Parallel Universes

BBC Two 9.00pm Thursday 14 February 2002

Everything you're about to read here seems impossible and insane, beyond science fiction. Yet it's all true.

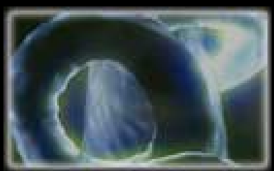
Scientists now believe there may really be a parallel universe - in fact, there may be an infinite number of parallel universes, and we just happen to live in one of them. These other universes contain space, time and strange forms of exotic matter. Some of them may even contain you, in a slightly different 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. But now it seems the speculation wasn't absurd enough. Parallel universes really do exist and they are much stranger than even the science fiction writers dared to imagine.

Greater dimensions

It all started when superstring theory, hyperspace and dark matter made physicists realise that the three dimensions we thought described the Universe weren't enough. There are actually 11 dimensions. By the time they had finished they'd come to the conclusion that our Universe is just one bubble among an infinite number of membranous bubbles which ripple as they wobble through the eleventh dimension.



A creative touch

Now imagine what might happen if two such bubble universes touched. Neil Turok from Cambridge, Burt Ovrut from the University of Pennsylvania and Paul Steinhardt from Princeton believe that has happened. The result? 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. It may well be that the Big Bang wasn't really the beginning of everything after all. 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.

Chat live online after the show

Michio Kaku went online to chat about parallel universes. Read his answers to your questions in the BBC Space site.

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http://feynman.princeton.edu/~steinh/

Dr Michio Kaku
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Superstring phenomenology and the brane-world
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Hyperspace: a scientific odyssey through parallel universes, time warps and the tenth dimension
Michio Kaku

The Elegant Universe: superstrings, hidden dimensions and the quest for the ultimate theory
Brian Greene

Parallel Universes: the search for other worlds
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Story in brief
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Horizon home
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Transcript

NARRATOR (DILLY BARLOW): Imagine you could find an explanation for everything in the Universe, from the smallest events possible to the biggest. This is the dream which has captivated the most brilliant scientists since Einstein. Now they think they may have found it. The theory is breathtaking and it has an extraordinary conclusion: that the Universe we live in is not the only one.

MICHIO KAKU (City University of New York): That there could be an infinite number of universes each with a different law of physics. Our Universe could be just one bubble floating in an ocean of other bubbles.

NARRATOR: Everything you are about to hear is true, at least in this Universe it is. For almost a hundred years science has been haunted by a dark secret: that there might be mysterious hidden worlds beyond our human senses. Mystics had long claimed there were such places. They were, they said, full of ghosts and spirits. The last thing science wanted was to be associated with such superstition, but ever since the 1920s physicists have been trying to make sense of an uncomfortable discovery. When they tried to pinpoint the exact location of atomic particles like electrons they found it was utterly impossible. They had no single location.

ALAN GUTH (Massachusetts Institute of Technology): When one studies the properties of atoms one found that the reality is far stranger than anybody would have invented in the form of fiction. Particles really do have the possibility of, in some sense, being in more than one place at one time.

NARRATOR: The only explanation which anyone could come up with is that the particles don't just exist in our Universe. They flit into existence in other universes, too and there are an infinite number of these parallel universes, all of them slightly different. In effect, there's a parallel universe in which Napoleon won the Battle of Waterloo. In another the British Empire held on to its American colony. In one you were never born.

ALAN GUTH: Essentially anything that can happen does happen in one of the alternatives which means that superimposed on top of the Universe that we know of is an alternative universe where Al Gore is President and Elvis Presley is still alive.

NARRATOR: This idea was so uncomfortable that for decades scientists dismissed it, but in time parallel universes would make a spectacular comeback. This time they'd be different, they'd be even stranger than Elvis being alive. There's an old proverb that says: be careful what you wish for in case your wish comes true. The most fervent wish of physics has long been that it could find a single elegant theory which would sum up everything in our Universe. It was this dream which would lead unwittingly to the rediscovery of parallel universes. It's a dream which has driven the work of almost every physicist.

MICHIO KAKU: On the ice rink I am communing with the fundamental laws of physics. At the instant of creation we believe that the Universe was symmetrical, it was pure, it was elegant. Without friction Newtonian laws are laid bare, simple, elegant and beautiful, pure, noble, elemental, just like it was at the beginning of time. When I was a child of eight my elementary school teacher came in the room and announced that a great scientist had just died and on the evening news that night everyone was flashing pictures of his desk with the unfinished manuscript of his greatest work. I wanted to know what was in that manuscript. Years later I found out that it was the attempt of Albert Einstein to create a Theory of Everything, a theory of the Universe and I wanted to be part of that quest.

NARRATOR: Einstein never achieved his goal of a Theory of Everything, but again and again others have thought they were on the brink of this ultimate achievement. This was always wishful thinking - until recently. A revolution occurred in the 1980s. In universities across the world new ideas in science streamed forth. Finally, it seemed, everything in the Universe was about to be explained. In Britain the famous physicist Stephen Hawking, was even so confident he claimed physics was ready to read the mind of God. There would soon be no big scientific problems left. One idea was the most revolutionary of all. It seemed a sure fire Theory of Everything and captured the imagination of scientists like Burt Ovrut. It was all to do with string.

BURT OVRUT (University of Pennsylvania): It has been thought since physics began that matter was made up of particles. We had changed that point of view now. We now think that matter is made up of little strings.

NARRATOR: For years it had been an article of faith that all the matter in the Universe was made of tiny, invisible particles. Now suddenly the particle physicists discovered they'd been studying the wrong thing. The particles were really tiny, invisible strings. The theory was called String Theory and it maintained that matter emanated from these tiny strings like music.

BURT OVRUT: You can think of it as a violin string or a guitar string. If you pluck it in a certain way you get a certain frequency, but if you pluck it a different way you can get more frequencies on this string and in fact you have different notes. Nature is made of all the little notes, the musical notes, that are played on these super-strings.

MICHIO KAKU: All of a sudden we realised the Universe is a symphony and the laws of physics are harmonies of a super-string.

NARRATOR: String Theory was so provocative and downright weird that it immediately began to sound like a perfect Theory of Everything.

BURT OVRUT: It certainly did sweep us all by storm. It's a beautiful, elegant and simple theory and a number of people said well if it's so elegant and simple why don't we try to use it as the basic unifying principle for nature.

NARRATOR: But if String Theory was to become Einstein's missing Theory of Everything it would have to pass one test. It would have to explain a rather special event: the birth of the Universe. The origins of the Universe had always been the special subject of the cosmologists who studied the big world of stars and galaxies. They, too, felt they were on the verge of a great triumph, a complete understanding of how the world had begun. They'd long known things had started with a giant explosion - the Big Bang - but by now cosmologists had refined the idea. They had worked backwards in time from the present day, closer and closer to the instant of the Big Bang. Their work was incredibly precise.

PAUL STEINHARDT (Princeton University): We have confidence in extrapolating back from the present to when the first stars and galaxies formed and the Universe was only a billion years old, or extrapolating back farther to when the first atoms were formed, when the Universe was a few hundred thousand years old, or when the first nuclei formed when the Universe was only a few seconds old.

ALAN GUTH: Physics was now actually ready to talk about these bizarre sounding events in the Universe, fractions of a second and even billionths and billionths and billionths of a second, 10^{-35} seconds after the instant of the Big Bang. Absolutely fantastic.

NARRATOR: If everything in the Universe was to be explained then String Theory and the Big Bang would now seamlessly merge and they'd complement each other perfectly. After all, one concerned the birth of the Universe and the other all the matter in it. It was surely a foregone conclusion. Physics seemed to be on the edge of glory, but it all went terribly wrong. Try as they might they just couldn't get the two ideas to merge and then, after 10 years of struggling, something even worse happened: their two pet theories now began to self-destruct. The first problem appeared with the Big Bang. The cosmologists had assumed that as they worked backwards in time they would eventually work their way back all the way to the beginning of the Big Bang. There would be no awkward gaps, but after years of end-less refinement there was one gap which refused to disappear, the most important one of all.

ALAN GUTH: In spite of the fact that we call it the Big Bang Theory it really says absolutely nothing about the Big Bang. It doesn't tell us what banged, why it banged, what caused it to bang. It doesn't even describe, doesn't really allow us to predict what the conditions are immediately after this bang.

MICHIO KAKU: The fundamental problem of cosmology is that the laws of physics as we know them break down at the instant of the Big Bang. Well some people say what's wrong with that, what's wrong with having the laws of physics collapse? Well for a physicist this is a disaster. All our lives we've dedicated to the proposition that the Universe obeys knowable laws, laws that can be written down in the language of mathematics and here we have the centrepiece of the Universe itself, a missing piece beyond physical law.

NARRATOR: The very beginning of the Big Bang was the single biggest mystery in all of cosmology. It was called the singularity.

PAUL STEINHARDT: When you extrapolate Einstein's general Theory of Relativity back to the beginning you discover what we call a singularity, a cosmic singularity, which is to say that the equations blow up.

NARRATOR: But the problem with the Big Bang was soon overshadowed. The strings were in trouble, too. The hope had been that String Theory would evolve into the single definitive explanation for the Universe, but as more and more people worked on it something puzzling happened. The physicists found a second version of it and then a third. Soon they had found five different String Theories. That wasn't single and it didn't sound very definitive.

BURT OVRUT: Five, even though it's not a very large number, is too large for us because we would like to have a more unique theory than that and this definitely was a problem, was a great crisis, so a lot of time was spent studying those individual five theories, but in the back of our minds always was why are there five of these things, shouldn't there only be one?

NARRATOR: String Theory had begun to unravel. It seemed as if the dream of a Theory of Everything was as far away as ever.

MICHIO KAKU: Cynics began to come out and say that String Theory is too hard, it's a dead end, it's simply not the way to go and it's not the Theory of Everything, it's the theory of nothing.

NARRATOR: But just as the scientists were about to give up hope, a new and startling discovery would be made. This would inspire them to begin their quest again and force them at last to confront their least popular ides: parallel universes. When String Theory fell apart, not everyone was distraught. Some people even seemed to relish the fact.

MICHAEL DUFF (University of Michigan): If String Theory really was this so-called Theory of Everything five theories of everything seems like an embarrassment of riches.

NARRATOR: Michael Duff had been the rising star of an earlier idea called super gravity. String Theory had displaced it and almost destroyed Duff's career.

MICHAEL DUFF: Physics tend to be dictated by fad and fashion. There are the gurus who dictate the direction in which new ideas grow. It was a very lonely time in many ways. When I tried to get graduate students interested many of them would say well look, you may be right and you may be wrong, but if I work in super gravity I'm not going to find a job.

NARRATOR: What made the experience of the super gravity guys so galling was that their theory wasn't so very different from String Theory to begin with. In fact, the main disagreement between them was a point of detail which, to outsiders, could seem like nitpicking. It was about the number of dimensions in the Universe. We normally think of ourselves as living in a three-dimensional world. We can move in three ways: left or right, up or down, and forwards and backwards, but physics liked adding extra dimensions. Einstein suggested time should be a fourth dimension. Then someone suggested a fifth special dimension and then a sixth. The numbers just kept growing. The extra dimensions were spaces in the Universe which we could never perceive. Most were microscopically small, but scientists believed they were really there. String Theory had been convinced there were in total exactly 10 dimensions.

BURT OVRUT: Now if you have a little oscillating string it has to have enough room to oscillate properly and when one works this out mathematically you find it, it just got a very clear answer. It had to be in 10 dimensional space.

MICHIO KAKU: Ten dimensions.

BURT OVRUT: Nine spatial dimensions and one time.

NARRATOR: Super gravity though had been convinced there were exactly eleven dimensions.

MICHAEL DUFF: The equations of super gravity took their simplest and most elegant form when written in this 11 dimensional framework.

MICHIO KAKU: There was a war between the tenth dimension and the eleventh dimension. In the 10-dimensional bandwagon we had string theorists, hundreds of them, working to tease out all the properties of the known universe from one framework: a vibrating string and then we had this small band of outcasts, outlaws, working in the eleventh dimension.

NARRATOR: While String Theory was in its ascendancy, few took seriously the eleventh dimension, but the super gravity guys never gave up hope.

MICHAEL DUFF: I did at bottom always feel convinced that eventually 11 dimensions would have its day. I wasn't sure when and I wasn't sure how, but I felt convinced that sooner or later 11 dimensions would be seen to be at the heart of things.

NARRATOR: But by now the boot was on the other foot. String Theory was in trouble. Its five different versions meant it couldn't be the all embracing theory physics was looking for. Everything, it seemed, had been tried to save String Theory. Well, almost everything.

MICHAEL DUFF: An astonishing announcement was made.

MICHIO KAKU: It was yet another shockwave that revolutionised the whole landscape.

NARRATOR: In a final desperate move the string theorists tried adding one last thing to their cherished idea. They added the very thing they had spent a decade rubbishing: the eleventh dimension. Now something almost magical happened to the five competing String Theories.

BURT OVRUT: The answer turned out to be - and it really was absolutely remarkable, I mean it really is remarkable - it turns out that they were all the same. These five String Theories turned out to be simply different manifestations of a more fundamental theory, precisely this theory which we had discarded back in the early 1980s.

MICHIO KAKU: In 11 dimensions looking from the mountain-top, looking down you could see String Theory as being part of a much larger reality, reality of the eleventh dimension.

MICHAEL DUFF: Well it was a wonderful feeling to think that all those years spent in the eleventh dimension were not completely wasted.

NARRATOR: The two camps had been absolutely certain the other was wrong. Now, suddenly, they realised their ideas complemented each other perfectly. With the addition of one extra dimension String Theory made sense again, but it had become a very different kind of theory.

BURT OVRUT: What happened to the string?

NARRATOR: The tiny invisible strings of String Theory was supposed to be the fundamental building blocks of all the matter in the Universe, but now, with the addition of the eleventh dimension, they changed. They stretched and they combined. The astonishing conclusion was that all the matter in the Universe was connected to one vast structure: a membrane. In effect our entire Universe is a membrane. The quest to explain everything in the Universe could begin again and at its heart would be this new theory. It was dubbed Membrane Theory, or M Theory, but so enigmatic and profound did the idea seem that some thought M should stand for other things.

BURT OVRUT: M Theory.

MICHAEL DUFF: Where M stands for magic, mystery or membrane.

BURT OVRUT: M theory.

PAUL STEINHARDT: Physicists get kind of dreamy-eyed when they talk about M Theory.

BURT OVRUT: M Theory.

MICHIO KAKU: Maybe M stands for mother, the mother of all strings. Maybe it's magic. Maybe it's the majesty, the majesty of a comprehensive theory of the Universe.

BURT OVRUT: M Theory.

NEIL TUROK (Cambridge University): Magical mystery, madness.

BURT OVRUT: M Theory.

NARRATOR: With M Theory it seemed at last there was a theory which might explain everything in the Universe, but before they could decide if this was true the scientists needed to know more about this new eleventh dimension. It quickly became clear it was a place where all the normal rules of common-sense have been abandoned. For one thing it is both infinitely long, but only a very small distance across.

PAUL STEINHARDT: That eleventh dimension will, at its maximum size, could be something like a trillionth of a millimetre.

BURT OVRUT: Well this is 10 to the -20 of a millimetre. That's taking a millimetre and dividing it by 10 with 20 zeros after it, so that's very, very small.

NARRATOR: That means that it exists only one trillionth of a millimetre from every point in our three-dimensional world. It's closer than your clothes to your body and yet we can't sense it. In this mysterious space our membrane Universe is floating. At first no one could imagine how that worked. Then some suggested it might float like a thin rubber sheet. Others that it might be more like a bubble which vibrated as it was blown aimlessly across hyperspace. If all this wasn't surreal enough, it was then proposed that there might be another membrane universe pulsating at the opposite end of the eleventh dimension. At first this idea wasn't taken very seriously, but eventually it would be re-examined for physics was about to ask whether our Universe was really alone. It began with Lisa Randall.

LISA RANDALL (Harvard University): People look at rock climbing and it's of course very physical, but you also find that you can concentrate on one little thing. I like solving problems, I like games, I like figuring things out.

NARRATOR: Randall had been fascinated by an apparently inexplicable phenomenon: the weakness of gravity.

LISA RANDALL: There are various forces we see in nature. Most of them we understand at some level and then there's gravity which seems very different. The gravitational force is extremely weak in comparison with the other forces. Now you might look around and say gravity doesn't seem weak, but if you think about it you have the entire Earth pulling on you and yet you can manage to pick things up.

NIMA ARKANI-HAMED (Harvard University): Gravity certainly does not look weak in everyday life. It's responsible for keeping our feet on the ground and keeping Earth spinning around the Sun and so on, but actually gravity is incredibly weak compared to the, to the other forces. This is easy to appreciate if you take an ordinary refrigerator magnet and stick it on top of a metal pin. We all know this fridge magnet will actually pick that pin up off the table, so that sort of dramatically illustrates how feeble gravity is compared even to the magnetic force of a tiny fridge magnet.

LISA RANDALL: It turns out that there are very new ideas on how to explain the weakness of gravity if we have extra dimensions.

NARRATOR: When M Theory emerged, Randall and her colleagues wondered if it might provide the explanation. Could gravity be leaking from our Universe into the empty space of the eleventh dimensions?

NIMA ARKANI-HAMED: Gravity might only appear to be weak even though it's fundamentally just as strong as everything else because it dilutes its strength out in all these extra dimensions that we can't see.

NARRATOR: Randall tried to calculate how gravity could leak from our membrane Universe into empty space, but she couldn't make it work. Then she heard the theory that there might be another membrane in the eleventh dimension. Now she had a really strange thought. What if gravity wasn't leaking from our Universe but to it? What if it came from that other universe? On that membrane, or brane, gravity would be as strong as the other forces, but by the time it reached us it would only be a faint signal. Now when she reworked her calculations everything fitted exactly.

LISA RANDALL: If you were to imagine that there are two membranes. Say there's one in which we sit and one in which if there's other stuff it sits there, but not our particles, not the stuff that we're made of and not the stuff that we see forces associated with. If we live anywhere else in the extra dimension we would see gravity as very weak because it's mostly spending its time near the other brane. We only see the tail end of gravity.

NARRATOR: The weakness of gravity could at last be explained, but only by introducing the idea of a parallel universe. Randall's idea opened a Pandora's Box. Now suddenly physicists all over the world piled into the eleventh dimension trying to solve age-old problems and every time it seemed the perfect explanation was another parallel universe. Everywhere they looked it seemed they began to find more and more of them. From every corner of the eleventh dimension parallel universes came crawling out of the woodwork. Some took the form of three-dimensional membranes, like our own Universe. Others were merely sheets of energy. Then there were cylindrical and even looped membranes. Within no time at all the eleventh dimension seemed to be jam-packed full of membranes.

MICHIO KAKU: We began to ask ourselves the question: who lives in the eleventh dimension? We have intersecting membranes, we have membranes with holes in them, we have membranes that look like doughnuts or have many different kinds of doughnut holes. We're just littered with different kinds of membranes.

MICHAEL DUFF: This eleventh dimension not only had the membrane which was the bubble-like or sheet-like object, but it had a whole wealth of different branes of varying dimensions, unfortunately called pea branes.

NARRATOR: Each of these membranes was a possible other universe. M Theory had unwittingly made the idea of parallel universes respectable again.

MICHIO KAKU: In another universe the proton may be unstable, in which case atoms would dissolve and DNA cannot form and therefore there's no intelligent life in these universes. Perhaps it's a universe of electrons and electricity, perhaps a universe of lightening bolts and neutrinos, but no stable matter.

MICHAEL DUFF: The other universes are parallel to ours and may be quite close to ours, but of which we'd never be aware. They may be completely different with completely different laws of nature operating.

ALAN GUTH: It may not all have life, but some fraction of them will have life and whatever that fraction is if there's an infinite number of these universes there'll be an infinite number of universes that have living civilisations.

MICHIO KAKU: Some of these universes may look just like ours, except perhaps you're not there.

NARRATOR: M Theory was getting stranger and stranger, but could it really be a theory which explained everything in our Universe? To have any chance of that it would have to do something no other rival theory had ever been able to do. It would have to make sense of the baffling singularity at the beginning of the Big Bang. M Theory was about to come up with a suitably outrageous answer and parallel universes would be at the very heart of it.

BURT OVRUT: I was a teenager, I don't remember quite when it was and I don't remember precisely why my father and I were down in Manhattan at the harbour. One of the great ocean liners at the time was the Michelangelo and it was in harbour I remember on the west side of Manhattan. Must have been near 42nd Street. It was a remarkable sight. It's an enormous ship, let's say 150 or 200ft high, and the entire superstructure in the front of the ship, the entire bow had been just crushed by a wave which had blown out all of the windows in the forward bulkhead right up to the bridge. This is one of what they call a white wave, or a rogue wave which had hit the Michelangelo and done all this damage. What's interesting is that there are waves somewhat similar to this which inhabit the higher dimensions and then you can imagine if you had this huge rogue wave moving through the higher dimension if it slams into another wave you're going to have a tremendous cataclysmic collision.

NARRATOR: Waves had long fascinated Burt Ovrut. Now they were just about to turn M Theory upside down. At the beginning of 2001 the received wisdom was that the eleventh dimension was a tranquil place with membrane universes gently floating in it, but Burt suggested a much more exciting idea. Universes moving through the eleventh dimension like giant, turbulent waves.

BURT OVRUT: These things can move. They are not static, they're, you know, like everything else in the world they can move around and there's not much room for them to move in. In fact if they move they're very likely to bang into each other. In fact they either move away from each other, or they bang into each other, and one thing that had occurred to me very early on is what happens if they collide?

NARRATOR: To a new generation of cosmologists like Neil Turok Burt's vision of the eleventh dimension sounded intriguing, but he and his colleagues had other things on their mind. They were still wrestling with the big problems of cosmology.

NEIL TUROK: Was there a beginning? Did time continue before the Big Bang? Where did the Universe come from?

NARRATOR: Above all, they were still trying to solve the biggest problem of all: what caused the very start of the Big Bang, the singularity?

NEIL TUROK: Nobody has a solution for the singularity problem other than essentially by hand starting the Universe at a certain time and saying let's go from there and let's not worry about what happened before and that's very unsatisfactory. This is the deepest problem in cosmology. If you can get through the singularity you're on your way to a complete theory of the Universe.

NARRATOR: Most cosmologists have begun to think they might never find a solution. They'd almost given up completely, which is when Turok and his colleagues heard Burt explain his idea properly for the first time. At a conference in Cambridge pioneers of M Theory had been brought together to explore its implications. Burt was the star of the show. His vision of a violent eleventh dimension wowed the assembled physicists and caught the attention of the cosmologists.

PAUL STEINHARDT: We heard about a vast variety of ideas. The ideas that struck both Neil and myself most strongly were the ideas that Burt presented.

NARRATOR: On the last day of the conference Neil Turok, Paul Steinhardt and Burt decided to take time out. They went to see a play.

BURT OVRUT: We wanted to see the play Copenhagen which was being performed in London at the time and the three of us took the train down to London one evening and we had whatever it was, an hour or so on the train to sit and talk about these ideas.

NARRATOR: On the journey they began to throw ideas around. Three physicists, one train, and the biggest secret about our Universe: what caused the Big Bang.

PAUL STEINHARDT: I think people get the wrong impression about scientists in that they think in an orderly, rigid way from step 1 to step 2 to step 3. What really happens that often you make some imaginative leap which at the time may seem nonsensical. When you capture the field at those stages it looks like poetry in which you are imagining without yet proving.

NEIL TUROK: Paul, Burt and me were sitting together on the train and just free associating.

PAUL STEINHARDT: One of us, maybe it was me, began by saying oh well why can't we make a universe out of collision and Neil sort of pitching in and saying well, if you did that then you could create all the matter and radiation of the Universe, so we had this conversation, one of us completing the sentences of the other in which we kind of just, just let our imaginations go.

BURT OVRUT: And as we went along, at least I learned more and more about how it might be possible to have these brane collisions produce all of the effects of the early Universe and in particular it's just easy to do with my hands, when they collide you might have a Big Bang.

NEIL TUROK: And the Big Bang is the aftermath of some encounter between two parallel worlds.

NARRATOR: But how could such a collision go on to cause the world we know? The Universe we live in has vast clumps of matter we call stars and galaxies.

BURT OVRUT: We know that things are not smooth out in the Universe. In fact we have little clumps, we have stars, we have galaxies, we have quasars, we have clumps of matter.

NARRATOR: Now they had to explain how the collision of two parallel universes could go on to create these lumps of matter. Was there something about the membranes, or branes, which could explain it?

NEIL TUROK: People tended to think of branes as being flat, perfect sheets, geometrical plains, but I think to us it was clear that that picture could not be correct. It cannot be perfectly flat. It has to ripple.

PAUL STEINHARDT: What would happen as these branes approach that there are ripples in the surface of each brane and when they come together they don't hit at exactly the same time, same place, but in fact they hit at different points and at different times.

BURT OVRUT: We found that as the brane moves it literally ripples, so when the collision takes place it imparts those ripples into real matter.

NARRATOR: The parallel universes move through the eleventh dimension like waves and like any wave these would ripple. It was the ripples which went on to cause the clumps of matter after the Big Bang. They finally had their complete explanation of the birth of our Universe and now they could do something even more profound. They could take the laws of physics back in time to the moment of the Big Bang and through to the other side.

NEIL TUROK: The existence of branes before the singularity implies there was time before the Big Bang. Time could, can be followed through the initial singularity.

BURT OVRUT: You sort of go back and back and back until you get near the place where the expansion would have taken place and then it just sort of changes into another world. When the branes collide the collision of those can be explained within M Theory, so it just simply enters the realm of mathematics and science now rather than being a, an unknown point that exploded.

NARRATOR: The singularity had disappeared and it had taken them just under an hour.

PAUL STEINHARDT: Then we went to see the play.

NARRATOR: This idea is so new it's only begun to be discussed, but if it's accepted it will mean Einstein's missing theory has finally been found. M Theory may really be able to explain everything in the Universe, but the victory will be bittersweet, for at the end of its long quest, science has discovered that the Universe it's thought to explain may be nothing special. It is nothing more than one of an infinite number of membranes, just one of the many universes which make up the multiverse.

MICHIO KAKU: The latest understanding of the multiverse is that there could be an infinite number of universes each with a different law of physics. Big Bangs probably take place all the time. Our Universe co-exists with other membranes, other universes which are also in the process of expansion. Our Universe could be just one bubble floating in an ocean of other bubbles.

NARRATOR: But this isn't quite the end of the story. Now that the Theory of Everything may have been found some are keen to use it. Physics is preparing for the ultimate flight of fancy: to make a universe of its very own without any mysteries or unanswered questions at all.

ALAN GUTH: I in fact have worked with several other people for some period of time on the question of whether or not it's in principle possible to create a new universe in the laboratory. Whether or not it really works we don't know for sure. It looks like it probably would work. It's actually safe to create a universe in your basement. It would not displace the universe around it even though it would grow tremendously. It would actually create its own space as it grows and in fact in a very short fraction of a second it would splice itself off completely from our Universe and evolve as an isolated closed universe growing to cosmic proportions without displacing any of the territory that we currently lay claim to.