# Neutron and $\alpha$-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 $\alpha$-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 $\alpha$-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 $\alpha$-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 $\mu m$ thick $CD_2$ target was used. A silicon detector array in the shape of a pentagon with $\Delta E$-$E$ telescopes was used to detect the emitted charged particles. The details of the experimental setup are described in Ref [9, 10].

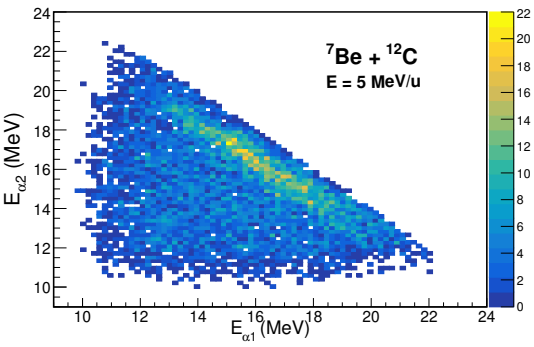


Fig 1: Energy correlation plot between two coincident $\alpha$-particles from the breakup of $^{8}$Be.

The relevant Monte Carlo simulations were carried out using NPTool [11] and compared to the experimental data. The events with two coincident $\alpha$-particles detected in the pentagon detectors were selected. The energy correlation plot of the coincident $\alpha$-particles from the breakup of $^{8}$Be is shown in Fig 1. Now, the $\alpha$-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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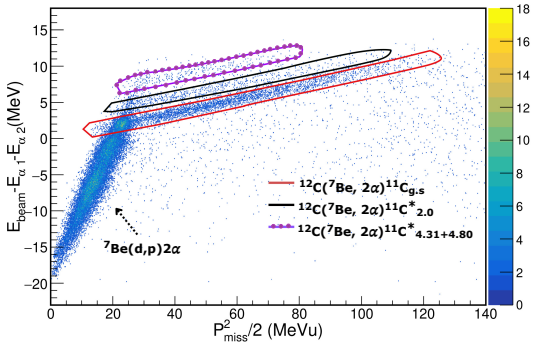


Fig 2: The Catania plot distinguishing $^{12}$C($^7$Be,2$\alpha$)$^{11}$C* from $^7$Be(d,p)2$\alpha$ reaction

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

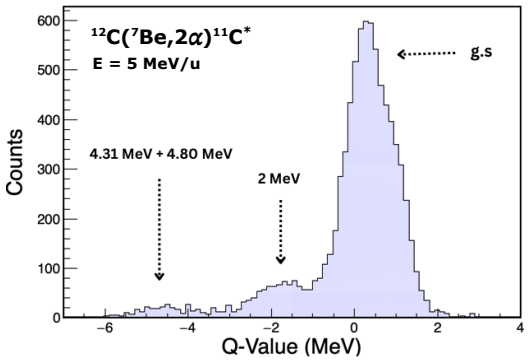


Fig 3: The $Q$-Value spectrum of the reaction $^{12}$C($^7$Be,2$\alpha$)$^{11}$C* at 5 MeV/u.

correspond to $^{12}$C($^7$Be,2$\alpha$)$^{11}$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 $\alpha$-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 $\alpha$-transfer channels in this reaction.

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