PhD Summer School on Neutrinos

Here, There & Everywhere

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Sensitivity of the T2K Near Detector Upgrade to constrain CCQE uncertainties in the Spectral Function model

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A substantial fraction of systematic uncertainties in neutrino oscillation experiments stems from the lack of precision in modeling the nucleus when describing neutrino-nucleus interactions. Reducing these uncertainties is crucial for present and next-generation long baseline experiments. The T2K experiment is preparing for its second phase with the upgrade of its near detector starting next year. The capabilities of full polar angle acceptance, lower proton tracking threshold as well as reconstruction of neutron kinematics with this upgrade will open the door to explore new physics with unprecedented precision thanks to new observables.

To model quasi-elastic interactions, T2K uses the Benhar Spectral Function (SF) model which offers significant improvements with respect to the more commonly used Fermi gas-based models. Based on constraints from electron scattering experiments, we develop a set of parameters that can alter the occupancy of the nuclear shells and the distribution of the nucleon momentum within each shell. In addition, the contribution of short-range correlations and the effect of Pauli blocking can also be modified. With such freedoms, uncertainties on the input models can be estimated for neutrino oscillation analyses.

In this talk, we will first show how this parameterisation can improve the SF model agreement with available cross section measurements of the muon momentum and direction as well as the transverse momentum imbalance from T2K and MINERvA. Then we will present the sensitivity of the upgraded T2K near detector to these parameters for the statistics expected during this second phase of T2K.

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