Effect of the nuclear dissipation on fusion-fission dynamics.

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Introduction

Study of fusion-fission dynamics in heavy ion induced reactions is a topic of great interest even today. Once the projectile and target nucleus interact with each other a composite system is formed. This composite system after following a long dynamical path equilibrates in all degrees of freedom and compound nucleus [1] is formed. This formed compound nucleus possesses high excitation energy and angular momentum and can decay via fission or particle emission. Several theoretical and experimental measurements have been made to study the effect of dissipation on fusion-fission dynamics [2,3]. It has been shown in some studies that dissipation slows down the fission process so as a result the fission width is reduced [4] and thereby, causing an increase in the number of evaporated particles and gamma-rays prior to fission. It is also observed that the dissipation causes increase in evaporation residue cross-section [5].

In this work, to study the effect of dissipation on fusion-fission dynamics, we have presented the statistical model calculations for the evaporation residue (ER) cross-section, fission cross-section, pre-scission neutron multiplicity for the system ^{48}Ti+^{124}Sn populating the compound nucleus (CN) ^{172}Hf. These calculations are performed using the statistical model code VECSTAT [6] for different values of dissipation parameter β.

Statistical model calculation

Decay of CN is described in terms of statistical model. The statistical model calculations were based on the assumption that once the projectile and target nucleus interact with each other, a fully equilibrated CN is formed and contribution from non-compound nucleus (NCN) events like fast-fission and quasi-fission was neglected. This formed CN possesses high excitation energy and angular momentum and can decay either via fission or particle emission (n, p, α) resulting in the formation of evaporation residue. The fission width given by Krammers [4] and the decay width of emitted particles given by Weiskopff formula [7] were used.

Results and Discussion

We have performed the statistical model calculations for the system ^{48}Ti + ^{124}Sn for lab energies E_{lab} = 177, 180, 185, 190, 195, 200, 205, 210 MeV populating the compound nucleus ^{172}Hf. Evaporation Residue cross-section, fission cross-section and neutron multiplicity were calculated for the ^{48}Ti+^{124}Sn system for different value of dissipation parameter β.

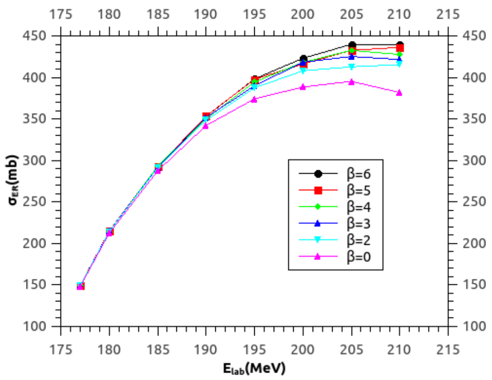

Fig.1. Variation of ER cross section with lab energy for different value of β.

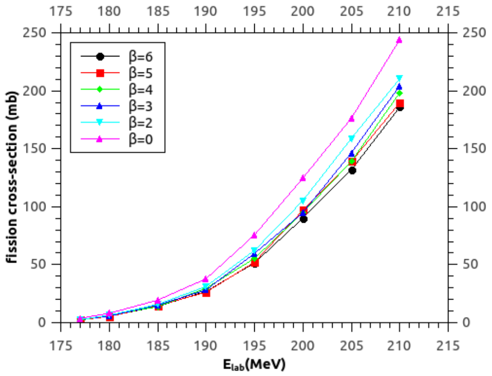

Fig.2. Variation of fission cross section with lab energy for different value of β.

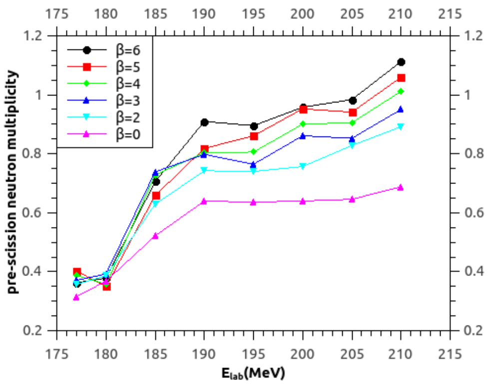

Fig.3. Variation of pre-scission neutron multiplicity with lab energy for different value of β.

Figures 1, 2 and 3 show the theoretically predicted results for evaporation residue cross-section, fission cross-section and neutron multiplicity for different value of dissipation parameter β. Fig.1 and Fig.3 show that there is enhancement in evaporation residue cross-section and neutron multiplicity as β increases. Fig.2 shows that fission cross decreases for different value of β. We are planning to perform the experiment in near future to measure ER cross-section using the HYRA facility for the system ^{48}Ti+^{124}Sn for which proposal has already been approved by IUAC. These calculations provide theoretical estimation and will be compared whenever the experimental results will be available.

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