Study of transfer followed by breakup reaction in ^{9}Be + ^{124}Sn system around the Coulomb barrier

Satbir Kaur[1,2], S. K. Pandit[1], V. V. Parkar[1,2], A. Shrivastava[1,2], K. Mahata[1,2], K. Ramachandran[1], Sangeeta Dhuri[1,2], P. C. Rout[1,2], A. Kumar[1], and Shilpi Gupta[1,2]
[1]*Nuclear Physics Division, Bhabha Atomic Research Centre, Mumbai - 400085, India and*
[2]*Homi Bhabha National Institute, Anushaktinagar, Mumbai - 400094, India*

Introduction

In recent times, the reaction mechanisms involving weakly bound stable light nuclei, e.g., ^{6,7}Li, ^{9}Be, have been received much attention for their special properties of having low breakup threshold and predominant α-cluster structure [1, 2]. Among them ^{9}Be has speciality for the investigation of three body correlation. The breakup threshold for ^{9}Be$\rightarrow \alpha+\alpha+n$ is 1.57 MeV. In case of ^{9}Be induced reaction, 1n-stripping channel is one of the dominant reaction channel [3, 4]. The ^{8}Be nucleus is particle unbound and consequently investigation of (^{9}Be,^{8}Be$\rightarrow$ α + α) reaction need a coincidence measurements. There are very limited exclusive measurements available of this channel in the literature [3]. In the present study, we have aimed to understand the n-transfer followed by breakup reaction for ^{9}Be + ^{124}Sn system.

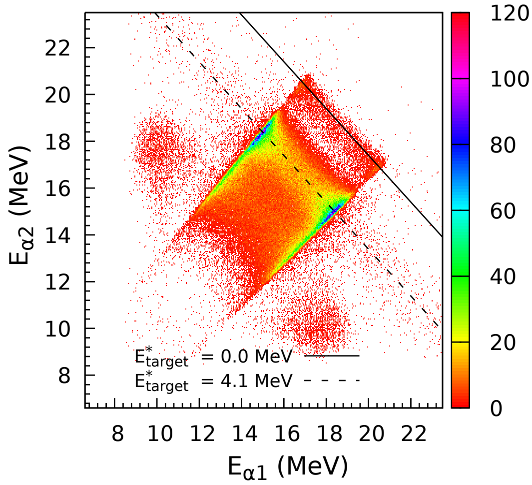

FIG. 1: Energy correlation spectra of breakup fragments in coincidence for ^{9}Be + ^{124}Sn reaction at E_{lab}=35.2 MeV and θ_{lab} = 52°.

Experimental Details

The experiment was performed using ^{9}Be beam at E_{beam}=35.8 MeV from Pelletron-Linac Facility at TIFR, Mumbai, India. Self-supporting target of ^{124}Sn ($\sim$ 1.74 mg/cm^{2}) was used. The Coulomb barrier for ^{9}Be + ^{124}Sn system is 28.1 MeV. Seven Si-strip detectors in the ΔE-E telescopic arrangement were mounted inside a 1.5 m diameter scattering chamber. The ΔE detectors were a single sided strip detector with 16 strips and E strip detectors were double-sided with 16 strips in front and 16 strips in back sides. Typical thicknesses of ΔE and E detectors were $\backsim$ 20-50 µm and 1-1.5 mm, respectively. The active area and width of each strip of the segmented detectors were 5 x 5 cm^{2} and 3.1 mm, respectively. Two Si surface-barrier detectors (thickness $\sim$ 300 µm) were kept at ±20° for absolute normalization and beam monitoring. The data were collected in an event by event mode, with the trigger generated from E detectors. The detectors were calibrated using the known α energies from the ^{229}Th source. The data with multiplicity (M) = 1 was used for the study of inclusive α production and elastic scattering which was presented in [5]. With M = 2 the coincidence study of two breakup fragments from the projectile like nucleus are performed, the results of which are reported here.

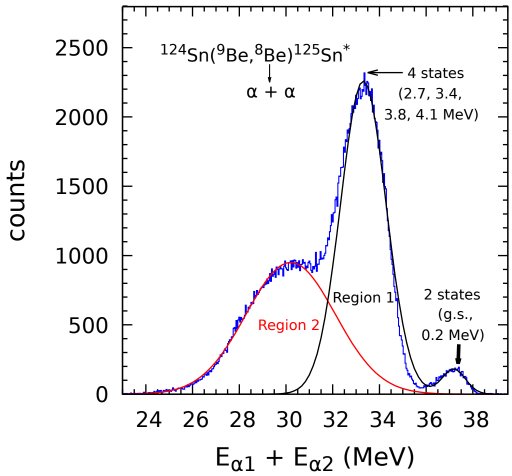

FIG. 2: $E_{\alpha1} + E_{\alpha2}$ spectrum for ^{9}Be + ^{124}Sn reaction at E_{lab}=35.2 MeV and $\theta_{lab} = 52°$. The Region 1 corresponds to breakup of ^{8}Be into two α after 1n-transfer and Region 2 corresponds to the breakup of ^{9}Be→ α+α+n. The position of the ground state of the target like product after 1n-stripping is $E_{\alpha1} + E_{\alpha2}$ = 37.4 MeV. States are identified according to E*= Q_{gg} - Q_{opt}.

Analysis and Results

The particles were identified using the energy loss information from the ΔE and E Si strip detector telescope. The events from breakup and transfer breakup process were identified by generating the energy correlation spectra of the two coincident breakup fragments as presented in Fig. 1. The two α particles are from the breakup of ^{8}Be after 1n - stripping channel at E_{lab} = 1.25V_B. The two distinctive band-like structures shown in Fig. 1 corresponds to the formation of ^{8}Be and ^{125}Sn both in its ground state and the other band corresponds to excitation of ^{125}Sn (with E^{*}_{target} = 4.1 MeV). By projecting the events in Fig. 1. onto a summed energy axis of both the α coincident fragments, peaks arising from the excitation of target like product can be determined. The $E_{\alpha1} + E_{\alpha2}$ spectrum for ^{9}Be + ^{124}Sn reaction at E_{lab}=35.2 MeV and θ_{lab} = 52° is shown in Fig. 2. In Fig. 2 Region 1 corresponds to breakup of ^{8}Be into two α after 1n-transfer and Region 2 corresponds to the two α's from the breakup of ^{9}Be into α+α+n. The excitation energy of target are expected to peak around the E*= Q_{gg} - Q_{opt} for transfer reaction as expected from the semi-classical theory. Here, Q_{gg} and Q_{opt} are the ground state and optimum Q values, respectively. For ^{124}Sn(^{9}Be,^{8}Be)^{125}Sn* the ground state Q value is 4.1 MeV, the states of ^{125}Sn with spectroscopic factor > 0.1 are marked in Fig. 2. These states are g.s ($11/2^-$), 0.2 ($1/2^+$), 2.7 ($7/2^-$), 3.4 ($7/2^-$), 3.8 ($3/2^-$) and 4.1 ($1/2^-$) MeV [6].

In future, the cross sections for the 1n transfer followed by breakup channels will be reported. The comparison of the experimental 1n-transfer followed by breakup channels with the theoretical calculations will be shown.

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