Fusion and Fission Barriers in Heavy Systems

P. Moller
Los Alamos National Laboratory

It is probably fair to say that no model of heavy-element evaporation-residue cross sections following heavy-ion reactions that is of useful accuracy or has predictive capability exists today. Of particular interest are the optimum energy and the cross section for evaporation-residue formation. One important quantity in models of these quantities is the fusion-barrier height in the entrance channel. It is sometimes referred to as the "Coulomb barrier" and is often modeled in terms of the potential energy between two spherical nuclei in a macroscopic model. We show that considerable modifications to this simple Coulomb-barrier picture occur due to deformation and microscopic effects in the target and projectile. We present some quantitative calculations of these effects.

In collisions leading to heavy-element evaporation-residue formation there is also considerable "hindrance" for compound-system formation. The qualitative explanation of this rapidly increasing hindrance in the heavy-element region is that the fission saddle-point shape corresponds to less and less deformed shapes as the compound system becomes heavier and "moves increasingly inside the touching configuration" (as systems become heavier than about uranium). We discuss in a qualitative fashion entrance-channel configurations that may reduce this hindrance.

PACS numbers:

The talk and much background is very well covered in the 3 papers listed below. A more printable version of the last paper is available from my web site http://t16web.lanl.gov/Moller/ - Capitalization is essential!

1. The Barrier for Cold-Fusion Production of Superheavy Elements,
   Takatoshi Ichikawa, Akira Iwamoto, Peter Möller, and Arnold J. Sierk,
   Phys. Rev. **C71** 044608 (2005) (Los Alamos National Laboratory Report LA-UR-04-7799)

2. Collisions of deformed nuclei: A path to the far side of the superheavy island,
   A. Iwamoto, P. Möller, J. R. Nix, and H. Sagawa
   Nucl. Phys. **A596** (1996) 329–354. (Los Alamos Preprint LA-UR-95-2443)

3. Macroscopic potential-energy surfaces for arbitrarily oriented, deformed heavy ions,
   P. Möller and A. Iwamoto
   Nucl. Phys. **A575** (1994) 381–411 (Los Alamos Preprint LA-UR-01-1648)