Higher profile

Lisa Randall: Warped view of the universe

Sometimes gravity can be a pain in the heel, Harvard physics professor Lisa Randall tells John Crace

John Crace
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Two years after her climbing accident, Lisa Randall shakes her head, still not quite able to accept the reality of the laws of physics. "It just shouldn't have happened," she says. "I was climbing safely, the conditions were good, the route wasn't that difficult and I was properly roped up. But somehow, I managed to fall and smash my heel."

It sounds like a straightforward, Newtonian case of "what goes up, must come down", but whenever Randall gets stuck into the laws of physics - and gravity in particular - things rarely turn out to be as simple as you imagined they would.

Randall is professor of theoretical physics at Harvard University and one of the most influential living scientists. In partnership with Raman Sundrum, she has published two papers that have transformed the way physicists think about the underlying structure of space, by showing that the hidden dimensions required by string theory could be not just large but infinite, provided space was warped in the right way.

This effectively solved the geometry of a high dimensional model of space and Randall's papers are now among the most cited in particle physics but, as she freely admits, this was not the problem she set out to answer. "I started out working on supersymmetry," she says. "The theory predicts that for every particle we know about, there will be an additional particle." It has implications for the standard model of particle physics, which embodies everything scientists know about the fundamental particles of the universe.

Randall then began to consider the upshot of her geometry. "The standard model of particle physics describes forces and particles very well," she says, "but when you throw gravity into the equation, it all falls apart. You have to fudge the figures to make it work. We know how gravity works, but no one had properly answered the question of what determines its strength. Why is it so much weaker than standard theory would predict?"

Once embarked on this track, things snowballed as she started to find other phenomena she hadn't anticipated. Randall "stumbled" on the fact that space is warped; accidentally realised, along with Sundrum, the radical implications of Einstein's equation of gravitational background, and proved gravity could be strong in some places and weak elsewhere.

Gravity was strong enough for Randall to fracture her heel in several places and she reluctantly concedes that it is possible that "we could just be a pocket of three-dimensional space".

The enforced lay-off - Randall was stuck in her bed for two months with her leg raised to prevent infection - had one benefit: it enabled her to get stuck into her first major book, Warped Passages, which aims to simplify her ideas for a wider readership. "I balanced my laptop on my chest and just got on with it," she shrugs. "There wasn't anything else to do."

Randall's notions of simplification may not be the same as her readers'. String theory, multidimensional multiverses, Higgs bosons and Kaluza-Klein particles do not readily submit to a simple reductive narrative, and though she works hard to make her work accessible - there's an interesting bit on how the crystals that make up the coating of a non-stick frying pan do not have the conformity of three-dimensional crystals, and so might be a projection of a crystalline structure from a higher dimension - even a PhD in theoretical physics is unlikely to guarantee total understanding.

But accessibility was not Randall's only motivation. "If you look through the shelves of science books, you'll find row after row of books written by men," she says. "This can be terribly off-putting for women."

Randall knows all about the difficulties of being a lone female voice. She was brought up in the New York borough of Queens, where her father was a sales rep and her mother stayed at home to look after her three daughters. "I'm not sure where my interest in science comes from," she says. "I guess I was just always good at math and things took off from there."

Even when Randall went to Harvard to study physics, she had her reservations about the academic life. "I never felt completely at home, even though I was clearly good at what I was doing and enjoyed the work," she says. "I missed out on the companionship of having women on my course. There were so few of them, it made life lonely at times. I considered going into business or becoming a lawyer - not for the money, but for the thrill of problem-solving."

But physics proved an irresistible attraction and, from the late 80s onwards, Randall has held prestigious posts at the University of California at Berkeley, the Massachussetts Institute of Technology and Princeton, before coming back to Harvard in 2001.

She was the first woman to win tenure in the physics departments of all three east coast universities. It's no more than her talent merited, but Randall leaves you in no doubt it's been an uphill struggle along the way.

She refuses to get involved in personalities, but dismisses both MIT and Princeton as "unhelpful working environments" and was less than impressed when Larry Summers, Harvard's president,

suggested at the beginning of the year that there were fewer women scientists because of innate differences between the sexes. "Though he's always been extremely complimentary about my work," she adds.

One upshot of the Summers episode was that Randall was invited to become a member of the Women in Science panel, a task force set up by Harvard to address the under-representation of women in science and engineering. She is hopeful that something positive will emerge from its report. "We need to give undergraduate women better opportunities for research," she says. "And we also need to make sure that students are properly supervised and have all the tools they need."

Randall believes things become more difficult for women the further they get up the career ladder. "I'm one of the big players in a very competitive arena," she says matter-of-factly. "So people have learned to take me seriously. But it's been a hard struggle at times." Not least because she has insisted on doing things her way.

Unlike her alpha male colleagues, she's never oversold her ideas for easy headlines, and in some ways this has made her work harder to pin down.

Randall sees it slightly differently. "I think it makes me a better scientist," she argues. "I don't have to believe in an idea to investigate it thoroughly. I can do good science while still remaining sceptical. We owe it to the public not to exaggerate our claims."

But, on a personal level, crunch time for Randall is rapidly approaching. No matter how much she bends time, there's no escaping the fact that she's just turned 43 and that if she wants to have kids she's going to have to get on with it soon. "Children are the biggest issue for most women in science," she says, "because, like it or not, society still sees women as the primary carers. Part of me really wants to have children, but another part of me wants to put it off as long as possible, because there is so much more work I want to do and I'm very intolerant of distractions. Like many scientists, I'm something of an obsessive."

So what are her plans? Randall is disarmingly hard to pin down. She hopes that when the particle accelerator at Cern in Switzerland comes on line in the next couple of years, physicists will get to see the Higgs particle, but concedes it's possible, "if we're very unlucky", they'll find nothing.

And if the Higgs particle does make an appearance? "We won't know until we see it," she smiles, "but I can guarantee it will present just as many problems as it solves."

Randall is happy to take a pop at string theorists who talk of 10 or 11 dimensions when "nobody really knows how string theory actually works", and she has no time for ideas that incorporate small dimensions. "Who cares about a dimension that is too small to be relevant to anything?"

But she is reluctant to talk up her own theories as the last word in the interplay between particle physics and cosmology. "They may or may not be right," she says. "All I will say is that, if we do ever understand the structure of the universe, then it's likely my ideas will play some part in it."

So to the biggest question of all. "You know, all the work I've done makes me think the existence of God less likely," she says. "I want solutions and God just seems like such a cop-out."

But if she ever does come across God? "You'll be the first to know."

You could call that an exclusive.

The CV

Name: Lisa Randall

Age : 43

Job : Professor of theoretical physics, Harvard University

Before that: President's fellow, University of California, Berkeley; junior fellow, Harvard; professor of physics, MIT; professor of physics, Princeton

Awards : Member of the American Academy of Arts and Science, 2004

Publications: Warped Passages, 2005; numerous journals

Likes : endorphins

Dislikes : making decisions and having them made for her

Single : with no children