The effects of core excitation in the breakup of exotic nuclei

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The exciting era introduced by the new radioactive beam facilities worldwide has pushed nuclear reaction theory to its limits of applicability [1]. Although significant progress has been achieved over the last decade, it is clear that nuclear reaction models are still lagging behind given the detail and quality of some coincidence measurements now available [2,3,4]. When considering breakup of loosely bound core+N systems, it is typical to describe the reaction process within a three body model (i.e. [5]). For breakup reactions, it is widely accepted that final state interactions need to be included in the description. In addition, it is generally necessary to calculate both nuclear and Coulomb effects on the same footing, and allow for nuclear-Coulomb interference. In most cases, perturbative methods are inadequate, as continuum-continuum effects become important [6]. Despite the good progress in modelling breakup of loosely bound nuclei of the type core+N, there are still some open questions [7].

One important approximation in these breakup models, is that the core is kept inert through the reaction process. Ideally one would like to have a microscopic description of scattering states of the projectile many-body system. Such a theory is well beyond computational capabilities, so one step towards that goal is to include core excitation.

It is reasonable to expect that if the energy necessary to excite the core is small, there will be dynamical core excitation during the reaction, through the interaction with the target. When the loosely bound projectile cannot be described as a single particle state, core excited components may well exist in the initial state of the projectile. Models that take into account core excitation during breakup processes [8,9] have either neglected interference between the various projectile components or made an eikonal approximation of the reaction. Here we introduce a new method: eXtended Continuum Discretized Coupled Channel method [5]. XCDCC incorporates in a consistent way, core excitation in the bound and scattering states of the projectile (fully coupled), as well as dynamical excitation of the core as it interacts with the target.

The method XCDCC is applied to a number of reactions where data exists, such as the breakup of ^{11}Be and ^{17}C on ^{9}Be [2,3]. Results show that the experimental spectroscopic factors, defined as ratios of the cross sections to specific states of the core to the total cross sections, do not translate directly into the spectroscopic factors of the ground state of the projectile [10].

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