Preface

The dynamics of weakly bound projectiles have been a topic of keen interest because the advancement of technology has provoked studies related to unstable weakly bound projectile (WBP), radioactive ion beams (RIBs) like ^{6}He, ^{7}Be, ^{8}Li, ^{8}B, ^{11}Li, etc. The availability of RIBs and unstable WBPs are in less intensity and therefore the precise study of their structure and reaction dynamics is a challenge. It is known that WBP is those nuclei which are having their B.E./nucleon around 1.5-2.5 MeV or even lesser viz. ^{6}Li (1.47 MeV),^{7}Li (2.48 MeV), ^{9}Be (1.57 MeV) etc. The various reaction channels thus may have an influence on breakup as compared to that of tightly bound nuclei (B.E./nucleon varies from 6-8 MeV). Also, it is suggested that the study of stable weakly bound projectiles could act as a platform for understanding of unstable ones/RIBs and thus it is mandatory to study them in detail. Apart from that the availability of high-intensity of stable WBP beams in comparison to unstable ones provides better statistics which avail a detailed interpretation of experiments and a better theoretical description can be modeled.

The energy dependence of phenomenological optical potential at the barrier displays Threshold Anomaly (TA) behavior for tightly bound systems. The imaginary component shows the quick closing of inelastic channels, but the real component shows a bell-shaped peak in the same energy range. On the other hand, for weakly bound projectiles the imaginary potential resists drop in the barrier area and exhibits an elevation that may be stable even when the bombarding energy decreases, implying that the breakup cross section is especially important below the Coulomb barrier. This contributed to the rise in the imagined component of potential, which again was coupled with a decrease in the real part. This unexpected reliance is referred to as Breakup Threshold Anomaly (BTA). Several studies have been performed to understand the

barrier behavior of weakly bound nuclei viz. interaction of ^{6}Li with targets of almost all mass range nuclei has been reported to show Breakup Threshold Anomaly (BTA) behavior ^{27}Al, ^{58}Ni, ^{80}Se, ^{112,116}Sn, ^{144}Sm, ^{208}Pb. In the case of ^{28}Si, a contradictory observation still exists. However, more studies are needed on the lighter mass side before a clear conclusion can be reached. For weakly bound projectile ^{7}Li, various mass ranges show results without coordination and a generalized conclusion is still difficult to be drawn. For example, the absence of TA was observed for ^{7}Li with lighter medium mass ^{27}Al, ^{28}Si while just a little heavier ^{59}Co, ^{80}Se have reported TA. Medium-heavy mass ^{144}Sm and ^{159}Tb don't show TA but ^{138}Ba which is in the same mass range show TA behavior. The heavy mass targets like ^{7}Li on ^{208}Pb and ^{232}Th have confirmed the appearance of TA. Further, enhancement/suppression of fusion cross section is discussed in terms of coupling to other reaction channels and breakup as a significant channel in the case of weakly bound projectiles. Thus, while channels such as transfer and inelastic excitation may increase the fusion cross section, channels such as breakup may limit the total flux for fusion. According to inclusive and exclusive investigations for alpha-production, the large alpha cross section is a related phenomenon to the breakup and transfer channels. It is observed that weakly bound projectiles having cluster structure 'α+x' tend to produce larger alpha compared to other fragment x via various channels. Several reports regarding inclusive and exclusive measurements are contributing to understand large inclusive alpha production however complete understanding of the phenomenon is still an open question to the community.

In the present work, the main objective has been to understand the effect of breakup on reaction dynamics of the weakly bound projectile (WBP) near the Coulomb barrier on various reaction channels such as elastic scattering, transfer, etc. with help of experimental and theoretical techniques. In the view of investigation of mentioned objective, two experimental measurements

have been carried out involving WBP ^{6}Li and ^{7}Li on medium heavy mass targets ^{51}V and ^{92,100}Mo. The first experiment was aimed at measurements of elastic scattering and transfer channel studies around the barrier energies for the system ^{6}Li+^{51}V, using 14 UD BARC-TIFR Pelletron, Mumbai, India. The data has been analyzed using the SFRESCO code. The theoretical breakup studies were done using the FRESCO code. The second experiment was conducted for measurements of elastic scattering and its dependence on target deformation around the barrier energies for the systems^{7}Li+^{92,100}Mo, using 15 UD Inter-University Accelerator Centre (IUAC) Pelletron, New Delhi, India [33]. The data has been analyzed using the SFRESCO code. The theoretical breakup studies were done using the FRESCO code. In the same setup one more projectile ^{6}Li was utilized to get the measurement of elastic scattering angular distribution for the system ^{6}Li+^{100}Mo and data analysis was done by SFRESCO code.

The whole work is listed in the thesis and divided into the following chapters:

Chapter 1avails the brief introduction about the nuclear reactions, weakly bound nuclei, and other detailings of thesis. Chapter 2decribs Experimental Methods and Theoretical Models.

Chapter 3: Elastic Scattering for ^{6}Li+^{51}V and Systematic Study of Breakup Threshold Anomaly.

Chapter 4: Inclusive Alpha Production for ^{6}Li+^{51}V System.

Chapter 5: Exploring Breakup Coupling Effect in ^{7}Li+^{92,100}Mo Elastic Scattering around Coulomb Barrier Energies.

Chapter 6: Study of Breakup Effect of Weakly Bound Projectile around Coulomb Barrier Energies for ^{6}Li+^{100}Mo System.

Chapter 7: Summary and Conclusion and Future Outlook of the Work.