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Decomposition of the fusion cross section in breakup reactions

The nuclear fusion cross section has been a quantity of interest since the advent of nuclear physics [1]. Its dependence on the combination of projectile and target, as well as incident energy, has been studied in great detail. More recently, interest has turned to the effects on the cross section of the breakup of weakly bound projectiles, which brings the possibility of incomplete fusion, where only a part of the projectile fuses with the target [2-5].

Two recent papers have performed a fairly thorough phenomenological analysis of the various contributions to the complete and incomplete fusion cross sections [6,7]. Using the reaction formalism of Ichimura, Austern and Vincent [8,9] and excluding the effects of inelastic excitation, we confirm the basic characteristics of their analysis. When taking into account the breakup of a weakly bound projectile into two fragments, the reaction cross section can be decomposed into a breakup cross section, two incomplete fusion cross sections, in which one or the other fragment fuses with the target, and a complete fusion cross section. The complete fusion cross section, in turn, can be decomposed into a cross section for fusion of the complete projectile with the target, as well as two cross sections describing the ordered sequential fusion of the two fragments with the target. Here, we analyze the energy and target dependence of these cross sections for the simple case of deuteron-induced reactions [10,11]. In closing, we briefly discuss how the formalism could be extended to treat three-body projectile breakup reactions, in particular, the case two-neutron halo nuclei [12].

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Topic

Theory

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