Theory of complete and incomplete fusion for weakly bound systems

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Collisions of weakly bound projectiles have attracted great interest over the last few decades. The low breakup threshold of the projectile plays an important role in the reaction dynamics, affecting strongly the fusion channel. Besides the ordinary fusion process, where the whole projectile fuses with the target (CF), there is the so-called incomplete fusion (ICF). In this case, the projectile breaks up into fragments as it approaches the target, and then one fragment is captured while the other survives the collision.

Most experiments can only determine the total fusion cross section (TF), which is the sum of the cross sections for the CF and ICF processes. However, for a few particular projectile-target combinations, it was possible to measure individual cross sections for the CF and ICF processes. To make predictions for the CF and ICF cross sections is also a great challenge to theorists, and several attempts have been made. Many of them are based on classical [1] or semiclassical [3] methods, which cannot properly handle important quantum mechanical effects. This problem is avoided in some quantum mechanical models based on the continuum discretized coupled channel (CDCC) method. However, these quantum mechanical calculations have some limitation. Some can only determine the TF cross section, some can give individual CF and ICF cross sections but are not valid when the projectile breaks up into fragments of comparable masses.

In this seminar I will review the approaches until recently available in the literature, and present a new quantum mechanical method to evaluate individual CF and ICF cross sections [4,5,6]. This method can be used to any weakly

bound projectile and, in addition, it distinguishes the direct and sequential contributions to the CF cross section. A few applications will be presented.

References

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