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IRA FLATOW, host:

You're listening to TALK OF THE NATION/SCIENCE FRIDAY. I'm Ira Flatow.

For the last hundred years, physicists have been scratching their heads over questions like: How did the universe begin? Where did our world come from? What else is out there? Why is there anything?

They've come up with some pretty far-out notions, like relativity, quantum mechanics, string theory, extra dimensions. We're all living and thinking comfortably enough in three dimensions, and then Einstein comes along and says, `Hey, you gotta add an extra dimension, a fourth dimension.' String theorists insist we live in a 10-dimensional universe. Stephen Hawking insists, `Hey, we may even have 11.'

If we live in so many dimensions, then where are they? Why can't we see them?
How do we know that these dimensions are not just a figment of our mathematical imagination and really have nothing to do with reality? How do we know they're there? Can we test them out? Can we find them? We're scientists. Can we do experiments to show that they exist?

Well, Lisa Randall has been thinking and writing about a universe with as many as nine extra dimensions, hidden dimensions, as I say, that we can't perceive.
And one answer to the riddle, she suggests, is that we may be living in our three-dimension world in an isolated neighborhood with fewer dimensions than other parts of the universe. So we may see just three dimensions, maybe the fourth dimension, time, as Einstein put in there. There may be other parts of the universe that have a lot more dimensions there. And ideas like this have made Randall the equivalent of, ooh, I'd say a rock star among theoretical physicists for her work on particle physics, string theory and cosmology. And theoretical physicists like Dr. Randall are trying to understand the universe on both its smallest and largest scales.

And she cares also about getting her ideas that she comes up with across to the rest of us, so her new book, "Warped Passages: Unraveling the Mysteries of the Universe's Hidden Dimensions," uses really very familiar analogies and images and even popular songs. One of her chapters has a song that, you know, begins with music that you'd recognize -- the lyrics of music you'd recognize right away, and she uses analogies that, you know -- of common, everyday items. And if you've ever read George Gamow's stuff back, you know -- that were written 50, 60 years ago, you'd recognize them immediately as being very similar. Maybe she'll tell us about whether she used George Gamow as one of her role models.

Lisa Randall is professor of theoretical physics at Harvard University and author, as I say, of "Warped Passages: Unvraveling the Mysteries of the Universe 's Hidden Dimensions." It's published by HarperCollins. She's also co-author of a forthcoming paper on why our world has only three dimensions that's coming out in the October edition of Physical Review Letters. She joins us now from Harvard News Office.

Welcome to SCIENCE FRIDAY, Dr. Randall.

Dr. LISA RANDALL (Harvard; Author, "Warped Passages"): Thank you for having me here.

FLATOW: Any influence from George Gamow?

Dr. RANDALL: You know, it's funny; I have to admit I actually didn't read very many popular science books as a kid and, actually, I didn't read that. And a couple of people have told me that there's some overlap with the sort of analogies that I use.

FLATOW: Yeah.

Dr. RANDALL: But, actually, they were completely original.

FLATOW: And one of my favorite when I was a teen-ager -- I read "Mr. Tompkins in Relativity Land," I think. You ever hear of that book?

Dr. RANDALL: Yeah. You know, I've heard of these books, and I did, actually, when I started to write, given that I hadn't read a lot of them -- I did, actually, glance through some of the books, and I read the first few pages of "One, Two, Three...Infinity" and just looked through them.

FLATOW: Yeah.

Dr. RANDALL: But I have to say I didn't actually read any of them very carefully.

FLATOW: You know, and the way you write is terrific, and you have a chapter, Chapter 7, The Standard Model of Particle Physics -- matter is most basic known structure and, you know, you might say, `Here we go again,' but you start it off with a riff from "West Side Story," (singing) `You're never alone, you're never disconnected,' and I thought that was terrific. You find that that helps in getting us going?

Dr. RANDALL: Well, it certainly helped me get going, because when I would sit down to write a chapter I would have music going through my head. But I actually think it's -- it was sort of fun. I mean, one of the things that I noticed in writing this book is just how much of our language involves spatial imagery.

FLATOW: Yeah.

Dr. RANDALL: And so it was very -- it was often easy to find something where -- I 'm misappropriating it, I admit, but it sort of has some of the concepts that are involved in that chapter. The one about the jets is actually just funny, because it turns out that in physics there is something called a jet, which is what you would see in an accelerator if you have a strongly interacting particle. And actually, the words that they use to describe it, that it's never alone, it's never disconnected, is exactly what happens with these strongly interacting particles.

FLATOW: See, that -- even Leonard Bernstein -- I can't remember the co-author of "West Side Story" -- must have known that. But...

Dr. RANDALL: It was Stephen Sondheim.

FLATOW: Sondheim. Yeah. But, you know, you're in a line of work that is, I think, to the public the hardest line of work to understand in all of science, and I'm sure you're aware of that, to try to make it clear to -- what the heck you do for a living.

Dr. RANDALL: It -- I became more aware of it as I was writing the book, and I can assure you, I thought, `What a place to start...'

FLATOW: Yeah.

Dr. RANDALL: `...writing a book on such a difficult subject.' And one of the things that was really interesting to me in writing it is that -- well, there were a couple of things. One is the fact that it really seemed like it was worthwhile. If I -- when I gave various pieces to friends to read -- you know, non-scientist friends -- I found they really were interested and they really appreciated the effort to try to explain things in a way that they could understand, and they actually were really interested.

FLATOW: Yeah.

Dr. RANDALL: But also, one thing I found that was somewhat surprising is that the hardest ideas to explain, in many ways, were the particle physics ideas. In some ways, these exotic ideas about extra dimension and even string theory -- there's some kind of imagery you can have. It's when you start talking about elementary particles, that concepts become so abstract, that that was where I think it was really difficult to try to explain why we're so excited about these things, what makes them interesting.

FLATOW: Well, which particle and what concept do you think you had the most success with explaining?

Dr. RANDALL: I had the most success with?

FLATOW: Yeah, that you enjoyed coming up with an analogy for, or that you thought worked real well in your book.

Dr. RANDALL: I think the -- some of it was just sort of the concepts, rather than any particular particle, but the idea of how things change with scale and what kind of interactions we have. And in the theory we used, which combines together quantum mechanics and special relativity -- it's called quantum field theory -- we can find that the way we -- what we would measure depends on what distance scale you're looking at, and it's because of various intermediate interactions. And I realized it was just -- if I tried to draw a spatial analogy for it, it didn't really convey anything. But I thought maybe, you know, passing it through a big bureaucracy where it would get sort of distorted at every level until it finally emerged -- and that's sort of what happens to these various interactions, so I kind of like that.

FLATOW: Yeah. You use -- go as far as in your book to use the fairy tale "The Princess and the Pea" to explain subatomic particles. Let's talk about that one.

Dr. RANDALL: Well, that one was really to try to explain, just sort of give a visceral feel for what it is that goes into discovering something like a quark, a quark inside the proton -- that you really have to be able to look at tiny distances. And basically, I was thinking about his ridiculous story of "The Princess and the Pea," and it turns out, just coincidentally, that a pea takes up about the same fraction of a mattress that a quark does of a proton, in some sense. And basically, if you -- you would have to -- if you wanted to see something, you'd have to really compress it. You'd have to -- if you really -- if you weren't this delicate princess, you'd want to sort of jump up and down on it until you could actually get to the pea. Even that would be very difficult, but you could do that. And that's sort of what's going on in these experiments.
You really have to just probe inside. You can't just look lightly. You have to have very hard interactions, very energetic interactions, so that you can see what's happening at very tiny distances.

FLATOW: Let's talk about your ideas of extra dimensions. I think, of everything in physics, when I talk to the public -- and we've talked about this a lot of times -- you know, how people can envision living in a universe that has nine, 10, maybe 11 dimensions to it, when, you know, we're used to just three, maybe four. Time, I think, you can understand.

Dr. RANDALL: Right.

FLATOW: How do you -- do you have yourself a visual image of what nine-dimension universe looks like?

Dr. RANDALL: No, I don't, actually.

FLATOW: That makes me feel better.

Dr. RANDALL: And I think one of the things that makes it difficult to get it across is that you can't picture it. We are not physiologically designed to picture more than three dimensions. It doesn't mean they're not there, but we certainly can't just picture them very simply. What we can do is we can try to extrapolate our ideas mathematically or in words, and we can find shortcuts for trying to picture things, the same way we try to picture three-dimensional worlds on two-dimensional pieces of paper. We can have little tricks to try to summarize various aspects.

But really, the right way to understand it is with words or equations. It's hard to understand it with pictures, because we just can't see them.

FLATOW: Mm-hmm.

Dr. RANDALL: But one thing you could do is try to go down a dimension. As -- that's what Edwin A. Abbott when he wrote "Flatland" at the end of the 19th century. He said, `Look, we can't picture extra dimensions, but let's go down a dimension so that we could at least understand the problem of trying to see a different dimension.' So what he said is: Suppose you had a square -- he was Edwin A. Abbott, where a square came from -- and suppose the square lives in a flat land, which could be, say, a tabletop, a two-dimensional surface. And he asked the question: What does the third dimension look like from the perspective of something in the two-dimensional world?'

And so you can then try to picture it. And if you were really stuck in the two-dimensional world, say a sphere passed through; what you would see would be a series of discs that increased and then decreased in size. And so we can extrapolate from that, and we would realize that in our three-dimensional universe, if a hypersphere passed through, we'd never see it in its entirety.
What we would see is a series of spheres that increased and then decreased in size. And so we can sort of use that to sort of at least understand both the frustration, but also how you can deal with it, trying to picture what would happen.

FLATOW: Mm-hmm. But you, as a mathematician, or at least as a physicist who's well versed in mathematics, can then use the numbers to try to create something that you can't actually visualize.

Dr. RANDALL: Well, in some way -- so what we can do is, because the three dimensions of our world are, in many respects, the same -- as far as we know, physics looks the same in any of the three spatial dimensions we know about. So what we can do is just draw a two-dimensional picture where one axis just represents all three dimensions and the other axis represents an extra dimension. And then we can ask questions like: How do things change as we go out along a single extra dimension? So if the only interesting extra dimension in physics is along a single direction, or it can be summarized in a single direction, we can actually draw pictures, and that's the kind of picture I have in my book.

FLATOW: Mm-hmm. And very few people can get to that point. We have to come up on a break here, but surely...

Dr. RANDALL: Hey, hey!

FLATOW: ...so I don't want to get you going...

Dr. RANDALL: I hope that's not the case.

FLATOW: No, we'll have -- we're going to come back. But when you have a problem, how do you parse it out in your own head? Where do you -- do you go away to think, like Einstein used to go on a walk? Do you have a place that you go to, or...

Dr. RANDALL: That's a really interesting question. Sometimes I'll just sit on my sofa and think. Sometimes I'll just talk to other people and exchange ideas. A lot of the time we'll have the blackboard filled up

with equations or pictures, where we try to have some back-and-forth about ideas, or sit in a coffee shop.
But sometimes I really will just sit and just -- you know, sometimes you'll sit down and work out the equations, but sometimes you'll sort of talk to the equations. You'll try to figure out, what are they trying to tell you? Or you might have some idea of where you're going when you use your equations, so where is this all heading?

FLATOW: Yeah.

Dr. RANDALL: And you try to put it in the context of some bigger picture a lot of the time.

FLATOW: All right. We're going to come back and talk lots more with Lisa Randall, author of "Warped Passages: Unraveling the Mysteries of the Universe's Hidden Dimensions," and try to answer some of the questions in your hidden dimensions. So stay with us. We'll be right back after this short break.

I'm Ira Flatow, and this is TALK OF THE NATION/SCIENCE FRIDAY from NPR News.

(Soundbite of music)

FLATOW: You're listening to TALK OF THE NATION/SCIENCE FRIDAY. I'm Ira Flatow.

We're talking with Lisa Randall, professor of theoretical physics at that little place up there in the Northeast called Harvard, and she's author of "Warped
Passages: Unraveling the Mysteries of the Universe's Hidden Dimensions,"
published this year by HarperCollins. Great book. I recommend it to you if you 're interested in any of this kind of stuff, which I always am. Our number: 1
(800) 989-8255.

Before we go to the phones, you know, something we've talked about a whole lot and I'm certainly, you know, not the only one talking about it, is how do you -- you know, the great mystery, the great unsolved problem of uniting the forces of nature with gravity. We've had people coming on who've said, `Hey, string theory does that, you know, maybe.'

Dr. RANDALL: Right. So, actually, one of -- the kind of research I do, it tries to take elements from these sort of big ideas, like string theory, and see how they can connect to our world. So let me just backtrack. So the basic problem that we have in our theory is that we have quantum mechanics, which describes things with small scales, atomic scales; we have general relativity, the theory of gravity, that describes things on big distance scales. And these theories work fine, but at some infinitesimal distance, not a distance we're going to experience, 10 to the minus 33 centimeters.

But there is a distance scale at which the theories are incompatible, and we 'd really like to have a theory that can describe everything.

FLATOW: Yeah.

Dr. RANDALL: That tells us that there's something wrong with the theory. So we want to have a fundamental theory, but if you think about it, we had this fundamental theory that's applying at this very short distance scale, and then we'd want to know, what does it say about the universe on the scales we see? So we haven't yet worked it out. We don't even really know, in many ways, what the theory is. In fact, one thing we've found is it's not even just a theory of strings; it has other exotic objects called branes, which are membranelike objects. So the theory clearly has a richness to it, but it also -- we don't know exactly where it's leading us.

So what I like to do is sort of connect to things that we can actually observe, ask questions about phenomena that we can test, like how do -- trying to understand why gravity is so weak compared to other forces, and maybe connect that on to ideas we might get from string theory.

FLATOW: Yeah. You talk about gravity being so weak that even the magnet on your refrigerator dwarfs the gravitational -- correct?

Dr. RANDALL: Yeah. It's probably not something that you think about very often...

FLATOW: Yeah.

Dr. RANDALL: ...but it is kind of remarkable that you can pick up a paper clip with a magnet when the entire Earth is pulling against it. And from the point of view of an elementary particle, gravity is just completely negligible, compared to other of the forces. In fact, it's very hard to test gravity because the other forces swamp it so much. So one thing we'd like to do is understand that, and it's even worse than that because, in order to have those two, we actually have to introduce such a big fudge in this area that we know there's something else, and that's why this question is really driving a lot of research today.

FLATOW: And it is -- this point I was aiming at, the fudges in physics that people introduce to make the things work. There are a lot of physicists who are, we know, very much involved in string theory and looking for the solutions, but there are others who say it's a dead end, that it's...

Dr. RANDALL: Well...

FLATOW: ...you know, you can't -- you're not going to be able to test it. You know, you -- whole populations of graduate students are wasting their time on this. It's like proton decay, you know, was 20 years ago. It's just not gonna go anywhere.

Dr. RANDALL: Well, it's always difficult to make those predictions. What's clear is that string theory has given rise to many interesting ideas. We know ideas like extra dimensions and these things called branes -- they might actually be a part of our universe, and so you can't just decree that we're not going to think about it. On the other hand, we do want to make connections to the world. And so I think really what we want are sort of two simultaneous directions, taking -- we know this theoretical problem of trying to reconcile gravity and quantum mechanics is there, but we also know that there are phenomena that we don't understand, even at observable scales, which is why we want to build accelerators like the Large Hadron Collider that will be at CERN in Geneva. And we want to see, can we make any connection between these? It doesn't mean we'll directly test string theory, but perhaps we can test ideas that come out of string theory.

FLATOW: Right.

Dr. RANDALL: And that's certainly a good direction to go in. And also, you want to use the string theory to see, can you understand the problems of quantum gravity? Like, do you understand black holes better, for example? So it's not -- I think saying it's identi -- is just short-sighted, but on the other hand, saying it's everything is also short-sighted. You really want to combine together these two different tracks.

FLATOW: Sure. Yeah. That's an easy thing. 1 (800) 989-8255. Let's go to Dan in Toledo. Hi, Dan.

DAN (Caller): Hi.

FLATOW: Go ahead.

DAN: I had a -- my question is: Is there any place in the discussion of the physical universe for the discussion of consciousness as a dimension? And I'm fascinated with the double-slit experiment, where the observation changes the experiment somehow.

FLATOW: Yeah, the John Wheeler effect.

DAN: Yeah.

Dr. RANDALL: Yeah. People -- a lot of people ask about these things. I think nobody -- well, some people do, but we really don't understand consciousness.
And so I should say before we moved on to think about extra dimensions of space to try to explain physical phenomena of our world, we tried really hard to understand them with three dimensions first. And it was only the fact that those explanations didn't seem satisfactory that sort of said, `OK, you know, maybe we do need to go a step further.' It's hard -- until we really understand the consequences of all the physics we know, about all the chemistry, I think it's really hard to try to say how we're going to solve the problem of consciousness, and certainly, to bring an extra dimension before we even understand anything about how it works with just three dimensions would be premature, I think.

And in terms of quantum mechanics, people like to -- again, it's just a way of interpreting what's going on. We really understand quantum mechanics well. We really know how to make predictions with the double-slit experiment. And they seem mysterious to us, but the reason they seem mysterious is because we don't live at -- we don't observe things on atomic scales. We observe things on much larger scales. So our intuition is based upon classical reasoning. If we really were living at scales where we'd see quantum mechanical effects all the time, it wouldn't be as mysterious to us, and I don't think we would start trying to invoke exotic ideas like extra dimensions for that.

FLATOW: 1 (800) 989-8255 is our number. And, you know, in researching talking to you in books and magazines and all kinds of places, you come across something that is common, and it's always common in our culture now, that you're a Jodie Foster look-alike.

Dr. RANDALL: (Laughs) That's, like, really -- I don't know where this comes from. It's really -- it is kind of funny. I don't actually look all that much like her. I think it's really funny, because I actually have another friend -- she does neuroscience. She doesn't do particle physics. But apparently, everyone thinks she looks like Jodie Foster, too. I think it might be that Jodie Foster played a scientist in a movie. I am -- I don't know what is ...(unintelligible)...

FLATOW: Well, the more I think, that's sort of a backhanded compliment, to say, `Look, this is a woman who's got brains, but she's got incredible beauty also.'
I look at the picture in your book; this is a very flattering picture, also, you know.

Dr. RANDALL: It is a flattering picture. You know, it's really funny, because you go through your life as a scientist, and you really don't think about those things very much, or you try not to. You try to -- you really want to focus on what you're doing. And then it's funny, because in writing a book, you are interacting more with the outside world, and the first they see isn't your ideas; the first thing they see is the picture. But I'm hoping that people will get through the rest of book and realize that's really what I'm trying to get across.

FLATOW: Well, but don't you think you can -- and I'm not trying to be chauvinist about this, but don't you think you have a talent, because of your looks, to bring people into science who may be not paying any attention?

Dr. RANDALL: Well, that's right. That is -- I have to -- I mean, that is part of what I'd like to do, especially bringing -- I'd like to show young girls, for example, that this really is something that they could think about doing, that it's not just a bunch of people that don't look anything like them. And so i think it is important to recognize that science -- I mean, well, that's the great thing about science, is it's not excluding anyone. Really, anyone is entitled to go work out these ideas. And it would certainly be a shame if people deprived themselves of the fun you can have.

FLATOW: Yeah. And that is the problem. How do you make string theory as popular as string bikinis, you know? How do you...

Dr. RANDALL: (Laughs) Well, I mean, it's part of a bigger problem in our country, I think, of just making -- basically, there is sort of an anti-intellectual edge a lot, and, you know, in countries like France, scientists really are known. Everyone knows who wins the Nobel Prize.

FLATOW: Right.

Dr. RANDALL: So it really is part of a general attitude. I don't think it's just about science.

FLATOW: Yeah. And you wrote a huge editorial, Op-Ed piece, in The New York Times a few weeks ago and said, you know, one of the reasons that people have trouble grasping science is that they want us to boil it down to such a, you know, level that it becomes incomprehensible at that point. And part of the problem with the media is that they try to do that.

Dr. RANDALL: And...

FLATOW: They don't -- they're not good conveyors and we're not doing a good job.

Dr. RANDALL: I don't mean you personally, but -- and I think that many people are -- you know, they are doing a good job. And I didn't mean to be universally critical. But we do...

FLATOW: No, I agree with you. I agree with...

Dr. RANDALL: I think we do need to just be a little bit more patient. I mean, some of these ideas -- unfortunately, they just are complicated. It doesn't -- and actually, they're more interesting because of that. They're rich. They're not ideas that you can just understand in two seconds. Some things you actually need to build up a little bit to understand them more deeply. You can understand things at a superficial level, but that's not really understanding. And it really is so much more worthwhile -- and one of the reasons it becomes important is because there are so many debates now about scientific issues, and it's just important that people can understand them a little better.

FLATOW: But we don't teach people enough to understand them a little better, do we?

Dr. RANDALL: Well...

FLATOW: I mean...

Dr. RANDALL: ...I certainly would like to see science education in this country improved. I think people have opportunities to learn things, but not everyone does. And it's -- that's just a huge problem, really...

FLATOW: Yeah.

Dr. RANDALL: ...trying to make education better.

FLATOW: Well, let's see if we can do a little educating. Paul in Tulsa -- hi, Paul. Welcome to SCIENCE FRIDAY.

PAUL (Caller): Welcome to you, too. Thanks much. This is a really interesting discussion, and by the way, being compared to Jodie Foster ain't too bad. I've got a question here. If we -- suppose we live in some little odd cul-de-sac in a part of the universe where so many of the levels that -- are less than they could be anywhere else in the universe. And let's pretend we build ourselves a great little spaceship, and we go to another part of the universe where there's more levels, that you're speaking of. Are we going to have to rewrite the laws of physics as we know it...

Dr. RANDALL: So...

PAUL: ...sound and light...

Dr. RANDALL: Yeah.

PAUL: ...and time and so on? I mean, if a butterfly flies by us, are we going to feel and hear and see wing movement differently? Is the...

Dr. RANDALL: Right.

PAUL: ...starlight going to knock us down?

Dr. RANDALL: So this...

PAUL: Are we going to have to rewrite those laws?

Dr. RANDALL: This is a perfect example of where we want to back-track a little bit and understand what I'm saying a little more carefully. So first of all, everywhere really is a higher dimensional universe. If the universe is higher dimensional that's true everywhere. What happens is the -- what we appear to observe, the laws of physics that we would measure, look as if there's a three-dimensional universe even though fundamentally there are many more. And that's what we find.

PAUL: All right.

Dr. RANDALL: We can have a pocket where gravity is so highly concentrated that it appears to have three dimensions of space even though there are more. And in this case, it turns out that the regions where you do see these higher dimensions are probably beyond what we'll call our horizon. So because of the finite speed of light, we can't see arbitrarily far away over the age of our universe. We know there has been no causal contact; we haven't interacted. And so it's those regions that are beyond what we can experience that would have the higher dimensions.

PAUL: OK. OK.

Dr. RANDALL: And also, as far as light goes, that's an even different question because light is different than gravity and it could be that if we live on a very particular region, it could be that light is actually living really, really confined. Gravity is everywhere; it could be concentrated somewhere. But really there are mechanisms in string theory, for example, for confining light to a very specific region in, say, three dimensions.

PAUL: OK.

FLATOW: All right? Thanks for calling.

PAUL: Do you have a book on this, or will you put one out?

FLATOW: She's got a book out right now called...

PAUL: I will buy it.

FLATOW: ..."Warped Passages" -- he's doing a commercial for you...

Dr. RANDALL: Thank you.

FLATOW: ..."Unraveling the Mysteries of the Universe's Hidden Dimensions." Very readable book.

PAUL: "Unraveling the" -- OK. Very good. Thank you.

FLATOW: We have it on our Web site in case you forget it. Thanks for calling.

PAUL: OK, thanks.

FLATOW: Bye-bye. 1 (800) 989-8255. I was talking to Jim Gates yesterday at an Einstein symposium at St. Peter's College and we were talking about these sort of things, and I asked him: Do you think we might need new physics for the dark energy? You know?

Dr. RANDALL: Yes.

FLATOW: And what do you think?

Dr. RANDALL: I -- it might well turn out to be the case. It's a problem, so I should say, the dark energy -- it's -- we know it's energy of -- most of the energy on our universe is this mysterious thing that's now called dark energy.
We knew about dark matter before, but now this dark energy, which is even more mysterious. It's not carried by any particles. It's just energy that exists in the universe. It's really part of a much bigger problem, which is actually, according to our theories, the energy should be enormous. We -- it's a very strange thing.

FLATOW: Right.

Dr. RANDALL: If we do the same sort of thing where we combine together quantum mechanics and special relativity and make a calculation, we would guess the energy is just huge. And the question is why is it so tiny compared to the number we would expect. And so -- and lots of smart people have been working on this for many years and we really haven't gotten anywhere. So it does seem like there has to be some new idea that's lurking out there that would hopefully explain that. I think that might be right.

FLATOW: Talking with Lisa Randall this hour on TALK OF THE NATION/SCIENCE FRIDAY from NPR News.

And how do we come up with new physics? How do we imagine what it even might be?
What does that mean: new physics? That the laws of physics we're used to don 't behave that way anymore?

Dr. RANDALL: If I knew the answer, I would solve the problem and we'd be done with it. It's not clear what it means. It could mean that we ha -- one of the explanations that I would find the least satisfying is it

could mean something like we have to take the anthropic principle seriously, which says that we just
-- there are many possibilities for the energy of the universe, but we only live in the one -- we live in the one that can give rise to these structures that we see. I find that unsatisfying because there's no explanatory power there. But it could mean that, for example, if we understood a theory like string theory -- maybe not string theory -- but if we understood it better, we would fundamentally understand something different about what's going on.

I mean, there are assumptions that are built into our theories like interactions are local, that they only occur with things that are right at the same point.
And so there basically -- it could mean that one of the assumptions that's built into our theory we have to loosen it a little bit so that at least in some regimes it doesn't work. I mean, I -- that's just an example. I don't know the answer. This is a big problem and we really don't know where it is. But it could be that one of the things that we think is just -- has to be true that...

FLATOW: Yeah.

Dr. RANDALL: ...the symmetries of the universe -- maybe there's something missing in what we're doing. Maybe we have to change an assumption from the very...

FLATOW: Right. You know...

Dr. RANDALL: ...beginning.

FLATOW: Yeah. You know, you -- like, science is always involved with trying to
-- reduction, in trying to reduce things down to their simplest form, so that it looks like the more we talk about physics and the universe and particles, it gets even -- the more question -- we get more questions than answers.

Dr. RANDALL: Well, the -- in some sense that's true, but in some sense that's the way science always is. We extend the realm of which we understand things and then we find that there are questions that lie beyond that. We could -- ultimately the theory might look simpler, but it has to connect onto what we see. And so it 's the steps of trying to make it connect that make it interesting.

And also, one of the reasons I actually like working on extra dimensions of space is because we do get to use laws of physics that we know. We use Einstein 's general relativity. That's a theory that's well-established; we understand.
But we apply it in this new regime where there's other dimensions. And because that's a new regime, we can find phenomena we just hadn't anticipated. So even within the context of the laws of physics we know about, there are things -- there are surprises awaiting us sometimes.

FLATOW: So this is a good time to be a physicist.

Dr. RANDALL: I certainly think so. I certainly think so.

FLATOW: What a...

Dr. RANDALL: And it's really exciting too because in a couple of years the Large Hadron Collider will turn on and we'll actually have more experimental information in addition to all these new theoretical ideas.

FLATOW: That will...

Dr. RANDALL: So that's going to be a thrilling time.

FLATOW: Yeah. Will that give us some ideas of whether string theory is correct or not?

Dr. RANDALL: I think it will give us ideas of where to head with string theory.
If we discover, for example, a symmetry called supersymmetry where we double the number of particles, that would tell us something about that symmetry holding to very low energies. If we discover extra dimensions, it would tell us something about what those dimensions look like. So it's certainly not going to tell -- I doubt very much it will tell us whether string theory is right, but I think it could tell us things that might guide string theory research in the future.

FLATOW: Well, I wish you very much luck in your research, and we'll have you come back and...

Dr. RANDALL: Thank you.

FLATOW: ...explain more to us 'cause, you know -- goes by so fast and there's so much to talk about and I'm sure you have a lot of fun talking about it amongst yourselves.

Dr. RANDALL: We certainly do.

FLATOW: Yeah, thank you very much. Lisa Randall is professor of theoretical physics at Harvard University. Her new book "Warped Passages: Unraveling the Mysteries of the Universe's Hidden Dimensions," published by HarperCollins. A great read. You know, everything you ever wanted to know about all these ideas are there and written in a very readable form. I highly recommend it.

We're going to take a short break, change gears, shift it into overdrive and talk about the waters of New Orleans. Maybe there's a good side to the waters there. They may have helped to wipe out part of the termite population. They can 't breathe underwater. So we'll talk about it when we get back. Stay with us.

I'm Ira Flatow. This is TALK OF THE NATION/SCIENCE FRIDAY from NPR News.

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