Fission fragment mass distribution in $^{32}S+^{144}Sm$

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Introduction

The fission fragment mass distribution (FFMD) is one of the important observables to understand the fusion fission mechanism involved in the heavy ion induced reactions. The fusion fission process is guided by the potential energy landscape of the fissioning system. The symmetric fission of actinide fissioning systems at relatively higher excitation energy could easily be explained by liquid drop model (LDM). Incorporation of shell correction in LDM could explain the asymmetric nature of the fission fragment mass distribution at low excitation energy. A few years back, Andreyev *et al.*, reported asymmetric fission with mass ratio 100/80 in β-delayed fission of ^{180}Hg [1]. Though, conventional shell effect predicts the symmetric splitting in ^{90}Zr with semi magic configuration (N=50, Z=40). This observation prompted a series of theoretical and experimental investigations. Theoretical calculations by Moller *et al.* showed that this behaviour is not only restricted to ^{180}Hg but also is expected for many other nuclei in this mass region ~180 [2].

With an objective to investigate the nature of fission fragment mass distribution around the mass region A~180, measurement has been carried out in $^{32}S+^{144}Sm$ reaction with excitation energy of the compound nucleus (^{176}Pt) in the range of 40-50 MeV.

Experimental Details

Experiments have been carried out at BARC-TIFR Pelletron LINAC facility at TIFR Mumbai. Electrodeposited target of ^{144}Sm having thickness of ~120μg/cm^2 was prepared on aluminum backing of 550 μg/cm^2. The energy of ^{32}S beam in the target was in the range 143.9 MeV to 154.7 MeV. Two multiwire proportional counters were placed at ±66.5^0 in order to detect the fission fragment formed in $^{32}S+^{144}Sm$ reaction. The position and timing signals of the two proportional counters were fed into TDC. The signals in TDC were recorded by taking RF signal as reference. Stop signals were recorded whenever a fission fragment was detected in one of the gas detector. Two monitor detectors were placed at ±20^0 used to detect the elastically scattered beam particles.

Results and Discussions

Here, the data obtained at beam energy of 143.9 MeV is presented. Mass distributions at different energies were obtained by time of flight (TOF) measurements of the fission fragments. Time of flight of the fission fragments were obtained by subtracting the electronic delay with respect the beam pulse which was obtained from the time of flight of the elastically scattered beam particles. The two detectors were placed at similar angle (±66.5^0) corresponding to the centre of mass angle of 90^0. Therefore, the overall delay was adjusted in such a way that average centre of mass angle for both the detectors become 90^0,

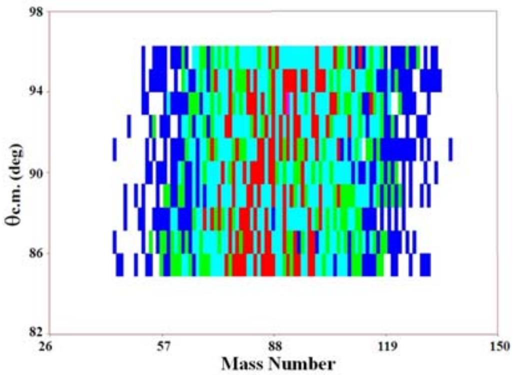

Fig. 1 Plot Of centre of mass angle vs Mass number at 143.9 MeV.

and also the parameter $V_{||}/V_{CN}$ was close to unity, where $V_{||}$ is the velocity of the fission system along the beam direction and V_{CN} is the recoil velocity of the compound nucleus. The average energy loss of the fission fragments in the target was estimated to be about 3.5 MeV. The energy loss calculation involves the effective charge of the fission fragments, which was obtained by using the prescription in ref [3]. Fig. 1 is showing the plot of centre of mass angle of the detected fission fragments as a function of mass no. The sharp cut off in the Y axis is due to

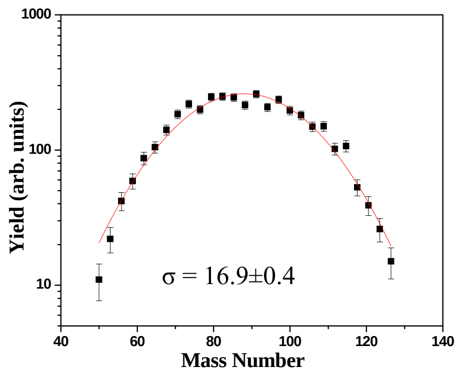

Fig. 2 Mass distribution in $^{32}S+^{144}Sm$ reaction at E_{lab}=143.9 MeV (E*=40 MeV). Solid line is the Gaussian fit of the mass distribution.

the selection of events within an angular range of 85^0-95^0. It can be seen from Fig. 2 that fission fragment mass distribution could be reasonably fitted by a single Gaussian. The standard deviation of the mass distribution was close to value obtained in $^{35}Cl+^{144}Sm$ reaction at similar excitation energy of the compound nucleus [4], though, slightly on the higher side. Mass distribution measured in $^{36}Ar+^{142}Nd$ system (compound nucleus ^{178}Pt) by I. Tsekhanovich *et al.*, showed an admixture of asymmetric and symmetric component with major contribution from the asymmetric fission at similar excitation energy [5]. Though, some systematic deviations are observed in the present study, further analysis involving determination of mass distribution by time difference method will be carried out to get more information.

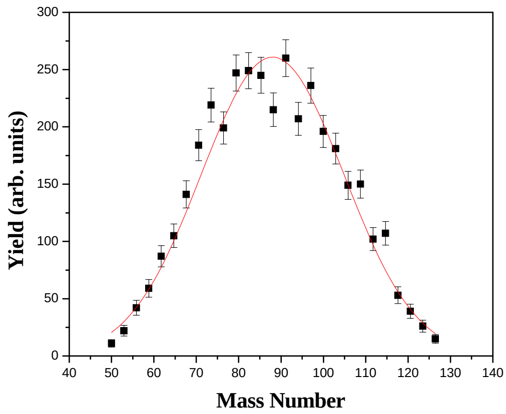

Fig. 3 Same as Fig. 2 (in linear scale)

Conclusions

Fission fragment mass distribution has been determined in $^{32}S+^{144}Sm$ reaction at beam energy of 143.9 MeV. The mass distribution has been observed to be grossly symmetric and could be reasonably fitted by a single Gaussian. The standard deviation of the mass distribution for $^{32}S+^{144}Sm$ was found to be close to the value observed earlier for $^{35}Cl+^{144}Sm$, though, slightly higher for the former system. Detailed data analysis, including the data at other beam energies, is being carried out to investigate the structures present in the mass distribution.

References

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