Quasi-elastic scattering measurements for ^{48}Ti+^{232}Th system leading to super-heavy element ^{280}Cn$_{112}$

Gurpreet Kaur[1,2], B.R. Behera[1], A. Jhingan[3], B.K. Nayak[4], R. Dubey[3], T. Banerjee[3], N. Saneesh[3], Priya Sharma[1], Meenu Thakur[1], Ruchi Mahajan[1], Khushboo[5], A. Yadav[3], Kushal Kapoor[1], N. Kumar[5], Kavita Rani[1], A. Saxena[4], and P. Sugathan[3]
[1]*Department of Physics, Panjab University, Chandigarh-160014, INDIA*
[2]*Department of Physics, Akal University, Talwandi Sabo-151302, Punjab, INDIA*
[3]*Inter University Accelerator Centre, Aruna Asaf Ali Marg, New Delhi-110067, INDIA*
[4]*Nuclear Physics Division, Bhabha Atomic Research Centre, Mumbai-400085, INDIA and*
[5]*Department of Physics &Astrophysics, Delhi University, New Delhi-110067, INDIA*

Introduction

Investigation of super-heavy elements (SHE) formation is a challenging study in nuclear physics [1]. They are synthesised in laboratory through nuclear fusion reactions [2]. Classically, for fusion to occur, the incident particle has to overcome the fusion barrier. Hence, the quantitative information of the fusion barrier plays a vital role in the synthesis of SHE, as it greatly influences the choice of target-projectile combination and the bombarding energy to maximize the fusion probability. In case of heavy systems, because of coupling to many degrees of freedom, the single uncoupled barrier splits to a distribution of barriers called barrier distribution (BD). Here, average value of the distribution gives the fusion barrier, which may be different from the theoretically proposed values. To extract the BD, one has to measure the fusion cross section and take its second derivative w.r.t. energy [3]. However, for heavy systems, due to very low cross sections ($\sim$ nbarn), measuring the fusion cross section is very time consuming process. Hence, the remedial complementary way to do the same is through first derivative of the quasi-elastic (QE) cross section [4].

In the present study, we have performed the QE scattering measurements for the ^{48}Ti+^{232}Th system leading to super heavy element, ^{280}Cn$_{112}$. The aim is to extract the information about fusion barrier from experimental BD and study the role of nuclear structure in the reaction dynamics. Moreover, the angular distribution measurement of QE events has been measured to study the nuclear potential.

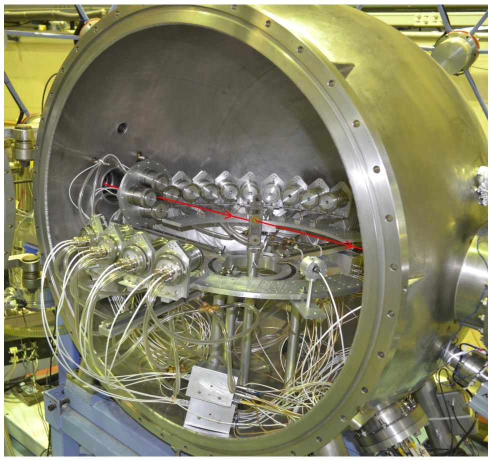

FIG. 1: HYbrid Telescope Array for Reaction dynamics (HYTAR) facility inside NAND chamber at IUAC, New Delhi.

Experimental Setup

The experiment was performed using the Pelletron + LINAC accelerator system of the IUAC, New Delhi. A ^{48}Ti beam was accelerated onto a ^{232}Th target of thickness $\sim$ 150 $\mu g/cm^2$ with carbon backing of $\sim$ 30 $\mu g/cm^2$ at incident energies varying from 220 MeV to 285 MeV in 5 MeV steps. The reaction products, mainly projectile like particles, were detected in the hybrid telescope array (HYTAR) [5] mounted in the 1 m diameter spher-

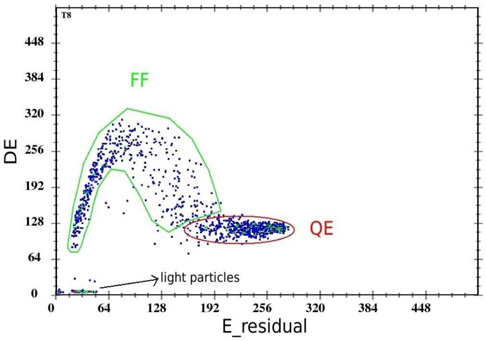

FIG. 2: Online 2D spectra (energy loss versus residual energy) of the ^{48}Ti+^{232}Th system, for E_{lab}=275 MeV obtained with one of the telescope detector placed at θ_{lab}=120^0 w.r.t. beam direction.

ical scattering chamber of the National Array of Neutron Detectors (NAND) facility. Fig. 1 shows the picture of the experimental set up. The present HYTAR set up has 16 telescopes. Four telescopes, two in plane and two out of plane, each at an angle of 173^0 w.r.t beam direction, were placed in the ring arrangement for the QE measurements at backward angle. Eight telescopes were placed at angles from 160^0 to 90^0 with an angular pitch of 10^0. Other four telescopes were at placed at angles of 105^0 to 75^0 with an angular pitch of 10^0. Two silicon PIPS detectors of thickness 300 μm were positioned at $\pm$13^0 w.r.t. beam direction to monitor the beam and for normalization so as to extract absolute value of cross-sections. The pre-amplifiers were placed inside vacuum to avoid the degradation of charge signals from the telescope detectors.

Preliminary Results

A typical particle identification spectrum obtained for the ^{48}Ti+^{232}Th reaction at θ_{lab}= 120^0 and E_{lab}=275 MeV is shown in Fig. 2. For such a heavy system, probability of fission is very high at energies above the Coulomb barrier. As seen in Fig. 2 the QE events, which are sum of all peripheral processes (elastic, inelastic and transfer etc.), are well separated from fission events (FF). Fig. 3 shows the excitation function as a function of E_{eff}, where E_{eff}=2E_{cm}/(1+cosec(θ_{cm}/2)) corrects for centrifugal effects. In addition to it, the angular distribution of the QE events at energies from 220 to 280 MeV in the steps of 5 MeV has been also measured. The measured QE events will be used to extract the experimental BD for the ^{48}Ti+^{232}Th system. From angular distribution measurements, the nuclear potential parameters will be extracted. Further analysis of the data is under progress and details will be presented in the conference.

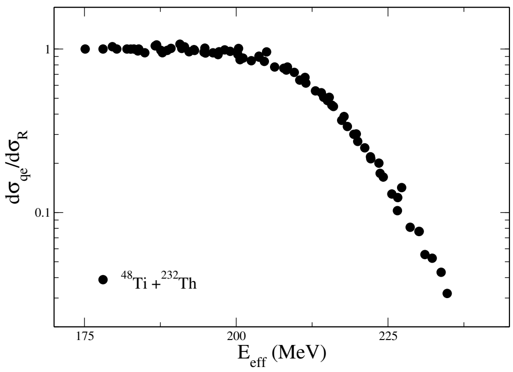

FIG. 3: Experimental Quasi-elastic (QE) excitation function for the ^{48}Ti+^{232}Th system.

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