Measurement of direct breakup and transfer-breakup for ^{7}Li+^{93}Nb,^{89}Y systems around the Coulomb barrier

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Introduction

Coulomb excitation leading to continuum (unbound) states in the outgoing channel is a common phenomenon observed in the reactions involving weakly bound nuclei [1, 2]. In our previous measurement for ^{7}Li+^{89}Y system, performed at beam energy of 25 MeV (E/V_B = 1.4) [3], the cross-section for 1-p pick-up leading to unbound states was found to be most dominant as compared to 1-n stripping followed by breakup and projectile breakup channels. In the present work we have extended these measurements to energies 1.3V_B and 1.5V_B for ^{7}Li+^{89}Y and ^{7}Li+^{93}Nb systems, to get the excitation function. The 1-p pick-up reaction for ^{7}Li+^{93}Nb, leads to Z=40 (proton close shell) and for ^{7}Li+^{89}Y leads to Z=38. Hence it will be interesting to study the role of nuclear structure of the target on the p-transfer reaction.

Experimental Details

The experiment was carried out at 14UD BARC-TIFR Pelletron facility, Mumbai, using ^{7}Li beam of 23 and 27 MeV on ^{89}Y target and, 24 and 28 MeV on ^{93}Nb target. Self supporting ^{89}Y and ^{93}Nb targets of thicknesses ∼1.9 mg/cm^2 and ∼1.6 mg/cm^2 respectively were used. The breakup fragments were detected in coincidence. In order to identify breakup fragments with small relative angle (corresponding to low excitation energy) and to have large solid angle coverage (for good statistics), two segmented large area Si-telescopes of active area 5 x 5 cm^2 were used. The ΔE detector was a single sided strip detector with 16 strips and E detector was double sided strip detector with 16 strips in X and Y directions. 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° to 16°, and the angular coverage from 40° to 130° (around the grazing angle). Three telescope consisting of Si-surface barrier detectors (thicknesses $\Delta E \sim$ 20-50 μm, $E \sim$ 450-1000 μm) were used to get the angular distribution for elastic scattering and inclusive α particle. Two Si-surface barrier monitor detectors (thicknesses 300 μm) kept at ±20° were used for absolute normalisation. 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. The data were collected in an event by event mode, with the trigger generated from E detectors. We had fixed multiplicity one to measure elastic scattering and multiplicity two for the measurement of breakup fragments in coincidence. A newly developed VME based data acquisition system was used to acquire data for 104 energy and 67 timing signals.

Analysis and result

Particles were identified using energy loss information from ΔE and E for 256 pixel of Si strip detector telescope. A good charge and mass resolution was achieved as can be seen in the inclusive spectra shown in Fig.1a. The projectile/ejectile breakup channels were identified by making a coincidence between the two fragments. Shown in Fig.1b,c and d are α spectra recorded in coincidence with the complimentary fragments i.e., α, deuteron and triton, respectively corresponding to breakup of ^{8}Be* (α+ α) after 1p-pickup, ^{6}Li*(α +d) after 1n-stripping and ^{7}Li*(α +t). In Fig.1c, the high (low) energy peak in the α - band aris-

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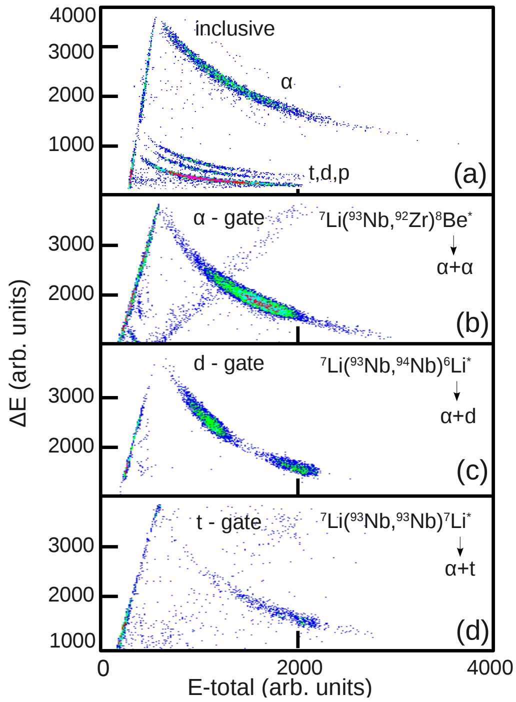

FIG. 1: Measured inclusive and exclusive α spectra for ^{7}Li+^{93}Nb at E_{lab} = 28 MeV. (a) inclusive spectra, Z=1 band is clearly separated. (b) α spectra in coincidence with α, (c) α spectra in coincidence with deuteron, (d) α spectra in coincidence with triton.

ing 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 [1]. In case of the direct breakup of ^{7}Li from its resonance state at 4.63 MeV, only the high energy α group in coincidence with triton is observed. The corresponding low energy α group is stopped in ΔE detectors. The differential cross-section of inclusive α-particles for ^{7}Li+^{93}Nb system at E_{lab} = 24 (solid circles) and 28 MeV (open circles) are presented in the Fig.2. As expected in case of direct reaction the inclusive α cross-section peak at the grazing angle.

Summary

The inclusive and exclusive alpha particle spectra and inclusive differential cross-section of α particle for ^{7}Li+^{93}Nb system at $E_{lab} = 24$ and 28 MeV are presented. The contribution

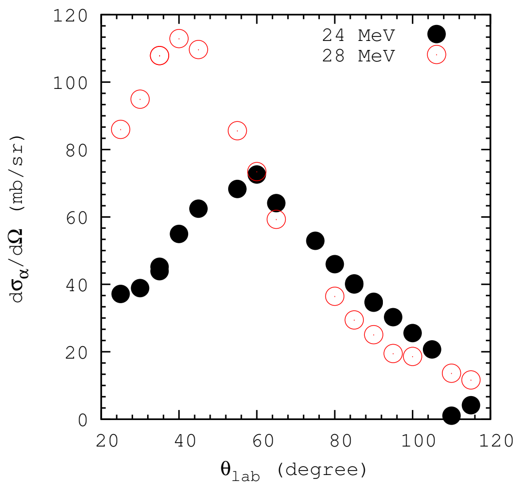

FIG. 2: Measured α yield angular distribution for ^{7}Li+^{93}Nb system at E_{lab} = 24 and 28 MeV.

to the inclusive α cross-sections arising from different transfer-breakup and direct breakup channels, extracted from the coincident data will be presented along with a comparison with results for ^{7}Li+^{89}Y system.

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