Fission dynamics of ^{192,202}Po compound nuclei using fission fragment mass-distribution as a probe.

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Introduction

In heavy ions induced fusion-fission (FF) reactions, along with complete fusion there are other competing processes such as quasi-fission (QF), and transfer induced fission at energies around the Coloumb barrier [1]. The complete fusion is described by equilibration in all degrees of freedom where as QF is characterized by full energy dissipation but incomplete drift toward the energetically favoured mass-symmetric configuration [2]. Transfer induced fission also plays important role in fission dynamics for the actinide targets. Measurements of fission fragment angular distribution (FFAD), mass-distribution (MD) and mass-energy correlation helps in distinguishing FF and QF processes [3]. The width of the MD depends strongly on the entrance channel properties, such as mass-asymmetry, deformation of interacting nuclei, collision energy, and the charge product $Z_P \times Z_T$ of the interacting partners. Any sudden change in the width of the MD would indicate departure from full equilibration. With this motivation in our mind, we have measured MD for the systems ^{48}Ti+^{144,154}Sm populating ^{192,202}Po compound nuclei (CN) with incident laboratory energy (E_{lab}) varying between 246-198 MeV. G. Knyazheva et al. [4] have studied the MD and FFAD for ^{48}Ca+^{144,154}Sm systems where fusion suppression and the presence of QF at energies near and below the Coulomb barrier have been observed for the reactions with the deformed target ^{154}Sm. In this work, our aim is to compare the MD results of the ^{48}Ti+^{144,154}Sm systems with the one reported in ref [4].

Experimental Details

The experiment was performed at IUAC-Pelletron Linac Facility, New Delhi. Pulsed beam of ^{48}Ti having repitition rate of 250 ns was bombarded on the ^{144,154}Sm (350 μg/cm^2) sandwiched targets. Fission fragments were detected in coincidence by using two position-sensitive Multi-Wire proportional counter (MWPC) detectors mounted inside the scattering chamber of National Array of Neutron Detectors (NAND) kept at fission fragment folding angle (59° each). Both the MWPCs used were having an active area of 11 cms × 16 cms and were kept at a distance of 16.5 cm from the target ladder. Two silicon surface barrier detectors were also placed inside the chamber at ±12.5° w.r.t to beam direction for monitoring the beam. The trigger of the data acquisition was generated by setting up a coincidence between RF of the beam pulse and any one of the fission detector. The VME based data acquisition using LAMPS software was used to acquire and store event mode data. A plot of time of flight spectrum (TOF1 vs TOF2; 1 and 2 refer to the frag-

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ments detected in MWPC detector 1, 2 respectively) for the ^{48}Ti+^{144}Sm reaction at E_{lab} = 246 MeV is shown in FIG. 1. A clear separation between the fission (fragment-fragment coincidence) and quasi-elastic scattering (projectile like-target like coincidence) events is obtained.

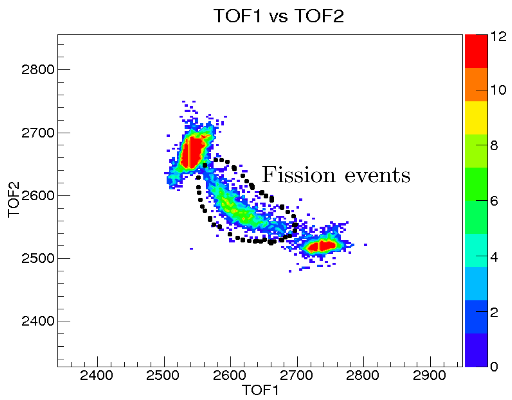

FIG. 1: Timing spectrum from the cathode of two MWPCs plotted against each other at E_{lab}=246 MeV. Events corresponding to fission are marked with black lobe.

Analysis and Summary

The calibrated positions and the time of flight information from the MWPCs were used to obtain the fragment emission angles and velocities assuming two-body kinematics [5]. The fission events were selected by putting a two-dimensional gate in the timing spectrum shown in FIG. 1. The folding angle distribution is plotted by adding the emission angle for each event, that peaks around 125° at E_{lab}= 246 MeV as shown in FIG. 2. The fission cross-section at 217 MeV relative to that at 246 MeV is smaller by a factor of 10, while at 203 MeV it is smaller by a factor of 500. At the lowest energy the event rate corresponding to the quasi elastic scattering is many order of magnitude larger than that of fission. The mass distribution so obtained for ^{48}Ti+^{144}Sm at E_{lab}=246 MeV is shown in FIG. 3. At all the measured energies, MD deduced from the above data for both ^{48}Ti+^{144,154}Sm systems will be presented during the symposium.

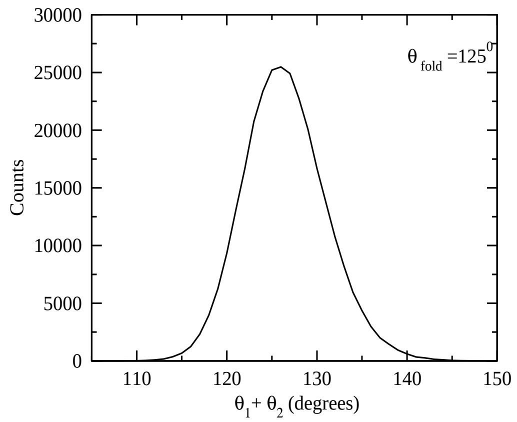

FIG. 2: Folding angle distribution of the fission fragments $\theta_1 + \theta_2$ at E_{lab}=246.

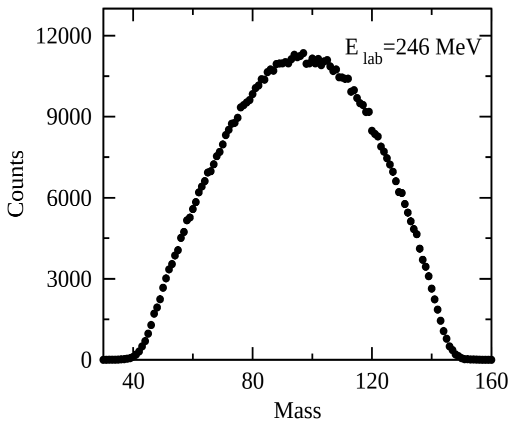

FIG. 3: Measured mass distribution of fission fragments for ^{48}Ti+^{144}Sm at E_{lab}=246 MeV.

Acknowledgments

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References

[1] J. Toke, et al. Nucl. Phys. A **440**, 327 (1985).
[2] R. N. Sagaidak, et al. Phys. Rev. C **79**, 054613 (2009).
[3] W. J. Swiatecki, Phys. Scr.**24**, 113 (1981).
[4] G. Knyazheva, et al. Phys.Rev. C **75**, 064602 (2007).
[5] D. J. Hinde et al. Phys. Rev. C **53**, 1290 (1996).