Nuclear structure effects in quasifission – understanding the formation of the heaviest elements

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Quasifission is an important process suppressing the fusion of two heavy nuclei in reactions used to create superheavy elements. Quasifission results in rapid separation of the dinuclear system initially formed at contact. Achieving reliable *a priori* prediction of quasifission probabilities is a very difficult problem.

Through measurements with projectiles from C to Ni [1], the Australian National University's Heavy Ion Accelerator Facility and CUBE spectrometer have been used to map out mass-angle distributions (MAD) - the fission mass-ratio as a function of centre-of-mass angle. These provide information on quasifission dynamics in the least model-dependent way. In particular, the quasifission time-scales have been extracted, and compared with TDHF calculations of the collisions, with good agreement being found [2].

Mapping mass-angle distribution characteristics against entrance channel and compound nucleus fissilities [1] helps to guide future experiments. Importantly this provides a baseline to determine crucial effects of nuclear structure on quasifission in collisions at near-barrier energies. The identification of broad trends, to then allow exploration of effects of nuclear structure, finds an analogy with the liquid drop model of nuclear masses, in which local shell effects become obvious when the underlying smooth trends are well defined. This principle is exploited in interpreting recent experimental MAD, particularly for the reactions of various isotopes of Cr with Pb, where the effect of closed shells and N/Z matching are strikingly displayed in collisions close to the Coulomb barrier.

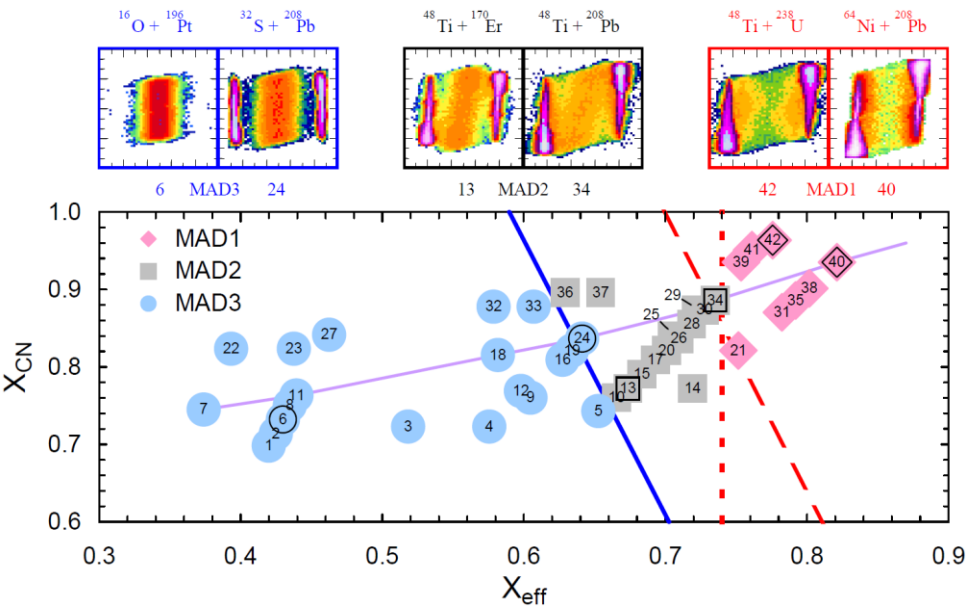

Fig. 1. Major quasifission MAD types 1, 2 and 3 (coloured symbols, corresponding to increasing sticking times) are clustered as a function of entrance-channel (x_{eff}) and compound nucleus (x_{cn}) fissilities. The diagonal blue line divides reactions with long (left) and shorter (right) sticking times, the latter evidenced by a mass-angle correlation. The purple line indicated the locus of reactions with doubly-magic ^{208}Pb, which will be shown to give higher fusion probability at near-barrier energies.

[1] R. du Reitz *et al.*, Phys. Rev. C **88** (2013) 054618
[2] A. Wakhle *et al.*, Phys. Rev. Lett. **113** (2014) 1825