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Physicist Randall explains extra dimensions to packed crowd

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When someone begins a conversation with phrases such as “string theory” and “extra dimensions,” you might find yourself running in the other direction. However, Brooks-Rogers Recital Hall was packed on Tuesday, Jan. 8, when Lisa Randall, a renowned but down-to-earth Harvard professor of theoretical physics, delivered the annual Richmond Lecture, sponsored by the Oakley Center for the Humanities and Social Sciences.

Wearing a smart brown pantsuit and gold hoop earrings, Randall spoke about “where we are now and what we’re excited about” in a talk titled “Warped Passages: Unraveling the Mysteries of the Universe’s Hidden Dimensions.” She focused on new results in theoretical physics and their “intriguing” possibilities, which include exploring extra dimensions of space beyond the three dimensions with which we’re familiar. “We don’t know when they will be discovered,” Randall said. “It could be tomorrow, a month, a year.”

Randall explained the differences between particle physics, which addresses the basic structure of matter, and string theory, which involves oscillating strings that manifest themselves as visible particles. String theory is a new model that unifies Einstein’s large-scale Theory of General Relativity and quantum mechanics, which deals with atomic scales

Throughout the lecture, Randall used numerous helpful analogies. She first compared extra dimensions to buying a house and the many criteria for purchase. “We can theoretically figure out what [the house] should be [like], without picturing it,” she said. Correspondingly, we can think of extra dimensions as slices, projections or holograms, but these two and three-dimensional conceptions suppress some dimensions. As such, Randall believes the best way to represent extra dimensions is through math or words. “A word is worth a thousand pictures,” she said.

The initial solution to why we cannot see extra dimensions came in 1926, with Swedish theoretical physicist Oscar Klein’s theory that these dimensions are “rolled up” to be infinitesimally small. To explain this theory, Randall used the analogy of a hose on a football field. “What you see depends on how you look at it,” she said. Effectively, the hose is a one-dimensional object from far enough away, but, as one gets closer, the hose becomes a two-dimensional surface and then a three-dimensional interior. Similarly, the entire universe may be curled up and there could be more than three dimensions. “There are three large ones that we observe and maybe more that are so small that we don’t see them,” Randall said.

Randall next introduced the more recent concept of branes, developed in 1999. A brane is a membrane-like object in higher dimensions. In a hypothetical “Brane World,” particles and matter exist stuck on a

brane, like water droplets trapped on a shower curtain. Particles can be confined to a two-dimensional brane – like the curtain – and thus only can move in two dimensions, despite being in a three-dimensional world – the bathroom.

"What makes extra dimensions interesting is that we know we're going to interact with them, at least via gravity," said Randall. Gravity, unlike particles, is a closed string with no ends and cannot be stuck on a brane. Since all energy interacts through gravity, and energy can be anywhere, branes provide a way to hide dimensions, giving us "a new concept of our place in the universe," Randall said. The most important implication of this theory is a "new way to explain the weakness of gravity:" physicists postulate that gravitons interact with branes of different strength, resulting in warped space-time geometry.

The Large Hadron Collider outside Geneva, Switzerland, will start testing these theories in the spring. The underground ring, 27 km in circumference, will be used to collide two protons to create new, heavier particles that can carry momentum in extra dimensions. When these particles decay, scientists detect them as "fingerprints" of extra dimensions.

"I think it's safe to say that we're entering a new era of physics," Randall concluded. "I'd like to think that new secrets of the universe are about to unravel."
