Sanford Underground Research Facility

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Deep Thoughts

Notes from the underground by Communications Director Constance Walter

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Solving the mysteries of neutrinos

Take 10 trillion, multiply it by 7 billion and you'll get the number of neutrinos that pass through every person on earth, every second of every day. Once they pass through you, they keep going—right through the earth and back into space. Scientists have known of the neutrino's existence since the late 1950s, yet all these years later, they still remain a mystery.

Why is that?

"Neutrinos have remained so mysterious because they are so hard to detect and we know so little about them," said Steven Elliott, Los Alamos National Laboratory Fellow. "However, they play a critical role in many physical processes, such as supernova and the evolution of the Universe."

A spokesperson for the Majorana Demonstrator project at Sanford Lab, Elliott has been studying neutrinos for decades, with a focus on double beta decay. "The neutrino is a fundamental particle often created during decay," Elliott said. "What we don't know about the neutrino is the key to resolving important unknowns in the standard model—and the universe."

When the universe first formed, it had equal parts of matter and antimatter. Somewhere along the line, matter triumphed and planets, stars and, eventually, humans came into existence. Why did matter win?

That's one question researchers with the Majorana Demonstrator want to answer. They're looking for a Majorana particle, a mysterious fermion that is its own antiparticle. Their search for a rare form of radioactive decay, called neutrinoless double-beta decay, could tell us why matter exists. If they find the answer to this perplexing question, it will require rewriting the Standard Model of Particle Physics, our basic understanding of the physical world.

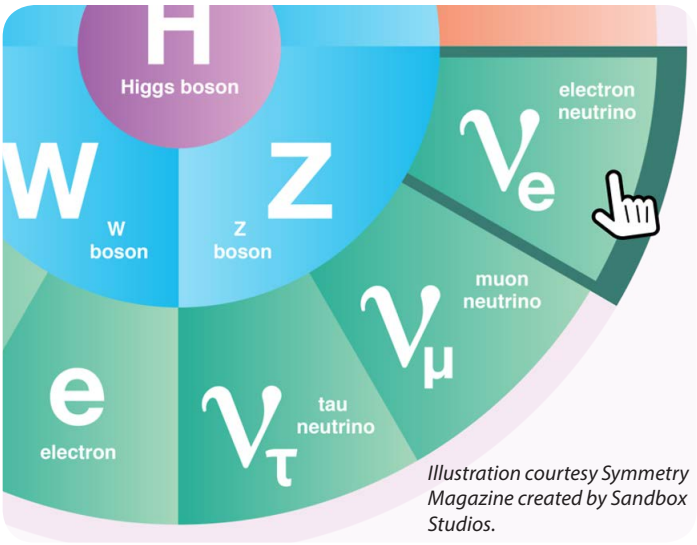

Illustration courtesy Symmetry Magazine created by Sandbox Studios.

In the Standard Model, neutrinos belong in the lepton family, fermions that make up matter. Scientists know neutrinos have mass; travel near the speed of light; pass right through matter, making them very difficult to detect; and that they oscillate, or change types, as they travel.

But this raises even more questions.

What is the mass of a neutrino? Why do neutrinos oscillate? Is the neutrino its own antiparticle? What is the neutrino's role in the universe? What can neutrinos tell us about supernova and newly formed neutron stars?

"Although they are elusive, we know they are involved in natural nuclear reactions everywhere: the early universe, the Sun, the Earth, and even within our human bodies," said Vince Guiseppe, associate professor of physics at the University of South Carolina and a member of the Majorana Demonstrator project at Sanford Lab.

"We owe it to ourselves to understand the universe we live in," Guiseppe said. "We cannot leave the last few threads of our understanding hanging—we need to continue our experiments and determine the theoretical framework that gives us a complete picture about neutrinos."

Save the Date: Neutrino Day July 8, 2017

"Discover" the fun at this year's Neutrino Day! In 2015, the LIGO Collaboration discovered gravitational waves. Learn more about that from our keynote speaker Michael Landry, director of the LIGO Hanford Observatory.

More information will be posted soon on our website and Facebook, so stay tuned.