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DOE Explains...Dark Matter

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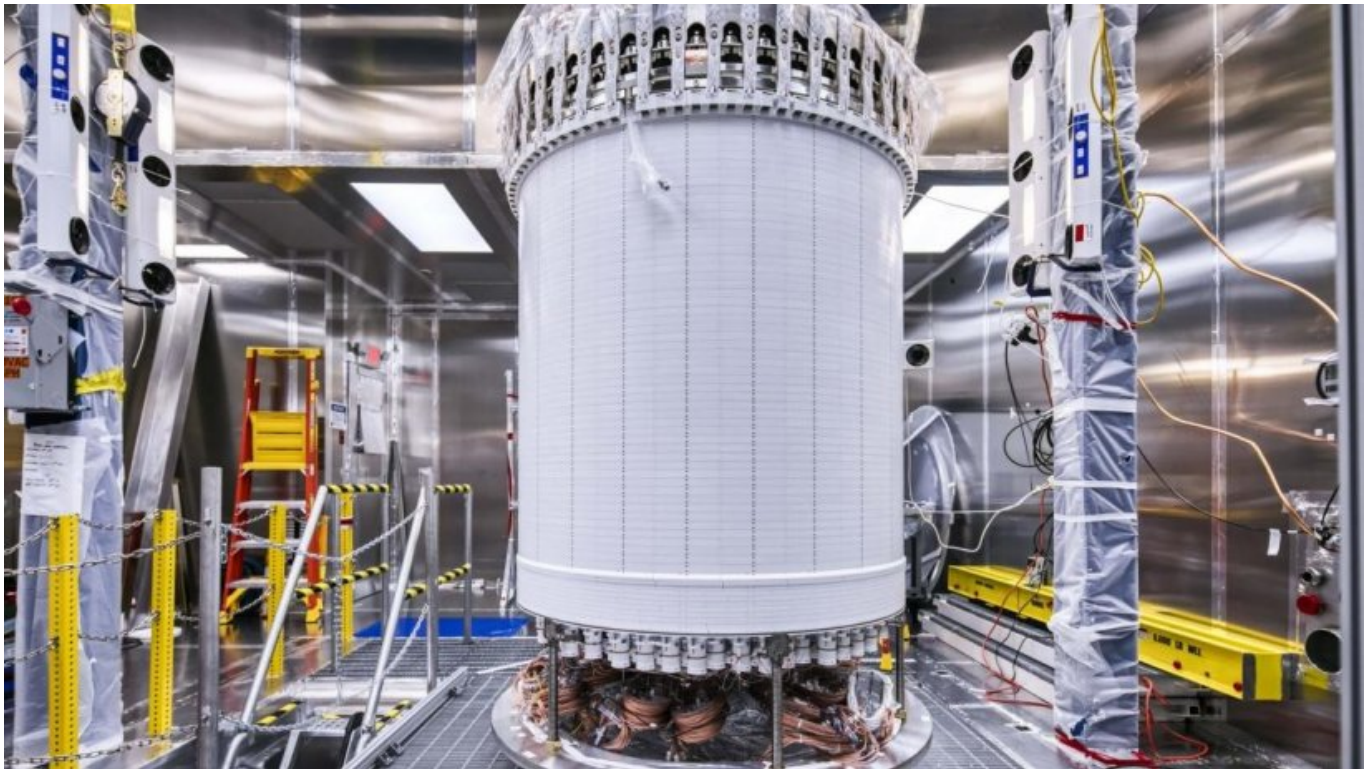

The LUX-ZEPLIN xenon-based dark matter detector being assembled at the Sanford Underground Research Facility.

Photo courtesy of Matthew Kapust, Sanford Underground Research Facility

Dark matter accounts for five times as much of the universe as ordinary matter. However, we know little about it other than that it only interacts with ordinary matter through gravity. Despite our lack of knowledge, scientists do have overwhelming indirect evidence for dark matter. For example, scientists can explain how galaxies rotate and how the large-scale structure of the universe forms and evolves by dark matter's existence. The term dark matter was coined in 1933 by Fritz Zwicky of the California Institute of Technology to describe the unseen matter that must dominate one feature of the universe—the Coma Galaxy Cluster. The galaxies in the Coma Cluster were moving too quickly for as much mass as there appeared to be, and dark matter was a potential explanation. In the 1970s, Vera Rubin of the Carnegie Institution found evidence for dark matter in her research on galaxy rotation. But the nature of dark matter remains a mystery.

Scientists have several candidates for the types of particles that make up dark matter. One possibility is that dark matter is made of WIMPs (weakly interacting massive particles) that would have 1 to 1,000 times more mass than a proton. Another candidate is the axion, a particle ten-trillionth of the mass of an electron. In theory, axions would convert to a particle of detectable light (called a photon) in the presence of a strong magnetic field. Alternately, dark matter may also exist in a rich and complex set of particles.

DOE Office of Science: Contributions to Dark Matter

The DOE Office of Science High Energy Physics program supports research on dark matter through complementary experiments, some in partnership with the National Science Foundation and other agencies. Researchers use large, sensitive detectors located deep underground to directly search for the dark matter particles that may continually pass through the Earth. Researchers can also detect dark matter indirectly through specific signatures in cosmic rays and gamma rays. Scientists search for these signatures using space-based and ground-based observatories. Researchers are also trying to create dark matter with particle accelerators, such as the Large Hadron Collider and various DOE

Office of Science user facilities.

Dark Matter Facts

- Dark matter makes up about 85 percent of the total matter in the universe, accounting for more than five times as much as all ordinary matter.
- Dark matter played an important role in the formation of galaxies.
- Researchers use astronomical surveys to build maps of the location of dark matter in the universe based on how the light from distant galaxies bends as it travels to us.

Resources and Related Terms

- **Office of High Energy Physics**
- **Physics at the National Science Foundation**
- **DOE's Direct Current podcast, A Shot in the Dark**
- **The Search for Dark Matter**
- **Cosmic Ray Tool Repaired in Space**
- Science Highlight: **Hunting for Sterile Neutrinos with Quantum Sensors**

Acknowledgements

Michael Cooke (DOE)

Scientific terms can be confusing. ***DOE Explains*** *offers straightforward explanations of key words and concepts in fundamental science. It also describes how these concepts apply to the work that the Department of Energy's Office of Science conducts as it helps the United States excel in research across the scientific spectrum.*

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