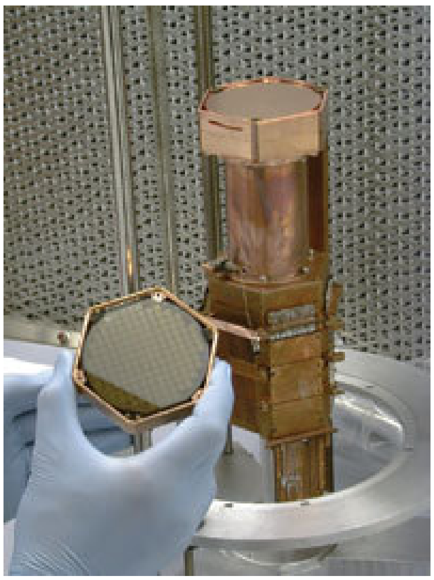
A Mine for Dark Matter

June 23 2010



Each CDMS detector is a 230-gram germanium crystal. Six detectors are stacked to form one of the five towers that make up the whole apparatus.

(PhysOrg.com) -- Deep in a mine 230 stories underground, physicists are trying to detect dark matter, the mysterious stuff that makes up nearly a quarter of the universe. Last December, tantalizing rumors of a major discovery by the Cryogenic Dark Matter Search (CDMS) set the physics world abuzz. The Caltech collaborators describe their experiment.

For two weeks in mid-December 2009, the physics world was abuzz with speculation. The Cryogenic Dark Matter Search (CDMS), which had just finished analyzing its final data set, was rumored to have struck gold—they'd actually detected dark matter, the unknown stuff that makes up nearly a quarter of the universe. The rumors had spread through the blogosphere and into the mainstream media.

In the 1930's, Caltech's Fritz Zwicky first proposed the existence of dark matter to account for mass that appeared to be missing in the Coma galaxy cluster. Although astronomers now have lots of evidence to convince themselves dark matter is out there, no one knows for sure what it's made of. The best guess, however, is the hypothetical weakly interacting massive particle, or WIMP. If WIMPs are all around us, they'd be zooming about at hundreds of kilometers per second. But because they hardly interact with regular matter, you can't see or feel them. There could be billions of them streaming through your body right now. Once in a while, though, a WIMP could crash into an atomic nucleus like a cue ball hitting an eight ball, and that's the idea behind most dark-matter searches, including CDMS.

The CDMS detector consists of 30 hockey-puck-sized crystals of germanium waiting for a WIMP to come along. To block cosmic rays that might confuse the signal, CDMS sits about 230 stories deep in the Soudan Underground Laboratory, a research facility run by the University of Minnesota in the bowels of an old iron mine nestled among the lakes and forests at the northeast tip of Minnesota. The CDMS team numbers nearly 80 people from 16 institutions around the world, including Caltech.

Although CDMS is far from alone in trying to detect WIMPs, it's been the standard bearer for the past few years. No experiment has yet detected anything, but each silent result narrows down what WIMPs might look like—any theory that predicts something the experiments don't see has to be refined or ruled out. CDMS has provided the tightest constraints yet, and these latest results, taken over a period of more than a year, have doubled the collaboration's data. If physicists are close to finding WIMP collisions, then CDMS will be the first experiment to do so—which explains why people became so anxious upon hearing the rumors. The hype underscores just how momentous a dark-matter discovery would be. "It's a really exciting topic," says Sunil Golwala, associate professor of physics and a member of the CDMS team. His two graduate students, Zeeshan Ahmed (MS '08) and David Moore, did a lot of the number crunching for the new data. "Suppose you have conclusive evidence that you just discovered the dark matter in the universe," Golwala says. "I mean, that's just amazing."

WIMP fever was running high on December 17, when physicists packed into auditoriums in California and Illinois to hear what, if anything, CDMS had discovered. The Economist had written on that day, "If the rumors are true, a solution to one of the great problems of physics may now be within reach." JoAnne Hewett, a particle physicist at the Stanford Linear Accelerator Center, even liveblogged the event on Cosmic Variance, a popular physics blog. "The excitement in the air is palpable," she wrote. "Not much work is being done—everyone is pretty much talking in the hallways, trying to pass the time until 2:00."

Finally, the results were announced—two events had been found! But before booking flights to Stockholm, the team calculated that there was a 23 percent chance these signals were caused by background—likely collisions with electrons, instead of nuclei, that had snuck past their set of criteria for a true WIMP detection. As Golwala points out, "No one claims discovery with that high of a chance." The team couldn't say they had discovered dark matter, but they couldn't rule it out, either.

So CDMS hasn't revolutionized our understanding of the universe—yet. As for all the hype? "In a couple of months, no one will remember this," Golwala says. Still, their results—published in the March 26 issue of *Science*—are noteworthy, placing the most stringent constraints yet on what WIMPs could be. "It's an exciting time in the bigger sense, because we've been producing results from this experiment for about five years," he says. "We've been the premier experiment in this field." These data sets are marking the end of the current chapter in dark-matter searches. But new experiments are already under way, and in the next couple of years, a half-dozen more projects will begin—and they'll be many times more sensitive than CDMS. Says postdoc and CDMS team member Jeff Filippini, "It's very possible that in the next five years we might be talking about WIMP astronomy, rather than just trying to detect something."

More information: Cryogenic Dark Matter Search - cdms.berkeley.edu/

Provided by California Institute of Technology

Citation: A Mine for Dark Matter (2010, June 23) retrieved 10 April 2024 from https://phys.org/news/2010-06-dark.html