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Interplay of different reaction channels in nuclear direct reactions with halo nuclei

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Direct reactions of weakly-bound nuclei involve the interplay of different channels: elastic and inelastic scattering, transfer, and breakup. An effective theoretical description of such processes has to take into account the continuum [1]. Time-dependent approaches are often used to disentangle the reaction mechanism [2-3], so in Ref. [4] a simple model, that assumes semiclassical relative motion and neglects angular coordinates, was used to understand how the continuum impacts on direct reactions with one-neutron halo nuclei. In particular, a coupled-channels solution involving different continuum configurations was compared to the numerical solution of the time dependent Schrödinger equation (TDSE). The use of sets of continuum states which are sensible to the phase shift induced by only one nucleus was found not to be very accurate in the case of dominant breakup channel. Therefore, we have extended this simple time-dependent framework to include a two center "molecular"description of the continuum [5]. This consists of a set of dicretized states that reflects the phase shift induced by both nuclei involved in the process and varies with the internuclear distance [6-8]. This constitutes an improvement respect to the previous technique, not only for the good agreement with the TDSE, but also because we are able to follow the interplay of the reaction channels at each moment, thanks to the unitarity of the time-evolution operator throughout the entire process. We will report on the good outcomes of our calculations which push our investigation towards the refinement of the molecular continuum basis. We are currently working on the extension of this model to the three-dimensional space and full quantum mechanical description of the dynamics.

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Topic

Theory

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