Fission fragment mass distribution for system ^{16}O+^{175}Lu

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Introduction

Fission fragment mass distribution is one of the probes widely used to study the shell effects as well as the reaction dynamics. The mass-asymmetric fission observed in low-energy fission of actinide nuclei is understood in terms of the effects of shell structure in the nascent fragments. According to liquid drop model as well as from the consideration of shell correction in the nascent fragments, proton rich ^{180}Hg was expected to exhibit symmetric mass distribution centered around semi magic ^{90}Zr. However in contrast to the anticipation, low energy fission of ^{180}Hg showed a pronounced asymmetric mass distribution, suggesting that shell structures other than those of the fragments may play a vital role in shaping fission outcomes [1]. Different theoretical models proposed to explain these results give contradictory interpretations. This has lead to a renewed interest in heavy-ion fusion-fission studies in this mass region. While mass asymmetric fission was observed in reactions induced by ^{35}Cl, ^{40}Ar and ^{40}Ca projectiles [2–4], relatively neutron rich compound nucleus (CN) populated in reaction induced by relatively lighter beam, ^{13}C, showed symmetric mass distribution [4] at energies near the Coulomb barrier. In order to disentangle the role of N/Z and entrance channel mass asymmetry more measurements are required. With this aim in present work, we have studied ^{16}O+^{175}Lu system ,which is populating CN similar to ^{35}Cl+^{154}Sm [3].

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Experimental Details

The experiment was performed at BARC-TIFR Pelletron-LINAC Facility, Mumbai, using ^{16}O beam of energies 76 and 88 MeV on a 300 μg/cm^2 thick ^{175}Lu (97.41% enriched) target with 150 μg/cm^2 aluminium backing. Fission fragments were detected in coincidence using three large area multiwire proportional counters (MWPCs) placed inside the scattering chamber. While one of the detectors was kept at 46° at a distance of 19 cm, the other two were kept at 94° and 134° on the other side of the beam direction at distance of 33 and 28 cm, respectively. The detectors were operated with isobutane gas at a pressure of about 3 torr. The timing signals were recorded using TDC with respect to the RF signal filtered with fission. Cathode signals were also recorded using QDC/ADC to get the energy loss information.

Data Analysis

The fission events were selected by putting two dimensional gates in time of flights (TOF) and energy losses spectra. The positions and TOF information were used to obtain the fragment emission angles and velocities. A correlation plot of the folding angle and azimuthal angle along with parallel and perpendicular components of velocities of the fragments are shown in Fig. 1.

Fission fragment mass distributions were deduced using the time difference method [5]. As shown in Fig. 2, the measured mass distributions could be fitted well with a single Gaussian.

Experimentally obtained variances from the present data for ^{191}Au are compared with those

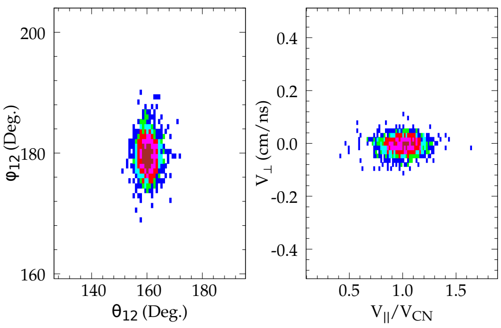

FIG. 1: Folding angle distribution of fission fragments detected in MWPC1 and MWPC2 respectively and Experimentally determined velocity components of fissioning nuclei at $E_{beam} = 88$ MeV

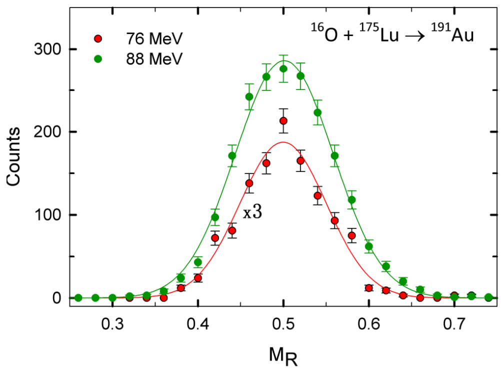

FIG. 2: Fission fragment mass distribution in terms of ratio of mass detected in one of the detector to the combined mass of projectile and nucleus at both measured energies.

for ^{179,189}Au (^{35}Cl+^{144,154}Sm) having similar excitation energy [3] in Fig. 3. Fitting of the measured mass widths (σ_m) for the present system using $\sigma_m^2 = \lambda T + \kappa\langle l^2\rangle$ results in $\lambda = (2.09{\pm}0.29){\times}10^{-3}$ and $\kappa = (7.15{\pm}3.35){\times}10^{-7}$. The obtained values agree well with those for ^{16}O+^{194}Pt system [6]. As shown in the figure, the calculated widths using the parameters for ^{16}O+^{175}Lu are found to be much smaller than the experimental widths for ^{35}Cl+^{144,154}Sm systems, which could be due to the presence of quasi-fission component in later cases.

Summary

Indication of contribution from mass asymmetric fission, found in similar systems [3] having more symmetric entrance channel, has not been observed in the present case. The observed width for ^{35}Cl+^{144,154}Sm is found to be more than the width expected from estimated widths of present data, this could be due to the presence of quasi-fission component for the more symmetric systems. Present study highlights the importance of dynamics in influencing fission fragment mass distribution for nuclei with A∼180.

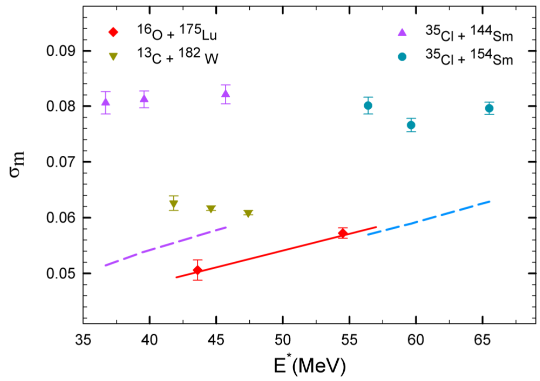

FIG. 3: Variation of experimental mass widths(σ_m) with E*. The continuous curve shows the fitted $(T,\langle l^2\rangle)$ dependence for ^{16}O+^{175}Lu. Dashed curves are estimated widths for ^{35}Cl+^{144,154}Sm (see text).

Acknowledgments

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