Nuclear Models for Inclusive Lepton-Nucleus Scattering in the Quasi-Elastic Region and Beyond

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High-precision measurements in neutrino oscillation experiments require a very accurate description of the lepton-nucleus scattering process. Several cross-section schemes are available, but important discrepancies are still present between different model predictions. Even the theoretical description of the charged current quasi-elastic process, a key channel for incident neutrino flavour identification, is affected by uncertainties, and it is strongly dependent on the adopted nuclear model. Moreover the incomplete knowledge of the incident neutrino energy leads to a very complex vertex reconstruction, reducing the measurement accuracy. An effect of this uncertainty is that the integration over the incident neutrino flux makes harder a detailed analysis of the adopted scheme, hiding some effects and reducing models differences. For the quasi-elastic channel, dominated by one-particle–one-hole excitations, an overview over several nuclear models – specifically Relativistic Fermi Gas (RFG), Su-perScaling Approach (SUSA), Spectral Function (SF), Hartree-Fock (HF) and Random Phase Approximation (RPA) – is presented and compared with data for electron–nucleus scattering, a very important process for testing theoretical models validity, highlighting the specific features of each approach. Furthermore an ongoing microscopic calculation of the two-particle–two-hole excitations contribution to the electromagnetic response, and its extension to the weak channel, is presented, and some preliminary results are shown.