Long-standing neutrino question resolved

11 April 2007

An announcement by scientists at the Department of Energy's Fermilab today significantly clarifies the overall picture of how neutrinos behave.

The results of the so-named MiniBooNE project resolve questions raised by observations an earlier DOE experiment – Liquid Scintillator Neutrino Detector (LSND) - in the 1990s that appeared to contradict findings of other neutrino experiments worldwide. The announcement today significantly clarifies the overall picture of how neutrinos behave.

In addition, scientists at Virginia Tech have proposed a new experiment, known as LENS (Low Energy Neutrino Spectroscopy), which will push the search for sterile neutrinos well beyond the scope of the MiniBooNE project.

"The possibility of sterile-neutrino-induced oscillation observed by LSND now seems to be ruled out," said Virginia Tech College of Science physicist Jonathan Link, who, along with 77 scientists from 16 other universities around the world, was a member of the MiniBooNE collaboration. "But there may still be sterile neutrinos with somewhat different properties."

Since the LSND result, theorists have used sterile neutrinos to solve many problems in physics from supernova explosions to the mysterious dark matter that binds galaxies together. Virginia Tech's LENS (full name here) project will push the search for mysterious sterile neutrinos even further.

Currently, three types or "flavors" of neutrinos are known to exist: electron neutrinos, muon neutrinos and tau neutrinos. In the last 10 years, several experiments—including the LSND collaboration—have shown that neutrinos can oscillate from one flavor to another and back. However, reconciling the LSND observations with the oscillation results of other neutrino experiments would have required the presence of a fourth, or "sterile" type of neutrino, with properties different from the three standard neutrinos. The existence of sterile neutrinos would throw serious doubt on the current structure of particle physics, known as the Standard Model of Particles and Forces. Because of the far-reaching consequences of this interpretation, the LSND findings cried out for independent verification.

The MiniBooNE experiment, approved in 1998, took data for the current analysis from 2002 until the end of 2005 using neutrinos produced by the Booster accelerator at the Fermilab. The experiment's goal was either to confirm or to refute the startling observations reported by the LSND collaboration, thus answering a long-standing question that has troubled the neutrino physics community for more than a decade.

The MiniBooNE collaboration used a blind-experiment technique to ensure the credibility of their analysis and results. While collecting their neutrino data, the MiniBooNE collaboration did not permit themselves access to data in the region, or "box," where they would expect to see the same signature of oscillations as LSND. When the MiniBooNE collaboration opened the box and "unblinded" its data less than three weeks ago, the telltale oscillation signature was absent.

Simply put, neutrinos are particles that originate from the center of the sun. They are one of the fundamental particles of the universe but also one of the least understood. Neutrinos differ from electrons in that they do not carry an electric charge and can pass through great distances in matter without being affected by it.

Studying neutrinos helps scientists understand about the sun, stars, and even the deep core of the Earth. It also provides the capability to detect extremely small trace amounts of radioactivity contained in samples of material, resulting in applications for homeland security, microelectronics, and space science.

For its observations, MiniBooNE relied on a

250,000-gallon tank filled with ultra pure mineral oil, clearer than water from a faucet. A layer of 1280 light-sensitive photomultiplier tubes, mounted inside the tank, detects collisions between neutrinos made by the Booster accelerator and carbon nuclei of oil molecules. Since January 2006, the MiniBooNE experiment has been collecting data using beams of antineutrinos instead of neutrinos and expects further results from these new data.

Source: Virginia Tech

APA citation: Long-standing neutrino question resolved (2007, April 11) retrieved 17 October 2021 from https://phys.org/news/2007-04-long-standing-neutrino.html