

Study of the physics potential neutrino oscillations of the future JUNO experiment in China.

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 future experiment JUNO will study the mechanism of the oscillation of these particles, their ability to transform into another flavour during their propagation. Its main objective is to measure the neutrino mass hierarchy. The experiment will be located near the site of future Chinese nuclear reactors and study with great precision the energy spectrum of electron antineutrinos emitted through the mechanism of nuclear chain reaction.

The determination of the mass hierarchy of neutrinos, or antineutrinos, is an important step to improve the standard model of particle physics and essential to be able to undertake the design of new generations of neutrino experiments. Indeed, the discovery by the T2K experiment of flavour appearance is a major breakthrough in particle physics and paves the way for new experiments concerning the violation of CP symmetry. This is a fundamental property of physics that permits 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 and therefore represents a major scientific challenge for the coming years.

The JUNO site will be located on the coast of China near Hong Kong. The detector complex will be placed in an underground laboratory about 53 km from the reactors under construction. The overwhelming power of the two future plants of about 26 GW, corresponding to a third of the nuclear capacity in France, will produce a very high flux of neutrinos thus increasing the likelihood of detecting them. The distance of 53 km between JUNO and the reactors was selected to optimise the quantum oscillation phenomenon.

The aim of the thesis will be to participate in a general way in the construction of the JUNO detector and to produce simulations to study the physics performance of the experiment. In particular the experiment must have very low background. Therefore, our group is involved in optimizing a "veto" detector whose main objective is to detect cosmic muons still present in the underground laboratory that can generate signals similar to those antineutrinos emitted by the Chinese nuclear reactors. The measurement of the energy spectrum of the electron antineutrinos also requires a very precise model of the characteristics of the scintillation fluid comprising the central part of the detector and the performance of the light detectors lining the outer walls. The construction of JUNO is due to be completed in 2019 with the first data to be taken in 2020.