Evaporation residue measurements for ^{16}O + ^{194}Pt reaction at energies around the Coulomb barrier using HYRA

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Introduction

Fusion-fission dynamics of heavy systems is a topic of considerable current interest. Measurement of evaporation residue (ER) cross section can reveal information about the presaddle dissipation. It is also pointed out that ER cross section is a more sensitive probe [1] for understanding nuclear friction, rather than neutron, proton and gamma multiplicities. The fusion-fission reaction dynamics is very much sensitive to the entrance channel parameters. It is well known that the entrance channel mass asymmetry with respect to Bussinaro-Gallone critical mass asymmetry value plays a decisive role in the reaction dynamics.

Experiment and Analysis

In a previous measurement [2] we had measured the fission fragment mass distribution for ^{16}O + ^{194}Pt reaction and we could not observe any hint of quasi fission process in this reaction. In the present experiment, we have measured the evaporation residue crosss sections for ^{210}Rn* formed in ^{16}O + ^{194}Pt reaction at laboratory energies 73.7(around 10% below the Coulomb barrier), 75.8, 79.9, 84.0, 88.1, 92.2, 96.3, 101.4, 103.4 MeV(around 25% above barrier), at Inter University Accelerator Centre, New Delhi. Hybrid Recoil Mass Analyser (HYRA)[3] was used in the measurements. The gas filled mode of the separator was used. Being very heavy, the compound nucleus undergoes its statistical decay mainly via fission and the ER cross section is low. Hence measuring ER cross section using vacuum mode separator is very difficult due to limitations in transmission efficiency. The gas filled separators, due to inherent charge state and velocity focusing, yield better transmission efficiency. Isotopically enriched ^{194}Pt

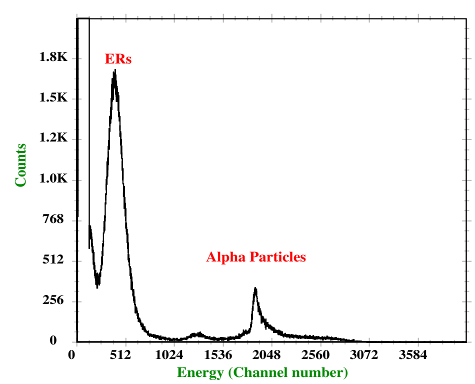

FIG. 1: The Evaporation residue and decayed alpha particles detected at the focal plane

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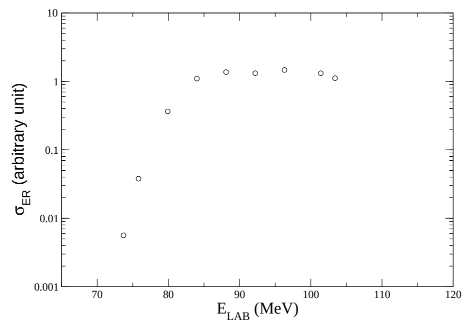

FIG. 2: ER cross section for ^{16}O + ^{194}Pt reaction (in arbitrary units) as a function of lab energy

target of thickness 300μg/cm^2 on 20μg/cm^2 carbon backing, was used as the target. Besides ^{194}Pt, ^{27}Al and ^{184}W targets were also mounted in the target ladder. Elastically scattered ^{16}O ions were detected in two silicon surface barrier detectors placed at $\pm$ 22^o with respect to the beam direction. The detection of ER at the focal plane was very challenging, as the recoil energy of the ER at the foacl plane was very small(at 73.7 MeV energy, the recoil energy of ^{206}Rn after the target was about 4.6 MeV, and after the polypropelene foil it was about 1.5 MeV, at a helium gas pressure of 0.15 Torr). The helium gas pressure in HYRA for such low energy ERs and the field settings were chosen from the calibration system ^{16}O + ^{184}W and using the Monte-Carlo simulation program [4] with proper scaling, where necessary. ^{27}Al target was used to check the beam-like contamination at the focal plane.

No appreciable beam-like or target-like particles was detected at focal plane for beam energies above the Coulomb barrier. At lowest energy, time of flight signal was used to separate the beam-like and target-like particles from ERs. Pulsed beam with pulse separation of 4 μs was used to record the time of flight (TOF) of the slowly moving evaporation residues at 73.7 MeV. The start signal was taken from the focal plane MWPC anode and stop signal was the TWD. The logically 'OR-'ed signal of two monitor detectors, MWPC anode and 2D surface barrier detector, was the master strobe for the data acquisition system. The ER ^{205}Rn undergoes alpha decay with a half life of 170 sec. This alpha decay was clearly observed in the 2D Si detector in this experiment. Fig.1. shows ER as well as the alpha decay spectrum in the 2D silicon detector. Due to very large gamma contamination coming from fission process and also from the reaction of beam with pressure window foil (Ni foil), conventional gamma ray method could not be used in this experiment for the transmission efficiency measurements of HYRA for the reaction studied. For transmission efficiency measurements ^{16}O + ^{184}W reaction, which was well studied in HIRA spectrometer[5] was used at 100 MeV beam energy in a separate experimental run. Transmission efficiency for ^{16}O + ^{194}Pt reaction at various energies will be calculated using this and the Monte-Carlo simulation code. Detailed analysis of the data is in progress. Fig.2. shows the ER excitation function in arbitrary units.

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