Neutrino-Nucleus interactions and multi-nucleon effects.

Next generation neutrino oscillation experiments aim to extract one of the most fundamental parameters of the standard model of particle physics: the magnitude of the CP-violating phase in the leptonic sector. A large CP-violating phase could explain the matter–anti-matter asymmetry in the universe, with some models claiming that the discovery of a small phase would necessarily indicate the existence of physics beyond the standard model. The CP-violating phase is related to the difference between neutrino and anti-neutrino oscillations, where the latter are extracted experimentally from measuring (anti) neutrino-nucleus scattering measurement.

The extraction of the CP-violating phase requires these measurements to be done to better than few percent, over a wide range of neutrino energies. This requires a full understanding of the contribution of multi-nucleon effects on the measured cross-sections. Specifically, such multi-nucleon effects could lead to a non-trivial 'artificial' difference between the neutrino and anti-neutrino interactions that need to be quantified before one can extract the CP-violating phase. In the coming years, the MicroBooNE experiment at Fermilab will allow measuring low energy neutrino-nucleus cross sections in a wide variety of reaction channels. The improved final-state detection capabilities of the MicroBooNE experiment will allow for a first extraction of semi-inclusive and exclusive cross-section, which are critical for achieving a complete understanding of the neutrino-nucleus interactions, at the precision required to extract the CP-violating phase from future experiments.

As an Intensity Frontier Fellow I plan to analyze neutrino-nucleus scattering data, with emphasis on multi-nucleon effects by incorporating initial-state short-range correlations in neutrino-nucleus Monte Carlo codes and study their effects on (anti) neutrino energy reconstruction and total cross-sections.