Universes is truly infinite, and if the many-world interpretation of quantum mechanics.

Messenger The existence of parallel universes may seem like something cooked up by science fiction writers, with little relevance to modern theoretical physics. The race is now on to find a way to test the theory, including searching the sky for signs of collisions with other universes. It is important to keep in mind that the multiverse view is not actually a theory, it is rather a consequence of our current understanding of theoretical physics. This distinction is crucial. We have not waved our hands and said: Instead the idea that the universe is perhaps one of infinitely many is derived from current theories like quantum mechanics and string theory. The act of opening the box allows us to follow one of the possible future histories of our cat, including one in which it is both dead and alive. The reason this seems so impossible is simply because our human intuition is not familiar with it. But it is entirely possible according to the strange rules of quantum mechanics. The reason that this can happen is that the space of possibilities in quantum mechanics is huge. Mathematically, a quantum mechanical state is a sum or superposition of all possible states. But how do we interpret this to make any practical sense at all? However, one can just as well choose to accept that all these possibilities are true, and that they exist in different universes of a multiverse. This is notoriously hard because gravitational force is so difficult to describe on small scales like those of atoms and subatomic particles â€” which is the science of quantum mechanics. But string theory, which states that all fundamental particles are made up of one-dimensional strings, can describe all known forces of nature at once: However, for string theory to work mathematically, it requires at least ten physical dimensions. Since we can only observe four dimensions: Perhaps for each point in our large four dimensions, there exists six extra indistinguishable directions? A problem, or some would say, a feature, of string theory is that there are many ways of doing this compactification â€” possibilities is one number usually touted about. Each of these compactifications will result in a universe with different physical laws â€” such as different masses of electrons and different constants of gravity. However there are also vigorous objections to the methodology of compactification, so the issue is not quite settled. But given this, the obvious question is: But fortunately, an idea from our study of early universe cosmology has turned this bug into a feature. The early universe During the very early universe, just after the Big Bang, the universe underwent a period of accelerated expansion called inflation. Inflation was invoked originally to explain why the current observational universe is almost uniform in temperature. However, the theory also predicted a spectrum of temperature fluctuations around this equilibrium which was later confirmed by several spacecraft such as Cosmic Background Explorer , Wilkinson Microwave Anisotropy Probe and the PLANCK spacecraft. While the exact details of the theory are still being hotly debated, inflation is widely accepted by physicists. However, a consequence of this theory is that there must be other parts of the universe that are still accelerating. However, due to the quantum fluctuations of space-time, some parts of the universe never actually reach the end state of inflation. This means that the universe is, at least according to our current understanding, eternally inflating. Some parts can therefore end up becoming other universes, which could become other universes etc. This mechanism generates a infinite number of universes. By combining this scenario with string theory, there is a possibility that each of these universes possesses a different compactification of the extra dimensions and hence has different physical laws. The cosmic microwave background. Scoured for gravitational waves and signs of collisions with other universes. Indeed, they inevitably must collide, leaving possible signatures in the cosmic sky which we can try to search for. The exact details of the signatures depends intimately on the models â€” ranging from cold or hot spots in the cosmic microwave background to anomalous voids in the distribution of galaxies. Nevertheless, since collisions with other universes must occur in a particular direction, a general expectation is that any signatures will break the uniformity of our observable universe. These signatures are actively being pursued by scientists. Some are looking for it directly through imprints in the cosmic microwave background , the afterglow of the Big Bang. However, no such signatures are yet to be seen. Others are looking for indirect support such as gravitational waves, which are ripples in space-time as massive objects pass through. Such waves could directly prove the existence of inflation, which ultimately strengthens the support for the multiverse theory. Whether we will ever be able to prove their existence is hard to predict. But given the massive implications of such a finding it should definitely be worth the search. Read other articles from our cosmology series here.

6: BBC - Earth - Why there might be many more universes besides our own

A few months ago, I met Randy Ribay, the author of An Infinite Number of Parallel Universes, for a cup of coffee and an afternoon of talking www.enganchecubano.com handed me an ARC of his book and then opened his laptop to write.

He went on to assert that what the equation that won him a Nobel prize seems to be describing is several different histories, they are "not alternatives but all really happen simultaneously". This is the earliest known reference to the many-worlds. The many-worlds interpretation shares many similarities with later, other "post-Everett" interpretations of quantum mechanics which also use decoherence to explain the process of measurement or wavefunction collapse. MWI treats the other histories or worlds as real since it regards the universal wavefunction as the "basic physical entity" [20] or "the fundamental entity, obeying at all times a deterministic wave equation". MWI is distinguished by two qualities: Decoherent interpretations of many-worlds using einselection to explain how a small number of classical pointer states can emerge from the enormous Hilbert space of superpositions have been proposed by Wojciech H. Other states decohere into mixtures of stable pointer states that can persist, and, in this sense, exist: Many-worlds is often referred to as a theory , rather than just an interpretation, by those who propose that many-worlds can make testable predictions such as David Deutsch or is falsifiable such as Everett or by those who propose that all the other, non-MW interpretations, are inconsistent, illogical or unscientific in their handling of measurements; Hugh Everett argued that his formulation was a metatheory , since it made statements about other interpretations of quantum theory; that it was the "only completely coherent approach to explaining both the contents of quantum mechanics and the appearance of the world. Please help improve this article by adding citations to reliable sources. Unsourced material may be challenged and removed. January Learn how and when to remove this template message As with the other interpretations of quantum mechanics, the many-worlds interpretation is motivated by behavior that can be illustrated by the double-slit experiment. When particles of light or anything else are passed through the double slit, a calculation assuming wave-like behavior of light can be used to identify where the particles are likely to be observed. Yet when the particles are observed in this experiment, they appear as particles i. Some versions of the Copenhagen interpretation of quantum mechanics proposed a process of " collapse " in which an indeterminate quantum system would probabilistically collapse down onto, or select, just one determinate outcome to "explain" this phenomenon of observation. Wavefunction collapse was widely regarded as artificial and ad hoc [citation needed], so an alternative interpretation in which the behavior of measurement could be understood from more fundamental physical principles was considered desirable. Everett stated that for a composite system â€” for example a subject the "observer" or measuring apparatus observing an object the "observed" system, such as a particle â€” the statement that either the observer or the observed has a well-defined state is meaningless; in modern parlance, the observer and the observed have become entangled ; we can only specify the state of one relative to the other, i. This led Everett to derive from the unitary, deterministic dynamics alone i. Everett noticed that the unitary, deterministic dynamics alone decreed that after an observation is made each element of the quantum superposition of the combined subjectâ€”object wavefunction contains two "relative states": The subsequent evolution of each pair of relative subjectâ€”object states proceeds with complete indifference as to the presence or absence of the other elements, as if wavefunction collapse has occurred, which has the consequence that later observations are always consistent with the earlier observations. All that one does, really, is to calculate conditional probabilitiesâ€—in other words, the probability of A happening, given B. Some people overlay it with a lot of mysticism about the wave function splitting into different parts. Reality is not a quality you can test with litmus paper. Quantum theory does this very successfully. The second issue with Bohmian mechanics may at first sight appear rather harmless, but which on a closer look develops considerable destructive power: These are the components of the post-measurement state that do not guide any particles because they do not have the actual configuration q in their support. At first sight, the empty branches do not appear problematic but on the contrary very helpful as they enable the theory to explain unique outcomes of measurements. On a closer view, though, one must admit that these empty branches do not actually disappear. Now, if the Everettian theory may be accused of ontological extravagance, then Bohmian mechanics could be accused of ontological wastefulness. On top of the ontology of empty branches comes the additional ontology of particle positions that are, on account of the quantum equilibrium hypothesis, forever unknown to the observer. Yet, the actual configuration is never needed for the calculation of the statistical predictions in experimental reality, for these can be obtained by mere wavefunction algebra. From this perspective, Bohmian mechanics may appear as a wasteful and redundant theory. I think it is considerations like these that are the biggest obstacle in the way of a general acceptance of Bohmian mechanics. There is no consensus on whether this has been successful. Everett stopped doing research in theoretical physics shortly after obtaining his Ph. Decision theory[edit] A decision-theoretic derivation of the Born rule from Everettarian assumptions, was produced by David Deutsch [40] and refined by Wallace â€" [41] [42] [43] [44] and Saunders He has proved that the Born rule and the collapse of the wave function follow from a game-theoretical strategy, namely the Nash equilibrium within a von Neumann zero-sum game between nature and observer. Carroll , building on work by Lev Vaidman , [55] proposed a similar approach based on self-locating uncertainty. This section does not cite any sources. Please help improve this section by adding citations to reliable sources. Measurement is regarded as causing M and S to interact. After S interacts with M, it is no longer possible to describe either system by an independent state. According to Everett, the only meaningful descriptions of each system are relative states: Schematic illustration of splitting as a result of a repeated measurement. For example, consider the smallest possible truly quantum system S, as shown in the illustration. This describes for instance, the spin-state of an electron. Considering a specific axis say the z-axis the north pole represents spin "up" and the south pole, spin "down". The superposition states of the system are described by the surface of a sphere called the Bloch sphere. To perform a measurement on S, it is made to interact with another similar system M. After the interaction, the combined system is described by a state that ranges over a six-dimensional space the reason for the number six is explained in the article on the Bloch sphere. This six-dimensional object can also be regarded as a quantum superposition of two "alternative histories" of the original system S, one in which "up" was observed and the other in which "down" was observed. Each subsequent binary measurement that is interaction with a system M causes a similar split in the history tree. The accepted terminology is somewhat misleading because it is incorrect to regard the universe as splitting at certain times; at any given instant there is one state in one universe. January Learn how and when to remove this template message In his doctoral dissertation, Everett proposed that rather than modeling an isolated quantum system subject to external observation, one could mathematically model an object as well as its observers as purely physical systems within the mathematical framework developed by Paul Dirac , von Neumann and others, discarding altogether the ad hoc mechanism of wave function collapse. One such is the relative state formulation. It makes two assumptions: Secondly, observation or measurement has no special laws or mechanics, unlike in the Copenhagen interpretation which considers the wavefunction collapse as a special kind of event which occurs as a result of observation. Instead, measurement in the relative state formulation is the consequence of a configuration change in the memory of an observer described by the same basic wave physics as the object being modeled. These splits generate a possible tree as shown in the graphic below. Subsequently, DeWitt introduced the term "world" to describe a complete measurement history of an observer, which corresponds roughly to a single branch of that tree. Note that "splitting" in this sense is hardly new or even quantum mechanical. The idea of a space of complete alternative histories had already been used in the theory of probability since the mids for instance to model Brownian motion. Partial trace as relative state. Light blue rectangle on upper left denotes system in pure state. Trellis shaded rectangle in upper right denotes a possibly mixed state. Mixed state from observation is partial trace of a linear superposition of states as shown in lower right-hand corner. An observation or measurement is modeled by applying the wave equation to the entire system comprising the observer and the object. Since many observation-like events have happened and are constantly happening, there are an enormous and growing number of simultaneously existing states. Each product of subsystem states in the overall superposition evolves over time independently of other products. Once the subsystems interact, their states have become correlated or entangled and it is no longer possible to consider them independent of one another. Properties of the theory[edit] MWI removes the observer-dependent role in the quantum measurement process by replacing wavefunction collapse with quantum decoherence. Quantum cosmology also becomes intelligible, since there is no need anymore for an observer outside of the universe. MWI achieves this by removing wavefunction collapse , which is indeterministic and non-local, from the deterministic and local equations of quantum theory. Comparative properties and possible experimental tests[edit] One of the salient properties of the many-worlds interpretation is that it does not require an exceptional method of wave function collapse to explain it. In most no-collapse interpretations, the evolution of the quantum state of the Universe is the same. Still, one might imagine that there is an experiment distinguishing the MWI from another no-collapse interpretation based on the difference in the correspondence between the formalism and the experience the results of experiments. Since then Lockwood , Vaidman and others have made similar proposals. Many other controversial ideas have been put forward though, such as a recent claim that cosmological observations could test the theory, [63] and another claim by Rainer Plaga , published in Foundations of Physics , that communication might be possible between worlds. January Learn how and when to remove this template message In the Copenhagen interpretation , the mathematics of quantum mechanics allows one to predict probabilities for the occurrence of various events. When an event occurs, it becomes part of the definite reality, and alternative possibilities do not. There is no necessity to say anything definite about what is not observed. The universe decaying to a new vacuum state[edit] Any event that changes the number of observers in the universe may have experimental consequences. This has not happened and is cited as evidence in favor of many-worlds. In some worlds, quantum tunnelling to a true vacuum state has happened but most other worlds escape this tunneling and remain viable. This can be thought of as a variation on quantum suicide. This objection is saying that it is not clear what is precisely meant by branching, and point to the lack of self-contained criteria specifying branching. In Dirac notation a measurement is complete when:

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7: The theory of parallel universes is not just maths â€“ it is science that can be tested

In layman's terms, the hypothesis states there is a very largeâ€”perhaps infinite â€”number of universes, and everything that could possibly have happened in our past, but did not, has occurred in the past of some other universe or universes.

Scientists now believe there may really be a parallel universe - in fact, there may be an infinite number of parallel universes, and we just happen to live in one of them. These other universes contain space, time and strange forms of exotic matter. Some of them may even contain you, in a slightly different form. Astonishingly, scientists believe that these parallel universes exist less than one millimetre away from us. In fact, our gravity is just a weak signal leaking out of another universe into ours. The same but different For years parallel universes were a staple of the Twilight Zone. Science fiction writers loved to speculate on the possible other universes which might exist. In one, they said, Elvis Presley might still be alive or in another the British Empire might still be going strong. Serious scientists dismissed all this speculation as absurd. Parallel universes really do exist and they are much stranger than even the science fiction writers dared to imagine. There are actually 11 dimensions. A creative touch Now imagine what might happen if two such bubble universes touched. A very big bang indeed and a new universe was born - our Universe. The idea has shocked the scientific community; it turns the conventional Big Bang theory on its head. Time and space all existed before it. In fact Big Bangs may happen all the time. Of course this extraordinary story about the origin of our Universe has one alarming implication. If a collision started our Universe, could it happen again? Anything is possible in this extra-dimensional cosmos. Perhaps out there in space there is another universe heading directly towards us - it may only be a matter of time before we collide. Michio Kaku went online to chat about parallel universes. Read his answers to your questions in the BBC Space site. Princeton University - Prof Paul Steinhardt.

8: If There Are an Infinite Number of Parallel Universes, Some Must Be Terrible Places

If our Universe really does contain an infinite number of "island universes" like ours, with matter and stars and planets, there must be worlds identical to Earth somewhere out there.

December 7, In fact, our universe could be just one of an infinite number of universes making up a "multiverse. In fact, some experts think the existence of hidden universes is more likely than not. Here are the five most plausible scientific theories suggesting we live in a multiverse: But if space-time goes on forever, then it must start repeating at some point, because there are a finite number of ways particles can be arranged in space and time. So if you look far enough, you would encounter another version of you â€” in fact, infinite versions of you. Because the observable universe extends only as far as light has had a chance to get in the In this way, a multitude of universes exists next to each other in a giant patchwork quilt of universes. A Gallery] Space-time may stretch out to infinity. If so, then everything in our universe is bound to repeat at some point, creating a patchwork quilt of infinite universes. Bubble Universes In addition to the multiple universes created by infinitely extending space-time, other universes could arise from a theory called "eternal inflation. Eternal inflation, first proposed by Tufts University cosmologist Alexander Vilenkin, suggests that some pockets of space stop inflating, while other regions continue to inflate, thus giving rise to many isolated "bubble universes. And in some of these bubble universes, the laws of physics and fundamental constants might be different than in ours, making some universes strange places indeed. The idea comes from the possibility of many more dimensions to our world than the three of space and one of time that we know. In addition to our own three-dimensional "brane" of space, other three-dimensional branes may float in a higher-dimensional space. Our universe may live in one bubble that is sitting in a network of bubble universes in space. Sometimes, they might slam into each other, causing repeated Big Bangs that reset the universes over and over again. Big Bang to Now in 10 Easy Steps] 4. Daughter Universes The theory of quantum mechanics, which reigns over the tiny world of subatomic particles, suggests another way multiple universes might arise. Quantum mechanics describes the world in terms of probabilities, rather than definite outcomes. And the mathematics of this theory might suggest that all possible outcomes of a situation do occur â€” in their own separate universes. For example, if you reach a crossroads where you can go right or left, the present universe gives rise to two daughter universes: Mathematical Universes Scientists have debated whether mathematics is simply a useful tool for describing the universe, or whether math itself is the fundamental reality, and our observations of the universe are just imperfect perceptions of its true mathematical nature.

9: BBC - Science & Nature - Horizon - Parallel Universes

Just as there are an infinite number of similar yet slightly different universes (like the one in which you have written this column not me), there will also be an infinite number in which the.

In your perception of the world, the answer is simple: But is our universe unique? The concept of multiple realities â€” or parallel universes â€” complicates this answer and challenges what we know about the world and ourselves. One model of potential multiple universes called the Many-Worlds Theory might sound so bizarre and unrealistic that it should be in science fiction movies and not in real life. However, there is no experiment that can irrefutably discredit its validity. The origin of the parallel universe conjecture is closely connected with introduction of the idea of quantum mechanics in the early s. Quantum mechanics, a branch of physics that studies the infinitesimal world, predicts the behavior of nanoscopic objects. Physicists had difficulties fitting a mathematical model to the behavior of quantum matter because some matter exhibited signs of both particle-like and wave-like movements. For example, the photon, a tiny bundle of light, can travel vertically up and down while moving horizontally forward or backward. Such behavior starkly contrasts with that of objects visible to the naked eye; everything we see moves like either a wave or a particle. This theory of matter duality has been called the Heisenberg Uncertainty Principle HUP , which states that the act of observation disturbs quantities like momentum and position. In relation to quantum mechanics, this observer effect can impact the form â€” particle or wave â€” of quantum objects during measurements. Artist concept of the multiverse. Florida State University In , a young student at Princeton University named Hugh Everett proposed a radical supposition that differed from the popular models of quantum mechanics. Everett did not believe that observation causes quantum matter to stop behaving in multiple forms. Instead, he argued that observation of quantum matter creates a split in the universe. In other words, the universe makes copies of itself to account for all the possibilities and these duplicates will proceed independently. Every time a photon is measured, for instance, a scientist in one universe will analyze it in wave form and the same scientist in another universe will analyze it in particle form. Each of these universes offers a unique and independent reality that coexists with other parallel universes. Any action that has more than one possible result produces a split in the universe. Thus, there are an infinite number of parallel universes and infinite copies of each person. These copies have identical facial and body features, but do not have identical personalities one may be aggressive and another may be passive because each one experiences a separate outcome. The infinite number of alternate realities also suggests that nobody can achieve unique accomplishments. Every person â€” or some version of that person in a parallel universe â€” has done or will do everything. Moreover, the MWT implies that everybody is immortal. Old age will no longer be a surefire killer, as some alternate realities could be so scientifically and technologically advanced that they have developed an anti-aging medicine. If you do die in one world, another version of you in another world will survive. The most troubling implication of parallel universes is that your perception of the world is never real. You might believe you are reading this article at this instance, but there are many copies of you that are not reading. In fact, you are even the author of this article in some distant reality. Thus, do winning prizes and making decisions matter if we might lose those awards and make different choices? Is living important if we might actually be dead somewhere else? Some scientists, like Austrian mathematician Hans Moravec , have tried to debunk the possibility of parallel universes. Moravec developed a famous experiment called quantum suicide in that connects a person to a fatal weapon and a machine that determines the spin value, or angular momentum, of protons. Every 10 seconds, the spin value, or quark, of a new proton is recorded. Based on this measurement, the machine will cause the weapon to kill or spare the person with a 50 percent chance for each scenario. When the quark measurement is processed, there are two possibilities: At this moment, MWT claims that the universe splits into two different universes to account for the two endings. The weapon will discharge in one reality, but not discharge in the other.

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