Quasifission timescales in the ^{40}Ca induced reactions with pre-actinide targets

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Quasifission is a non-compound nuclear process which severely hinders the compound nucleus (CN) formation in heavy ion fusion. This process is understood to have a very strong dependence on entrance channel properties/reaction parameters such as mass asymmetry, beam energy, static deformation of the reaction partners, shell closure, N/Z matching of projectile and target nuclei and CN fissility. The complex dependence of quasifission on these variables makes it difficult to understand this process completely. In addition, the experimental observables of quasifission often overlap significantly with fusion-fission making their separation very difficult.

An important quantity that characterises quasifission is the timescales involved in this process. The mass-angle distributions (MAD) of the binary fragments can be used to calculate the average sticking times involved in the fast quasifission processes. The angular distribution of the fragments from the MADs provide information about the sticking time, which, combined with the measured masses (or mass-ratios) can be used to understand the mass evolution after capture.

In this contribution we discuss the fast quasifission timescales involved in reactions using ^{40}Ca beams as projectiles in heavy targets such as ^{186}W and ^{192}Os. The MADs were measured at 199.3, 204.3, 214.3 and 225.4 MeV for the ^{40}Ca+^{186}W reaction and 199.3, 204.3, 214.3, 225.3, 239.8, 262.8 MeV for the ^{40}Ca+^{192}Os reaction at the Australian National University. The experimental MADs were simulated using a classical, phenomenological approach [1] in this work. The colliding nuclei are assumed to follow the Coulomb trajectories until contact, the combined system rotates through an angle, and the re-separated fragments also move along the Coulomb trajectories to infinity in this model.

The capture angular distributions and moment of inertia are the major ingredients of these simulations. The capture angular momentum distributions are generated using coupled channels code [2] by reproducing the capture cross sections. Capture cross sections are obtained from the fission angular distribution measurements [3]. The moment of inertia is calculated using a scaling method from the TDHF moment of inertia calculated for a heavier compound system [3]. The mass is assumed to evolve exponentially towards symmetry following the prescriptions of Ref.[4]. The simulations are carried out separately for the tip and side orientations of the deformed targets and the mass ratio and angular distributions of the binary fragments are simultaneously matched to constrain the sticking time distributions. The simulation results along with experimental observations for the ^{40}Ca+^{192}Os reaction at different beam energies are shown in FIG. 1.

The simulations show that the average

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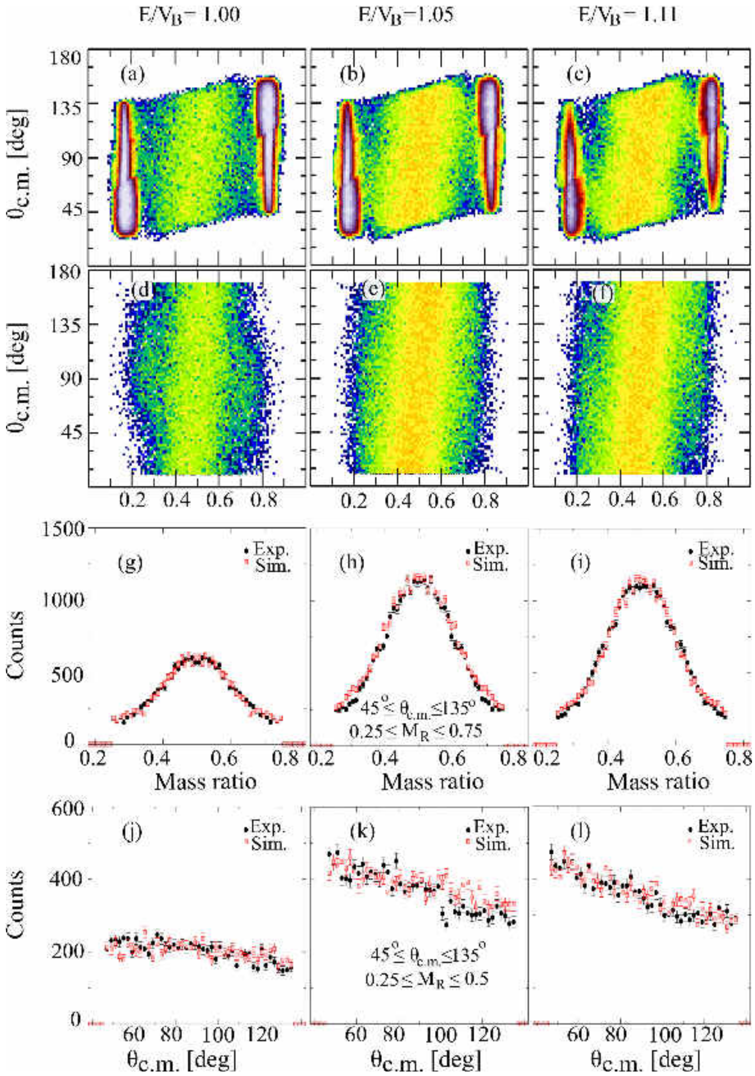

FIG. 1: The experimental (panels: a-c) and simulated (panels: d-f) MADs of the binary fragments from the ^{40}Ca+^{192}Os at different beam energies. Corresponding mass ratio (panels: g-i) and angular distributions(panels: j -l) are also shown.

sticking time of the fast quasifission component is $\sim$ 10 zs in the ^{40}Ca+^{186}W,^{192}Os reactions. This is consistent with the strong mass-angle correlation observed in these reactions, indicating the non-equilibration in quasifission in these reactions.

References

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