UCLA 'dark matter' conference highlights new research on mysterious cosmic substance

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Dark matter, for more than 70 years as mysterious and unknowable a subject to science as the legendary island of Atlantis has been to history, is bringing 140 scientists from the U.S., Europe and Asia to the Marriott Hotel in Marina del Rey for the ninth UCLA Symposium on Sources and Detection of Dark Matter and Dark Energy in the Universe. The three-day conference runs through Friday, Feb. 26.

"Dark matter is one of the last great frontiers in science," said David B. Cline, UCLA professor of physics, high-energy astrophysicist and symposium organizer. "Once we know what it really is, we will break through into a new realm of nature. It's going to be an entirely new era for science, it's going to pose fascinating new questions, it's going to be exciting."

First proposed in the 1930s by the late California Institute of Technology scientist Fritz Zwicky to explain why some galaxies appeared more ponderous than their luminosity would suggest, dark matter is thought to account for almost 25 percent of the universe today. Just 5 percent is made up of visible, tangible matter; the remaining 70 percent is in the equally baffling form of dark energy. Despite its abundance, uncontested reality and ubiquity, dark matter has so far evaded direct observation.

At the symposium, scientists will discuss a range of topics, from tantalizing hints of dark matter gleaned from a dozen or so experiments currently underway around the world, to more sophisticated detectors that will perhaps reveal at last the true identity of this mysterious stuff, to considerations of a still deeper and more profound stratum in nature.

UCLA professor of physics Katsushi Arisaka and Hanguo Wang, a UCLA physics researcher, will describe the newest dark matter detector, XENON100, which UCLA has been operating beneath Italy's Gran Sasso mountain, some 70 miles west of Rome, in partnership principally with Columbia University and Rice University, along with seven other institutions in Switzerland, Portugal, Italy, Germany, France, Japan and China.

The XENON100 detector is an instrumented vat, about the size of a stockpot — 12 inches in diameter and 12 inches tall — holding 220 pounds of frigid liquid xenon. It is, in effect, a traffic surveillance camera that can record the occasional, if very infrequent, collision between a dark matter particle and a xenon atom.

There is a certain irony to this, given that xenon is a heavy, noble gas that does not react easily with other elements and yet is the target of choice for subatomic particles that themselves are very aloof. But both are large entities in their respective realms, the physicists reason, and so are bound to collide sooner or later. And when they do, the UCLA team believes the XENON100 detector will capture the event through signals that only a xenon-dark matter collision can produce.

Dark matter is widely thought to be a kind of massive elementary particle that interacts weakly, when it interacts at all, with ordinary matter; physicists call these particles WIMPs, for weakly interacting massive particles.

WIMPs are everywhere throughout the universe, streaming constantly through the Milky Way galaxy, the solar system, Earth's atmosphere, mountains — and even cylinders filled with liquid xenon. And when the occasional WIMP does bump into a xenon molecule, the xenon atom recoils and emits a tiny flash of scintillation, or light. The bump also causes the struck xenon to give off a small burst of ionizing radiation.

Both signals fall on an array of small, sensitive sensors — "avalanche photon-intensifying devices," so-called because a single scintillating flash sets off a cascade of electrons into the instrument's recorders. Imagine the sound of a pin dropped on a marble counter instantly transformed into booms of a bass drum and you begin to appreciate the effectiveness of these sensors.

Cline praised Arisaka and Wang for the way they integrated these sensors into the overall XENON100 detector, saying that the devices can discriminate between those signals triggered by dark matter and those triggered by gamma rays and naturally occurring radioactive elements in Gran Sasso mountain.

As proud as they are of the XENON100 instrument and its performance to date — indeed, even before they know definitively if they have caught sight of one or more WIMPs — the UCLA team is working on bigger, more sensitive dark matter detectors. A XENON1000 device, 10 times larger than the one now operating, would provide a 100-times larger arena, and much greater opportunities, for WIMPs and xenon to collide, for confirming test results to be gathered and for the unraveling of dark matter to begin.

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