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Neutrino cross sections at the transition region between shallow- and deep-inelastic scattering

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Neutrino experiments at the LHC such as FASERν, SND@LHC and potentially the FPF will detect neutrinos at the energy range of a few GeV to a few TeV. In neutrino scattering, there is a transition region from the so-called shallow inelastic scattering (SIS) to deep inelastic scattering (DIS). Although the boundary of the SIS and DIS is not clearly defined, the SIS region is generally considered as 1.4 GeV $< W <$ 2 GeV and $Q^2 < 1\ \mathrm{GeV}^2$ for the final state hadronic invariant mass and the momentum transfer, respectively. One of the essential components in evaluating the neutrino cross sections is the structure functions, and their perturbative treatment is not reliable for $Q^2 < 1\ \mathrm{GeV}^2$. There are several prescriptions to construct the structure functions for such non-perturbative regime by fitting to the data, and the most well-known is the Bodek-Yang model. In this work, we use the alternative phenomenological structure functions, known as the CKMT parameterization to evaluate the neutrino DIS CC interaction cross section and compare with the Bodek-Yang prescription. We investigate the dependence on the W and Q^2 in the SIS region and find that contributions to the neutrino-nucleon cross section from the transition region are applicable for $E_\nu < 100$ GeV.

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