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Can this experiment identify dark matter?

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"The key question we want to tackle," Gianfranco Bertone tells *PhysOrg.com*, "is what dark matter is."

Bertone is a scientist at the Institute of Astrophysics in Paris, working toward a better understanding of dark matter, which makes up most of the matter in the universe. He and his colleagues, David Cerdeño at the Theoretical Physics Institute in Madrid and Juan Collar and Brian Odom at the University of Chicago, have studied how to combine data from different experiments in order to obtain more stringent constraints on dark matter particles, and hopefully to identify them.

Their work is published in a *Physical Review Letters* article titled "Identification of Weakly Interacting Massive Particles Through a Combined Measurement of Axial and Scalar Couplings."

"Many experiments and observations all point to the existence of some form of matter that is different from the ordinary matter that makes up starts, planets and even people," Bertone explains. Because dark matter is so prevalent in the universe, many scientists are interested in better understanding its role in fundamental physics, as well as the formation of the universe. "There are efforts to clarify the nature of dark matter."

Bertone explains that there are three main approaches to detecting dark matter particles, which are likely to be weakly interacting massive particles (WIMPs). The first, he says, is an earthbound method using particle accelerators, like the Large Hadron Collider due to go online at CERN next year. "Scientists hope to find particles in accelerators that could be like the dark matter found in the rest of the universe."

The next method of detection is one of indirect observation. Looking out into space, Bertone says, scientists "look for some signal due to interaction of particles amongst themselves."

The strategy set forth in the article belongs to the third approach, which is to build a large detector and wait for a dark matter particle to interact with ordinary matter. "To show the power of this technique, we focused on an experiment called COUPP [Chicagoland Observatory for Underground Particle Physics]" Bertone says. "It is a bubble chamber, much like what has been used before in other fields."

He explains that when a dark matter particle enters the chamber, it releases a tiny amount of energy, and is visible in the form of bubbles. "In case positive detection, the idea is to change the target liquid in the bubble chamber and repeat the experiment. We would measure the rate in two different targets and by crossing the results, we can get the properties of the dark matter particles with better accuracy."

There are technological problems to this setup, Bertone concedes. "If you operate the bubble chamber at the ground level, you get a huge amount of bubbles, as many particles enter and they all interact with the nuclei." To reduce this "background" from ordinary matter, Bertone says that the bubble chamber must be brought deep underground.

"The group of Juan Collar has built a prototype at Fermilab in Chicago, still in its early phase and under development," explains Bertone. He points out that the bubble chamber detector's main advantage is that it can be operated at room temperature. "Most of the time, when looking for tiny signals, it needs to be done at very low temperatures. Being able to do this at room temperature makes things easier and cheaper."

Bertone says that plans to "scale up" the prototype chamber in Chicago are moving forward, along with the other dark matter experiments being attempted around the world. The technique they have proposed can however be applied to any experiment, and can even be used to combine data from different experiments. "We live in a moment of excitement," he continues. "I am eager to see the results from all the dark matter experiments. We could really be about to discover new things."