Contribution ID: **136** Type: **Parallel**

Isolating Neutrino Cross Section Uncertainties with Theory

Thursday, 31 May 2018 18:10 (20 minutes)

Studies of neutrino oscillation physics lay at the intersection point of nucleon physics, nuclear physics, and experimental physics. Computations of the neutrino scattering cross sections that are necessary to understand oscillation physics require nuclear models with weak matrix elements of the nucleon. These matrix elements are difficult to probe experimentally or can be subject to substantial systematic corrections, and common model parametrizations significantly underestimate the uncertainties of the pertinent nucleon amplitudes. Furthermore, these amplitudes are often determined from scattering of neutrinos with nuclei, which entangles the uncertainties from nucleon amplitudes and nuclear model assumptions. In this talk, I will highlight recent work to dissect and understand the uncertainties from neutrino scattering with free nucleons, with the intention of providing realistic estimates of the nucleon amplitude uncertainties. These studies include use of the model-independent z-expansion parametrization to reanalyze deuterium bubble chamber data as well as preliminary first-principles calculations from lattice QCD. With robust estimates of the uncertainty, it will then be possible to unambiguously isolate the discrepancies with experimental data that come from nucleon amplitudes and nuclear models.

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Session Classification: Neutrino Masses and Neutrino Mixing

Track Classification: NMNM