High-K ground states and isomers in superheavy nuclei

P.Jachimowicz (UZ), M.Kowal, J.Skalski (NCBJ)

A. Motivation – how long-lived could be high-K (near) ground states and isomers in SHN?
B. Method
C. Candidates for high-K g.s. in (mostly) odd-odd nuclei
D. Candidates for 3qp K-isomers in odd-even Z=101-111, N=142-166
E. Candidates for 3qp K-isomers in even-odd Z=100-112, N=141-167

- K-isomers provide some information on the level scheme /deformation of nuclei.
- There is a hope that some SH K-isomers could be more stable than the g.s., especially if their structure, shape etc. would make fission and alpha decay less probable, e.g. F.R.Xu at al. Phys. Rev. Lett. 92 (2004) 252501, and others.

Heavy isomers living longer than the g.s. :

	g.s.			is.		
^{256}Es	$(1^+, 0^-)$	25.4 m	β^-	(8^+)	7.6 h	β^-
^{250}No	0^+	3.8 μs	sf	(6^+)	35 μs	IT
^{254}Rf	0^+	23.2 μs	sf	(16^+)	247 μs	IT
^{270}Ds	0^+	100 μs	α	(10^-)	6 ms	α/IT

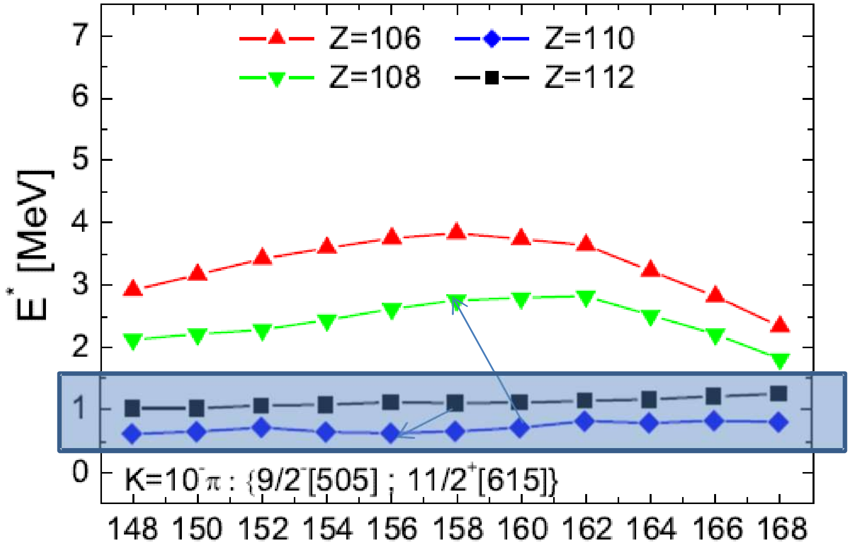
Microscopic-macroscopic method with a possibility of many various deformations

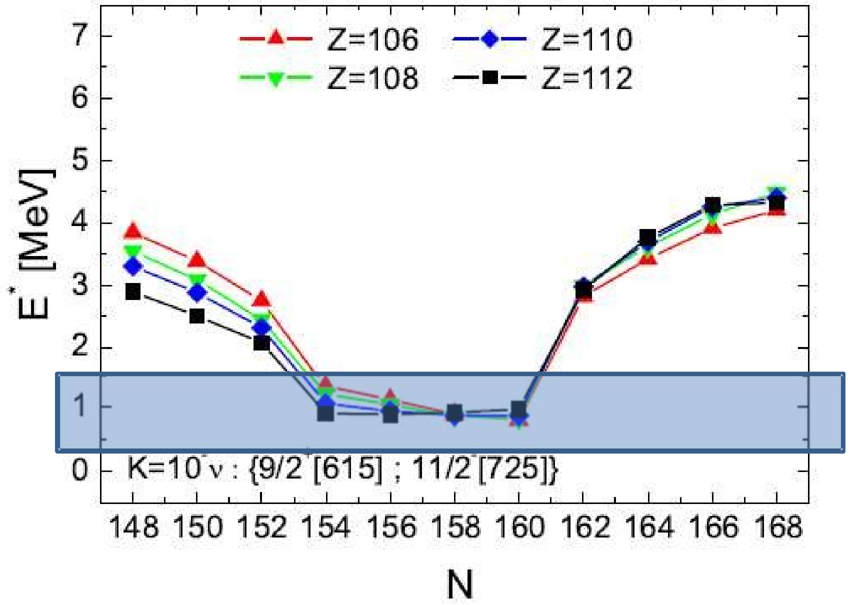
252)

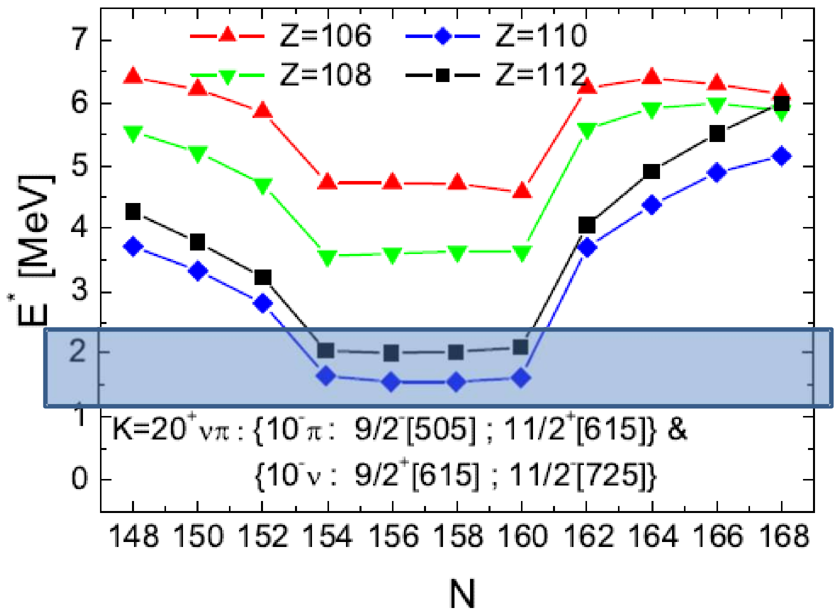
2qp & 4qp high-K isomers in even-even SHN

Stability of high-spin isomers against alpha decay is determined mainly by three factors:

- the overlap between final and initial states wherein a similar structure of states favors the transition between them;
- change in angular momentum - a significant change is associated with a large centrifugal barrier which blocks a decay;
- transition energy, which we shall also call *Q* for a given decay, that follows from the *Q* value for the g.s.->g.s. transition and the difference in the excitation energies of the initial and final state in, respectively, mother and daughter nucleus.







S. Hofmann et al. *, "The new isotope ^{270}110 and its decay products ^{266}Hs and ^{262}Sg"* *. Eur. Phys. J. A.* ***10*** *(1): 5–10, 2001*

^{207}Pb(^{64}Ni,n) ^{270}Ds

σ = (13 ± 5) pb

$$HF = [T_{1/2}^{a \rightarrowtail b} / T_{1/2}^{gs \rightarrowtail gs}]$$

a – initial state; b - final state

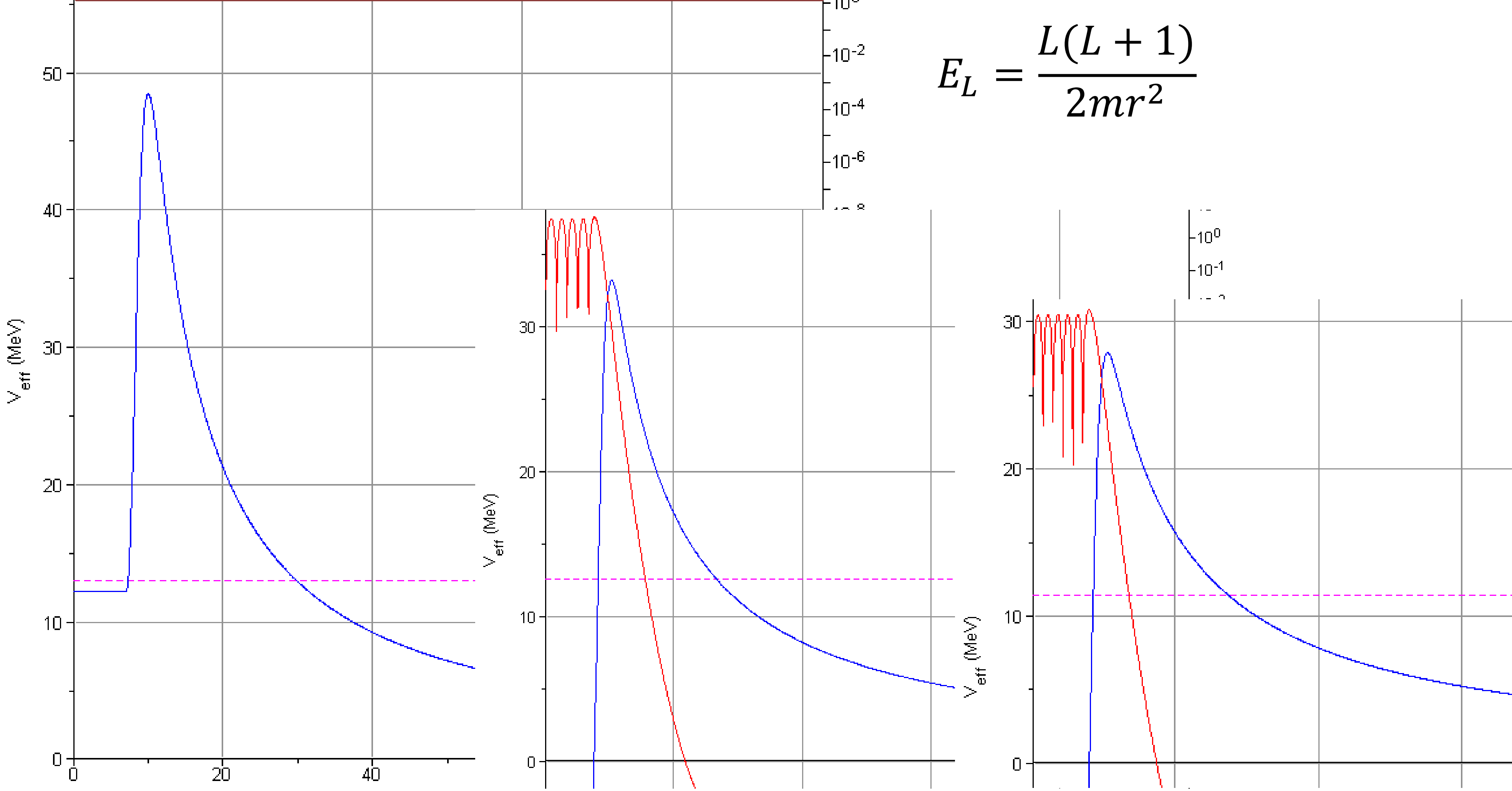
(structural) (tunneling)

$$HF = HF_S * HF_\Gamma$$

(difference in Q) (centrifugal)

$$HF_\Gamma \simeq HF_Q * HF_L$$

http://nrv.jinr.ru/nrv/webnrv/alphadecay/index.php



$$E_L = \frac{L(L+1)}{2mr^2}$$

$\Delta L[\hbar]$	$20\hbar$	$10\hbar$	$0\hbar$
Turning Points [fm]:	7.27; 29.70	8.21; 27.15	8.45;27.33

K=20+ {KN=10- : 9/2+[615] & 11/2-[725]}
& {KP=10- : 9/2-[505] & 11/2+[615]}

Crucial is the hindrance in the fastest channel, between two identical configurations. This is especially true for four quasi-particle states!

significant increase in the centrifugal barrier.
With $L = \Delta K = 20h$

$$HF_L \simeq 10^{12}$$

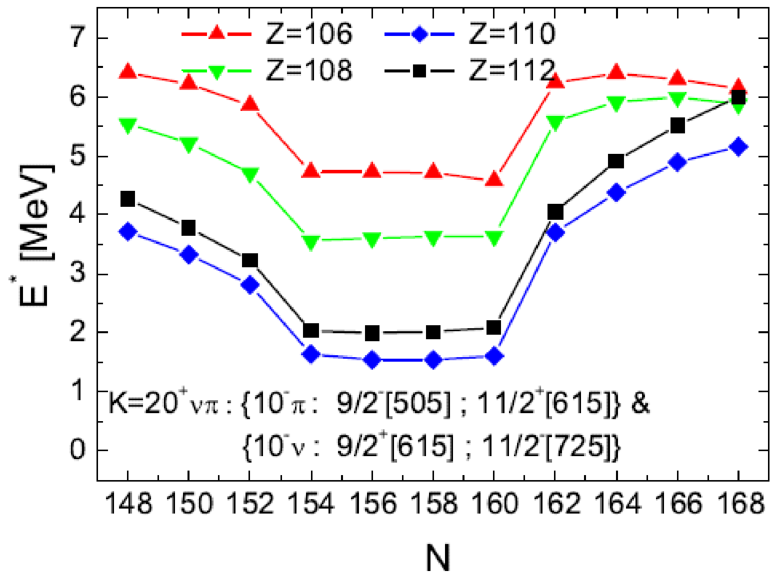
A structural hindrance for 4 q.p. isomers must be also substantial. If one assumes that it is a product of the hindrance factors for protons and neutrons

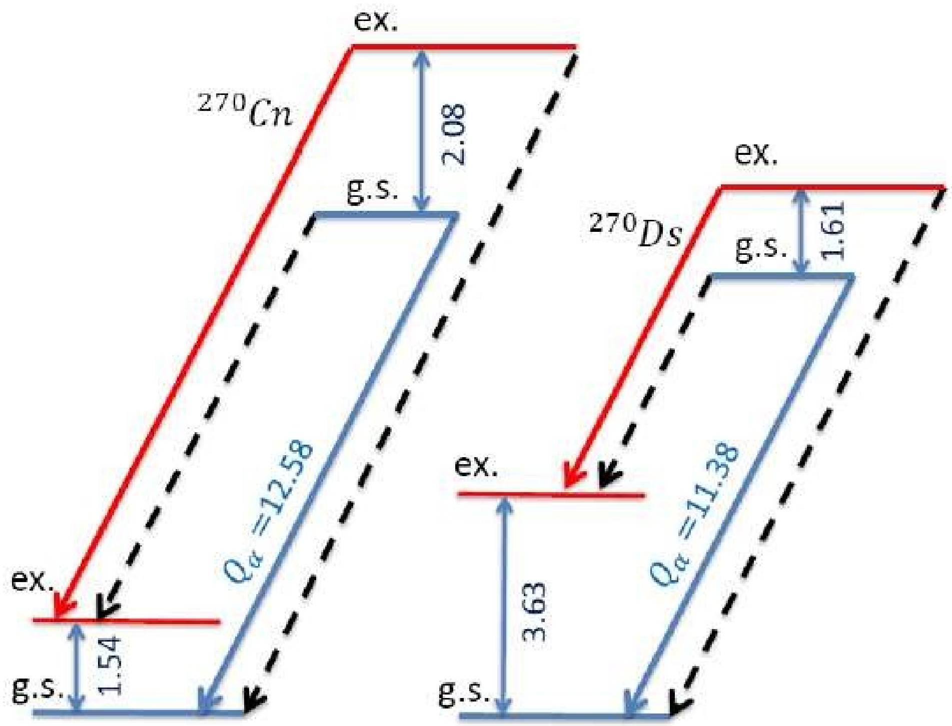
$$HF_S = 10^9$$

Taken together, this leads to the conclusion that transitions *ex -> gs* or *gs -> ex* are excluded.

TABLE II: Q_α-values (in MeV) and hindrance factors corresponding to the change $\Delta Q_\alpha = Q_\alpha^{ex\rightarrow ex} - Q_\alpha^{gs\rightarrow gs}$ for the $K^\pi = 20^+\nu\pi$: $(10^-\nu$: $\{(9/2^+[615], 11/2^-[725]\} \otimes 10^-\pi$: $\{(9/2^-[505], 11/2^+[615]\})$ configuration in ^{270}Cn and ^{270}Ds, calculated using: WKB method (WKB) [34], the formula of Royer [36] (ROY), and the Viola-Seaborg-type formula by Parkhomenko and Sobiczewski (PS) [39].

	Q_α	ΔQ_α	$Log^{WKB}[HF]$	$Log^{ROY}[HF]$	$Log^{PS}[HF]$
^{270}Cn	13.06	0.48	-0.87	-0.92	-0.88
^{270}Ds	9.36	-2.02	6.75	5.42	5.13





3qp K - isomers in odd-even Md – Rg nuclei:
(P. Jachimowicz, M. Kowal, J. Skalski, arXiv:2308.02893

They are either 1p2n (>2500 conf.) or 3p (>500 conf.).

energy minimization

$$R(\vartheta,\varphi) = R_0\{1 + \beta_{20}Y_{20} + \cancel{\beta_{30}}Y_{30} + \beta_{40}Y_{40} + \\ + \cancel{\beta_{50}}Y_{50} + \beta_{60}Y_{60} + \cancel{\beta_{70}}Y_{70} + \beta_{80}Y_{80}\}.$$

Four-dimensional minimization

Pairing was treated by three methods: BCS with blocking, in the quasiparticle scheme (sum of BCS qp energies added to the energy of the core) and with the particle number projection (PNP) for the lowest configurations.

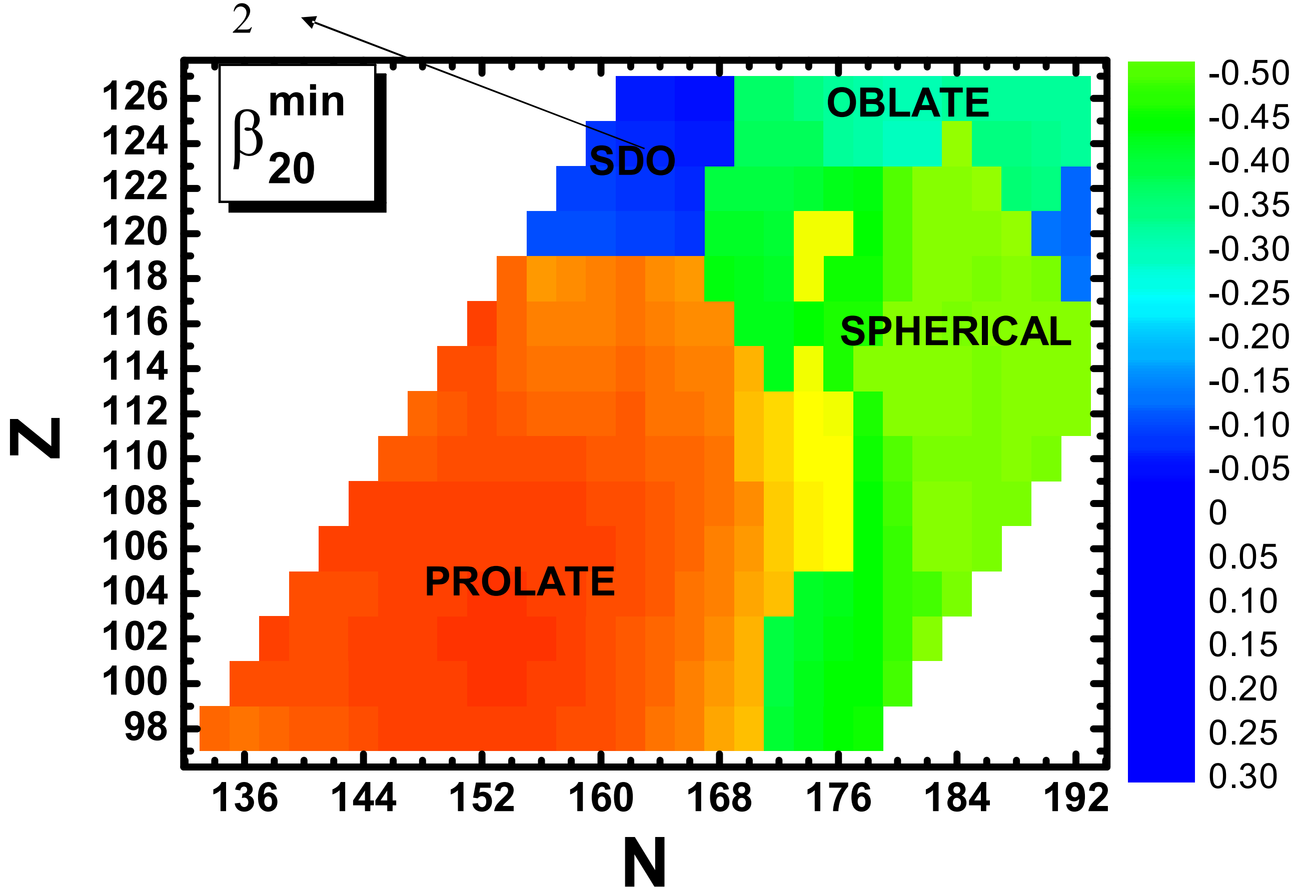
Ground state shapes

$SDO:$

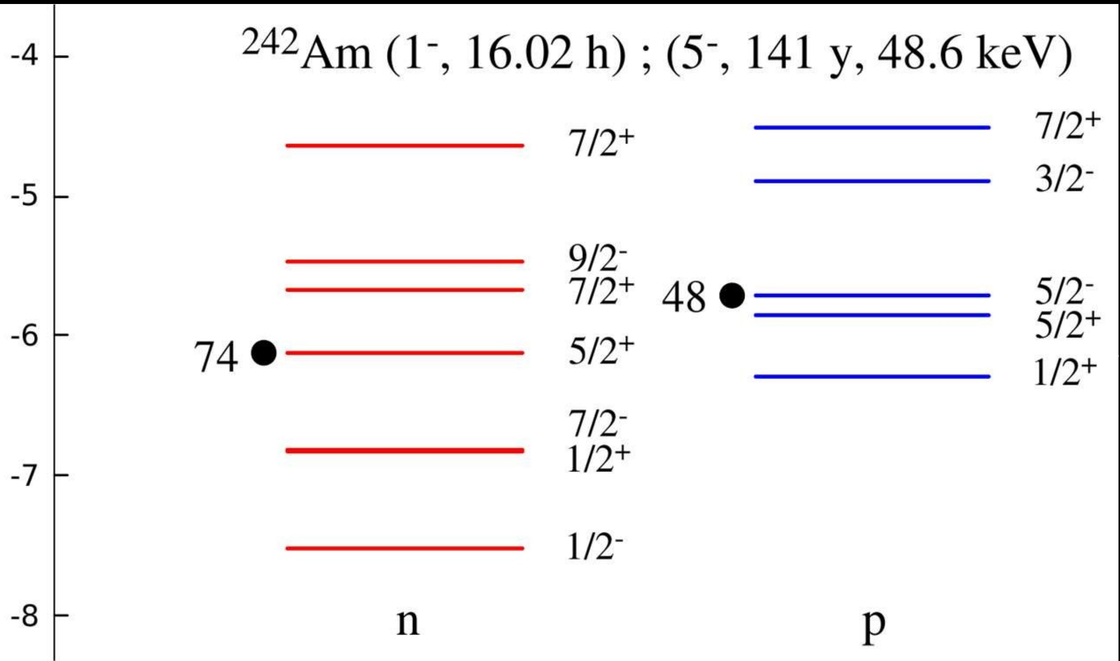
$\beta_{20} \approx -0.5$

$Axis.ratio \approx \frac{3}{2}$

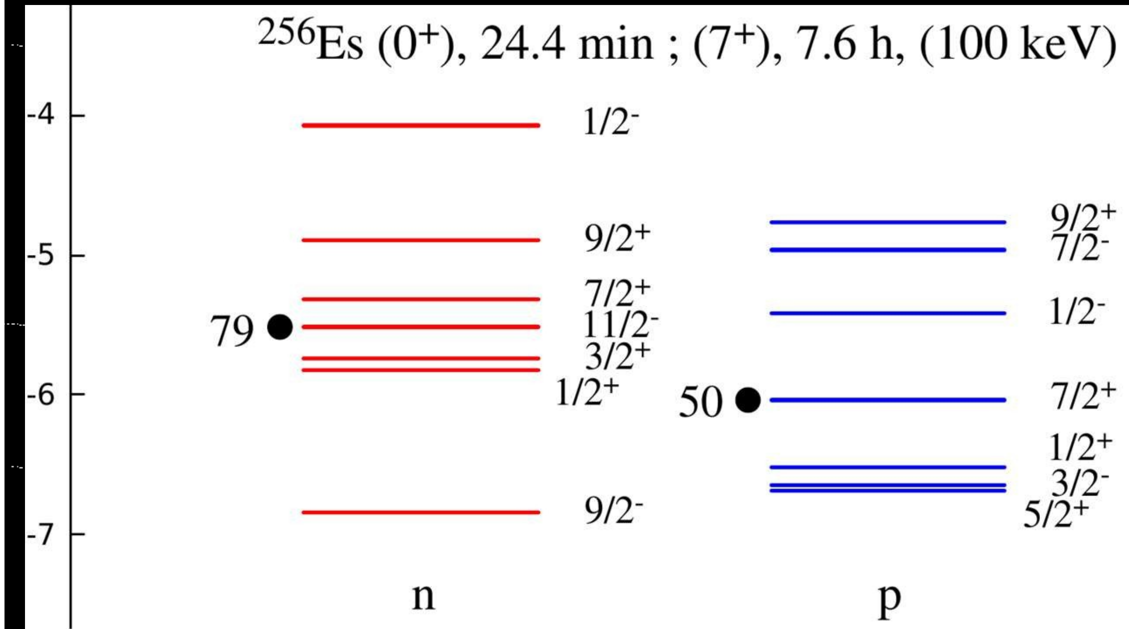
Micro-macro results; mostly four - dimensional minimization



In contrast to many Skyrme forces, Woods-Saxon micro-macro model gives lower barriers and mostly oblate ground states for Z>=124,126 (no magic gap for 126 protons).

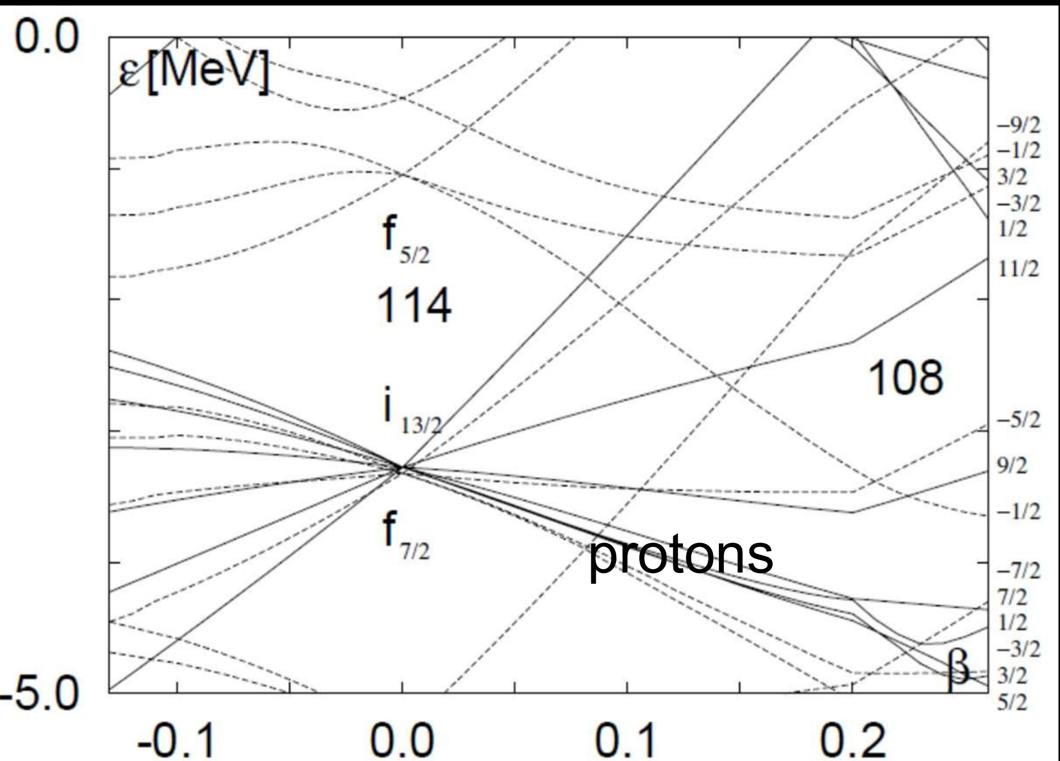


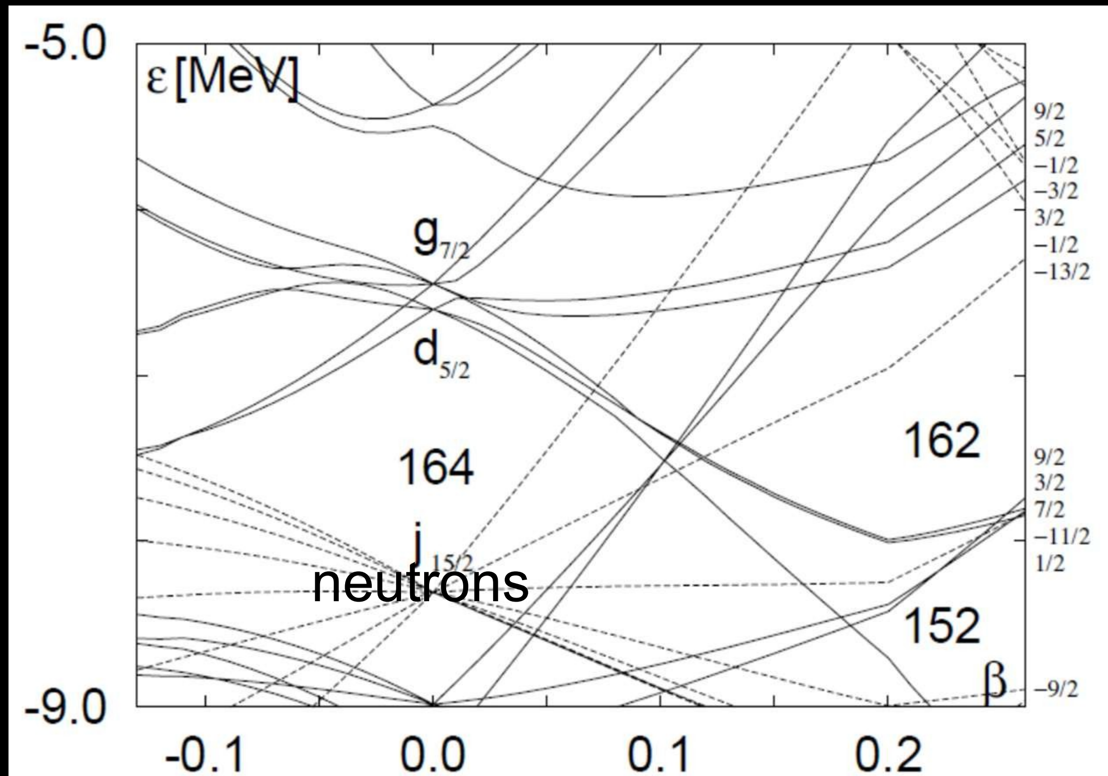
242Am (1-, 16.02 h) ; (5-, 141 y, 48.6 keV)
-4
-5
-6
-7
-8
7/2+
9/2-
7/2+
74
5/2+
7/2-
1/2+
1/2-
7/2+
3/2-
48
5/2-
5/2+
1/2+
n
p



256Es (0+), 24.4 min ; (7+), 7.6 h, (100 keV)
-4
-5
-6
-7
1/2-
9/2+
7/2+
79
11/2-
3/2+
1/2+
9/2-
9/2+
7/2-
1/2-
50
7/2+
1/2+
3/2-
5/2+
n
p

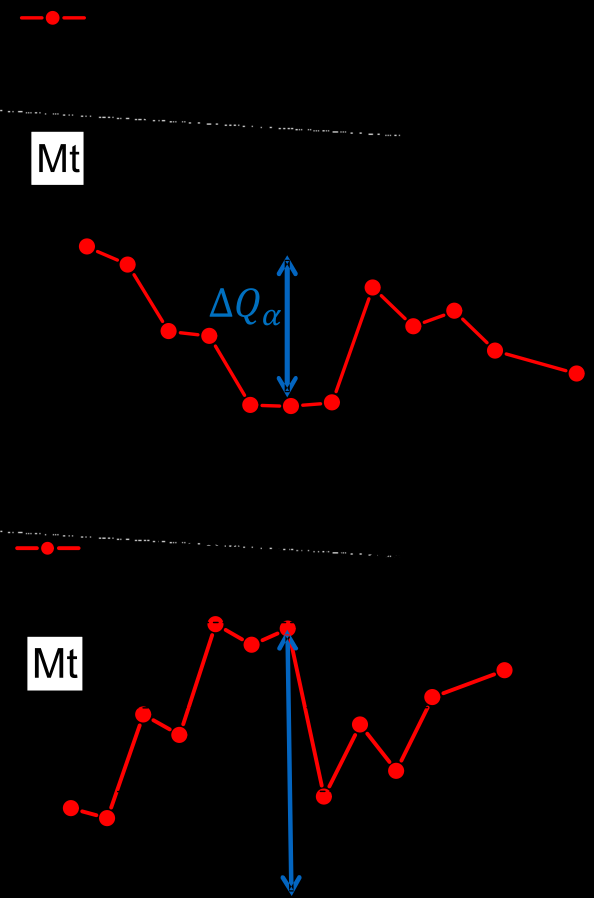
High-K g. s. in odd and odd-odd SHN



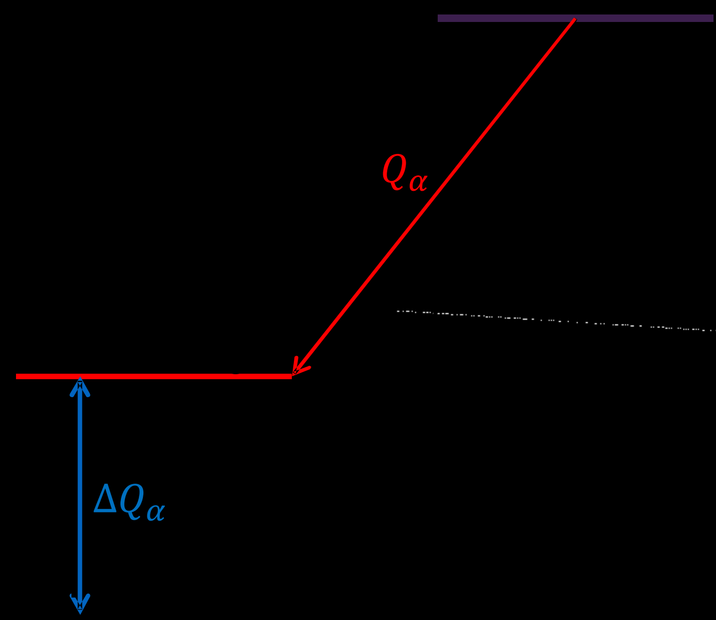


The effect of intruder states lying sclose to the Fermi level is most apparent in heavier nuclei

101	151	1/2-	9/2-	5+
	157	„	11/2-	6+
103	149	7/2-	7/2+	7-
	151	„	9/2-	8+
	157	„	11/2-	9+
105	151	9/2+	9/2-	9-
	155	„	3/2+	6+
	157	„	11/2-	10-
107	157	5/2-	11/2-	8+
	159	„	7/2+	6-
	161	„	9/2+	7-
	163	„	13/2-	9+
109	157	11/2+	3/2+	7+
	159	„	9/2+	10+
	161	„	9/2+	10+
	163	„	13/2-	12-
	165	„	3/2+	7+
	167	„	5/2+	8+
	169	„	9/2+	10+
111	163	3/2-	13/2-	8+
	169	9/2-	5/2+	8+
	157	„	11/2-	7+



A particular situation occurs above double closed subshells $N = 162$ and $Z = 108$ where two intruder orbitals, neutron $13/2^-$ from $j_{15/2}$ and proton $11/2^+$ from $i_{13/2}$ spherical subshells, are predicted. These orbitals combine to the 12^- g.s. in $Z = 109$, $N = 163$,

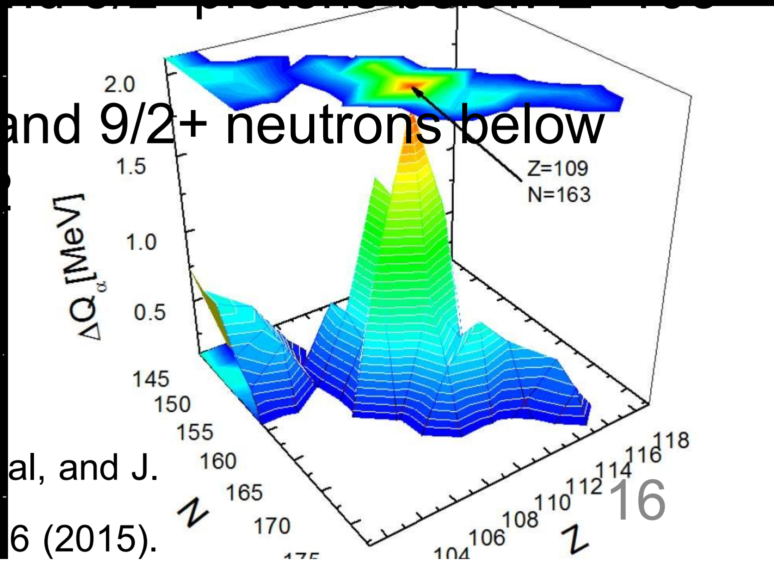


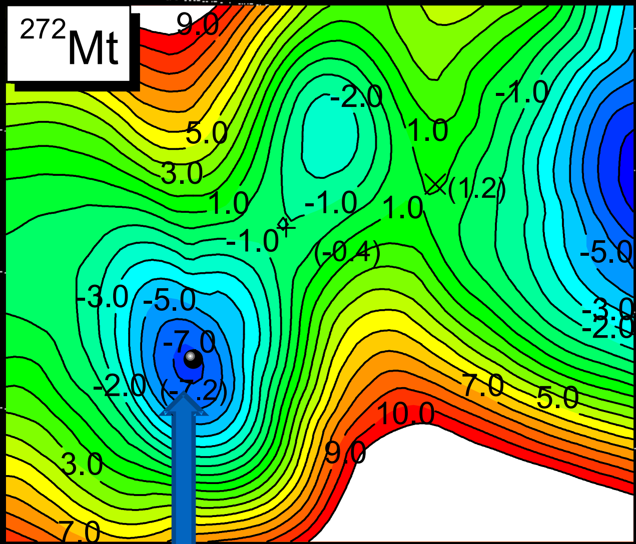
Z	N	Ω^p	Ω^n	K^π	ΔQ_α
111	169	$9/2^-$	$5/2^+$	7^-	0.74
111	163	$3/2^-$	$13/2^-$	8^+	1.31
111	161	$3/2^-$	$7/2^+$	$7/2^-$	0.52
110	163		$13/2^-$	$13/2^-$	0.97
109	169	$11/2^+$	$9/2^+$	10^+	0.51
109	167	$11/2^+$	$5/2^+$	8^+	0.71
109	166	$11/2^+$		$11/2^+$	0.88
109	165	$11/2^+$	$3/2^+$	7^+	1.38
109	164	$11/2^+$		$11/2^+$	1.13
109	163	$11/2^+$	$13/2^-$	12^-	1.99
109	162	$11/2^+$		$11/2^+$	1.27
109	161	$11/2^+$	$9/2^+$	10^+	1.32
109	160	$11/2^+$		$11/2^+$	1.37
109	159	$11/2^+$	$9/2^+$	10^+	1.56
109	158	$11/2^+$		$11/2^+$	1.39
109	157	$11/2^+$	$3/2^+$	7^+	1.41
108	163		$13/2^-$	$13/2^-$	1.00
107	163	$5/2^-$	$13/2^-$	9^+	1.17
107	157	$5/2^-$	$11/2^-$	8^+	0.57
106	163		$13/2^-$	$13/2^-$	0.96
105	153	$9/2^+$	$1/2^+$	5^+	0.97
103	157	$7/2^-$	$11/2^-$	9^+	0.52
103	154	$7/2^-$		$7/2^-$	0.54
103	153	$7/2^-$	$1/2^+$	4^-	1.45
103	151	$7/2^-$	$9/2^-$	8^+	0.58
103	149	$7/2^-$	$7/2^+$	7^-	0.63
101	151	$1/2^-$	$9/2^-$	5^+	0.68
101	149	$1/2^-$	$7/2^+$	4^-	0.92

High-K states: a chance for longer half-lives.

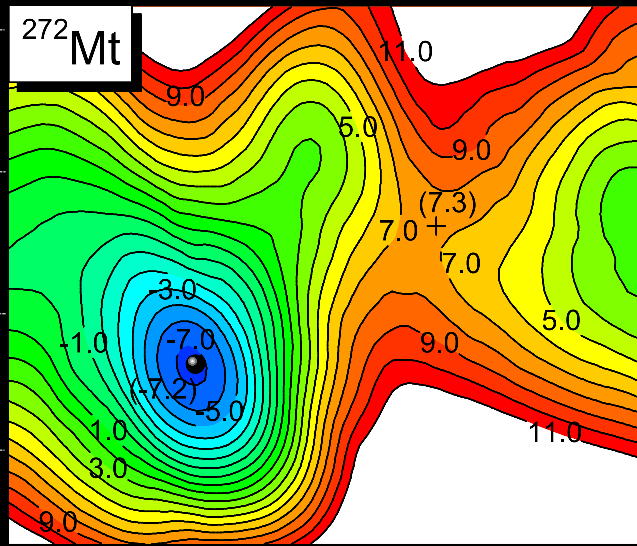
Candidates for high-K Ground states.

in odd or odd-odd SHN in the W-S model

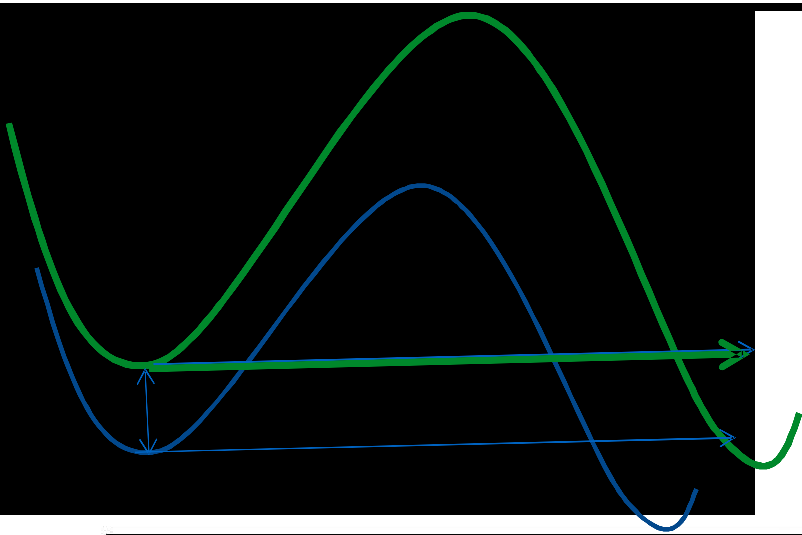


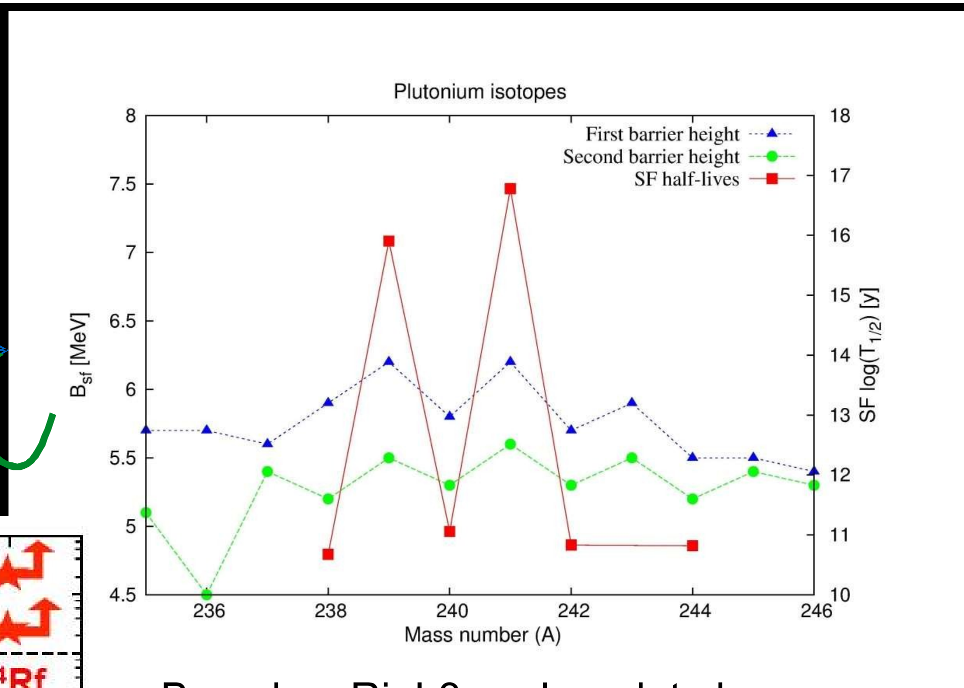


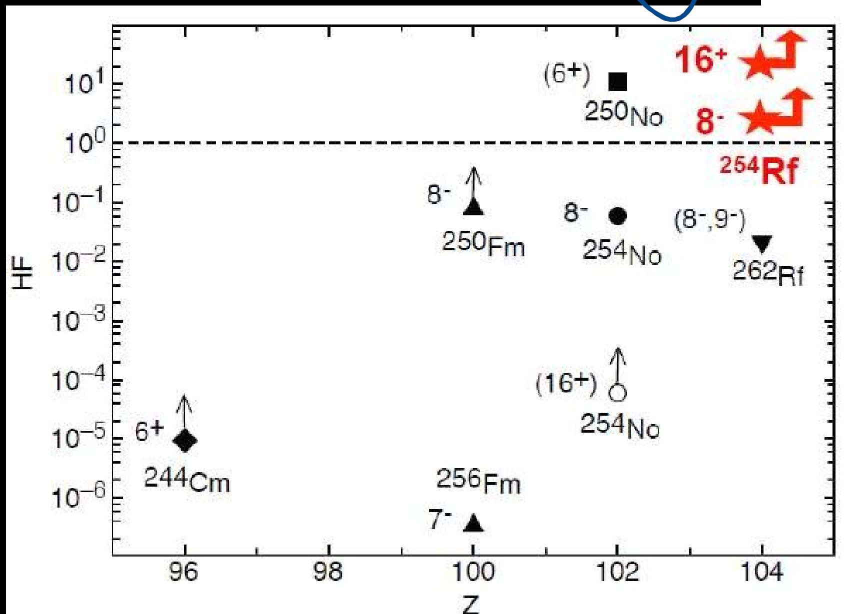
^{272}Mt
9.0
5.0
3.0
1.0
-2.0
1.0
-1.0
-1.0
1.0
(1.2)
-1.0
(-0.4)
-3.0
-5.0
-7.0
-2.0
(-7.2)
-5.0
-3.0
-2.0
7.0
5.0
10.0
9.0
3.0
7.0



^{272}Mt
11.0
9.0
5.0
9.0
(7.3)
7.0
7.0
-3.0
-1.0
-7.0
9.0
5.0
(-7.2)
-5.0
1.0
3.0
11.0
9.0

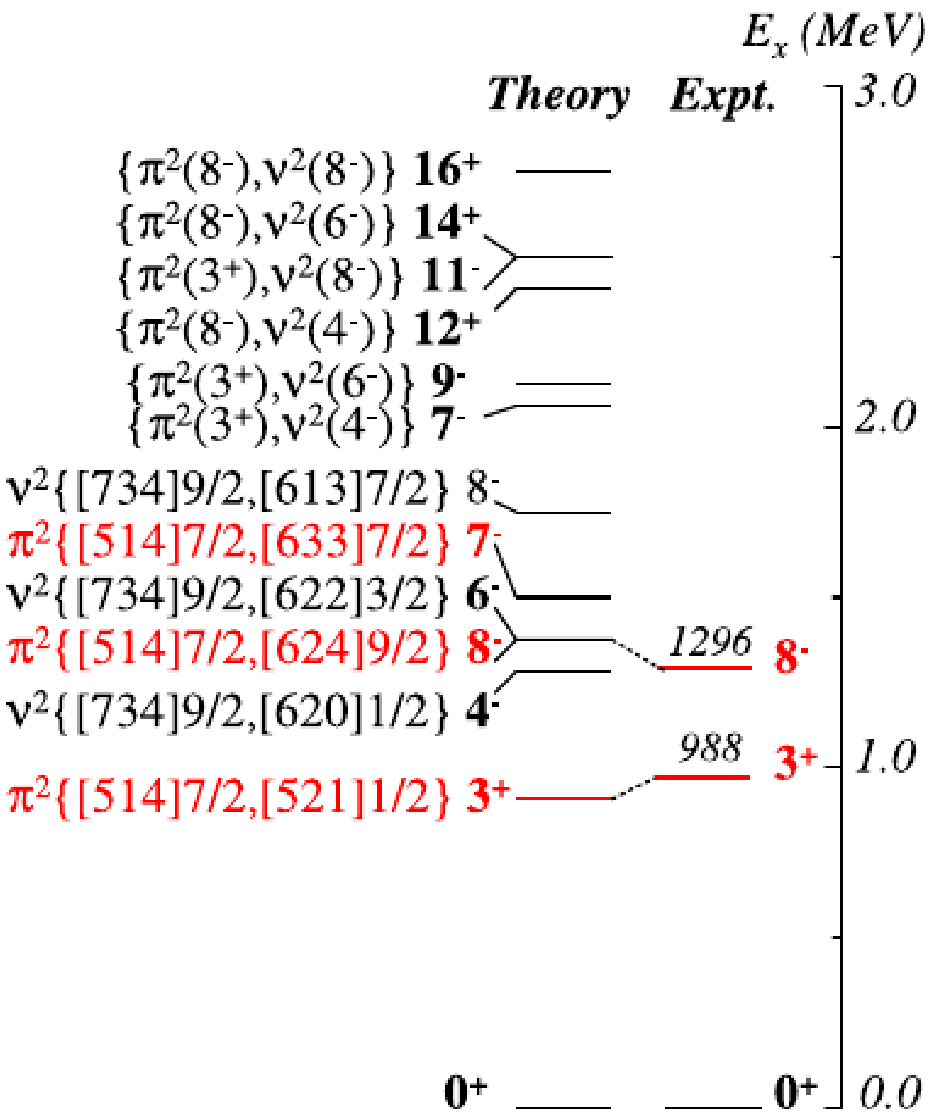






https://www-nds.iaea.org/RIPL-3/

F. G. Kondev, G. D. Dracoulis, T. Kibedi, *Atomic Data and Nuclear Data Tables*, 103-104, (2015).

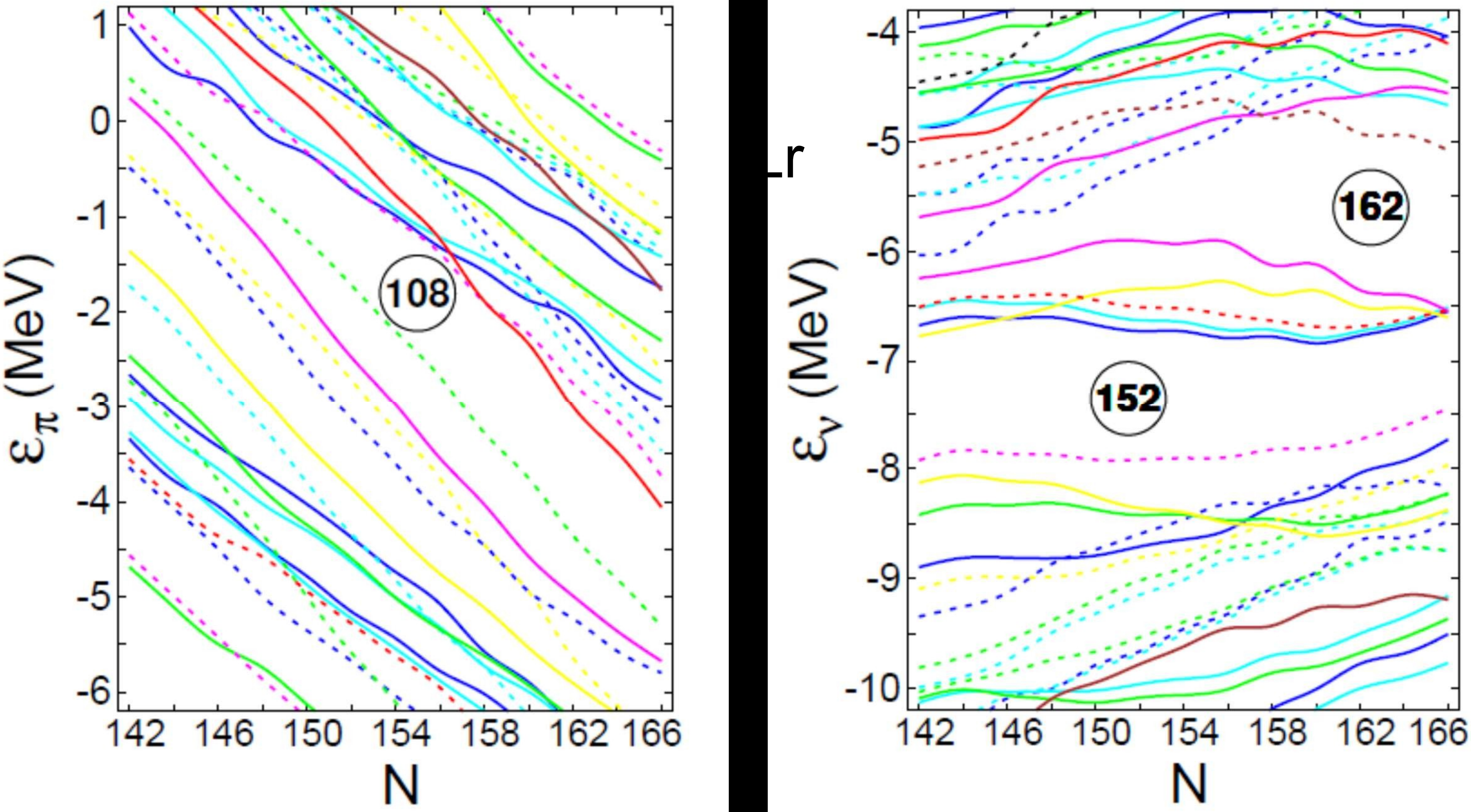


S. K. Tandel et al., Phys. Rev. Lett. 97, 082502 (2006)

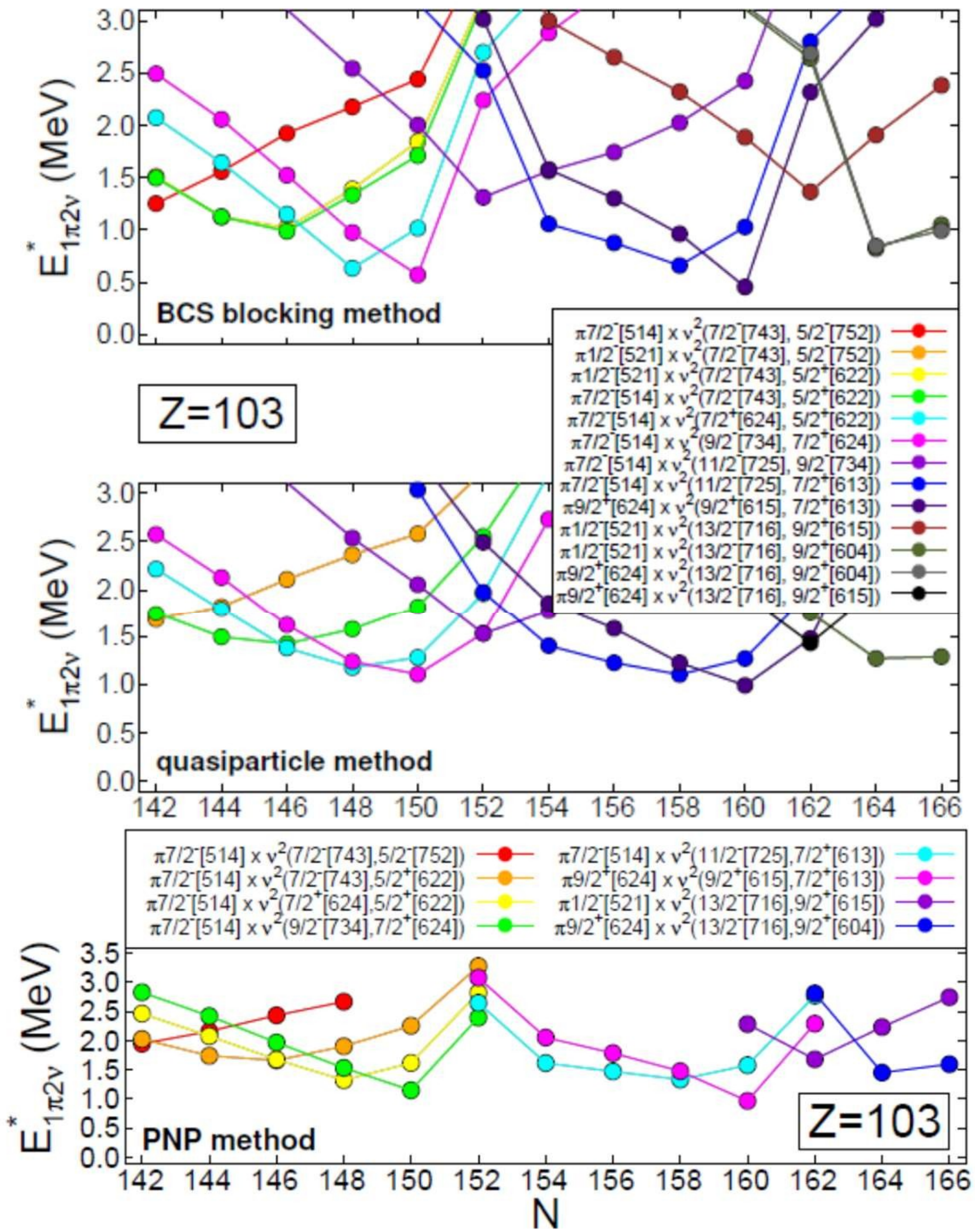
Interpretation of experimental results is often induced by models. Two candidates for the 8^- isomer in ^{254}No, either a proton or a neutron 2qp configuration, are predicted by the Woods-Saxon model.
Although g_K factors for two configurations are very different, $|g_K-g_R|$ controlling intraband transitions are probably similar. (hyperfine structure splitting measurement will decide?)

This assignment is related to isomer assignments in Md, Lr and Db nuclei.

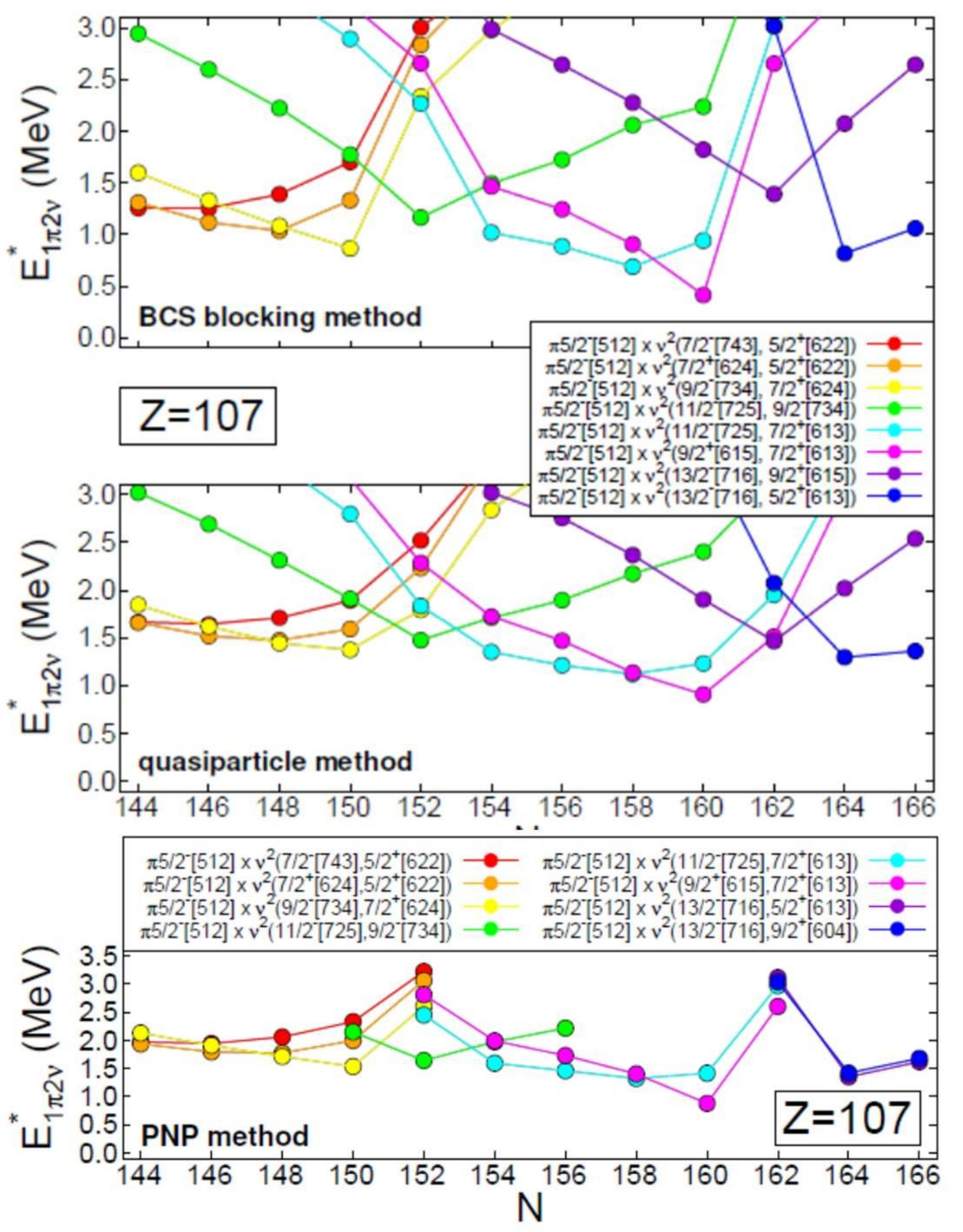
[redacted]Lr



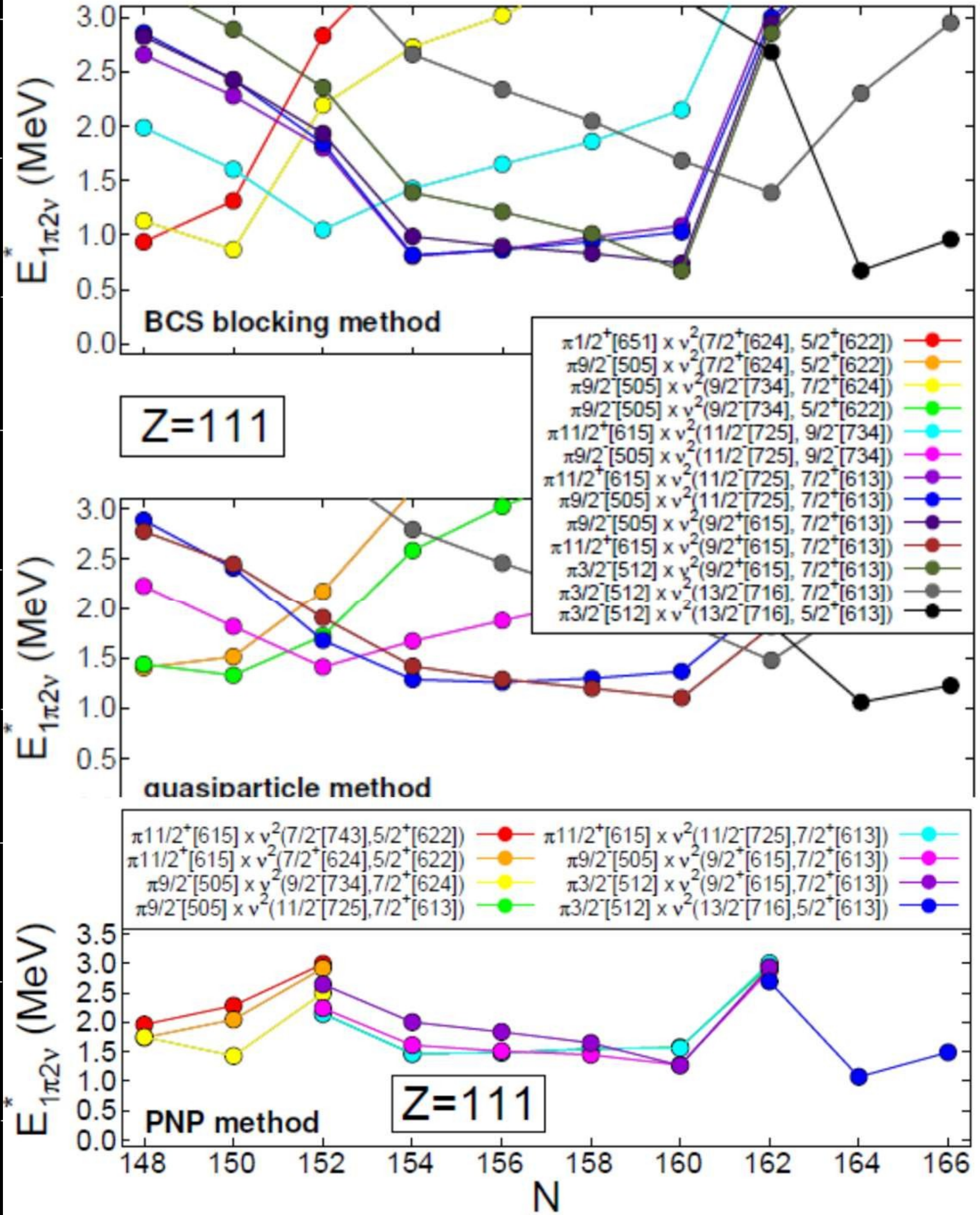
[redacted]

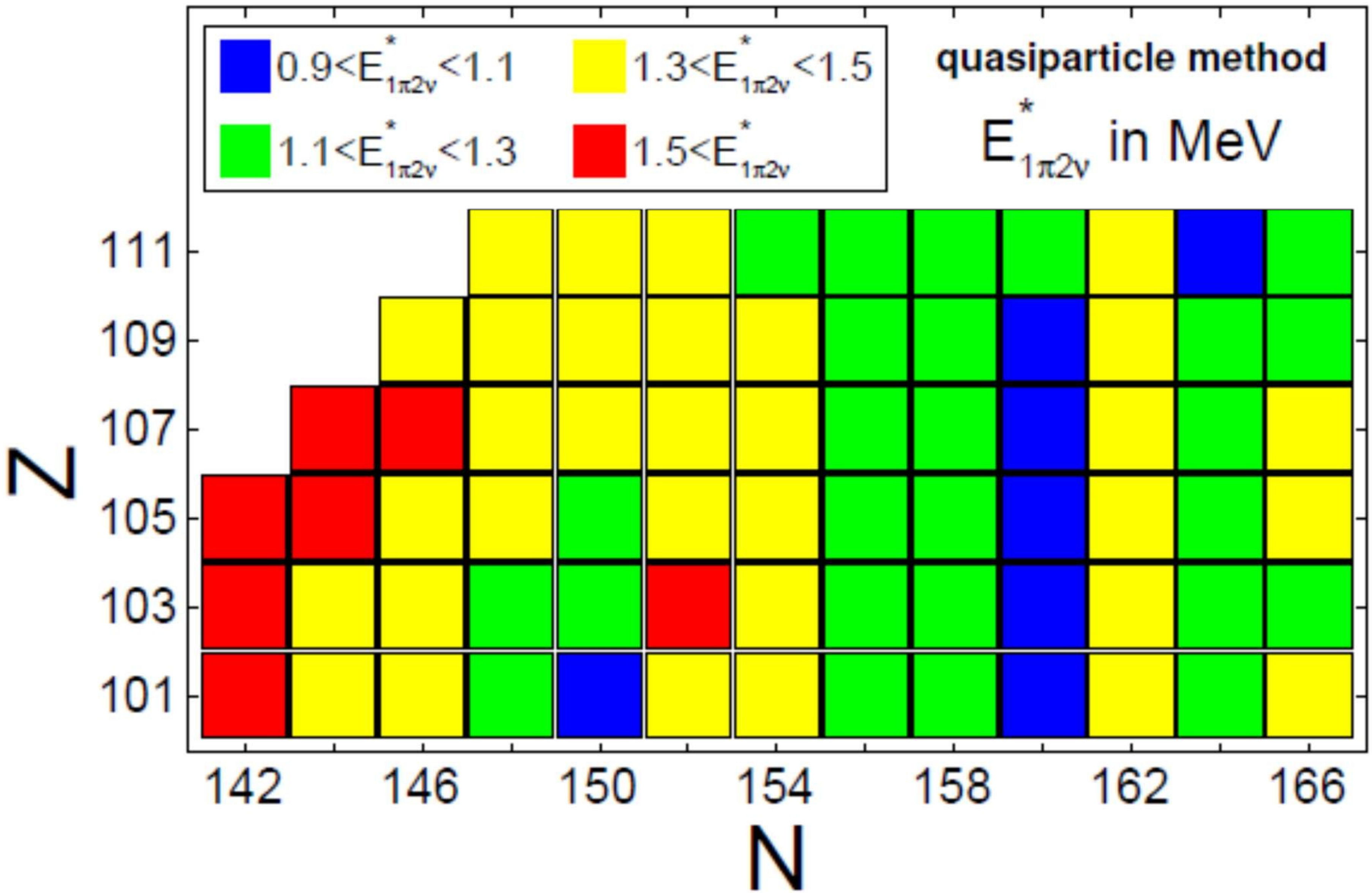


BCS blocking method
quasiparticle method
PNP method
Z=103
Z=103
E*1π2ν (MeV)
N
π7/2⁻[514] x ν²(7/2⁻[743], 5/2⁻[752])
π1/2⁻[521] x ν²(7/2⁻[743], 5/2⁻[752])
π1/2⁻[521] x ν²(7/2⁻[743], 5/2⁺[622])
π7/2⁻[514] x ν²(7/2⁻[743], 5/2⁺[622])
π7/2⁻[514] x ν²(7/2⁺[624], 5/2⁺[622])
π7/2⁻[514] x ν²(9/2⁻[734], 7/2⁺[624])
π7/2⁻[514] x ν²(11/2⁻[725], 9/2⁻[734])
π7/2⁻[514] x ν²(11/2⁻[725], 7/2⁺[613])
π9/2⁺[624] x ν²(9/2⁺[615], 7/2⁺[613])
π1/2⁻[521] x ν²(13/2⁻[716], 9/2⁺[615])
π1/2⁻[521] x ν²(13/2⁻[716], 9/2⁺[604])
π9/2⁺[624] x ν²(13/2⁻[716], 9/2⁺[604])
π9/2⁺[624] x ν²(13/2⁻[716], 9/2⁺[615])
π7/2⁻[514] x ν²(7/2⁻[743],5/2⁻[752])
π7/2⁻[514] x ν²(7/2⁻[743],5/2⁺[622])
π7/2⁻[514] x ν²(7/2⁺[624],5/2⁺[622])
π7/2⁻[514] x ν²(9/2⁻[734],7/2⁺[624])
π7/2⁻[514] x ν²(11/2⁻[725],7/2⁺[613])
π9/2⁺[624] x ν²(9/2⁺[615],7/2⁺[613])
π1/2⁻[521] x ν²(13/2⁻[716],9/2⁺[615])
π9/2⁺[624] x ν²(13/2⁻[716],9/2⁺[604])

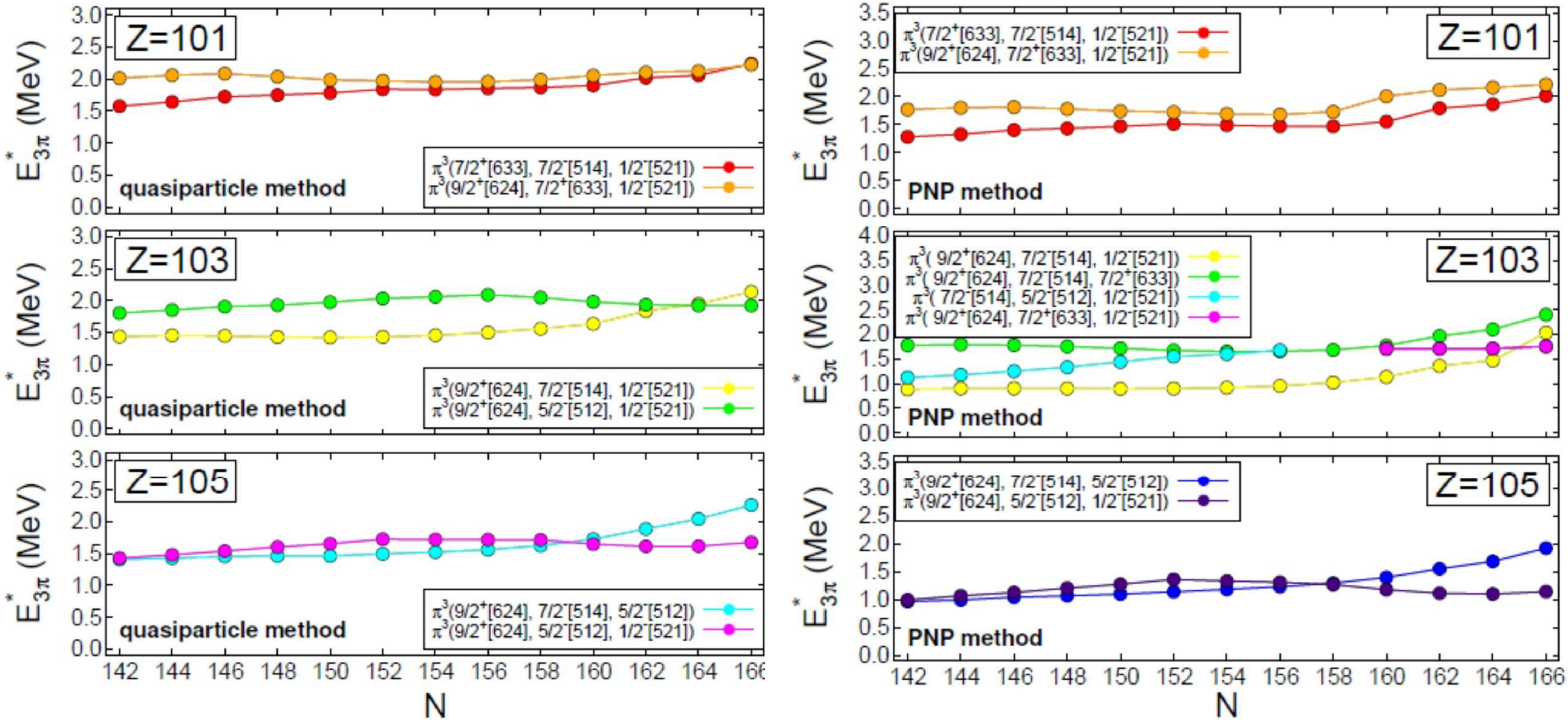


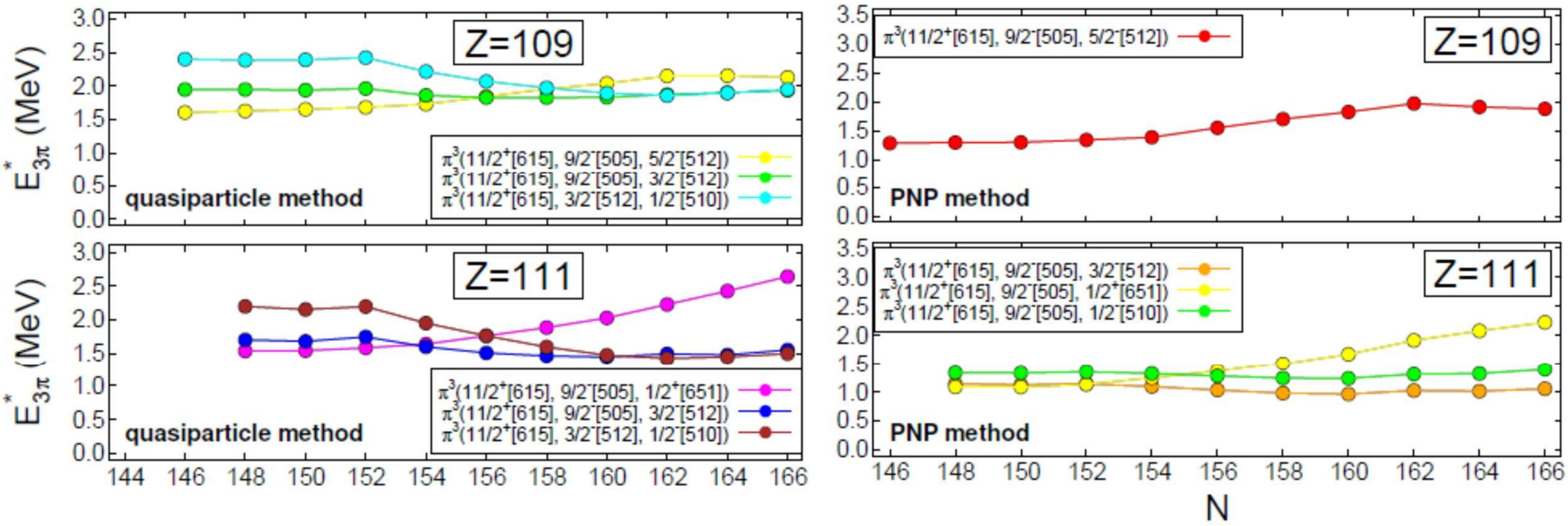
BCS blocking method
Z=107
quasiparticle method
PNP method
Z=107
N
π5/2-[512] x ν2(7/2-[743], 5/2+[622])
π5/2-[512] x ν2(7/2+[624], 5/2+[622])
π5/2-[512] x ν2(9/2-[734], 7/2+[624])
π5/2-[512] x ν2(11/2-[725], 9/2-[734])
π5/2-[512] x ν2(11/2-[725], 7/2+[613])
π5/2-[512] x ν2(9/2+[615], 7/2+[613])
π5/2-[512] x ν2(13/2-[716], 9/2+[615])
π5/2-[512] x ν2(13/2-[716], 5/2+[613])
π5/2-[512] x ν2(13/2-[716],9/2+[604])


BCS blocking method
Z=111
quasiparticle method
PNP method
Z=111
$E^*_{1\pi2\nu}$ (MeV)
N
π1/2+[651] x ν2(7/2+[624], 5/2+[622])
π9/2-[505] x ν2(7/2+[624], 5/2+[622])
π9/2-[505] x ν2(9/2-[734], 7/2+[624])
π9/2-[505] x ν2(9/2-[734], 5/2+[622])
π11/2+[615] x ν2(11/2-[725], 9/2-[734])
π9/2-[505] x ν2(11/2-[725], 9/2-[734])
π11/2+[615] x ν2(11/2-[725], 7/2+[613])
π9/2-[505] x ν2(11/2-[725], 7/2+[613])
π9/2-[505] x ν2(9/2+[615], 7/2+[613])
π11/2+[615] x ν2(9/2+[615], 7/2+[613])
π3/2-[512] x ν2(9/2+[615], 7/2+[613])
π3/2-[512] x ν2(13/2-[716], 7/2+[613])
π3/2-[512] x ν2(13/2-[716], 5/2+[613])
π11/2+[615] x ν2(7/2-[743],5/2+[622])
π11/2+[615] x ν2(7/2+[624],5/2+[622])
π9/2-[505] x ν2(9/2-[734],7/2+[624])
π9/2-[505] x ν2(11/2-[725],7/2+[613])
π11/2+[615] x ν2(11/2-[725],7/2+[613])
π9/2-[505] x ν2(9/2+[615],7/2+[613])
π3/2-[512] x ν2(9/2+[615],7/2+[613])
π3/2-[512] x ν2(13/2-[716],5/2+[613])



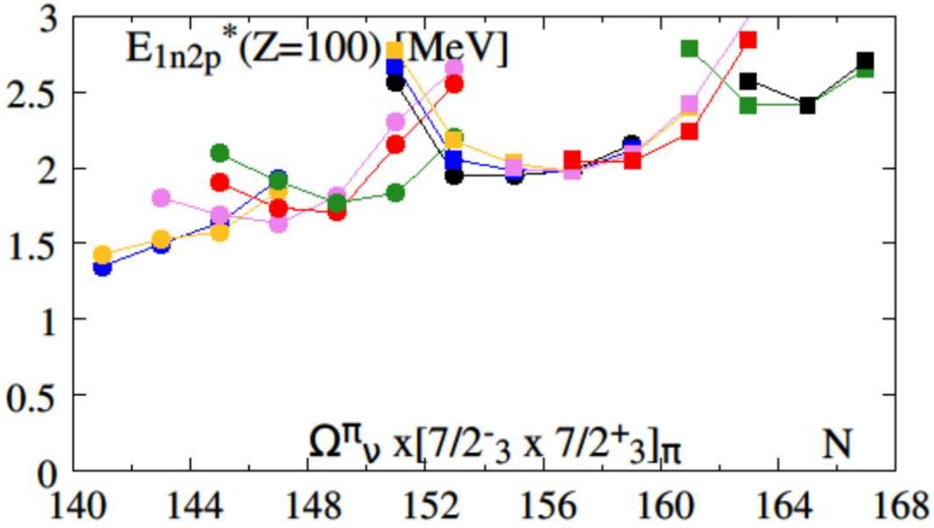
0.9<E*1π2ν<1.1
1.3<E*1π2ν<1.5
1.1<E*1π2ν<1.3
1.5<E*1π2ν
quasiparticle method
E*1π2ν in MeV
111
109
107
105
103
101
Z
142
146
150
154
158
162
166
N

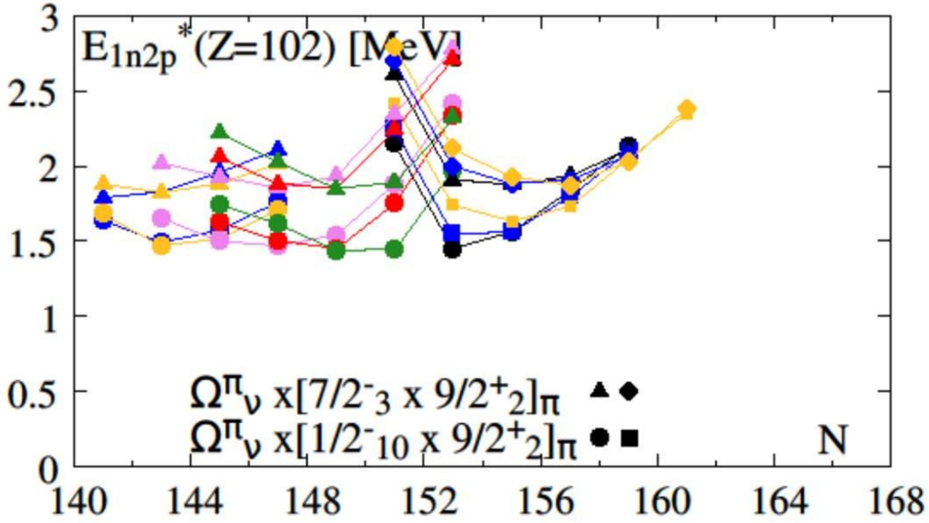

Z=101
quasiparticle method
π³(7/2⁺[633], 7/2⁻[514], 1/2⁻[521])
π³(9/2⁺[624], 7/2⁺[633], 1/2⁻[521])
Z=103
quasiparticle method
π³(9/2⁺[624], 7/2⁻[514], 1/2⁻[521])
π³(9/2⁺[624], 5/2⁻[512], 1/2⁻[521])
Z=105
quasiparticle method
π³(9/2⁺[624], 7/2⁻[514], 5/2⁻[512])
π³(9/2⁺[624], 5/2⁻[512], 1/2⁻[521])
Z=101
PNP method
π³(7/2⁺[633], 7/2⁻[514], 1/2⁻[521])
π³(9/2⁺[624], 7/2⁺[633], 1/2⁻[521])
Z=103
PNP method
π³(9/2⁺[624], 7/2⁻[514], 1/2⁻[521])
π³(9/2⁺[624], 7/2⁻[514], 7/2⁺[633])
π³(7/2⁻[514], 5/2⁻[512], 1/2⁻[521])
π³(9/2⁺[624], 7/2⁺[633], 1/2⁻[521])
Z=105
PNP method
π³(9/2⁺[624], 7/2⁻[514], 5/2⁻[512])
π³(9/2⁺[624], 5/2⁻[512], 1/2⁻[521])
E*₃π (MeV)
N
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
142 144 146 148 150 152 154 156 158 160 162 164 166

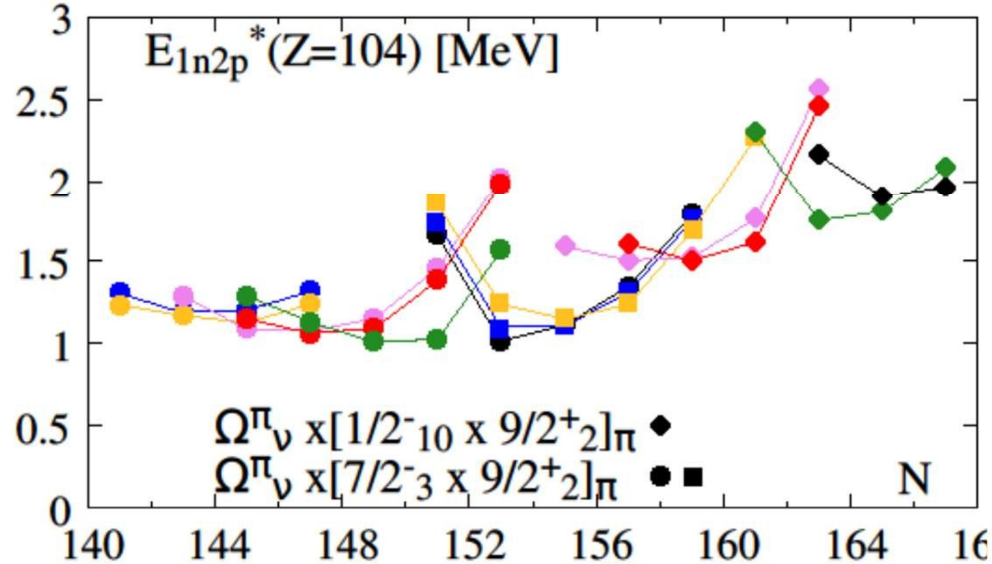


Z=109
Z=111
quasiparticle method
PNP method
π3(11/2+[615], 9/2-[505], 5/2-[512])
π3(11/2+[615], 9/2-[505], 3/2-[512])
π3(11/2+[615], 3/2-[512], 1/2-[510])
π3(11/2+[615], 9/2-[505], 1/2+[651])
π3(11/2+[615], 9/2-[505], 1/2-[510])
E*3π (MeV)
N

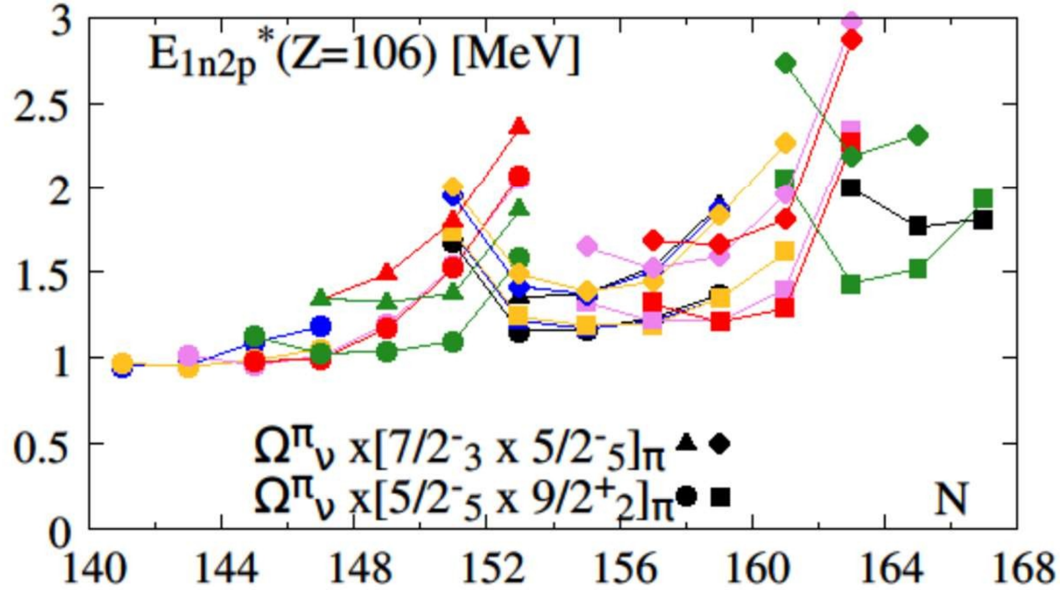
Even-odd systems Z=100-112, N=141-167; PNP results, 1n2p



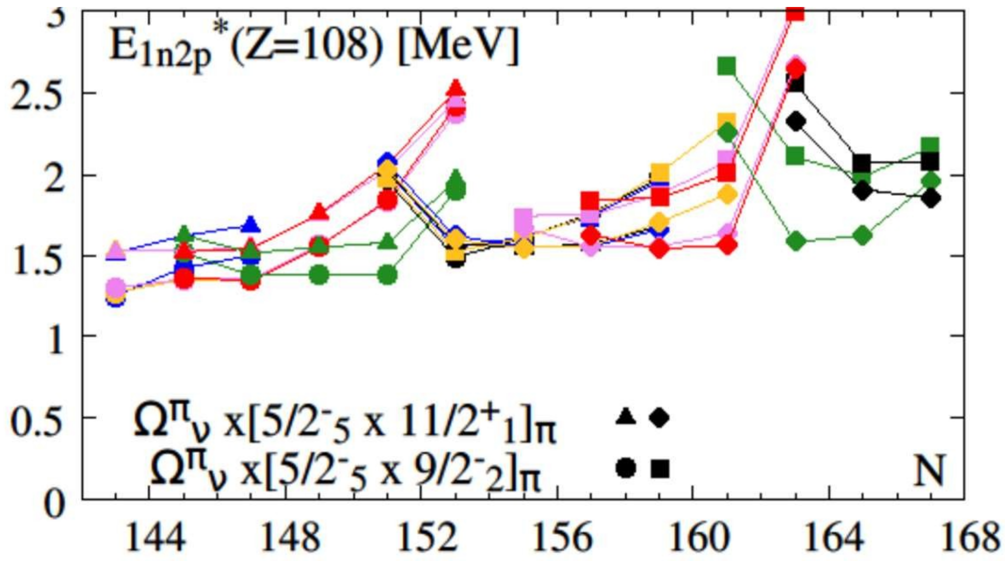


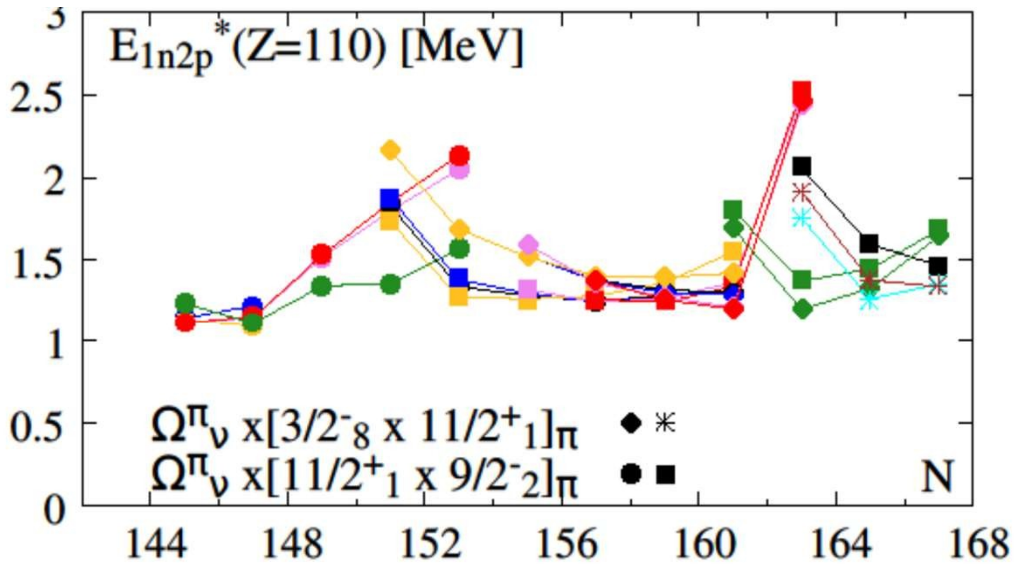


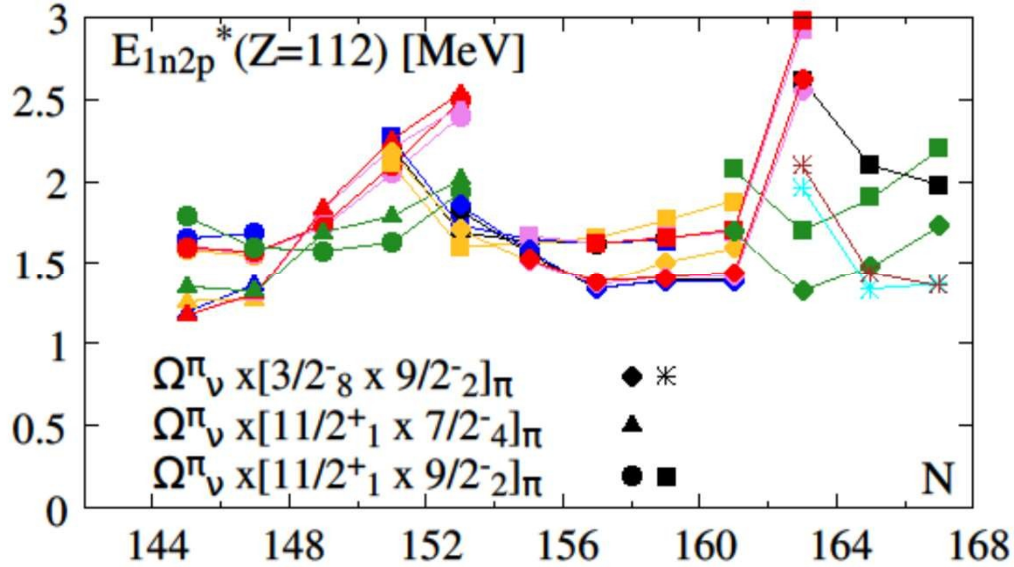
E1n2p*(Z=104) [MeV]
Ωπν x[1/2-10 x 9/2+2]π
Ωπν x[7/2-3 x 9/2+2]π
N

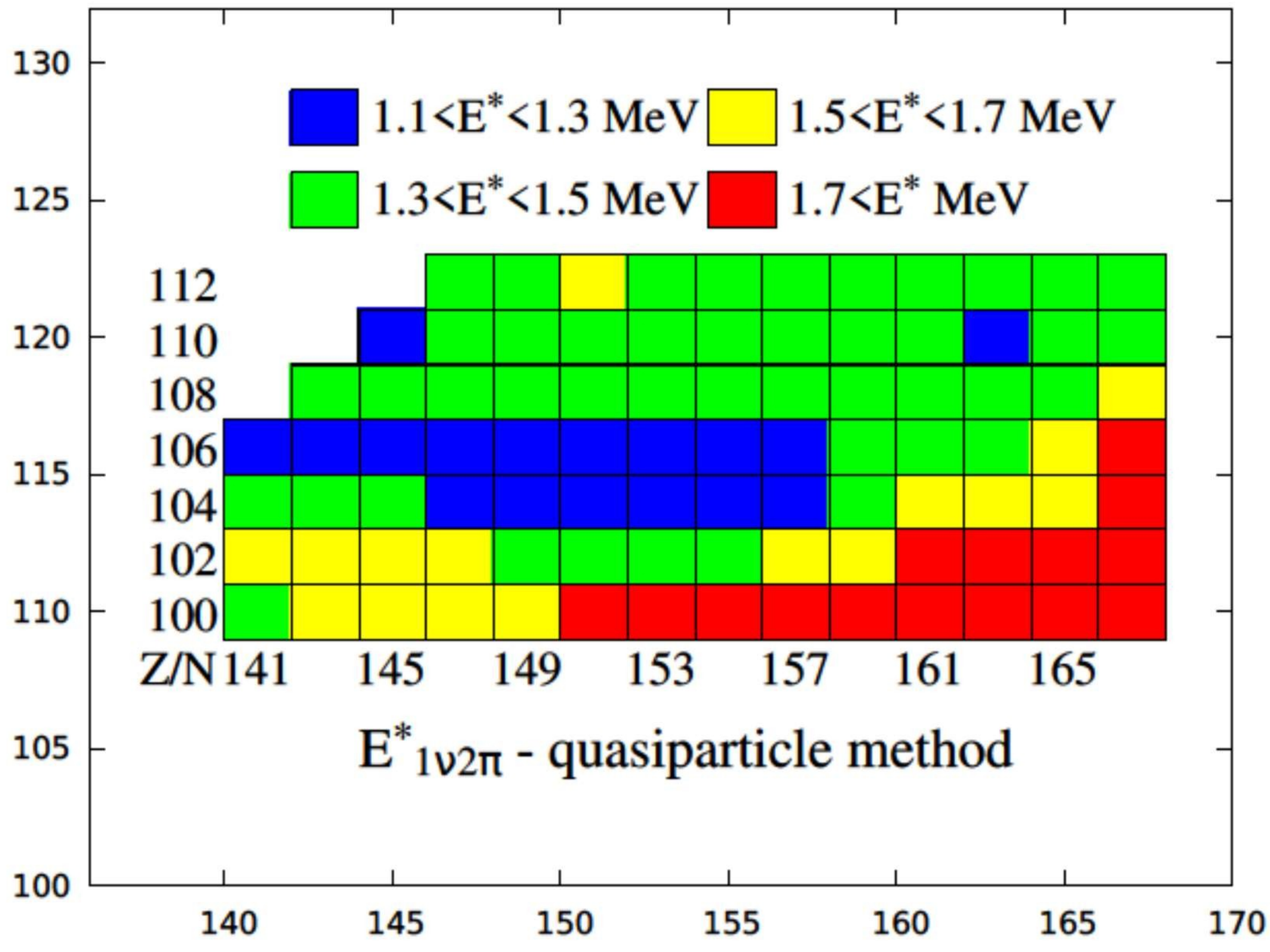


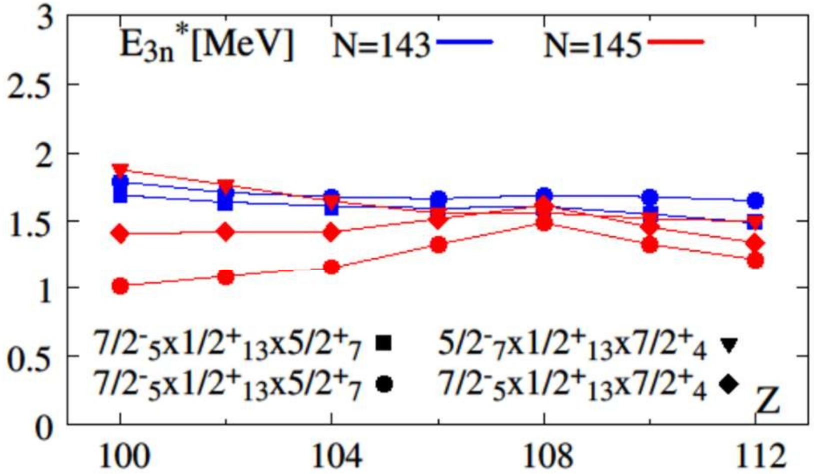
E1n2p*(Z=106) [MeV]
Ωπν x[7/2-3 x 5/2-5]π
Ωπν x[5/2-5 x 9/2+2]π
N

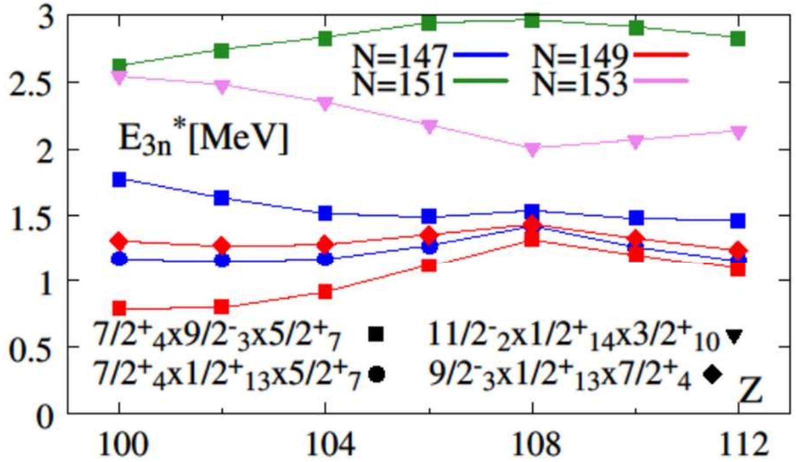

E1n2p*(Z=108) [MeV]
Ωπν x[5/2-5 x 11/2+1]π
Ωπν x[5/2-5 x 9/2-2]π
N
0
0.5
1
1.5
2
2.5
3
144
148
152
156
160
164
168

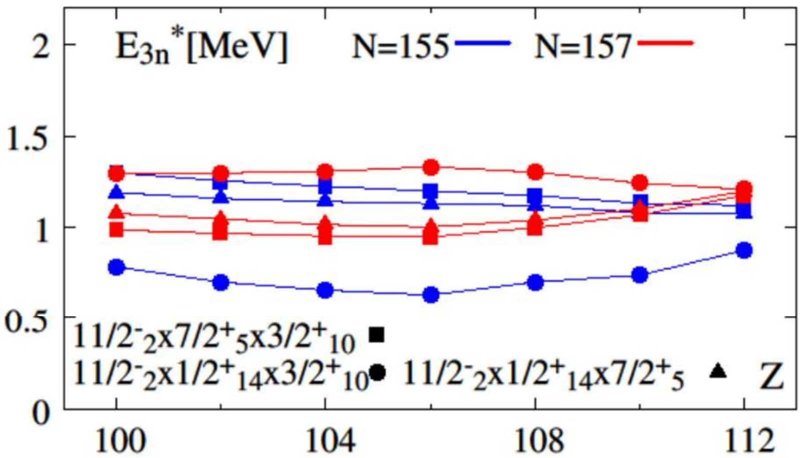

E1n2p*(Z=110) [MeV]
Ωπν x[3/2-8 x 11/2+1]π
Ωπν x[11/2+1 x 9/2-2]π
N
0
0.5
1
1.5
2
2.5
3
144
148
152
156
160
164
168


E1n2p*(Z=112) [MeV]
Ωπν x[3/2-8 x 9/2-2]π
Ωπν x[11/2+1 x 7/2-4]π
Ωπν x[11/2+1 x 9/2-2]π
N
0
0.5
1
1.5
2
2.5
3
144
148
152
156
160
164
168

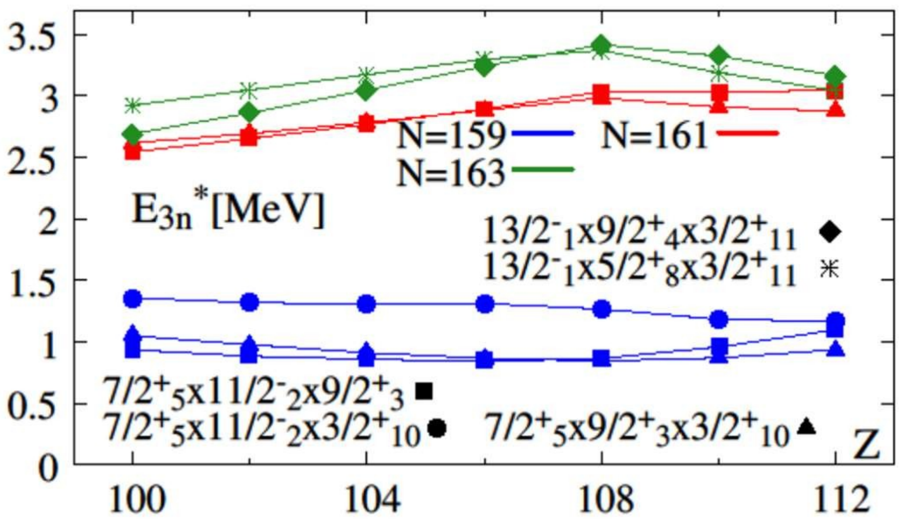

1.1<E*<1.3 MeV
1.5<E*<1.7 MeV
1.3<E*<1.5 MeV
1.7<E* MeV
112
110
108
106
104
102
100
Z/N 141 145 149 153 157 161 165
E*1ν2π - quasiparticle method
130
125
120
115
110
105
100
140 145 150 155 160 165 170

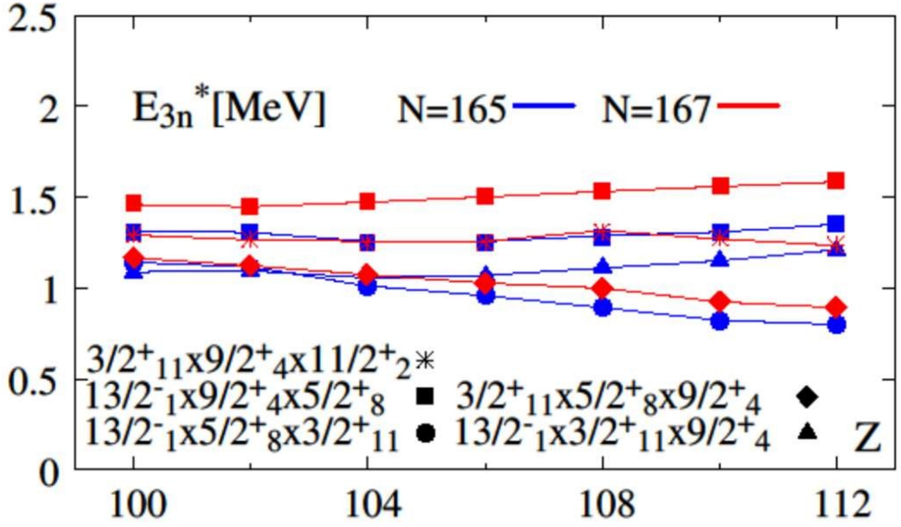






3n – PNP results


E3n*[MeV]
N=159
N=161
N=163
13/2-1x9/2+4x3/2+11
13/2-1x5/2+8x3/2+11
7/2+5x11/2-2x9/2+3
7/2+5x11/2-2x3/2+10
7/2+5x9/2+3x3/2+10
Z


E3n*[MeV]
N=165
N=167
3/2+11x9/2+4x11/2+2
13/2-1x9/2+4x5/2+8
3/2+11x5/2+8x9/2+4
13/2-1x5/2+8x3/2+11
13/2-1x3/2+11x9/2+4
Z

Conclusions

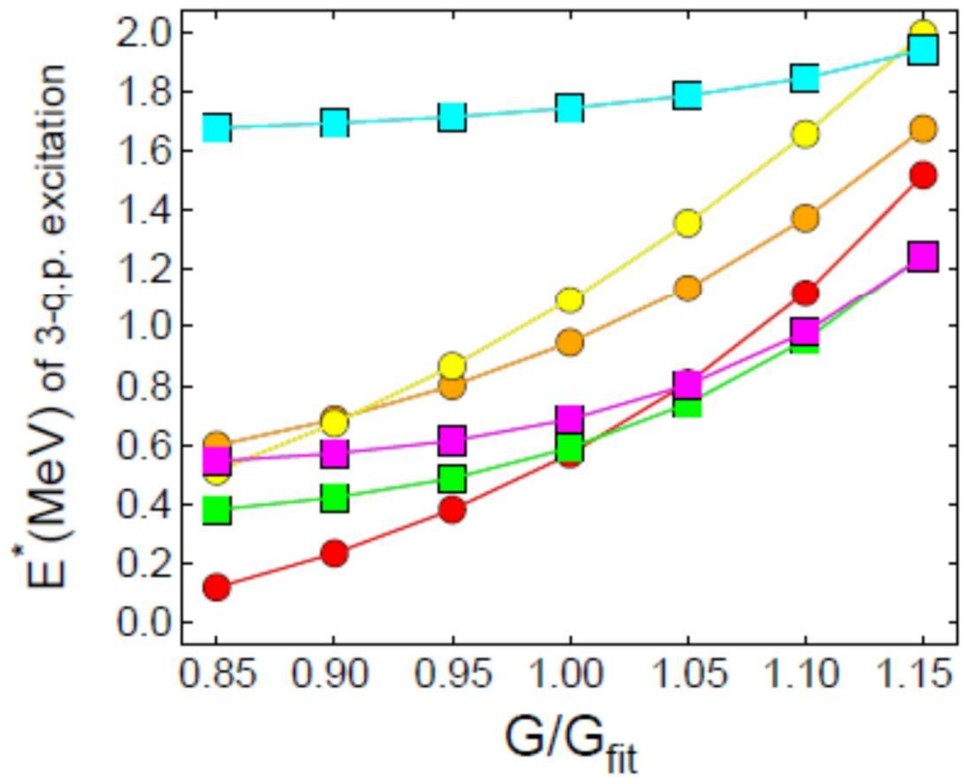
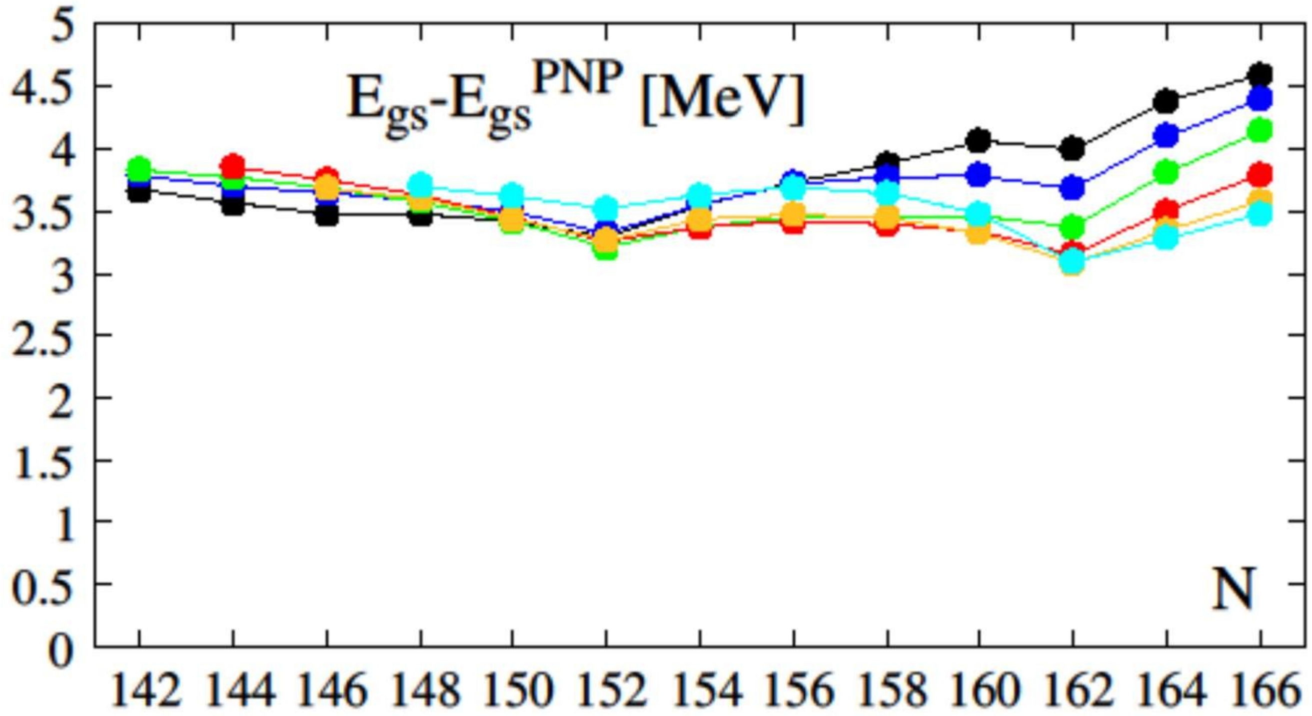
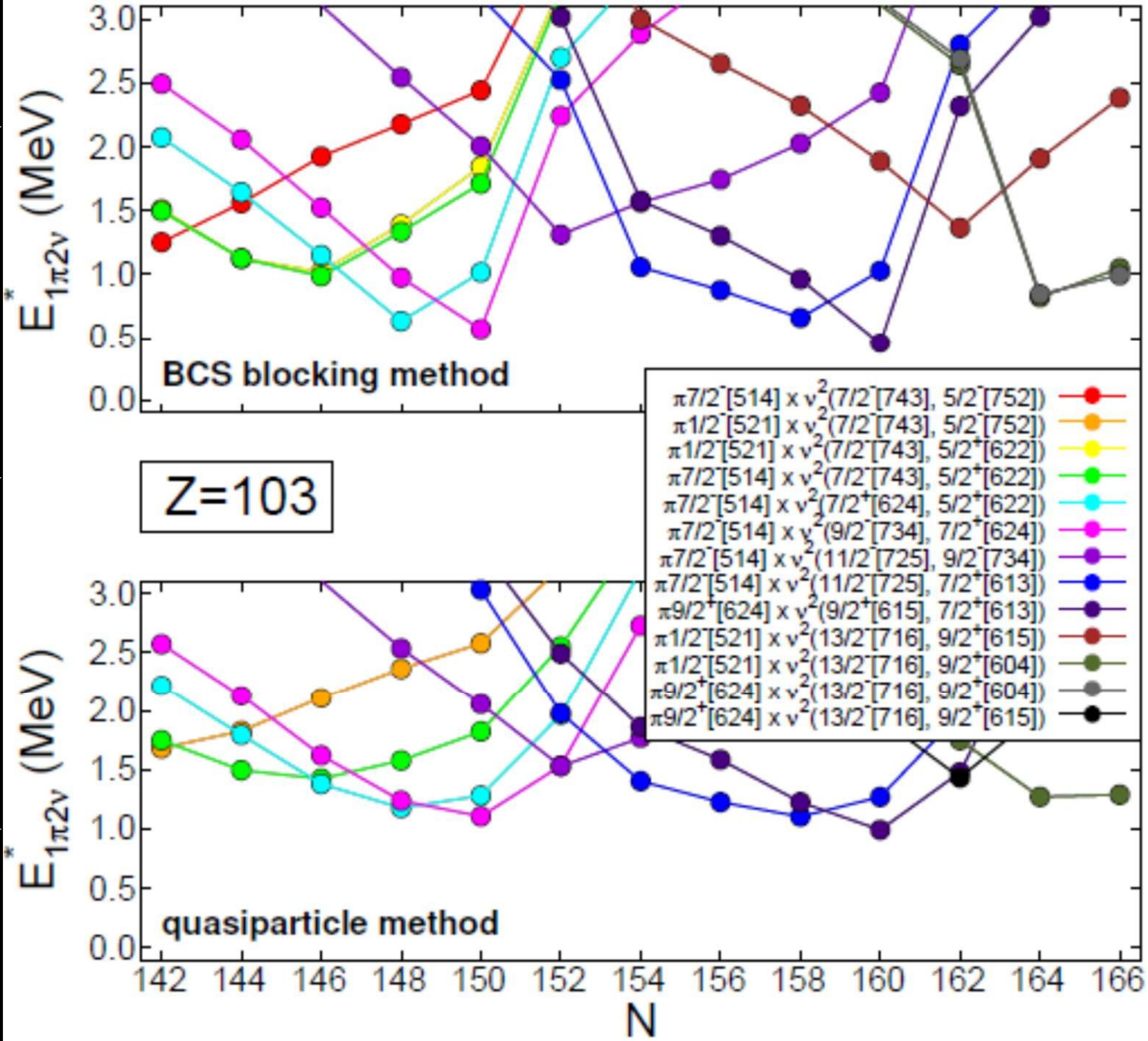


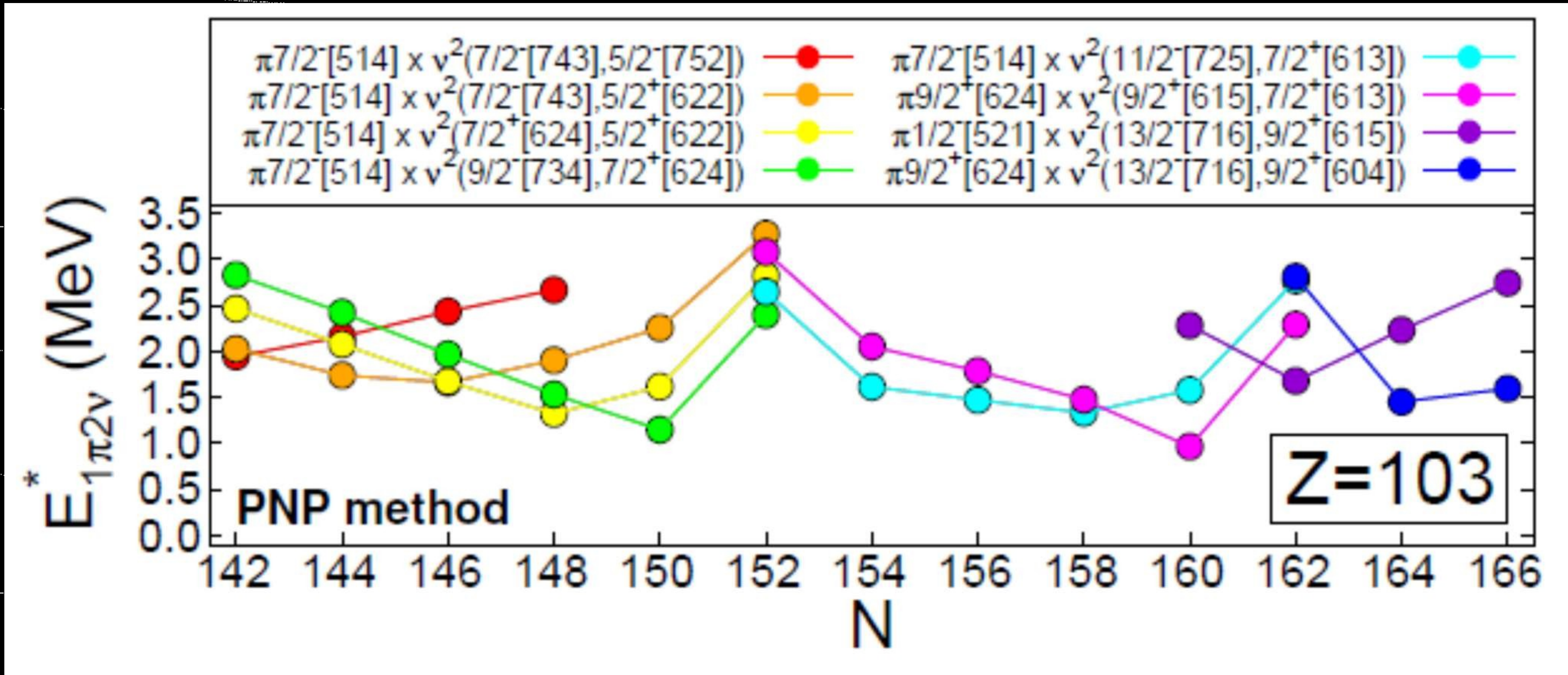
FIG. 17: Energy of the 3-q.p. excitation ($E^*_{1\pi 2\nu}$ or $E^*_{3\pi}$ in MeV) from the PNP method vs pairing strength (in units of the value of the fit G/G_{fit}) at the fixed, near g.s. shape, for $1\pi 2\nu$ states in Mt isotopes (dots): $\pi 9/2^-_2 \otimes \nu 7/2^+_4 \otimes \nu 5/2^+_7$ in ^{255}Mt (yellow), $\pi 11/2^+_1 \otimes \nu 9/2^+_3 \otimes \nu 7/2^+_5$ in ^{267}Mt (orange) and ^{269}Mt (red), and for 3π states (squares): $\pi 7/2^-_3 \otimes \pi 9/2^+_2 \otimes \pi 1/2^-_{10}$ in ^{259}Lr (green), $\pi 11/2^+_1 \otimes \pi 9/2^-_2 \otimes \pi 5/2^-_5$ in ^{265}Mt (cyan), and $\pi 9/2^+_2 \otimes \pi 11/2^+_1 \otimes \pi 3/2^-_8$ in ^{271}Rg (magenta).



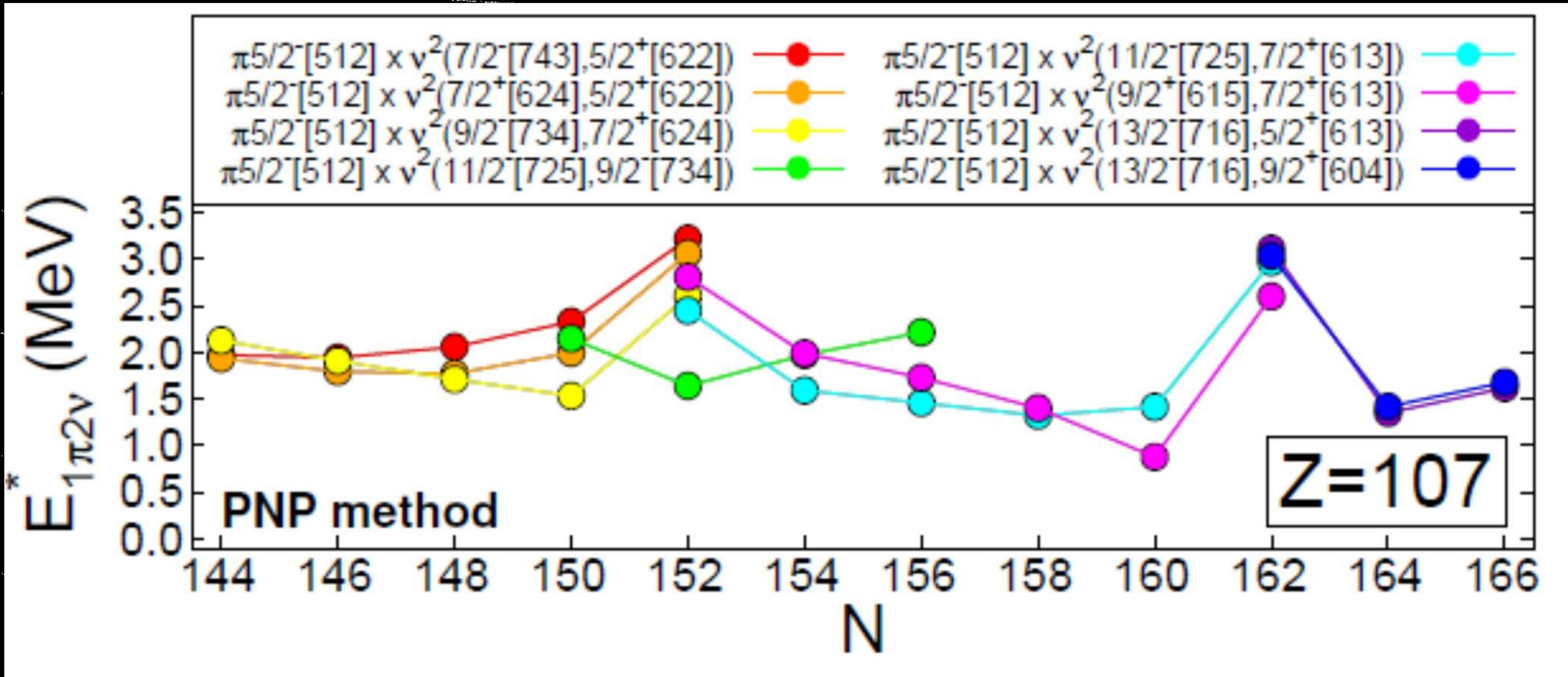
Egs-Egs^PNP [MeV]
N
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
142 144 146 148 150 152 154 156 158 160 162 164 166



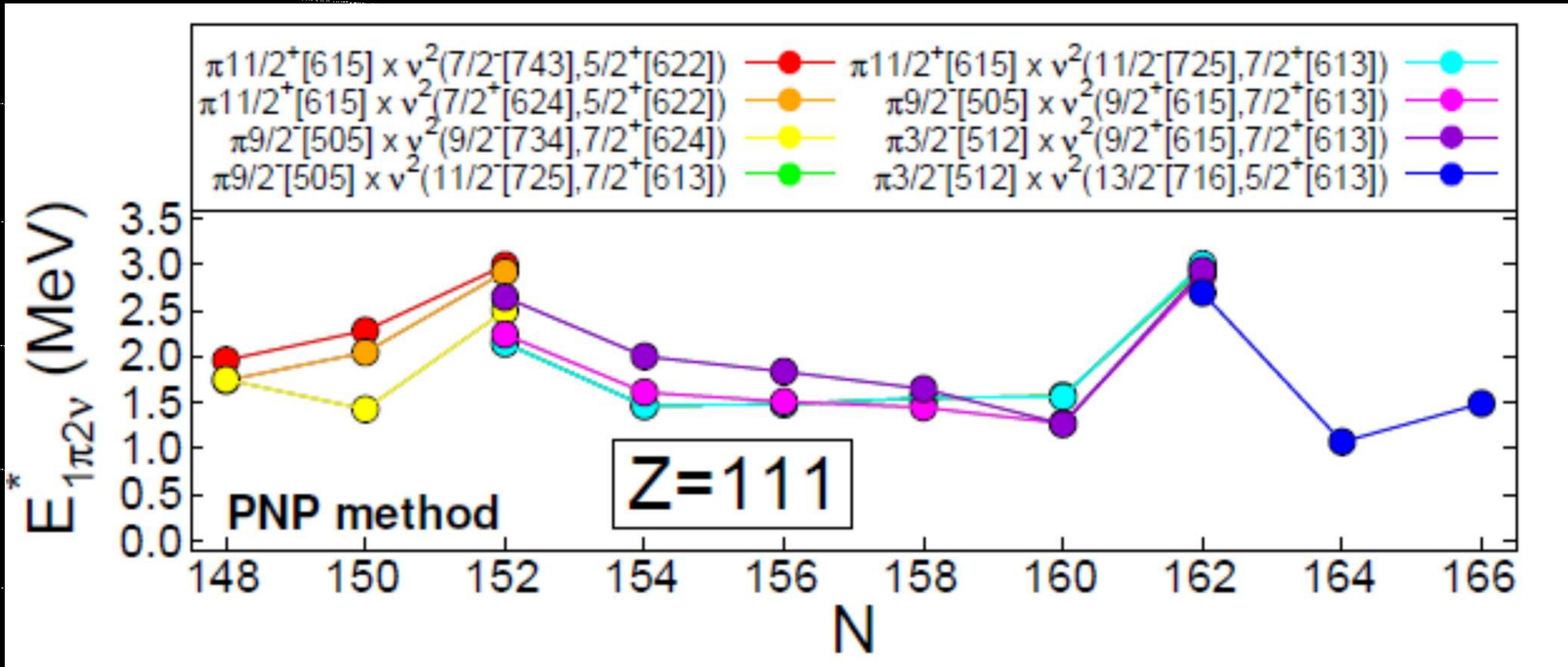
BCS blocking method
Z=103
quasiparticle method
$E^*_{1\pi2\nu}$ (MeV)
N
$\pi7/2^-[514] \times \nu^2(7/2^-[743], 5/2^-[752])$
$\pi1/2^-[521] \times \nu^2(7/2^-[743], 5/2^-[752])$
$\pi1/2^-[521] \times \nu^2(7/2^-[743], 5/2^+[622])$
$\pi7/2^-[514] \times \nu^2(7/2^-[743], 5/2^+[622])$
$\pi7/2^-[514] \times \nu^2(7/2^+[624], 5/2^+[622])$
$\pi7/2^-[514] \times \nu^2(9/2^-[734], 7/2^+[624])$
$\pi7/2^-[514] \times \nu^2(11/2^-[725], 9/2^-[734])$
$\pi7/2^-[514] \times \nu^2(11/2^-[725], 7/2^+[613])$
$\pi9/2^+[624] \times \nu^2(9/2^+[615], 7/2^+[613])$
$\pi1/2^-[521] \times \nu^2(13/2^-[716], 9/2^+[615])$
$\pi1/2^-[521] \times \nu^2(13/2^-[716], 9/2^+[604])$
$\pi9/2^+[624] \times \nu^2(13/2^-[716], 9/2^+[604])$
$\pi9/2^+[624] \times \nu^2(13/2^-[716], 9/2^+[615])$



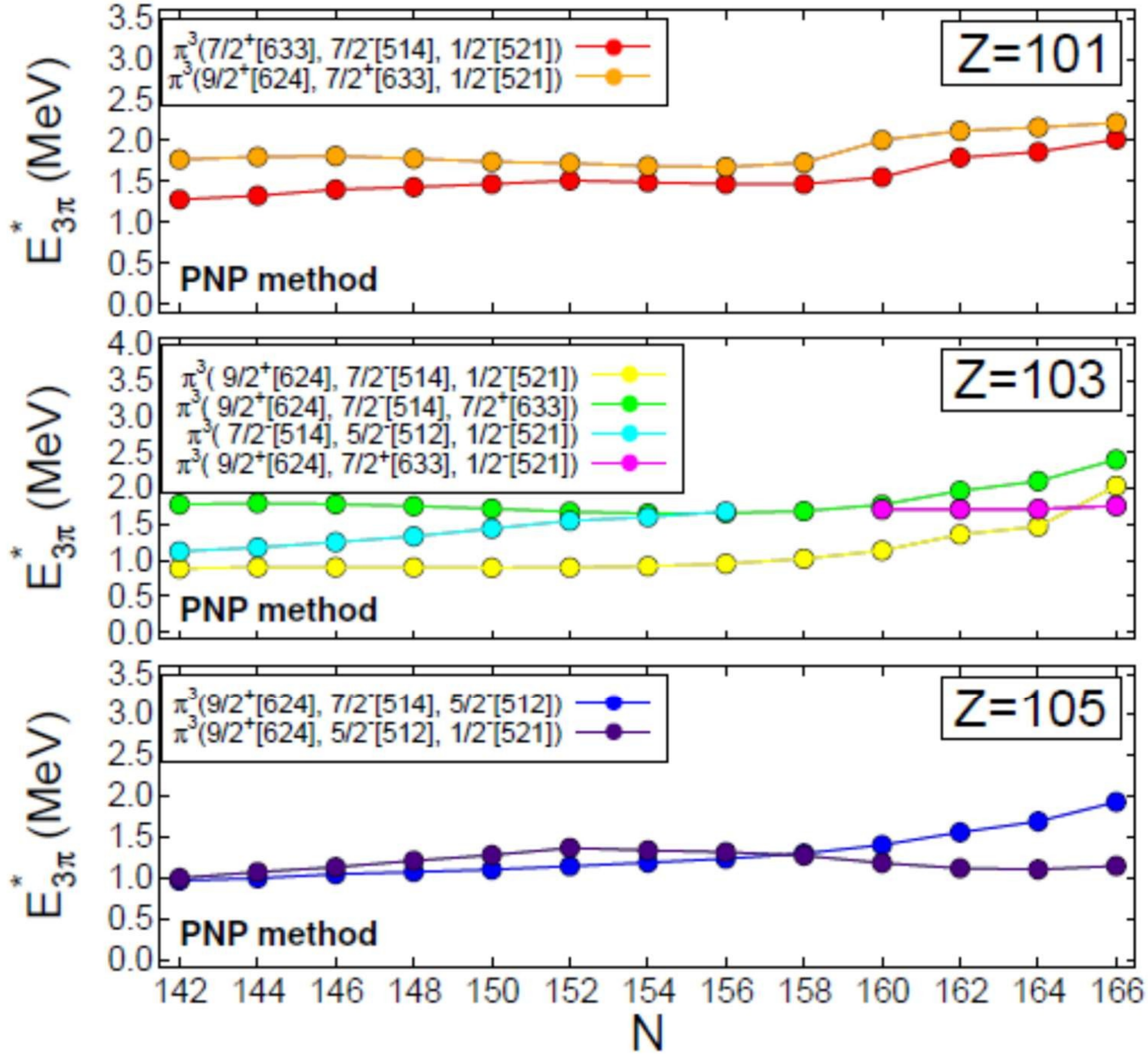
π7/2⁻[514] x ν²(7/2⁻[743],5/2⁻[752])
π7/2⁻[514] x ν²(7/2⁻[743],5/2⁺[622])
π7/2⁻[514] x ν²(7/2⁺[624],5/2⁺[622])
π7/2⁻[514] x ν²(9/2⁻[734],7/2⁺[624])
π7/2⁻[514] x ν²(11/2⁻[725],7/2⁺[613])
π9/2⁺[624] x ν²(9/2⁺[615],7/2⁺[613])
π1/2⁻[521] x ν²(13/2⁻[716],9/2⁺[615])
π9/2⁺[624] x ν²(13/2⁻[716],9/2⁺[604])
$E^*_{1\pi2\nu}$ (MeV)
PNP method
Z=103
N



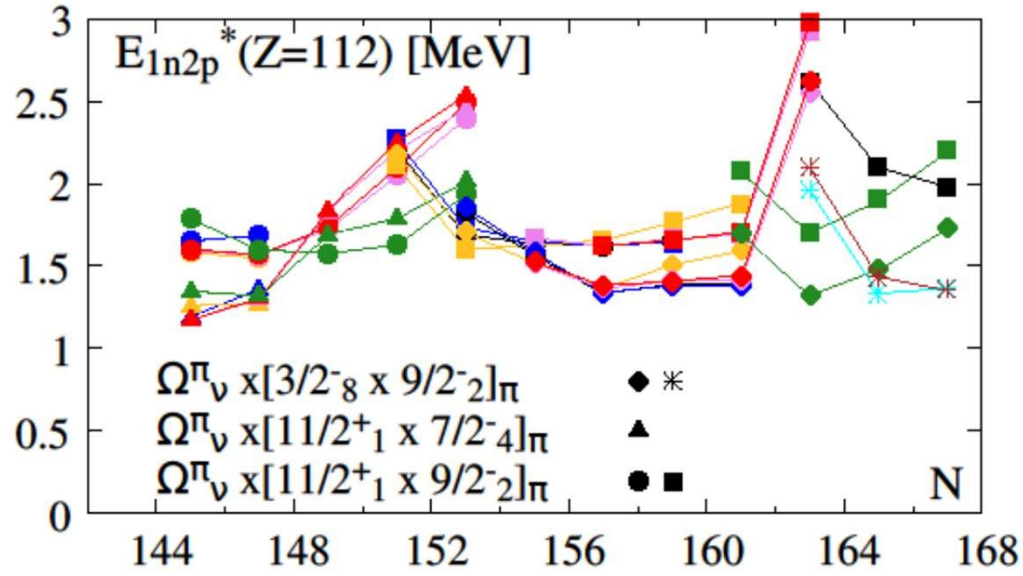
π5/2⁻[512] x ν²(7/2⁻[743],5/2⁺[622])
π5/2⁻[512] x ν²(7/2⁺[624],5/2⁺[622])
π5/2⁻[512] x ν²(9/2⁻[734],7/2⁺[624])
π5/2⁻[512] x ν²(11/2⁻[725],9/2⁻[734])
π5/2⁻[512] x ν²(11/2⁻[725],7/2⁺[613])
π5/2⁻[512] x ν²(9/2⁺[615],7/2⁺[613])
π5/2⁻[512] x ν²(13/2⁻[716],5/2⁺[613])
π5/2⁻[512] x ν²(13/2⁻[716],9/2⁺[604])
E*1π2ν (MeV)
PNP method
Z=107
N



π11/2+[615] x ν2(7/2-[743],5/2+[622])
π11/2+[615] x ν2(7/2+[624],5/2+[622])
π9/2-[505] x ν2(9/2-[734],7/2+[624])
π9/2-[505] x ν2(11/2-[725],7/2+[613])
π11/2+[615] x ν2(11/2-[725],7/2+[613])
π9/2-[505] x ν2(9/2+[615],7/2+[613])
π3/2-[512] x ν2(9/2+[615],7/2+[613])
π3/2-[512] x ν2(13/2-[716],5/2+[613])
E*1π2ν (MeV)
N
PNP method
Z=111



NARODOWE CENTRUM BADAŃ JĄDROWYCH ŚWIERK

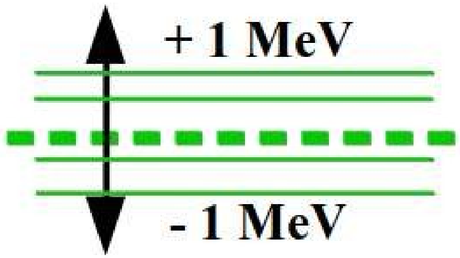


E1n2p*(Z=112) [MeV]
Ωπν x[3/2-8 x 9/2-2]π
Ωπν x[11/2+1 x 7/2-4]π
Ωπν x[11/2+1 x 9/2-2]π
N
0
0.5
1
1.5
2
2.5
3
144
148
152
156
160
164
168

ODD-A NUCLEI

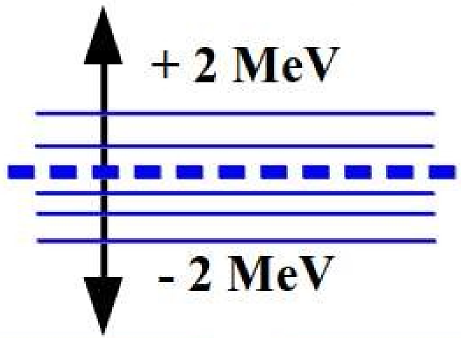
Search for candidates for long-lived 3-qp isomers in odd-A nuclei: Z=105–111, N=148–166

PROTONS:



Fermi level

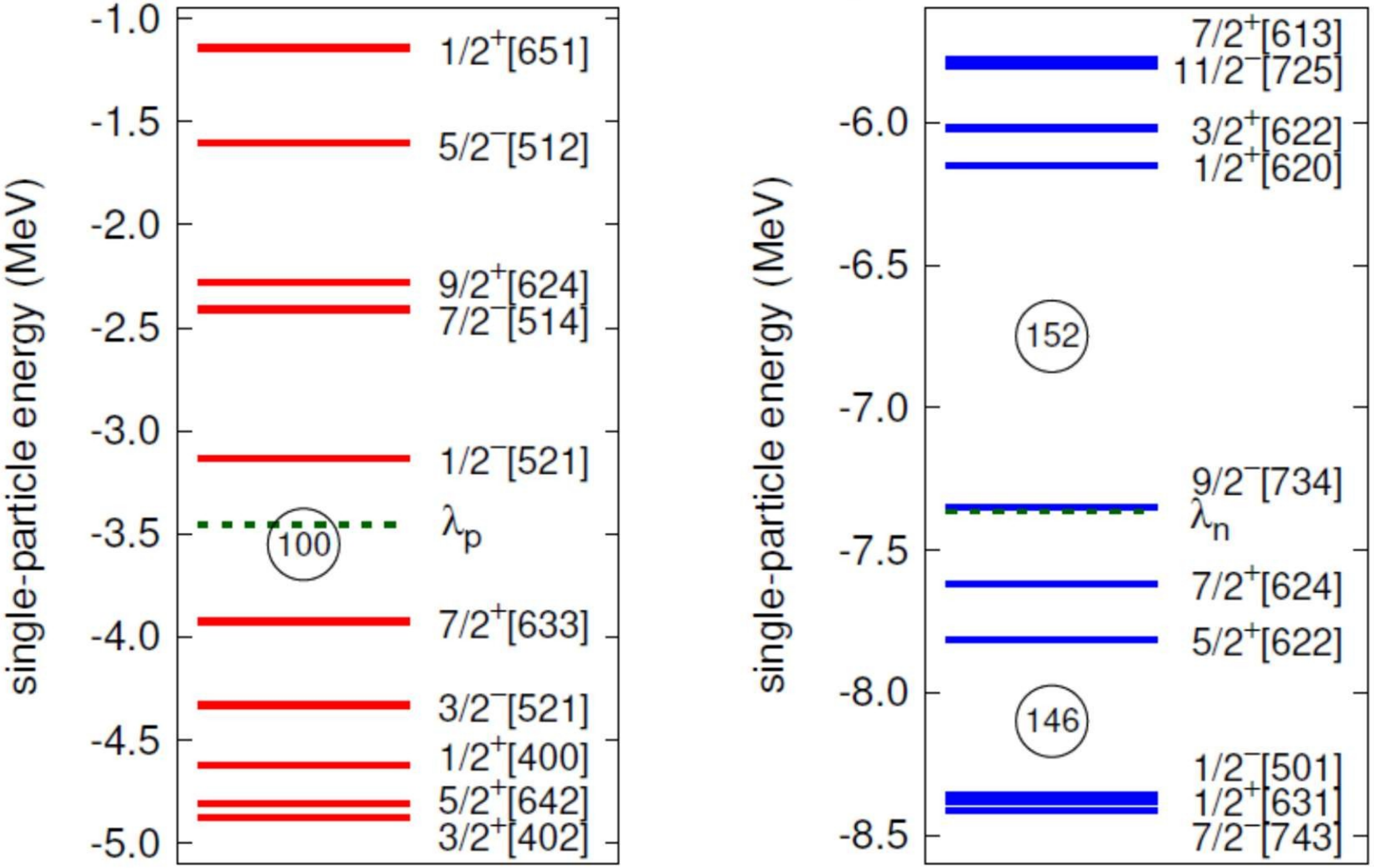
NEUTRONS:



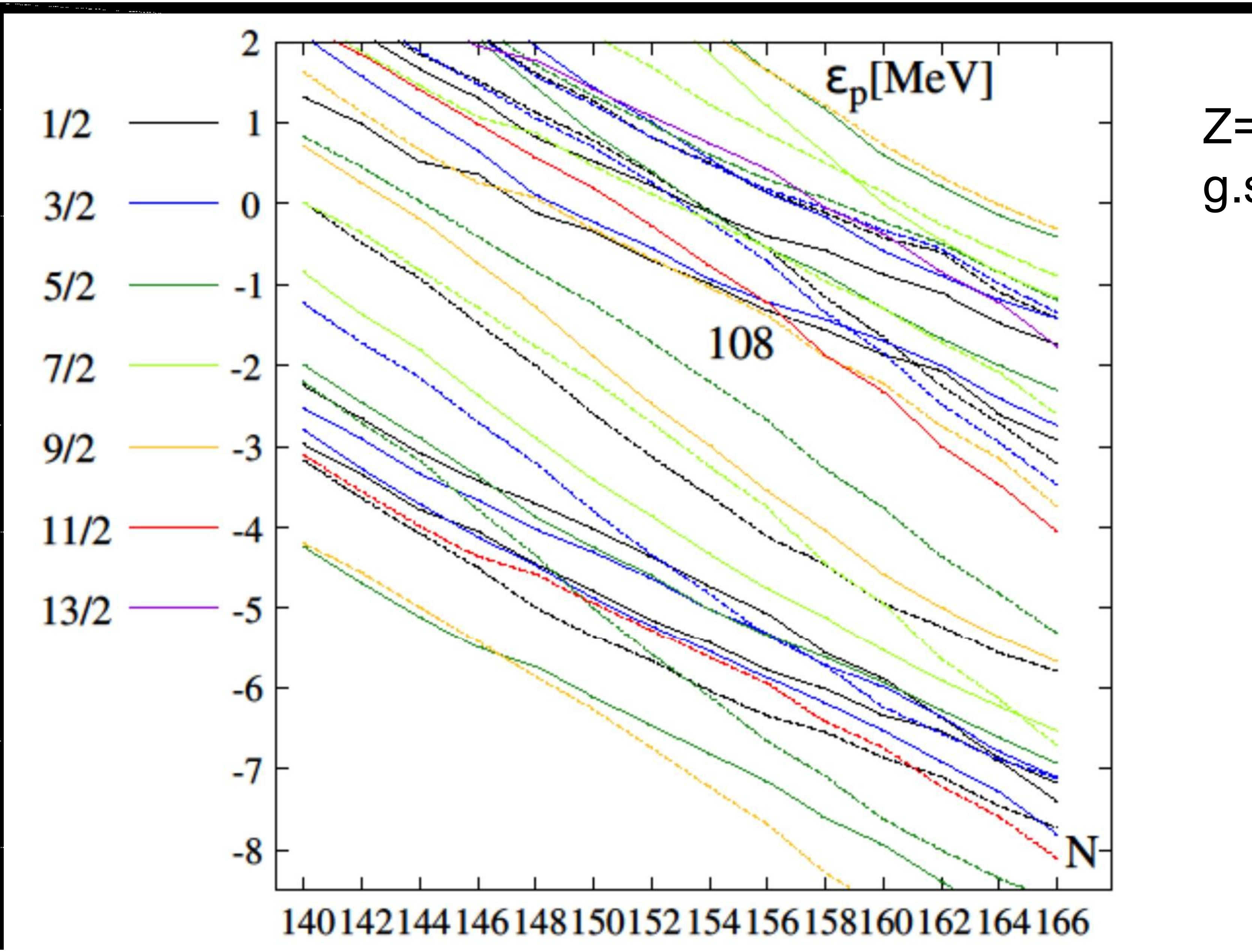
11 single-quasiproton states $\times$ 156 two-quasineutron configurations combined to $K \geq 6$

Considered 1716 configurations (3-qp) for each nucleus

^{251}Md

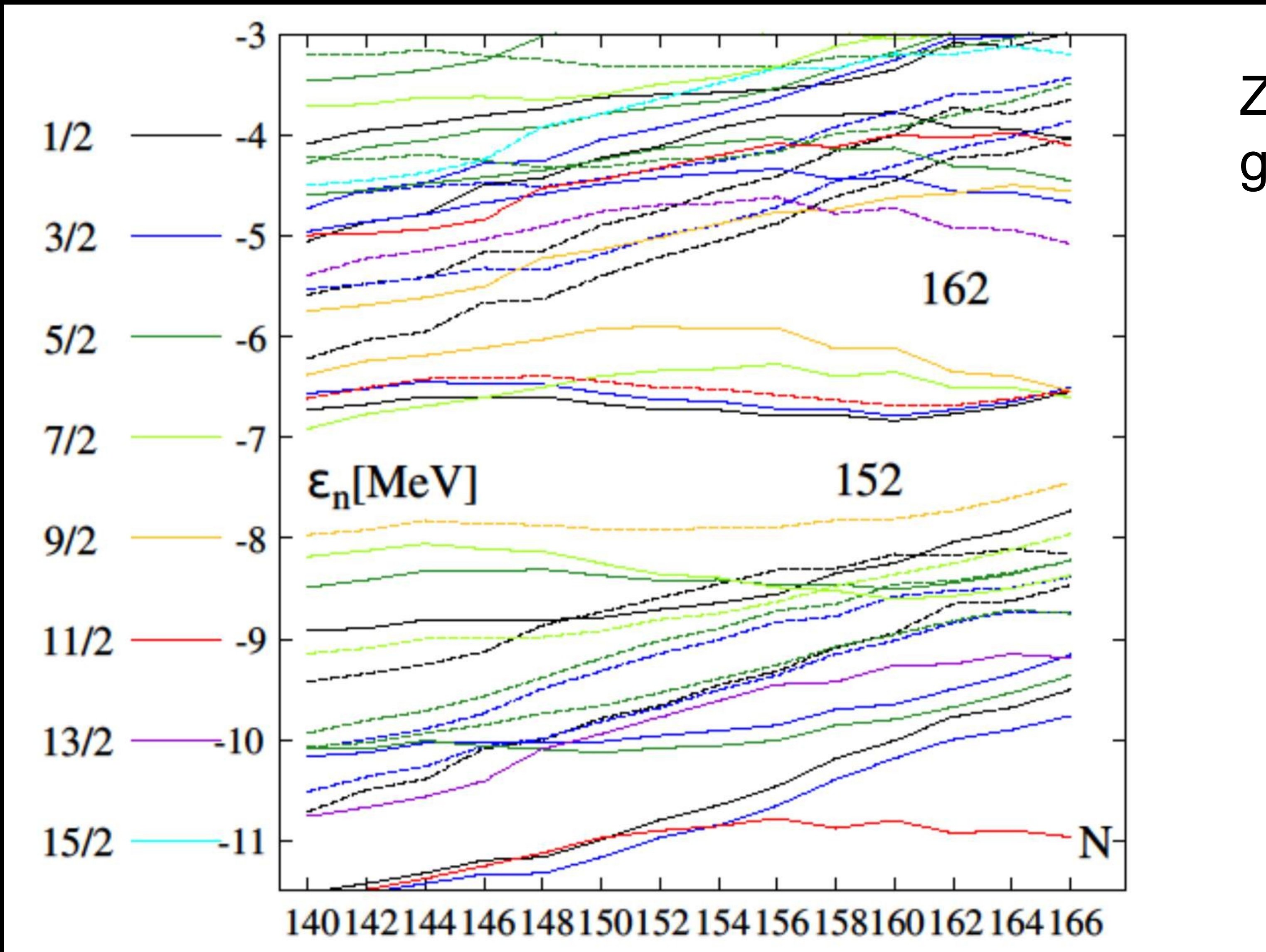


NARODOWE CENTRUM BADAŃ JĄDROWYCH ŚWIERK

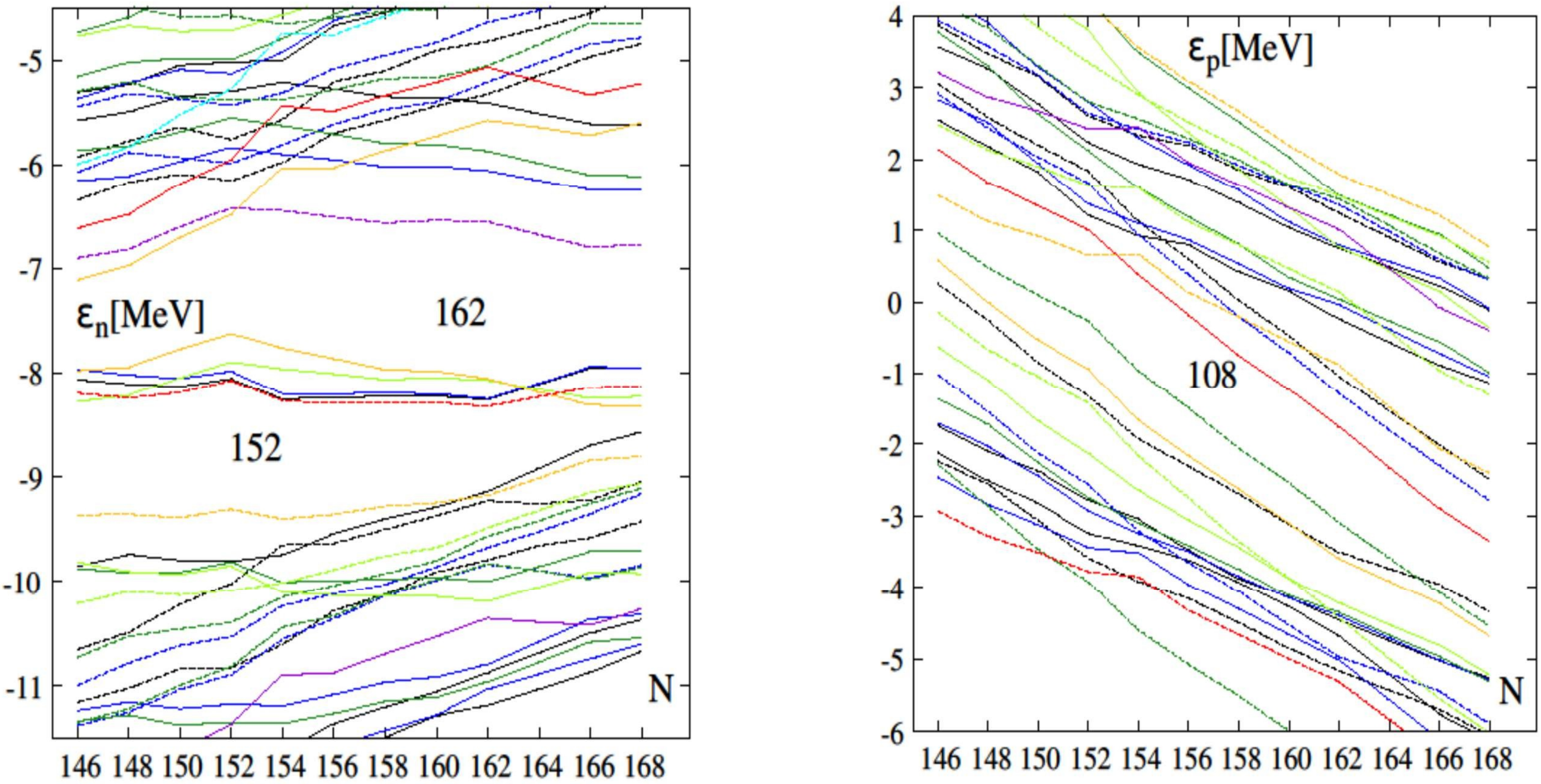


Z=[redacted]

g.s[redacted]


1/2
3/2
5/2
7/2
9/2
11/2
13/2
15/2
-3
-4
-5
-6
-7
-8
-9
-10
-11
ε_n[MeV]
162
152
N
140 142 144 146 148 150 152 154 156 158 160 162 164 166

Z
g

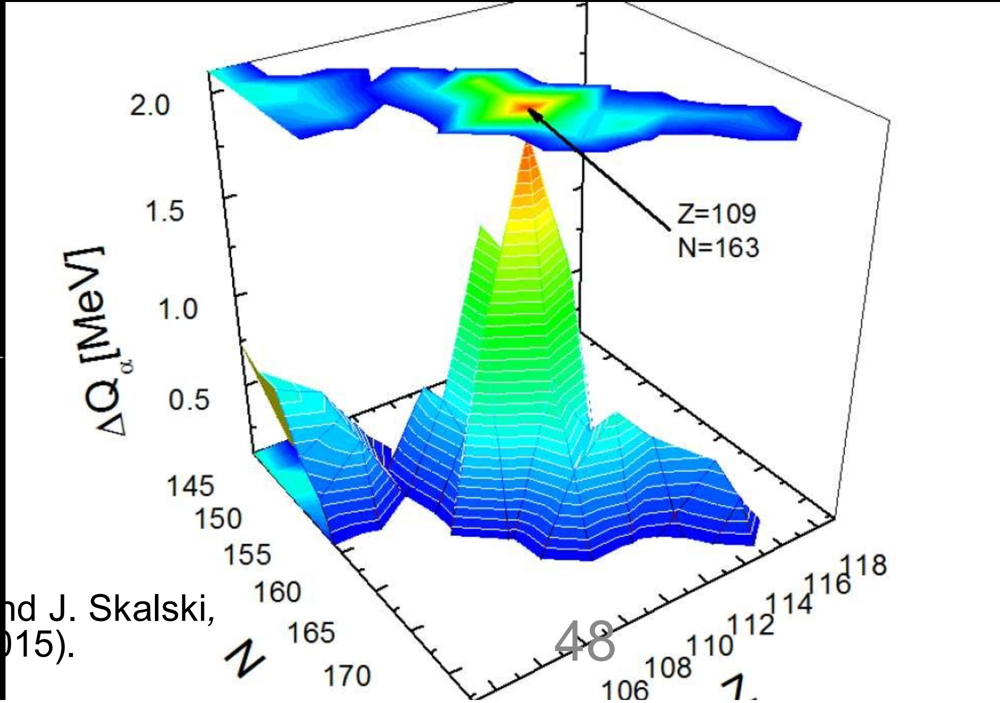


-5
-6
-7
-8
-9
-10
-11
ε_n[MeV]
162
152
N
146 148 150 152 154 156 158 160 162 164 166 168
4
3
2
1
0
-1
-2
-3
-4
-5
-6
ε_p[MeV]
108
N
146 148 150 152 154 156 158 160 162 164 166 168

Z	N	Ω^p	Ω^n	K^π	ΔQ_α
111	169	$9/2^-$	$5/2^+$	7^-	0.74
111	163	$3/2^-$	$13/2^-$	8^+	1.31
111	161	$3/2^-$	$7/2^+$	$7/2^-$	0.52
110	163		$13/2^-$	$13/2^-$	0.97
109	169	$11/2^+$	$9/2^+$	10^+	0.51
109	167	$11/2^+$	$5/2^+$	8^+	0.71
109	166	$11/2^+$		$11/2^+$	0.88
109	165	$11/2^+$	$3/2^+$	7^+	1.38
109	164	$11/2^+$		$11/2^+$	1.13
109	163	$11/2^+$	$13/2^-$	12^-	1.99
109	162	$11/2^+$		$11/2^+$	1.27
109	161	$11/2^+$	$9/2^+$	10^+	1.32
109	160	$11/2^+$		$11/2^+$	1.37
109	159	$11/2^+$	$9/2^+$	10^+	1.56
109	158	$11/2^+$		$11/2^+$	1.39
109	157	$11/2^+$	$3/2^+$	7^+	1.41
108	163		$13/2^-$	$13/2^-$	1.00
107	163	$5/2^-$	$13/2^-$	9^+	1.17
107	157	$5/2^-$	$11/2^-$	8^+	0.57
106	163		$13/2^-$	$13/2^-$	0.96
105	153	$9/2^+$	$1/2^+$	5^+	0.97
103	157	$7/2^-$	$11/2^-$	9^+	0.52
103	154	$7/2^-$		$7/2^-$	0.54
103	153	$7/2^-$	$1/2^+$	4^-	1.45
103	151	$7/2^-$	$9/2^-$	8^+	0.58

High-K states: a chance for longer half-lives.

Candidates for high-K ground states.
in odd or odd-odd SHN in the W-S model.



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[redacted] 015).