More Dark Matter Experiment Results

Curious Cat Science and Engineering Blog

A dark-matter experiment deep in the Soudan mine of Minnesota now has detected a seasonal signal variation similar to one an Italian experiment has been reporting for more than a decade.

The new seasonal variation, recorded by the Coherent Germanium Neutrino Technology (CoGeNT) experiment [1], is exactly what theoreticians had predicted if dark matter turned out to be what physicists call Weakly Interacting Massive Particles (WIMPs).

“We cannot call this a WIMP signal. It’s just what you might expect from it,” said Juan Collar, associate professor in physics at the University of Chicago. Collar and John Orrell of Pacific Northwest National Laboratory, who lead the CoGeNT collaboration, are submitting their results in two papers to Physical Review Letters.

WIMPS might have caused the signal variation, but it also might be a random fluctuation, a false reading sparked by the experimental apparatus itself or even some exotic new phenomenon in atomic physics, Collar said.

Dark matter accounts for nearly 90 percent of all matter in the universe, yet its identity remains one of the biggest mysteries of modern science [2]. Although dark matter is invisible to telescopes, astronomers know it is there from the gravitational influence it exerts over galaxies.

Theorists had predicted that dark matter experiments would detect an annual modulation because of the relative motion of the Earth and sun with respect to the plane of the Milky Way galaxy.

The sun moves in the plane of the galaxy on the outskirts of one of its spiral arms at a speed of 220 kilometers per second (136 miles per second). The Earth orbits the sun at 30 kilometers per second (18.5 miles per second). During winter, Earth moves in roughly the opposite direction of the sun’s movement through the galaxy, but during summer, their motion becomes nearly aligned in the same direction. This alignment increases Earth’s net velocity through a galactic halo of dark matter particles, whose existence scientists have inferred from numerous astronomical observations.

WIMPs would be moving in random directions in this halo, at velocities similar to the sun’s. “You find yourself in a situation similar to a car moving through a cloud of gnats,” Collar explained. “The faster the car goes, the more gnats will hit the front windshield.”

CoGeNT seems to have detected an average of one WIMP particle interaction per day throughout its 15 months of operation, with a seasonal variation of

approximately 16 percent. Energy measurements are consistent with a WIMP mass of approximately 6 to 10 times the mass of a proton.

These results could be consistent with those of the Italian DArk MAtter (DAMA) experiment [3], which has detected a seasonal modulation for years. “We are in the very unfortunate situation where you cannot tell if we are barely excluding DAMA or barely in agreement. We have to clarify that,” Collar said.

In particle physics, he further cautioned, agreement between two or three experiments doesn’t necessarily mean much. The pentaquark is a case in point. Early this century, approximately 10 experiments found hints of evidence for the pentaquark, a particle consisting of five quarks, when no other known particle had more than three. But as time went on, new experiments were unable to see it.

“It’s just incredible,” said UChicago physics Professor Jonathan Rosner. “People still speculate on whether it’s real.”

Collar and his colleagues have calculated the probability that their finding is a fluke to be five-tenths of a percent. Other dark-matter experiments, including Xenon100, have not detected the seasonal signal that CoGeNT and DAMA have reported.

CoGeNT operated from December 2009 until interrupted by a fire in the Soudan mine in March 2011. Fifteen months of data collection is a relatively brief period for a dark-matter experiment. In fact, Collar and his colleagues decided to examine the data now only because the fire had stopped the experiment, at least temporarily.

Read the full press release [4].

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