

The study of oscillations and interactions of antineutrinos at the T2K experiment in Japan.

The phenomenon of neutrino oscillation is a manifestation of a very long distance quantum interference process. Neutrinos exist in three forms or "flavours," electron, muon and tau. The T2K experiment located in Japan is studying the mechanism of the oscillation of these particles, their ability to transform into another flavour during their propagation.

Our experiment uses an intense beam of muon type neutrinos produced by the proton accelerator research centre located at J-PARC in Tokai on the east coast of Japan. The neutrino beam, controlled and analysed at Tokai by two detectors, named INGRID and ND280, is directed toward the giant underground detector Super-Kamiokande (SK), near the west coast of Japan, at a distance of 295 km from J-PARC.

The analysis of data recorded by the SK detector shows that the number of electron neutrinos detected is much higher than expected in the absence of this new type of oscillation. The discovery of the appearance of flavour is a major breakthrough in particle physics. It opens the way to new experiments concerning the violation of CP symmetry. This is a fundamental property of physics that allows the distinction between matter and antimatter. Its violation could have played a very important role in the early moments of the formation of the universe.

With the discovery of this new type of oscillation, flavour appearance sensitive to the phenomenon of CP violation, searching for a possible asymmetry between neutrinos and their antiparticles, antineutrinos, is a major scientific challenge for the coming years. The T2K experiment expects to collect and analyse over the next few years, accurate data on the mechanism of oscillation through the combination of data using a neutrino beam and an antineutrino beam. The objective of this thesis is to participate in the acquisition and exploitation of data to obtain a first measurement of a possible leptonic CP violation.

The prospective PhD student will also have the rare opportunity in high energy physics to participate in the development of a new project, the future WAGASCI detector, as well as commissioning and analysis of initial results. The main objective of this highly original sensor in the near detector complex, is to measure electron neutrino cross sections on water at the energies of electron neutrinos detected in the water tank of the far detector.