



# New elementary particle evidence found, 'sterile neutrino' long suspected

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## Los Alamos experiment at Fermilab explores potential 'dark matter' link, confirms earlier experiment

LOS ALAMOS, N.M., June 6, 2018—New research results have potentially identified a fourth type of neutrino, a “sterile neutrino” particle. This particle provides challenges for the Standard Model of particle physics, if found to be a valid result in future experiments. The work, conducted by a multi-institutional team at Fermi National Accelerator Laboratory (Fermilab) near Chicago, confirms results found in the 1990s in the Los Alamos Liquid Scintillator Neutrino Detector (LSND).

“This is a fascinating step forward for particle physics,” said Los Alamos National Laboratory Director Terry Wallace. “Of course, this needs to be tempered by the fact that future observations are required to really clinch this beyond any shadow of doubt. Modifications to the Standard Model, including dark matter, new particles and other interpretations of this result are still speculative. What stands with high confidence is that two experiments with completely different approaches observe the same effect.”

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### The Sterile Neutrino Discovery

Neutrinos, traditionally understood to come in three “flavors,” electron, muon and tau, have been measured by the Mini Booster Neutrino Experiment (MiniBooNE) for some 15 years. The key to the current result is the existence of more electron-flavored neutrinos than expected. Neutrinos normally oscillate between the three types, but the overpopulation of the electron-flavored ones leads to a theory that some of the muon neutrinos became sterile neutrinos for a time during the regular oscillations. The sterile neutrinos could reasonably be assumed to have transitioned into electron neutrinos in their next oscillation phase, thus explaining the higher electron numbers.

“We cannot say definitively that it’s sterile neutrinos, but we can conclusively say something fundamental is going on,” said Richard Van de Water, the Los Alamos co-lead on the project.

## This is how you do science

“Over the past 20 to 30 years, neutrino oscillations have been observed from one flavor to another,” he said. “But in the late 1990s the LSND at Los Alamos saw evidence of electron neutrinos in the beam, and if our observations were correct, a much heavier type of neutrino was also in existence. That’s where the idea of sterile neutrinos came about. So the MiniBooNE experiment, designed very differently from LSND, has shown that the results were valid. But this is how we do science—you have an effect, and you build a new experiment to test the original physics effect. This passes muster; it must be something new.”

“I’m careful about saying it’s sterile neutrinos. It could be, but it could be something else. The same effect has now been observed in two experiments, with a small chance that it is a mistake in both experiments. We still see what shouldn’t be there, and it could be even more exciting. Speculating, I like to think of this as the first hint of the dark sector, perhaps interacting through neutrinos, and this could be a way to probe dark matter and dark energy,” Van de Water said.

“These are exciting times for neutrino scientists,” said Joe Lykken, deputy director for research, [Fermilab](#). The latest results from the MiniBooNE collaboration, he said, provide even stronger motivation for the three new short-baseline neutrino experiments at Fermilab based on liquid argon technology.

The MiniBooNE detector was established by a collaborative effort at Fermilab in 2002 to search for unusual neutrino interactions. In recent years the detector has collected data to study background interactions related to the short-baseline neutrino program. About 50 scientists from 20 institutions continue to work on the analysis of data recorded by the experiment.

Neutrino research has been an ongoing effort at Los Alamos, since the 1950s research by Frederick Reines and George Cowan that earned Reines the 1995 Nobel Prize in Physics for the detection of neutrinos experimentally, after the particles had been theorized by Wolfgang Pauli in 1930.

**Publication:** [Observation of a Significant Excess of Electron-Like Events in the MiniBooNE Short-Baseline Neutrino Experiment](#), A. A. Aguilar-Arevalo, B. C. Brown, L. Bugel, G. Cheng, J. M. Conrad, R. L. Cooper, R. Dharmapalan, A. Diaz, Z. Djurcic, D. A. Finley, R. Ford, F. G. Garcia, G. T. Garvey, J. Grange, E.-C. Huang, W. Huelsnitz, C. Ignarra, R. A. Johnson, G. Karagiorgi, T. Katori, T. Kobilarcik, W. C. Louis, C. Mariani, W. Marsh, G. B. Mills, J. Mirabal, J. Monroe, C. D. Moore, J. Mousseau, P. Nienaber, J. Nowak, B. Osmanov, Z. Pavlovic, D. Perevalov, H. Ray, B. P. Roe, A. D. Russell, M. H. Shaevitz, J. Spitz, I. Stancu, R. Tayloe, R. T. Thornton, M. Tzanov, R. G. Van de Water, D. H. White, D. A. Wickremasinghe, E. D. Zimmerman

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### About Neutrinos:

- [All Things Neutrino website](#)
- [Experiment website for BooNE, MiniBooNE and MicroBooNE](#)
- [Fermilab release](#)

**Captions for images below:** *MiniBooNE Control Room - participants from Los Alamos (left to right) Gordon McGregor, Richard Van de Water, Geoffrey Mills and Bill Louis / Inside the MiniBooNE detector at Fermilab.*

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