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No sign of dark matter in underground experiment

LUX, the most sensitive dark matter detector yet, fails to capture mysterious particles.

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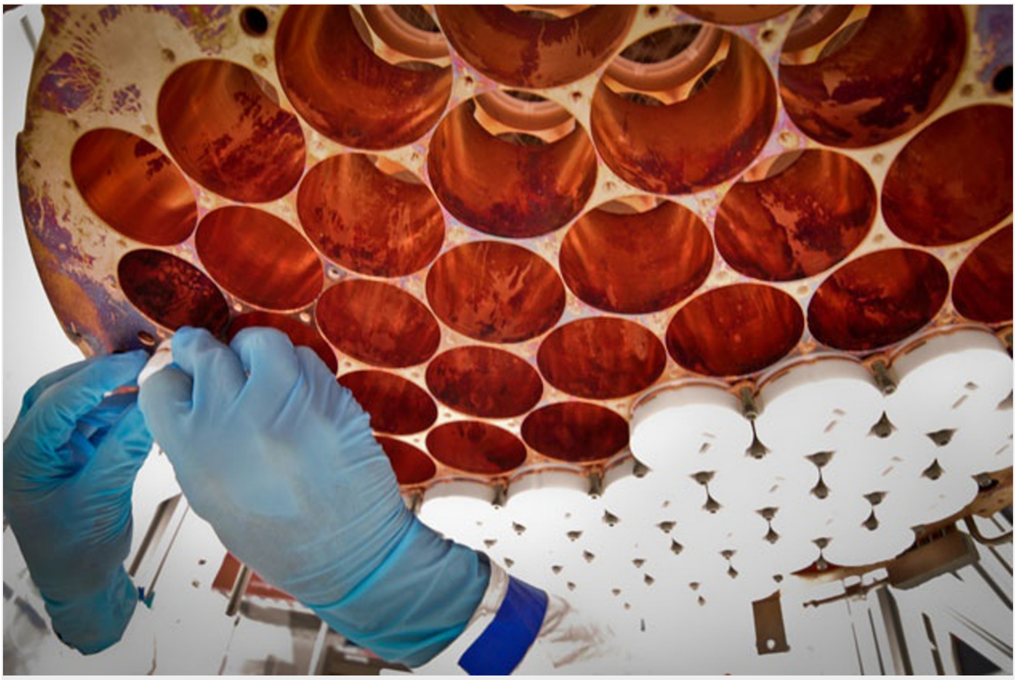

C.H. Faham/luxdarkmatter

The LUX dark-matter experiment uses photomultiplier tubes to amplify flashes of light from particle collisions.

A US team that claims to have built the world's most sensitive dark matter detector has completed its first data run without seeing any sign of the stuff.

In a webcast presentation today at the Sanford Underground Laboratory in Lead, South Dakota, physicists working on the Large Underground Xenon (LUX) experiment said they had seen nothing statistically compelling in 110 days of data-taking. "We find absolutely no events consistent with any kind of dark matter," says LUX co-spokesman Rick Gaitskell, a physicist at Brown University in Providence, Rhode Island.

Physicists know from astronomical observations that 85% of the Universe's matter is dark, making itself known only through its gravitational pull on conventional matter. Some think it may also engage in weak but detectable collisions with ordinary matter, and several direct detection experiments have reported tantalizing hints of these candidate dark matter particles, known as WIMPs (Weakly Interacting Massive Particles). Gaitskell says that it is now overwhelmingly likely that earlier sightings were statistical fluctuations.

LUX contains more than 300 kilograms of liquid xenon held 1,480 metres underground at the Sanford lab, where rock shields it from the confounding effects of cosmic rays striking Earth's surface. The hope is that dark matter particles, passing through Earth, will occasionally hit xenon nuclei, causing flashes of light that can be picked up by the experiment's 122 photomultiplier tubes, situated in arrays above and below the xenon. But only 160 events were seen, a level consistent with background levels of radioactivity from the materials making up the experiment, and well short of what would be expected if candidate dark matter particles seen by previous experiments were real, says Gaitskell.

LUX has now set a limit on dark matter particle interactions that is two to five times more stringent than its closest rival, an experiment called XENON-100 in Gran Sasso National Laboratory near L'Aquila, Italy. In 2011, XENON-100 also saw no evidence for dark matter, but had been criticized for not being sensitive enough to very low-mass dark matter particles tentatively reported by other experiments. LUX has five times the sensitivity of XENON-100 in the low-mass realm, which should allay those concerns, says Gaitskell.

Despite the no-shows at XENON-100 and LUX, Laura Baudis, a physicist on XENON-100 at the University of Zurich in Switzerland says physicists are not ready to give up on the idea of detecting WIMPs. They may simply have a lower mass, or may be more weakly interacting than originally hoped. “We have some way to go,” she says.

Baudis adds that LUX's results may help the US$10 million experiment to win further funding. The LUX team hopes to scale up to seven tonnes of xenon in an $30 million upgrade called LUX-ZEPLIN. The US Department of Energy is currently deciding which of three experiments to fund: LUX-ZEPLIN; an upgrade to solid-state silicon detectors called the Super Cryogenic Dark Matter Search, to be based initially in the Soudan mine in Minnesota; and an argon-based liquid detector called DarkSide, also at Gran Sasso.

Juan Collar, a dark-matter physicist at the University of Chicago in Illinois, agrees that LUX's solid results will boost its chances of being selected. On the other hand, he says that it would be more strategic for the Energy Department to fund one of the other two experiments, because they would develop other detection materials; European governments and the US National Science Foundation have already agreed to upgrade XENON-100 to the one-tonne level. More than one large-scale xenon experiment may not be necessary, Collar says. “Everyone acknowledges that what this field needs is a variety of targets.”

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