Influence of projectile breakup coupling for ^{6,7}Li+^{232}Th systems around the Coulomb barrier energies

D. Patel[1],* J. Lubian[2], S. Santra[3], C. Bhuptani[1], A.K. Rai[1], and B.K. Nayak[4]
[1]*Department of Physics, Sardar Vallabhbhai National Institute of Technology, Surat-395007, India.*
[2]*Instituto de Fısica, Universidade Federal Fluminense, Av. Litoranea s/n, Gragoatá, Niteroi, R.J., 24210-340, Brazil.*
[3]*Nuclear Physics Division, BARC, Mumbai 400085, India. and*
[4]*Homi Bhabha National Institute, Anushaktinagar, Mumbai 400094, India.*

Introduction

In recent years, heavy ion reaction study with projectile nuclei near the drip-line, such as (^{6}He, ^{9,11}Li, ^{10,11,14}Be *etc.*)[1–3] is being given a great deal of attention to probing the internal structure of the nuclei by exploring the break-up coupling effects on various reaction channels. However, due to the limited beam intensity and availability of unstable weakly bound nuclei, stable weakly bound nuclei such as ^{6,7}Li and ^{9}Be are being considered extensively on the experimental front. The similarity in structural properties of stable and unstable weakly bound nuclei further enhanced the importance of various reaction studies with stable weakly bound nuclei. Experimentally as well as theoretically it has been seen that in the reactions using weakly bound nuclei the breakup channel does not vanish in the vicinity of the Coulomb barrier; rather, it enhances in magnitude owing to the coupling of the breakup channel to the continuum and thus produces a repulsive polarization potential. Which is now well-established observation known as "Breakup Threshold Anomaly(BTA)"[1]. The breakup reaction also depends on the combination of the involved projectile and/or Target nuclei. It may affect the lower mass target differently from heavier target masses nuclei. In some of the reactions, suppression in Coulomb Nuclear interference peak is observed[4]. It is also of great interest to explore the breakup coupling effects involving ^{6,7}Li projectiles and heavier target mass nuclei ^{232}Th.

The present work focuses on exploring the breakup reactions involving weakly-bound nuclei, namely, ^{6,7}Li, by employing theoretical model code Fresco[6]. It also aims to explore the relative importance of nuclear, Coulomb, and total breakup contributions for ^{6,7}Li+^{232}Th systems around the Coulomb barrier energies.

Method and Analysis

The experimental data on elastic scattering angular distribution at various energies was taken from the Ref.[5]. Presently, preliminary theoretical calculations have been carried out using Fresco code by applying continuum discretized coupled channels (CDCC) method for ^{6,7}Li+^{232}Th systems to study projectile breakup coupling effects on elastic scattering channel. In these calculations, ^{6,7}Li are treated as the two-cluster systems:^{6}Li≡^{2}H+^{4}He and ^{7}Li≡^{3}H+^{4}He with separation energy of around 1.47MeV and 2.45MeV respectively. For ^{7}Li+^{232}Th system, multipole expansion of the potentials was carried out, taking into account multipoles up to λ=4. Adopted method of CDCC calculations includes a matching radius of 40 fm and total angular momenta up to J=200$\hbar$.

Results and Discussion

In the absence of resonances, good convergence can be obtained using bins width ≈1−2MeV or even more significant than this. Smaller bins were considered for sharp resonances. For the maximum excitation energy ε_{max}∼8.5 MeV and l_{max}=3$\hbar$, good convergence was obtained. Fig. 1 shows the results

*Electronic address: dipikapatel@phy.svnit.ac.in

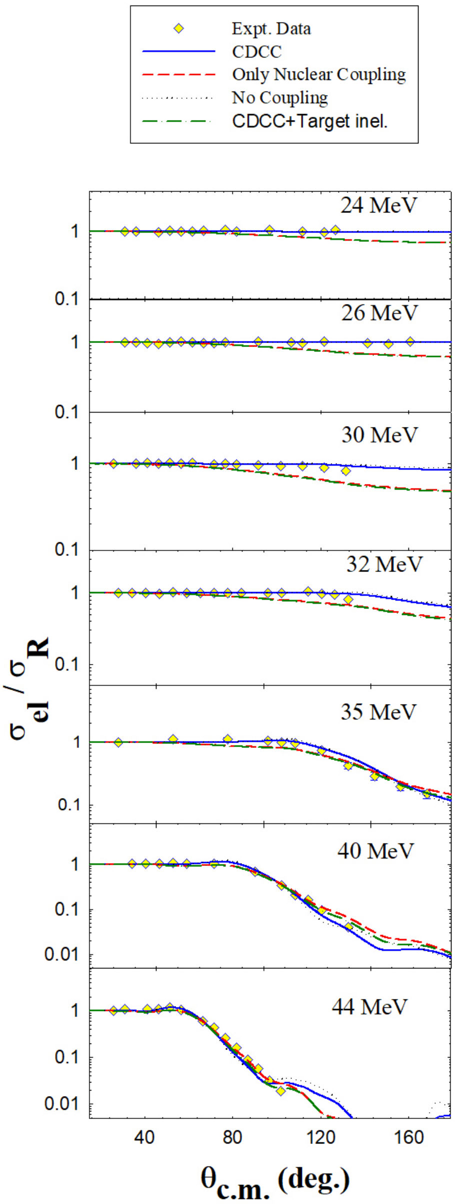

FIG. 1: Elastic scattering angular distribution compared with the results of CDCC calculation for ^{7}Li+^{232}Th system at around the Coulomb barrier energy. The results of breakup coupling along with Target inelastic states, without target inelastic states and only nuclear coupling are shown by dot-dashed, continuous and dashed curves respectively. The results without any type of coupling are shown by the dotted curves.

of the present CDCC calculation for direct breakup of ^{7}Li into α+t along with Target inelastic states, without target inelastic states, and only nuclear coupling are shown by dot-dashed, continuous and dashed curves, respectively. One can see that inclusion of target inelastic states result in the suppression of coulomb nuclear interference peak.

Conclusions

For ^{7}Li+^{232}Th system at around the Coulomb barrier energy, small breakup coupling effects have been observed at various energies which might be due to the one bound state of ^{7}Li at ∼0.47MeV. However, large coupling effect was observed after incorporating target inelastic states coupling in the breakup reaction calculation thus suppresses the coulomb nuclear interference peak in the ^{7}Li+^{232}Th reaction. Further investigation on the influence of breakup coupling by extracting dynamic polarization potentials (DPP) from the CDCC calculations is also being carried out, which will be presented for both the ^{6,7}Li+^{232}Th systems during the symposium.

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