Study of reactions populating unbound states after one nucleon transfer for ^{7}Li+^{89}Y system at E$\sim$V$_B$

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Introduction

Inelastic excitation leading to continuum states in the outgoing channel is a common phenomenon observed in the reactions involving weakly bound nuclei [1]. Recently it has been observed that the yield of unbound states populated after transfer of a nucleon is more dominant than the direct breakup of the projectile at energies near the Coulomb barrier [2, 3]. At present, very limited data is available in the literature for simultaneous measurement of the breakup and transfer-breakup reactions. As the exit channel in these reactions consists of three outgoing particles, coincident measurement of the two fragments is necessary for an unambiguous identification of the process. To understand the effect of continuum states populated through different outgoing channel on reaction dynamics near the barrier, which is a topic of current interest, we have carried out exclusive measurements of breakup fragments for ^{7}Li+^{89}Y system at 25 and 30 MeV.

Experimental Details

The experiment was carried out using 14UD BARC-TIFR Pelletron, Mumbai, using 25 and 30 MeV ^{7}Li beam on ^{89}Y target. A self supporting ^{89}Y target of thickness $\sim$1.9 mg/cm^2 was used. A major challenge in this experiment was to detect low lying resonant states having very small relative energy that correspond to small kinematically allowed cone angle between the fragments. Secondly to measure low cross-section events large solid angle was required. Both these requirements were achieved by using segmented large area Si-telescope of active area 5 x 5 cm^2. The ΔE detector was a single sided strip detector with 16 strips. E detector was double sided strip detector with 16 strips in X and Y directions allowing maximum number of pixels to be 64. Thicknesses of ΔE and E detectors were 50 μm and 1.5 mm respectively. In the present geometry, the cone angle between the two detected fragments ranged from 1^o to 10^o. Three sets of coincident measurements were performed for each beam energy keeping the strip detector at 50^o, 60^o and 70^o, corresponding angular coverage 40^o to 80^o (around the grazing angle). A Si-detector (2 mm thick) placed at 15^o was used as monitor. Mesytec MPR-16 multichannel preamplifier and Mesytec MSCF-16 F shaping/timing filter amplifier with constant fraction discriminator and multiplicity trigger modules specially designed for single or double sided multistrip silicon detectors were used in the experiment. The data were collected in an event-by-event (list) mode with the trigger generated from the multiplicity in the ΔE detector. Multiplicity one and two were used to measure elastic scattering and break up, respectively.

Data analysis

Each of the 64 pixels of the Si-strip detector was working as an individual telescope having fixed co-ordinates. A particle hitting the detector was characterized by its position coordinate and the kinetic energy. Energy calibration of each strip was performed using the elastic scattering data for ^{7}Li on ^{89}Y and ^{209}Bi at 25 and 30 MeV. A good particle identification was achieved for each pixel, as seen in (Fig.1). The breakup and transfer-breakup events were identified by generating correlation plots between the kinetic energies E_1 and E_2 of the coincident fragments (Fig.2). The

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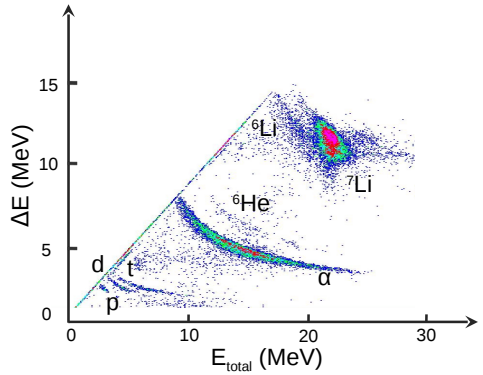

FIG. 1: A typical two dimensional spectrum of ΔE vs. E_{tot} for ^{7}Li+^{89}Y measured at E_{lab} = 25 MeV.

two α particles due to breakup of ^{8}Be resulting from one proton pickup channel, form two distinct bands in the correlation spectrum. Strongly populated band 1 corresponds to formation of ^{8}Be in its ground state with ^{88}Sr also populated in the ground state while band 2 corresponds to ^{88}Sr left in its first excited state (1.8 MeV). The coincident events between α and d correspond to breakup of ^{6}Li from its first resonant state formed after transfer of one neutron to the target. In α-d correlation spectra two localized contributions high (low) energy α (d) and low (high) energy α (d) were observed (region 4+5 and 3). Events in region 4 (high energy α) are due to α particles emitted along the direction of ^{6}Li* before breakup. However, only part of the events arising from forward moving d were observed (region 3) since the energy deposited by the high energy d in ΔE detector was less than the electronic threshold set to cut the noise. The region 4 corresponds to ^{90}Y populated in ground state mixed with excited state at 0.202 MeV (3^{-}) and region 5 corresponds to 1.2 (0^{-}) and 1.37 (1^{-}) MeV states of ^{90}Y. The coincidence between α-t are from the direct breakup of ^{7}Li through its first resonance state at 4.63 MeV.

Summary

The reaction channels leading to unbound states were studied for ^{7}Li+^{89}Y system at beam energies 25 and 30 MeV. The resonant

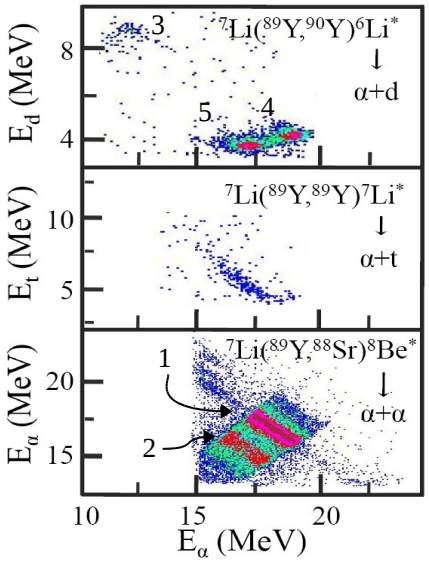

FIG. 2: Energy correlations of coincident breakup fragments for ^{7}Li+^{89}Y measured at E_{lab} = 25 MeV.

states of ^{8}Be (92 keV) and ^{6}Li (2.67 MeV) were clearly identified from the relative energy spectrum. The coincidence yields of α-α and α-d arising from the transfer-breakup reactions were found to be much larger than the direct breakup of ^{7}Li. This is consistent with earlier observations [2, 3]. These results along with the role of resonant and non resonant states on the fusion reaction around the Coulomb barrier will be discussed.

Acknowledgments

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