Resonant breakup in ^{7}Li + ^{208}Pb reaction

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Introduction

The breakup of the projectile in the coulomb field of target including the nuclear breakup is of renewed interest in nuclear reaction involving loosely bound projectiles. It is important an interesting in the context of RIB facilities [1]. Over the last decade, many studies has been done using loosely bound projectiles (^{6,7}Li, ^{9}Be…etc) to understand the reaction mechanics and it has understood up to certain extent. Many reports [2-4] has been found that the effect of breakup is present including the coupling of the breakup channel with the other reaction channels as a result the suppression and enhancement of the fusion cross section has been found. People are trying to develop the theoretical models which explain this phenomena and so far we have classical trajectory model [5] and CDCC is available for the calculation, not in a direct but in an indirect way. In many reports also it has found that the alpha cross section is higher compared to what is expected. Which is far from being fully understood. It has well established and seen that there are contribution from the transfer and pickup channels to the reaction mechanics. Also It has been reported that 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 fragments and detected experimentally. This work is a continuation of our earlier work. It has been seen that there are exclusive as well inclusive alpha events for ^{7}Li+^{208}Pb reaction. In this contribution we have discussed the breakup from the resonant states (Ex-4.652, 6.67 MeV) of the projectile. The higher resonant state has been observed with low statistics. A Monte Carlo simulation has been performed to understand the process.

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 31,33,35 & 39 MeV. The beam currents was between 5-10 nA. A self-supporting target of ^{208}Pb having of thickness 200 μg/cm^2 has been used for the experiment. In the exit channels only the emitted particles has been detected in Singles and coincidence. For the measurement the 4π array 8πLP setup has been used. It has two main part The "WALL" and the "BALL". The WALL is in forward directions and the BALL is in backward. Both covers the lab. angles from 3^0 up to 163^0 ·There are in total 246 Telescope (ΔE and CsI(TI) as E) has been used out of which 126 numbers are in BALL and the remaining are in WALL. The wall is matrix of 11×11 telescope. For the particle identification, for each telescope the ΔE vs Time and ΔE vs E_{res} matrices has been recorded. A variety of particles (α, t, d, p & elastic ^{7}Li) has been detected and very well separated from each other. The elastic ^{7}Li has been stopped in the ΔE part since the thickness of the ΔE was more so in the E-ΔE spectrum all the other particles are there except the elastic one . But the elastic is present in the ΔE vs Time graph. For the Present purpose the ΔE vs E_{res} spectrum has been considered and only the Coincidence events has been analyzed for the full setup. There are other channels are also present but the focus has been given for the resonant states only.

Results and discussions:

The particles which emitted during the reaction in the exit channel has been identified by the above mentioned process. A typical raw spectrum has been shown in Fig.1.

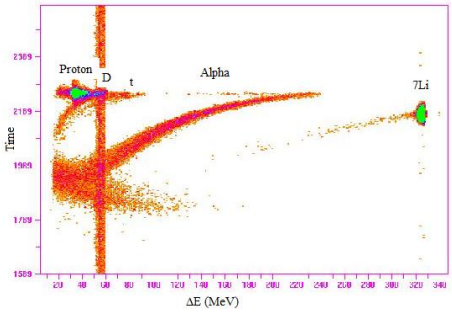

Fig. 1: Experimental ΔE vs Time (T) spectra for ^{7}Li+^{208}Pb reaction at 33 MeV. All the particles has been identified separately including the elastic one also.

The coincidence between two breakup fragments (alpha and triton in this case) confirms the breakup channels have of different origin, like: the direct breakup of ^{7}Li from its resonance states, elastic/inelastic breakup. The alpha and the triton of different origin has been detected in coincidence and the spectrum for 33 MeV has been shown in the Fig.2. It has been seen that there are breakup from the resonant states (4.652MeV,E_{rel}=2.18 MeV & 6.67 MeV, E_{rel}= 4.2 MeV) with different statistics indicated as different patches in the coincidence band between alpha and triton. But there are other patches also which indicates the presence of different excited states of the targets shown in Fig.2. To understand the resonant breakup a Monte Carlo simulation has been done considering the geometry of 8PLP and the results has been shown in Fig.2 (b). There are different patches indicated as different Situation. For the breakup of ^{7}Li to alpha-triton, one of the detector can detect alpha whereas the other can detect the triton and vice versa. So for one mode of breakup (breakup from one resonant state) two plots has been shown leading to two detection alpha/triton in the same detector. The 1D histogram for the alpha has been shown in the Fig.2(c) and one can see the different peaks for the different resonant states. Higher the resonant states makes the breakup cone larger which required to cover the larger solid angle in practical. The cross section estimation is under progress which will be presented in the conference. The detail of the calculation will be presented.

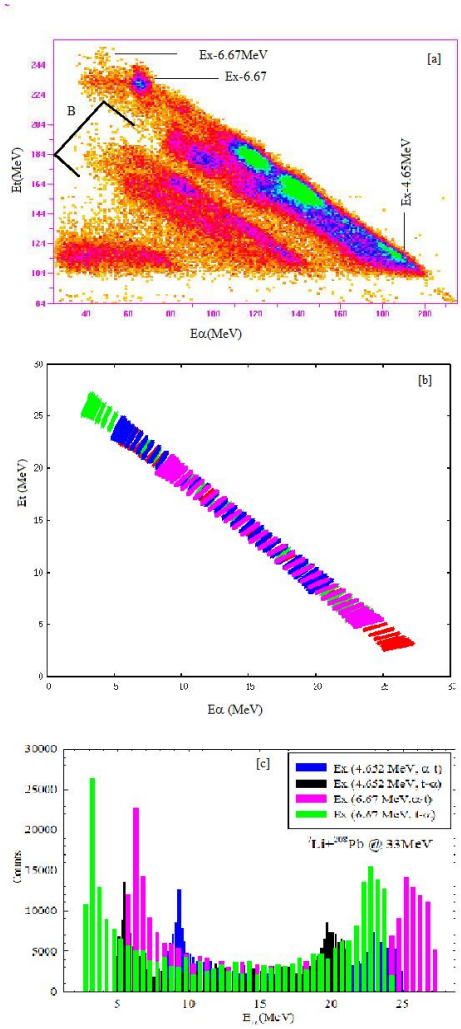

Fig. 2: (a) alpha –triton coincidence events (b) the calculation for resonant breakup (c) the 1D histogram of exclusive alpha.

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