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**Saturdays at 12.10pm, repeated Mondays at 7.10pm**
**with Robyn Williams**

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# How many dimensions might there be?

**Saturday 20 August 2005**

## Summary

Lisa Randall has theoretically modelled a scenario where there could be infinite dimensions which we just can't see - yet.

## Program Transcript

**Robyn Williams:** Thirty years ago, if meeting the professor of Theoretical Physics at Harvard, I would not have expected a young woman, but 2005 is different. Lisa Randall has been here for *National Science Week* and her field is strings and other dimensions.

**Lisa Randall:** Well, to actually know that string theory is right will be quite a challenge, but there are ideas that come out of string theory that we might well be able to test. One of the ideas that I'm excited about is the idea that there could be extra dimensions of space. And in certain contexts we might actually be able to test whether there are extra dimensions of space. If string theory really combines with physicals phenomena in our world then it's likely that it will apply at scales that are actually measurable. So, although we might not be able to say we've definitely discovered string theory we could say we've discovered extra dimensions, which might provide evidence for string theory. And if we're very lucky we might actually see evidence of strings when we build colliders, when we build high energy particle colliders that reach energies higher than those we've explored before.

**Robyn Williams:** Understand these dimensions is tough because you've got up, down, sideways and time and then there's supposed to be something like another seven at least.

**Lisa Randall:** Yeah, and they are indeed very hard to picture and in fact it's not the best way to think about it to try to picture these dimensions in some sense. I mean, it's actually easier to use math or words but if you want to try to picture them, actually the easiest thing to do is to do what Abbott did in the late 19th Century, which is to say he wrote *Flatland* where you imagined that there are creatures that live on a two dimensional surface. So now we can picture what an extra dimension is for those people. Suppose if they were living on a tabletop, a two dimensional surface, but the third dimension really exists but they never experience it, they don't see it directly, they don't actually go out into the third dimension, they are stuck to the tabletop. Well, nonetheless there could be evidence of those extra dimensions. For example, something could pass through from an extra dimension, that is to say, from the third dimension.

So suppose a sphere passed through from the third dimension, what someone in *Flatland* would see would be a series of discs that got bigger in size and then smaller. So there could be energy that gets transferred between this two dimensional surface and the rest of the world. They might see gravitational evidence with this extra dimension but they don't necessarily experience it directly, and it could well be that we're like that. We could be stuck not on a tabletop but a surface called a brane, which is like a membrane-like object in higher dimensional space and maybe we're stuck on this object that has three spatial dimensions but there are these other dimensions of space that again, we don't directly experience but nonetheless they could have an impact on our world which would be very exciting.

**Robyn Williams:** Strings, maybe you need a string to tie the connection between relativity and quantum mechanics, if there is one. But Lisa Randall's quest to find those extra dimensions is getting results, taking her to places we didn't even think existed.

**Lisa Randall:** One of the most exciting things we found is that if there *is* an extra dimension of space it doesn't have to be tiny. Before, what people thought was even if there are extra dimensions they'd be so tiny that they'd have no impact on the world. What do I mean by that? Well, if you see say, a long rope, you might see that as having one dimension even though it truly has the extra dimensions, two or three, depending on how you look at it. And what we found is that you can actually have an extra dimension that's *infinite* in size – that is to say you could arbitrarily far in the extra dimension but nonetheless it would be hidden from our world, and again that's a consequence of having warped space-time, and that was quite radical. Pretty soon after Einstein developed his Theory of General Relativity, the idea of extra dimensions was introduced and by the 1920s that was basically the way people looked at it, if there are extra dimensions they have to be rolled up to a really tiny size. And really, until we did this work that was what was thought. And now we realise that you can have extra dimensions, they can be infinite in size and still be hidden.

**Robyn Williams:** If they're hidden how did you find them?

**Lisa Randall:** Theoretically. That is to say, we found a *theory* in which space-time was warped - and it wasn't a very artificial theory, it came out automatically; we had a very reasonable set up. And what we found was that, if this described the world, that is to say if our assumptions hold and that is actually what the world looks like as far as the number of dimensions goes, it would look identical to what it would look like if there were only three dimensions in space; which is to say there could be this fourth spatial dimension and actually, rather than being so simple to rule out it could be very difficult to test. And basically we could show the experimental consequences of this theory: it would look the same as if that extra dimension didn't exist.

**Robyn Williams:** Why do you find that so exciting?

**Lisa Randall:** Because it really opens up the possibilities of what our universe can look like. It really makes us rethink our place in the universe in some sense. A lot of physics as it develops is moving beyond what we think of as intuitive because it's what's immediately in front of our eyes. And so three dimensions of space, I mean, what could be more obvious - you look around there's three dimensions in space. What this is saying is that, even that obvious assumption isn't necessarily correct, there could be infinite extra dimensions that we actually don't see. And in fact we went beyond that with another physicist, Andreas Karch, we went beyond that and we showed that actually three dimensions of space could be a purely local phenomena. That is to say, we could be in a three dimensional sink hole, so we could be in a place where there seems to be three dimensions of space, whereas the rest of space could look like it has more dimensions. So really it's kind of like the Copernican Revolution revisited. I mean, it really us rethink where we sit in the universe and my hope is that it will also help us understand phenomena that we are having trouble understanding at this point by rethinking the very most basic assumptions that we build physics upon.

**Robyn Williams:** And Lisa Randall says that that may one day even tell them what Dark Energy is all about.

## Guests on this program:

**Lisa Randall**
Professor of Physics
Harvard University
http://www.physics.harvard.edu/randall.htm

## Publications:

**Warped Passages: unravelling the universe's hidden dimensions**
**Author:** Lisa Randall
**Publisher:** Penguin/Allen Lane
ISBN 0-713-99699-4

**Presenter:** Robyn Williams
**Producer:** Polly Rickard and David Fisher

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