Study of \(\alpha\)-cluster transfer reaction with \(^7\)Be

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Introduction

The \(\alpha\)-cluster transfer reaction studies involving loosely bound stable and unstable nuclei have a profound impact on astrophysics. In particular, the reactions with \(^6\)Li and \(^7\)Li have been widely used to get spectroscopic factors and reduced \(\alpha\)-widths. These quantities in turn have been successfully utilized in the understanding of stellar nucleosynthesis [1,2]. In the present work, we have studied \(\alpha\)-transfer reaction with the radioactive nucleus \(^7\)Be on \(^{12}\)C at 5 MeV/A.

Experimental setup

We have carried out an experiment at HIE-ISOLDE, CERN with \(^7\)Be beam of intensity \(\sim\) \(5\times10^5\) pps. We used deuterated polyethylene (CD\(_2\)) target of thickness 15 \(\mu\)m. The detector setup consisted of a 1000 \(\mu\)m annular silicon detector (S3) covering angles 8° - 25°. Five 16 \(\times\) 16 double-sided silicon strip detectors (DSSD) backed by 1500 \(\mu\)m thick unsegmented Si detectors in a \(\Delta E\) - \(E\) telescope configuration cover angles 40° - 80° in a pentagon geometry. At the back angles, two 32 \(\times\) 32 DSSDs of thickness 60 \(\mu\)m and 140 \(\mu\)m backed by 1500 \(\mu\)m unsegmented silicon pad detectors cover 120° - 140°. This setup covers 29% of the total solid angle 4\(\pi\) [3].

Analysis

The transfer reaction, \(^{12}\)C\((\ ^7\)Be,\(^3\)He)\(^{16}\)O has been studied and compared to similar reaction from the mirror counterpart \(^7\)Li. A typical \(\Delta E\) - \(E\) tot plot with angular correction and the front-back matching of energy within the tolerance 500 keV is shown in Fig. 1. The banana gate drawn on this plot selects the particle of interest, \(^3\)He. Subsequently, those events give the energy spectrum showing the excitation states of \(^{16}\)O (Fig. 2).

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In Fig. 2, the energy spectrum of $^3\text{He}$ at $\theta_{\text{lab}} = 44^\circ$ shows the $^{16}\text{O}$ excited states at 6.049, 6.917 and 10.36 MeV. In the figure, we also show the relevant simulation using NPTool [4], a package built on GEANT4 and ROOT.

Conclusions and outlook
The spectra show higher level excitations of $^{16}\text{O}$ up to 25 MeV. Our angular coverage will allow us to arrive at improved angular distribution as compared to earlier data [5]. Since $^7\text{Be}$ has a prominent $\alpha$-cluster structure, its breakup channel is also being investigated as compared to the above transfer reaction. Data analysis is underway.

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References