Fission fragment mass distribution studies in ^{28}Si + ^{197}Au reaction.

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Introduction

In heavy ions induced reactions, complete fusion, quasi-fission, and transfer induced fission are the competing processes at energies around the coulomb barrier [1]. The quasi-fission process, in which the system reseparates before reaching a compact compound nucleus, is a major hurdle in forming heavy and superheavy evaporation residues (ER) in heavy-ion reactions. Transfer induced fission also plays important role in fission dynamics for heavy fissile targets.

Fission fragment mass distribution is one of the probe which helps to distinguish between the fully equilibrated compound nucleus fission and quasi-fission process. In both the processes the full momentum transfer takes place from projectile to target. The width of the mass distribution depends strongly on the entrance channel properties, such as mass asymmetry, deformation of interacting nuclei, collision energy, and the Coulomb factor Z_1Z_2 . Any sudden change in the width of the mass distribution would indicate departure from full equilibration. While onset of mass asymmetry or a sudden increase in width would be a strong signal of quasi-fission [2,3].

In the present work, we have investigated the mass distribution of fission fragments formed in ^{28}Si ion induced fission on ^{197}Au target.

Experimental details and data analysis

The experiment was performed at BARC-TIFR-Pelletron-Linac Facility, Mumbai. Pulsed beam of ^{28}Si of ~1.5 ns width and a period of 107.3 ns was used. The ^{197}Au (300 μg/cm^2) target was mounted on a target ladder that was oriented at 45° to the beam direction. Fission fragments were detected in coincidence by using two position-sensitive Multi-Wire proportional counter (MWPC) detectors mounted inside e general purpose scattering chamber and kept at folding angle. Both the MWPCs used were having a window dimension of 17.5cms X 7cms. One of the detector was kept at a distance of 54.17cm from the target ladder while the other at a distance of 27.5cm. Angular coverage of the detectors were around 18° and 35° respectively. Two Silicon detectors as monitor of elastically scattered particles were used with one placed at an angle of 20° while other at an angle of -16°. The ionizing medium used was isobutane gas at 2.5mbar. The X-Y positions, the energy loss in each of the detectors, the time difference between the arrivals of coincident fragments at the detector as well as individual time of flight of fragments with repect to RF beam bunching signal were recorded event by event. The position calibration of the detectors was carried out using the known positions of the edges of the illuminated areas of the detectors, when the events were collected in singles mode using ^{252}Cf source. The calibrated X and Y positions from the two detectors were then converted to θ and φ. The velocities were reconstructed from the position and timing information. The Kinematic coincidence method to separate transfer and elastic events from full momentum transfer fission events was used [5]. Fig. 1. shows the graph between the perpendicular and parallel velocity components of fissioning nucleus. The center rectangular region is taken to minimize the contribution of any partial momentum transfer fission events. Fig. 2. shows distribution of fission fragments in θ and φ space. The mass distribution so obtained is shown in Fig. 3.

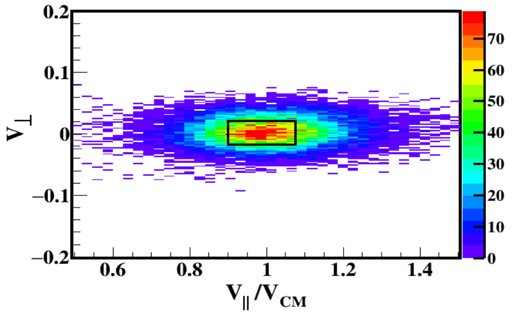

Fig. 1. Measured distribution of perpendicular and parallel components of velocities of fissioning nucleus..

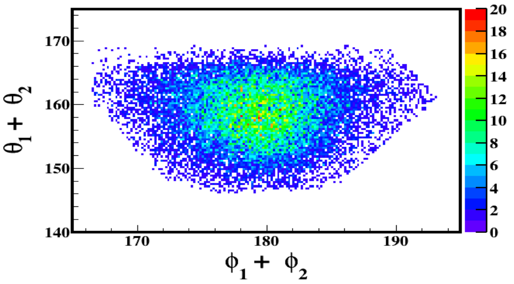

Fig. 2. Distribution of fission fragments in θ and φ space.

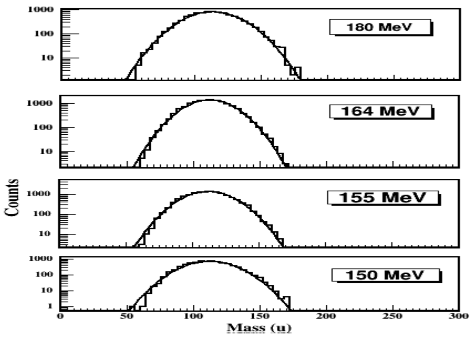

Fig. 3. Measured mass distribution of fission fragments at various energies.

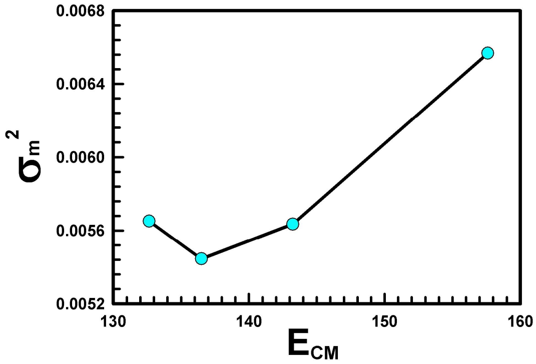

Fig. 4. Measured mass widths of fragments versus projectile center of mass energy.

Results and conclusion

The mass width obtained around 150 MeV as shown in Fig. 3. clearly deviate from the monotonic decrease trend observed at higher energies. This indicates the presence of quasi-fission component of fission apart from fully equilibrated compound nucleus fission. Further investigation at lower energies will help us to identify the true nature of the processes occurring.

References

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