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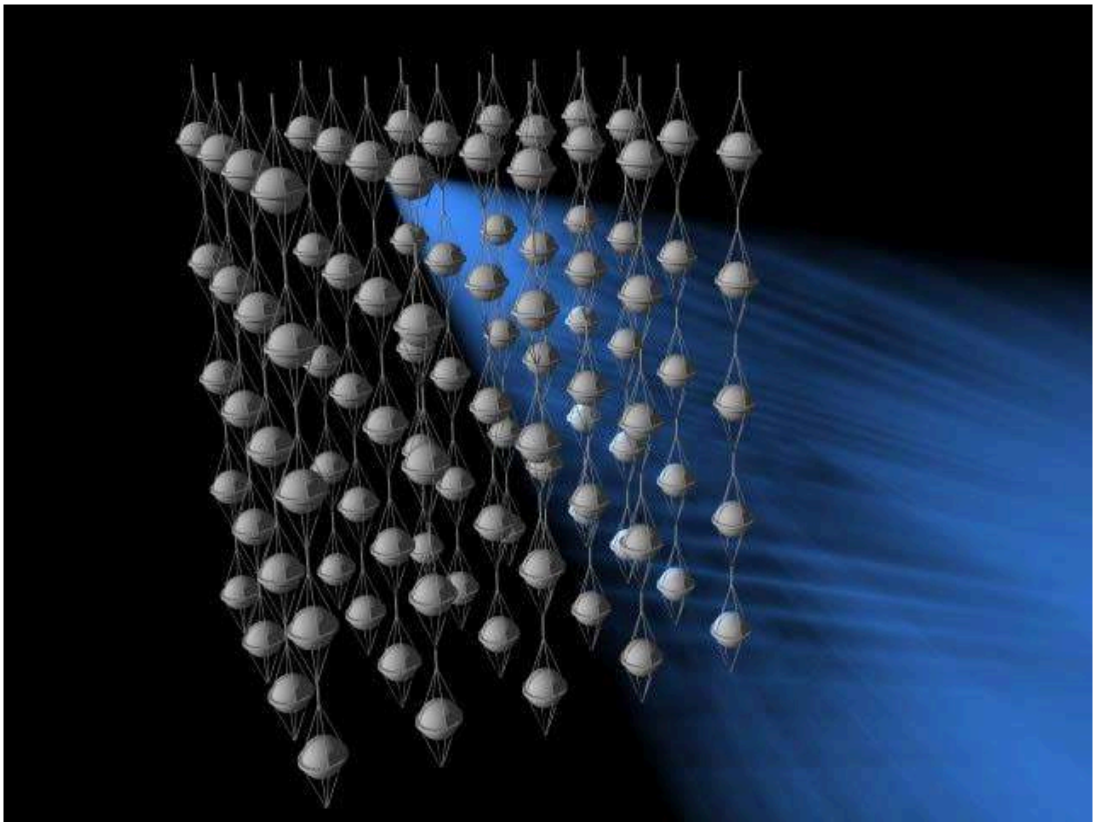
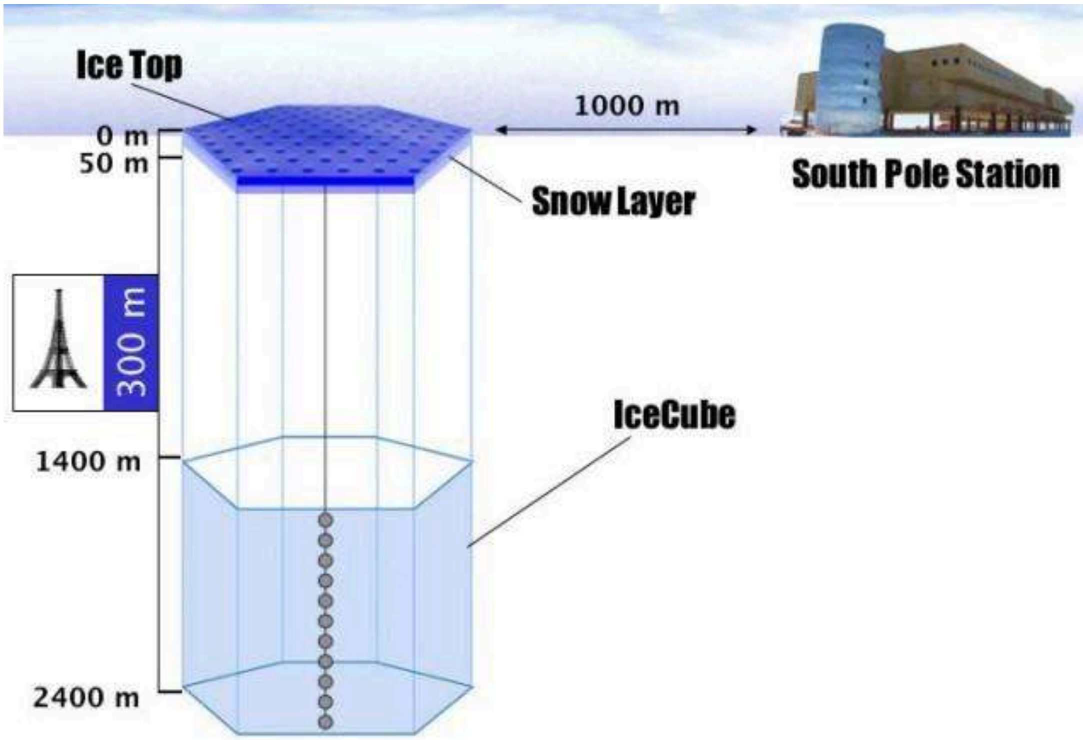
Ice-bound neutrino hunter may bolster string theory

By **Maggie McKee**



When a neutrino collides with a water molecule deep in Antarctica's ice, the particle it produces radiates a blue light called Cerenkov radiation, which IceCube will detect (Steve Yunck/NSF)



IceCube will occupy a volume of 1 cubic kilometre – one of its 80 strings of optical modules (number and size not to scale) is shown
(Image: Steve Yunck)

Future neutrino experiments at the South Pole may be able to detect the predicted effects of string theory or other exotic phenomena, a new study suggests.

Neutrinos are near-massless elementary particles produced in stars and in high-energy processes in space. Billions of neutrinos churned out by the Sun stream through every cubic centimetre of the Earth per second. But they interact extremely weakly with matter, so they rarely collide with atoms and are therefore difficult to detect.

But high-energy neutrinos from cosmic sources other than our Sun – such as colossal black holes that are devouring their surroundings – are thought to pass through the Earth only rarely. None of these cosmic neutrinos has yet been detected.

Researchers hope future detectors, such as IceCube – an array of detectors under construction beneath the Antarctic ice that will eventually cover a cubic kilometre – will be large enough to detect between one and 10 cosmic neutrinos per year.

Now, a team led by Luis Anchordoqui of Northeastern University in Boston, Massachusetts, US, says those neutrinos may reveal the existence of new types of physics. These include the existence of extra spatial dimensions, a possibility arising in theories – such as string theory – that attempt to explain gravity in the context of other known forces.

In some of these theories, gravity – which is weak in the universe we know – may be “hiding” in extra dimensions. Theoretical work in the last decade suggests these dimensions may be large enough (measuring about one-millionth of a nanometre across for string theory, which employs six extra dimensions) to probe with high-energy experiments.

Gravity spill

Anchordoqui and his colleagues say cosmic neutrinos can achieve the energies needed when they slam into atoms on Earth. If gravity is hiding in the posited unseen dimensions, such collisions could open a floodgate between the dimensions and theoretically produce microscopic black holes that exist for just a fraction of a second before decaying into other particles.

“These black holes are formed because gravity spills in from the extra dimensions and its strength increases rapidly with the energy of the collision,” Anchordoqui told **New Scientist**.

The team says IceCube may be able to detect such black holes, or other exotic phenomena. It can measure neutrinos that have first passed through the Earth – “up” neutrinos – as well as those that simply fall to the detector from the sky – “down” neutrinos.

If cosmic neutrinos produce these fleeting, mini-black holes, IceCube should detect fewer “up” events than “down” events because the creation of black holes inside the Earth would prevent the neutrinos from reaching the detector.

Definitive effect

Team member Haim Goldberg of Northeastern University says the effect should be relatively easy to detect because neutrinos normally interact so weakly with matter. Any indication of a high-energy cosmic neutrino collision would signal something new, he told **New Scientist**. “It may not be a definitive string effect, but it would not be termed mundane, that’s for sure.”

John Schwarz, a string theorist at the California Institute of Technology in Pasadena, US, agrees. “If something non-standard is established, string theory has a long list of exotica that would provide candidates to explain it,” he told **New Scientist**. “Experiments like those of IceCube and AMANDA-II are very challenging, so it would probably take several years of hard and careful work to achieve definitive results.”

Goldberg estimates IceCube could begin taking data around 2008. Depending on the rate of cosmic neutrinos it detects, the experiment may be able to reveal new physical phenomena in as few as two years, or as many as 15.

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