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NEWS & VIEWS

A new kind of neutrino transformation was found by Daya Bay neutrino experiment

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At 14:00 Beijing time of March 8, 2012, Professor Yifang Wang, the spokesperson of International Collaboration of Daya Bay neutrino experiment, declared in Beijing that a new kind of neutrino transformation was found during Daya Bay neutrino experiment (see Fig. 1). Also, the transformation probability hereof was measured. The result showed that $\sin^2(2\theta_{13})$ was 9.2%, and the error was 1.7%. Also, as over 5 times per the standard deviation, it was determined that $\sin^2(2\theta_{13})$ was not zero.

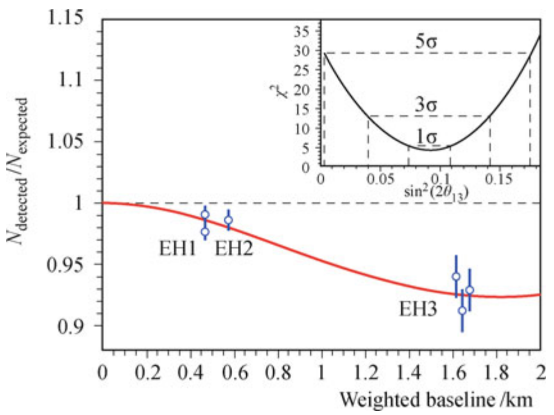

Fig. 1 Daya Bay Collaboration discovers a new kind of neutrino transformation (pic/Daya Bay Collaboration).

Neutrino is a kind of neutral elementary particle with extremely tiny quality. Here, three kinds thereof are available, i.e., electron neutrino, μ neutrino and τ neutrino, which account for one quarter of 12 kinds of currently known existing elementary particles that constitute the natural world. Meanwhile, neutrino plays a very important role in the microphysics, cosmic origin and evolution. Neutrino is provided with a unique feature that it can change from one form to another during flying. This feature is usually called neutrino transformation. In principle, mutual transformation and pair combination occur among three kinds of neutrino. Thus, three modes are available theoretically. Since 1960s, evidence has been found on two of them, which were called "Solar Neutrino Puzzle" and "Atmospheric Neutrino Puzzle". In 1998, the atmospheric neutrino transformation was officially detected in Japan's Super-Kamiokande Test. Soon afterwards, the solar neutrino transformation was verified by a plurality of tests. However, the third kind of transformation has been undetected yet. Some theories even predicted it does not exist at all (i.e., transformation probability is zero.).

Daya Bay neutrino experiment is built inside the cave nearby Daya Bay Nuclear Power Station, which is around 50 km away from the urban area of Shenzhen to the east. Closely neighboring one of the world's largest nuclear reactors: Daya Bay Nuclear Power Station and Ling'ao Nuclear Power Station. The geographical location is advantageous. Here, the natural universal line can shield the neutrino experiment because the location thereof closely neighbors the high mountains. In 2003, the scientific personnel from the institute of high energy physics proposed the overall plan for experiment and detector design, which were approved in 2006 and launched in October, 2007. 3 km long tunnel and 3 underground experiment halls are made available for the whole experiment, among which each of the two near halls are equipped with two neutrino detectors. The rear hall is equipped with 4 detectors. Thus, 8 neutrino detectors are put into use. Each detector is 5 m high, 5 m in diameter and weighs 110 tons. They are placed in a 10 m deep pool. Daya Bay experiment has been conducted under innovative design philosophy. Accordingly, it reaches the highest level in the world in terms of both design index and accuracy. Besides, the design concept and technology thereof are well developed. The experiment boasts originality in such aspects as detector modularization, mobility, use of reflection plate and Gd loaded liquid scintillator, so as to achieve or even exceed the advanced international standards. The physics data was taken from near point (Hall 1) on August 15, 2011. The physics data was taken from

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far point (Hall 3) on December 24, 2011. To obtain the physical results as soon as possible, the scientific personnel divided the experiment into two stages. The result herein was from the data at the first stage, which ranges from December 24, 2011 to February 17, 2012. During the first stage, only 6 neutrino detectors were used, among which 2 neutrino detectors were in Daya Bay near hall (Hall 1), 1 detector was in Ling'ao near hall (Hall 2) and 3 detectors were in the far hall (Hall 3) (see Fig. 2). This precise measurement will complete the understanding of the neutrino oscillation and pave the way for the future understanding of matter–antimatter asymmetry in the universe.

As the largest international cooperative project in China's basic science field, Daya Bay reactor neutrino experiment is jointly supported by the Ministry of Science and Technology, Chinese Academy of Sciences, National Natural Science Foundation of China, Guangdong Province, Shenzhen Municipality Government and China Guangdong Nuclear Power Group as well as U.S. Department of Energy and other foreign institutions. Currently, this experiment is attended by over 100 scholars from domestic R&D institutions such as Chinese Academy of Sciences' High Energy Physics Institute, Tsinghua University, Shanghai Jiaotong University, Shandong University and China Institute of Atomic Energy, as well as more than 100 scientists from the United States, Russia, The Czech Republic, and China's Hong Kong and Taiwan.

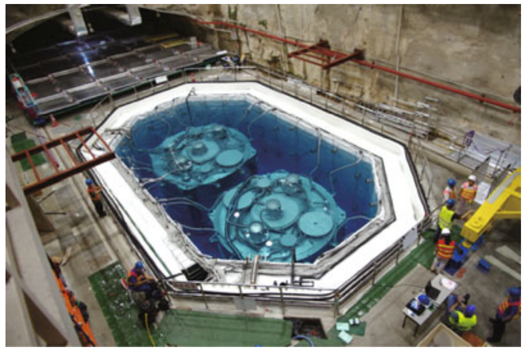

Fig. 2 The antineutrino detectors are submerged in pools of water to shield them from radioactive decays in the surrounding rock (pic/Daya Bay Collaboration).