Estimation of CF in ^{7}Li + ^{208}Pb reaction

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Introduction

The study of nuclear reaction induced by loosely bound projectiles is a most interesting and challenging topics to study. This is also important w.r.t radioactive ion beam facilities [1]. Over the last decade, peoples have studied many reaction induced by the loosely bound projectiles and try to understand the breakup effect in reaction mechanics, specially the breakup effect in the fusion cross section. [2]. The breakup of the Projectile modifies the conventional accepted picture of two body fusion to form new nuclei. It has been observed that the breakup of the projectile can occur either in the vicinity of the target or it can break at very far away (elastic, inelastic/sequential breakup) [3]. Due to this breakup there is a loss in incident flux which leads to the suppression of the fusion cross section. On the other hand the coupling of the breakup channels to the other reaction channels leads to the enhancement of the cross section below the barrier. The comparison has done always w.r.t single barrier penetration model calculation at above the barrier and below the barrier with the Coupling calculation. This behavior of the fusion cross section has been studied in many system [4-6]. There are certain ambiguity in the lighter system but for heavier system it is well establish. From theoretical point of view peoples are using CDCC, PLATYPUS, CCFULL to understand the coupling effect. In the present contribution we have tried to find the complete fusion cross section for the ^{7}Li + ^{208} Pb reaction. Experimentally the particle spectrum has been measured in singles and coincidence. The details has been explained below.

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 31 to 39 MeV (only four energy). 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 setup. The "WALL" in forward directions and the BALL, covering lab. angles from 3^0 up to 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 coincidence exclusive breakup event has been recorded and considered for the calculation. The projectile will breakup into two or more fragments and they have been detected in coincidence mode.

Results and discussions:

The detected Particles were identified by the energy loss (dE/dx) method and ΔE Vs Time (T) method. The elastic ^{7}Li has been stopped in the ΔE part. So in the E- ΔE spectra there is no any elastic peak. A typical raw spectrum of the particle has been shown in Fig.1. The coincidence between different detected particles confirms the different reaction process from where the particles has been emitted. There are different origin for particles like: the direct breakup (elastic, inelastic breakup), transfer breakup, pickup breakup etc. Similarly ICF channel can also possible. All the contribution will be present and the cumulative particle

spectrum has shown Fig.1. From ΔE vs Eres plot different particles has been identified and the coincidence spectra has been built .

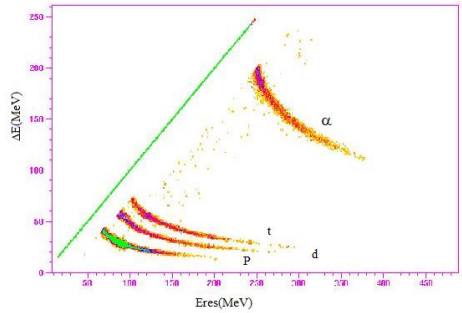

Fig. 1: Experimental ΔE vs Eres spectra for ^{7}Li+^{208}Pb reaction at 39 MeV. The scale has been multiplied with a factor of 10.

The alpha cross section (exclusive events for, NCBU(no-capture breakup)) has been determined for the four energy points (31,33,35 & 39 MeV) experimentally . To understand the observed cross section a classically trajectory model calculation has been performed using PLATYPUS to explain the NCBU cross section which has been shown in Fig,2(a). From the Fig.2 one can see that the NCBU has been nicely reproduced by the calculation and the corresponding CF cross section predicted by the model has been recorded for further analysis. The predicted CF cross section has been shown in Fig.2 (b). A separate calculation using CCFULL has been done to understand the fusion cross section behavior and shown in the Fig.2 (b). From the Fig.2 (b) one can see that the measured cross section which are above the barrier shows a suppression of the fusion cross section w.r.t the SBP calculation. The coupling calculation has not performed since there is no data below the barrier (V_B~30 MevV) and above the barrier coupling effect is negligible. The parameters has been taken from [7] for the calculation. One can see that from the Fig.2 (b) the CF cross section is not matching with the SBP calculation where as a multiplication factor of (0.62) has been multiplied with the CF calculated value to reproduce the estimated data which indicates the suppression of ~38% . This suppression is little more compared to other reaction involving loosely bound projectiles. Since there are very few points we did not improved further. In future we like to measure the CF cross section for more data points (both below and above the barrier). The detail calculation and the extraction method will be presented including the parameters for the calculations.

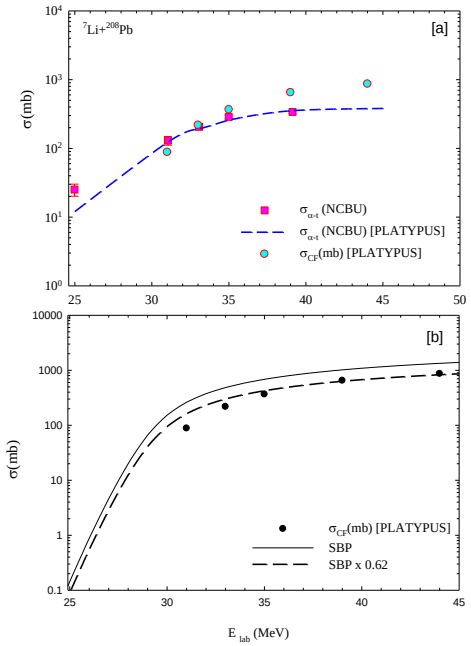

Fig. 2: (a) PLATYPUS calculation to reproduce the exclusive NCBU cross section. (b) The estimated CF cross section from PLATYPUS has been compared with CCFULL.

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