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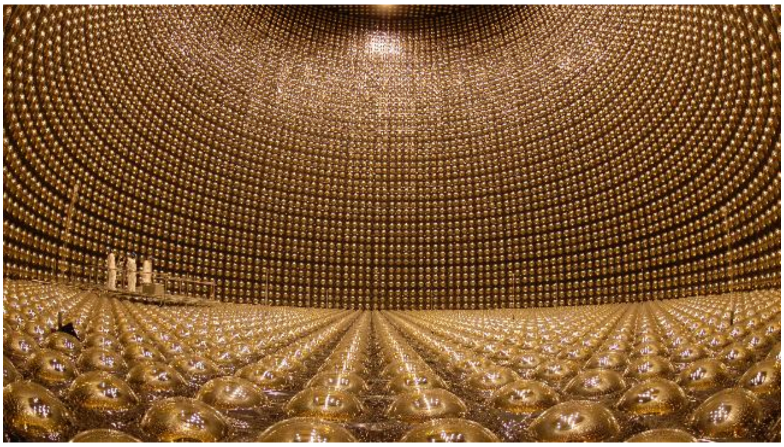
Scientists are close to knowing the energy in neutrinos and this could change standard Physics



Representational image of Kamioka neutrino Observatory

Neutrinos are subatomic particles which have no electric charge unlike the positive charge of protons and the negative charge of electrons. They hardly interact with matter and their weak nuclear force is all that allows them to interact with the core of the atom.
Understanding how neutrinos work could help us understand the building blocks of matter. But since they are hard to produce or detect, it is close to impossible to conduct research on them.
But with this week's breakthrough at Fermilab's MiniBooNE experiment conducted by the Department of Energy was able to observe muon neutrinos (a particular type of neutrinos) with exactly known energy hit at atoms in their particle accelerator. Now, scientists will no more be uncertain when testing theoretical models of neutrino interactions and neutrino oscillations.

„It is extraordinarily rare to know the energy of a neutrino and how much energy it transfers to the target atom. For neutrino-based studies of nuclei, this is the first time it has been achieved."

- Joshua Spitz, the Norman M. Leff assistant professor at the University of Michigan and co-leader of the team that made the discovery, along with Joseph Grange at Argonne National Laboratory

HOW DO SCIENTISTS LEARN MORE ABOUT NUCLEI?

To understand more about nuclei, physicists allow particles to collide with atoms to see how they scatter. If the atom is hit by a high energy particle, then the nucleus hit by the particle can break apart. This reveals information about the subatomic forces which are binding the nucleus together.

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But to be perfectly accurate, scientists needs to know the exact energy of the particle which is hitting and breaking apart the atom. When experimenting with neutrinos this hadn't been possible because of the lack of knowledge regarding their energy.

HOW DOES THE MINIBOONE EXPERIMENT WORK?

In the experiment with muon neutrinos, MiniBooNE uses a beam that comprises muon neutrinos with a range of energies. Scientists cannot 'filter' a certain type of neutrinos with a specific energy which would be allowed to hit the atom as neutrinos do not have any electric charge.

Scientists realized that some of the muon neutrinos in their experiment have an exact energy of 236 million electronvolts (MeV). These neutrinos come from the decay of kaons at rest. Kaons are a certain type of particle produced in high-energy collisions between nuclei and other particles.

Energetic kaons decay into muon neutrinos with a range of energies. The trick is thus identifying those muon neutrinos that emerge from the decay of kaons at rest. The physics laws of conservation of energy and momentum thus ensure that all muon neutrinos emerging from the kaon-at-rest decay have to have exactly the energy of 236 MeV.

„With the first observation by MiniBooNE of monoenergetic muon neutrinos from kaon decay, we can study the charged current interactions with a known probe that enable theorists to improve their cross-section models. This is important work for the future short- and long-baseline neutrino programs at Fermilab."

- said MiniBooNE co-spokesperson Richard Van De Water of Los Alamos National Laboratory, according to the official release form the website.

"We were able to extract this result because of the well-understood MiniBooNE detector and our previous careful studies of neutrino interactions over 15 years of data collection," said physics professor at Indiana University Bloomington and co-spokesperson of the MiniBooNE collaboration, Rex Tayloe.

"MicroBooNE will provide more precise measurements of this known-energy neutrino," he said. "The results will be extremely valuable for future neutrino oscillation experiments."

The MiniBooNE result was published in the April 6, 2018, issue of *Physical Review Letters.*

ABOUT THE DUNE EXPERIMENT:

To figure out the answer to what constitutes the universe, scientists from all across the world are working on the breathtaking project -- The Deep Underground Neutrino Experiment (DUNE), which is a leading-edge, international experiment for neutrino science and proton decay studies, says a release by the Fermi National Accelerator Laboratory.

DUNE includes two neutrino detectors placed in the world's most intense neutrino beam. One detector will record particle interactions near the source of the beam, at the Fermi National Accelerator Laboratory in Batavia, Illinois.

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A second, much larger detector will be installed more than a kilometer underground at the Sanford Underground Research Laboratory in Lead, South Dakota -- 1,300 kilometers downstream of the source.
These detectors will enable scientists to search for new subatomic phenomena and potentially transform our understanding of neutrinos and their role in the universe.