Understanding the fusion-fission dynamics in heavy mass region

R. Dubey[1]*

[1]*Inter University Accelerator Centre, Aruna Asaf Ali Marg, New Delhi - 110067, India*

Survival of heavier elements play a key role in the formation of super heavier elements (SHE) in the Nature [1]. These elements are largely depend upon the nature of fusion process of two or more massive partners. Fusion process, specially low energy light ion induced reactions are hindered by fission process such as pre-equilibrium [2], quasi-fission [3–5]. Interestingly, the nature of colliding partners like their charge products (Coulomb repulsive) , relative mass (mass asymmetry)[6], orientation (static deformation) [5] and ground state spin [7] majorly decide these aspects of fission process.

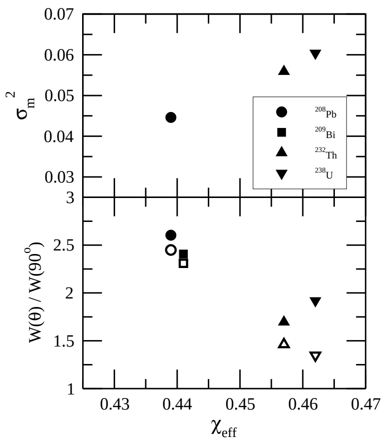

FIG. 1: Experimental(filled dots) mass variance [9],angular anisotropy[8][9]and theoretical calculation(open dots) of angular anisotropy [11]for (^{16}O+^{238}U,^{232}Th,^{209}Bi,^{208}Pb) v/s scaled fisility are shown at same excitation energy 45 MeV.

Theoretically, mass variance of fission fragments coming from complete compound nucleus exhibit the saddle point temperature dependence and slight dependence of angular momentum. The transient statistical model (TSM) also served a very good approximation to understand the complete compound nucleus (CN). However, it has been observed that these theoretical models unable to interprete the cause of deviation from compound nucleus. In the present work, we will try to understand fission mechanism through empirical study of ^{16}O, ^{19}F + ^{208}Pb, ^{209}Bi, ^{232}Th, ^{238}U, reactions. For ^{16}O, ^{19} + ^{208}Pb, ^{209}Bi, reaction all the probes (mass distribution, angular distribution, mass angle distribution, capture cross section, pre-scission neutron multiplicity, evaporation residue cross section measurements) are supporting the standard models (Fig 1, 2). Conversly, for ^{16}O, ^{19}F + ^{232}Th, ^{238}U reactions, there has been some contradictory results reported.

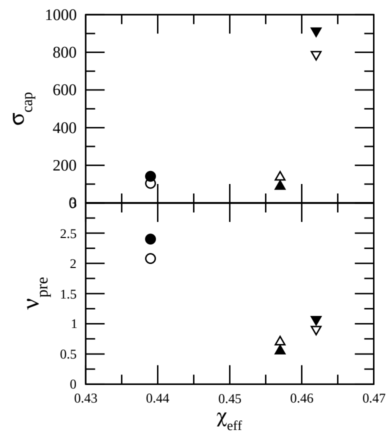

FIG. 2: Experimental(filled dots) prescission neutron multiplicity [10],capture cross sections[11] and theoretical calculation(open dots) of neutron multiplicity[8] and capture cross sections[11–13]for (^{16}O+^{238}U,^{232}Th,^{209}Bi,^{208}Pb) v/s scaled fissility are shown at same excitation energy 45 MeV.

Here, broadening of mass widths, decrease

*Electronic address: rdube.iuac@gmail.com

in angular anisotropy, decrease in pre-scission neutron multiplicity and increase in capture cross section against effective fissility in systematic study at same excitation energy are found (Fig. 1, 2). The standard model calculation for ^{16}O, ^{232}Th, ^{238}U at same excitation 45 MeV against effective fissility for all measurements exhibit slight deviation. These are just our preliminary observation. We will extend the study for other reactions also with all probes together for arriving the complete clear the picture of fission mechanism in this mass region .

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