Neutron and α-transfer reaction ^{12}C(^{7}Be,^{8}Be)^{11}C* at 5 MeV/u

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Introduction

The one-neutron and alpha-transfer reactions involving weakly bound stable nuclei have been extensively studied to obtain valuable insights into nuclear structure and reaction dynamics [1–4]. However, studies involving radioactive nuclei are relatively less in number [5]. Jarczy *et al.* [6] investigated the relative contribution of $1n$ and α-transfer channels from ^{9}Be + ^{12}C at E = 20 MeV. The energy dependence of the reaction was also studied at sub-Coulomb energies [7]. The measurements of $1n$ transfer reactions involving ^{7}Li + ^{13}C was carried out by Cook *et al.* [8]. The present work reports the $1n$ and α-transfer reactions from ^{7}Be + ^{12}C at 5 MeV/u for the first time. Both reactions produce the ^{11}C nucleus in the exit channel which has a half-life of 20.4 minutes. The excited states of ^{11}C at 2.00, 4.31 and 4.80 MeV have also been identified. The ^{8}Be formed in the reactions immediately breaks up into two α-particles.

Results & Discussion

The experiment was carried out at HIE-ISOLDE, CERN using a 5 MeV/u ^{7}Be radioactive beam with an intensity of $\sim 5 \times 10^{5}$ pps. A 15 μm thick CD_2 target was used. A silicon detector array in the shape of a pentagon with ΔE-E telescopes was used to detect the emitted charged particles. The details of the experimental setup are described in Ref [9, 10].

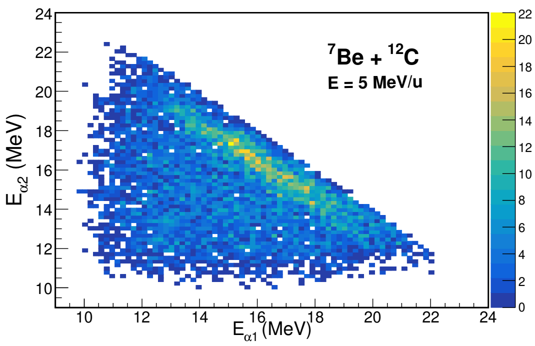

Fig 1: Energy correlation plot between two coincident α-particles from the breakup of ^{8}Be.

The relevant Monte Carlo simulations were carried out using NPTool [11] and compared to the experimental data. The events with two coincident α-particles detected in the pentagon detectors were selected. The energy correlation plot of the coincident α-particles from the breakup of ^{8}Be is shown in Fig 1. Now, the α-particles can come from the scattering of ^{7}Be from d as well as ^{12}C in the CD_2 target. To separate these two types of events

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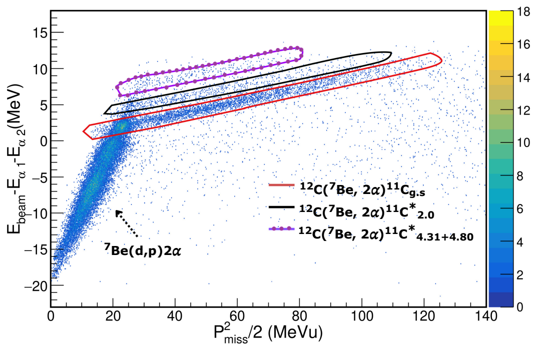

Fig 2: The Catania plot distinguishing ^{12}C(^{7}Be,2α)^{11}C* from ^{7}Be(d,p)2α reaction

we resorted to generating a Catania plot as shown in Fig 2. This is a kinematic technique to identify distinct reaction channels, as each channel corresponds to a unique straight line on the plot which intercepts the y-axis at y= $-Q$ and has a slope of $\frac{1}{m}$, where Q is the reaction Q-value & m is the mass of the undetected particle [12]. Selected gates in Fig 2

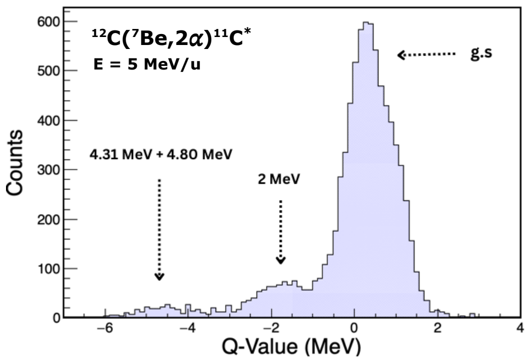

Fig 3: The Q-Value spectrum of the reaction ^{12}C(^{7}Be,2α)^{11}C* at 5 MeV/u.

correspond to ^{12}C(^{7}Be,2α)^{11}C* events. After separation of the transfer channels leading to ^{11}C from the Catania plot, the Q-value was reconstructed for every event. Fig 3 displays the Q-value spectrum, delineating a peak at 0.27 MeV corresponding to the ground state of ^{11}C. The other peaks in the figure correspond to the excited states of ^{11}C at 2.00, 4.31 and 4.80 MeV. In summary, the present work reports the first measurement of 1n and α-transfer channels forming ^{11}C from ^{7}Be + ^{12}C. Detailed theoretical analysis would also be carried out to study the relative contribution of the 1n and α-transfer channels in this reaction.

Acknowledgments

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