Study of nuclear fusion fission dynamics in mass region A∼200

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Researchers working in the field of the heavy ion reaction have always been fascinated with a quest to extend the periodic table. Following this, several investigation have been made in the search of the Super Heavy Element (SHE) by colliding two heavy nuclei and studying several aspects. For the nuclear transmutation, a nucleus of certain species is bombarded with the projectile nuclei carrying suitable energy. If the energy favors the fusion process, the two colliding partner merge to form a single entity i.e., compound nucleus (CN) in highly excited state. This CN then meets its fate in two different ways, it may either split in two separate fragments (fusion-fission) or may disintegrate with an emission of radiation and some light particles like neutrons, protons and alpha particles leading to the formation of the evaporation residue (ER). However, for the heavy mass region, it is observed that the dinuclear system (DNS) may reseparate before CN is formed. One of such non compound nuclear fission (NCNF) processes is quasifission.

Quasifission hinders the fusion process, hence the SHE formation [1]. It plays a crucial role in tracing the complete fusion fission dynamics. Entrance channel mass asymmetry, $\alpha = \frac{A_T - A_P}{A_T + A_p}$ is one of the major factor that explains the occurance of the quasifission. Coulomb factor $Z_p Z_T$ is another parameter that determines the onset of quasifission. Early studies had indicated the onset of quasfission for entrance channel with $Z_P Z_T \geq 1600$ [2]. However, recent studies has revealed the presence of quasifission for the system with $Z_p Z_T \sim 1000$.

We have taken the measured ER cross section for the systems i)^{16}O+^{194}Pt [3], ii)^{30}Si+^{180}Hf [4], iii) ^{28}Si+^{180}Hf [4] and iv)^{28}Si+^{178}Hf [5] from the literature. Entrance channel mass asymmetry and $Z_P Z_T$ factor for the systems are tabulated as follow:

System	CN	α	$Z_P Z_T$
^{16}O+^{194}Pt	^{210}Rn	0.848	624
^{30}Si+^{180}Hf	^{210}Rn	0.714	1008
^{28}Si+^{180}Hf	^{208}Rn	0.731	1008
^{28}Si+^{178}Hf	^{206}Rn	0.728	1008
^{48}Ti+^{160}Gd	^{206}Rn	0.539	1008

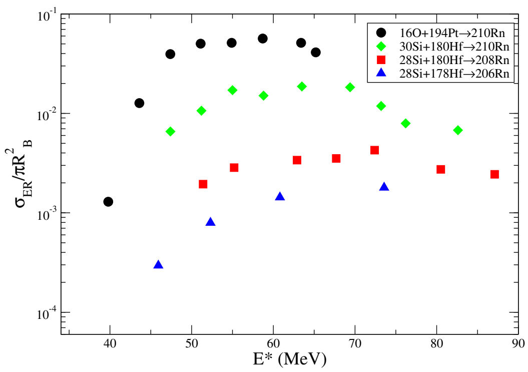

FIG. 1: Reduced ER cross section for i)^{16}O+^{194}Pt, ii)^{30}Si+^{180}Hf, iii) ^{28}Si+^{180}Hf and iv)^{28}Si+^{178}Hf.

As shown in Fig.1, we compared the reduced ER cross section at the similar

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excitation energies E*, for above mentioned systems. ^{16}O+^{194}Pt undergoes complete fusion, thereby yields $\sigma_{Capture} = \sigma_{Fusion}$ [3]. Among the two systems that populates same CN, ^{210}Rn, larger ER cross section for most asymmetric system ^{16}O+^{194}Pt was observed when compared with symmetric one i.e., ^{30}Si+^{180}Hf.

Fig.1 also indicates larger ER cross section for more neutron rich CN.

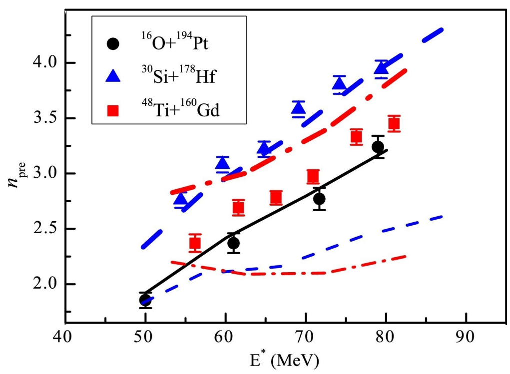

FIG. 2: Measured n_{pre} for ^{48}Ti+^{160}Gd,^{30}Si+^{178}Hf and ^{16}O+^{194}Pt. Thin lines are calculated n_{pre} without formation delay and thick lines with the formation delay .[6]

N. Kumar *et al.*, measured the pre scission neutron multiplicty n_{pre}, for the neighbouring systems ^{30}Si+^{178}Hf and ^{48}Ti+^{160}Gd and analyzed the data using 2D Langevin dynamical model [6]. Available data on the ^{16}O+^{194}Pt was taken for comparision. It was observed that ^{30}Si induced reaction follow fusion fission path predominatly while quassi fision dominates for ^{48}Ti induced reaction. This study validates larger ER cross section for most asymmetric system ^{16}O+^{194}Pt compared to ^{30}Si+^{178}Hf which is in complete agreement with the previously discussed result.

As has been demonstrated in this paper, nuclear fusion fission is strongly influenced by entrance channel mass asymmetry. ER being most reliable probe for determining the pre saddle dynamics, we have planned the ER cross section and ER gated spin distribution measurements for ^{30}Si+^{178}Hf and ^{48}Ti+^{160}Gd in IUAC. We have initiated Langevin Dynamical model calculation for these systems.

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