Fission hindrance studies in ^{224}Th: Spin distribution measurements

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1. Introduction

Physics of fusion-fission of heavy nuclei in the mass region 200 amu and above remains to be an interesting topic. It can throw light on super heavy element formation as well. Experiments [1–4] carried out in the past reveal that yields of evaporation residues (ERs), charged particles, neutrons, GDR γ-rays are much larger than the values predicted by the standard statistical model. This implies that collective mass flow from the equilibrium position to the scission point is hindered by nuclear viscosity. Detailed studies [5–7] have been carried out for the system ^{16}O+^{208}Pb $\rightarrow$ ^{224}Th and fission hindrance factor has been reported in Ref [8]. However, ER spin distribution has not been measured for this system. Recent studies [9, 10] demonstrate that the ER spin distribution measurement provides another sensitive tool to investigate the effects of dissipation in fusion-fission process. The aim of the present experiment is to study fission hindrance phenomenon by ER spin distribution measurement.

2. Experimental details

The ER spin distribution measurements were carried out for the system ^{16}O+^{208}Pb $\rightarrow$ ^{224}Th, using the gas-filled mode of the HYbrid Recoil mass Analyzer (HYRA) [11] and the TIFR 4π spin spectrometer, consisting of 32 NaI detectors [12] set up at IUAC, New Delhi. ^{16}O pulsed beam with pulse separation of 4 μs was provided by the 15 UD Pelletron accelerator and the first module of the LINAC at IUAC. The measurements were carried out for the energies (E_{lab}) 124.6, 116.5, 108.5 MeV. The remaining part of the experiment for three more lower energy points (100, 90, 80 MeV) around the Coulomb barrier will be carried out later with Pelletron beam. Enriched (99%) isotopic ^{208}Pb target of thickness 360 μg/cm^2, sandwiched between carbon layers of thicknesses 55 μg/cm^2 (entrance) and 10 μg/cm^2 (exit) was used. The ER cross section for the above mentioned system is ∼10 mb for E_{lab} = 110 MeV [5]. The recoil energy of the ERs at the focal plane was ∼1.5 MeV. It was a challenging task to detect ERs with such a low recoil energy and small cross section. The ERs were detected at the focal plane of HYRA using a multi-wire proportional counter (MWPC) (57×57 mm^2). One monitor detector was used at 45° with respect to the beam direction to record elastically scattered ^{16}O beam particles. This also helped in tuning the beam on the target. The 4π spin spectrometer was mounted in close geometry at the target chamber to detect γ-rays from ERs. Two time to amplitude converter (TAC) spectra were defined, *viz.* RF-TAC and MULT-TAC. For RF-TAC, the start was taken from the MWPC anode signal and the stop was the RF used for beam pulsing. For MULT-TAC the start signal was same as RF-TAC and the stop signal was the logic 'OR' of all the NaI detectors of the 4π spin spectrom-

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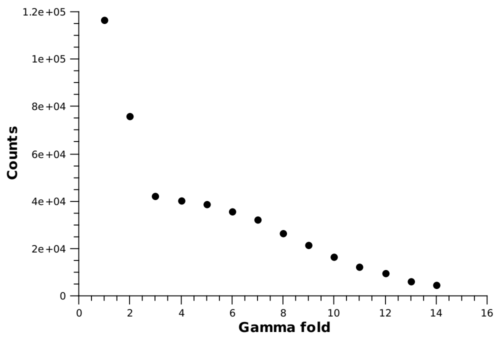

FIG. 1: Ungated gamma fold spectrum for E_{lab} = 118 MeV.

eter. We used 25 detectors out of the total 32 detectors in the present experiment. The logic 'OR' of the timing signal of the monitor detector and the anode signal from the MWPC was used as the master strobe for the data acquisition system.

3. Preliminary results

The experiment was done recently and analysis of data is in progress. We show raw γ-fold and ER-gated γ-fold spectra in FIG. 1 and FIG. 2, respectively. Detailed results will be presented in the Symposium.

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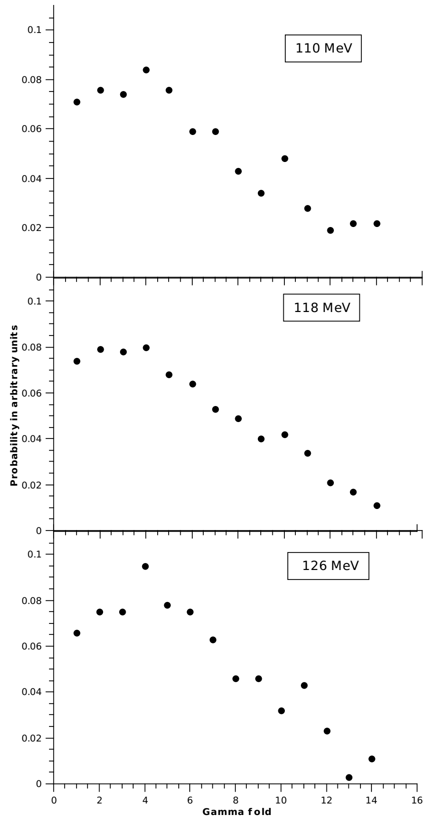

FIG. 2: ER gated gamma fold spectrum for three different labarotary energies.

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