Implementing Spectral Function Model Into GENIE Using Wrapper-Based Infrastructure

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Neutrinos and Fermilab

Figure: ICARUS

Figure: DUNE

Figure: MicroBooNE
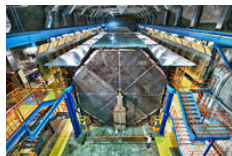

Figure: NOvA

Figure: MINERvA

Figure: MINOS

- Numerous Fermilab experiments focused upon neutrinos research.
- However, we will focus on the simulation side of things.

Figures obtained from Fermilab website.

GENIE and Quasielastic Interactions

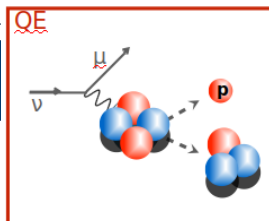Figure: GENIE neutrino event generator.

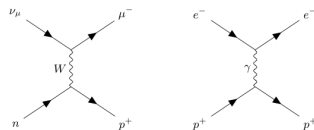Figure: Neutrino-nucleus quasielastic scattering interaction.

Figure: Feynman diagrams show similarity for the charged current quasi-elastic neutrino (left) and quasi- elastic electron (right) scattering processes. (Credit: K. Ewart, J. Ellis, M. Allen)

- GENIE event generator: Used for Fermilab neutrino simulations.
- GENIE's quasielastic neutrino scattering models need to improve.
- Better models for quasielastic electron scattering extrapolate better models for quasielastic neutrino scattering (related physics).

Figures obtained from (left) GENIE website and (middle, right) Dr. Minerba Betancourt, respectively.
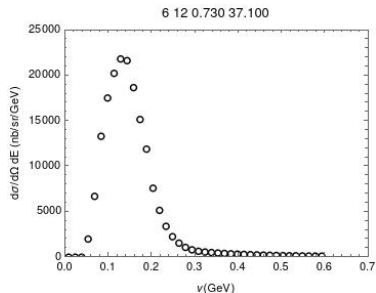
Spectral Function Nuclear Model

Figure: Carbon-12 quasielastic electron scattering simulation, incident electron energy is 0.730 GeV, scattering angle is 37.1°.
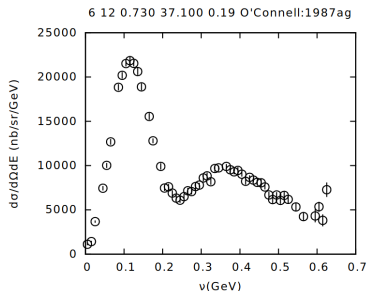

Figure: Experimental data "version" from: (http://discovery. phys.virginia.edu/research/groups/qes-archive/index.html)

- Dr. Noemi Rocco's nuclear model, called spectral function, has better quasielastic electron scattering data agreement.
- Thus, this gives better quasielastic neutrino scattering models.
- Spectral Function is written in Fortran, but GENIE is in C++.

GENIE and Spectral Function Model Wrapper

- As such, this project's goal is to create an implementation of wrappers to interface the spectral function model (in Fortran) with the GENIE neutrino event generator (in C++).
- This will capitalize upon the existing extensive framework of GENIE, along with the improved accuracy of the spectral function's quasielastic data agreement, unifying both frameworks.
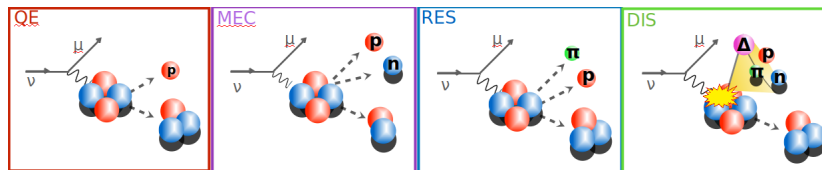- Future: Include other improved reaction mechanism models.

Figure: Quasielastic interaction (leftmost) and other reaction mechanisms.

Figures obtained from Dr. Noemi Rocco.