Projectile break-up mechanism in ^{7}Li + ^{208}Pb reaction around the Coulomb barrier

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Introduction

Interactions of the most weakly bound stable nuclei, ^{6,7}Li and ^{9}Be, display a range of anomalous behaviors, all attributed to the low break-up threshold. As a result, the projectiles breaks up into their cluster constituents [1]. Projectile dissociation in the field of target nucleus is a topic of continued interest because of its application to the determination of radiative capture cross section of astrophysical interest. The cross sections for radiative capture of α-particles, deuterons and protons by light nuclei at very low relative energies are of particular importance for the understanding of the nucleosynthesis and for determining the relative elemental abundances in stellar burning processes at various astrophysical sites [2]. Over the last decade, with the availability of secondary radioactive ion beams, understanding the role of break-up has become a major research focus [3]. Understanding the reaction mechanisms of loosely bound projectiles and the coupling of their break-up on various channels is very important. Projectile break-up modifies the accepted picture for two body fusion of strongly bound nuclei. Measurements involving the projectiles ^{6,7}Li, ^{6}He, with α+x cluster structure, show significantly larger cross sections for the inclusive alpha particle production [4] compared to the production of the complementary fragment (x). This indicates that there are mechanisms other than α+x break-up responsible for the inclusive production of alpha particles[5].
In this report we present the different outgoing channel leading to break-up of the projectile in coincidence condition at the beam energy of 35 MeV for the^{7}Li+^{208}Pb system. An interpretation of α spectra from projectile break-up will be discussed. It will shed light on the implications of the higher binding energy of ^{7}Li on the exclusive break-up. This is a continuation of our previous investigation[6].

Experimental Detail

The experiment was performed at LNL (Laboratori Nazionali di Legnaro) Tandem Van de Graaff accelerator , using a ^{7}Li beam, having beam currents ranging between 5 and 10 nA, and bombarding on a ^{208}Pb (self-supporting) target having thickness 200 μg/cm^{2}. The beam energies ranged from 35 to 39 MeV. The emitted particles were detected by the 4π array 8πLP [7]. The "WALL" in forward directions (from 2.5^{0} to 23^{0}) and the BALL, covering lab angles from 34^{0} in up to 163^{0}, are the two essentially part of the array. A silicon surface barrier detector used as a ΔE and a CsI(TI) scintillator used as E (300 μm and 5 mm thick) makes a telescope. There are 126 telescopes in BALL divided in to 7 rings A, B, C, D, E, F &G. The WALL is a matrix of 11×11 telescopes. As the WALL is in forward direction we have used the WALL data for the present case. A very good identification of light charged particles α, t, d and proton were clearly observed. ^{7}Li was completely stopped in the ΔE. For each telescope the ΔE vs Time and ΔE vs E_{res} matrices has been recorded to identify each particle independently.

Results and discussions

The detected particles were identified by the two method : the energy loss ΔE and E_{res} matrix and ΔE Vs Time (T) matrix. A typical raw matrix is shown Fig.1.

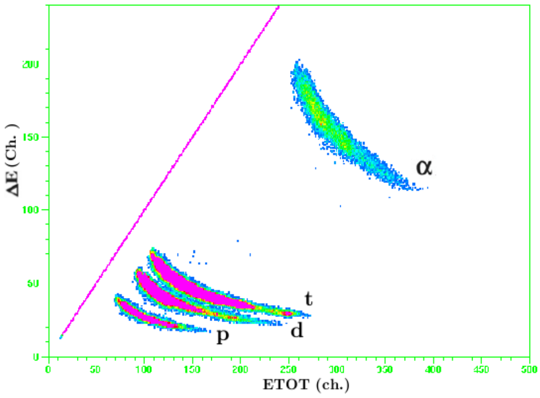

Fig. 1 Experimental matrix at E_{lab}= 35 MeV. Different particles (p, d, t, α) are very clearly identified.

The break-up events were identified by generating plots between the kinetic energies E1(α) and E2(t) of the coincident particles. An example is shown in Fig.2. The α and tritium (t) coincidence data have been used for the present case. From Fig.2[a] one can observe that there are different breakup sources indicated by different bands (B1 & B2).

Strongly populated band B1 corresponds to the break-up of projectile from the g.s of ^{208}Pb, whereas break-up due to inelastic excitation of the target ^{208}Pb is present in band B2. The strongly populated area in B1 are due to forward and backward motion of breakup fragments in the rest frame of ^{7}Li. In order to understand the origin of the break-up process a Q value reconstruction has been done and shown in Fig.2[b]. The peak at highest Q value corresponds to ^{208}Pb$^{g.s}$, while the different excited states correspond to the other peaks on the Q spectrum [8]. Same plot was found for 39 MeV case and will be presented. The reconstructed relative energy spectrum (E_{rel}) will be presented at the presentation along with a Monte Carlo simulation of the projectile break-up.

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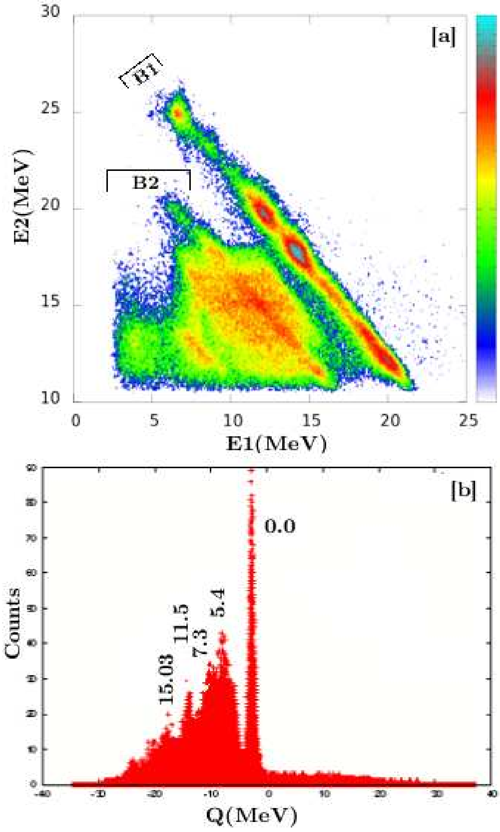

Fig. 2[a] Coincidence spectra of E1(α) and E2 (t) at E_{lab}=35 MeV for ^{7}Li+^{208}Pb reaction. [b] Q value reconstruction from [a]. see text for detail.

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