Chapter 5

Summary, conclusions and future outlook

5.1 Summary and conclusions

In the present thesis, we have measured the elastic scattering angular distribution for ^{6,7}Li + ^{232}Th and ^{10,11}B + ^{232}Th systems to study the threshold and breakup threshold anomaly, below and around the Coulomb barrier energies. The details are summarized below:

5.1.1 Measurement of elastic scattering angular distribution and investigation of TA/BTA for ^{6,7}Li + ^{232}Th systems.

The study of reactions with the weakly bound projectile ^{6,7}Li have been carried out using a heavy mass target ^{232}Th with the main aim of understanding the effect of projectile breakup on reactions mechanism. The experiments have been carried out at the 14UD Pelletron-Linac facility at TIFR, Mumbai, India. The measurement of elastic scattering angular distribution have been carried out for ^{6,7}Li + ^{232}Th reactions, for ^{7}Li + ^{232}Th system at 24, 26, 30, 32, 35, 40, and 44 MeV and for ^{6}Li + ^{232}Th system at 26, 30, 32, 35, 40, and 44 MeV bombarding energies. The Coulomb barrier for both systems are nearly 32 MeV. The elastic scattering angular distributions have been obtained, in the angular range from 20^0 to 170^0 in laboratory system. Optical model

analysis have been carried out for both the systems, using two methods, one using the Woods-Saxon potential and the second is Sao Paulo double folding potential. The relevant parameters that gives a best fit to the angular distribution of elastic scattering were acquired from a method of χ^2-minimization. The character of real and imaginary optical potential parameters as a function of energy is relevant with a condition near to the threshold anomaly for ^{7}Li + ^{232}Th system. The increasing behavior of imaginary optical potential parameters around the Coulomb barrier energy shows the presence of breakup threshold anomaly for ^{6}Li + ^{232}Th system.

The total reaction cross section were compared with fusion and fission reaction cross section for both systems. The total reaction cross sections of ^{6}Li + ^{232}Th system is enhanced at sub-barrier energies in comparison to the ^{7}Li + ^{232}Th system. Similar cross section behavior were obtained from fusion and fission cross sections for both systems.

5.1.2 Study of quasi elastic scattering and transfer angular distribution of ^{10,11}B + ^{232}Th systems.

In the present work, we have measured simultaneously the quasi-elastic (elastic + low-lying inelastic) scattering and transfer angular distributions for ^{10,11}B + ^{232}Th systems. With the aim of systematic investigation of the real and imaginary optical potential parameter as a function of energies for the ^{10,11}B + ^{232}Th systems, it is important to establish the presence of TA or BTA in these reactions.The quasi-elastic scattering and transfer angular distribution measurements were carried out using ^{10,11}B beams from the 14UD BARC-TIFR Pelletron facility, Mumbai, India, for ^{11}B + ^{232}Th reaction the incident energies at below the Coulomb barrier is 52, 53, 54 MeV and above the barrier is 55, 56, 57, 59, 61, and 65 MeV. The incident energies for ^{10}B + ^{232}Th reaction at below the Coulomb barrier is 49, 51, 52, 53, 54 MeV and above the barrier is 55, 56, 57, 59, 61, and 65 MeV.

The range of energies relative to the Coulomb barrier [E_{lab}/V_b] is $\sim$ 0.96 to 1.20 for ^{11}B + ^{232}Th system and it is $\sim$ 0.90 to 1.19 for the ^{10}B + ^{232}Th system. The angular distribution data are analyzed by using a phenomenological Woods-Saxon form of potential (WSP). Optical model analysis of the experimental data have been performed to determine both the real and the imaginary parts of the optical potential as a function of beam energy. It is observed that as the bombarding energy decreases, the imaginary potential decreases and real potential increases. This behavior of the corresponding potential parameters as a function of energy is consistent with the usual threshold anomaly (TA), confirming the tightly bound characteristics of both the projectiles, ^{10,11}B. The total reaction cross sections of ^{10}B + ^{232}Th system is more than ^{11}B + ^{232}Th system at sub barrier energies.The total cross section procured from the elastic scattering angular distribution by Woods Saxon potential.

The reduced reaction cross sections have been obtained for both ^{10,11}B + ^{232}Th reactions and compared with the reactions of other projectiles (^{6,7}Li) with ^{232}Th target. The transfer products show a bell-shaped angular distribution at energies above the Coulomb barrier and the grazing angle shifts towards back angles at sub-barrier energies.

5.2 Future outlook

The study of heavy ion reaction with stable and weakly bound nuclei(^{6,7}Li, ^{9}Be, ^{10,11}B) at near Coulomb barrier energies have been of great interest for investigating threshold and breakup threshold anomaly with different targets. Weakly bound projectiles have low breakup threshold energy and as a result these nuclei have more breakup coupling effects in all the channels like elastic scattering, inelastic, fusion, transfer etc. This suggest that for the better understanding of breakup coupling effects experimentally, all these reactions should be measured and analyzed cumulatively . For this type of studies radioactive ion beams can also be used. Further we can use different projectiles

with heavy mass target. We can also plan some other reactions studies like fission fragment mass distribution, fission angular distributions etc.