

Neutron stripping cross sections in ${}^7\text{Li}+{}^{205}\text{Tl}$ system

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Introduction

Elastic scattering, fusion, transfer and breakup reactions and their relative importance on reaction mechanism involving weakly bound projectiles is a topic of interest for last few decades [1, 2]. In this context, several experimental studies have been performed over the years utilizing projectiles of both stable and unstable weakly bound nuclei. The systematic studies of inclusive α , reaction and total fusion cross sections with various projectiles have been highlighted in these studies [1]. However, the contribution of neutron transfer cross sections in reactions with these projectiles has not received similar attention. Stable weakly bound nuclei ${}^6,{}^7\text{Li}$, ${}^9\text{Be}$ have the well known cluster structure $\alpha + d$, $\alpha + t$, $\alpha + \alpha + n$ respectively. There is also the possibility of transfer followed by breakup with these projectiles [3, 4].

In the present work, we report the measurements of 1n and 2n stripping cross sections for the ${}^7\text{Li}+{}^{205}\text{Tl}$ system along with the coupled channels calculations.

Experimental Details

The experiment was carried out by utilizing ${}^7\text{Li}$ beam from 14UD BARC-TIFR Pelletron LINAC Facility, Mumbai at energies ranging from $E_{\text{beam}} = 24\text{--}40$ MeV. The details of the measurement are reported in our earlier work

[5]. The target ${}^{205}\text{Tl}$ of thickness of 1 mg/cm^2 with a carbon backing of $25\text{ }\mu\text{g/cm}^2$ was used. Prompt γ -ray transitions were detected using seven Compton suppressed High Purity Germanium (HPGe) Clover detectors surrounding the target chamber. Two Si surface barrier detectors were placed at 25° and 35° for absolute normalisation. Data were collected using a digital data acquisition system with a sampling rate of 100 MHz. Standard calibrated ${}^{152}\text{Eu}$ and ${}^{133}\text{Ba}$ γ -ray sources are used for efficiency and energy calibration of the clover detectors.

Coupled channels calculations

Coupled Reaction Channel (CRC) calculations considering the one neutron transfer were performed to various excited states of the residual nucleus using the code FRESKO [6]. The details of the CRC calculation method are given in our earlier work [7]. The calculations require optical model potential parameters in the entrance and exit channel. The recently developed phenomenological global optical model potentials for ${}^6,{}^7\text{Li}$ [8, 9] were utilised. Potential of the Woods-Saxon form with radius $1.25A^{1/3}$ fm and diffuseness 0.65 fm, with 'A' being the mass number of the core nucleus is used for binding of the transferred particle with the core of the target. The depths were automatically adjusted to obtain the required binding energies of the particle-core composite system. Energy states and corresponding spectroscopic amplitudes of the residual nucleus ${}^{206}\text{Tl}$ have been considered

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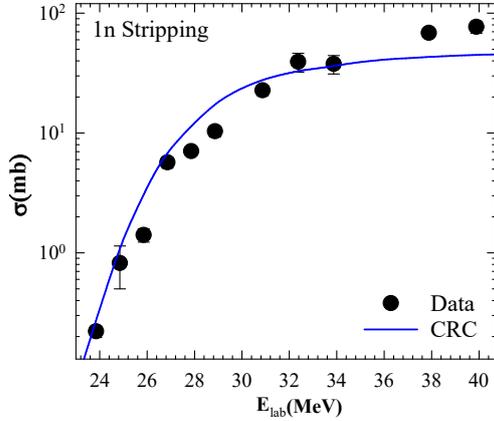


FIG. 1: Comparison of measured 1n stripping cross sections as a function of beam energy in the laboratory for ${}^7\text{Li}+{}^{205}\text{Tl}$ system with the CRC calculations.

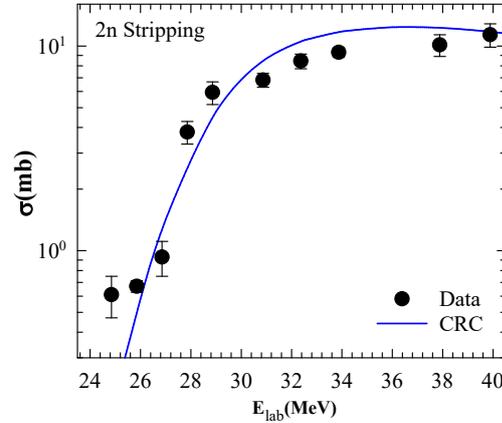


FIG. 2: Comparison of measured 2n stripping cross sections as a function of beam energy in the laboratory for ${}^7\text{Li}+{}^{205}\text{Tl}$ system with the CRC calculations.

upto 2.4 MeV in the calculations. The ground state coupling spectroscopic factor (C^2S) for the overlapping of the states ${}^7\text{Li}/{}^6\text{Li}$ is taken to be 0.43 for the $p_{3/2}$ and 0.28 for the $p_{1/2}$ orbital, as reported in Ref. [10]. Similar calculations were performed for 2n transfer considering the excited states of residual ${}^{207}\text{Tl}$ nucleus.

Results and Discussion

Measured 1n and 2n stripping cross sections are compared with the calculated cross sections in Figs. 1 and 2, respectively. A very good agreement between the data and calculations can be seen. The measured 1n and 2n stripping cross sections from the present work are found to match with the systematic reported in the Ref. [7].

Summary

1n and 2n stripping cross sections were measured using online γ -ray measurement technique for ${}^7\text{Li}+{}^{205}\text{Tl}$ system. The CRC calculations were performed using the reliable global optical model potential parameters of ${}^7\text{Li}$ projectile for investigating the role of neutron transfer around barrier energies. The calculations match both the data very well.

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