Fission Fragment angular distribution measurements in $^{16}O+^{194}Pt$ reaction.

E. Prasad[1],* K. M. Varier[1], R. G. Thomas[2], K. Mahata[2], A. M. Vinodkumar[1], S. Appannababu[3], P. Sugathan[4], K. S. Golda[4], B. R. S. Babu[1], A. Saxena[2], B. V. John[2], and S. Kailas[2]

[1]*Department of Physics, University of Calicut, Calicut 673635, India*
[2]*Nuclear Physics Division, Bhabha Atomic Research Centre, Mumbai 400085, India*
[3]*Department of Physics, Faculty of Science, The M. S. University of Baroda, Vadodara 390002, India and*
[4]*Inter University Accelerator Centre, Aruna Asaf Ali Marg, New Delhi 110067, India*

Introduction

Angular distribution of the fission fragments in heavy ion induced fission is an important probe to understand the dynamics of heavy ion collisions. The angular distribution and anisotropy data are generally explained by Statistical Saddle Point Model (SSPM) [1]. The observation of anomalous angular anisotopies in heavy ion induced fission reactions involving actinide targets resulted in a renewed interest in this topic [2] and it was realized that the admixture of non-compound nucleus proecesses could be a possible reason for this anomalous behavior. Shell clossure and shell corrections [3] at equilibrium deformation and saddle point were also reported to have influence on fragment angular distributions. Here, we report fission fragment angular distributions measurements of ^{16}O + ^{194}Pt reaction, populating the compound nucleus ^{210}Rn. The measurements were carried out in the energy range 5% below to 10 % above the Coulomb barrier.

Experiment Details

The experiment was performed using the general purpose scattering chamber of the BARC-TIFR 14UD Pelletron accelerator facility at Mumbai. ^{16}O beam (dc) in the energy range 79 - 90 MeV was used to bombard on ^{194}Pt target (300 μg/cm^2 thick target on 20 μg/cm^2 thick carbon foil). The beam energies

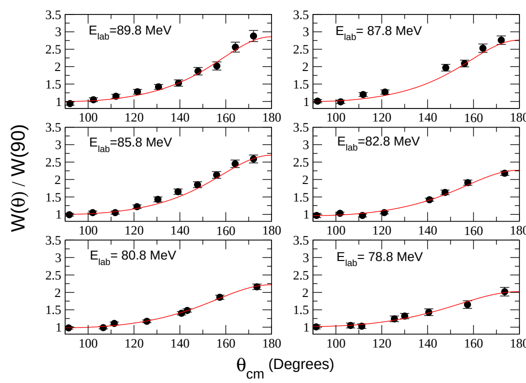

FIG. 1: The angular distribution of the fragments at different projectile energies. Solid lines are the fits using standard expression.

were corrected for the energy loss in the half thickness of the targets. The fission fragments were collected using three collimated ΔE - E silicon detector telescopes consisting of 15 - 20 μm thick ΔE detectors and 300 - 500 μm thick E detectors. These telescopes subtended equal solidangles and were placed on the same side of the movable arm. Two silicon surface barrier detectors were mounted at a distance of 42.0 cm at an angle of $\pm 20^\circ$ with respect to the beam direction and were used to monitor the beam incidence. Another monitor detector was kept at an angle of 40°, at a distance of 42 cm from target and used for the normalization of fission yields and estimation of the absolute fission cross sections. The angular distribution of the fission fragments were measured at 10° intervals from 80° to 170° in the laboratory frame. The relative solid angle of the telescopes were taken care by measuring

*Electronic address: `prasad.e.nair@gmail.com`

the data at overlapping angles.

Statistical Analysis

The measured fission fragment angular distributions were transformed from laboratory to center-of-mass frame using Viola systematics for symmetric fission [4]. The angular distributions in centre-of-mass were fitted using the standard expression for fragment angular distribution [5, 6] and the experimental fission cross section (angle-integrated) and angular anisotopies (A) were obtained. Fig. 1 shows the angular distribution of the fragments at different beam energies along with the fitting (solid line). The fusion l-distributions were obtained using coupled channels code CCFULL (including the rotational couplings of the target nuclei) by fitting the measured fusion cross sections (ER cross sections for the present system was measured in a separate run [7]). Using this l-distribution, statistical model calculations were performed using the code PACE with the modified prescription for fission barrier and level density parameter at the saddle point [3] to reproduce the ER cross section, fission probability and neutron multiplicity (obtained from the systematics [8]). The level density parameter at equilibrium deformation was fixed to be $\frac{A}{9}$ in the calculations. After fixing the statistical parameters, anisotropies were calculated following the SSPM prescriptions (using the excitation energy and $< l^2 >$ values obtained from PACE). However, these calculations overpredicted the anisotropies, especially at higher energies. When the neutron separation energies and fission barriers are comparable, multichance fission become dominant and the calculations assuming average excitation energy and angular momentum may not give correct results. Calculations were performed using the excitation energy and spin distributions for chance fission taken from PACE output. As the statistical parameters were already fixed, the effective moment of inertia $\Im_{eff}$ was scaled to fit the anisotropy values. It has been observed that

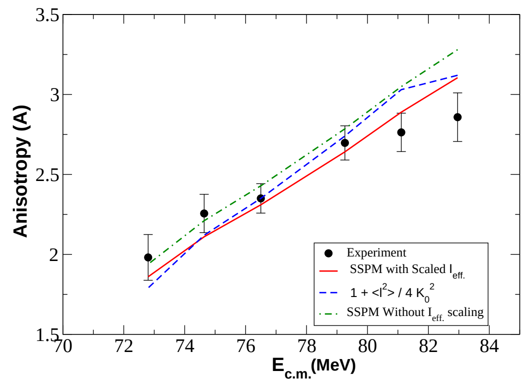

FIG. 2: The fragment angular anisotropy at different beam energies compared with theoretical calculations.

Fig. 2 shows the angular anisotropies at different beam energies along with the theoretical calculations. It can be seen that the statistical model calculations incorporating the multichance nature of fission along with $\Im_{eff}$ increased by 10 % explain the data well at all energies.

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