Evaporation residue excitation function measurement for the $^{16,18}O + ^{198}Pt$ reactions

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Introduction

The process of heavy-ion collision has shown unexpected facets that have been uncovered by the considerable amount of work (both experimentally and theoretically), accumulated during the last decade in fusion-fission dynamics. Differences found in the excitation functions as the number of neutrons or protons changes suggest that the structure of the colliding nuclei plays an important role in this kind of reaction [1]. It is also found that fusion-fission reaction dynamics is very much sensitive to the entrance channel parameters. Measurement of evaporation residue (ER) cross section can reveal information about the pre-saddle dissipation. It is also pointed out that ER cross section is a more sensitive probe [2] for understanding nuclear friction In this abstract we report the experimental techniques and methods of analysis for extracting the values of the fusion cross section for the $^{16,18}O+^{198}Pt$ reactions, at different set of excitation energies. These reactions populate the compound nuclei with same Z (Z=86, Rn) but different value of N (i.e different N/Z and (N-Z)/A). This is a part of our programme to study the effect of N/Z in the neutron multiplicity to understand the dissipative effects in fusion-fission dynamics [3].

Experimental Arrangement

The experiment was performed at the 15 UD Pelletron accelerator facility of the Inter University Accelerator Centre (IUAC), New Delhi. Pulsed $^{16,18}O$ beams with a pulse separation of 4 μs was used in the experiment to bombard isotopically enriched ^{194}Pt and ^{198}Pt targets of thickness 260 μg/cm^2 and 170 μg/cm^2 each on 10 μg/cm^2 thick carbon backing, respectively. ER excitation function measurements were performed at laboratory beam energies (after correcting for the loss in the pressure window foil (660 μg/cm^2 of Ni foil) and half thickness of the targets) of 78.0 to105.6 MeV for ^{16}O beam and 77.8 to 105.4 MeV for ^{18}O. Along with these, ER excitation function was measured at few energy points for $^{16}O+^{194}Pt$ reaction, for which data for ER measurement is already published [4], for normalization. The heavy ERs produced in the reaction were separated from the intense beam background by the gas-filled separator Hybrid Recoil Mass Analyzer (HYRA) [5]. Elastically scattered Oxygen ions were detected in two silicon surface barrier detectors placed at ± 22.7^o with respect to the beam direction. The helium gas pressure in the HYRA was set at 0.15 Torr and HYRA magnetic fields setting were calculated using a simulation program. Low-energy ERs reaching the focal plane were detected using a position sensitive multiwire proportional counter (MWPC). At each energy point, magnetic field values were also optimized by maximizing the ER yield at the focal plane, keeping the pressure fixed at 0.15 Torr. To get the time of flight signal, the start was taken from the focal plane

MWPC anode and stop signal was taken from RF used for beam pulsing. The logical 'OR' signal of two monitor detectors and MWPC anode was the master strobe for the data acquisition system.

Analysis and Results

The total ER cross section was calculated using the expression

$$\sigma_{ER} = \frac{Y_{ER}}{Y_{mon}}\left(\frac{d\sigma}{d\Omega}\right)_R \Omega_{mon}\frac{1}{\varepsilon_{HYRA}}$$

Where σ_{ER} is the ER cross section in mb, Y_{ER} is the ER yield at the focal plane, Y_{mon} is the yield in the monitor detector, ε_{HYRA} is the HYRA transmission efficiency, and Ω_{mon} is the solid angle subtended by the monitor detector. $(d\sigma/d\Omega)_R$ is the differential Rutherford cross section in the laboratory system. We followed the method outlined in Ref. [4] to get transmission efficiency of the HYRA for the given reactions. ER angular distributions for the reactions $^{16,18}O+^{198}Pt$ along with the $^{16}O+^{194}Pt$ (at 96 MeV beam energy were simulated using the Monte Carlo code TERS [6]. The statistical model code PACE3 [7] was used to check major decay channels for all the reactions. The angular distributions were simulated (for 10000 events) for individual evaporation channels and those were combined to obtain the total ER angular distribution, taking proper weightage from PACE3 results for each reaction. The circular exit aperture of the target chamber, translating to an angle (polar) of 3.35^o, defined angular acceptance of the HYRA in the present experimental arrangement. Areas under each curve (shown for two reactions in Fig. 1) within the acceptance were compared, keeping the total area under each curve same, to estimate transmission efficiency in each case. It was assumed that transmission efficiency relies only on the angular distribution of ERs and angular acceptance of the HYRA. Experimentally extracted ER excitation functions in arbitrary units for the two systems are shown in Fig. 2. Detailed analysis of data and statistical model calculations are in progress.

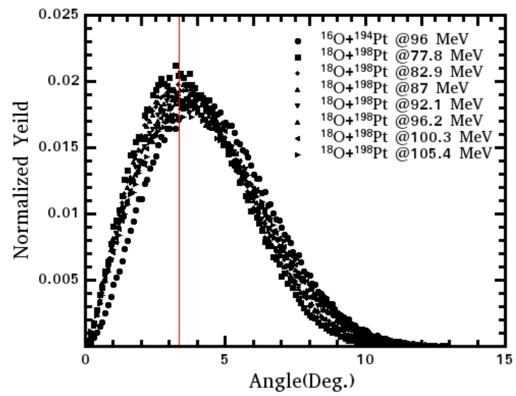

Fig. 1: Normalized ER angular distributions for $^{16}O+^{194}Pt$ and $^{18}O+^{198}Pt$ reactions, simulated using the Monte Carlo code TERS. The vertical line at 3.35^o defines angular acceptance in the present set-up.

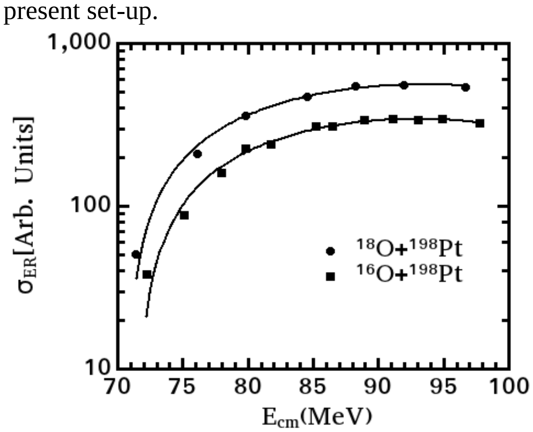

Fig. 2: ER excitation functions for $^{16,18}O+^{198}Pt$ reactions. The continuous lines are for guiding the eyes.

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