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Determining Quasifission Time-scales in Superheavy Element Formation Reactions

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Quasifission competes strongly with fusion in reactions forming superheavy elements. The heaviest element that in practice can be created using a 48Ca beam is Z=118 (Oganesson), which has recently been formally approved and named. To form still heavier elements by fusion, use of heavier projectiles is necessary.
In general it is understood that heavier projectiles such as 50Ti, 54Cr, 64Ni give lower yields of heavy elements than does 48Ca. In cold fusion, this seems to be associated with the magicity as well as the neutron-richness of 48Ca. Evidence is seen in both evaporation residue cross sections and fission characteristics.
In the case of actinide (hot fusion) collisions, it is not clear whether it is the neutron-richness and low Z of 48Ca that has led to the successful synthesis of superheavy elements from 112 to 118, or whether its doubly-magic property is also critical. It is important to understand this question to reliably predict cross sections for reactions to create new superheavy elements in future.
To address this issue, measurements of quasifission mass-angle distributions have been carried out very recently at the Australian National University. Projectiles of 48Ca, 50Ti, 54Cr, 58Fe and 64Ni bombarded (radioactive) targets of 249Cf, 248Cm, 244Pu, 238U and 232Th respectively. Fusion in each reaction forms Z=118 compound nuclei with similar masses A from 296 to 298. Beam energies from below-barrier to above-barrier have been measured. With an enhanced MWPC detector setup allowing c.m. angular coverage from 20 to 160 degrees, these new mass and angle data reveal the difference in the typical reaction timescale, and the associated mass evolution dynamics in these reactions. This new information is complementary to previous fission mass-energy distribution measurements, and throws light on the difference between cold fusion and hot fusion reaction dynamics.

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