Estimation of ICF and NCBU in ^{7}Li + ^{208}Pb reaction

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Introduction

The study of the reaction dynamics induced by loosely bound projectiles is one of the most challenging topics in nuclear physics, especially in the context of the increasing number of radioactive ion beam facilities [1]. Over the last decade, with the availability of secondary radioactive ion beams, understanding the breakup effect has become a major research focus [2]. Projectile breakup modifies the accepted picture for two body fusion of strongly bound nuclei. It has been reported that [3] the projectile breakup phenomena can occur either in the vicinity of the target or it can break at very far away (elastic, inelastic/sequential breakup). In both the situation the projectile can break into two or more fragments keeping the heavy recoil nuclei either in ground or excited state. 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. It has been reported that using above loosely bound projectiles ~20-30% suppression of fusion cross section has been found compared to coupled channel calculation as well as the other reaction forming the same compound nucleus but involving strongly bound projectile. It has also reported that in addition with breakup, transfer and incomplete fusion (ICF) is also important channel to be considered using loosely bound nuclei [4]. In this report we presented a classical trajectory model calculation to understand the effect of incomplete fusion & the contribution of the no capture breakup on total exclusive measurement for ^{7}Li+^{208}Pb.

Experimental details

The experiment was performed at LNL (Laboratori Nazionali di Legnaro) Tandem Van de Graaff accelerator, using a ^{7}Li beam having beam energies ranged from 25 to 39 MeV. The incident beam currents was between 5-10 nA. A ^{208}Pb target (self-supporting) having thickness 200 μg/cm^2 has been used. The emitted particles from the reaction were detected by the 4π array 8πLP [5] setup. The "WALL" in forward directions and the BALL, covering lab angles from 3^0 upto 163^0, are the two essentially part of the array. There are 126 Telescope (ΔE and CsI(TI) as E) presents in BALL where as the WALL consists of a matrix of 11×11 telescope. For each telescope the ΔE vs Time and ΔE vs E_{res} matrices has been recorded to identify each particle independently. A variety of particles (α, t, d, p & elastic ^{7}Li) has been detected and very well separated from each other. Presence of all the above particles indicates the presence of different reaction process. The ICF are the events where the projectile will breakup into two or more fragments and one of the fragment will fuse with target and the remaining will move away with ~ beam velocity.

Results and discussions:

The detected Particles were identified by the following mechanisms: a) The energy loss (dE/dx) method using ΔE and E_{res} matrix for each telescope b) ΔE Vs Time (T) matrix to separate independent particles including elastic peak. The coincidence between two breakup fragments confirms the different breakup channels. There are different origin for particles like: the direct breakup of ^{7}Li from its resonance state into alpha and t; ^{7}Li will pick up of a Proton to become ^{8}Be then breaks to (alpha + alpha) ; a neutron will strip out from ^{7}Li and becomes ^{6}Li which will break to α and d. Similarly ICF channel can also possible. All the contribution will be present and effect the detected particle spectrum. Fig.1 shows a ΔE vs.

Time plot of detected particles for 31 MeV ^{7}Li beam . From the Fig.1 one can observe that there are very nice separations between different particles say p, d, t ,α and elastic ^{7}Li. The ΔE vs Time plot has been used to extract the elastic data and the analysis of the elastic scattering angular distribution [6] was performed using phenomenological potentials in the code FRESCO.

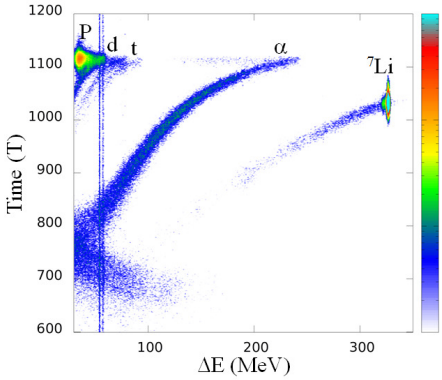

Fig. 1: Experimental ΔE vs Time (T) spectra for ^{7}Li+^{208}Pb reaction at 31 MeV. The different particles were identified clearly.

The alpha angular distribution (inclusive, exclusive, pickup/transfer, NCBU(no-capture breakup)) has been already reported [7]. The angle integrated cross section has been extracted and in order to understand the contribution of σ_{ICF} & σ_{NCBU} channel a classical trajectory model calculation has been performed using the code PLATYPUS [8]. The measured data has been well reproduced by the calculation for σ_{NCBU} and shown in Fig.2. The contribution of the σ_{NCBU} + σ_{ICF} (cal) has been estimated above the barrier (V_B ~ 30 MeV) and found ~10-20% of total measured exclusive channel cross section ($\sigma_{\alpha\alpha,}+\sigma_{\alpha t}+\sigma_{\alpha d}$). Similarly the contribution of $\sigma_{\alpha\alpha,}+\sigma_{\alpha d}$ found as ~80-90% of the total $\sigma_{exclusive}$. It has reported [4] that contribution of $\sigma_{\alpha t}$ ~60-70% and the contribution of ($\sigma_{\alpha\alpha,}+\sigma_{\alpha d}$) ~40% of the total exclusive measurement bellow the barrier region. Comparing both result (present & [4]) one can observe a wide range of contribution of different channels to the total exclusive cross section of the present given system which need to be investigated. The code PLATYPUS is a classical model so only above barrier calculation has been performed and shown in Fig.2. The details of parameters for the calculation are taken from literature which will be presented.

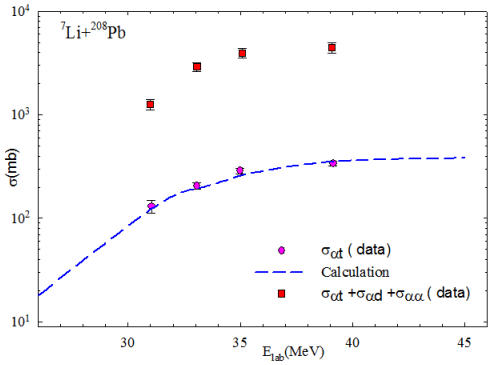

Fig. 2: The σ_{NCBU} and the total exclusive channel with PLATYPUS calculation has presented.

A study of contribution of different channels to the total exclusive cross section has been presented. A classical model calculation has been performed to understand the ICF and NCBU cross section. The detail of the calculation and data extraction will be presented.

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