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Multidimensional Framework for Modeling Fusion and Fission of Heaviest Nuclei

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This work presents the development of a comprehensive computational framework for modeling fusion and fission processes in heavy and superheavy nuclei ($Z \geq 90$). The framework is based on the Warsaw Macroscopic-Microscopic Model (WMMM), extended to incorporate multiple shape parameterizations, including the traditional beta parameterization and the Fourier-over-Spheroid (FoS) approach, which enables description of nuclear shapes from compact configurations to scission.

The framework combines several methodological advances in shape parameterization conversion, model modernization, and large-scale computational capabilities to generate multidimensional potential energy surfaces spanning over 100 million configurations per nucleus. Stochastic shape evolution is described through both simplified and sophisticated formalisms, enabling predictions of fusion probabilities, ground state properties, fission barriers, and mass fragment distributions. Applications to superheavy elements and actinide systematics demonstrate the framework's ability to reproduce experimental observables without parameter fitting, suggesting promising prospects for a unified theoretical description of fusion-fission dynamics across the heavy element region.

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