

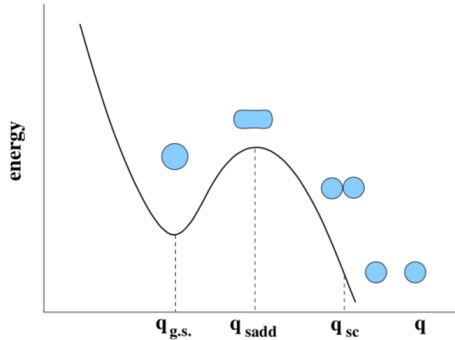
Fission barriers and fragment mass asymmetry in super-heavy nuclei

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Lublin, Poland

IUPAP Conference "Heaviest nuclei and atoms"
25-30.04.2023 Yerevan, Armenia





H.J. Krappe, K. Pomorski, Theory of Nuclear Fission, Lecture Notes in Physics Volume 838, Springer, 2012



Fission barriers heights

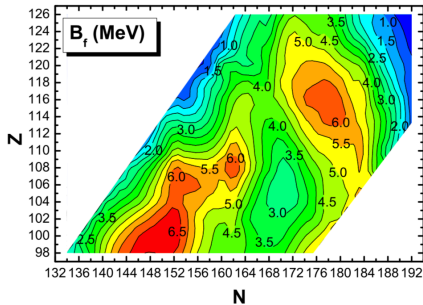


Figure 1: Contour map of calculated fission barrier heights B_f for even-even superheavy nuclei.

High barriers:

$N=162$, $Z=108$ (deformed magic numbers)

$N=178$, $Z=114$

Low barriers

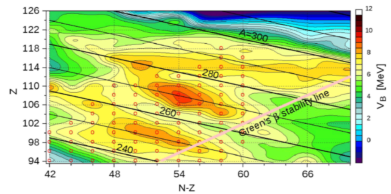
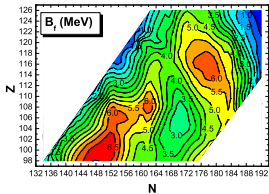
$N=168$

$N > 184$

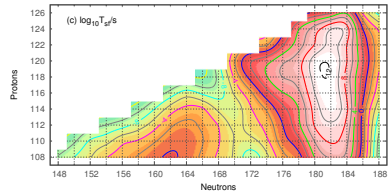
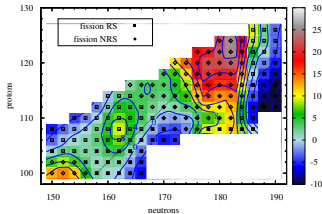
A. Baran, M. Kowal, P.G. Reinhard, L.M. Robledo, A. Staszczak, M. Warda, Nucl. Phys. A 944 (2015) 442



Macroscopic-microscopic models

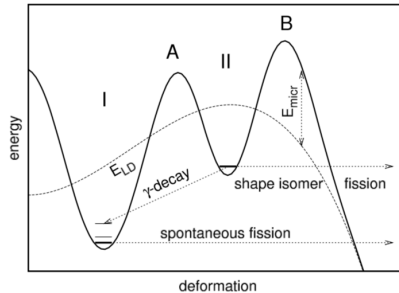


Self-consistent calculations



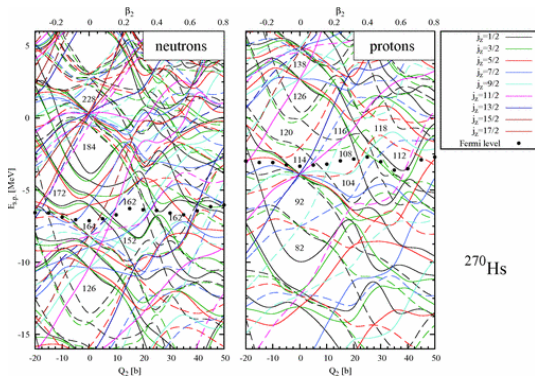
K. Pomorski, B. Nerlo-Pomorska, J. Bartel and C. Schmitt, Phys. Rev. C97, 034319 (2018)
 A. Staszczak, A. Baran, and W. Nazarewicz, Phys. Rev. C 87, 024320





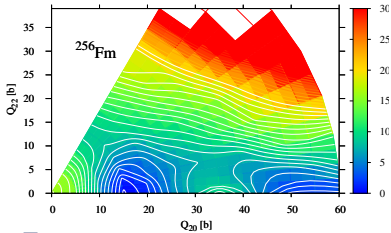
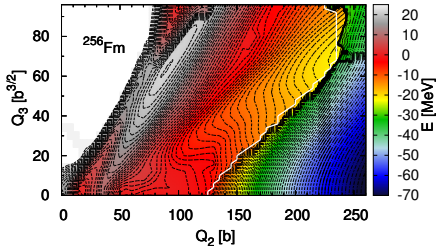
H.J. Krappe, K. Pomorski, Theory of Nuclear Fission, Lecture Notes in Physics Volume 838, Springer, 2012

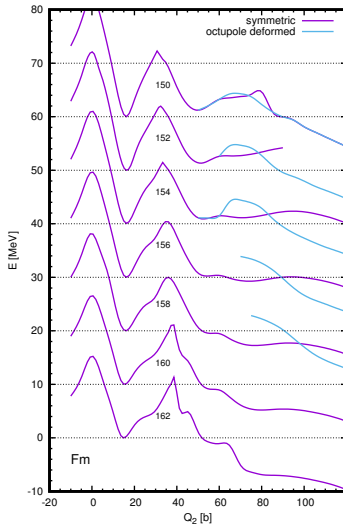
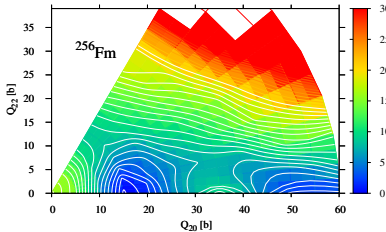
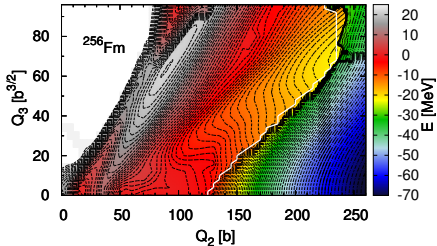


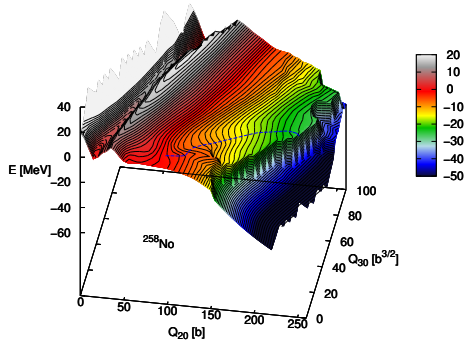


HFB self-consistent calculations
Gogny D1S force

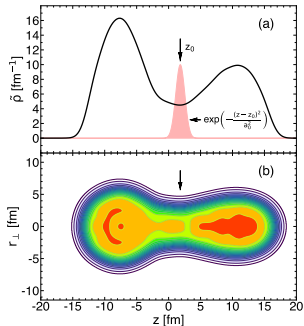








Neck parameter



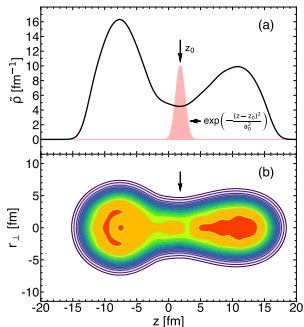
$$\hat{Q}_N = \exp\left[-\frac{(z-z_0)^2}{a_0^2}\right]$$

R. Han, M. Warda, A. Zdeb,

L.M. Robledo, PRC104,064602 (2021)



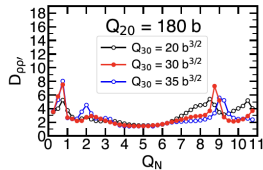
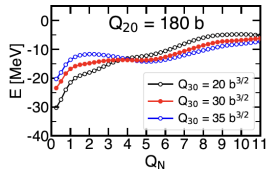
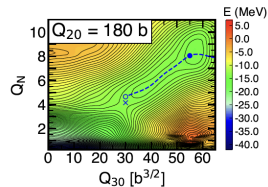
Neck parameter



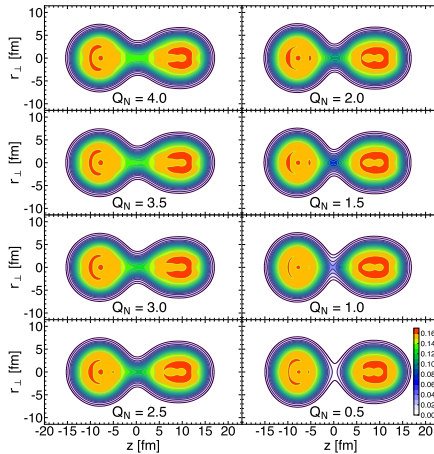
$$\hat{Q}_N = \exp\left[-\frac{(z-z_0)^2}{a_0^2}\right]$$

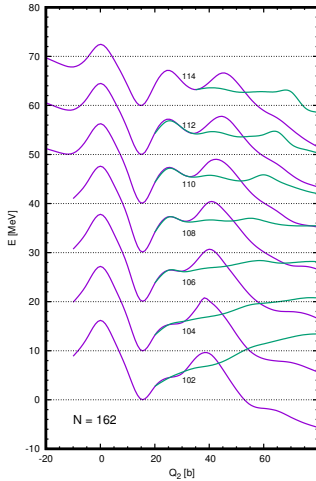
R. Han, M. Warda, A. Zdeb,

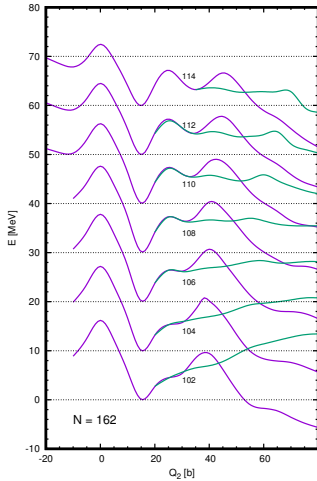
L.M. Robledo, PRC104,064602 (2021)



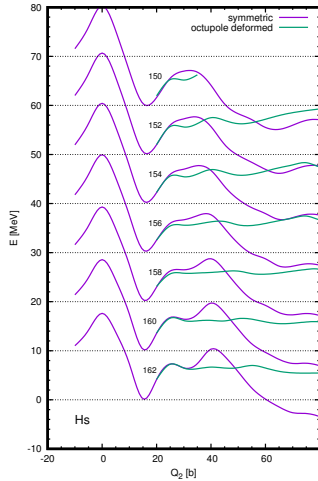
Neck parameter





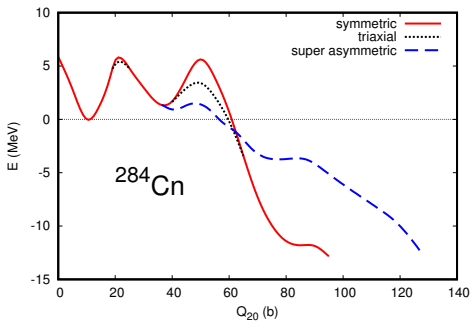


$N = 126$ & Hs

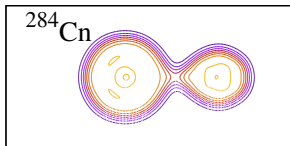
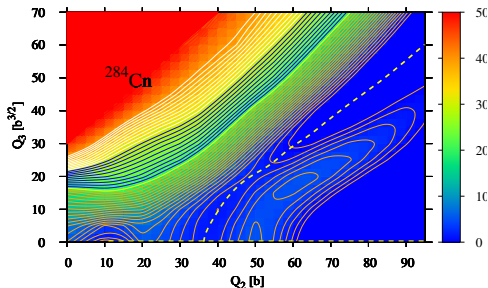


Experiments:

- GSI: **9 events**
Ch. Düllmann, et al., Phys. Rev. Lett. 104, 252701 (2010)
- Dubna: **19 events**
Yu. Oganessian, Radiochim. Acta 99, 429 (2011)
- RIKEN: **2 events**
D. Kaji, et al., J. Phys. Soc. Jpn. 86, 034201 (2017)



Super asymmetric fission



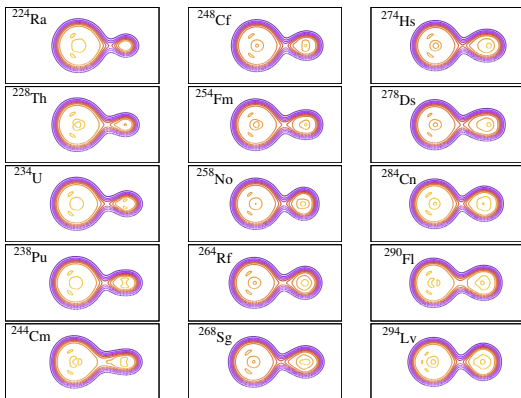
$$A_{HEAVY} = 208$$

M. Warda, A. Zdeb, L.M. Robledo, Phys. Rev. C **98** 041602(R) (2018)

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Pre-scission shapes



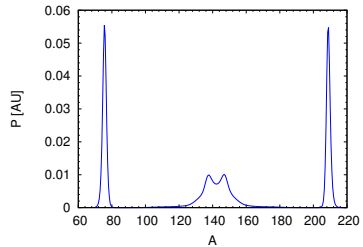
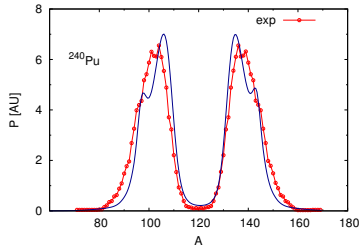
Cluster radioactivity in light actinides and SHE
 $N/Z=208/82$

M. Warda, L.M. Robledo, Phys. Rev. C 84, 044608 (2011)

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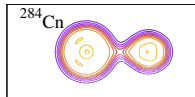
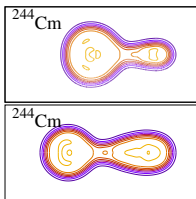
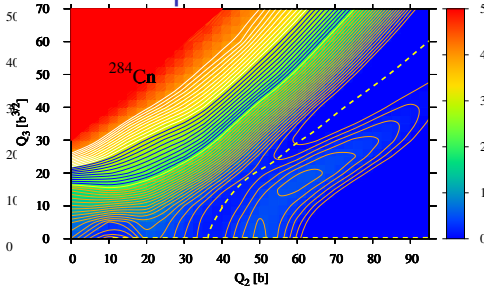
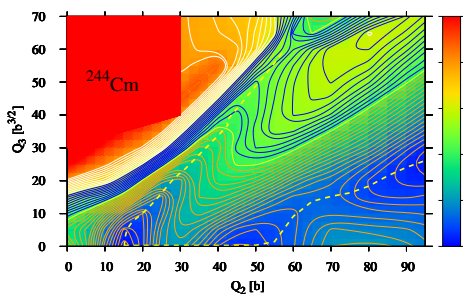
Super asymmetric fission



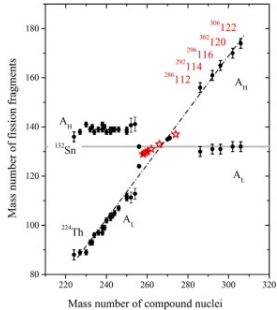
A. Zdeb, A. Dobrowolski, and M. Warda, Phys. Rev. C 95, 054608 (2017)



Actinides and superheavies



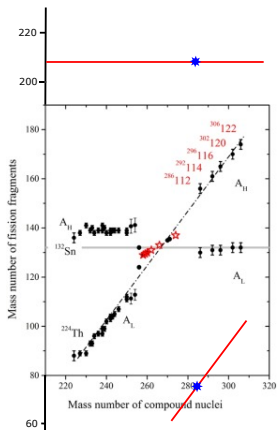
Mean fission fragment mass



M.G.Itkis, E.Vardaci, I.M.Itkis, G.N.Knyazheva, E.M.Kozulin, Nuclear Physics A944 (2015) 204

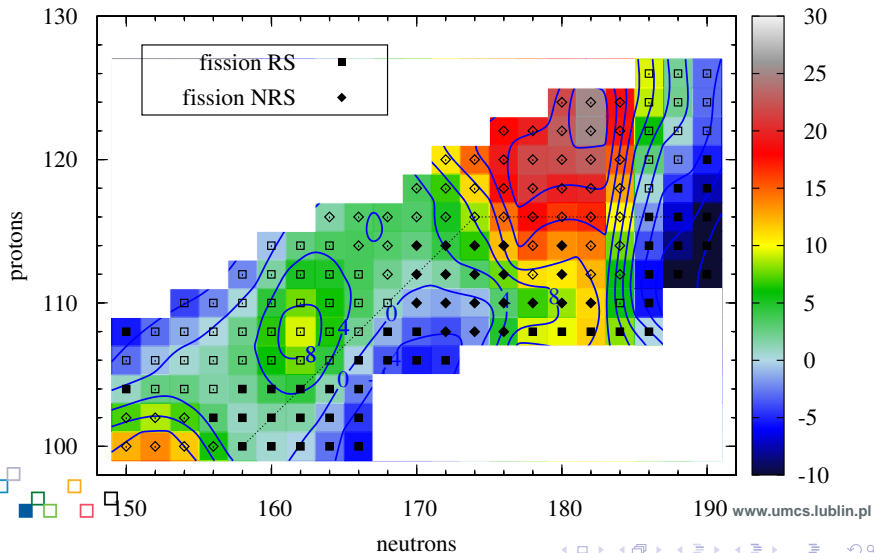


Mean fission fragment mass

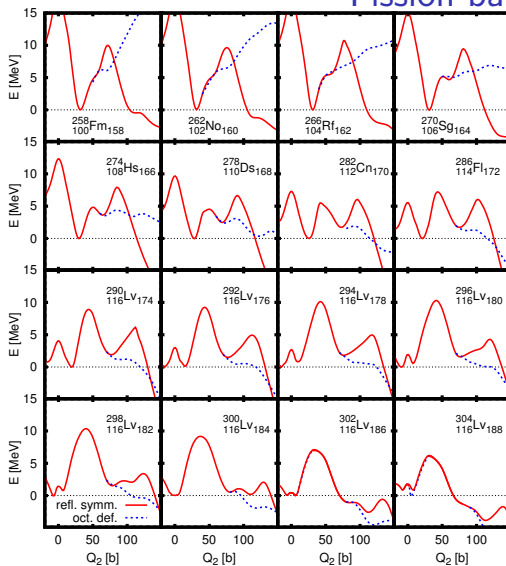


M.G.Itkis, E.Vardaci, I.M.Itkis, G.N.Knyazheva, E.M.Kozulin, Nuclear Physics A944 (2015) 204





Fission barriers



- Fission barriers have been determined in self-consistent procedure in HFB theory with Gogny D1S force
- Fission barriers in SHE have got very complicated structure
- Octupole asymmetry and triaxiality is important mostly on the second barrier
- Super-asymmetric fission mode is predicted in some SHE isotopes





Fission and α -decay half-lives

