

Breakup phenomena study in ${}^7\text{Li}+{}^{208}\text{Pb}$ reaction using 8PLP

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Abstract. Inclusive α particle spectra for ${}^7\text{Li}+{}^{208}\text{Pb}$ reaction has been studied. There are different reaction mechanism such as pickup/transfer including breakup influence the observed α particle spectra. Presence of different bands of triton indicates the origin is different which needs more study.

1 Introduction

Coulomb excitation leading to the continuum (unbound) states in the outgoing channel is a common phenomenon observed in the reactions involving weakly bound nuclei. Study of fusion reactions involving weakly bound (stable or radioactive) projectiles is a subject of topical interest [1,2]. In case of loosely bound nuclei, projectile breakup modifies the accepted picture for two-body fusion of strongly bound nuclei. Some of the loosely bound projectiles are ${}^6\text{Li}$ and ${}^9\text{Be}$, where the α separation energies are $S_\alpha=1.48$, 2.45 and 1.57 MeV respectively. Projectile breakup can occur in nuclear collisions if a state above the relevant breakup energy threshold is populated. Some observations shows that breakup was found to be predominantly triggered by nucleon transfer, with p-pickup leading to $\alpha + \alpha$ coincidences being the preferred breakup mode for ${}^7\text{Li}$ and n stripping leading to $\alpha + p$ for ${}^6\text{Li}$ [3,4]. Our current study has the purpose to investigate the breakup of ${}^7\text{Li}$ at energy around the coulomb barrier. The present work describes an experiment, measuring the α -particle (inclusive / exclusive) yield from ${}^7\text{Li} + {}^{208}\text{Pb}$ reaction

2 Experimental details

The experiment was performed with a highly efficient and sophisticated 4π array (8 π LP) [5,6]. A ${}^7\text{Li}$ beam was delivered by the Laboratori Nazionali di Legnaro Tandem Van de Graaff accelerator having beam energy 31 MeV. Beam currents ranged between 5 and 10 nA. Light charged particles were detected by (8 π LP) array as described in detail in [7]. An enriched ${}^{208}\text{Pb}$ of thickness $150 \mu\text{g}/\text{cm}^2$ on a backing of ${}^{12}\text{C}$ of thickness $10 \mu\text{g}/\text{cm}^2$ was used as target. The array is essentially made of two parts: a “WALL” in forward directions, covering the angles from 2.5° to 34° and a “BALL” part covering the angles up to 163° . Only charge particles has been detected, there was no any neutron detector. The data acquisition has arranged to record for each telescope the

Time Vs ΔE and ΔE vs. E_{res} matrices for particle identification.

3 Results and discussions

Particles were identified by two mechanisms: 1) using energy loss information from ΔE and E_{res} for each telescope, 2) ΔE and Time (T). The time is a mix of time of flight and pulse shape discrimination rise time. The efficiency of the detector has been measured by the standard sources and the geometric efficiency has been corrected by using the solid angle subtended by the detector. We studied the different types of particle emitted in the reaction ${}^7\text{Li}+{}^{208}\text{Pb}$ at 31 MeV, same as in [8]. The case of ${}^7\text{Li}$ is however more interesting as ${}^7\text{Li}$ has larger breakup threshold (BT) ($E_{\text{at}}=2.47$ MeV) compare to ${}^6\text{Li}$ ($E_{\text{ad}} = 1.48$ MeV) and ${}^7\text{Li}$ has one bound excited state (0.477 MeV) below the the BT whereas ${}^6\text{Li}$ has none.

The ${}^7\text{Li}$ projectile, while moving in the field of a target nucleus, can dissociate into α and t . This dissociation can either be direct or sequential. The identification of different breakup processes and their measurements are challenging tasks. In this report we have presented the inclusive/exclusive measurement of ${}^7\text{Li}$ breakup cross sections.

An experimental E- ΔE spectrum is shown in Fig. 1. Different energy peaks are clearly visible for both deuterons and tritons. The different patterns on the triton band may indicate the strong presence of the projectile breakup into an α particle and a triton. A good charge and mass resolution was achieved. The breakup channels were identified by making a coincidence between two breakup fragments. The α particles have different origins: as the direct breakup of ${}^7\text{Li}$ from its resonance state at 4.63MeV into α and triton (t); pickup of a proton (very unlikely) to become ${}^8\text{Be}$ then breaks to ($\alpha + \alpha$) or strip of

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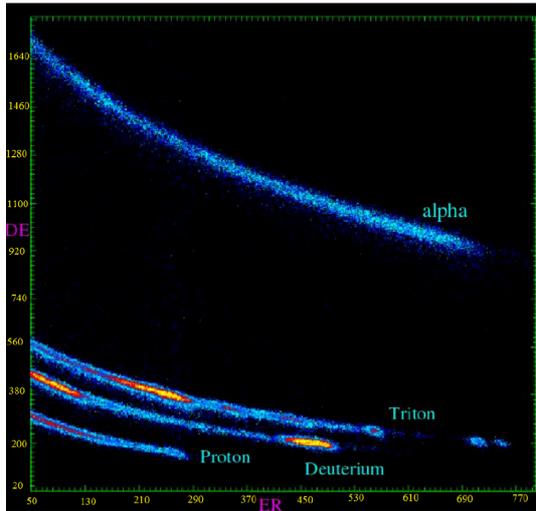


Figure 1. (Color online) Experimental two-dimensional particle spectra for ${}^7\text{Li}+{}^{208}\text{Pb}$ reaction at 31 MeV. The telescope was at forward angle ($\theta=20.6^\circ$ and $\phi=346.53^\circ$). Deuterons and tritons of different energies are clearly separable and are expected to belong to different types of reaction mechanism. Different peaks in the triton band indicate different emission process, including breakup via inelastic excitation (see text for details)

a neutron and becomes ${}^6\text{Li}$ which will break to α and deuteron(d). There is another channel for breakup of ${}^7\text{Li}$ ($\alpha+d+n$), as we had no any neutron detector this channel was not explored. Particle-particle coincidences were measured to gain insight on the exclusive events. The inclusive/exclusive differential cross sections have been extracted from the coincidence data. Extracted Inclusive/exclusive cross-section has been shown in Fig. 2.

4 Summary

The inclusive α particle spectra for ${}^7\text{Li}+{}^{208}\text{Pb}$ reaction at 31 MeV has been presented. The different bands of triton indicates the presence of different mechanism like transfer and pickup. We can conclude that other reaction mechanisms which provides significant amount of α to the inclusive cross section need further study.

Acknowledgment

One of the authors (P.K.Rath) acknowledges the financial support of University of Naples Federico II, Naples, Italy, in carrying out these investigations.

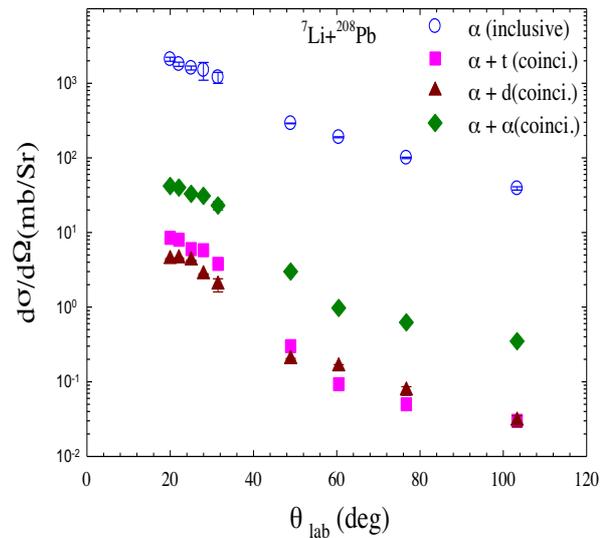


Figure 2. (Color online) Measured cross sections for different channels at $E_{\text{beam}}=31$ MeV. Two important observation has been found 1) addition of all the coincidence channel also not able to reproduce the inclusive data indicates the contribution of some other channels like ($\alpha+d+n$) which needs further study. 2) the ${}^7\text{Li}+p \rightarrow {}^8\text{Be}^* \rightarrow \alpha+\alpha$ channels is more significant than $\alpha+t$ channel indicate the importance of p-pickup process.

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