A shot in the dark: Detector on the hunt for dark matter

November 6 2013

University of Washington physicists Leslie Rosenberg (right) and Gray Rybka examine the experiment package as it is positioned above the bore of a large superconducting magnet, two primary components of the detector being used in the Axion Dark Matter Experiment. The components were assembled in mid-October and lowered into the magnet bore (lower right) to begin the detector's commissioning phase. Credit: Mary Levin / University of Washington

Leslie Rosenberg and his colleagues are about to go hunting. Their quarry: A theorized-but-never-seen elementary particle called an axion.

The search will be conducted with a recently retooled, extremely sensitive detector that is currently in a testing and shakeout phase at the University of Washington's Center for Experimental Nuclear Physics and Astrophysics.

The axion was first conjectured by physicists in the late 1970s as a solution to a problem in a theory called quantum chromodynamics. Little is known for sure about the axion. It appears to react gravitationally to matter, but otherwise it seems to have no other interaction.

Since the 1930s, scientists have believed there must be some unseen but massive substance, a sort of gravitational glue, that prevents rotating galaxies from spinning apart. Axions, if they in fact do exist, are candidates for the makeup of cold dark matter that would act as that gravitational glue.

Dark matter is believed to account for about one-quarter of all the mass in the universe. However, because axions react so little – and the reactions they are likely to produce are so faint – finding them is tricky.

"We have probably the most sensitive axion detector in operation," Rosenberg said. "It looks for the incredibly feeble interaction between the axion and electromagnetic radiation."

The aim of the Axion Dark Matter Experiment is to search for cold dark matter axions in the halo of the Milky Way galaxy by detecting the very weak conversion of axions into microwave photons.

The detector employs a powerful magnet surrounding a sensitive microwave receiver that is supercooled to 4.2 kelvins, or about

minus-452 F. Such low temperature reduces thermal noise and greatly increases the chance that the detector will actually see axions converting to microwave photons.

The microwave receiver can be fine-tuned to the axion mass, which also increases the possibility of detecting an interaction between axions and the detector's magnetic field. A reaction would deposit a minuscule amount of electromagnetic power into the receiver, which could be recorded by computers monitoring the detector.

There have been previous efforts to locate the axion, but there is greater interest in the Axion Dark Matter Experiment because of recent developments in physics research. The most notable is that the Large Hadron Collider near Geneva, Switzerland, lauded for its discovery of the elusive Higgs boson in 2012, did not find evidence to support supersymmetry, a proposed resolution for some inconsistencies among theories of particle physics.

That lack of evidence provided impetus to separate the search for dark matter from work on supersymmetry, Rosenberg said, so the newest version of the Axion Dark Matter Experiment is drawing substantial interest among researchers.

"This is a needle-in-a-haystack experiment. Once we find the needle, we can stop immediately," Rosenberg said.

"We could find it in our first week of data-taking, our last week of data-taking, or never."

Assembly of the detector was completed in early October, and the team has begun weeks to months of commissioning, which involves testing and fine-tuning the equipment. Then the hunt will begin in earnest.

Collaborators in the research come from Lawrence Livermore National Laboratory; the National Radio Astronomy Observatory; the University of California, Berkeley; the University of Sheffield in England; the University of Florida; and Yale University. The work is funded by the Department of Energy.

Provided by University of Washington