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# Tiny, But Significant

## Elusive Tau Particle Is Detected

DONUT spokesman Vittorio Paolone, University of Pittsburgh, poses inside the magnet used to eliminate charged particles from the neutrino beam. (www.fnal.gov)

By Joseph B. Verrengia  
The Associated Press

July 21 — In what is being hailed as a heroic achievement in physics, scientists have found the first direct evidence of the tau neutrino, an elusive and ghostly subatomic particle that was thought to be the last missing piece in the architecture of matter.

The breakthrough, announced on Thursday, was achieved by scientists at the Fermi National Accelerator Laboratory outside Chicago.

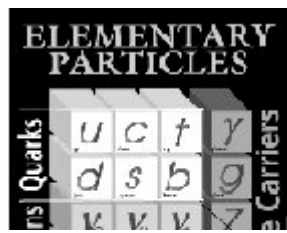
“It’s a tremendous milestone,” said Stanford University physicist and Nobel Prize winner Martin Perl, who first theorized the existence of the tau neutrino in 1978. “Now it has been seen, and it behaves in the way we expected.”

Since 1997, fifty-four scientists from the United States, Japan, Korea and Greece collaborated on tracking down the tau neutrino at the Fermi Laboratory.

### Final Building Block

The tau is one of the fundamental building blocks of all matter. It is the 12th and last of the impossibly tiny particles described in the Standard Model of Particle Physics to be confirmed in experiments.

The standard model seeks to encapsulate all elementary particles and forces in a single explanation. Now the bits have been identified, though the many forces that guide



**A chart of the theoretical Standard Model where the tau neutrino was once a missing piece. The Standard Model describes all known building blocks of matter.** (www.fnal.gov)

international team. "It is one thing to think there are tau neutrinos out there. But it is a hard experiment to do."

Perl said there may be other types of neutrinos out there, but they have not been identified or even theorized.

Finding the tau has no immediate practical applications. But physicists were thrilled.

"No one doubted the existence of the tau neutrino, but finding it is a heroic accomplishment," said astrophysicist John Bahcall of Princeton University and the Institute of Advanced Studies.

## Everywhere, But Elusive

Neutrinos are hurtling everywhere and all the time at nearly the speed of light. Every second, trillions pass through all of us and the Earth itself.

Yet they are among the shiest of all subatomic particles, carrying no electrical charge and virtually no mass — perhaps one-millionth that of an electron. They are loners, barely interacting with the world.

The tau neutrino is the third and perhaps final type of neutrino to be found. The first two types — electron neutrinos and muon neutrinos — were discovered in 1956 and 1962. Neutrino — Italian for "little neutral one" — became part of physicists' lexicon in the 1930s.



**John Trammell and Dave Ciampa, University of Minnesota, working on the target station of the DONUT experiment.** (www.fnal.gov)

In 1978, tests by Perl and others at Stanford discovered the existence of another class of subatomic particle, the tau lepton. This suggested there would be a tau neutrino, too, because neutrinos are precursors to leptons. But finding the tau neutrino was more difficult.

## A Long Search

their interplay remain a mystery.

"We finally have direct evidence that the tau neutrino is one of the building blocks of nature," said Byron Lundberg, a physicist and spokesman for the

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Mathematical computations started in 1993. In 1997, scientists using the ring-shaped particle accelerator at Fermi Laboratory fired an intense neutrino beam into a 3-foot detector composed of iron plates coated with an emulsion. Then the scientists analyzed the 6 million impressions left on the coating.

The researchers used computer-assisted video cameras to create 3-D images of the particle tracks. They narrowed down the field and found four clear tracks of a tau lepton that scientists say were caused by tau neutrino collisions.

The experiment was called the Direct Observation of the Nu Tau, or DONUT. Researchers celebrated Thursday by serving doughnuts in their offices.

The findings have not been published in a scientific journal, but other scientists said they were confident of the results.

### Bits of the Universe

“Because neutrinos have no charge, you can never detect them directly,” Perl said. “Tau neutrinos make tau leptons, which decay very quickly. Their signature is what you detect.”

It is the latest in a series of large-scale efforts to detect the tiny cosmic bits, which scientists suspect may add up to a big chunk of the universe.

In 1998, an international team of scientists in Japan, including University of Hawaii researchers, determined that neutrinos have mass, however infinitesimal. The discovery is forcing physicists to reconsider the part of the Standard Model that says neutrinos have no mass at all.

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