Crystal bells stay silent as physicists look for dark matter

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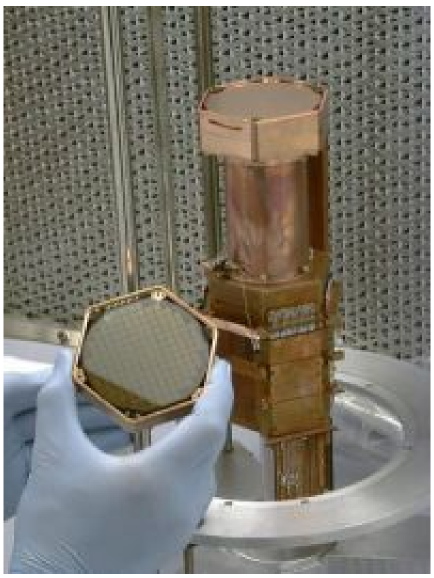

Closeup of a CDMS detector, made of crystal germanium. Credit: Fermilab

Scientists of the Cryogenic Dark Matter Search experiment today announced that they have regained the lead in the worldwide race to find the particles that make up dark matter. The CDMS experiment, conducted a half-mile underground in a mine in Soudan, Minn., again sets the world's best constraints on the properties of dark matter candidates.

"With our new result we are leapfrogging the competition," said Blas Cabrera of Stanford University, co-spokesperson of the CDMS experiment, for which the Department of Energy's Fermi National Accelerator Laboratory hosts the project management. "We have achieved the world's most stringent limits on how often dark matter particles interact with ordinary matter and how heavy they are, in particular in the theoretically favored mass range of more than 40 times the proton mass. Our experiment is now sensitive enough to hear WIMPs even if they ring the 'bells' of our crystal germanium detector only twice a year. So far, we have heard nothing."

WIMPs, or weakly interacting massive particles, are leading candidates for the building blocks of dark matter, which accounts for 85 percent of the entire mass of the universe. Hundreds of billions of WIMPs may have passed through your body as you read these sentences.

"We were disappointed about not seeing WIMPs this time. But the absence of background in our sample shows the power of our detectors as we enter into very interesting territory," said CDMS co-spokesperson Bernard Sadoulet, of the University of California, Berkeley.

If they exist, WIMPs might interact with ordinary matter at rates similar to those of low-energy neutrinos, elusive subatomic particles discovered in 1956. But to account for all the dark matter in the universe and the gravitational pull it produces, WIMPs must have masses about a billion times larger than those of neutrinos. The CDMS collaboration found that if WIMPs have 100 times the mass of protons (about 100 GeV/c^2) they collide with one kilogram of germanium less than a few times per year; otherwise, the CDMS experiment would have detected them.

"The nature of dark matter is one of the mysteries in particle physics and cosmology," said Dr. Dennis Kovar, Acting Associate Director for High Energy Physics in the U.S. Department of Energy's Office of Science. "Congratulations to the CDMS collaboration for improved sensitivity and a new limit in the search for dark matter."

The CDMS experiment is located in the Soudan Underground Laboratory, shielded from cosmic rays and other particles that could mimic the signals expected from dark matter particles. Scientists operate the ultrasensitive CDMS detectors under clean-room conditions at a temperature of about 40 millikelvin, close to absolute zero. Physicists expect that WIMPs, if they exist, travel right through ordinary matter, rarely leaving a trace. If WIMPs crossed the CDMS detector, occasionally one of the WIMPs would hit a germanium nucleus. Like a hammer hitting a bell, the collision would create vibrations of the detector's crystal grid, which scientists could detect. Not having observed such signals, the CDMS experiment set limits on the properties of WIMPs.

"Observations made with telescopes have repeatedly shown that dark matter exists. It is the stuff that holds together all cosmic structures, including our own Milky Way. The observation of WIMPs would finally reveal the underlying nature of this dark matter, which plays such a crucial role in the formation of galaxies and the evolution of our universe," said Joseph Dehmer, director of the Division of Physics for the National Science Foundation.

The discovery of WIMPs would require extensions to the theoretical framework known as the Standard Model of particles and their forces. On Feb. 22, the CDMS collaboration presented its result to the scientific community at the Eighth UCLA Dark Matter and Dark Energy symposium.

"This is a fantastic result," said UCLA professor David Cline, organizer of the conference.

The CDMS result tests the viability of new theoretical concepts that have been proposed.

“Our results constrain theoretical models such as supersymmetry and models based on extra dimensions of space-time, which predict the existence of WIMPs,” said CDMS project manager Dan Bauer, of DOE’s Fermilab. “For WIMP masses expected from these theories, we are again the most sensitive in the world, retaking the lead from the Xenon 10 experiment at the Italian Gran Sasso laboratory. We will gain another factor of three in sensitivity by continuing to take more data with our detector in the Soudan laboratory until the end of 2008.”

A new phase of the CDMS experiment with 25 kilograms of germanium is planned for the SNOLAB facility in Canada.

“The 25-kilogram experiment has clear discovery potential,” said Fermilab Director Pier Oddone. “It covers a lot of the territory predicted by supersymmetric theories.”

Source: Fermi National Accelerator Laboratory