Two-Nucleon Emission in Quasielastic Neutrino and Electron Scattering induced by short-range correlations

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We present predictions for the inclusive two-nucleon emission cross section induced by neutrinos and electrons including both short- range correlations (SRC) and meson-exchange currents (MEC). The SRC are described by a phenomenological model based on two key premises. Firstly, we assume that the properties of scaling in the right-hand side of the quasielastic peak, are dominated by the high-momentum components of the nuclear wave function. Secondly, we describe the emission of two correlated nucleons within the framework of the Independent Pair Approximation, based on the Bethe-Goldstone equation in nuclear matter, which generates a two-body correlation current [1].

Using this correlation current, we show that the hadronic tensor for the two-particle two-hole (2p2h) process can be written as the product of the 2p2h phase space, the averaged single-nucleon hadronic tensor [2], and a correlation coefficient dependent on the momentum transfer q , for pn, pp or nn pairs. The correlation coefficient is interpreted as the average high-momentum distribution of the initial nucleon pair. It is extracted from experimental data of the (e, e') cross-section by fitting the high-energy tail (corresponding to high-momentum nucleons) of the phenomenological superscaling function of the SuSAM* model [3].

The correlated 2p2h cross-section obtained in this manner is calculated and compared with the results from the Valencia and Ghent models of neutrino and electron scattering [4,5], which include SRC calculated differently. Remarkably, our model demonstrates both qualitative and quantitative agreement with these independent and distinct theoretical models of SRC. This suggests that the assumptions made in our semi-phenomenological approach, derived from experimental data, are indeed valid.

The findings discussed previously provide a promising avenue to microscopically calculate the contribution of correlated two-nucleon emission (2p2h) to neutrino cross-sections. This can be achieved by leveraging the high-momentum wave function and solving the Bethe-Goldstone equation using the Granada 2013 realistic potential, which enables analytical solutions within a partial-wave expansion. Such an approach holds great potential for studying the impact of Short-Range Correlations (SRC) on the analysis of neutrino data.

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