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A Comparative Analysis of Langevin and Random Walk Methodologies within a 4D Framework for Fission Fragment Mass Distributions in Actinide Nuclei

Friday, 13 March 2026 10:35 (25 minutes)

We present a comparative study of Langevin dynamics and a density-of-states-based random-walk approach for modeling fragment mass distributions in neutron-induced fission of thorium-229, thorium-232, uranium-235, plutonium-239, curium-245, and californium-249. We ensure a consistent theoretical framework by using the same four-dimensional potential energy surface derived from a macroscopic-microscopic model with Fourier-over-Spheroid shape parametrization. We adapt the random-walk methodology to simulate fission dynamics and analyze its relationship to the Langevin approach. We show that Langevin dynamics converge to the random-walk model in the low-friction limit. Calculations for several actinides indicate that both methods accurately reproduce the positions of the asymmetric fission peaks. The random-walk model, guided solely by the potential energy surface, predicts zero symmetric fission yield at low energies, in line with experimental trends. The Langevin model, by incorporating fluctuations, allows a small symmetric yield even at low energies. Differences in the predicted widths of the mass distributions—Langevin typically producing peaks only slightly narrower than experiment, while the random-walk approach yields narrower peaks—highlight the importance of dynamical effects such as inertia and friction, which are explicitly included only in the Langevin formalism. the importance of dynamical effects like inertia and friction, which are explicitly included only in the Langevin formalism.

Type of contribution

Invited Speaker

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