

## Particle smasher may reveal extra dimensions

by World-Science

When the world's most powerful particle smasher starts up this summer, exotic new particles may offer a glimpse of the existence and shapes of extra dimensions, says a group of physicists. Extra dimensions are a prediction of string theory, a model of the universe popular among some scientists that describes nature's fundamental particles as tiny vibrating threads of energy.

Engineers check the electronics at the Large Hadron Collider (Image courtesy CERN)

String theory offers relatively simple explanations for disappearing particles and claims to reveal hidden universes among nature's forces. But mathematically, it all works out only if you add six or seven extra dimensions of space in to the equations, beyond the three familiar ones. Explaining the apparent invisibility of these dimensions beyond, theorists say they're curled up into tiny spaces. In a new study, researchers say the telltale signatures of a new class of subatomic particles could help test these ideas and distinguish between possible shapes of the dimensions. Much as a musical instrument's shape determines its sound, the shape of these dimensions determines the behavior of our visible universe "with its three space dimensions plus one time dimension," said physicist Gary Shiu of the University of Wisconsin-Madison. "The shape of the dimensions is crucial because, in string theory, the way the string vibrates determines the pattern of particle masses and the forces that we feel," said Shiu, lead author of a paper on the subject in the Jan. 25 issue of the research journal *Physical Review Letters*. Pinning down that shape should further our understanding and predictions of our four-dimensional world, Shiu added. "There are myriad possibilities for the shapes of the extra dimensions out there. It would be useful to know a way to distinguish one from another and perhaps use experimental data to narrow down the possibilities. Such experimental evidence could appear in data from a new particle accelerator, the Large Hadron Collider, Shiu continued. It's scheduled to begin operation later this year near Geneva. An accelerator smashes atomic nuclei head-on at nearly the speed of light, creating new, energetic and very unstable particles. These quickly disintegrate or decay into showers of detectable, lower-energy ones. Characteristic patterns of decay serve as fingerprints of the fleeting exotic particles and, possibly, the shape of the unseen dimensions, Shiu explained. With colleagues at his school and the University of California-Berkeley, Shiu proposes in the new study that the signatures from particles called Kaluza-Klein (KK) gravitons can distinguish among different proposed geometries for extra dimensions. How? Shiu compares the effect to a dark room where patterns of sound resonating off the walls can reveal the room's shape. Similarly, KK gravitons are sensitive to the extra-dimensional shape and, through their behavior and decay, may reveal clues to that, he argued. The new study shows that in simple terms, even small geometric variations lead to visible differences in KK graviton signatures, said Bret Underwood, a colleague at Shiu's university. Based on this, Shiu said, "At least in principle, one may be able to use experimental data to test and constrain the geometry of our universe." Last year, Shiu and Underwood reported that clues to dimensional geometry might also be visible in patterns of radiation left over from the Big Bang. The new work complements the previous approach, they say. "The more hints we get, the better idea we have about the underlying physics," said Shiu. Added Underwood, "If the cosmology and particle physics data agree, it's an indication we're on the right track."

Courtesy University of Wisconsin-Madison and World Science staff

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