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Observatory could detect hidden dimensions

Cosmic rays could find holes in Standard Model of particle physics.

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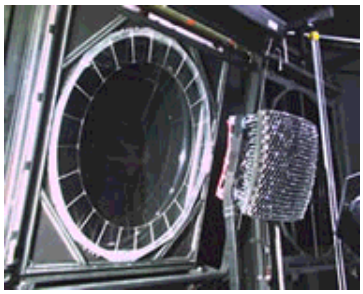
The Pierre Auger Observatory, currently being constructed in Argentina to study cosmic rays, could examine the structure of spacetime itself, say physicists in the United States.



Hole story: part of the Pierre Auger Observatory

If, as some suspect, the Universe contains invisible, extra dimensions, then cosmic rays that hit the atmosphere will produce tiny black holes. These black holes should be numerous enough for the observatory to detect, say Jonathan Feng of the Massachusetts Institute of Technology in Cambridge, Massachusetts and Alfred Shapere of the University of Kentucky at Lexington[1].

The observatory will consist of two 3,000-square-kilometre arrays - one in Argentina, one somewhere in the Northern Hemisphere - each containing 1,600 particle detectors. Scheduled for completion by 2004, scientists hope that the equipment will help to solve the mystery of cosmic rays. These rays consist of extremely high-energy particles that stream into the Earth's atmosphere from space - from where, exactly, no one knows.

Many cosmic rays collide with atoms in the upper atmosphere, producing showers of other particles that the Pierre Auger Observatory is designed to detect. These showers can be several kilometres across by the time they reach the ground, hence the observatory's huge area.

Some of the highest-energy cosmic rays could create collisions that are energetic enough to generate miniature black holes, much smaller than a single atom, Feng and Shapere calculate. These black holes will evaporate very quickly, betraying their ephemeral existence with distinctive showers of secondary particles.

The Standard Model of particle physics summarizes almost everything that physicists have discovered in this field over the past several decades. It predicts that only collisions with utterly enormous energies will produce miniature black holes. Virtually

no cosmic rays are likely to be this energetic.

But the Standard Model does not account for the possibility that the universe contains one or more hidden dimensions over and above the three of space and one of time that we know so well.

Just as a garden hose looks one-dimensional - like a line - when seen from far off, so spacetime could, from afar, seem to have fewer dimensions than it really does. Many physicists now argue we cannot experience these extra dimensions directly because they became rolled up more tightly than the width of a single atom during the Big Bang.

Although extra dimensions are not detectable, their consequences could well be. In theory, they would allow black holes to form at considerably lower energies than first calculated. If this is the case, Feng and Shapere estimate, then the Pierre Auger Observatory might detect hundreds of holes by observing their secondary particles.

High-energy particle collisions in the Large Hadron Collider, a particle accelerator that is under construction at CERN, the European particle-physics laboratory near Geneva, might also generate copious quantities of tiny black holes. But the Pierre Auger Observatory should be operating sooner than its European counterpart.

References

1. Feng, J. L. & Shapere, A. D. Black hole production by cosmic rays. *Physical Review Letters,* 88, 021303, (2002).