Fission fragement angular anisotropy in ^{18}O+^{232}Th,^{209}Bi fission at 110 and 125 MeV

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Many studies on fission dynamics were carried out theoretically and experimentally over the years to obtain a favorable way of the synthesis of super heavy elements or exotic nuclei far from the stability line. Fission fragment angular distribution is an effective probe to understand the dynamics of heavy ion induced fusion-fission reactions [1]. The angular distribution of the fission fragments is also a rich source of information about the saddle point shape of fissioning nuclei. The measured fission anisotropies depend on the entrance channel, the deformation and the spin of the target, the mass of the projectile, the bombarding energy with respect to the fusion barrier, and the fission dynamics. The theoretical angular anisotropy is given by the the Standard Statistical Saddle Point Model (SSPM) predictions[2]. Deviation from predicted angular anisotropy is due to non-equilibrium processes or a Non compound Nucleus (NCN) fission in the heavy ion induced fission. The Non compound Nucleus (NCN) fission mechanisms contain processes such as quasi fission, fast fission and pre-eqilibrium fission[2, 3]. Earlier the fragment angular anisotropies have been observed for ^{16}O+^{232}Th system [4]. In order to investigate the role of projectile structure of fission fragment anisotropy, in the present contribution we report the measurement of fission fragment anisotropy using ^{18}O projectile on ^{232}Th target .

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The experiment was performed at the BARC-TIFR Pelletron LINAC facility using 109.9 and 125.1 MeV ^{18}O beam. In the experiment self supporting Thorium and Bismuth targets of thickness 1.2 $\frac{mg}{cm^2}$ and 300 $\frac{\mu g}{cm^2}$ respectively were used. Two monitor detectors were placed at forward angles in order to normalize the data. The fragment-fragment folding angular distribution measurements were performed by employing three ΔE (25-30 μm)-E (300 μm) silicon detector telescope and two (Multi wire proportional counter) MWPC gas detector. Both the MWPCs used were having a window dimension of 17.5×7 cms. One of the gas detector was kept at a distance of 54.1 cm from the target ladder while the other at a distance of 27.5 cm. The angular coverage of the detectors were around 18^o and 35^o respectively. Isobutane gas pressure of 2.5 $mbar$ was maintained in two MWPCs with automated gas pressure handling system. Data were recorded in VME acquisition system. The pair of telescopes were taken to maximum back angles in order to cover angles close to 180^o. Forward angle movement of MWPC were restricted due to the large count rate. Present fission anisotropy data were obtained by analyzing fission fragment in silicon telescope detectors in singles only.

The normalized fission fragment yield has been plotted as a function of c.m. angle as shown in Figs.1-2 for ^{18}O+ ^{232}Th and ^{209}Bi reactions at the 109.9 MeV and 125.1 MeV. The fission fragment anisotropy values are extracted by least square fitting to the experimental data using the Legendre Polynomial of the forth order. For ^{18}O+ ^{232}Th system

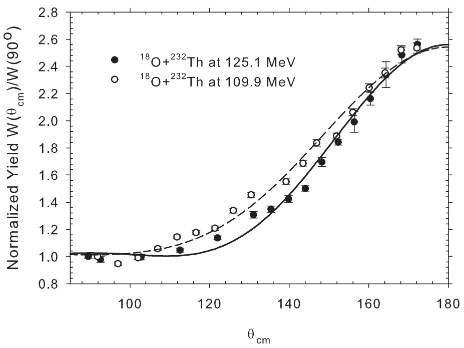

FIG. 1: Fission fragment angular anisotropy measurement for ^{18}O+^{232}Th at 125.1 MeV and 109.9 MeV.

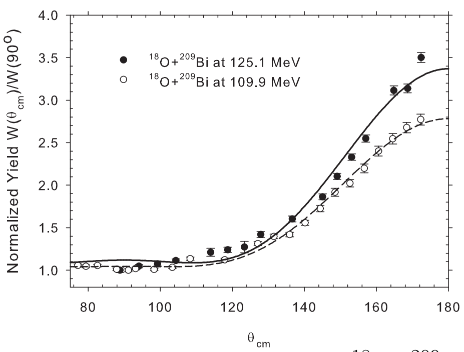

FIG. 2: Same as Fig.1 except for ^{18}O+^{209}Bi.

measured angular anisotropy comes out to be 2.56 ± 0.06 for 125.1 MeV and 2.54 ± 0.06 for 109.9 MeV and for the ^{18}O+ ^{209}Bi system measured angular anisotropy comes out to be 3.36 ± 0.12 for 125.1 MeV and 2.78 ± 0.04 for 109.9 MeV.

The fission fragment anisotropy is given by the following equation,

$$A = 1 + \frac{<\ell^2>}{4k_0^2} \quad (1)$$

Where k_0^2 is given by,

$$k_0^2 = TJ_{eff}/\hbar^2 \quad (2)$$

T, J_{eff} and $\langle \ell^2 \rangle$ are the temperature, effective moment of inertia at the saddle point and the mean square angular momentum of the fissioning system respectively.

The saddle point temperature is give by,

$$T = \sqrt{\frac{E^*}{a_f}} \quad (3)$$

where, E^* is the excitation energy of the fissioning system and a_f is level density parameter at the saddle point. The excitation energy E^* is written as,

$$E^* = E^*_{cn} - B_f(\ell) - E_{rot}(\ell) - E_n \quad (4)$$

where E is the excitation energy of the compound nucleus, $B_f(\ell)$ and $E_{rot}(\ell)$ are the ℓ dependent fission barrier and rotational energies, E_n is the average energy removed by the pre-fission neutrons.. The values of $B_f(\ell)$ and $E_{rot}(\ell)$ are calculated by using a rotating finite-range model [5]. E_n, is obtained from ref [6].

Preliminary data analysis of the fragment angular distribution of ^{18}O induced fission is different from that obtained from ^{16}O [4], suggesting that the di-neutron configuration of ^{18}O is playing a role in fusion-fission dynamics.

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