One and two proton transfer reactions for ^{28}Si + ^{90,94}Zr systems at much above the barrier energy

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Introduction

During the recent decades, the study of heavy ion collisions has received considerable attention for understanding the coupling effects of various channels on each other [1]. The heavy ion transfer reactions at energies much above the barrier help us to observe the second step transfer couplings in the medium mass region as observed in the case of ^{33}S + ^{90,91,92}Zr systems [2], for example.

Here we report the results of measurements of one and two proton transfer channels for ^{28}Si + ^{90,94}Zr systems at an energy much above the barrier. The main aim of this experiment was to measure the angular distribution of the proton stripping channels and extracting their cross sections at this energy. These measurements are an extension of our earlier measurements of the fusion excitation functions and the multineutron transfer channels for the same systems [3].

Experimental Setup

The experiment was performed with ^{28}Si beam at a lab energy of 120 MeV using General Purpose Scattering Chamber (GPSC) at IUAC, New Delhi. The targets used were isotopically enriched ^{90,94}Zr (97.65% and 96.07% respectively) 280 μg/cm^2 foils prepared on 45 μg/cm^2 carbon backings in the target lab of IUAC. Two silicon surface barrier detectors were placed at ±10^o with respect to the beam for monitoring and normalization purpose. The GPSC is equipped with two movable arms which can be rotated to large angles. On one of the arms, a multiwire proportional counter was placed at a distance of 60.5 cm from the target for the detection of target-like particles and on the other arm, a multiwire proportional counter followed by an ionization chamber was placed at a distance of 37.5 cm for the detection of the corresponding projectile-like particles. The active area of both the multi wire proportional counters was 5×5 cm^2 and for the ionization chamber, it was 4.5×8 cm^2. The grazing angle at 120 MeV for these systems is approximately 66^o, so the angular distribution measurements were performed around this angle. The angles covered were 42^o, 50^o, 58^o, 66^o, 72^o, 78^o for both the systems. The experimental arrangement of the detectors is shown in Fig. 1.

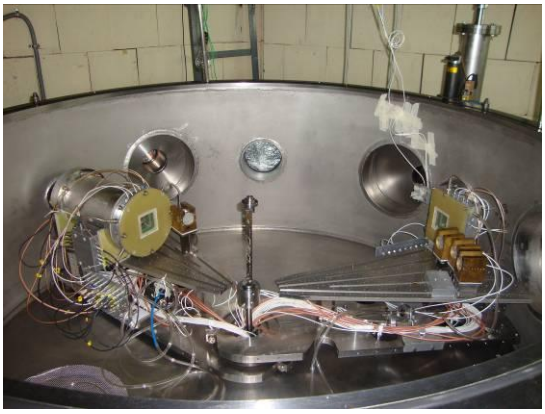

Fig. 1 The experimental setup used for the measurement of the transfer channels for ^{28}Si+^{90,94}Zr systems.

Results

Two dimensional particle identification spectrum for ^{28}Si + ^{90}Zr at 66^{o} is shown in Fig. 2. A very clear Z-identification could be obtained and the transfer of up to three proton stripping and one proton pick-up can be noted in the figure.

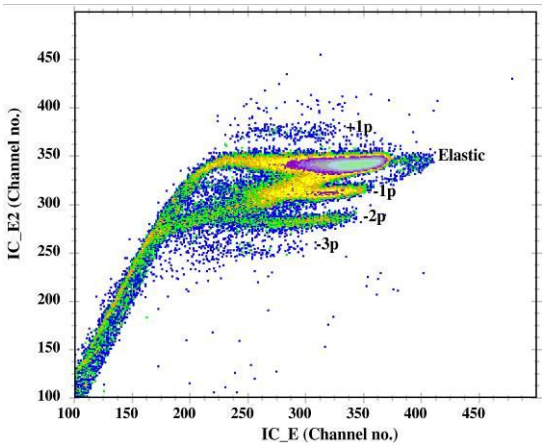

Fig. 2 A 2-dimensional spectrum of ^{28}Si + ^{90}Zr at 66^{o}.

The kinematic coincidence was setup between the target-like and projectile-like particles. A gated two dimensional spectrum between X-positions of both detectors is shown in Fig. 3. This spectrum is gated by time of flight defined between these two detectors.

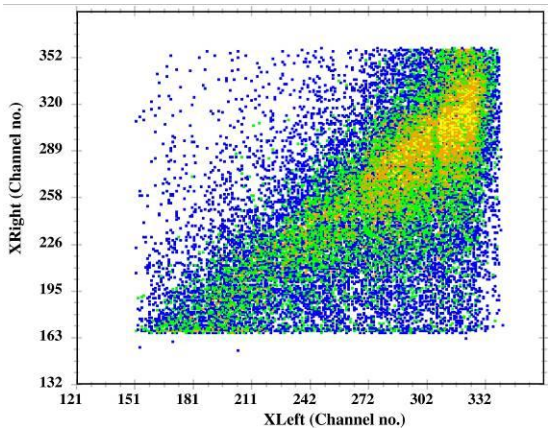

Fig. 3 A correlation plot between the two MWPCs X-positions for ^{28}Si + ^{94}Zr.

The angular distributions of one and two proton stripping are extracted and the theoretical calculations are performed with coupled channels code FRESCO [4]. Figure 4 shows the one proton stripping angular distribution extracted for the ^{28}Si+^{90}Zr system along with the coupled channels calculations. A reasonably good agreement between the experimentally extracted and theoretically predicted angular distributions can be noted. The Akyuz-Winther potential parameters [5] were used for performing these calculations. The theoretical calculations for the other system are in progress.

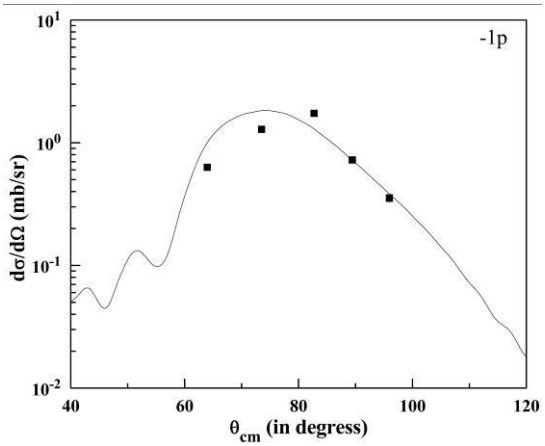

Fig. 4 Angular distribution of one proton stripping (with statistical errors) along with the theoretical calculations for ^{28}Si + ^{90}Zr system.

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