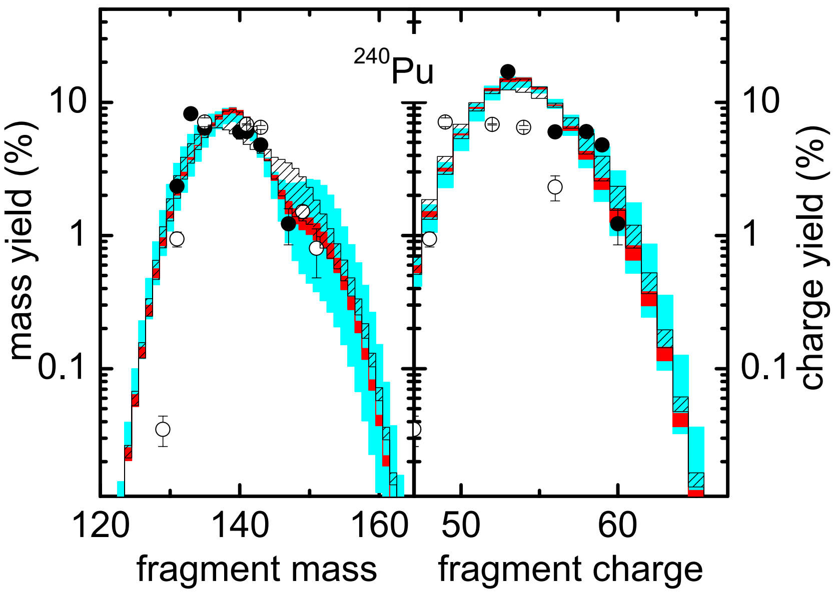
Yield distributions in the spontaneous fission of ^{240}Pu from microscopic theory

Objectives

- Advanced theoretical methods and high-performance computers may finally unlock the secrets of nuclear fission, a fundamental nuclear decay that is of great relevance to society.
- To calculate mass and charge distributions of spontaneous fission yields, we combine the multi-dimensional minimization of collective action with stochastic Langevin dynamics to track the relevant fission paths from the ground-state down to scission.

Impact

- Enables rigorous data-driven predictive modeling in complex physical systems.
- Provides benchmark for future model developments.
- Develops a predictive framework to describe spontaneous fission yields of a heavy nucleus.
- Uses symmetry-free DFT solver HFBODD, optimized for performance under UNEDF/NUCLEI SciDAC projects.



Mass (left) and charge (right) distributions of spontaneous fission yields of ^{240}Pu obtained in this work.

The experimental values are shown by circles. The shaded regions are uncertainties in the distributions due to variations in model parameters.

Accomplishments

- We propose a microscopic approach rooted in nuclear density functional theory to calculate mass and charge distributions of spontaneous fission yields.
- By combining many trajectories in the collective space, we predict spontaneous fission yield distributions of ^{240}Pu. The simulation results are in excellent agreement with experiment.
- We quantify uncertainties of our predictions.
- We demonstrate that the predictions are fairly robust with respect to the details of dissipative aspects of the model.

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Reference: J. Sadhukhan et al, Phys. Rev. C 93, 011304(R) (2016).

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