α- particle multiplicity in ^{16}O+^{194}Pt fusion-fission reaction

Kushal Kapoor[1*], A. Kumar[1#], Navneet Kaur[1], B.R. Behera[1], K.P. Singh[1], Gurpreet Kaur[1], Priya Sharma[1], Ruchi Mahajan[1], Hardev Singh[2], A. Jhingan[3], P. Sugathan[3], G. Mohanto[3], R. Dubey[3], N. Saneesh[3], Ish Mukul[3], Varinderjit Singh[1], B. K. Nayak[4], A. Saxena[4], and H.P. Sharma[5]

[1]*Department of Physics, Panjab University, Chandigarh, India-160014*
[2]*Department of Physics, Kurukshetra University, Kurukshetra, India-136119*
[3]*Inter University Accelerator Centre, New Delhi, India-110067*
[4]*Nuclear Physics Division, Bhabha Atomic Research Centre, Mumbai, India-400085*
[5]*Department of Physics, Banaras Hindu University, Varansi, India-221005*
**email: kapoor.phys@gmail.com*
#Corresponding Author: ashok@pu.ac.in

Introduction

In the past, extensive theoretical and experimental efforts have been made to understand the various aspects of the heavy ion induced fusion-fission reactions. Extraction of the fission time scales using different probes is of central importance for understanding the dynamics of fusion-fission process. Compelling evidences have been obtained from the earlier studies that the fission decay of hot nuclei is hindered i.e. slowed down relative to the expectations of the standard statistical model, and large dynamical delays are required to introduce due to this hindrance [1]. Nuclear dissipation [2] is assumed to be responsible for this delay and more light particles are expected to be emitted during the fission process. These particles are emitted from various stages of the reaction process i.e. from compound nucleus (CN) (prescission) and from fully accelerated fission fragments (postscission). The multiplicities of various particles (neutrons, protons, alphas etc.) emitted during the decay of the excited nucleus provide the information about these time scales and hence, help in understanding the fusion-fission dynamics.

Recently, neutron multiplicity measurements have been performed for the ^{16}O+^{194}Pt populating the CN ^{210}Rn and the excess neutron multiplicities were interpreted in terms of nuclear viscosity [3]. In order to have complete understanding for the dynamics of ^{210}Rn nucleus we planned to measure the charged particle multiplicity for ^{16}O+^{194}Pt system. Charged particles are more sensitive probe for understanding the dynamics of fusion-fission reactions [4]. In the present work, we are reporting the preliminary results of the analysis.

Experimental Details

The experiment was performed at 15 UD Pelletron facility at Inter University Accelerator Centre (IUAC), New Delhi, using the 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 with incident energy of 98.4 MeV, was used to form ^{210}Rn compound nucleus. The charged particles (protons and alphas) were detected in coincidence with fission fragments, so as to extract the particle multiplicities for the reaction under study. In total, four detectors (16 crystals) of CsI(Tl) were used for the detection of protons and alpha particles. Two Multi-Wire Proportional Counters (MWPCs) were used for the detection of the 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 at a distance of 38 cm from the centre of the target, whereas, the second was kept at an angle of 112^0 at a distance of 32 cm. Four CsI(Tl) detectors were kept at angles of 45^0, 85^0, 115^0 and 135^0 w.r.t 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 each 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, α-particle energies are in the range of 1.63 MeV to 18.5 MeV. Similarly, from ^{7}Li + ^{12}C reaction, α-particle energies are in the range of 5.27 MeV to 16.19 MeV. Schematic diagram of the experimental setup is shown in Fig 1.

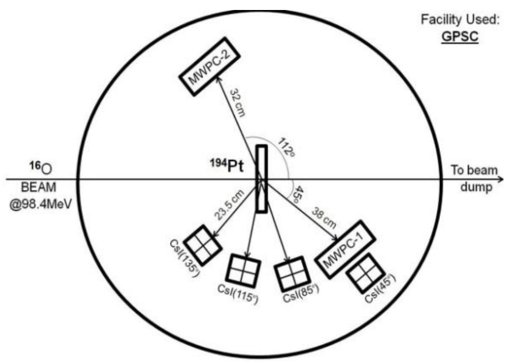

Fig. 1: Schematic diagram for experimental setup.

Data Analysis and Results

Charged particles were identified using the Ballistic Deficit technique for the particle identification exploring the decay characteristics of CsI(Tl). 2-D spectrum of CsI(Tl) detector is shown in Fig 2. Various bands represent different particles as mentioned in the figure [5]. α- particles were further gated with anode of MWPC to obtain the spectrum of α-particles in coincidence with fission fragments.

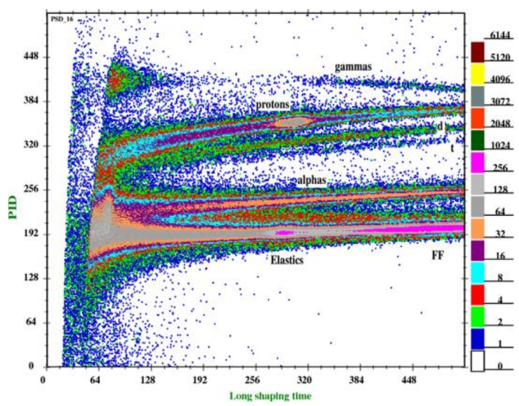

Fig. 2: 2-D spectrum of CsI(Tl) for particle identification.

α- particles were fitted using the moving source fitting expressions for charged particle emission [6]. Total contribution to α-particles from various sources such as CN, fragment 1, fragment 2, along with the experimental points is shown in the Fig 3.

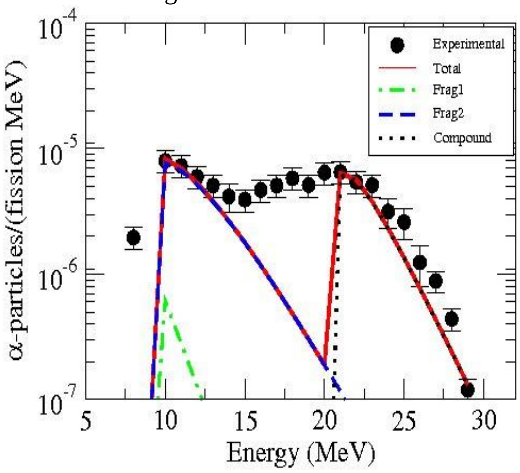

Fig. 3: - Particle multiplicity spectrum along with the fits obtained from moving source model. a) Solid line represents the total contribution, b) Dashed and dashed-dot line represents the Fragment 1 and fragment 2 contribution, and c) Dotted curve represents the compound contribution.

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

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