

RUNNING AXIAL MASS OF THE NUCLEON FOR THE NO ν A EXPERIMENT*

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Uncertainty in the expected count rates of $\nu/\bar{\nu}$ charge-current quasielastic interactions in the Far Detector of the NO ν A experiment is studied.

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One of the main sources of ambiguity in predicted neutrino event rates in the accelerator experiments at low and intermediate energies is caused by nuclear effects for the charged current quasielastic (CCQE) neutrino interactions with various detection targets. Another closely-related problem arises from the experimental uncertainty of the nucleon axial mass parameter in the dipole model of the nucleon axial form factor. The most familiar Relativistic Fermi Gas (RFG) model [1] cannot describe the up-to-date CCQE data with a unique value of M_A , although the RFG-based calculations can be somewhat fine-tuned by using a larger value of M_A in the lower energy range. It is shown in Refs. [2, 3] that disadvantages of the RFG model can be effectively compensated by introducing the energy-dependent (“running”) axial mass $M_A^{\text{run}} = M_0 (1 + E_0/E_\nu)$ with the parameters $M_0 = 1.006 \pm 0.025$ GeV and $E_0 = 0.334^{+0.058}_{-0.054}$ GeV obtained from a global fit to all available data on neutrino–nucleus CCQE scattering. This allows to phenomenologically account for the nuclear effects beyond RFG, significant at low and medium neutrino energies — exactly where the NO ν A experiment operates.

As an example, Fig. 1 shows the expected CCQE event rates in the NO ν A Far Detector (FD). Adopted set of input parameters is listed in the legends. The method used for calculation of the neutrino propagation through matter is described in Ref. [3]. It is seen that the event rates calculated with M_A^{run} are significantly higher and have a much smaller uncertainty compared to those evaluated with the conventional (constant) value of M_A .

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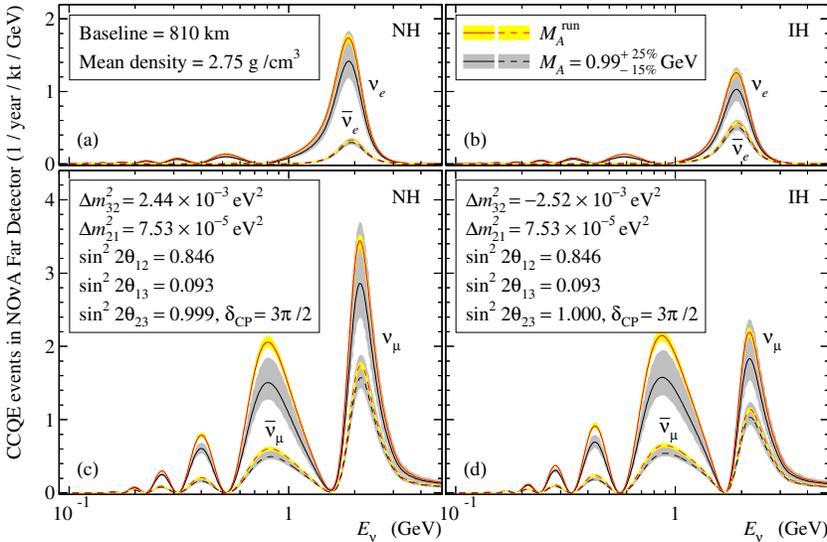


Fig. 1. Rates of the CCQE events in the NO ν A FD, induced by $\nu_{e,\mu}$ (solid curves) and $\bar{\nu}_{e,\mu}$ (dashed curves). Calculations based on the RFG model [1] are done for the normal (a), (c) and inverse (b), (d) neutrino mass hierarchies, by using the default value of M_A [4], currently accepted in the NO ν A analysis, and the running axial mass. The bands show 1σ uncertainties due to ones in the both axial mass values.

Generally, we expect that the running axial mass approach allows to significantly reduce the inherent data processing errors in the accelerator and atmospheric neutrino oscillation experiments, related to the uncertainty in the predicted (anti)neutrino–nucleus CCQE cross sections.

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