CDCC analysis of elastic scattering angular distribution and fusion excitation function for ^{9}Be + ^{64}Zn system at around barrier energies

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Thanks to the development of Radioactive Ion Beam facilities (RIB), the reaction dynamics of exotic systems have been extensively studied in the last three decades [1-3 and refs. therein]. The effects of breakup of the loosely bound stable and radioactive nuclei on ESAD (elastic scattering angular distributions) and fusion cross-sections have become a field of much interest. From the data available in the literature, there are evidences of complete fusion suppression at energies above the Coulomb barrier due to breakup, for systems involving heavy targets, both for stable and radioactive beams. This suppression is found to be ranged from 10% to 40% which is attributed to the ICF cross-sections. In fact, the calculations are in good agreement with the experimental TF cross sections. For medium and light targets, no significant suppression has been observed so far. However, the fusion is found to be enhanced at sub barrier energies and this enhancement is more intense for radioactive nuclei. Further, the elastic scattering angular distributions are also found to have dramatic features in comparison to conventional behaviour because of the breakup of the weakly bound projectile.

Thus, to contribute to the study of dynamical effects of weakly bound projectiles, in the present work, we have analyzed the ESAD and fusion excitation function for the processes induced by loosely bound stable projectile ^{9}Be on ^{64}Zn target. We are primarily interested in the effects of breakup couplings on a medium mass target. The Continuum Discretized Coupled Channels (CDCC) calculations [4] by employing the code FRESCO [5,6] have been performed at near and above barrier energies. A two body structure (^{8}Be + n) with a breakup threshold of just 1.667MeV is assumed for the projectile ^{9}Be. Both, the non-resonant continuum and the resonant states are taken into consideration. The continuum spectrum is discretized using binning method with a maximum excitation energy of 7MeV above the breakup threshold. The neutron - target interaction potential used in the calculations is taken from the global parameterization of Koning et al. [7]. For real part of core- target nuclear potential, the Akyuz winther (AW) parameterization [8] is used whereas an imaginary part with parameters, potential depth = 50MeV, range = 0.9fm and diffuseness = 0.25fm is used. In addition, calculations without considering any couplings have also been performed with AW parameters.

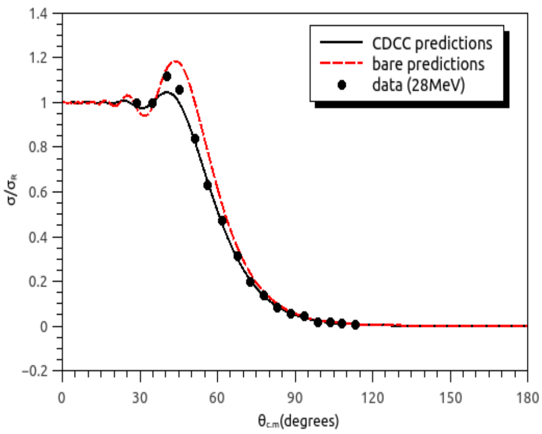

Fig. 1 (Color online) The comparison of elastic scattering data taken from ref. [9] with the predictions at 28MeV. The solid (dashed) line represents the results of calculations with (without) inclusion of breakup couplings.

The results of the calculations for ESAD are shown in figs. 1 and 2. It can be clearly seen from fig. 1 that the ESAD at above barrier

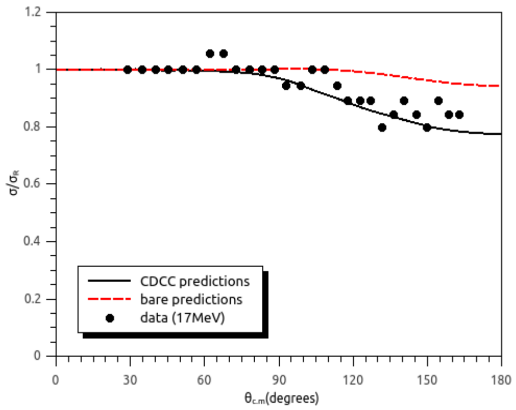

Fig. 2 (Color online) The comparison of elastic scattering data taken from ref. [9] with the predictions at 17MeV. The solid (dashed) line represents the results of calculations with (without) inclusion of breakup couplings.

energy is reproduced very well when breakup couplings are taken into account. The results of the bare calculations follow the normal Fresnel pattern but a minor fall in interference peak along with some reductions at higher angles is observed in data with respect to these results which is accounted well by CDCC predictions. The reduction obtained in scattering cross sections is not as pronounced as obtained for heavy targets.

For lower incident energy, (see fig. 2), the scattering distribution with a changed shape is obtained and none of the predictions has reproduced the data very well.

The fusion excitation function for the system is shown in fig. 3. Unlike heavy targets [10] where CDCC predictions have shown a major enhancement with respect to TF data, here the results of CDCC calculations reproduce the TF data well at above barrier energies. Further, the results of bare calculations underestimate the data for all the energies except for the near barrier energies although the results of the same calculations for ESAD have produced reasonable results at higher energies. Now as for ^{9}Be + ^{64}Zn , only TF data have been measured, nothing can be said about CF suppression because of breakup couplings.

In nut shell, the CDCC calculations for elastic scattering angular distributions and fusion excitation functions have been performed for ^{9}Be + ^{64}Zn system at around barrier energies. A reasonably well agreement between the CDCC predictions have been obtained for scattering and fusion data at near and above barrier energies.

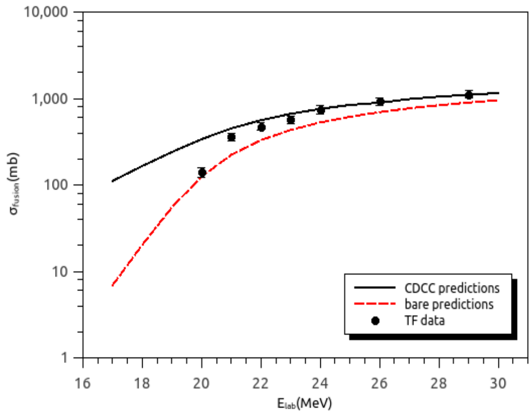

Fig. 3 (Color online) The calculated fusion excitation functions for the system ^{9}Be + ^{64}Zn are compared with the measured TF data taken from ref. [9,11]. The solid (dashed) line represents the results of calculations with (without) inclusion of breakup couplings.

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