Mean-field methods:

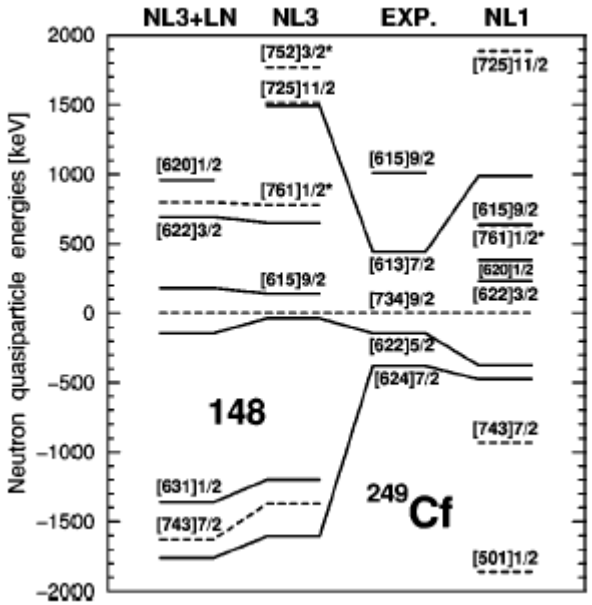
where are we and where do we go?

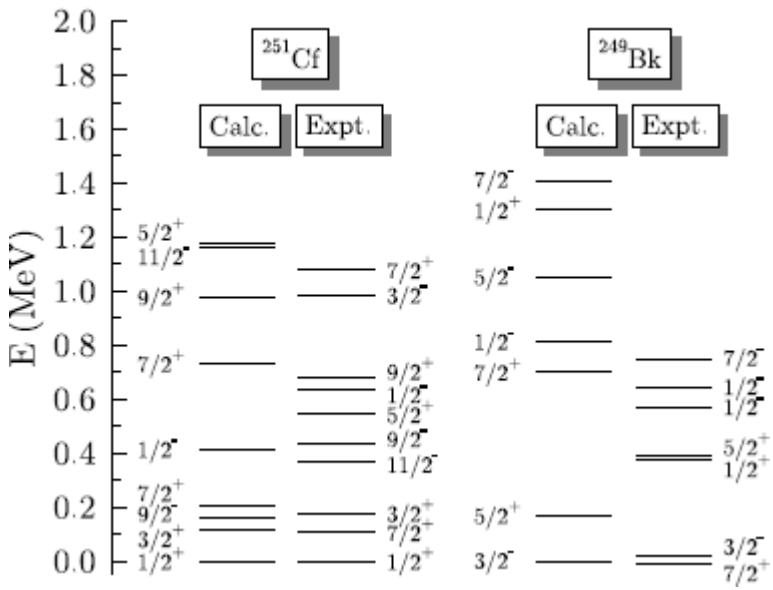
Major developments in the last years:

- Systematic calculations
- Correlations beyond mean-field
- Detailed analyses of mean-field functionnals

SYSTEMATIC CALCULATIONS

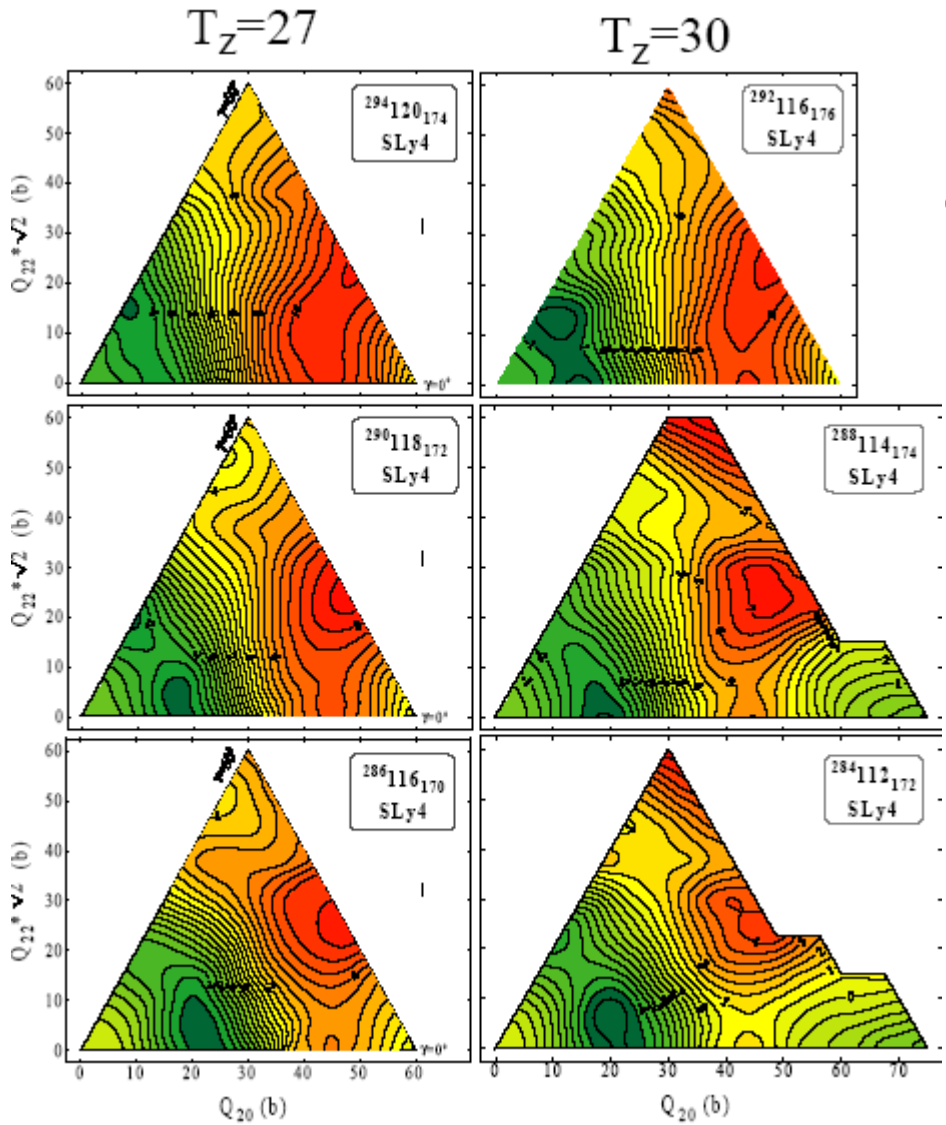
Spectra of odd nuclei including blocking and self consistency





Afanasjev et al.
C RMF
Phys Rev C67 024309 (2003)

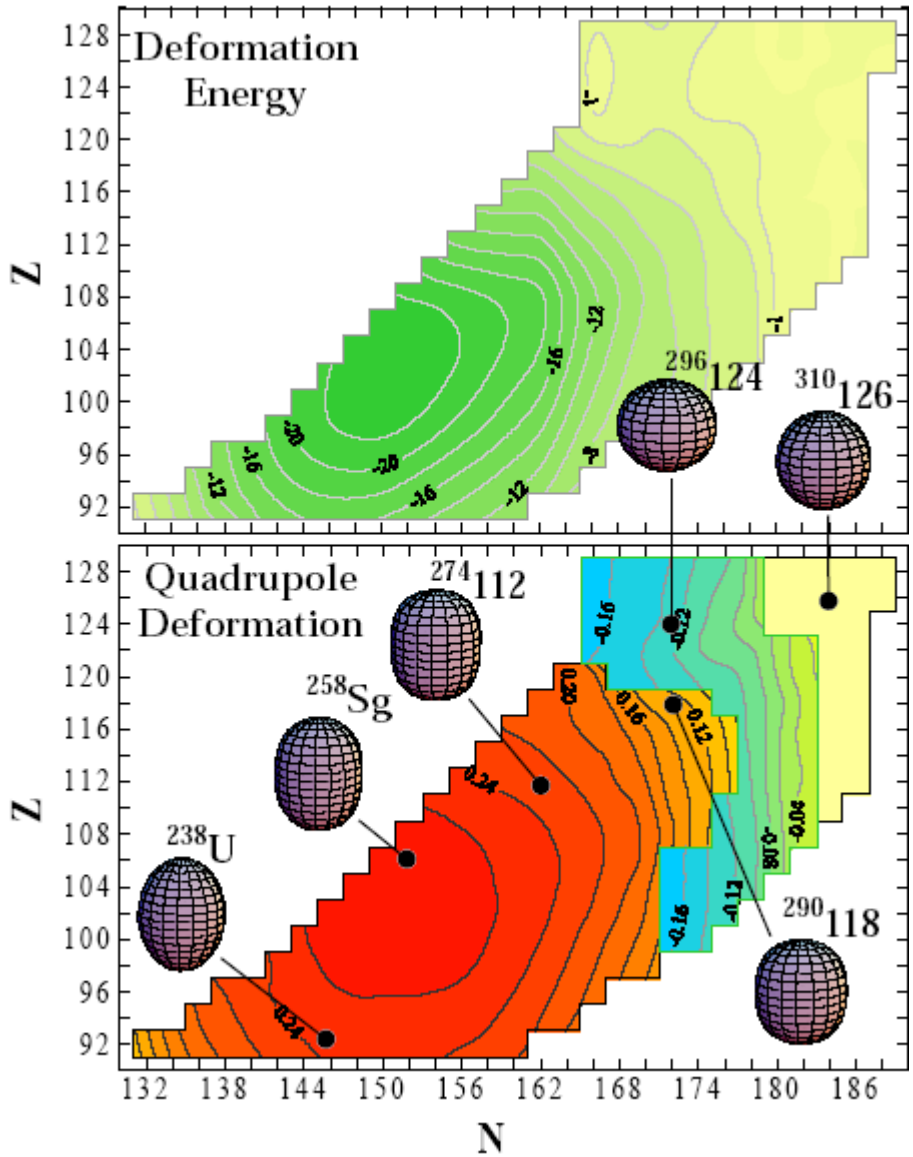
Duguet et al.
CHFB+LN SLy4
Nucl. Phys. A 273 264 (2003)



Cwiok, Heenen and Nazarewicz

Systematic calculations of triaxial deformation properties of super heavy nuclei

Skyrme interaction SLy4
Density dependent pairing
HFB + LN


Deformation
Energy
Quadrupole
Deformation
Z
N
296124
310126
274112
258Sg
238U
290118
128
124
120
116
112
108
104
100
96
92
132
138
144
150
156
162
168
174
180
186

Beyond the mean-field approximation

Microscopic introduction of correlations

Beyond mean-field

Set of mean-field wave functions depending on axial Q

- Projection on N, Z, J:

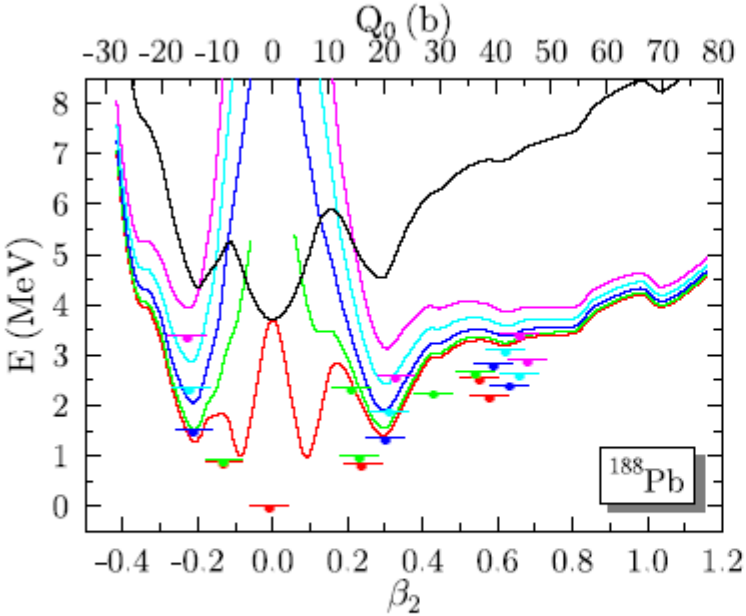
$$|J0q\rangle = \frac{1}{\mathcal{N}_{J0q}} \hat{P}^J_{00} \hat{P}_Z \hat{P}_N |q\rangle,$$

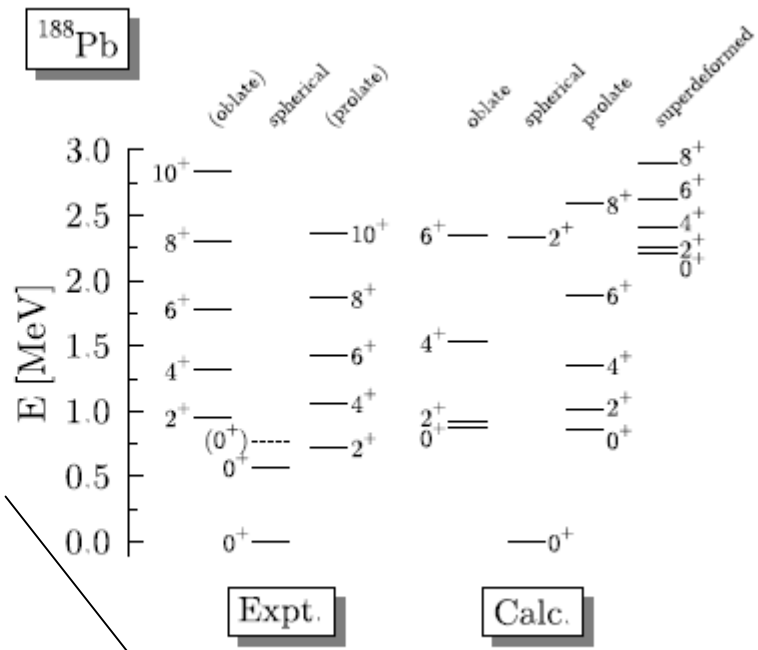
- New wave functions by mixing on q:

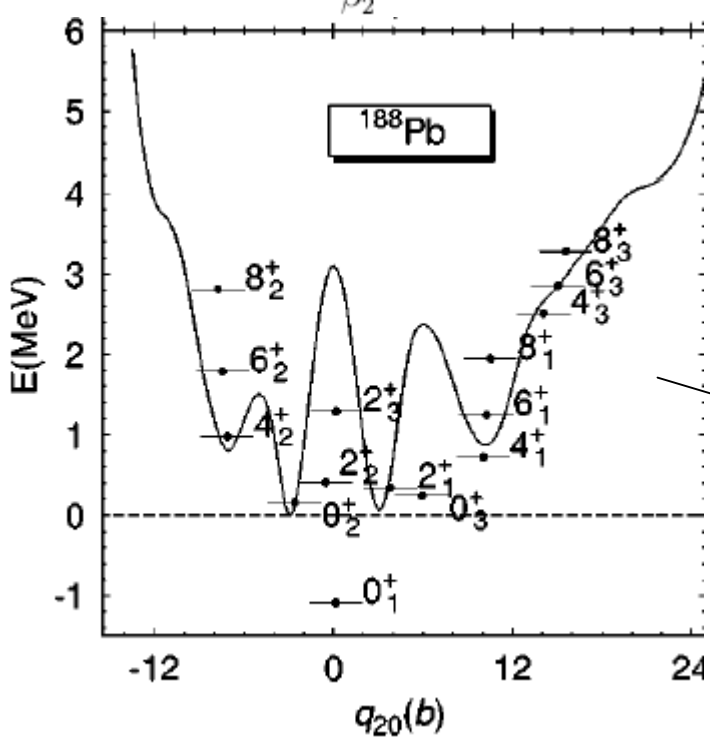
$$|J0k\rangle = \sum_q f_{J,k}(q) |J0q\rangle$$

with $f_{J,k}(q)$ determined by minimizing the energy:

$$E_{J,k} = \frac{\langle J0k|\hat{H}|J0k\rangle}{\langle J0k|J0k\rangle}$$

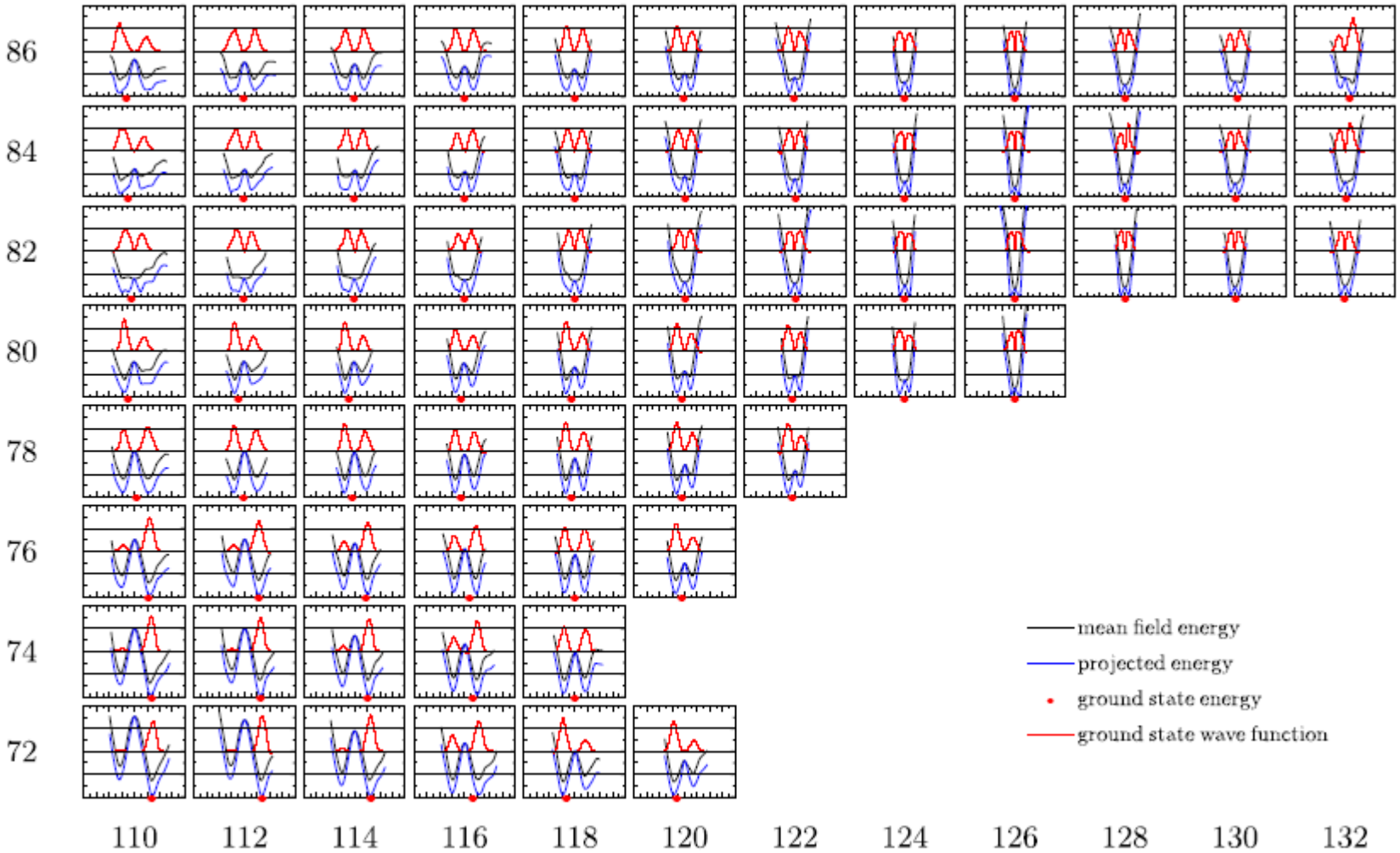






Skyrme interaction:
M. Bender et al.
Phys. Rev. C 69, 064303 (2004)

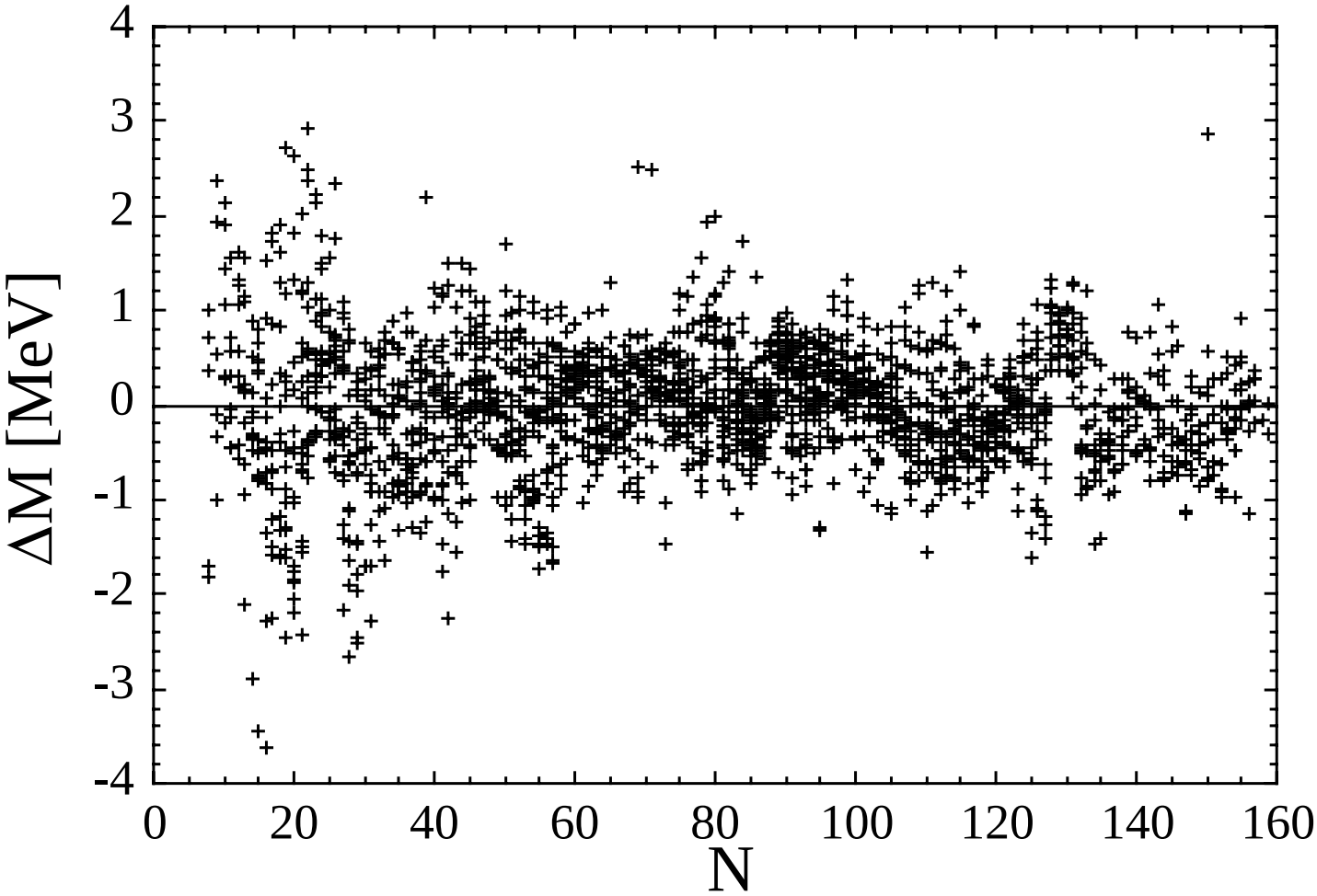
Gogny interaction
R.R. Rodriguez Guzman et al.
Phys. Rev. C 69, 054319 (2004)



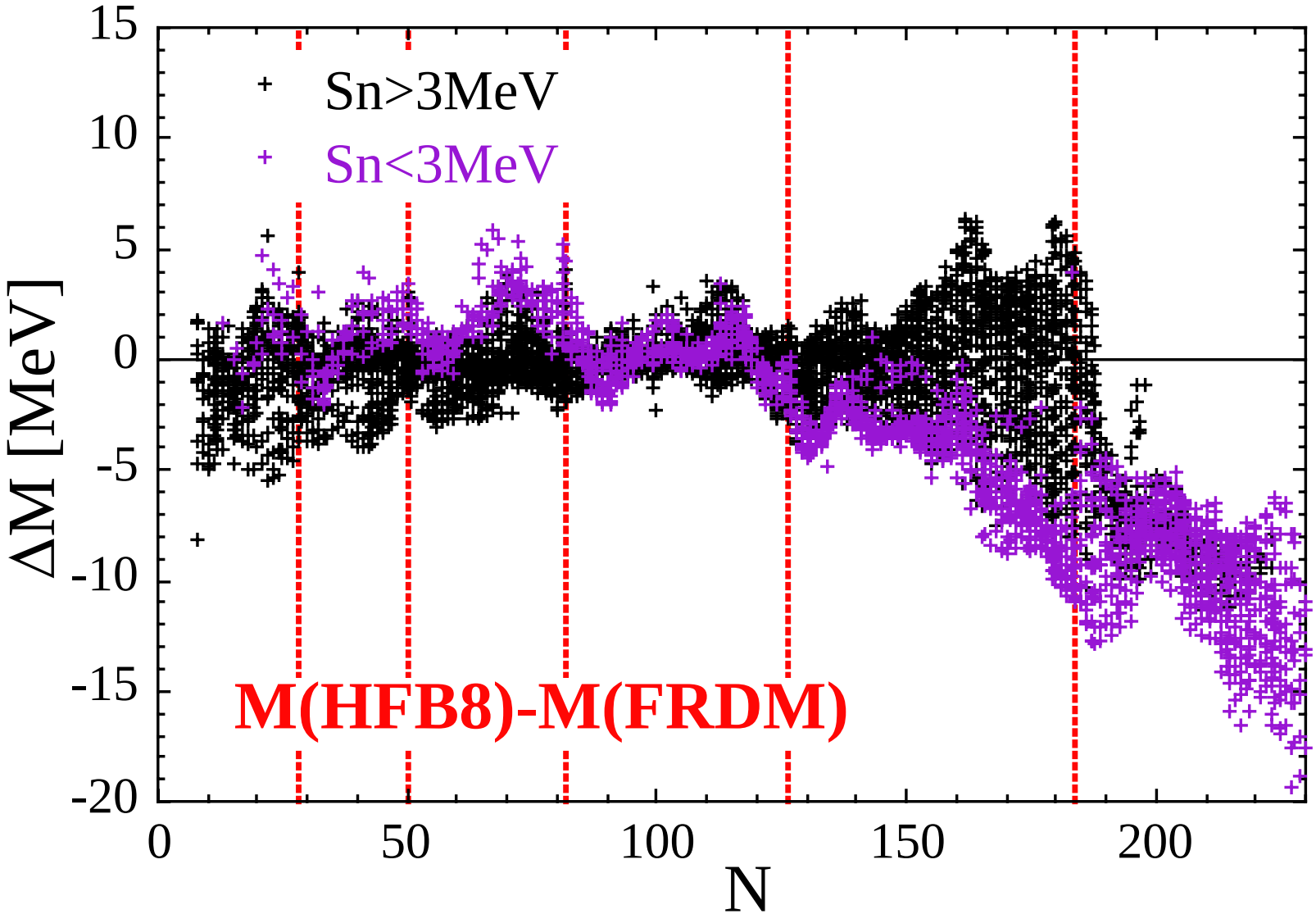
Bender et al. Systematic calculation of correlations

Goriely et al.: Skyrme HFB (8) M^*_s=0.80, vol. pairing,

Comparison with Audi and Wapstra 2003: rms error 641 keV



Comparison between HFB and FRDM predictions



The future:

- new energy density functionals, more directly derived from bare N-N interaction

(Duguet and Bonche)

- new degrees of freedom (triaxiality and pairing vibrations)

- breaking of symmetries
  (time reversal invariance) (Bender and Heenen)