Study of quasi-elastic scattering for the system ^{7}Li + ^{159}Tb at around barrier energies

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Introduction

Systematic experimental and theoretical studies of the effect of coupling of collective degrees of freedom (like inelastic excitation, rotation, surface vibration and transfer of nucleons) on the fusion process of tightly bound nuclei at energies around the Coulomb barrier have been studied and reported in literatures[1, 2] in the last two decades. The fusion barrier distribution function (D_{fus}) can be extracted directly from fusion excitation function. D_{fus} is very sensitive to the coupling scheme and can be used to understand the consequence of these couplings on fusion reaction. The effect of the breakup of weakly bound light nuclei on the fusion process is a subject of current experimental and theoretical investigations due to the recent availability of radio-active ion beams. As second derivative of cross sections are involved in extracting fusion barrier distribution function (D_{fus}), it is essential that a high-precision measurement of fusion excitation function is done. But it is still very difficult to perform high-precision measurements of fusion cross sections with radioactive beams. An alternative method for obtaining information about barrier distribution is the derivation of backward angle quasi-elastic scattering (QES) barrier distribution.The barrier distribution extracted from quasi-elastic cross-section (D_{qel}), involves the first derivative of the ratio of QEL scattering cross section to the Rutherford scattering cross section with respect to energy. Fusion and quasi elastic methods are complementary to each other. Barrier distributions obtained from two complementary experimental approaches have been found to be similar for the systems where both the reactants are strongly bound [2, 3]. As this method involves the first derivative of QES cross sections, which are large at lower energies compared to the fusion cross sections, the uncertainty associated with D_{qel} is less than that associated with D_{fus}. Also, the QES excitation function is easier to be measured than the fusion excitation function at low energies. In view of the experimental benefits of D_{qel} over D_{fus} , the function D_{qel} can be considered to be a suitable alternative to D_{fus}.

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Experimental Setup

Beams of ^{7}Li in the energy range 17-34 MeV, in steps of 1 MeV, delivered by the 14UD BARC-TIFR Pelletron Accelerator, Mumbai, India were used to impinge a self-supporting ^{159}Tb target foil of thickness $\sim$ 1.1 mg/cm^2. A set of four ΔE-E telescopes were placed at $\pm$170° and $\pm$160° relative to the beam direction inside a big scattering chamber of diameter 1 m. Two Si- surface barrier detectors (M1, M2) were placed at $\pm$20° with respect to the beam direction for monitoring the beam and also for normalization purposes.

Analysis and Results

Data were taken and analyzed using the program LAMPS [4]. The detected charged particles were identified by making the conventional ΔE-E_{res} spectrum and using the well-known Bethe formula E.ΔE $\sim$ MZ^2. It shows rectangular hyperbolic nature with high

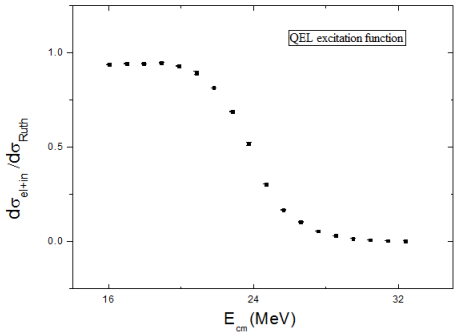

FIG. 1: Partial QES excitation function measured at $\theta_{lab} = 170^{\circ}$ for the system ^{7}Li + ^{159}Tb

Z-value at the top which appears as (elastic + inelastic) scattering, followed by Z=2 band and Z=1 being the lowest in the ΔE-axis. The low lying levels of ^{159}Tb are very closely spaced and so the inelastic states of target could not be separated from the elastic events. This band may also contain contribution from the first inelastic state of ^{7}Li, if any. The emission of -particles (Z=2) may originate from the break-up related processes, like NCBU process and the ICF process or may also result from transfer reaction. The Z=1 band shows a fall back feature because the stop detectors were not thick enough to stop the Z=1 particles.

Analysis have been done considering only Z = 1 band and hence the partial QES cross-section (elastic + inelastic) have been obtained. Barrier distribution have been extracted from those partial QES cross-section. Fig.1 shows the partial QES excitation function obtained for the reaction ^{7}Li + ^{159}Tb. Results of the analysis of QES measurements for the system ^{7}Li + ^{159}Tb at different energies below and above the barrier will be presented at the conference.

References

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