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# Physicists find elusive tau neutrino

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Physicists have completed their quest to find a specimen of every member in the menagerie of subatomic building blocks that make up the material world.

The 12th and last particle to be directly detected is the tau neutrino, one of three types of neutrino -- an elusive particle that has little or no mass, no electrical charge and passes through matter like a ghost. Scientists estimate that about 1,800 neutrinos per cubic inch swarm throughout the cosmos and that 65 million generated by the sun are whizzing through a person's thumb every second.

Today, an international collaboration of 54 scientists at the Department of Energy's Fermi National Accelerator Laboratory (Fermilab) outside Chicago will formally announce that it has detected four instances of the predicted signature of the tau neutrino: a track with a distinctive kink in it, etched in an emulsion.

Researchers spent almost three years painstakingly culling the quartet of telltale zigzags from among 6 million potential particle interactions recorded by their 50-foot-long detector.

"We finally have direct evidence that the tau neutrino is one of the building blocks of nature and that it reacts with other particles in accordance with our current scientific theory," said physicist Byron Lundberg, spokesman for the Direct Observation of the Nu Tau (**DONUT**) experiment conducted by physicists from the United States, Japan, Korea and Greece.

UofM collaborates

Nobel laureate Leon Lederman called the confirmation "an important and long-awaited result." He and colleagues Jack Steinberger and Melvin Schwartz were awarded the prize in 1988 for the discovery of one of the other two types of neutrino.

"In some sense, this discovery is comforting," said Ken Heller, one of the University of Minnesota physicists who collaborated on the project. "If [the neutrino] didn't exist ... it would mean there was something wrong with our fundamental understanding of the universe."

Roger Rusack, another University of Minnesota physicist, said the project involved half a dozen Minnesota graduate students and several faculty

members for more than two years. The Minnesota team built some of the equipment needed to detect the neutrinos and helped sift through the 6 million pieces of information to find evidence of four neutrinos.

He said the Minnesota team was one of the largest in the international collaboration.

Widely accepted evidence two years ago from the U.S.-Japanese project called Super-Kamiokande (Super-K), along with others, indicated that the neutrino has a slight mass, contrary to leading theory. Because the particle is so ubiquitous, scientists said, a confirmation of its mass could have profound implications.

The results of numerous neutrino experiments underway or planned, including one in Europe using the same emulsion technique developed for **DONUT**, could reverberate throughout scientific understanding of the smallest elements in nature to the fundamental composition of the universe, to scientists' search for a unifying theory of everything.

How it began

The term atom to the ancient Greeks meant "uncuttable." But beginning with Ernest Rutherford in 1910, scientists learned to fire subatomic projectiles at targets and study the resulting debris to discover new particles. They showed that even the tiny atom is cuttable -- made up of even smaller units dubbed quarks (from a line in James Joyce's "Finnegans Wake") and electrons, bound together by particles called gluons (because they act like glue) and photons (the particles that make up light).

Physicists soon found themselves with hundreds of particles with varying masses, energies and longevity. Like biologists struggling to classify invisible animals, they began to lump the particle zoo into families. The resulting distillation, known as the Standard Model, postulates that virtually every conceivable state of matter or energy can be embodied in a few particles: The "matter particles" include six kinds of quarks and six kinds of leptons (from the Greek word for small). Other particles carry fundamental forces, such as electromagnetism.

The neutrino resides in the lepton clan. Scientists now know it comes in three personalities, each linked to one of three cousins in the clan -- the electron, which carries electrical current in household appliances; the muon, like the electron but more massive and therefore less stable, and the tau, a dramatically porkier version of the electron.

***-- Staff writer Maura Lerner contributed to this report.***