Problems in Neutrino-Nucleus Scattering ($0.3<E_\nu<3.0$ GeV)

Recently published differential cross sections for $\nu_\mu+^{12}C$ charged current quasi-elastic scattering (CCQE) by the MiniBooNE collaboration are ~40% larger than typical impulse approximations calculations of CCQE. Some of the difference is do to poor communication between the theorists and experimentalists as to the definition of CCQE scattering. More fundamentally the observed cross section appears to be larger than the CCQE on 6 free neutrons. A prominent theorist in the field claims "*a new paradigm.....will be required".* There have been several recent publications failing to account for the observed cross sections.

In order to proceed with analysis of their data in the search for $\nu_\mu \rightarrow \nu_e$ oscillation the MiniBooNE collaboration fit the $\nu_\mu+^{12}C$ CCQE yield by employing $M_A=1.35$ GeV for the nucleon axial vector form factor. The world average for M_A is 1.02 ± 0.02GeV. There exits an RPA calculation that finds good agreement with the measured yield using $M_A=1.03$ GeV but does not reproduce the measured angular distribution.

Some earlier work on electron quasi-elastic scattering demonstrated that short-range correlations plus two-body currents greatly enhance the nuclear transverse vector response in agreement with experiment. Extending this approach to neutrino CCQE is most attractive. A direct consequence of the approach is that the assigned neutrino energy becomes more uncertain than previously realized. The current state of affairs in this active area will be presented noting improvements needed in theory and experiment for neutrino–nucleus scattering for $0.3<E_\nu<3.0$ GeV.