Reaction Dynamics in Heavy Element Formation

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After contact of two colliding nuclei, the dinuclear system is pictured as moving in deformation space over the potential energy surface. The system may reach compact (mononuclear) shapes inside the fission barrier (fusion), or may re-separate into two heavy fragments, intermediate in mass between the projectile and target nuclei (quasi-fission). The probability of fusion is determined by many variables, predominantly the mass-asymmetry of the two colliding nuclei, the charge of the heavy element being formed, and the neutron and proton shell structure encountered during the fusion process.

Measurements of mass-angle distributions (see Fig.1) of the quasi-fission fragments is a very sensitive way to investigate the dynamics of quasi-fission. Measurements [1] for ^{32}S + ^{232}Th (prolate) at near-barrier energies show two distinct components, both with the characteristics of quasi-fission. Their relative probabilities vary rapidly with the ratio of the beam energy to the capture barrier, suggesting a relationship with deformation aligned (sub-barrier), or anti-aligned configurations (above-barrier) at contact. Further measurements will be presented [2] which allow disentangling of the effect of shell structure in the colliding nuclei, and during the subsequent motion over the PES.

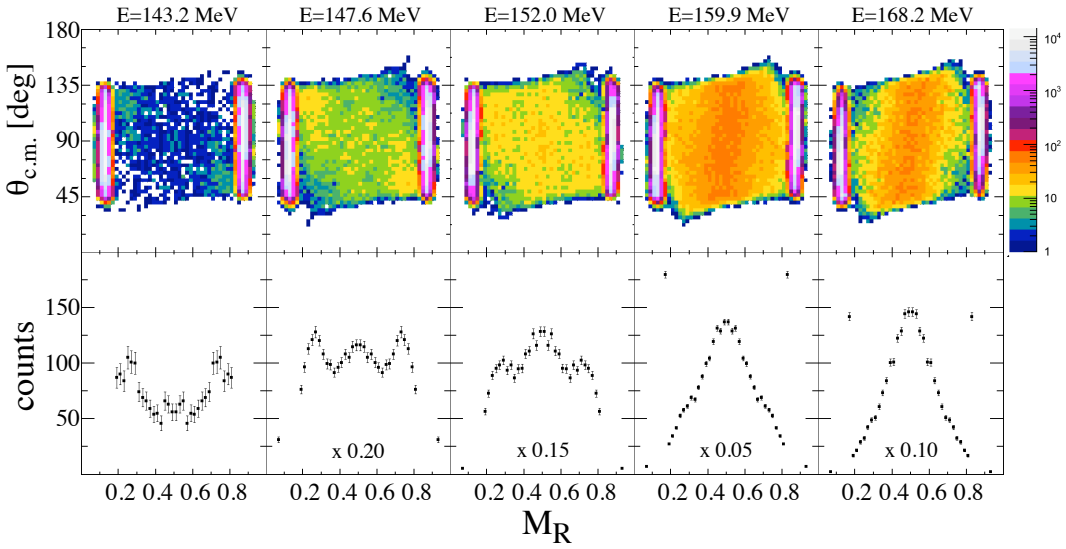

Figure 1: Mass-angle distributions of fission following capture for ^{32}S + ^{232}Th. The values of E (indicated) span the average capture barrier energy (154.5 MeV). The projected mass-ratio distributions below show a transition from dominantly mass-asymmetric divisions at sub-barrier energies, to an apparently mass-symmetric process at above-barrier energies. However the MAD show that this "mass-symmetric" component actually has a significant mass-angle correlation, which is inconsistent with fusion-fission.

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[1] D.J. Hinde *et al.*, Phys. Rev. Lett. **101**, 902701 (2008).
[2] D.J. Hinde *et al.*, Phys. Rev. Lett. **100**, 202701 (2008).