Study of ^{9}Be scattering with ^{64}Zn and ^{144}Sm

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Introduction

In the very recent paper by Pandit *et al.*[1], two cluster configurations: ^{8}Be+n and ^{5}He+^{4}He of ^{9}Be have been thoroughly investigated through high precision elastic scattering data below Coulomb barrier energies on ^{208}Pb target. It was demonstrated that below Coulomb barrier only ^{8}Be+n cluster structure of ^{9}Be can able to explain the data satisfactorily. Interestingly, it was observed that the coupling effect of one neutron transfer channel remains present even at these sub Coulomb barrier energies. Motivated by these investigations, we decided to validate these two models of ^{9}Be for two other targets (^{64}Zn [2] and ^{144}Sm [3]), where elastic scattering data is available around Coulomb barrier energies. The results of the calculations are reported here.

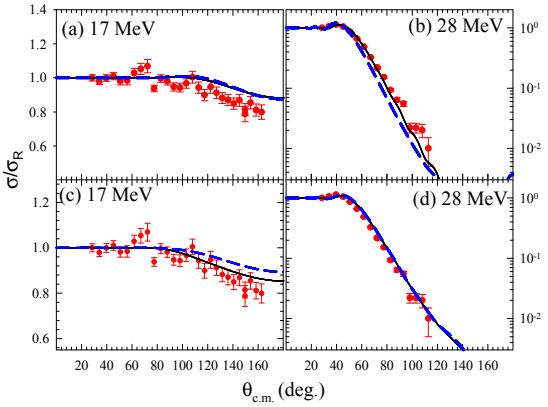

FIG. 1: The elastic scattering data for ^{9}Be+^{64}Zn [2] has been compared with two models: (a,b) ^{5}He+^{4}He and (c,d) ^{8}Be+n. The dashed and solid lines are without and with full (breakup + neutron transfer) couplings respectively.

Calculations Details

The Continuum Discrtised Couupled Channel (CDCC) calculations have been performed using the code FRESCO, version frxy.18 [4], to see the effect of breakup couplings in the ^{9}Be+^{64}Zn,^{144}Sm reactions. Two cluster configurations: ^{8}Be+n and ^{5}He+^{4}He are considered in these calculations. The binding potentials for ^{5}He+^{4}He cluster and ^{8}Be+n cluster have been taken from Ref. [5] and [6]. The required optical potentials for core-target and valence-target interaction are taken from Refs. [3, 7–10]. The relevant coupling scheme for these two models is same as described in Ref. [1]. In addition to the breakup couplings, the effect of 1n-transfer couplings have also been investigated through Coupled Reaction Channel (CRC) calculations. The ^{64}Zn(^{9}Be,^{8}Be)^{65}Zn, ^{144}Sm(^{9}Be,^{8}Be)^{145}Sm have Q-values +6.31 MeV and +5.09 MeV respectively. We have considered the 1n-transfer to following states: 0.0 MeV $5/2^-$, 0.054 MeV $1/2^-$, 0.115 MeV $3/2^-$, 0.207 MeV $3/2^-$, 0.769 MeV $5/2^-$, 0.864 MeV $7/2^-$, and 1.066 MeV $9/2^+$ of ^{65}Zn and 0.0 MeV $7/2^-$, 0.894 MeV $3/2^-$, 1.105 MeV $13/2^+$, 1.423 MeV $9/2^-$, 1.538 MeV $11/2^+$, 1.607 MeV $1/2^-$, and 1.706 MeV $9/2^-$ of ^{145}Sm. The calculations for the two systems are shown in Figs. 1 and 2. The dashed and solid lines are the uncoupled and coupled (breakup + neutron transfer) calculations respectively. As can be seen from these two Figs., it can be concluded that below Coulomb barrier energies (Figs. 1(c) and 2(c)) ^{8}Be+n model, while above barrier (Figs. 1(b) and 2 (b)) ^{5}He+^{4}He model has significant effects on

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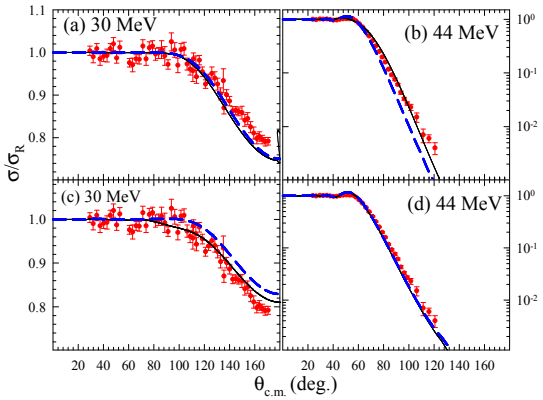

FIG. 2: Same as Fig. 1 but for ^{9}Be+^{144}Sm [3] reaction.

couplings. The effect of neutron transfer couplings has been found to be negligible for these two systems.

Summary and Conclusions

The effect of breakup and 1n-transfer couplings have been studied for ^{9}Be+^{64}Zn,^{144}Sm reactions. The elastic scattering data available around Coulomb barrier have been utilised for these investigations. Two different cluster models of ^{9}Be namely ^{8}Be+n and ^{5}He+^{4}He have been investigated, while the lower energy data can only be explained by the coupling effects seen in the ^{8}Be+n model, the data at energies above the barrier show large coupling effects for ^{5}He+^{4}He model. It is observed that the main contribution in continuum in both the cluster models is due to the lowest resonances. It is to be noted that the E1 couplings in ^{8}Be+n model have the dominant coupling effects, while 2.43 MeV, $5/2^{-}$ state of ^{9}Be gives the maximum coupling in the ^{5}He+^{4}He model. Hence the ^{8}Be+n model is important at lower energies and ^{5}He+^{4}He model at higher energies (above Coulomb barrier). Further studies are in progress to confirm these observations.

References

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