Study of prescission and postscission charged particle multiplicity in $^{16}O+^{194}Pt$ system

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Introduction

In nuclear physics, the study of fusion–fission reaction mechanism is an active area of research since a long time [1]. Fusion between two heavy nuclei is characterized by a long dynamical path starting from the contact between the colliding partners to the formation of a fully equilibrated compound nucleus (CN). During the course of fusion-fission reaction, neutrons [2], light charged particles [3], and GDR (γ-rays) [4] emission takes place. These particles are emitted from various stages of the reaction process i.e. from compound nucleus (prescission) and from fully accelerated fission fragments (postscission). Measurements of these particles in coincidence with fission fragments are used as probes to understand the fusion-fission dynamics [5]. In the present experiment, we have measured the light charged particles multiplicity for the $^{16}O+^{194}Pt$ reaction. The other experimental probe to understand the reaction dynamics, like neutron multiplicity is already measured for the given reaction [6]. So, the present measurements along with the existing data would help in creating a consistent picture of the reaction dynamics in the reaction under study.

Experimental Details

The experiment was performed at the 15UD Pelletron facility at Inter University Accelerator Centre (IUAC), New Delhi, using General Purpose Scattering Chamber (GPSC). Enriched and self-supporting target of ^{194}Pt having thickness 1.7 mg/cm^2 was used in the experiment. Beam of ^{16}O at the energy of 98.4 MeV, was used to form ^{210}Rn CN. The charged particles (protons and alphas) were detected in coincidence with fission fragments, so as to extract the particles multiplicity for the reaction under study. In total, four detectors (16 crystals) of CsI(Tl) were used for the detection of protons and alpha particles and two Multi-Wire Proportional Counters (MWPCs) were used for the detection of fission fragments. The MWPCs were kept at the folding angle to detect complimentary fission fragments. One MWPC detector was kept at an angle of 45^0 w.r.t beam and at a distance of 38 cm from the centre of the target, whereas, the second was kept at an angle of 112^0 and at a distance of 32 cm. Four CsI(Tl) detectors were kept at angles of 45^0, 85^0, 115^0 and 135^0 with respect to the beam direction. All charged particle detectors were kept at a distance of 23.5 cm from the centre of the target covering a solid angle of 7.3 msr for one detector.

In order to obtain the energies of the detected charged particles, CsI(Tl) detectors were calibrated using both offline and online techniques. The offline calibration was done using ^{241}Am and ^{229}Th sources. The online calibration was done using two reactions ^{12}C + ^{12}C at 30 MeV and ^{7}Li + ^{12}C at 20 MeV. From ^{12}C + ^{12}C reaction, alpha energies are in the range of 1.63 MeV to 18.5 MeV. Similarly from ^{7}Li + ^{12}C reaction, alpha energies are in the range of 5.27 MeV to 16.19 MeV. Schematic diagram of the experimental setup is shown in figure 1.

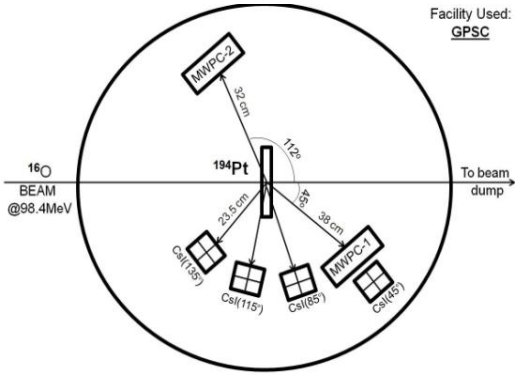

Figure 1- Schematic diagram for experimental setup.

Data Analysis and Results

The data were analysed using the ROOT software package. In the present study, the composite system is expected to undergo symmetric fission. The mass ratio distribution obtained in the present study is shown in figure 2.

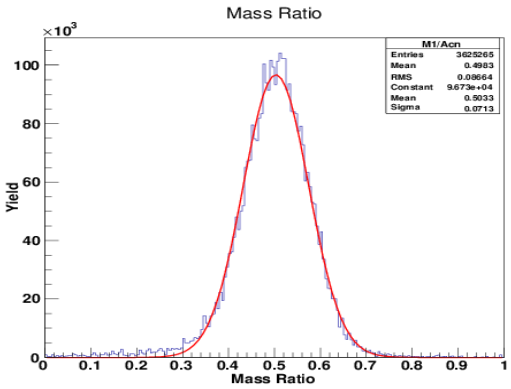

Figure 2- Fission Fragment mass ratio distribution for ^{16}O+^{194}Pt reaction.

As expected this distribution peaks at around 0.5 only. Mass ratio is calculated using the formula [7],

$$M_R = \frac{M_2}{M_1 + M_2},$$

where M_1 and M_2 are the masses of fission fragments. The fission coincident alpha particles energy spectra obtained at laboratory angle of 70° is shown figure 3.

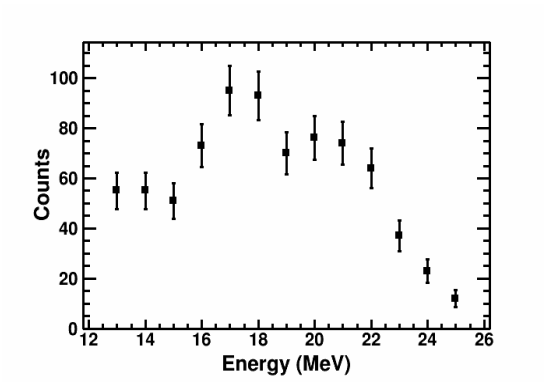

Figure 3- α-particle energy spectra in coincidence with fission fragments.

Further moving source analysis for this data is in progress. The data will also be analysed to extract the mass gated multiplicity of the charged particles.

References

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