Search for quasifission in $^{12}C+^{238}U$ and $^{18}O+^{232}Th$ reactions at near and sub-barrier energies.

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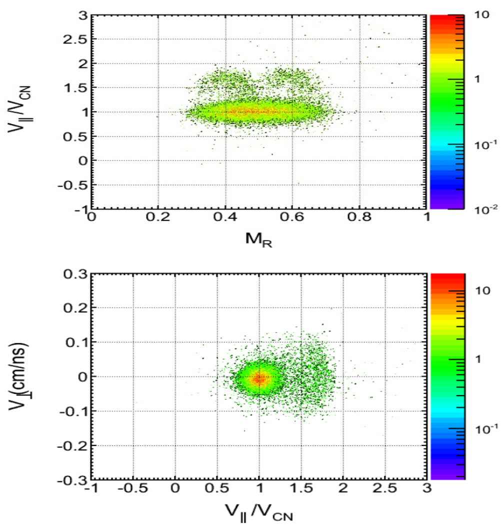
Introduction

In the early eighties, it was first recognized that the observation of fission fragments in heavy ion induced reaction does not necessarily originate from fission decay of a compound nucleus formed by fusion of projectile and target nuclei[1]. The process responsible for this observation is a non-equilibrium fission process called quasifission, which is associated with the incomplete relaxation in the mass asymmetry within the time available for the reaction.Though much progress in the description of this process, which is also expected to play a critical role in the synthesis of heavy and superheavy nuclei via fusion of heavy nuclei, have been achieved over the years, a comprehensive understanding of this complex processes is yet to be reached[2]. Of late, several measurements have shown unexpected presence of quasifission even in less fissile and asymmetric systems (i.e. systems of fissility < 0.8)[3,4,5].

The main motivation of this present work is to study the onset of quasifission process in the fissility region > 0.8. It was observed that angular distribution of fission fragments produced in reaction in this fissility region showed anomalously large anisotropies at sub-barrier energies as compared to SSPM, implying presence of pre-equilibrium fission[6]. Here, we report mass-angle correlation studies of $^{12}C+^{238}U$ and $^{18}O+^{232}Th$ reactions, forming same compound nucleus ^{250}Cf (Fissility=0.86), at similar excitation energy and angular momentum. The measurements were carried out in the energy range $E_{cm}/V_b \sim 0.88 - 1.1$, where E_{cm} is the energy in centre of mass frame and V_b is the Coulomb barrier.

Experiment and Preliminary Analysis

The experiment was carried out at the 15UD pelletron accelarator facility of Inter University Accelarator Centre (IUAC) New Delhi , using pulsed beams of ^{12}C(Elab=61-76MeV) and ^{18}O(Elab=80-96MeV) with a pulse width of ~1 ns and pulse separation of ~250 ns, bombarded on a ^{238}U target of thickness 108 μgm/cm^2 sandwiched between carbon backings of ~10 μgm/cm2 and ^{232}Th target of thickness 150 μgm/cm^2 on a carbon backing of thickness 30 μgm/cm^2 respectively. Fission fragments produced in the reactions were detected by a pair of large area Multi-Wire Proportional Counters (MWPC) with the active area of 20 cm x 10 cm, kept at mean fission fragment folding angle.The distance of forward detector from target was 58 cm and that of backward detector from target was 36 cm.



Fig(1):The figure in the above panel shows scatter plot of mass-ratio M_R Vs parallel velocity component of the fissioning nuclei, and figure in the lower panel shows plot of parallel component Vs perpendicular component of fissioning nuclei for $^{18}O+^{232}Th$ reaction at 84MeV.

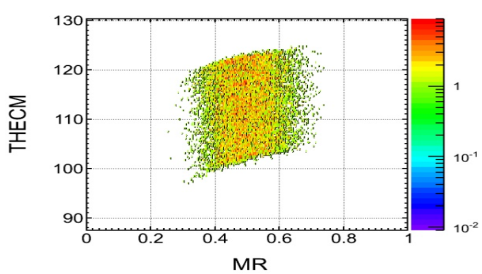
Two silicon surface barrier detectors were also placed at 10^0 with respect to beam direction for the beam monitoring purpose.

Time distribution of fission fragments were recorded by taking the start signal from MWPC's anode and a delayed stop signal from RF. The time distribution spectra were then converted to time of flight(TOF) spectra after appropriate calibration. The calibrated position spectra alongwith TOF spectra were then used to deduce the velocity of compliementary fragments. In the analysis, the velocities of fissioning system in the reaction plane and perpendicular to it was used to separate the full momentum transfer (FMT) events and nucleon transfer induced fission (TF) events. Using the conservation of linear momentum, the mass ratio was then obtained from the relation[7]

$$M_R = M_2/(M_1+M_2) = V_{1cm}/(V_{1cm}+V_{2cm})\ ;$$

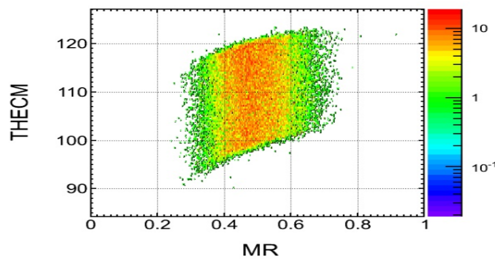
where V_{1cm} and V_{2cm} is centre of mass velocity vectors of fission fragments with mass M_1 and M_2 respectively.

In Fig(1), the plots of mass ratio M_R against parallel velocity component of fissioning nuclei relative to centre of mass velocity V_{CN} of fissioning nuclei and parallel velocity component against perpendicular velocity component of fissioning nuclei , is shown and it is seen that full momentum transfer fission (FMT) events and nucleon transfer fission (TF) events are clearly visible. It is found that the contribution from transfer fission events increases as the beam energy fall through coulomb barrier for both the systems.For further analysis we have put the gate on FMT events to get the mass angle distribution of fusion-fission events.

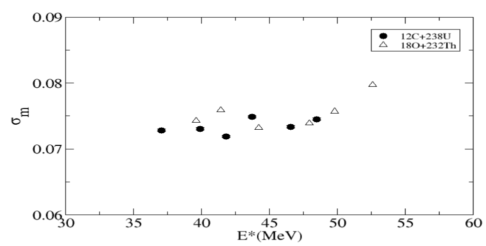


Fig(2):The figure shows experimental mass angle distribution for $^{12}C+^{238}U$ reaction at E_{cm}/V_b =1.

In the Fig(2) and Fig(3), the experimental mass angle distribution is shown for $^{12}C+^{238}U$ and $^{18}O+^{232}Th$ reactions at the coulomb barrier i.e. at $E_{cm}/V_b = 1$. As can be seen that there is no mass-angle correlation observed in both of the systems.



Fig(3):The figure shows experimental mass-angle distribution for $^{8}O+^{232}Th$ reaction at E_{cm}/V_b =1.



Fig(4):Plot of σ_m against Excitation energy E*(MeV).

Fig(4) shows the variation of the standard deviation (σ_m) of mass ratio distribtions as a function of excitation energy for both the systems. Analysis is in progress to obtain variances of mass distribution as a function of E* and $<l^2>$ of the composite system for the both the systems.The details of the analysis and results will be presented in the symposium.

Acknowledgement

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