Mass distribution of fission fragments from ^{197}Tl*

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Introduction

When two nuclei collide near Coulomb barrier, they fuse together to form a compound nucleous (CN). This compound nucleous either emits few neutrons and light charged particles to form a stable nucleus called evaporation residue (ER) or fissions into two equal fragments. Another interesting phenomenon which takes place, in the mentioned energy regime is quasi-fission where in after collission, instead of forming an equilibrated CN, the dinuclear system reseparates resembling fission. Quasi fission has been theoretically predicted for heavy target projectile combinations, where the product of charges of the target and projectile is greater than 1600 [1]. However, it has been experimentally noticed that, quasi-fission is present even for much lighter systems [2].

Keeping these factors in mind we have made an investigation near mass 200 region, where the presence of quasi-fission has been interpreted based on spin distribution [3] while the fission fragment mass distribution [6] has not shown any signature of the presence of quasi-fission. It has been observed that the entarnce channel mass asymmetry with respect to the Businnaro-Gallone critical mass asymmetry plays an important role in determining the fate of the dinuclear system [2, 4, 5]. We have selected two systems (^{16}O + ^{181}Ta and ^{19}F + ^{178}Hf) which are lying on either side of Businnaro-Gallone critical mass assymetry to form the same compound nuclei (^{197}Tl) for our studies. The pre-scission neutron multiplicities of these systems have been already studied by Hardev et. al. [4]. It has been observed that the avarage number of pre-scission neutrons emitted in ^{19}F + ^{178}Hf reaction was higher than that in case of ^{16}O + ^{181}Ta system at matching excitation energies. The detailed statistical model analysis of the data has shown that the the average spin of the system is higher in the case of ^{19}F + ^{178}Hf, and the higher average pre-scission neutron multiplicity has been partially attributed to this. We have carried out the study of the fission fragment mass distribution of these systems considering the fact that presence of quasi-fission in general widens the width of the mass distribution.

Details of Experimental Setup

The experiment has been performed using pulsed beams of ^{16}O and ^{19}F delivered by 15 UD Pelletron at Inter University Accelerator Centre (IUAC). The energy of the beams varied from 60 to 105 MeV. Thin targets of ^{181}Ta (150μg/cm^2) and isotopically enriched ^{178}Hf (200μg/cm^2) were used. The measurement has been carried out using 1.5m diameter General Purpose Scattering Chamber(GPSC) of IUAC. Fission fragments were detected using two large area position sensitive MWPCs

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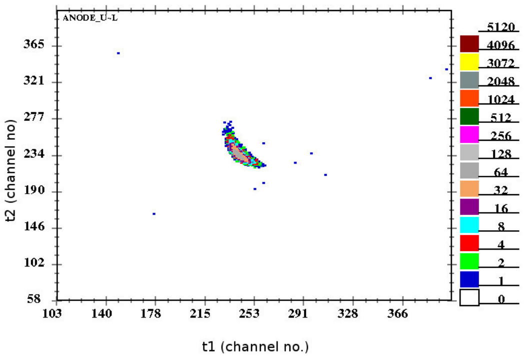

FIG. 1: Time of Flight correlation between complimentary fragments.

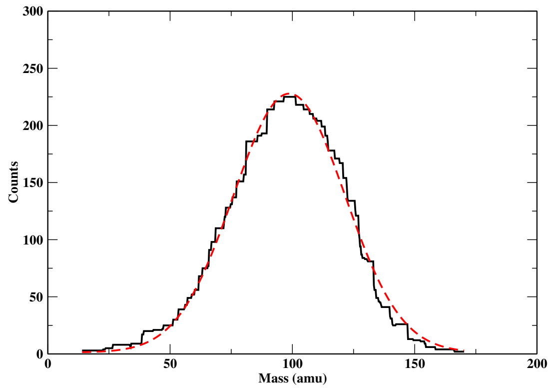

FIG. 2: Fission fragment mass distribution with Gaussian fit (red dotted line) for ^{19}19F + ^{178}Hf system at 94 MeV beam energy.

placed at folding angles at a distance of around 30 cm from the target. These detectors have active area of 6.4" x 4.4". The detectors have a three electrode geometry, having a cathode sandwiched between two position sensitive anodes. Timing signal is obtained from the cathode and the detctor was operated at 3 Torr of isobutanne gas pressure. Two PIPS detectors of 300μm thickness were mounted at 10^o with respect to beam direction for spacial and time monitoring of the beam. A valid RF signal (selcted by either of fission fragment timing ANDed with RF) was used as the strobe to the data acquisition system. Figure 1 gives the time correlation between the complimentary fission fragments.

Data analysis and Results

The masses of the fission fragments can be obtained from the angle and time of flight information obtained using MWPCs assuming symmetric mass split and no particle emission before scission. From the measured time difference between complementary fragments and the path length of fission flight, fission fragment mass distribution can be obtained as explained by Ghosh et al. [7]. The correlation of polar and azimuthal angles was used to separate the transfer fission component from the complete fusion-fission events as these angles correlation carry the signature of transfer of linear momentum of the projectile to the fused system of the projectile and target. Since RF signal from the beam buncher is taken as the time reference for TOF measurements, the mass resolution is limited mainly by the width of the beam pulse which is of the order of 1-1.5 ns in the present case.

Figure 2 gives the mass distribution of fission fragments obtained for ^{19}F + ^{178}Hf system at 94 MeV beam energy. Further analysis of the data is in progress.

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