# Highly Sensitive Dark Matter Experiment Disproves Earlier Findings

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Light sensors making up the lower detector on the XENON experiment. Image credit: Guillaume Plante

(PhysOrg.com) -- Early data from a Columbia-led dark matter experiment rule out recent hints by other scientists who say they have found the elusive particle that holds the universe together. The findings show that dark matter, which is believed to make up 83 percent of the matter in the universe, is more elusive than many had hoped.

"Dark matter particles continue to escape our instruments, yet we are getting much more clever in our search and feel confident that we will soon unveil them," said Elena Aprile, spokesperson of the XENON100 experiment and a professor of physics at Columbia University.

Aprile and her collaborators, who number more than three dozen physicists at nine institutions around the world, presented their findings at a dark matter workshop on May 1 and have submitted a paper to the journal Physical Review Letters. The scientists, whose experiment is the most sensitive search for dark matter to date, plan to release a much larger set of data over this summer.

The group did not expect to find dark matter in this short run of data taken last fall. Instead, their results show that the detector is better than any other at screening out background radiation that can be mistaken for the elusive particles.

The hunt for dark matter has become highly competitive in recent years, with more researchers entering the field. In 1997, the DAMA/LIBRA research group of the University of Rome Tor Vergata became one of the first to claim it had found dark matter. This past February, the CoGeNT collaboration lead out of the University of Chicago, announced that it, too, had found a signal indicative of dark matter.

The new results from XENON100 cast doubt on both of these findings. If the earlier signals were due to dark matter, XENON100 would have seen dozens of events—unless the properties of dark matter are very different than expected.

Scientists first suggested the existence of dark matter in the 1930s to explain how galaxies keep from breaking apart as they spin. Like merry-go-rounds, galaxies generate centrifugal force as they rotate. Gravity is the glue that holds stars and galaxies together, but there isn't enough visible matter in the universe to generate the amount of gravity needed to keep galaxies from tearing apart. That's why scientists believe there must be additional, unseen matter out there. Scientists working on XENON100 believe that dark matter is made up of new elementary particles called Weakly Interacting Massive Particles, or WIMPS, which

rarely bump into normal matter.

Aprile and her colleagues have been working on XENON100 since 2007 as part of a project funded largely by the National Science Foundation. Their detector, which was built at Columbia, consists of a stainless steel container filled with ultra-pure liquid xenon sandwiched between two highly sensitive cameras. It is located beneath 5,000 feet of rock in Italy's Gran Sasso Underground Laboratory (LGNS) in a chamber of lead and copper that, along with the rock, helps filter out cosmic and background radiation that may otherwise be mistaken for WIMPS.

Should a dark matter particle come into contact with a xenon atom, it will transfer a tiny amount of energy that will trigger the emission of a flash of ultraviolet light that the cameras will pick up. The energy also manifests itself in a small amount of electrical charge—weaker than that produced by the passage of other known particles. If the XENON100 detector registers these light and charge signals and can exclude with high certainty that they were produced by other sources, it will be a strong indication that Aprile's team has found dark matter.

The Columbia researchers use liquid xenon because it is one of the heaviest elements in the periodic table; at three times the density of water, it has many atoms per liter, maximizing the chances that a WIMP will collide with it.

"Liquid xenon is a precious and wonderful material for catching and studying WIMPS," said Aprile, who has worked with the liquid for most of her research career.

Provided by Columbia University