Studies of DIS models for improved accuracy in ν-A scattering

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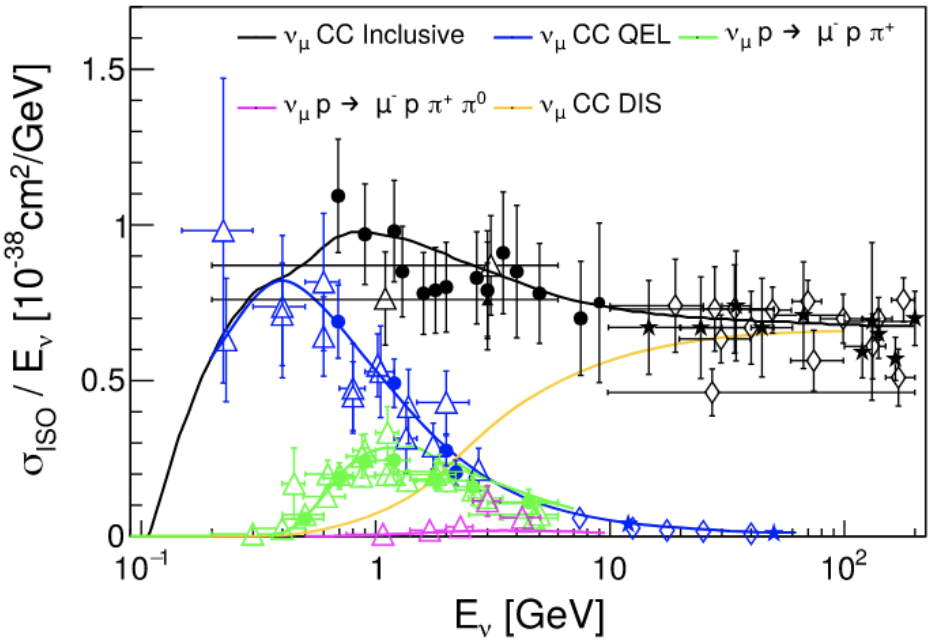
Introduction

- Uncertainties in neutrino-nucleus cross section predictions are a limiting factor in experiments like DUNE.
- We will attempt to improve theory inputs for ν-A event generators in the deep inelastic region.

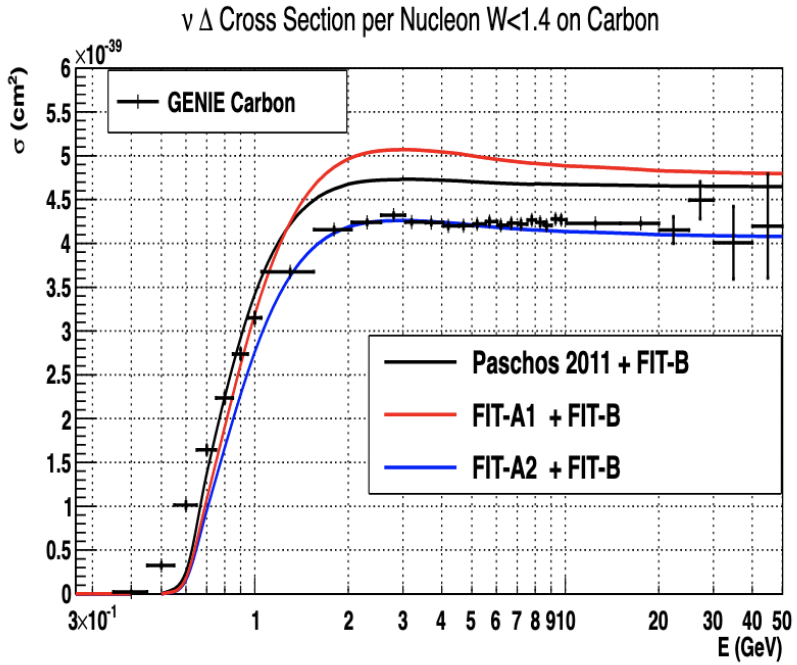
DUNE



(a) ν_μ CC cross section.

In the region where DUNE operates, there is a complicated mix of different processes, with DIS playing an important role. However, in this region the DIS contribution remains poorly controlled.

Problem



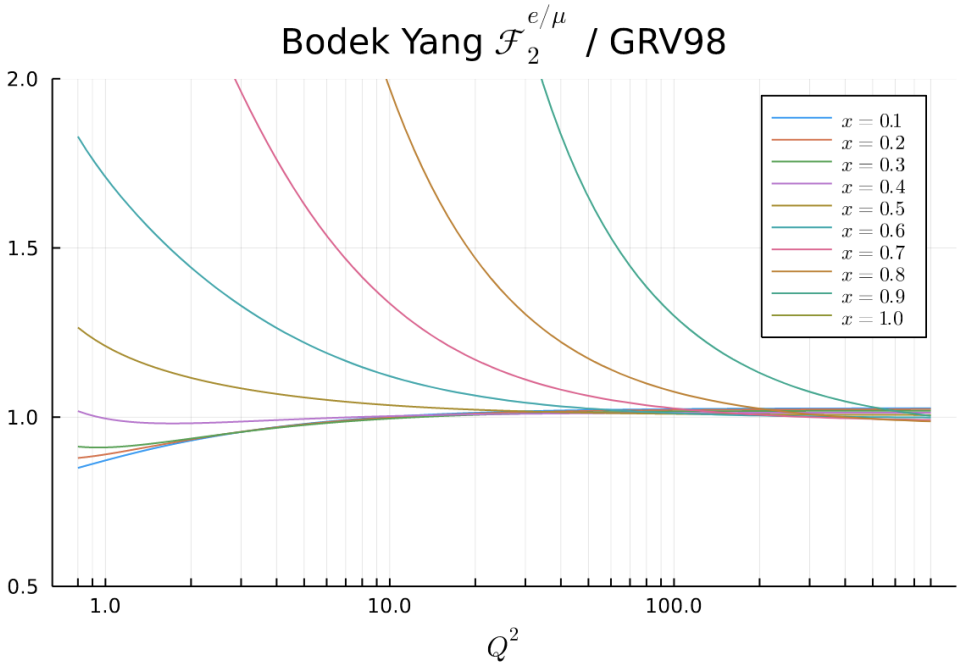
Current DIS models have not been substantially updated in decades, and rely more heavily on fitting parameters to data rather than theory. Given that the Bodek-Yang model [1] plays an important role in event generators, we must understand it better. We now have models for DIS at higher energies that use PDFs that are extracted at NNLO accuracy in QCD.

What are we doing?

- Compare the current Bodek-Yang model with a DIS model that relies on QCD.
  - Compare structure functions, cross sections based on Bodek-Yang with more systematic QCD-based calculations from (nuclear) PDFs.
- (*Possibly*) Look into additional improvements to the model, and extrapolate from the DIS region down to lower energies relevant for the future DUNE program.

Current Status

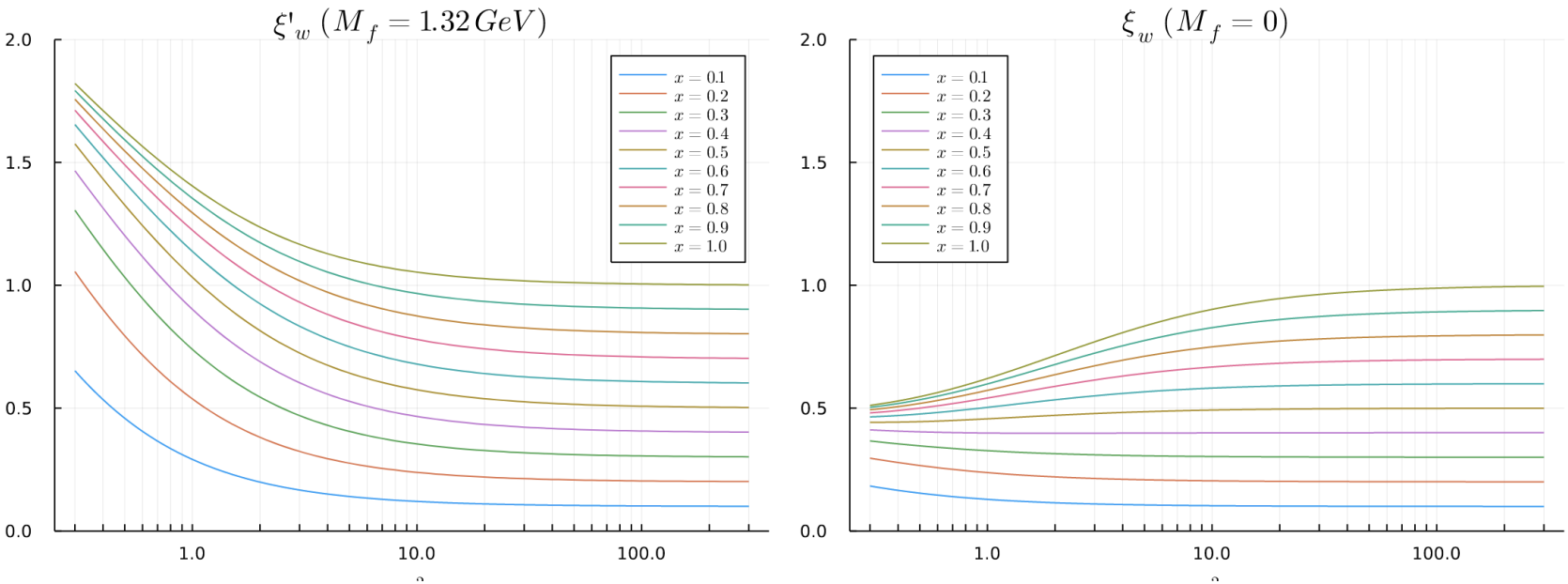
Preliminary comparison plot:



We have preliminary, flexible code which implements the Bodek-Yang DIS model, both as commonly handled in, e.g., GENIE, as well as including the 2021 axial-vector updates.

Current Status

$$\xi_w = \frac{Q^2 + M_f^2 + B}{M\nu(1 + \sqrt{1 + Q^2/\nu^2}) + A}$$



Next Steps

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- Compare against higher-W^2 DIS data (e.g., CDHSW, CCFR) to validate the performance of the model in the pQCD regime.
- Stress test this implementation against nPDF and NLO calculations; the Bodek-Yang rescaling purports to mimic the LO $\rightarrow$ NLO correction; we are close to quantifying the uncertainty associated with this, as well as other low-Q^2 corrections.

References

A. Bodek, U.-k. Yang., and Y. Xu, "Inelastic Axial and Vector Structure Functions for Electron- and Neutrino- Nucleon Scattering 2021 Update", PoS **NuFact2021**, 080 (2022).

J. Tena-Vidal et al. (GENIE), "Neutrino-nucleon cross-section model tuning in GENIE v3", Phys. Rev. D **104**, 072009 (2021).