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Understanding the Quasi-Elastic Neutrino Energy Reconstruction.

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In neutrino oscillation experiments, heavy nuclear targets are used to increase the number of neutrino interactions and improve statistical accuracy, but this introduces systematic uncertainties due to the complex nuclear environment. The interaction of neutrinos with nuclear targets results in an imprecise neutrino energy reconstruction and cross-sectional uncertainties, which affect the measurement of oscillation parameters. Therefore, understanding the neutrino-nucleus interaction and accurately reconstructing the neutrino energy are crucial for the precise measurement of oscillation parameters. In this work, we studied these uncertainties in the Quasi-elastic (QE) interactions by analyzing events with one proton, zero pions, and multiple neutrons for DUNE and MicroBooNE experiments. Using these specific interactions, we applied the kinematic methods for neutrino energy reconstruction. Our analysis shows that the kinematic method can achieve an energy resolution within 100 MeV, which is the essential energy resolution to study the region between the first and second oscillation maxima. The shift of around 100 MeV is observed for both the DUNE and MicroBooNE experiments, using the GENIE and NuWro Monte Carlo event generators. These results show the critical role of proper event selection for accurate neutrino energy reconstruction and the potential of kinematic methods for precision physics in neutrino experiments. In addition to this, a comparison with the calorimetric method will be presented.

Track type

Neutrino Physics

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