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Neutrinos as nuclear microscopes: studying short-range nucleon-nucleon correlations in argon nuclei

The current generation of neutrino beams and short-baseline detectors has the capability to generate thousands of interactions per day, and these rates should only increase with the next generation. These high rates will allow neutrinos to be used as probes for nuclear physics. In particular, the study of short-range nucleon-nucleon correlations (SRC) was already shown to be feasible on smaller detectors. In large nuclei, nucleons tend to form pairs, particularly protons pairing with neutrons due to their different electric charges but similar behavior under the strong nuclear force. This pairing is energetically favorable because it lowers the total energy of the nucleus. Using a muon neutrino beam, the interaction results in a muon and two protons in the final state, ejected back-to-back, where one of the protons results from a charged-current quasi-elastic interaction (CCQE). Another possibility for the same event topology occurs when a two-body meson-exchange current (MEC) produces one of the emerging protons. LArTPC technology enables easy identification of these events. In this work, we review the literature for the methodology, latest results, and implications of such studies in preparation for future experiments.

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