THEME: Low Energy Reaction Dynamics

SYSTEMATIC STUDY OF FUSION PROBABILITY IN PRE-ACTINIDES

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Presence of fission-like processes (NCNF) in fusion between two massive nuclei, without the formation of a compound nucleus (CN), causes the fusion probability, P_{CN}, to deviate from unity. Quantitative estimation of average fusion probability, $\langle P_{CN} \rangle$, has been attempted from different experimental probes e.g. (a) fission fragment (FF) angular distribution, (b) FF mass and total kinetic energy (TKE) distribution and (c) evaporation residue (ER) excitation function. In a recent systematic analysis of ER excitation functions for 52 reactions [1], $\langle P_{CN} \rangle$ was found to be dependent both on the entrance channel parameters and bulk properties of the composite system. This study helped to find out approximate boundaries from where $\langle P_{CN} \rangle$ started to deviate from unity, signifying a transition from statistical to dynamical regime. For the experimental verification of the same, a systematic investigation of the FF angular anisotropy in pre-actinide nuclei (Z = 83-88) was carried out at IUAC. FF angular distributions were measured for six ^{28}Si-induced reactions involving ^{169}Tm, ^{176}Yb, ^{175}Lu, ^{180}Hf, ^{181}Ta and ^{182}W targets at and above the Coulomb barrier. FFs were detected by nine hybrid telescopes, each consisting of a ΔE (gas) detector and a E (silicon) detector, with large angular coverage (θ_{lab} = 41°-170°). The experimental anisotropies and fission cross-sections were compared with theoretical predictions. The ratio of the experimental to the calculated anisotropy, $[(A_{exp}-1)/(A_{cal}-1)]$, showed deviation from unity near the Coulomb barrier, indicating presence of NCNF in the studied reactions. We also observed, by comparing anisotropies with those from neighbouring systems, that $\langle P_{CN} \rangle$ increasingly deviates from unity as one moves from pre-actinides to actinides.

[1] Tathagata Banerjee, S. Nath and Santanu Pal, Phys. Rev. C 91, 034619 (2015).