Breakup of deuteron from ^{7}Be + d reaction at 5 MeV/u

S. Maity[1],* D. Gupta[1],† Sk M. Ali[1], K. Kundalia[1], Swapan K. Saha[1],‡
O. Tengblad[2], J.D. Ovejas[2], A. Perea[2], I. Martel[3], J. Cederkall[4], and J. Park[4§]
[1]*Department of Physics, Bose Institute, 93/1 APC Road, Kolkata 700009, India*
[2]*Instituto de Estructura de la Materia – CSIC, Serrano 113 bis, ES-28006 Madrid, Spain*
[3]*University of Huelva, Avenida Fuerzas Armadas sin numero Campus "El Carmen", 21007, Huelva, Spain and*
[4]*Department of Physics, Lund University, Box 118, SE-221 00 Lund, Sweden*

Introduction

The deuteron has been studied for decades in the context of breakup and stripping nuclear reactions [1–8]. Since the deuteron is loosely bound with binding energy 2.225 MeV, it is also studied in the context of loosely bound stable and unstable nuclei. The deuteron projectile breakup on several targets [2, 3] and the deuteron target breakup with different projectile nuclei [4–7] were carried out earlier, involving stable nuclei. An earlier study [8] of the deuteron breakup reactions on ^{7}Li shows that the stripping process is more important than the elastic breakup process. However, similar studies with the radioactive counterpart ^{7}Be does not exist. The ^{7}Be(d,p) transfer reaction is studied in Ref. [9]. To compare it with the breakup of deuteron yielding a three-body final state, the ^{7}Be(d,pn) needs to be studied. The deuteron being loosely bound disintegrates into a proton and a neutron. Neutron yields from the missing mass spectra can be obtained to study deuteron breakup.

Experimental Results

The experiment was carried out at HIE-ISOLDE, CERN with 5 MeV/u ^{7}Be beam on a 15 μm CD_2 target. A 15 μm CH_2 and a 1 mg/cm^2 ^{208}Pb target were also used for background subtractions and normalization respectively. The setup consisted of an annular detector S3 covering $8° - 25°$, a set of 5 W1 DSSDs in a pentagon geometry covering $40° - 80°$. The back angles $127° - 165°$ were covered by BB7 DSSDs. The DSSDs were backed by Silicon pad detectors. The details of the setup are given in Ref. [9, 10]. The Monte Carlo simulations for the deuteron breakup from ^{7}Be + d reaction were carried out with NPTool [11]. The neutron is considered as the missing mass in the simulations as it is not detected in the experiment. Using energy momentum conservation in ^{7}Be(d,pn), the missing mass can be obtained from the en-

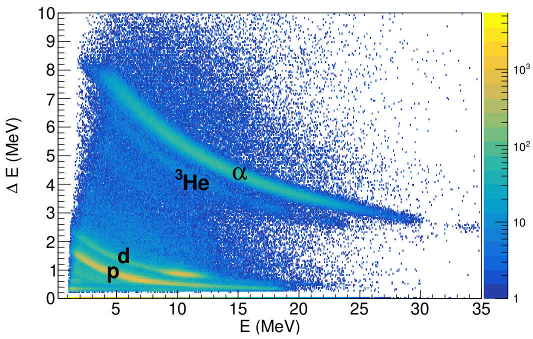

FIG. 1: The $\Delta E - E$ spectrum of p, d, ^{3}He, and α, detected at W1 + Pad pentagon telescopes, from 5 MeV/u ^{7}Be on CD_2 target.

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*Electronic address: `subhankar@jcbose.ac.in`
†Electronic address: `dhruba@jcbose.ac.in`
‡Former faculty
§Present Address: Center for Exotic Nuclear Studies, Institute for Basic Science, 34126 Daejeon, South Korea

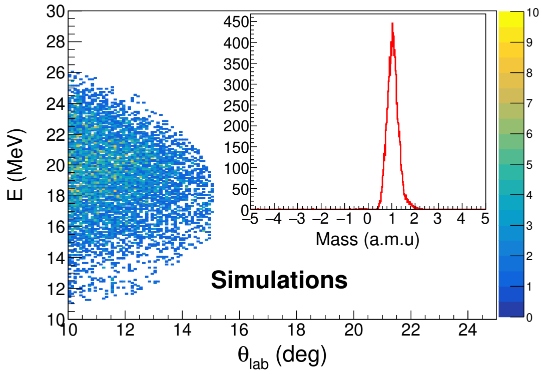

FIG. 2: $E - \theta$ plot from simulations for ^{7}Be detected in coincidence with protons from the breakup reaction ^{7}Be(d,pn) at 5 MeV/u. The inset shows the resulting missing mass spectrum.

ergy of protons and ^{7}Be,

$$E_{beam} = E_p + E_n + E_{^7Be} + 2.225\,MeV \quad (1)$$

$$\vec{P}_{beam} = \vec{P}_p + \vec{P}_n + \vec{P}_{^7Be}. \quad (2)$$

The particles in the pentagon W1 telescopes are identified from $\Delta E - E$ spectra (Fig. 1). In S3, there is no particle identification. Thus Monte-Carlo simulations, $E - \theta$ plots, etc of particles detected in S3 were used to identify ^{7}Be. The protons and ^{7}Be were detected in coincidence for identification of deuteron breakup events.

Discussion

Fig. 2 shows $E - \theta$ plot from the Monte-Carlo simulations of the deuteron breakup reaction ^{7}Be(d,pn) at 5 MeV/u. The energy and angular range of the detected ^{7}Be in coincidence with protons is apparent from the plot. The resulting missing mass distribution is also shown in the inset of the figure. Preliminary analysis of the missing mass distributions from the experimental data gives a value of 1.152 ± 0.443 a.m.u as compared to the mass of the neutron 1.008 a.m.u. Angular distributions of the breakup fragments and detailed theoretical studies are in progress.

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