Fusion hindrance for asymmetric systems at deep sub-barrier energies

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The phenomenon of fusion hindrance, observed initially in symmetric systems involving medium-heavy nuclei at deep sub-barrier energies, has inspired current activities related to challenging low cross-section measurements [1, 2]. Theoretical models suggested to explain this behavior have different physical bases [3, 4]. The sudden model proposed by Mišicu [4] takes into account the nuclear incompressibility when the two nuclei overlap by including a repulsive core to density folded potential. In the model proposed by Ichikawa et al. [3] based on an adiabatic picture, a damping factor is imposed on the coupling strength as a function of the inter-nuclear distance to take into account a gradual change from the sudden to the adiabatic case. Reduction in tunneling probability as a result of Pauli exclusion principle has been studied recently using the density constrained frozen Hartree-Fock method [5]. However fusion hindrance is a generic property of heavy-ion collision below certain threshold energy in all the models. The data corresponding to asymmetric systems, presently scarce [6, 7], are important to understand the origin of the fusion hindrance and to establish the generic nature of this phenomenon.

We have recently investigated the evolution of the fusion hindrance as a function of increasing mass and charge of relatively light projectiles (both weakly bound and stable) on heavy targets [8]. A sensitive off-beam-γ-spectroscopy method to obtain the cross-section of residues from fusion, utilizing a coincidence between characteristic KX-rays and γ-rays from the daughter nuclei, has been developed for this purpose. It has been observed that the fusion hindrance gradually becomes larger in moving from lighter (6,7Li) to heavier (12C,16O) projectiles. This result has been interpreted employing the adiabatic model [3] that reveals a weak effect of the damping of coupling to collective motion for lighter projectiles as compared to that obtained for heavier projectiles. We have performed a new measurement of fusion excitation function with 11B beam on 197Au target at Pelletron-Linac facility, Mumbai to probe further the behavior of fusion hindrance observed in Ref. [8] for asymmetric systems. In this talk we will present these recent results along with data over a wide range of target-projectile combination to highlight various aspects like charge product, coupling strength, weak binding etc that can influence occurrence of fusion hindrance.

References

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