

Oscillation physics with reactor antineutrinos in JUNO

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The Jiangmen Underground Neutrino Observatory (JUNO) is a next-generation neutrino experiment in South China currently in its commissioning phase. Situated under 650 meters of rock overburden (~ 1800 meters water equivalent), JUNO's central detector consists of a 20-kton liquid scintillator target housed in a 35.4-meter-diameter acrylic sphere. It achieves remarkable 75% photocathode coverage thanks to a hybrid system of 17,612 large (20-inch) and 25,600 small (3-inch) photomultiplier tubes (PMTs). This high coverage is crucial for reaching its target and unparalleled energy resolution of 3% at 1 MeV.

JUNO's primary objective is to determine the neutrino mass ordering (NMO) using reactor antineutrinos from two nuclear power plants located 52.5 km from the detector. This baseline places JUNO at the first solar oscillation maximum (where $\Delta_{21} \simeq \frac{\pi}{2}$), enabling simultaneous sensitivity to both solar-scale (Δm_{21}^2) and atmospheric-scale (Δm_{31}^2) oscillations. Notably, JUNO is the first experiment capable of probing the NMO in the vacuum-dominated regime, thanks to the interference between two oscillation terms and without relying on matter-induced effects.

JUNO also aims for sub-percent precision on Δm_{31}^2 , Δm_{21}^2 , and $\sin^2 \theta_{12}$, surpassing current measurements by an order of magnitude. These high-precision measurements will play a central role in the global landscape of neutrino oscillations, enabling synergies with experiments using accelerator and atmospheric neutrinos. This contribution will focus on JUNO's potential in neutrino oscillation physics using reactor antineutrinos and how it will play a key role in both the precision and discovery frontiers.

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