Modelling of the low energy fission of atomic nuclei

A. Dobrowolski,B. Nerlo-Pomorska, K. Pomorski, A. Zdeb
Instytut Fizyki, Uniwersytet Marii Curie Skłodowskiej, 20-031 Lublin, Poland.

J. Bartel, H. Molique, C. Schmitt
Institut Pluridisciplinaire Hubert Curien, CNRS-IN2P3, 67-200 Strasbourg, France.

Project No. 08-131

Abstract

Potential energy landscapes (PEL) of even-even actinide and super-heavy nuclei are evaluated within the macroscopic-microscopic approximation [1]. A very rapidly converging analytical Fourier-type shape parametrization [2, 3] is used to describe nuclear shapes throughout the periodic table, including those of fissioning nuclei. The Lublin Strasbourg Drop (LSD) [4] is used to determine the macroscopic part of the nuclear energy. The Yukawa-folded single-particle potential, the Strutinsky shell-correction method, and the BCS approximation for including pairing correlations are used to obtain microscopic energy corrections. The evaluated nuclear binding energies, fission-barrier heights, and Q_α energies show a relatively good agreement with the experimental data [1]. The spontaneous fission life-times obtained within the WKB approximation agree well with the data [5]. It was shown in Ref.[6] that the Fourier shape parametrization containing only three deformation parameters effectively reproduces the shapes of nuclei approaching the scission point. The fission fragment mass distributions of the considered nuclei are obtained by solving a 3D Langevin equation [7, 8]. Charge equilibration at scission and de-excitation of the primary fragments after scission are further considered. The model gives access to a wide variety of observables, including fission fragment mass, charge, and kinetic energy yields, mean fragment N/Z ratios, postscission neutron multiplicities, and, importantly, their correlations. The latter are crucial to unravel the complexity of the fission process. Further applications and extensions of the model are on our agenda.

References

[1] K. Pomorski, A. Dobrowolski, B. Nerlo-Pomorska, M. Warda, J. Bartel, Z. G. Xiao, Y. J. Chen, L. L. Liu, J-L. Tian, X. Y. Diao, Eur. Phys. Journ. A**58**, 77 (2022).

[2] C. Schmitt, K. Pomorski, B. Nerlo-Pomorska, J. Bartel, Phys. Rev. C **95**, 034612 (2017).

[3] K. Pomorski, B. Nerlo-Pomorska, C. Schmitt, Z.G. Xiao, Y.J. Chen, L.L. Liu, Phys. Rev. C **107** , 054616 (2023).

[4] K. Pomorski, J. Dudek, Phys. Rev. C **67**, 044316 (2003).

[5] J. Marin Blanco, A. Dobrowolski, A. Zdeb, J. Bartel, Phys. Rev. C **108**, 044618 (2023).

[6] K. Pomorski, B. Nerlo-Pomorska, J. Bartel, H. Molique, Acta Phys. Pol. B Supl. **13**, 361 (2020).

[7] K. Pomorski, B. Nerlo-Pomorska, C. Schmitt, Z.G. Xiao, Y.J. Chen, L.L. Liu, Phys. Rev. C **107**, 054616 (2023).

[8] K. Pomorski, A. Dobrowolski, B. Nerlo-Pomorska, M. Warda, A. Zdeb, J. Bartel, H. Molique, C. Schmitt, Z.G. Xiao, Y.J. Chen, L.L. Liu, Acta Phys. Polon. B **54** , 9-A2 (2023).