so participants can decide for themselves whether the results are worth acting on. Current measures of future risk typically rely on symptoms that have already appeared, such as high blood pressure or spinal degeneration, noted NHGRI director Francis Collins during the announcement. Genetic testing, he said, "has the potential of moving the timetable back to an earlier point so that you can begin to practice prevention before you're already half in the grave."

PHYSICS

Dimensional Shortcuts

Is there evidence for string theory in a neutrino experiment? BY MARK ALPERT

The neutrino is the oddball of particle physics. It has no charge and rarely interacts with other particles, but it comes in three flavors—electron, muon and tau—and madly oscillates from one flavor to the next as it travels along. For the past five years, researchers at the Fermi National Accelerator Laboratory in Batavia, Ill., have been firing beams of muon neutrinos at the MiniBooNE detector, a huge spherical tank filled with 800 tons of mineral oil, to see how many of the particles changed in flight to electron neutrinos. The first results, announced in April, mostly vindicated the Standard Model—the conventional theory of particle physics—but an unexplained anomaly in the data leaves open a more exotic possibility. Some scientists speculate that the cause of the anomaly is a new kind of neutrino that can take shortcuts through the extra dimensions predicted by string theory.

BOON FOR NEUTRINOS: A researcher examines the photomultiplier tubes that detect the flashes of light from neutrino interactions.

PETER GINTER

The impetus behind MiniBooNE was to follow up a previous experiment, conducted at Los Alamos National Laboratory in the 1990s, which had shown evidence for a fourth type of neutrino. Called the sterile neutrino, this putative particle would be even more elusive than the three ordinary flavors because it would not be subject to the weak nuclear force as the other particles are but would interact only through gravity. Because the existence of sterile neutrinos would challenge the Standard Model, researchers were eager to run a similar experiment to confirm or refute the findings. The results from MiniBooNE, however, were a mixed bag. For neutrinos with energies ranging from 475 million to three billion electron volts, the number of flavor oscillations nicely matched the Standard Model predictions, but at lower energies investigators found a significant excess of electron neutrinos.

Even stranger, three physicists had anticipated this result. Their work is an outgrowth of string theory, which stipulates the existence of at least 10 dimensions to create a framework that incorporates both gravity and quantum mechanics. To explain why we do not perceive the extra dimensions, string theorists have posited that all the ordinary particles in our universe may be confined to a four-dimensional "brane" floating within an extra-dimensional "bulk," like an enormous sheet of flypaper suspended in the air. But certain special particles can travel in and out of the brane, notably the graviton (which conveys the gravitational force) and the sterile neutrino. In 2005 Heinrich Päs, now at the University of Alabama, Sandip Pakvasa of the University of Hawaii and Thomas J. Weiler of Vanderbilt University proposed that if the brane is curved or microscopically deformed, then sterile neutrinos could take shortcuts through the bulk. These shortcuts would influence the flavor oscillations, increasing the probability of a transition at certain energies.

As it turned out, MiniBooNE's results closely tracked the predictions made by Päs, Pakvasa and Weiler. Several researchers involved in the experiment were so struck by the similarity that they sent congratulatory e-mails to the three theorists. "It is indeed startling to see how well your model appears to fit our excess of low-energy events!" wrote Bill Louis, co-spokesperson for the MiniBooNE team. Because scientists have found no experimental evidence for string theory so far, confirming the existence of extra dimensions would indeed be a major breakthrough.

Physicists caution that the similarity could simply be nothing more than a spooky coincidence. The MiniBooNE researchers are now trying to determine whether background effects or faulty analysis could have skewed their count of electron neutrinos. In the meantime, Päs and his colleagues are refining their theory. "Our solution seems to be a little speculative at first glance," Päs admits. "But I think it is absolutely legitimate to discuss possible scenarios that can explain the excess, should it be confirmed."

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