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## Physicists Find First Direct Evidence for Tau Neutrino, Elusive Constituent of Matter

Jul. 20, 2000 | 11:51 a.m.

ATTENTION: Science editors

DAVIS, Calif., July 20 (AScribe News) -- Scientists will announce tomorrow at Fermi National Accelerator Laboratory that they have produced the first direct evidence of the tau neutrino, confirming the existence of an extraordinarily elusive constituent of matter.

Earlier experiments had produced only indirect evidence for the existence of the tau neutrino, which is massless or almost massless, carries no electric charge and barely interacts with surrounding matter.

"This completes the picture of the subatomic constituents of matter," said Phil Yager, a physicist at the University of California, Davis, and a participant in the experiment. "It's really important to see that this thing does in fact exist and that it behaves the way we expected it to."

"It's amazing that human beings can contemplate things like this and understand them. We're looking at what is in the protons that make up the compounds that form the human genome. We're getting right down to the nitty-gritty of all matter."

"And because we can now detect the tau neutrino, we can build another experiment that may take physics beyond the Standard Model of elementary physics. In the near future, there's going to be a lot of even more exciting neutrino physics."

The idea for the experiment that produced the neutrino evidence came in 1994 from one of Yager's graduate students, Vittorio Paolone, who is now on the faculty of the University of Pittsburgh, and a Fermilab physicist, Byron Lundberg. The experiment was named Direct Observation of the Nu Tau, or DONUT. Paolone, who was then a research physicist at UC

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Davis, and Yager and others at Davis built a key component of the experiment in 1995-96.

Yager said that he'll be serving donuts in his UC Davis office today in celebration of the achievement.

Donuts could be consumed in many other physics labs as well; overall, 54 scientists were involved in pinning down the tau neutrino, from 21 institutions and four countries, including the United States, Japan, Greece and South Korea.

Physicist Wolfgang Pauli first proposed in 1930 the existence of a neutral particle, later named "neutrino," for "little neutral one," by Enrico Fermi. Experiments since have demonstrated the existence of two species of neutrinos, the electron neutrino and the muon neutrino, and suggested the existence of a third species.

Physicist Leon Lederman, who received the Nobel Prize in 1988 for the muon neutrino discovery, along with Jack Steinberger and Melvin Schwartz, commented on the new results.

"Having participated in the research that established that there are two neutrinos, it would seem to be disconcerting to now learn that there are three. I can hear the people complaining: 'Can't these guys make up their minds?'" Lederman said. "But seriously: The direct confirmation of the tau neutrino is an important and long-awaited result. Important because there is a huge effort underway to study the connections among neutrinos, and long awaited because the tau lepton (partner of the tau neutrino) was discovered 25 years ago, and it is high time the other shoe was dropped."

A news release from Fermilab calls tau neutrinos the loners of the particle world. "They sail through space, through walls, through planets, never even slowing down. Every minute, trillions of solar neutrinos flit through our bodies at nearly the speed of light. When they have passed through, they leave no trace, because they almost never interact with other particles."

Those characteristics make the tau neutrino particularly hard to study. Paolone and his colleagues created a situation in 1997, using Fermilab's Tevatron particle accelerator, in which a beam of neutrinos was fired at a sandwich of iron plates and layers of emulsion. Their hope was that out of trillions of tau neutrinos in the beam, one would interact with an iron nucleus and produce a tau lepton, which would leave a distinctive one-millimeter signature, or track, in the emulsion. That track would be their direct evidence of the existence of the tau neutrino.

Tomorrow, after three years of painstaking analysis of hundreds of candidate tracks, they will report that they have identified four tau lepton tracks.

"The tau lepton leaves a track in the layers of emulsion, just as light leaves a mark on photographic film, but in three dimensions," Paolone explained. "The main signature of a tau lepton is a track with a kink, indicating the decay of the tau lepton shortly after its creation."

The tau neutrino results will be officially announced tomorrow at a 4 p.m. colloquium at Fermilab, in Batavia, Ill. Next week, the collaboration will present the results at the 30th International Conference on High Energy Physics, in Osaka, Japan. A scientific publication of the results will be submitted to a major physics journal in the near future.

Fermilab is operated by Universities Research Association, Inc., for the U.S. Department of Energy. More information on the tau neutrino announcement can be found at <http://www.fnal.gov/pub/donut.html>.

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NOTE TO EDITORS: A color photograph of UC Davis physics professor Phil Yager is available by e-mail. Contact Sylvia Wright, News Service, 530-752-7704; swright(at)ucdavis.edu.

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