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Core-valence absorption in breakup reactions: a source of binding-energy asymmetry in nucleon removal observables?

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Nucleon removal reactions at intermediate energies have proven to be a powerful tool to extract spectroscopic information from atomic nuclei. Despite their extensive use, there remain some open questions in their description. In particular since the early 2000s, a trend was noticed in which cross sections for nucleon knockout with heavy targets was found to be significantly overestimated for the removal of deeply-bound nucleons in asymmetric nuclei, while the removal of the weakly-bound species in these same nuclei did not present such an overestimation [1]. The fact that this trend has not been observed in transfer or knockout reactions with proton targets (p, pN) urges for the reevaluation of the description for these reactions [2].
An effect that is usually left out of the description of nucleon knockout reactions that could, at least partially, explain this trend is the absorption due to the interaction between the removed nucleon and the residual nucleus (core) after the breakup of the projectile. Since nucleon and core are left in a state of medium or high relative energy, their interaction can lead to the destruction of the core and a subsequent reduction of the cross section. This effect would naturally be more intense in the removal of more deeply-bound nucleons, which interact more strongly with the core.
As a first step to assess the importance of this effect, in this contribution we study it in nucleon elastic breakup reactions, in which both nucleon and residual core are detected after the collision. We extend the usual description via Continuum-Discretized Coupled-Channels (CDCC) [3] to include the absorption between nucleon and core through an expansion in the eigenstates of a complex potential which describes this absorption, correcting for their non-orthogonality through the use of a biorhogonal basis [4]. This extended CDCC formalism is then applied to neutron breakup of 11 Be and 41 Ca on 12 C targets at energies of 70 MeV/A. We find a significant reduction for the more deeply-bound neutron in 41 Ca and only a moderate one for 11 Be, which is similar to the reduction factors found in nucleon knockout reactions.

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Topic

Theory

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