Elastic and inelastic scattering of ^{7}Be on ^{12}C at 5 MeV/A

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Introduction

Elastic scattering is widely used in the study of change in properties of nuclei as we move towards the drip lines [1, 2]. The breakup and transfer reactions significantly alter the elastic scattering when the nucleus involved is loosely bound and has cluster structure. The loosely bound stable Lithium isotopes ^{6}Li and ^{7}Li [3], have cluster structures and their breakup channels have been extensively studied. The work of Amro *et al.* [4] with ^{7}Be + ^{12}C at 34 MeV shows that the α-cluster transfer reaction is more significant than breakup of ^{7}Be. Low breakup cross section was also found for ^{7}Be + ^{58}Ni measurement at 21.5 MeV [5]. Owing to this low breakup yield as evident in earlier works, such reactions are favourable tools to study high-excitation α-cluster states in the residual nuclei in the context of helium-burning process in nuclear astrophysics [4]. In the ^{7}Be + ^{12}C work [4], the uncertainty in the optical model parameters (OMP) due to the limited angular range of the elastic scattering data posed a serious problem in the study of transfer reactions. This demanded new measurements at this energy. The present work reports the measurement of elastic and inelastic scattering of ^{7}Be on ^{12}C using a detector array covering a wide angular range.

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Experiment

The experiment was carried out at the HIE-ISOLDE [6] radioactive ion beam facility of CERN using a 5 MeV/A ^{7}Be beam of intensity $\sim 5 \times 10^{5}$ pps on a 15 μm CD_2 target. A 15 μm CH_2 and 1 mg/cm^2 Pb targets were also used for background measurements and normalization respectively. The charged particles emitted from the reaction were detected in the forward angles $8^\circ - 25^\circ$ by a Micron S3 annular detector of thickness 1000 μm. At $40^\circ - 80^\circ$, we had a pentagon geometry configuration consisting of 5 double sided 16×16 Micron W1 silicon strip detectors (DSSD) of thickness 60 μm (ΔE), backed by MSX25 unsegmented silicon-pad detectors of thickness 1500 μm (E). A pair of 32×32 Micron BB7 DSSDs of thickness 60 μm and 140 μm backed by pads is also placed symmetrically about the beam axis at the back angles covering $127^\circ - 165^\circ$.

Analysis and Outlook

The elastic peak from ^{7}Be + ^{12}C scattering can be distinctly seen in each ring of the annular S3 detector. In Fig. 1 the energy spectrum at $\theta = 12^\circ$ shows elastic ^{7}Be peak from CD_2 and CH_2 (scaled 12 times) targets represented by the blue and red curves respectively. The overlapping of peaks correspond to elastically scattered ^{7}Be from C nuclei in each of the targets. From CH_2 target, the proton scattered off ^{7}Be can be seen in the figure. Also, the ^{7}Be scattered off deuteron from CD_2 target can be seen adjacent to ^{7}Be

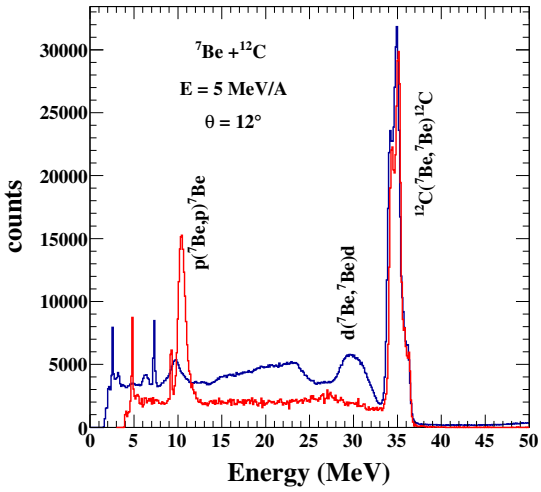

FIG. 1: Energy spectrum of elastic scattering of ^{7}Be + ^{12}C at 5 MeV/A in S3 detector, at $\theta = 12°$. The blue (red) curve represents the data for CD_2 (CH_2) target.

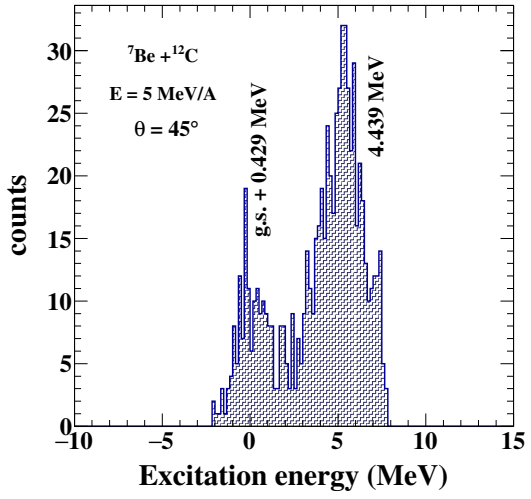

FIG. 2: Excitation energy spectrum of ^{12}C at $\theta = 45°$ at the pentagon detectors.

- ^{12}C peak. Inelastic scattering to the 4.439 MeV (2^+) excited state of ^{12}C can be identified from the pentagon DSSDs. Here, the detected ^{7}Be deposits complete energy in the ΔE detector of the telescopes. The excitation energy of ^{12}C is shown in Fig. 2. The bound excited state of ^{7}Be at $E_x = 0.439$ MeV ($1/2^-$) could not be separated from the ground state due to energy resolution. Thus the present data represents quasi-elastic scattering of ^{7}Be on ^{12}C. The elastic scattering data covers an angular range $\sim 8° - 80°$ while the inelastic data could only be extracted from the pentagon DSSD detectors covering $40° - 80°$ in lab. Phenomenological and microscopic analysis of the elastic and inelastic data and calculation of the deformation parameter are in progress.

Acknowledgments

The authors thank the ISOLDE engineers in charge, RILIS team and Target Group at CERN for their support. D. Gupta acknowledges research funding from the European Union's Horizon 2020 research and innovation programme under grant agreement no. 654002 (ENSAR2) and ISRO, Govt. of India under grant no. ISRO/RES/2/378/15−16.

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