Fusion suppression in ^{9}Be + ^{197}Au reaction

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Introduction

Fusion reactions involving weakly bound projectile (^{6,7}Li, ^{9,11}Be) act as an important probe to investigate the reaction dynamics around the barrier [1, 2]. Due to their unique features, *i.e.,* extended nuclear mass distribution, low breakup threshold, cluster structure (α+ x), and small binding energy. These properties reflect during the projectile-target interaction in a significant manner as experimental fusion cross sections is somewhat different than that expected from the theoretical calculations. The weakly bound projectiles may breakup into their constituents before reaching the fusion barrier. The difference between theoretical and experimental cross sections is a signature of breakup mechanism, and termed as fusion suppression. The main focus of this work is to investigate the role of entrance-channel dependence on fusion. Hence, the excitation functions of ^{9}Be + ^{197}Au system contributes to understanding of fusion suppression.

Experimental details and Data analysis

The ^{9}Be +^{197}Au experiment was performed using Pelletron Linac facility at TIFR, Mumbai, India and details given in Ref.[3]. Fig.1 shows a typical offline gamma energy spectrum obtained after irradiation at E_{lab} = 40.6 MeV. The residues were identified by their

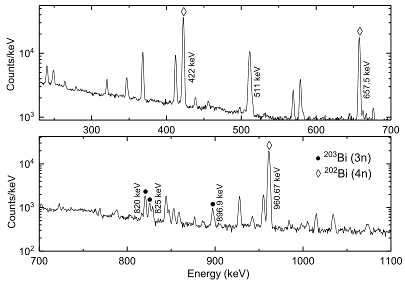

FIG. 1: Offline γ spectra measured in ^{9}Be + ^{197}Au reaction at E_{lab} = 40.6 MeV.

characteristic gamma lines, and confirmed by the half-life decay curve analysis. In the present case, ^{203}Bi (3n), ^{202}Bi (4n) are the dominant evaporation channels from the compound nucleus (^{206}Bi). The cross sections of various reaction products have been determined by their corresponding photopeak yields using standard cross section formulation [4]. In order to establish the extent to which the experimental cross sections can be interpreted in the framework of compound nucleus formation and decay, the cross sections have been analyzed using PACE2 and quantum mechanical code CCFULL [5] as presented in Fig.2. Coupled-channel calculations (CC) include the inelastic states of interacting target and projectile nuclei. Fig.2 clearly depicts that the theoretical cross section obtained from CC over predict experimental complete fusion (CF) cross section at above barrier energies. It has been found that a factor of 0.61 ($\pm$0.2) brings down the coupled-channel cal-

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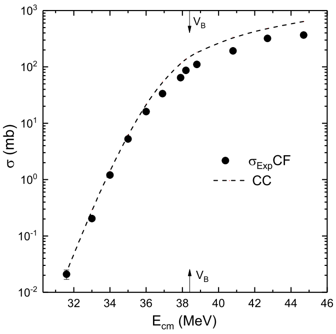

FIG. 2: Measured fusion excitation functions of ^{9}Be + ^{197}Au along with CC calculations.

culations to match experimentally measured CF excitation function reasonably well. Consequently, present analysis shows fusion suppression factor ≈ 39(±2)%.

To apprehend the reaction dynamics involving ^{9}Be projectile on different targets, reduced excitation functions of various systems have plotted in Fig.3. A common platform is required to compare the different target-projectile combinations which leads to the requirement of any of the reduction scaling procedures. The reduction process [6] used in Fig.3 is a model-independent approach which corrects the geometrical effects. However, the factors related to the physical processes to be investigated, are not taken care in this procedure. Thus, the differences in the excitation functions may be attributed to the inherent features of the interacting nuclei. The trend presented in Fig.3 suggests that the complete fusion reaction dynamics is independent of the target nuclei which lie in the same heavy mass region (A ∼ 170 - 210). It may be interpretated that at above barrier energies, suppression in the CF cross section is attributed due to the onset of the α breakup channels, and also, the enhancement of below barrier cross section contributed by the transfer processes. These processes mainly depend on the breakup threshold and the neutron separation energy of the projectile. Here, ^{9}Be is solely responsible for the fusion process which can be seen by the systematic behaviour of CF as presented in Fig.3. It is noted that the cross

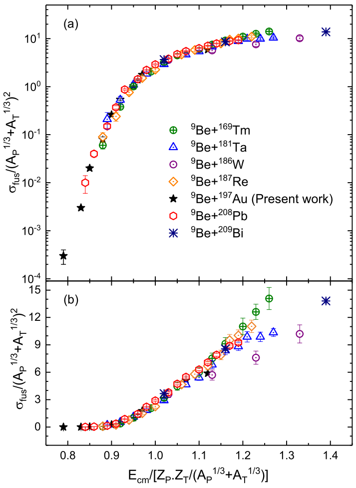

FIG. 3: Comparison of fusion excitation functions for ^{9}Be+^{197}Au (present work) along with other targets plotted on (a)log (b)linear scales.

sections for ^{9}Be + ^{197}Au system have been measured down to 18% below the barrier. Fusion suppression of the present system is consistent with all other systems involving ^{9}Be projectile on the heavy targets. The suppression factor of ^{9}Be systematics lies in a range from 25% to 40%.

Acknowledgments

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