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

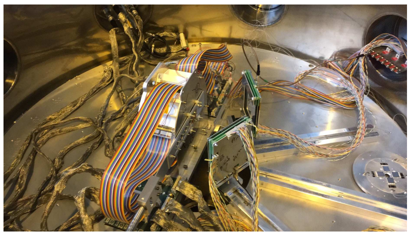

FIG. 1: The ^{7}Be + d experimental setup at ISOLDE.

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).

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).

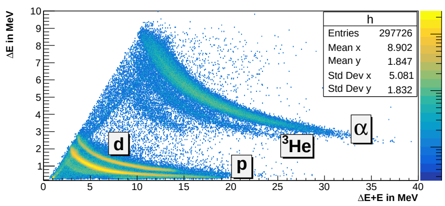

FIG. 2: A typical ΔE vs E_{total} spectrum from the experiment.

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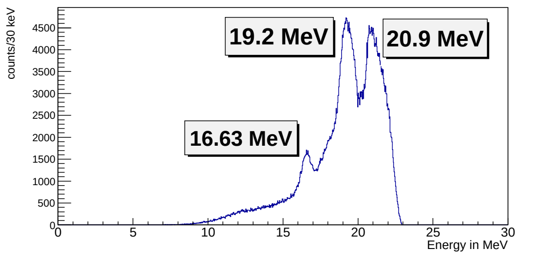

FIG. 3: Excitation energy spectrum of $^{8}Be^{*}$ from the ^{7}Be + d experiment at E_{lab}= 5 MeV/A.

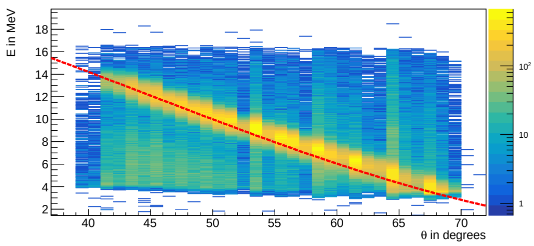

FIG. 4: E vs θ plot of deuterons from ^{7}Be + d elastic scattering at E_{lab}= 5 MeV/A. The red dotted line represents the corresponding kinematics.

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

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