Role of projectile breakup on quasi-elastic excitation function in the reaction of ^{7}Li with ^{209}Bi

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Introduction

Recently, the study of nuclear reactions with weakly bound nuclei (^{6,7}Li, ^{9}Be), is of paramount importance due to their applications for the synthesis of super heavy elements and astrophysical processes [1, 2]. Elastic scattering and fusion cross sections are highly affected by the breakup channel coupling. Quasi-elastic scattering study is one of the well known method to unfold the coupling effects of other direct reaction channels(breakup and/or transfer).

In one of our earlier study [3], we have investigated fusion barrier distribution for ^{7}Li + ^{209}Bi reaction by quasi-elastic scattering measurements at backward angle. In these measurements along with elastic and inelastic channels, large α-yields were also observed. These α-particles can come from the direct breakup of projectiles or breakup following the transfer of nucleons. In the direct breakup of projectile (^{7}Li) breaks into α and t. In the case of projectile breakup following the various transfer channels such as $1p$-pick up and $1n$-stripping, the projectile may break after forming ^{8}Be and ^{6}Li nuclei respectively. In the present work, the Continuum Descritized Coupled Channels(CDCC) calculations are carried out, to understand the projectile(^{7}Li) breakup coupling effects on quasi-elastic excitation function for ^{7}Li + ^{209}Bi reaction.

Analysis and Results

The quasi-elastic barrier distributions are obtained for ^{7}Li + ^{209}Bi system at 140° with the inclusion of α-particle contributions from direct reactions such as direct breakup and/or breakup following the transfer. In the experimental spectrum a distinct peak of α-particles peaking at 4/7 of lab energy with widths of 13-17 MeV, is observed for ^{7}Li + ^{209}Bi reaction. In the CDCC calculations the projectile ^{7}Li is considered as α + t cluster. The resonant and non resonant continuum parts are also included in the CDCC calculation. The continuum part is descritized with momentum bins of width Δk ~0.2 fm^{-1} for non resonant part and fine binning are done for resonant part for ^{7}Li excitation. The maximum excitation is taken upto ~9 MeV and reduced to lower excitation for the near barrier energies in the reaction of ^{7}Li+ ^{209}Bi. The set of potentials for α + ^{209}Bi and for t + ^{209}Bi are [V_0 = 85.93 MeV, r_0 = 1.361 fm, a_0 = 0.578 fm] and [V_0 = 128.96 MeV, r_0 = 1.2 fm, a_0 = 0.72 fm] respectively. The scattering wave functions in the solution of coupled-channels calculations are integrated up to 200 fm in steps of 0.05 fm and the relative angular momentum is taken up to 150$\hbar$.

The CDCC calculations, shown by continuous lines (Fig. 1, are in good agreement with observed quasi-elastic excitation function except at well above the barrier energies. From the fig. 2, it is observed that present barrier distribution from quasi-elastic(elastic+inelastic+α-breakup part) excitation function is following the one obtained from fusion excitation function, though the CDCC calculations does not reproduce. The contributions of α-breakup part from CDCC

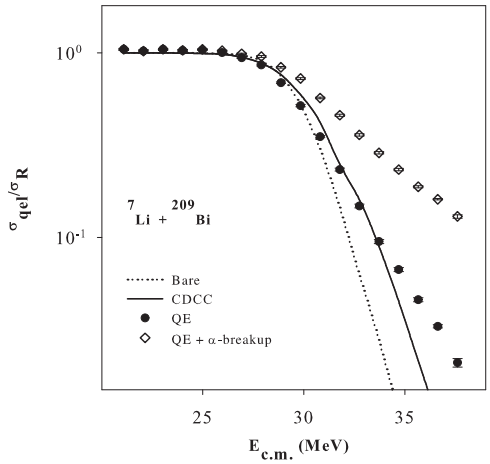

FIG. 1: Quasi-elastic excitation function at 140° for ^{7}Li+^{209}Bi system. The filled circles show the data points with elastic + inelastic and diamonds show the data points with elastic + inelastic + α-breakup part. The dotted and continuous lines indicate the results of calculations with bare potential and with CDCC.

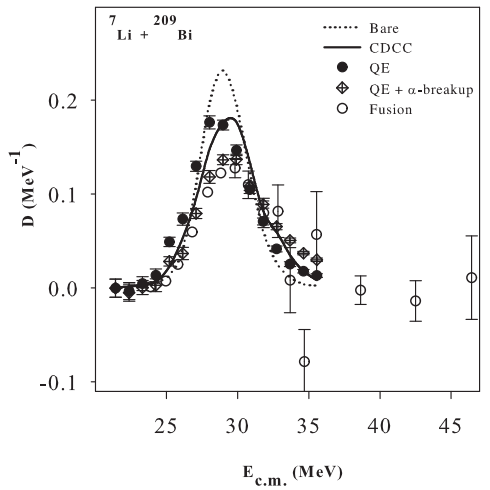

FIG. 2: Barrier distributions for ^{7}Li + ^{209}Bi system at 140°. The dotted and continuous lines indicate the results of calculations with bare potential and with CDCC. The data points shown by unfilled circles are taken from the literature.

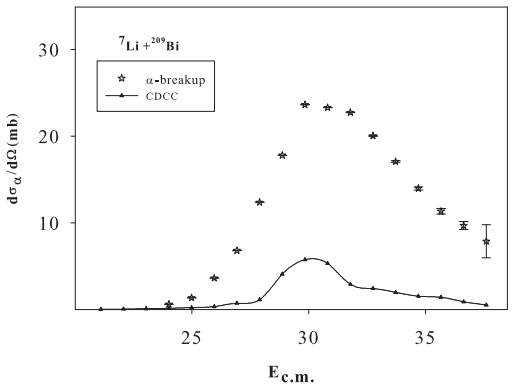

FIG. 3: α-particles cross sections for ^{7}Li + ^{209}Bi reaction.

as well as from experimental measurement is compared in the fig. 3. To match the observed differences between experimentally observed α-particle cross sections and CDCC calculations, an additional transfer calculations ($1p$-pick up and $1n$-stripping) are being carried out. The details and results of CDCC calculations with the inclusion of target inelastic coupling and transfer channels will be presented in the symposium.

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