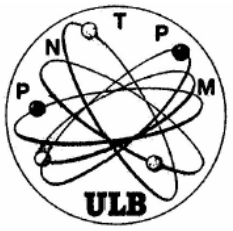
Single particle spectra in heavy nuclei: A window on SHE nuclei?

Application of Skyrme HFB with SLy4 and Ski4 interactions
Full self consistent of qp creation and breaking of
time reversal invariance.

M. Bender, P. Bonche, T. Duguet, P-H Heenen and A. Chatillon



HFB methods

- Effective interaction for mean-field and pairing:

Minimization of the total energy $\rightarrow$ HFB ground state $|\Phi\rangle$

$$E = \langle\Psi|\hat{H}|\Psi\rangle = E[\rho, \kappa, \kappa^*]$$

with constraints on N and Z $\langle\Psi|\hat{N}_q|\Psi\rangle = N_q$.

+ cranking constraint $-\omega J_z$

Skyrme interaction + dd pairing

For an even nucleus: gs vacuum

For an odd nucleus: 1qp state $\beta_i^\dagger |0\rangle$

associated with the quantum numbers *I*
(two operators for 2qp states in even nuclei)

Full self consistency , inclusion of time odd terms
The only well defined quantity is the total energy of a configuration

It works!

- Rotational properties of actinides and transactinides (self consistent cranking):

  test of pairing

- Interpretation of spectra of odd nuclei

  test of the mean-field part of the interaction

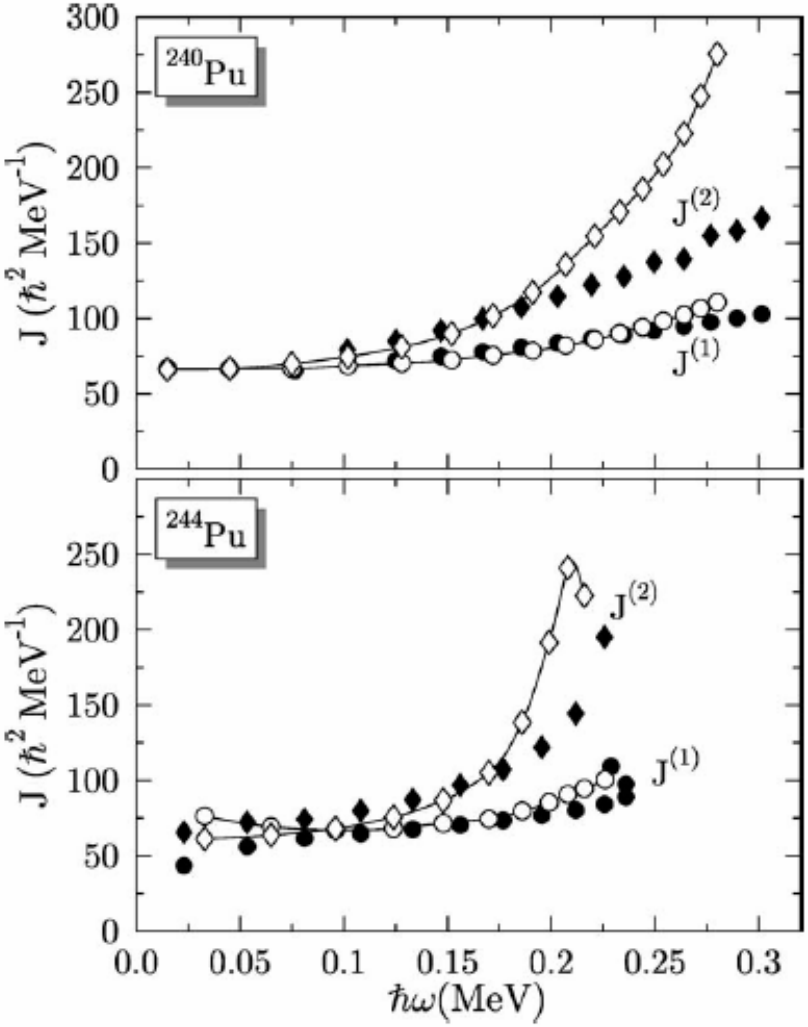
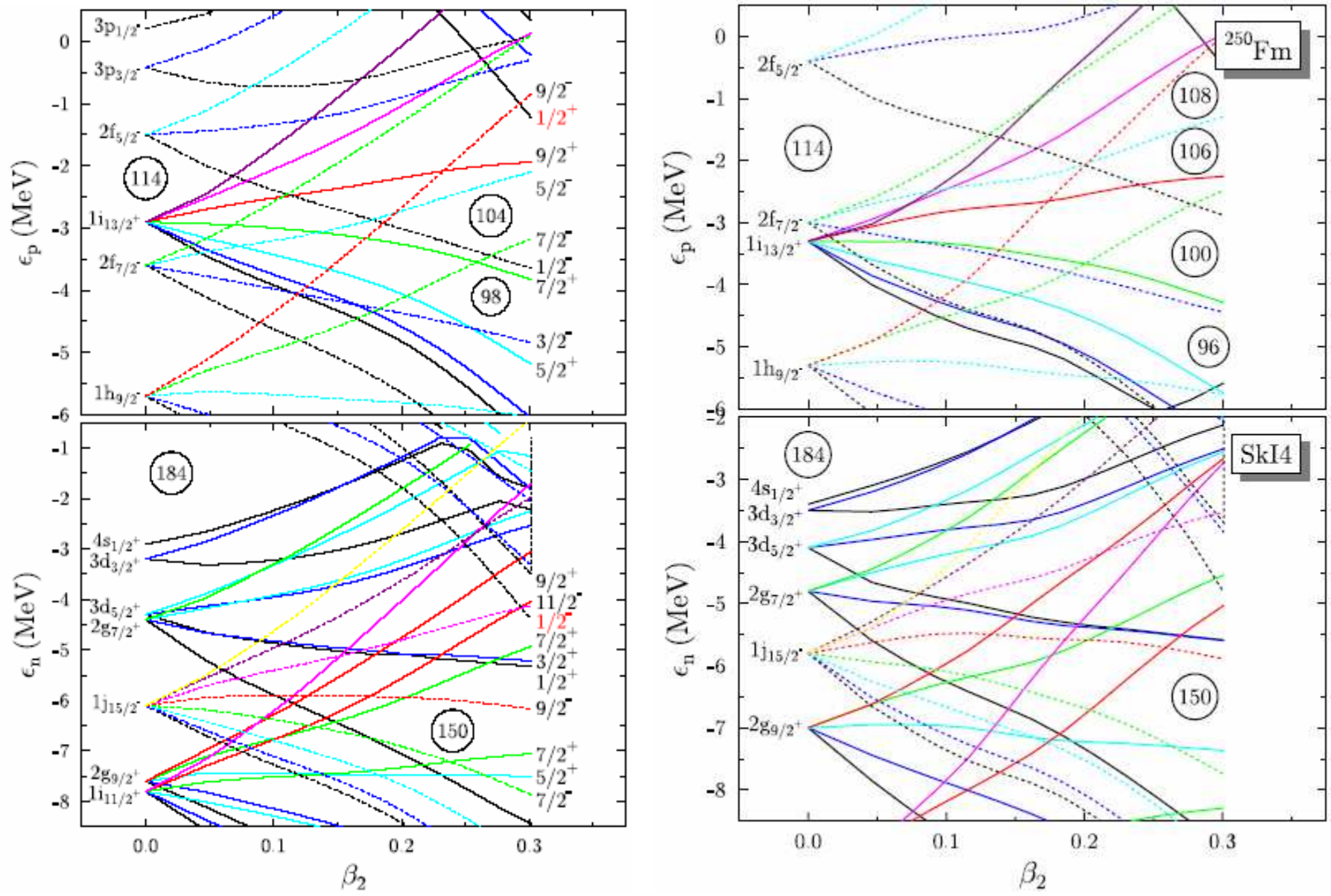


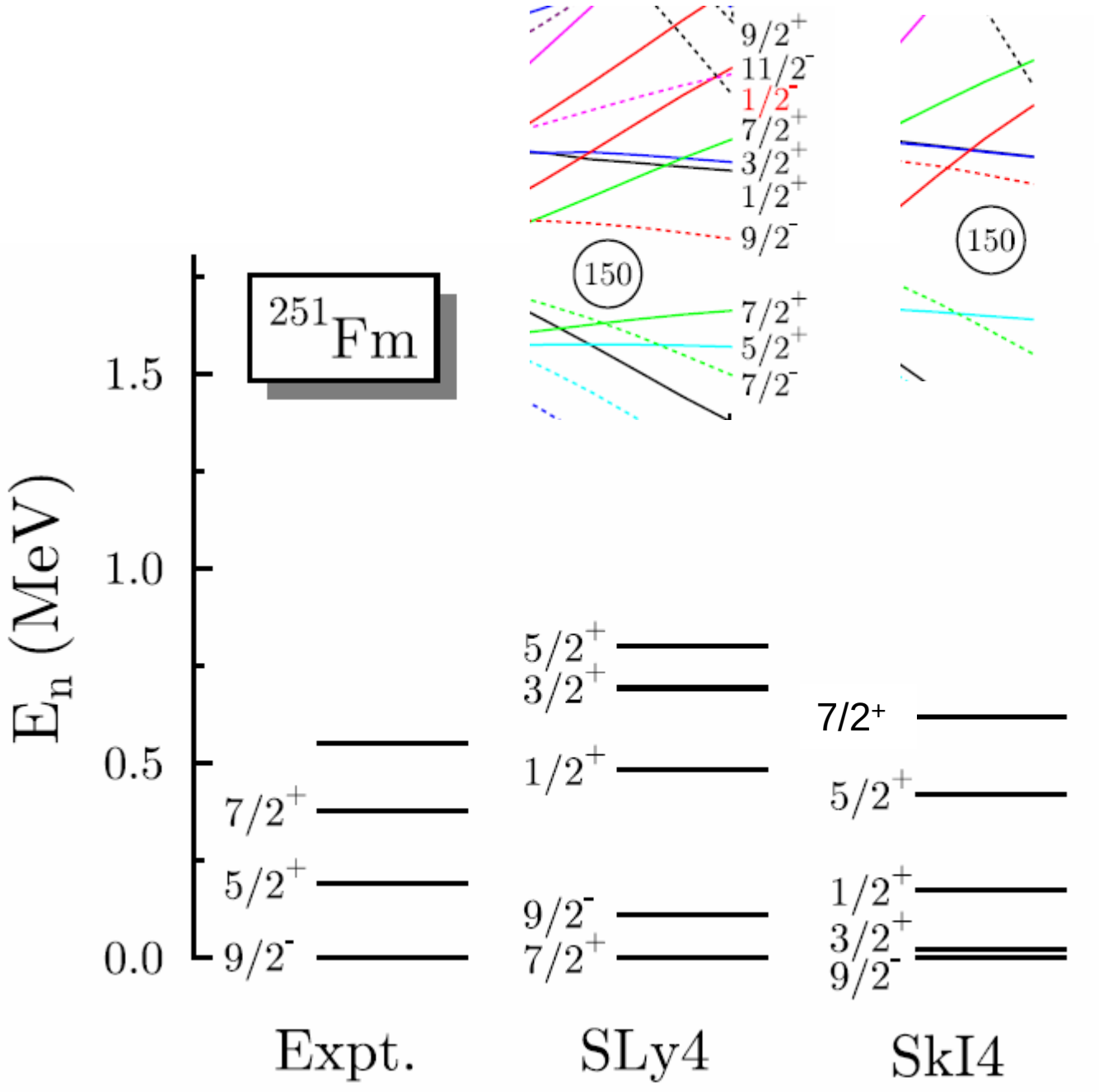
Fig. 3. Kinematical (circles) and dynamical (diamonds) moment of inertia for ^{240}Pu (top) and ^{244}Pu (bottom). Open (filled) markers denote calculated (experimental) values.

2 different Skyrme parametrizations

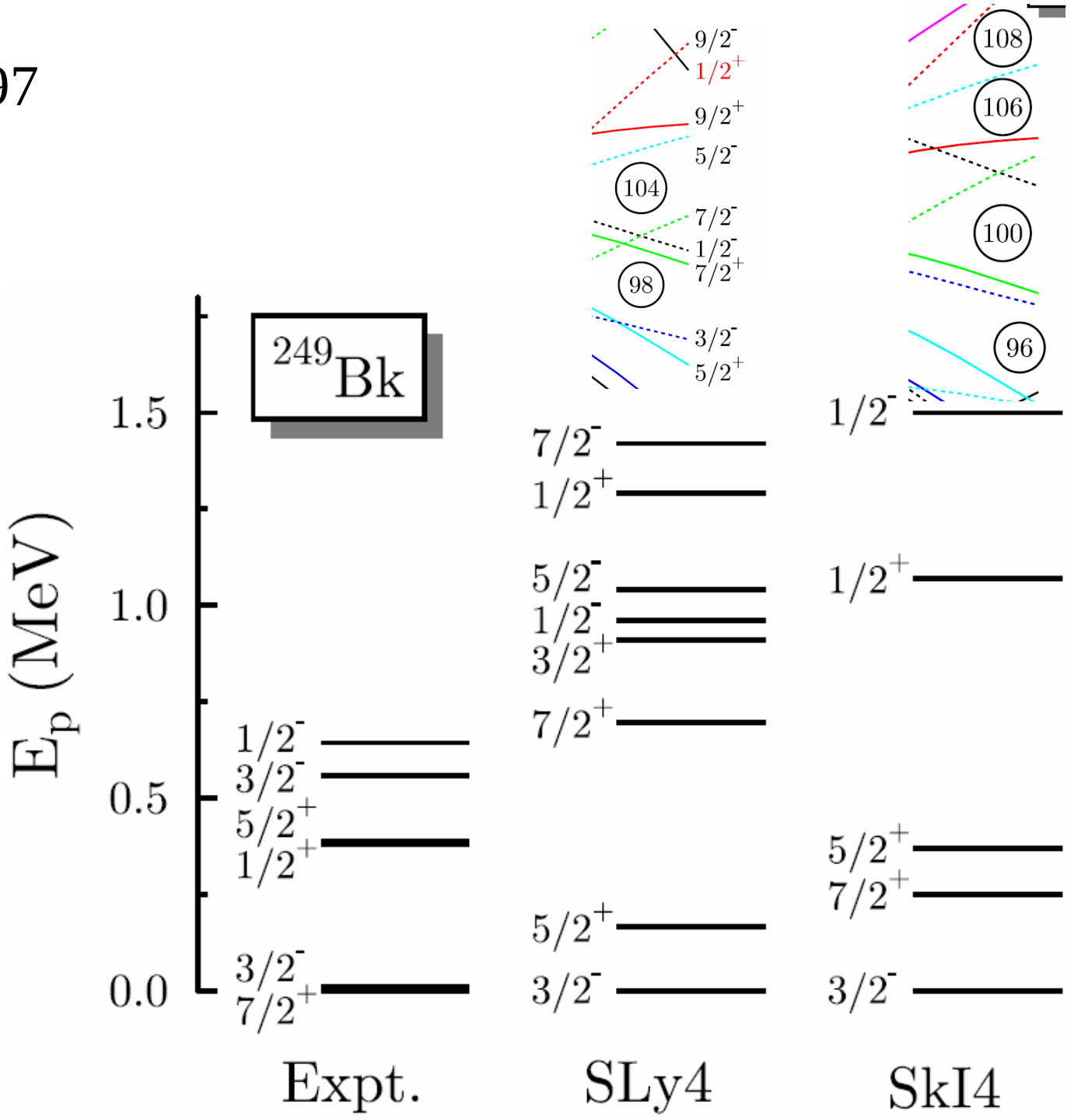
SLy4

Ski4

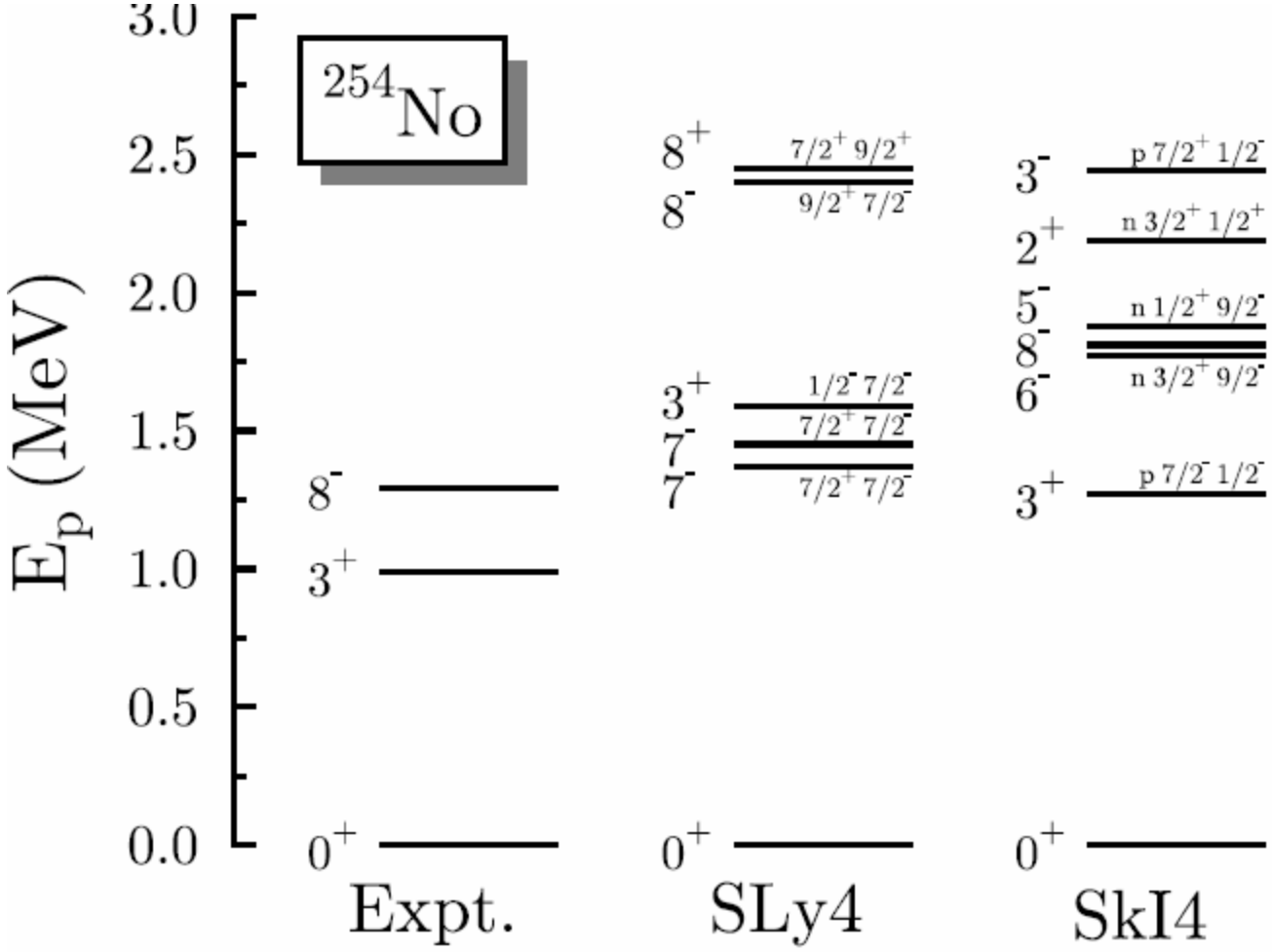



^{251}Fm
E_n (MeV)
1.5
1.0
0.5
0.0
$9/2^-$
$5/2^+$
$7/2^+$
Expt.
$7/2^-$
$5/2^+$
$3/2^+$
$1/2^+$
$9/2^-$
$7/2^+$
150
$9/2^+$
$11/2^-$
$1/2^-$
$7/2^+$
$3/2^+$
$1/2^+$
$9/2^-$
SLy4
$7/2^+$
$5/2^+$
$1/2^+$
$3/2^+$
$9/2^-$
150
SkI4

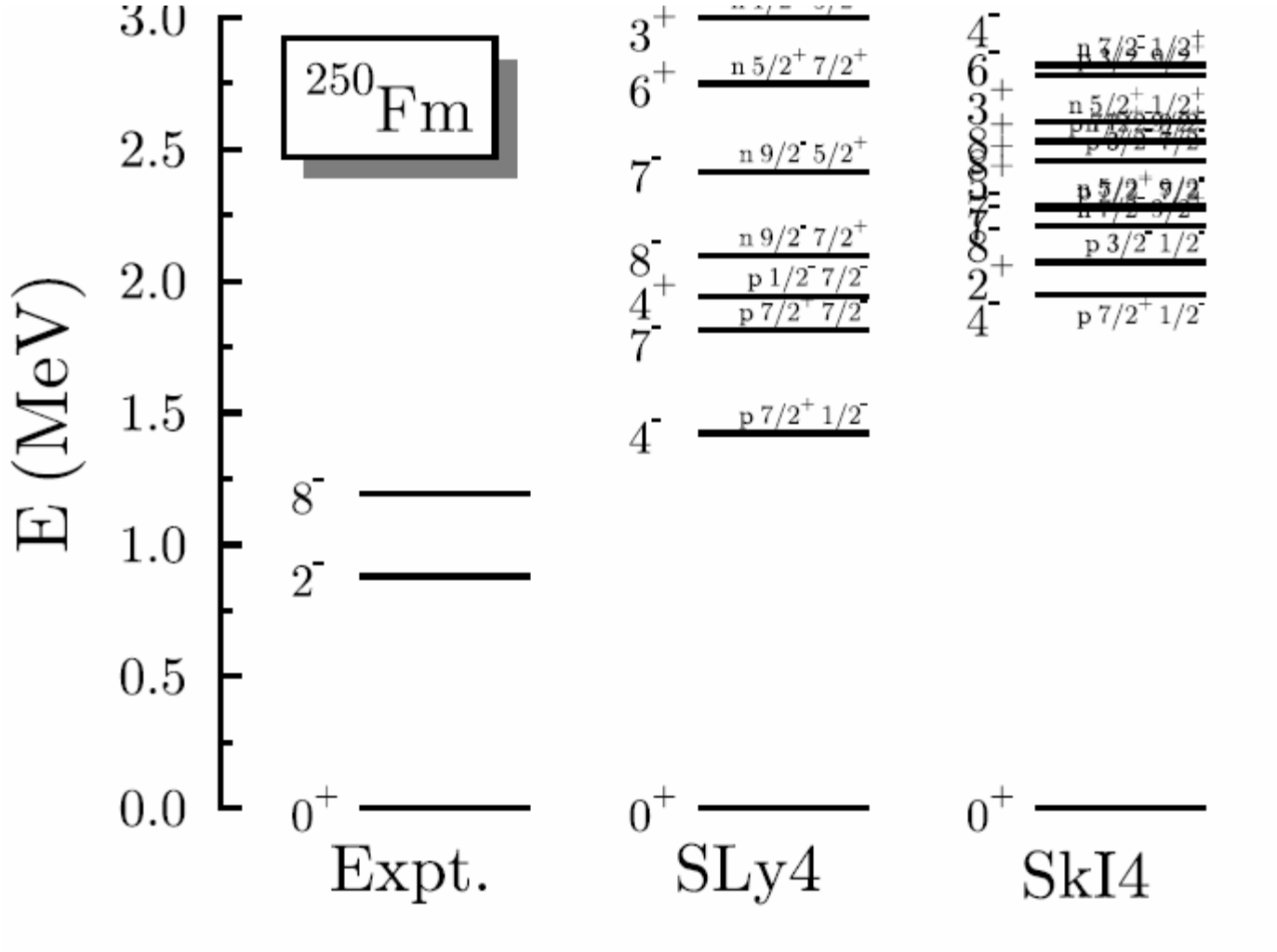
Z=97


^{249}Bk
E_p (MeV)
1.5
1.0
0.5
0.0
$1/2^-$
$3/2^-$
$5/2^+$
$1/2^+$
$3/2^-$
$7/2^+$
Expt.
$9/2^-$
$1/2^+$
$9/2^+$
$5/2^-$
104
$7/2^-$
$1/2^-$
$7/2^+$
98
$3/2^-$
$5/2^+$
$7/2^-$
$1/2^+$
$5/2^-$
$1/2^-$
$3/2^+$
$7/2^+$
$5/2^+$
$3/2^-$
SLy4
108
106
100
96
$1/2^-$
$1/2^+$
$5/2^+$
$7/2^+$
$3/2^-$
SkI4

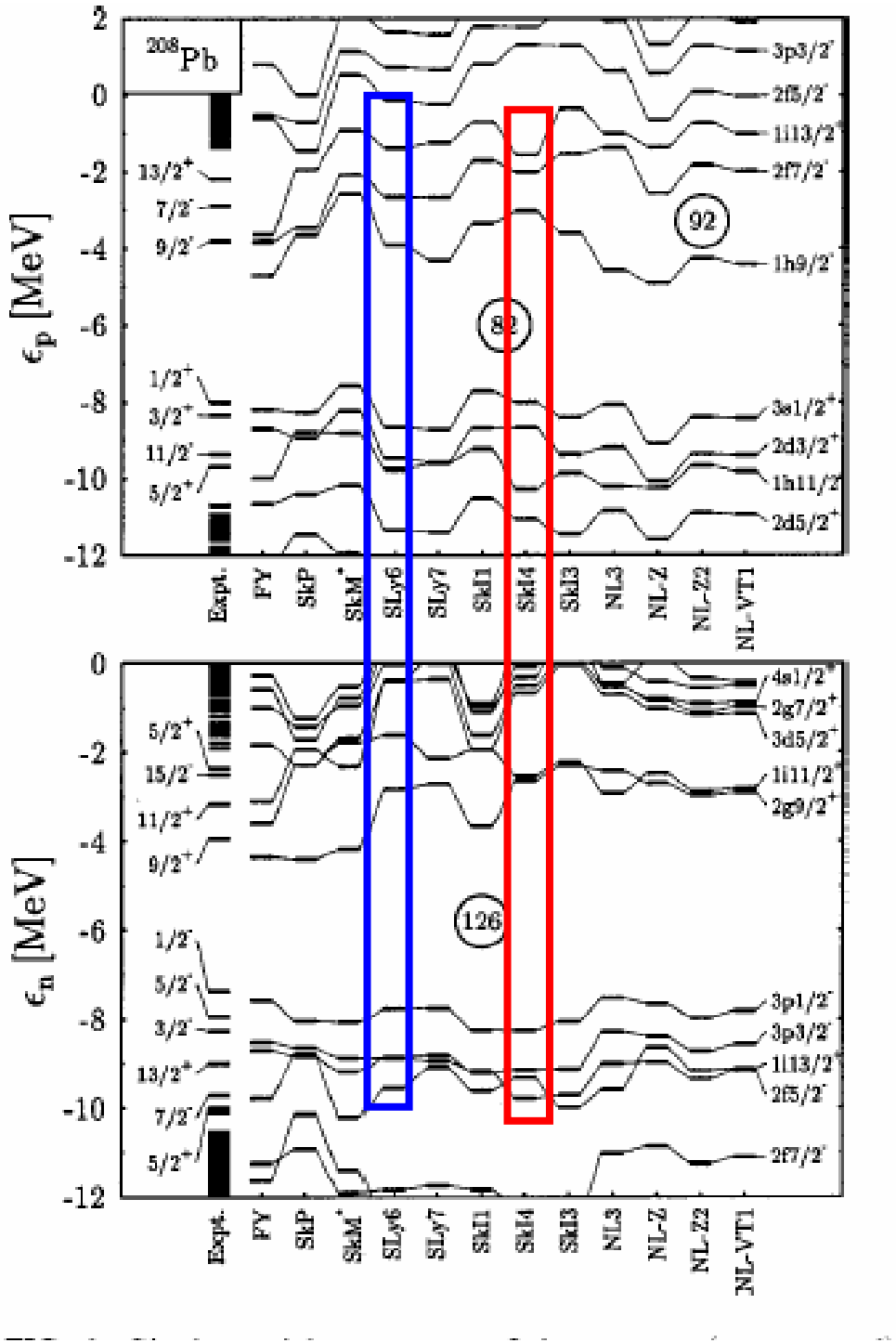
2 qp isomers in 254No



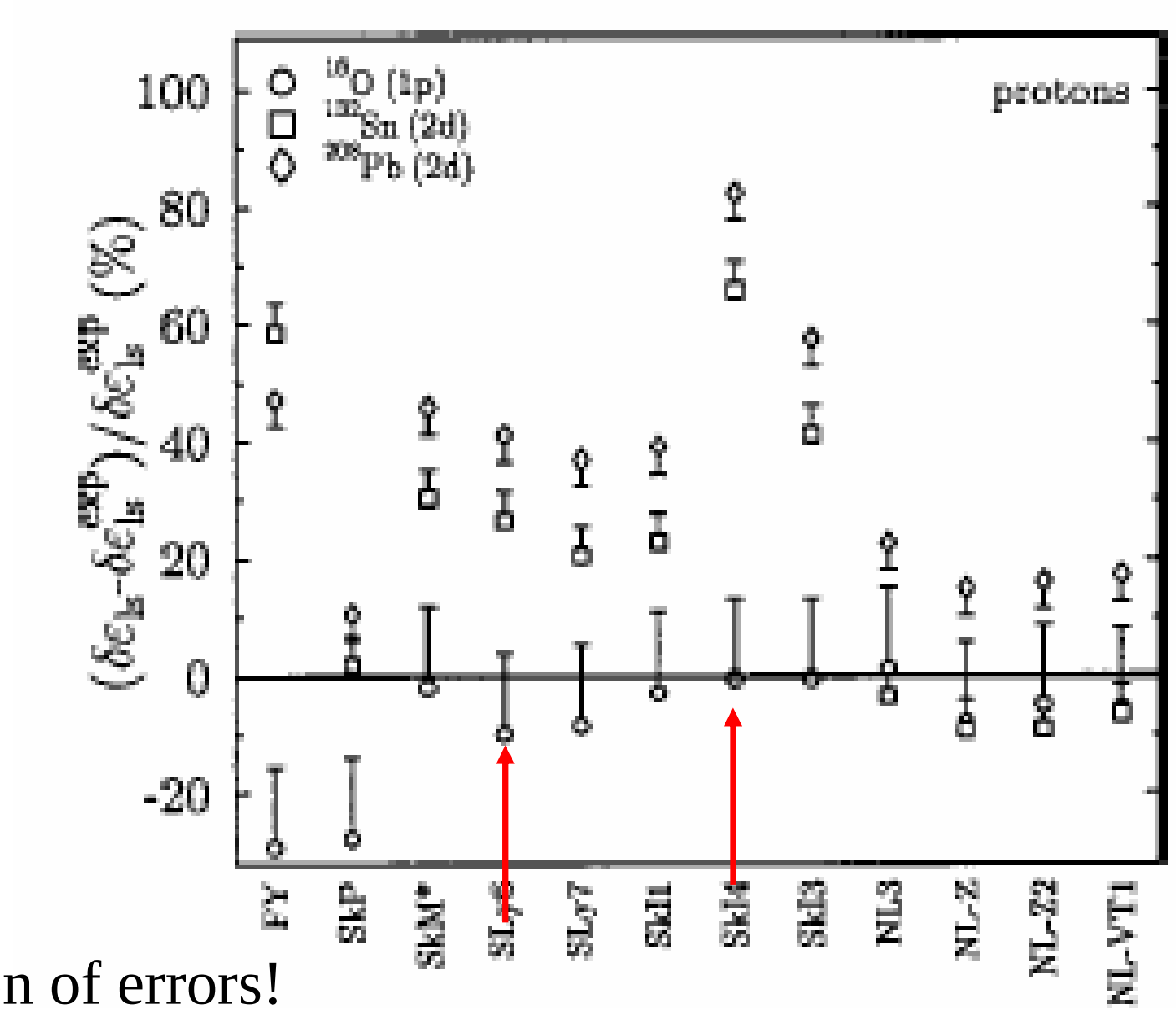
Gogny force gives results similar to SLy4


E (MeV)
3.0
2.5
2.0
1.5
1.0
0.5
0.0
^{250}Fm
8$^-$
2$^-$
0$^+$
Expt.
3$^+$
6$^+$
n 5/2$^+$ 7/2$^+$
7$^-$
n 9/2$^-$ 5/2$^+$
8$^-$
n 9/2$^-$ 7/2$^+$
4$^+$
p 1/2$^-$ 7/2$^-$
7$^-$
p 7/2$^+$ 7/2$^-$
4$^-$
p 7/2$^+$ 1/2$^-$
0$^+$
SLy4
4$^-$
6$^-$
3$^+$
8$^-$
2$^+$
4$^-$
p 3/2$^-$ 1/2$^-$
p 7/2$^+$ 1/2$^-$
0$^+$
SkI4

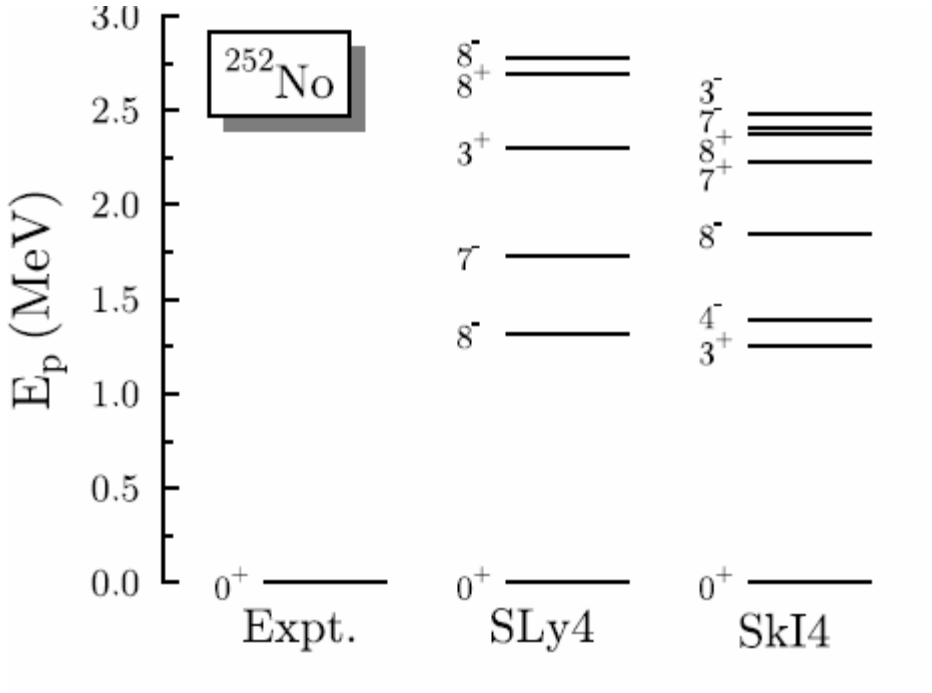
Ski4:
i13/2 much too low!

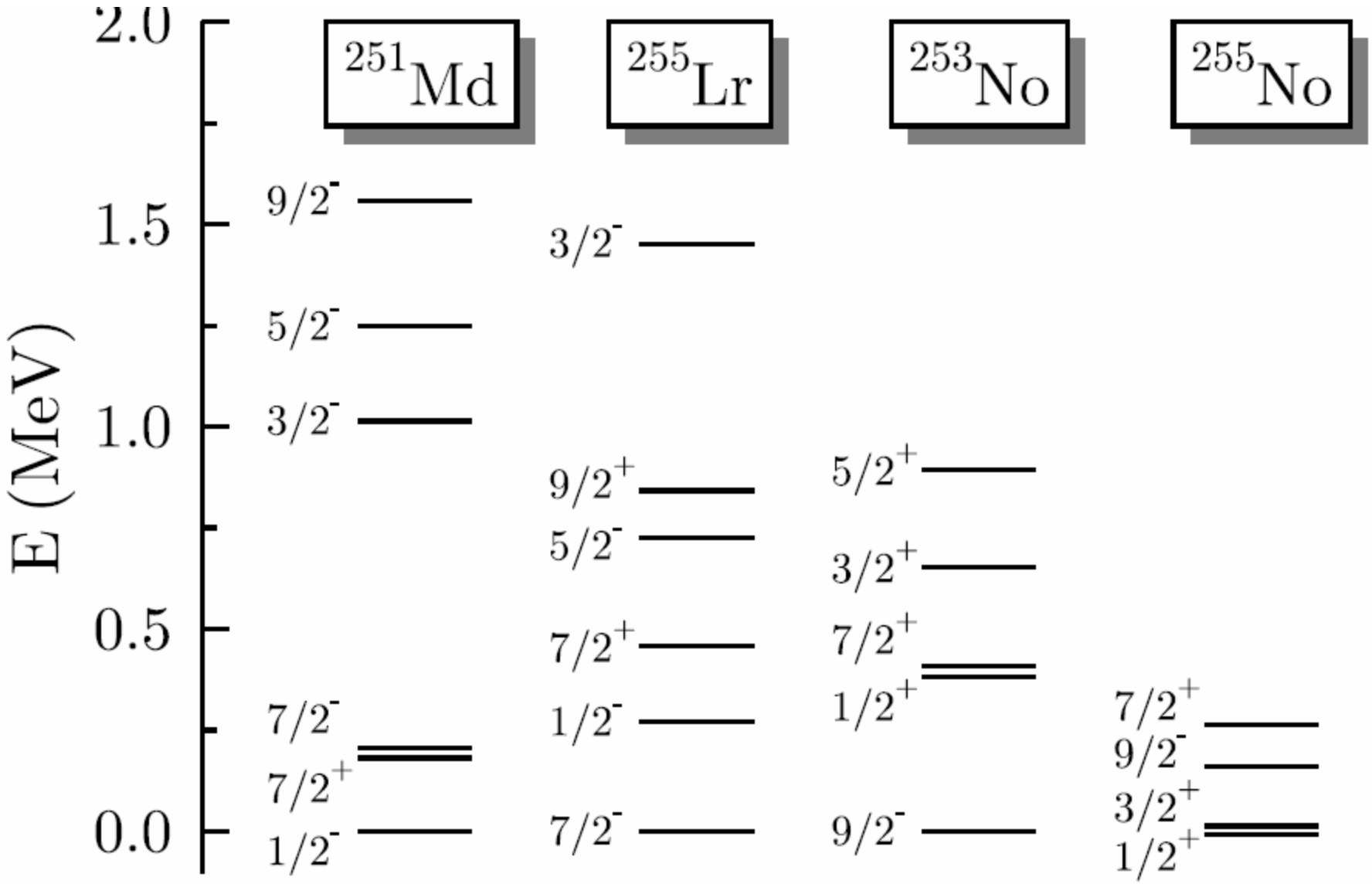


level splittings much too large for Ski4



compensation of errors!


3.0
2.5
2.0
1.5
1.0
0.5
0.0
E_p (MeV)
^{252}No
8^-
8^+
3^+
7^-
8^-
0^+
Expt.
8^-
8^+
3^+
7^-
8^-
0^+
SLy4
3^-
7^-
8^+
7^+
8^-
4^-
3^+
0^+
SkI4


E (MeV)
2.0
1.5
1.0
0.5
0.0
^{251}Md
^{255}Lr
^{253}No
^{255}No
$9/2^-$
$5/2^-$
$3/2^-$
$7/2^-$
$7/2^+$
$1/2^-$
$3/2^-$
$9/2^+$
$5/2^-$
$7/2^+$
$1/2^-$
$7/2^-$
$5/2^+$
$3/2^+$
$7/2^+$
$1/2^+$
$9/2^-$
$7/2^+$
$9/2^-$
$3/2^+$
$1/2^+$