Three-body observables for the low energy breakup of dripline nuclei

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Breakup reactions are frequently used to probe properties of nuclei at the edge of stability, considering their propensity for falling apart, arising from very low binding energies. From a theoretical point of view, these reactions become particularly challenging at low energies. Then, most approximations are not suitable, and a rich interplay of multistep processes, multipolarity mixing and nuclear-Coulomb interference, are present. The new generation ISOL facilities reflect the need for a solid theoretical description of low energy breakup reactions.

The great technological improvements on radioactive beams and detection systems, offering much better statistics, allow for detailed exclusive/coincidence measurements where before only integrated observables were possible to obtain. Theoretically, it is essential that the full kinematics is incorporated in the calculation and that observables for each specific experimental setup can be constructed.

In this talk, we review the Continuum Discretised Coupled Channels (CDCC) method for calculating the breakup of loosely bound projectiles $a = b + x$, where the $b + x$ continuum is explicitly included [1]. As an application, we discuss in detail the results for the breakup of ^{8}B on ^{58}Ni at 26 MeV, measured at the Notre Dame Laboratory [2-3].

The Coulomb Dissociation process has been suggested as providing an indirect measurement of low energy direct capture reactions with astrophysical interest. The Notre Dame ^{8}B breakup experiment was initially designed to determine the relative strength of the E2 component in the Coulomb Dissociation process, an important ingredient that has generated some controversy in the community [4]. The DWBA calculations for this reaction [5] predicted a very large nuclear contribution for the ^{8}B* centre of mass (c.o.m.) cross section, an effect that was already present for impact parameters as large as 20 fm. The first CDCC results for this reaction [6] found that the ^{8}B angular distribution was extremely sensitive in particular to the continuum-continuum couplings. A strong multipole nuclear-Coulomb interference was evident in those results.

From the CDCC two-body scattering amplitude it is possible to construct the triple differential cross sections (such as $d^3\sigma/d\Omega_b d\Omega_x dE_b$) with full three-body kinematics, necessary to describe the inclusive measurements in [2-3]. These observables contain more information of the physical process than the integrated c.o.m. angular cross sections reported in [6]. Also, the CDCC model space has to be larger in order to obtain stable results. We show that the three-body observables display even more clearly the importance of higher order effects present in the low energy breakup of loosely bound projectiles.

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