Neutron transfer study in ^{9}Be + ^{187}Re system

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Introduction

Fusion, transfer and breakup reactions and their relative importance on reaction mechanism involving weakly bound projectiles is a topic of intense current interest [1–3]. In this context, several experimental studies have been performed over the years utilizing projectiles of both stable and unstable weakly bound nuclei. The systematic of inclusive α, reaction and total fusion cross sections with various projectiles have been highlighted in these studies. However, the neutron transfer cross sections with these projectiles have not received much attention. ^{9}Be, being a cluster structure of α + α + n, with a breakup threshold of 1.67 MeV, the neutron may play major role in reaction dynamics.

In the recent paper of ^{9}Be + ^{187}Re system [4, 5], complete (CF), incomplete fusion (ICF) and neutron transfer cross sections have been measured. In the present work, We have estimated the neutron transfer cross sections from Coupled Channel Calculations and also deduced the relative importance of CF, ICF and neutron transfer with respect to the reaction cross sections.

Coupled Reaction Channel Calculations

Optical model potential parameters required for entrance (^{9}Be + ^{187}Re) and exit channels (^{8}Be + ^{188}Re) were taken from phenomenological global optical model potentials for ^{9}Be projectile [6]. Apart from this, binding potentials of the fragment and core for the projectile and target partitions are required.

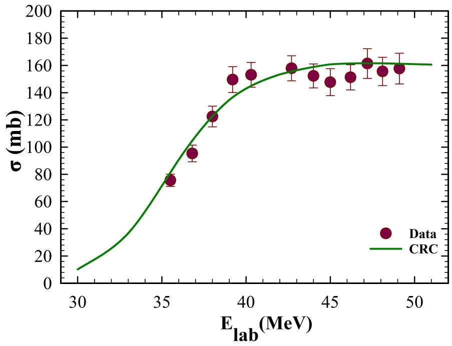

FIG. 1: Measured one neutron stripping cross section for ^{9}Be+^{187}Re system with the coupled channels calculations.

The potentials binding the transferred particles were of Woods-Saxon volume form, with radius 1.25A$^{1/3}$ fm and diffuseness 0.65 fm, with 'A' being the mass of the core nucleus. The depths were automatically adjusted to obtain the required binding energies of the particle-core composite system. The single particle states along with unit Spectroscopic factors (C^{2}S) of the residual nucleus ^{188}Re upto 1.3 MeV were considered in the calculations. The spectroscopic factor (C^{2}S) for ^{9}Be/^{8}Be is taken to be 0.42 and 1 for the ground state and 2^{+} resonance state of ^{8}Be, respectively as used in Ref. [7]. The calculations were performed using FRESCO code [8].

Results and Discussion

Experimental one neutron stripping cross sections as the function of lab energy along with the CRC calulations are shown in Fig. 1. The good agreement between calculations and the data at all the energies can be seen from the figure.

The reaction cross sections σ_R obtained

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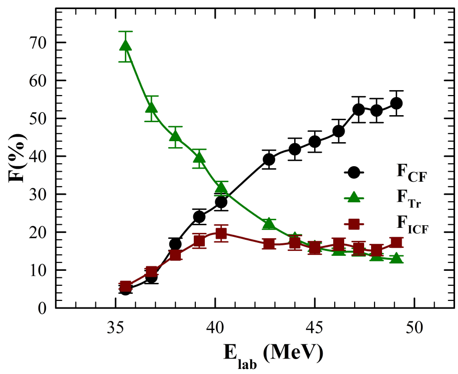

FIG. 2: The percentage contribution of CF, ICF and 1n transfer cross sections in reaction cross section for ^{9}Be+^{187}Re system.

from the entrance channel optical model potential was used for extracting the fraction of CF, ICF and neutron transfer in the reaction process. Measured data of n-transfer, CF and ICF for the ^{9}Be + ^{187}Re taken from [4, 5] was used. Percentage fraction of the neutron transfer cross section, $F_{tr} = \frac{\sigma_{tr}}{\sigma_R}$, percentage fraction of complete fusion, $F_{CF} = \frac{\sigma_{CF}}{\sigma_R}$ and percentage fraction of incomplete fusion, $F_{ICF} = \frac{\sigma_{ICF}}{\sigma_R}$ have been extracted and shown in Fig. 2. As can be seen, neutron transfer is dominant mode (70 %) at below barrier energies and it decreases with the energy. CF contribution is found to increase with beam energy and is dominant at above barrier energies. ICF cross sections have 10-20 % contribution in reaction cross section at all the energies.

Summary

Calculated one neutron transfer cross section using CRC calculation was compared with the measured data for ^{9}Be+^{187}Re system. Also the measured CF, ICF and neutron transfer fractions have been extracted. Neutron transfer is found to be dominant reaction channel at below barrier while CF dominates at above barrier energies.

Acknowledgments

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