ScienceNews

Fermilab data hint at possible new particle

Powerful collisions of protons and antiprotons produce unexplained result

By Ron Cowen
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Call it the little particle accelerator that could. For the second time in weeks, the relatively small Tevatron at the Fermi National Accelerator Laboratory in Batavia, Ill., has found evidence of a possible new particle that would govern a new force in nature.

The latest finding, reported online April 6 at arXiv.org (arxiv.org/abs/1104.0699), is based on an unexpected excess in jets of particles produced at the accelerator.

A new particle similar to but heavier than the W boson and Z boson would explain the observed excess. W and Z bosons are fundamental particles that transmit the weak force, which is responsible for radioactive decay.

Less likely, says Fermilab theorist Dan Hooper, is the possibility that the new particle is a version of the long-sought Higgs boson. This version of the Higgs would be heavier than the one predicted by physicists' standard model of particles and forces, and it would interact less often with matter. Considered the last missing piece of the standard model, the elusive Higgs boson was conceived of as a way to explain why some elementary particles have masses.

On the other hand, explaining the data may not require a new particle or a new force. The excess may have arisen from some aspect of ordinary particle interactions that researchers don't understand, says Hooper, who was not involved in the new work.

The evidence is based on studies at the CDF experiment, one of two projects at the Tevatron, which collides a beam of protons with antiprotons moving at energies of nearly 1 trillion electron volts. In the new analysis, Titta Aaltonen of the University of Helsinki and a long list of collaborators homed in on collisions between 2001 and 2009 that produced a W boson along with two lightweight jets of particles, including electrons. Jets are relatively common and are a sign of quarks, which can't be seen directly, but which fragment into other particles. The production of such jets in conjunction with the W boson is an essential starting point in probing physics beyond the standard model, Aaltonen and his colleagues note.

Looking at collision products at energies between 120 billion and 160 billion electron volts, the physicists saw an unexpected peak: They found about 250 more such events than predicted by the standard model.

There's only a 0.076 percent chance that the excess is a fluke, the team notes in the paper. Though small, that percentage isn't small enough to meet the standard criteria for proof in physics. In comparison, another unexpected recent finding at the Tevatron's CDF, which also hints at a new elementary particle, has a smaller chance — 0.04 percent — of being wrong. But even that does not meet the standards of proof generally accepted in the field. CDF spokesperson Rob Roser of Fermilab does say, however, that the earlier finding "has a better chance of standing the test of time" than the excess jets result reported April 6.

Still, the jet excess captivates several theorists, including Hooper, because of the potential to actually find a new particle at the Tevatron and determine the particle's mass. Visually, the peak energy of the excess, at about 145 billion electron volts, "jumps out at you," indicating the mass of a possible new elementary particle, Hooper notes.

In an article that Hooper and colleagues posted online at arXiv.org on April 1 (arxiv.org/abs/1103.6035), they propose a particle that could explain both new findings. The team calculated that a hypothetical particle known as the Z' boson, a heavier cousin of the Z boson with a proposed mass of 150 billion electron volts, could account for both results if the particle interacts strongly with quarks but avoids interactions with electrons and their heavier brothers, muons.

Physicists are eagerly awaiting the results of an analysis by the Tevatron's other experiment, known as DZero. If that experiment also finds a jet excess in the same set of collisions, it could elevate the detection from a mere curiosity to a true discovery, Roser says. It would also constitute a last hurrah for the Tevatron, which will stop operation at end of the September due to budget cuts.