Study of fission fragment mass distribution in $^{12}C + ^{178}Hf$ reaction

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Introduction

In recent years, observation of the presence of quasi-fission (QF) in relatively less fissile systems, where the product, $Z_PZ_T < 1600$ (Z_P and Z_T are the atomic charges of the projectile and target, respectively), has been a topic of current interest in heavy ion induced nuclear physics research [1,2]. QF is partly responsible for the low production cross section of super heavy elements (SHEs). Many experimental measurements of mass distribution of fission fragments (FF) using different projectile-target combinations are conducted by different groups to explore the characteristics of QF in medium mass region. In the present study, we have measured the fragment mass distribution (FFMD) from the fission of ^{190}Pt compound system populated at various excitation energies using $^{12}C + ^{178}Hf$ reaction. FFMD measurements also provide valuable information about the potential energy landscape of the fissioning nucleus [3]. The experiment was performed at Inter University Accelerator Centre (IUAC), New Delhi, using general purpose scattering chamber (GPSC) setup and Pelletron accelerator facility. The details of the experimental setup can be found in the Ref. [4].

Experimental Results

The fission fragments from complete fusion events followed by fission were selected by imposing the condition of full momentum transfer (FMT) of fission-like events using the correlation of the velocities of the fissioning system in the beam direction relative to the recoil of the system (Vpar) and the velocity perpendicular to the reaction plane (Vperp) [5]. The velocities correlation plot between the measured Vperp and Vpar-Vc.m (where Vc.m is the center of mass velocity of the fissioning system) which is used to identify different emission sources, is shown in Fig. 1.

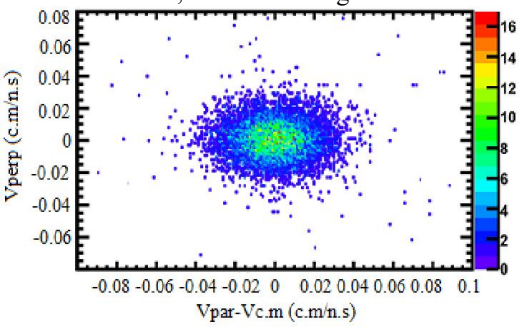

Fig. 1 Contour plot of velocities correlation for the fissioning nuclei in the reaction $^{12}C + ^{178}Hf$ at 88.2 MeV.

The events originated from the FMT fission are shown by the intense region around the velocity coordinates (Vpar-Vc.m, Vperp) = (0, 0). The relatively uniform distribution of the correlation plot indicates that most of the events are originating from the single emission source, which in present case is expected to be compound nucleus. The fission fragments masses were determined from TOF difference between the correlated fragments, the azimuthal and polar angles, the momenta and the recoil velocities for each event [3]. The extracted fission fragment mass distribution at different lab energies is shown in Fig. 2.

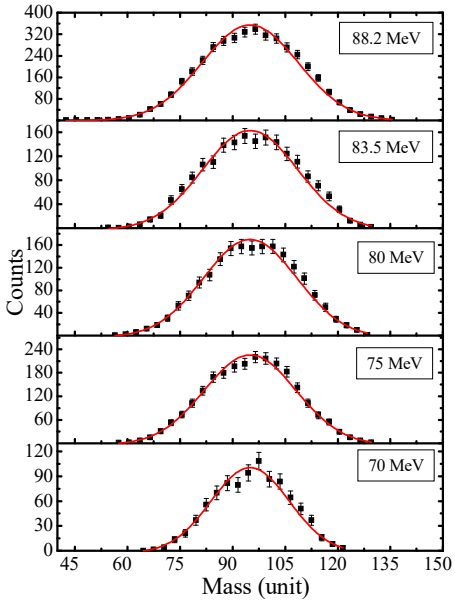

Fig. 2 The mass distributions of fission fragments for the system $^{12}C + ^{178}Hf$ at different lab energies. The Continuous line represents the Gauss fit to the experimental data.

It is observed that the mass distributions are relatively symmetric in shape and are well described with a single Gaussian function peaking around approximately half of the compound nucleus mass. Fig. 3 shows the variation of mass width with excitation energy for the same system. From the figure, it is evident that the width of mass distribution does not show any appreciable change over the studied energy range. Based on these observations, we may conclude that the system mainly proceeds towards the formation of an equilibrated compound nucleus after the capture of the projectile by the target nucleus.

In future, the experimental findings will be corroborated using the theoretical models of fusion-fission dynamics in order to have a complete picture of the reaction processes for the chosen reaction. Further, the data will be compared with the mass distribution of nearby compound systems populated using different entrance channels.

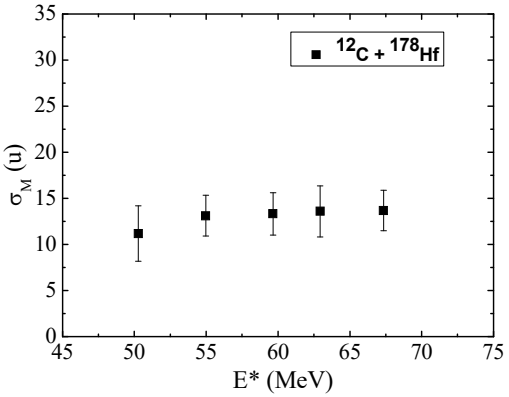

Fig. 3 Variation of the fission fragment mass width (σ_m) with the excitation energy.

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