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Physicists find missing piece in puzzle

A 3-year analysis proves that the fundamental, yet elusive, tau neutrino exists

By Dan Vergano, USA TODAY

Physicists plan to announce Friday the first direct detection of the tau neutrino, an unimaginably small particle whose confirmation has eluded science for 25 years.

At an afternoon event, members of an international physics team at Fermilab in Batavia, Ill., will present evidence of the particle, the last theorized but unconfirmed member of the family of particles that make up the universe. Together, the elements compose the so-called standard model of physics.

"It's like finding the Z in the alphabet of fundamental particles," said Phillip Schewe of the American Institute of Physics in College Park, Md. He did not take part in the study.

The standard model holds that all matter is made of fundamental particles — which form neutrons, protons and electrons — that interact through nuclear, electromagnetic and gravitational forces.

Smaller than electrons, neutrinos remain hidden inside neutrons, hence their name, which means "little neutrons," until released by radioactivity.

Neutrinos come in three varieties. The tau is the last to be discovered. Every day, the sun blasts Earth with trillions of neutrinos, most of which pass harmlessly through the planet.

The last scientists who detected a neutrino, the muon neutrino, found in 1962, won a Nobel Prize in physics. The existence of the tau neutrino has not been proven until now.

Understanding that neutrinos are a byproduct of fusion helped scientists explain how the sun burns and how radioactive decay takes place.

To capture tau neutrinos in action, the Direct Observation of the Nu Tau (DONUT) team fired a beam of all types of neutrinos at a

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3-foot-long sandwich of iron and photographic plates, beginning in 1997.

Rarely, collisions between tau neutrinos and the interiors of iron atoms produce related particles called tau leptons, which exist for only one-tenth of a trillionth of a second before decaying back into tau neutrinos. In that span, they leave a track perhaps 1 millimeter long on a photographic plate.

"They're gone almost as soon as they're created," said team member Jacob Schneps of Tufts University in Medford, Mass. Tau leptons were discovered only 25 years ago, he notes.

Of about 6 million potential collisions, a three-year computer analysis confirmed four tau lepton sightings.

"This is the final nail in the box that confirms their existence," Schneps said. He predicts that the data will show five or six more tau neutrino tracks in the next year.

Interest in neutrinos has risen since the discovery in 1998 that neutrinos might possess mass and offer an explanation for the mysterious "dark matter" that is believed to make up much of the universe.

"Particle physics doesn't save lives or fill stomachs," Schewe said. "But it does investigate the most fundamental structures in the universe out of which everything, including ourselves, is made."

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