Study of reactions populating unbound states for ^{6}Li+^{93}Nb system around the Coulomb barrier

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Introduction

Role of low breakup threshold on the reaction dynamics involving weakly bound nuclei has been the subject of current interest [1–4]. Recently a detailed study on nucleon transfer followed by breakup along with direct breakup for the ^{7}Li nuclei, bombarding it on medium mass target ^{93}Nb has been reported [3]. The present work is aimed to investigate the processes of direct breakup and nucleon transfer followed by breakup in detail for another weakly bound projectile ^{6}Li, which has relatively lower breakup threshold (1.47 MeV) with respect to ^{7}Li (2.47 MeV). Elastic scattering and inclusive-α along with inelastic excitation, 1n-stripping and d-pickup followed by breakup have been studied.

Experimental Details

The experiment was carried out at PLF, Mumbai, using ^{6}Li beam of energies 25 and 35 MeV. Self-supporting ^{93}Nb foil of thickness $\sim$2.0 mg/cm^2 was used as target. Five segmented large area Si-telescopes of active area 5 x 5 cm^2 (thicknesses: ΔE $\sim$30-50 μm, E $\sim$1.0-1.5 mm) and two telescopes consisting of Si-surface barrier detectors (thicknesses ΔE $\sim$ 20-50 μm, E $\sim$ 450-1000 μm) were used for measurements of the outgoing fragments. The strip-detector-telescopes were mounted at angles 35°, 55°, 85°, 105° and -55° in a scattering chamber of diameter 1.5 m. Two Si-surface barrier detectors (thicknesses 300 μm) kept at $\pm$20° were used to monitor Rutherford scattering. The data were collected in an event by event mode, with the trigger generated from the E detectors. Multiplicity threshold was kept at one for singles measurements and at two for the measurement of breakup fragments in coincidence.

Analysis and Result

All the strips were calibrated using the known alpha energies from ^{229}Th source. Particles were identified using energy loss information from ΔE and E for 256 pixel of Si strip detector of all telescopes. A good charge and mass resolution was achieved as can be seen in the inclusive spectra shown in Fig.1(a). Various breakup channels were identified by making a coincidence between the two fragments. In Fig.1(b), 1(c) and 1(d) α spectra recorded in coincidence with the complimentary fragments α, deuteron, and proton are shown, respectively. The α-α, α-d, and α-p coincident events are corresponding to breakup of ^{8}Be (d-pickup), ^{6}Li (inelastic excitation), and ^{5}Li (1n-stripping), respectively. In Fig.1(c), the high (low) energy peak in the α - band arising due to break up of ^{6}Li from its first resonant state, corresponds to α particle moving forward (backward) in the α-d centre of mass system [4]. The extracted angular distribution of elastic scattering and inclusive α-particles measured at E_{beam} = 25 MeV (solid squares) and 35 MeV (solid circles) are presented in the Fig. 2(a) and 2(b), respectively.

Continuum discretized coupled channels (CDCC) calculations have been carried out, using the code Fresco, to understand the measured data. Cluster folding potentials were used as target-projectile interaction potentials. The α+^{93}Nb and d+^{93}Nb optical po-

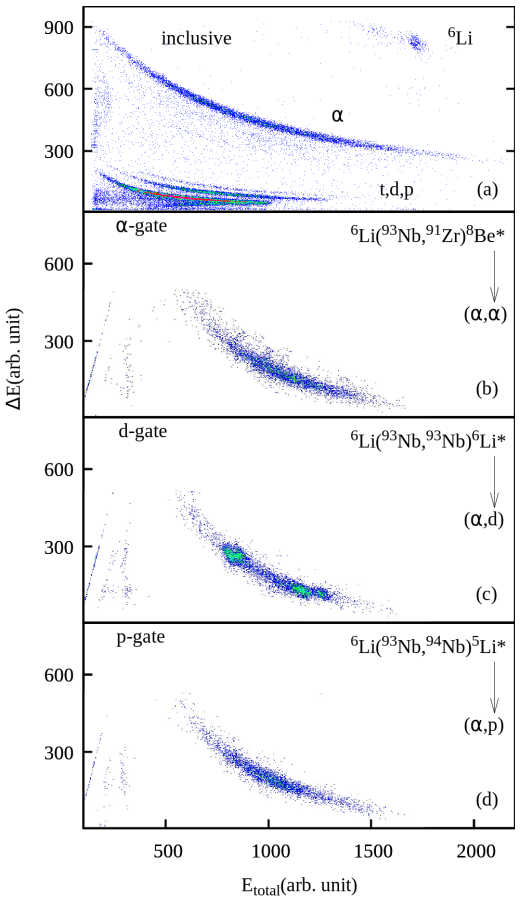

FIG. 1: Measured inclusive and exclusive α spectra for ^{6}Li+ ^{93}Nb at E_{beam} = 25 MeV and 35 MeV. (a) inclusive spectra, Z=1 band is clearly separated. (b) α spectra in coincidence with α, (c) α spectra in coincidence with deuteron, (d) α spectra in coincidence with proton..

tentials were taken from the global parameterizations, respectively. The real and imaginary depths of these potentials were renormalized to fit the elastic scattering data of E_{beam} = 35 MeV. The $\alpha + d$ continuum model space in momentum was limited to $0 \leq k \leq 0.8$ fm^{-1} with $\Delta k = 0.1$ fm^{-1}. The relative angular momenta (L) of $\alpha + d$ system 0−4 and couplings up to multipolarity $\lambda = 4$ were considered in the calculations. Calculated elastic scattering angular distributions at E_{beam} = 35 MeV and

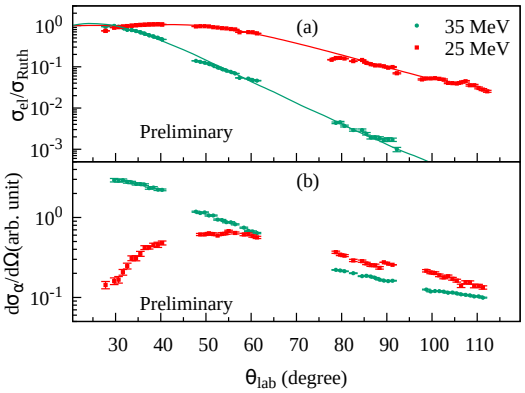

FIG. 2: Measured angular distribution of (a) elastic scattering, (b) inclusive-α. Solid curves in (a) are corresponding to CDCC calculations.

25 MeV are shown in Fig. 2 (a).

Summary

In summary, measured elastic scattering and inclusive-α along with inelastic excitation, 1n-stripping, and d-pickup followed by breakup channels for ^{6}Li+^{93}Nb system at E_{beam} = 25 MeV and 35 MeV are presented. CDCC calculations were carried out to understand the measured elastic scattering angular distributions. Present investigation along with a comparison with ^{7}Li+^{93}Nb[3],^{6}Li+^{112}Sn[5] system will be discussed.

Acknowledgments

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