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Disentangling the role of transfer channels on fusion dynamics

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Heavy-ion fusion reaction dynamics in the vicinity of the Coulomb barrier have been an active field of investigation over the past few decades. The fusion and Multi-Nucleon Transfer (MNT) reactions are elemental for the synthesis of exotic nuclei away from the valley of stability. These studies can further be extrapolated to extremely lower energies, where the reaction dynamics can shed some light on the astrophysical significance of the heavy ion reactions in nucleosynthesis [1]. The fusion cross-sections at the sub-barrier energies are significantly enhanced as compared to one-dimensional barrier penetration model (1-D BPM) calculations. The coupling of various internal degrees of freedom with the relative motion viz. static deformation, surface vibrations, and nucleon transfer channels have been employed to explain the experimentally obtained fusion cross sections [2-4]. The unambiguous influence of multi-nucleon transfer channels on the sub-barrier fusion enhancement is still not properly understood. Further, based on the quantum tunneling concept, quasi-elastic scattering (a sum of elastic scattering, inelastic scattering, and transfer channels) serves as an alternative approach for extraction of the fusion cross section as the former is related to the reflection probability of a potential barrier while the latter is related to the penetration probability. Therefore, to address the aforementioned aspects of the heavy ion reaction dynamics, fusion, and its complementary, quasi-elastic excitation function measurements have been performed for 28Si + 116,120,124Sn systems using Recoil Mass Separator (RMS), Heavy Ion Reaction Analyzer (HIRA) at Inter University Accelerator Centre (IUAC) New Delhi, India [5]. The fusion crosssections for all three Sn isotopes are significantly enhanced over the predictions of 1-D BPM calculations. The Coupled-channels framework using CCFULL has been invoked to explain the underlying reaction mechanism [6]. The influence of Multi-nucleon transfer channels has been highlighted in the coupled-channel calculations [7]. The fusion and complementary quasi-elastic barrier distribution have also been extracted from the experimental data to reveal the identity of various channels coupled in the reaction [8]. Detailed analysis and results will be presented during the workshop.

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