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Prof. 'shedding light on dark matter'

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Richard Gaitskell, associate professor of physics, is hunting dark matter 4,850 feet underground.

Hunting dark matter is not as easy as game hunting though, because the elusive particles cannot be detected by telescopes, satellites, radios or other typical observational devices used in astrophysics. Dark matter is only known to exist because its gravitational field affects matter that scientists can directly observe.

Gaitskell hopes to change that.

He and his nine-university team are developing a dark-matter-detection device to be called the Large Underground Xenon detector, or LUX, which means "light" in Latin. Gaitskell joked that his team will be "shedding light on dark matter."

The fundamental dark matter particles - called weakly interacting massive particles, or WIMPs - are so elusive because of their ability to simply pass through most substances, including those that scientists would traditionally use as detectors. Gaitskell hopes that, by using an extremely dense detector, he might be able to record traces of dark matter activity.

The LUX project, which began in Oct. 2006, will feature a detector containing 300 kilograms of liquid xenon, which is three times denser than water, maintained at around 165 degrees below zero Fahrenheit. As the hypothesized WIMPs interact with the liquid xenon, the detector will record the energy released.

In the next few weeks, testing of the sensors will begin so that they will be ready for the project's launch about a year from now at the Homestake gold mine in Lead, South Dakota. The detector has to operate in a mine so that it will be shielded by bedrock from interfering radiation.

The last time Gaitskell arranged for a rendezvous with the particles, he came close to detecting them but failed to produce conclusive results. This time around, the determined physicist has a new set of tools to bring him face-to-face with the dark matter particles - his new detector is over 100 times more sensitive than the one he used in his previous project, XENON 10.

"Last year, XENON 10 worked so well that we've gone ahead and scaled it up," Gaitskell said. "It's justified by how well the last experiment actually worked."

But despite the promise of a new discovery, Gaitskell said he remains emotionally unattached to the search. "After 19 years, I've learned to be a little bit more philosophical than that," he said.

Gaitskell began his dark matter search as a Ph.D. candidate at Oxford University in the 1980s and then followed the particles to the University of California, Berkeley, a school known for its strong physics program. There he met friend and long-time collaborator Tom Shutt, who is now an associate physics professor at Case Western Reserve University in Cleveland, Ohio.

"I've known Rick for some time - 14, 15, 16 years," Shutt said. "We were post-docs together at Berkeley and we were both on XENON 10. We're friends at this point."

Shutt, who began his search in 1987 as a graduate student at Berkeley, said that at the time, little was known about dark matter, so it was regarded as a wild goose chase for something that may or may not exist. Regardless, Shutt said that when he heard about the search for dark matter, he thought that it sounded "totally cool!"

However, recent decades have seen the development of a standard model of the universe that has strong implications for the search for dark matter. This widely-accepted model, Gaitskell said, describes the universe as only four percent regular matter, 22 percent dark matter and 74 percent dark energy, which is another separate but strange, elusive form of energy needed to make the model of the universe agree with scientists' observations.

Gaitskell said more is known about dark matter than about dark energy, so it will likely be found first, hopefully in the "next five to ten years."

Of course, Gaitskell and Shutt hope that their project is the one to find it. "A new form of matter hasn't been discovered since the 1930s, so learning the nature of dark matter or dark energy would be colossal," Shutt said, laughing about using the word "colossal" to describe the tiny WIMPs.

If dark matter is found, "someone will win a Nobel Prize," Shutt said.

The "stuff" that we're made of -- all of the matter that we can see in our daily lives -

doesn't make up the majority of the universe, Shutt and Gaitskell said. They both said that "finding dark matter is the second Copernican revolution." Just as Copernicus showed in the 16th century that Earth was not the center of the universe, researchers today hope to prove what we are is very different than what comprises most of the universe.

"The evidence is conclusive of dark matter so it is no longer disreputable to be looking for dark matter," Shutt said.

The team is using Case Western as a staging and assembly ground for the detector. In the next few weeks, a few sensors will be shipped to Cleveland to be tested in the detector. Once the detector is assembled and working, it will be shipped to South Dakota, where it will run in the closed-down Homestake gold mine.

The LUX detector will be placed in Homestake's historic Davis cavern, named for Raymond Davis Jr., who won the Nobel Prize in Physics in 2002 for the detection of solar neutrinos using a 110,000-gallon tank of chlorine-based chemicals. The Davis experiment shut down in 2001.

The team is hoping to get the dark matter detector running in the mine by late 2008 or early 2009 and run it for about a year. The detector has to conclusively detect a few WIMPs to confirm their existence.

"We don't know exactly how small (WIMPs) are or how often they will hit the detector," Shutt said. If the team is unable to detect WIMPs, Shutt said they would build an even bigger detector.

Despite the uncertainty, Gaitskell said he is confident that dark matter is out there, waiting to be discovered.

"If I really believed we were wrong," Gaitskell said, "I wouldn't be searching for dark matter."
