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Opening Strange Portals in Physics

Physicist Lisa Randall explores the mind-stretching realms that new experiments soon may expose

By Robert Irion
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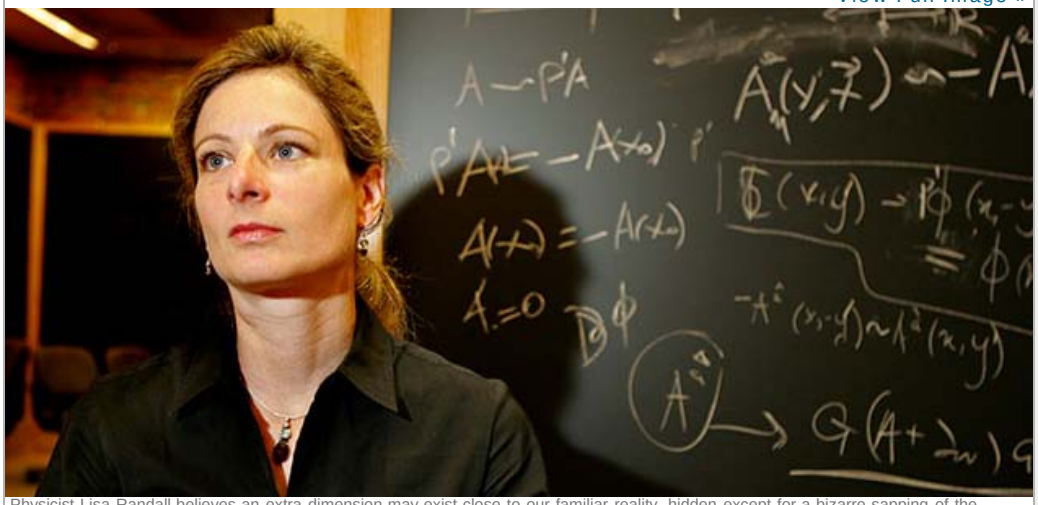

Physicist Lisa Randall believes an extra dimension may exist close to our familiar reality, hidden except for a bizarre sapping of the strength of gravity as we see it.

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In her new book, *Knocking on Heaven's Door*, Harvard University theorist Lisa Randall explores how physics may transform our understanding of the fundamental nature of the world. She thinks an extra dimension may exist close to our familiar reality, hidden except for a bizarre sapping of the strength of gravity as we see it. She also ponders the makeup of dark matter, unseen particles that have shaped the growth of the entire cosmos. These ideas, once the sole province of fiction writers, face real tests in a new generation of experiments. Sensitive detectors now sniff for dark matter, while the most complex scientific machine ever created, the Large Hadron Collider (LHC), beneath the border of Switzerland and France, smashes subatomic particles into one another at almost the speed of light.

What were your main goals for your new book?

One goal was to describe the science I'm interested in today: the physics happening at the LHC and searches for dark matter. But I also wanted to clarify the nature of science: what it means to be right and wrong, what it means to make measurements, and the roles of uncertainty, risk and creativity.

Do you feel the physics community is on the verge of

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finding something remarkable?
I certainly hope so. We have a good chance [with the LHC] to see the Higgs particle, which tells us how elementary particles acquire mass. Other deep issues include space-time symmetry and whether there are extra dimensions. We really do have a chance of making inroads on those subjects.

Knocking on Heaven's Door: How Physics and Scientific Thinking Illuminate the Universe and the Modern World

by Lisa Randall
HarperCollins Publishers

There are a lot of bizarre ideas here, from string theory to a "brane" of extra dimensions right next to our own. Why should we regard these ideas as more than fanciful constructs?
I'm certainly not asking anyone to take on faith any of the ideas that I present. That's part of the point of the book: science proceeds, and we systematically end up with new ideas and explanations, going from the human scales we're very familiar with to scales that are so remote it's hard to have intuition about them. Science is a self-correcting process, too, something that I expect will happen with the recent announcement of neutrinos that may move faster than the speed of light.

Can you describe the essence of your idea about extra dimensions?
There could be more to the universe than the three dimensions we are familiar with. They are hidden from us in some way, perhaps because they're tiny or warped. But even if they're invisible, they could affect what we actually observe in the universe. There are lots of things we cannot see with the naked eye that turn out to be based in reality.

Extra dimensions could be relevant to one of the questions we're trying to answer at the LHC: how particles get their mass, and why they have the masses that they do, which are far smaller than physicists would expect them to be. So our idea is there's an extra dimension that's so warped, the masses would be big in one place and small in another. In other words, gravity could be weaker in one place and stronger in another. If so, it could be a natural explanation both for why particles masses are what they are, and why gravity is so much weaker than the other elementary forces we observe.

This extra dimension could be separated from ours by a million trillion trillionth of a centimeter. Is this a parallel yet inaccessible universe?
It interacts with our dimensions only via gravity. And gravity is extremely weak. An elementary particle at ordinary energies exerts negligible gravitational force. But at the LHC, if this idea is right, we would see evidence of this extra dimension. Particles could carry momentum into the extra dimension, and that could actually be observable.

But it's not something you think of as a "parallel universe?"
Technically, yes, it could exist parallel to our universe. But it's not just a carbon copy of our universe, which a lot of people think of when they hear that phrase.

If physicists do find solid evidence of extra dimensions, how would that affect our view of the universe and our place in it?
You can have very exotic underlying phenomena, but they still would be consistent with the ordinary rules we're familiar with. At some level, it doesn't change anything. However, it means that at some deep underlying level, there's a much richer universe out there. It's just a wonderful thing to know what our universe is made of.

You describe the LHC as a "stupendous achievement."
Technologically, it's a tour de force. The fact that this thing works is amazing. We're looking for very rare events, so you need a very precise, very well understood machine to make them and detectors to understand what you see. You need an extreme amount of energy focused in a very tiny region to make these collisions happen, allowing the subcomponents of protons—quarks and gluons—to collide directly. And when they do, they can make new forms of heavier matter.

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