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Deuteron quasi-free scattering reactions: a tool to probe nucleon-nucleon short-range correlations in atomic nuclei

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The experimental evidence points to the existence, at short distances, of strongly correlated neutron-proton pairs much like they are in the deuteron or in free scattering processes. As it moves through the nuclear medium, a “bare” nucleon in the presence of the nucleon-nucleon interaction becomes “dressed” in a quasi-deuteron cloud [1], about 20% of the time. A phenomenological analysis of the quenching of spectroscopic factors [2] and recent data from Jefferson Lab [3] point to an isospin dependence of the independent-particle model content in a dressed nucleon. It is expected that this dependence should also be reflected in the dressed amplitude and thus, in the virtual quasi-deuteron content in the ground state.

Following from the qualitative arguments above, quasi-free scattering (QFS) of deuterons for which the fast reaction time t_R becomes comparable to the time scale of the virtual excitations, $t_R \sim \hbar/\Delta E$, could offer a sensitive probe to examine these concepts.

In this contribution, we will discuss these ideas within a single-j approximation and put forward an experimental case that can serve as a template to test the above conjecture, i.e., measuring the (p,pd) QFS cross-section for knocking out a deuteron in $^{10,14,16}\text{C}$ relative to ^{12}C as an additional tool to probe short-range correlations and their isospin dependency.

[1] K. Brueckner, in Proceedings of the Rutherford Jubilee Int. Conf. Manchester 1961 (Heywood & Company LTD, London, 1961)

[2] S. Paschalis, M. Petri, A. O. Macchiavelli, O. Hen, and E. Piasetzky, Physics Letters B 800 (2020) 135110

[3] M. Duer, et al., Nature 560 (2018) 617

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Collaboration

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