

# First results from RENO: Observation of the weakest neutrino transformation

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The Reactor Experiment for Neutrino Oscillations (RENO) research team announced the first result of the search for the remaining, most elusive puzzle of the neutrino transformation. They have found disappearance of neutrinos emitted from six reactors at the Yonggwang nuclear power plant in Korea, on the way to their 1.4 km distant detector. The exciting result of solving the longstanding secret provides a complete picture of neutrino transformation among three kinds of neutrinos, and opens a bright window of understanding why there is much more matter than antimatter in the Universe today.

Neutrinos are almost invisible and massless particles with no electric charge, traveling at close to the [speed of light](#) and interacting with matter so weakly. In 1998, the Super-Kamiokande detector found transformation among the [neutrinos](#) and therefore existence of their masses for the first time. Two out of three different neutrino-transformation strengths are observed to be rather large, close to 100% or 80%, but the last one is known to be less than 15%.

The RENO is the first experiment to search for the last smallest neutrino transformation, so-called "mixing angle  $\theta_{13}$ ", with two identical detectors at different distances, 290 m and 1400m, from the [reactor](#) center. The construction of both detectors was completed in February 2011 and after commissioning, the data taking began from August 2011. More than 7 months of unprecedentedly copious neutrino data revealed a quite clear signal of the neutrino transformation, with a significance of 6.3 standard deviations, as an effect of the unknown mixing angle that

physicists have been anxiously searching for. The RENO determined the new type of neutrino transformation strength to a good precision, to be 10.3%.

"This was the hardest neutrino transformation to measure, but it turns out to be rather large", says Soo-Bong Kim of Seoul National University, spokesperson of the RENO experiment. "This surprisingly large value of  $\theta_{13}$  will strongly promote the next round of neutrino experiments to find the reason for asymmetry of matter-antimatter in this universe. An exciting time ahead..."

During the power production, a nuclear reactor emits a trillion-times-billion neutrinos every second. The measurement in the detector close to the reactor predicts how many reactor neutrinos should be counted in the other detector far from the reactor if there were no neutrino transformation. Comparison with the actual measurement in the far detector can determine how much the reactor neutrinos were transformed to other neutrinos, namely the smallest mixing angle.

The RENO takes full advantage of 6 nuclear reactors with 16.5 Gigawatt of full thermal power, located at a town of Yonggwang on the west coast of Korean peninsula. The total of 16.5 ton of organic transparent and scintillating liquid mixed with 0.1% of Gadolinium can capture some of these neutrinos and emits light, which are subsequently recorded by about 350 photo sensors ("photomultipliers") of radius 25cm. The main part of the detector is then shielded by several layers of other materials in order to enhance its performance and also to protect it from natural radiation produced outside. To reduce cosmic rays resulting in substantial backgrounds, the two detectors are located at underground.

The result was submitted to the *Physical Review Letters* on April 2, 2012.

Provided by RENO Collaboration

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