Resonance excitations in the ^{7}Be + d experiment at CERN–ISOLDE

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Introduction

The Big Bang Nucleosynthesis (BBN) theory has been very successful in predicting the observed abundances of light elements like ^{2}H, ^{3,4}He. There is, however, a serious discrepancy of a factor of about four in the observed abundance of ^{7}Li as compared to that predicted by the BBN theory [1–2]. The high precision measurement of the baryon to photon ratio η by the Wilkinson Microwave Anisotropy Probe (WMAP) and recent observations of metal poor halo stars shows that the ^{7}Li abundance predicted by the BBN theory is about 5.12×10^{10}, whereas the observed value is about 1.23×10^{10}. This anomaly has been unsolved for decades and is well known. Several avenues have been searched for a solution, of which the resonance excitations in reactions with ^{7}Be appear to be very attractive [3].

Experiment

We carried out an experiment at the HIE-ISOLDE facility in CERN, Geneva using a 5 MeV/A ^{7}Be beam of intensity $\sim 5 \times 10^{5}$ pps on a CD_2 target of thickness 15 μm. The setup consisted of 5 double sided 16×16 silicon strip detectors (DSSD) of thickness 60 μm backed by unsegmented silicon-pad detectors of thickness 1500 μm. The $\Delta E - E$ telescope configuration of the detectors were set up in a pentagon geometry for charged particle detection covering 40° – 80° in the lab. The forward angles from 8° – 25° were covered by an annular detector of thickness 1000 μm. The back angles from 120° – 140° were covered by two 32×32 DSSDs of thickness 60 μm and 140 μm backed by unsegmented silicon-pad detectors of thickness 1500 μm (Fig. 1).

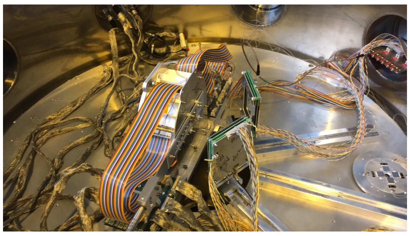

FIG. 1: The ^{7}Be + d experimental setup at ISOLDE.

Analysis and discussions

A typical ΔE vs E_{total} spectrum of the detectors from the ^{7}Be reaction on a CD_2 target shows clear bands of p, d, ^{3}He and α particles (Fig. 2).

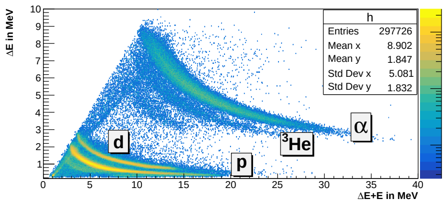

FIG. 2: A typical ΔE vs E_{total} spectrum from the experiment.

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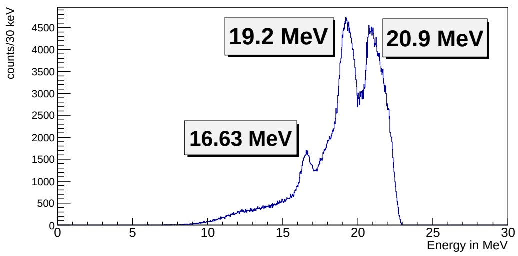

FIG. 3: Excitation energy spectrum of ^{8}Be* from the ^{7}Be + d experiment at E_{lab}= 5 MeV/A.

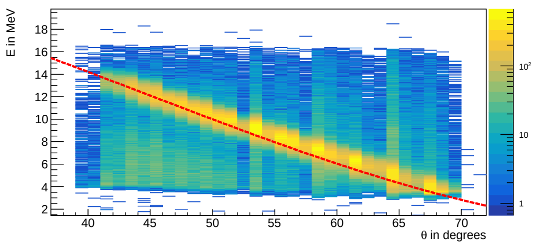

FIG. 4: E vs θ plot of deuterons from ^{7}Be + d elastic scattering at E_{lab}= 5 MeV/A. The red dotted line represents the corresponding kinematics.

In search for resonance excitations to solve the lithium anomaly, previous works [4−5] on ^{7}Be + d reaction could populate states upto 13 MeV in ^{8}Be. In the present work, preliminary data analysis shows higher excitations upto 20 MeV as is apparent from the excitation energy spectrum of ^{8}Be (Fig. 3). The energy (E) vs scattering angle (θ) plot for the elastically scattered deuterons from ^{7}Be along with kinematics is shown in Fig. 4. The relevant Monte Carlo simulations and efficiency calculations for the present experiment have been carried out using NPTool and is presented separately [6]. It is pertinent to note that the study of the above reaction might go a long way in probing the ^{7}Li abundance anomaly as well as issues related to ^{8}Be breakup through higher excitations. Data analysis is in progress.

Acknowledgement

We thank the ISOLDE engineers incharge, RILIS team and Target group at CERN for their support. DG acknowledges financial support from ENSAR2 (Grant no. 654002) and ISRO, Govt. of India (Grant no. ISRO/RES/2/378/15−16).

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