Fission anisotropy in $^{16,18}O+^{232}Th$ reaction at 92 MeV

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Introduction

Heavy ion fusion-fission reactions are still interesting area in nuclear physics because of their many applications. 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 angular distribution is characterized by the anisotropy of the fissioning nuclei. The angular anisotropy (A) is defined by the ratio of yields of the fission fragments at the 180^o ($W(180^0)$) to the 90^0 ($W(90^0)$) with respect to the beam direction [2]. To understand the dynamics of fission process, the observed angular anisotropy is compared with the Standard Stastical Saddle Point Model (SSPM) predictions[3]. 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 mechanism contains precess such as quasi fission, fast fission and preeqilibrium fission[3, 4]. Earlier anomalous fragment angular anistotropies have been observed at energies around the Coulomb barier for $^{16}O+^{232}Th$ system and the observed anomaly has been explained in terms of the preequilibrium fission model [1]. In the present work we have measured the fission fragment angular distribution for $^{16}O,^{18}O+^{232}Th$ systems to investigate the role of projectile structure on fragment anisotropy.

Experiment

To measure the fission fragment angular distribution, the experiment was carried out at the BARC-TIFR Pelletron-Linac facility general purpose scattering chamber. Beams of $^{16,18}O$ of 92 MeV were bombarded on natural ^{232}Th target of thickness $\sim 1.5 mg/cm^2$. The fission fragments were detected by using Si-detectors telescopes (E-ΔE) of thickness ($300\mu m$-$35\mu m$) kept at a distance of 20 cm from the target. Two monitor detectors were placed at forward angles (± 20^0) to measure beam current and normalize the data.

Results and Discussion

The normalized fission fragment yield has been plotted as a function of c.m. angle as shown in Fig.1 for $^{16,18}O+^{232}Th$ reactions at the 92 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 $^{16}O+^{232}Th$ system measured angular anisotropy comes out to be ~ 1.8 and for the $^{18}O+^{232}Th$ system measured angular anisotropy comes out to be ~ 2. The theoretical anisotropy calculated by using the Standard Statistical Saddle Point Model (SSPM) is about 1.43 for the $^{16}O+^{232}Th$ and 1.49 for the $^{18}O+^{232}Th$ system. The fission fragment anisotropy is given by the following equation,

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

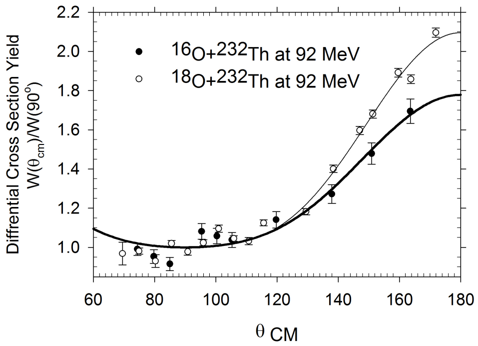

FIG. 1: Fission fragment angular anisotropy measured for the $^{16,18}O$+^{232}Th reaction at 92 MeV normalized to 90^0.

Where k_0^2 is given by,

$$k_0^2 = TJ_{eff}/\hbar^2 \tag{2}$$

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,

$$T = \sqrt{\frac{E^*}{a_f}} \tag{3}$$

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,

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

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].

The results on the fragment angular distribution of $^{16,18}O$ induced fission on ^{232}Th target show anamolous fission fragment angular distribution as compared with the SSPM model calculations.

Acknowledgments

We thank staff of Pelletron-LINAC facility for the smooth running of he experiment.

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