Shell effects in fission and quasifission

C. Simenel[a], P. McGlynn[a], A.S. Umar[b], and K. Godbey[c]

[a] *Department of Fundamental and Theoretical Physics, Research School of Physics, The Australian National University, Canberra ACT 2601, Australia.*

[b] *Department of Physics and Astronomy, Vanderbilt University, Nashville, TN 37235, U.S.A.*

[c] *Facility for Rare Isotope Beams, Michigan State University, East Lansing, MI 48824, U.S.A.*

Fission of atomic nuclei is often affected by quantum effects leading to asymmetric mass splits (see Fig. 1). Quantum shells stabilising fission fragments with various shapes have been invoked as a factor determining the distribution of nucleons between the fragments at scission. While spherical shell effects in ^{132}Sn are responsible for the symmetric fission mode in neutron rich fermiums, octupole shell effects have been invoked [1] to explain the fact that the centroid of the heavy fragment charge distribution is found around Z ≃ 54 protons in actinide asymmetric fission. Shell effects have also been recently identified, both theoretically [2,3] and experimentally [4], in the quasifission process. Quasifission occurs in fully damped heavy-ion collisions following a significant mass transfer from the heavy to the light fragment, without formation of a compound nucleus.

In this talk, we use static and time-dependent mean-field approaches to investigate and compare the shell effects affecting fragment formation in both fission and quasifission. In particular, we discuss the possibility to use quasifission to obtain some information on potential fission modes in superheavy nuclei, which would benefit from the fact that quasifission cross-sections are much larger than for fusion-fission.

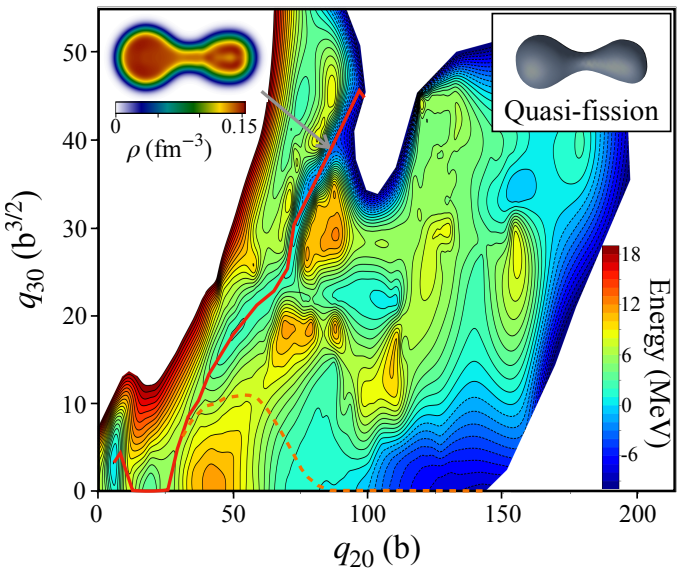

Fig. 1. Potential energy surface of ^{226}Th from mean-field calculations. The red solid (dashed orange) line shows a fission path leading to asymmetric (symmetric) fragments. Time-dependent mean-field calculations (grey isodensity) show that quasifission produces similar fragments as in asymmetric fission.

[1] G. Scamps, C. Simenel, Nature **564**, 382 (2018).

[2] K. Godgey, A. S. Umar, C. Simenel, Phys. Rev. C **100**, 024610 (2019).

[3] C. Simenel, P. McGlynn, A. S. Umar, K. Godgey, Phys. Lett. B **822**, 136648 (2021).

[4] M. Morjean *et al.*, Phys. Rev. Lett. **119**, 222502 (2017).