Reaction dynamics for fusion of weakly bound nuclei

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Because of the recent availability of radioactive beams, subbarrier fusion of weakly bound nuclei has attracted much interests in the past few years. These nuclei often exhibit characteristic features such as a density distribution extending to large radii, an associated low-lying dipole mode, and a low energy threshold for breakup. Those features may dramatically affect fusion and other reaction processes in a non-trivial way.

In this talk, we will discuss several open problems of fusion reactions induced by weakly bound nuclei. These include i) the separation of complete and incomplete fusion cross sections, and ii) combined effects of breakup and transfer on barrier penetration.

The effect of breakup on subbarrier fusion was discussed in Ref. [1] using the coupled-channels framework. There, we have demonstrated that fusion cross sections are determined by the competition of two mechanisms, i.e., dynamical modulation of fusion barrier and flux loss due to the breakup couplings (the real and imaginary parts of the dynamical polarization potential, respectively), and their net effect differs depending on the bombarding energy. Namely, the *complete* fusion cross sections are enhanced at energies below the barrier, while they are hindered above the Coulomb barrier, compared with cross sections for a tightly bound system. In Ref. [1], we defined the complete fusion as absorptions from bound state channels while the incomplete fusion as those from continuum state channels in the projectile. In reality, however, there is a contribution from breakup followed by complete fusion, and these definitions only provide the lower limit of complete fusion cross sections. We will present results of a classical three-body trajectory calculation, which fully takes into account the kinematical motion of breakup fragments after breakup takes place, and show that this contribution may play an important role [2].

Compared with the breakup effects, a discussion on the effect of transfer process on subbarrier fusion of weakly bound nuclei has yet been scarce. For a weakly bound system, an important transfer channel would have a positive transfer Q value, which may lead to a reduction of fusion cross sections [3]. We will discuss the combined effects of breakup and transfer by using a simple one dimensional three-body model, and demonstrate their influence on fusion cross sections. A comparison with a time-dependent wave packet approach [4] will also be made.

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