

Antarctic neutrino trap comes with superstrings attached

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SENSORS buried deep within the Antarctic ice to pick up distant cosmic events might show up something even more exciting. They could finally prove whether extra dimensions really exist and help particle physicists validate superstring theory.

Extra dimensions are central to superstring theory – physicists' most promising "theory of everything". By uniting the properties of electromagnetism, gravity and the forces within atomic nuclei, this theory tries to explain how everything in the Universe behaves. It predicts six extra dimensions in space on top of the familiar three dimensions in space and one in time.

The extra dimensions predicted by superstring theory are incredibly small. If they even approached the size of an atom, we would have detected them by now. But if they do exist, they would give rise to a bunch of new particles of very high mass, which

physicists call Kaluza-Klein particles. These would be formed when wave-like fields associated with known particles travel into the extra dimensions. There the waves create resonances that behave like particles.

Now, Konstantin Matchev at the University of Florida, Gainesville, and colleagues Hsin-Chia Cheng at the University of Chicago and Jonathan Feng at the University of California, Irvine, say that detectors designed to study cosmic events could find unequivocal evidence of these new particles, proving that hidden dimensions actually exist.

One of these detectors, known as AMANDA (for Antarctic Muon and Neutrino Detector Array), consists of strings of light sensors buried more than a kilometre beneath the Antarctic ice. It is designed to pick up cosmic neutrinos – particles with no charge or mass – that may be emitted from high-energy events such as gamma-ray bursts or stars exploding as supernovae.

But Kaluza-Klein particles would also produce characteristic high-energy neutrinos, Matchev's team says (*Physical Review Letters*, vol 89, p 211,301). Because these particles are so heavy, they would be attracted to the centres of the Galaxy, the Sun and the Earth, where they would interact with their antiparticles and produce decay products, including neutrinos.

Physicists believe the Kaluza-Klein particles are likely to have about 1000 times the mass of a proton, giving the neutrinos they

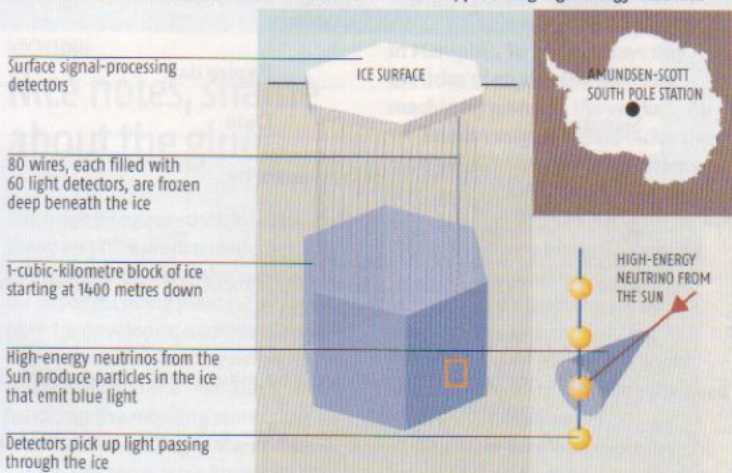
"One of these detectors consists of strings of sensors buried more than a kilometre under the ice"

produce around 1 million times as much energy than those emitted from fusion reactions in the Sun. So if superstring theory is correct and extra dimensions exist, scientists running AMANDA, and its upgrade ICECUBE, should detect very-high-energy neutrinos from the centre of the Galaxy, the Sun, or the Earth's core (see Graphic). "An excess of very high energy neutrinos from the Sun's direction would be an unmistakable signal of extra dimensions," says Matchev.

The Large Hadron Collider at CERN, the European particle-physics lab in Geneva, could also detect extra dimensions by producing Kaluza-Klein particles and "supersymmetric" particles also predicted by superstring theory. "The crucial advantage of the experiments we highlight is that they can distinguish between these," says Matchev. ●

DETECTING EXTRA DIMENSIONS WITH 'ICECUBE'

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