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Exploring nonlocal potentials in few-body reactions

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The dynamics of quantum few- and many-body systems is often modeled with local interaction models, mainly due to simplicity, though more microscopic or fundamental approaches yield nonlocal interactions. For few-cluster nuclear reactions the interactions usually are given in the local form of real binding and complex optical potentials. We made a two-fold extension of that standard dynamics by developing a new nonlocal form of binding and optical potentials and simultaneously including the excitation of the nuclear core. Exact three-body Faddeev-type equations in momentum-space are solved for the description of nucleon transfer reactions (d,p) and (p,d) and deuteron inelastic scattering(d,d'). Example results for 10Be and 24Mg nuclei demonstrate a good reproduction of the experimental data and an improved consistency between the two-body (elastic and inelastic nucleon-nucleus scattering) and three-body description [1].

A different application of the nonlocality is presented in the context of local strongly repulsive interatomic potentials such as those between 4He atoms. Making a gradual extension of the original potential into a nonlocal form it becomes more smooth enabling to achieve well converged solutions of three- and four-body bound-state or scattering equations. An extrapolation back to the original potential yields the desired results such as the dimer-dimer scattering length or tetramer binding energies [2].

1. A. Deltuva, D. Jurčiukonis, Physics Letters B 840, 137867 (2023).
2. A. Deltuva, Phys. Rev. A 105, 043310 (2022).

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