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Nucleon pairing in *N*=126 isotones

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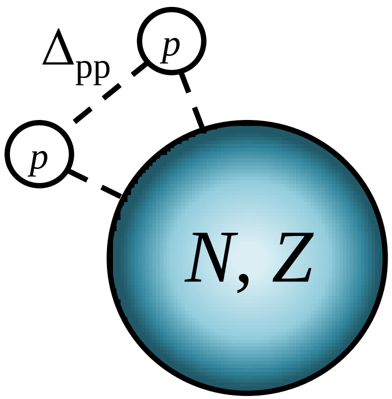
Structure of this work

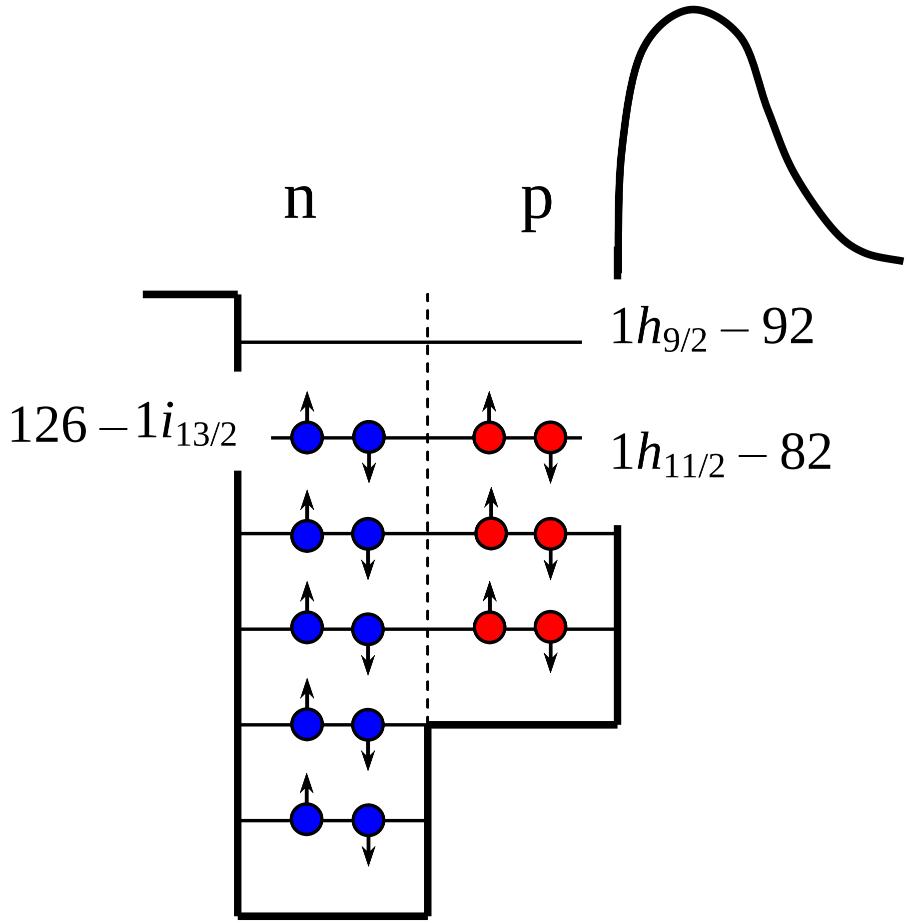
- Introduction
- Basic definitions and formalism
- Results of calculations for isotones $N = 126$
- Formation of a multiplet on excited state
- Conclusions

Shell model

- Non-interacting particles
- Residual interaction
- Magic core

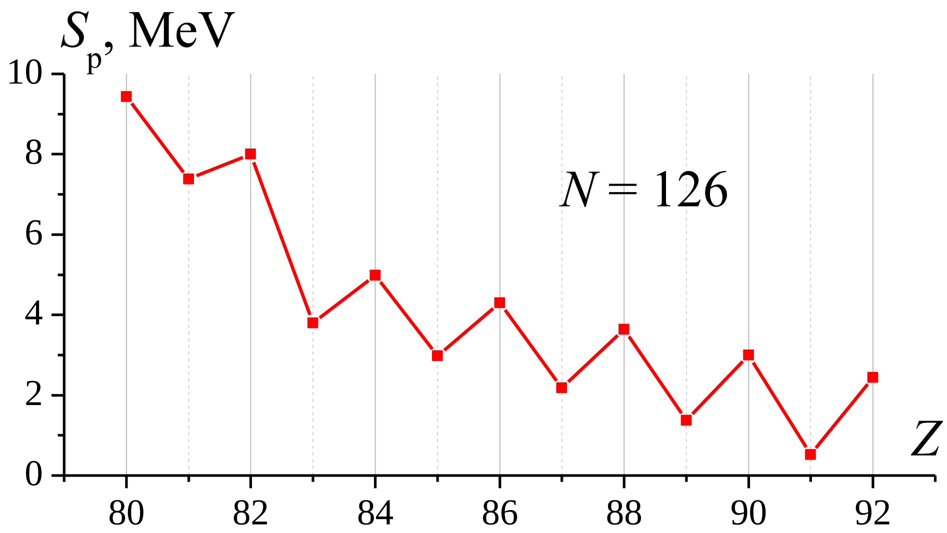


(*N*, *Z*) = (126, 82)



Heavy nuclei

Pairing effect



Proton separation energy on the proton number $S_p(Z)$ in isotones N = 126

$$S_p(N, Z) = M(N, Z-1) + m_p - M(N, Z) = \\ = E_{bind}(N, Z) - E_{bind}(N, Z-1)$$

$$\Delta_{pp}(N,Z) = S_{pp}(N,Z) - 2 \cdot S_p(N,Z-1) = \\ = E_{bind}(N,Z) - 2 \cdot E_{bind}(N,Z-1) + E_{bind}(N, Z-2) = \\ = S_p(N,Z) - S_p(N, Z-1).$$

$$\Delta_{pp}(N,Z) = S_p(N,Z) - ½[S_p(N, Z-1) + S_p(N, Z+1)].$$

Residual interaction

- Ground State Multiplet (GSM)

$$J = 0,\ 2,\ 4, \ldots J_{\max},$$

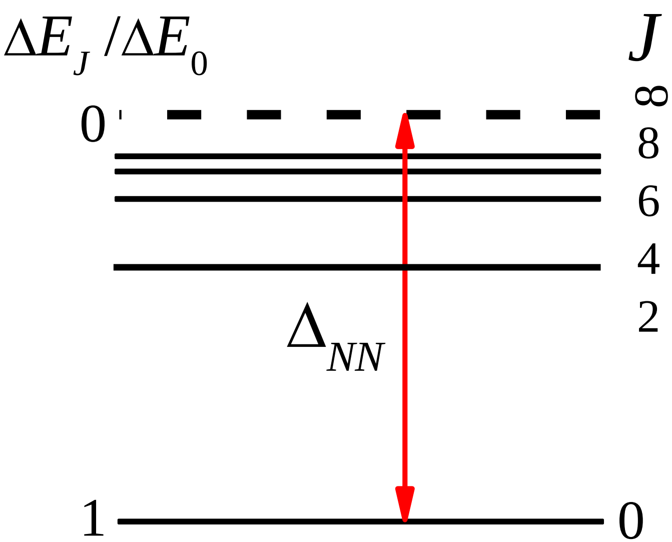
$$\mathbf{J_{max} = 2j - 1.}$$

- Delta-interaction

$$V(\vec{r}_1, \vec{r}_2) = -V_0 \delta(\vec{r}_1 - \vec{r}_2)$$

$$\frac{\Delta E_J}{\Delta E_0} = \begin{pmatrix} j & j & J \\ \frac{1}{2} & -\frac{1}{2} & 0 \end{pmatrix}^2 (2j+1)$$

$T = 1$, $S = 0$, even J [1].



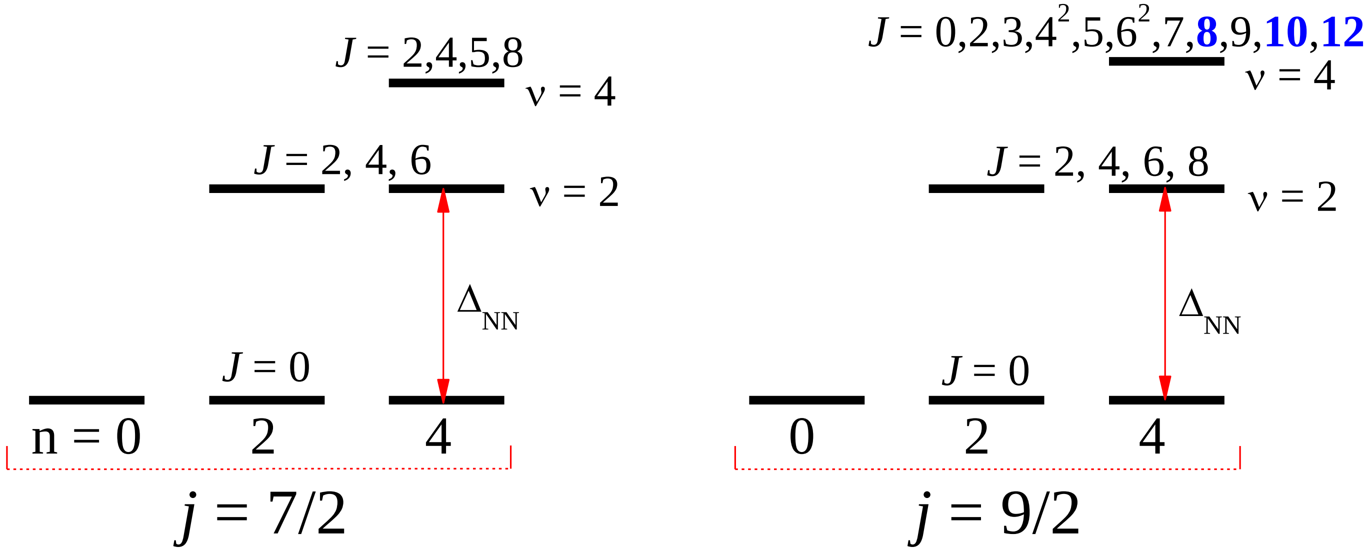
$$E(J) = \Delta_{NN}\left(1 - \frac{\Delta E_J}{\Delta E_0}\right)$$

[1] I. Talmi, Simple Models of Complex Nuclei, Harwood Ac. Publ., Chur, 1993.

Seniority scheme

ν – number of unpaired nucleons

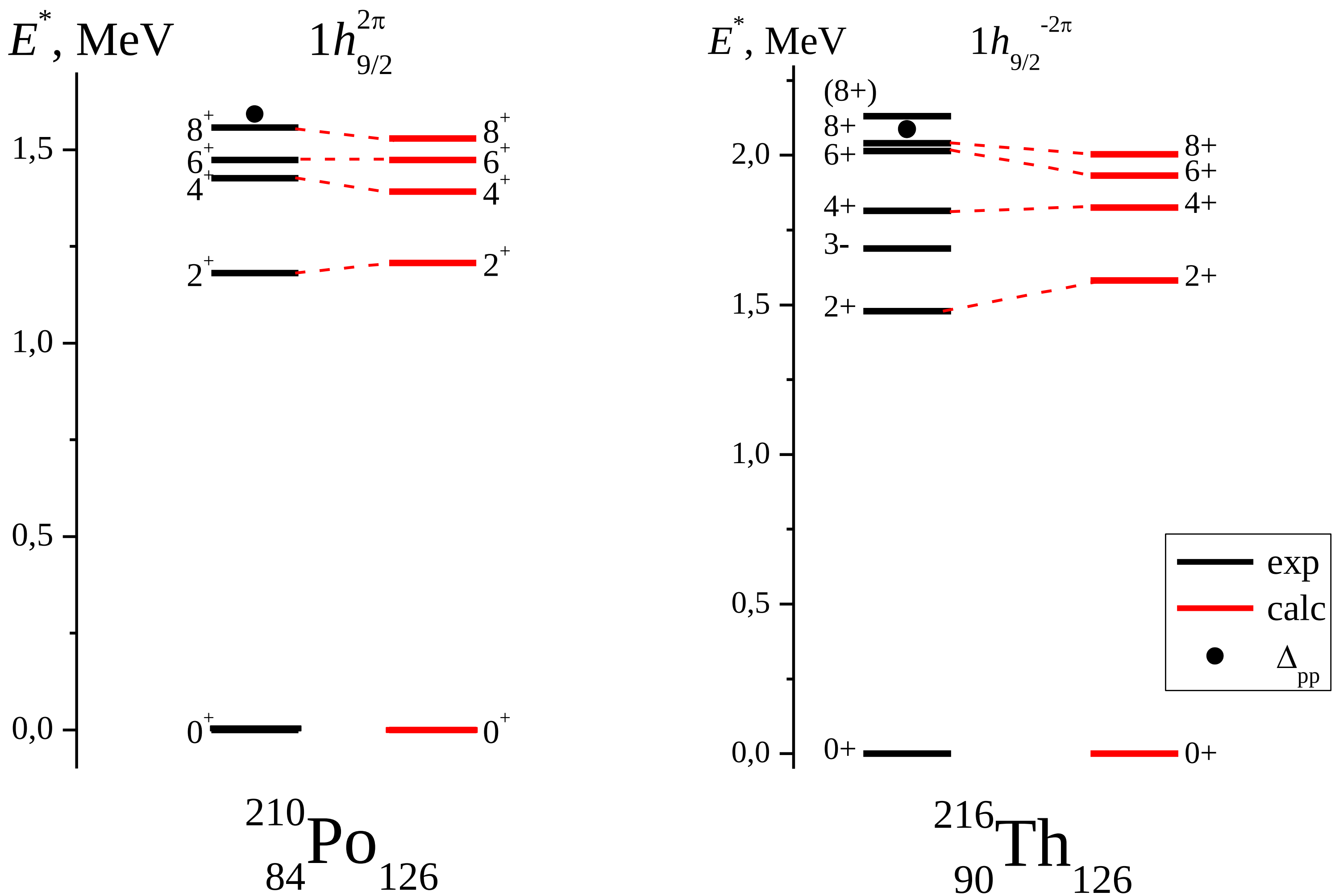
n – number of identical nucleons in *j* subshell



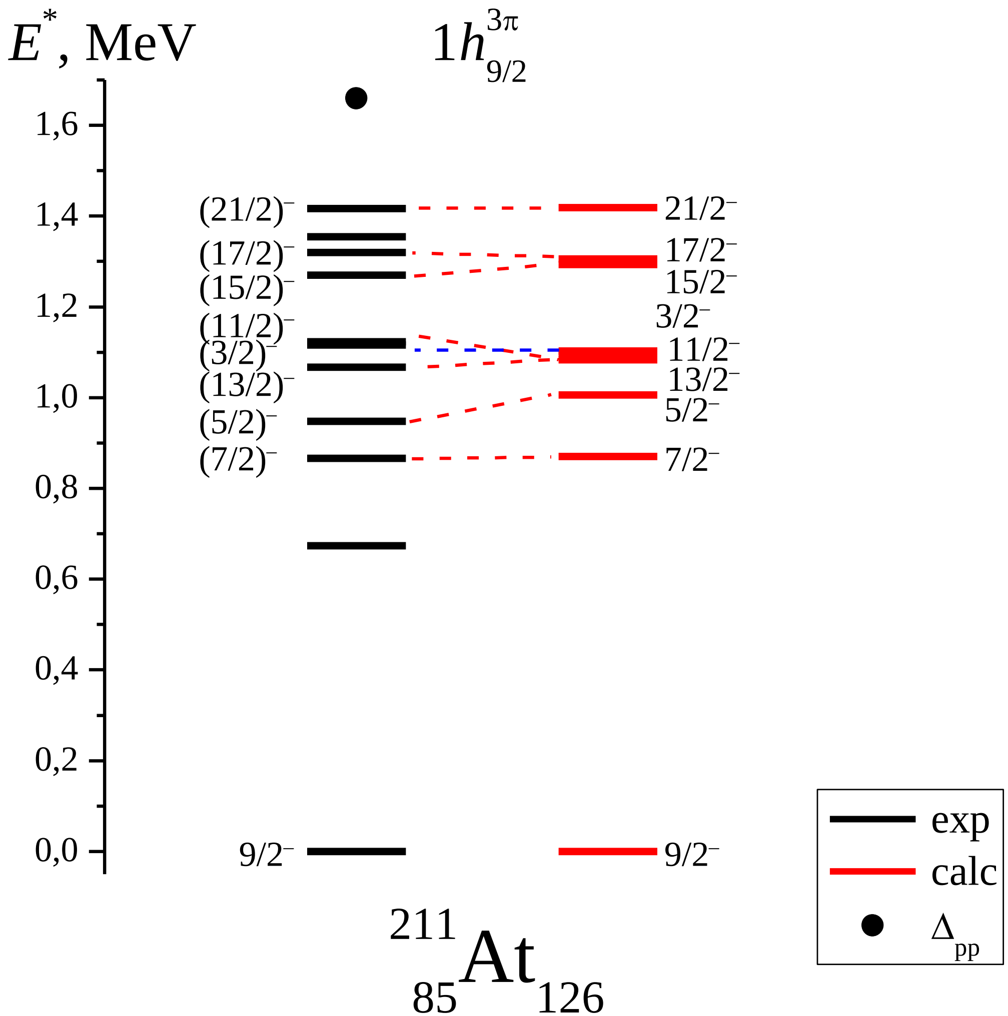
$$J_{max} = \nu(2j - \nu + 1)/2$$

$$n = 2 \rightarrow n = 3 \rightarrow n = 4 \rightarrow \dots$$

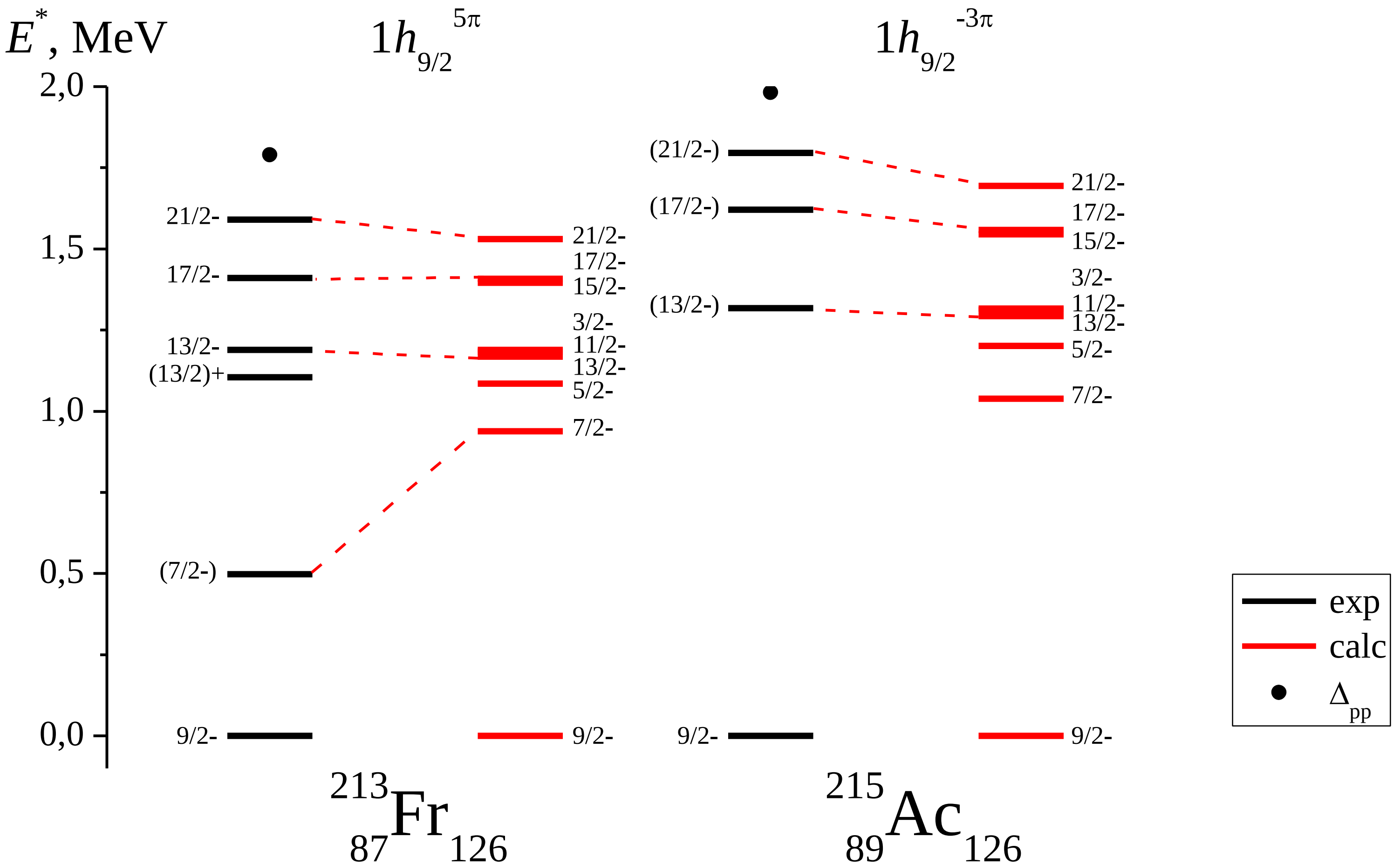
Results. Seniority = 2



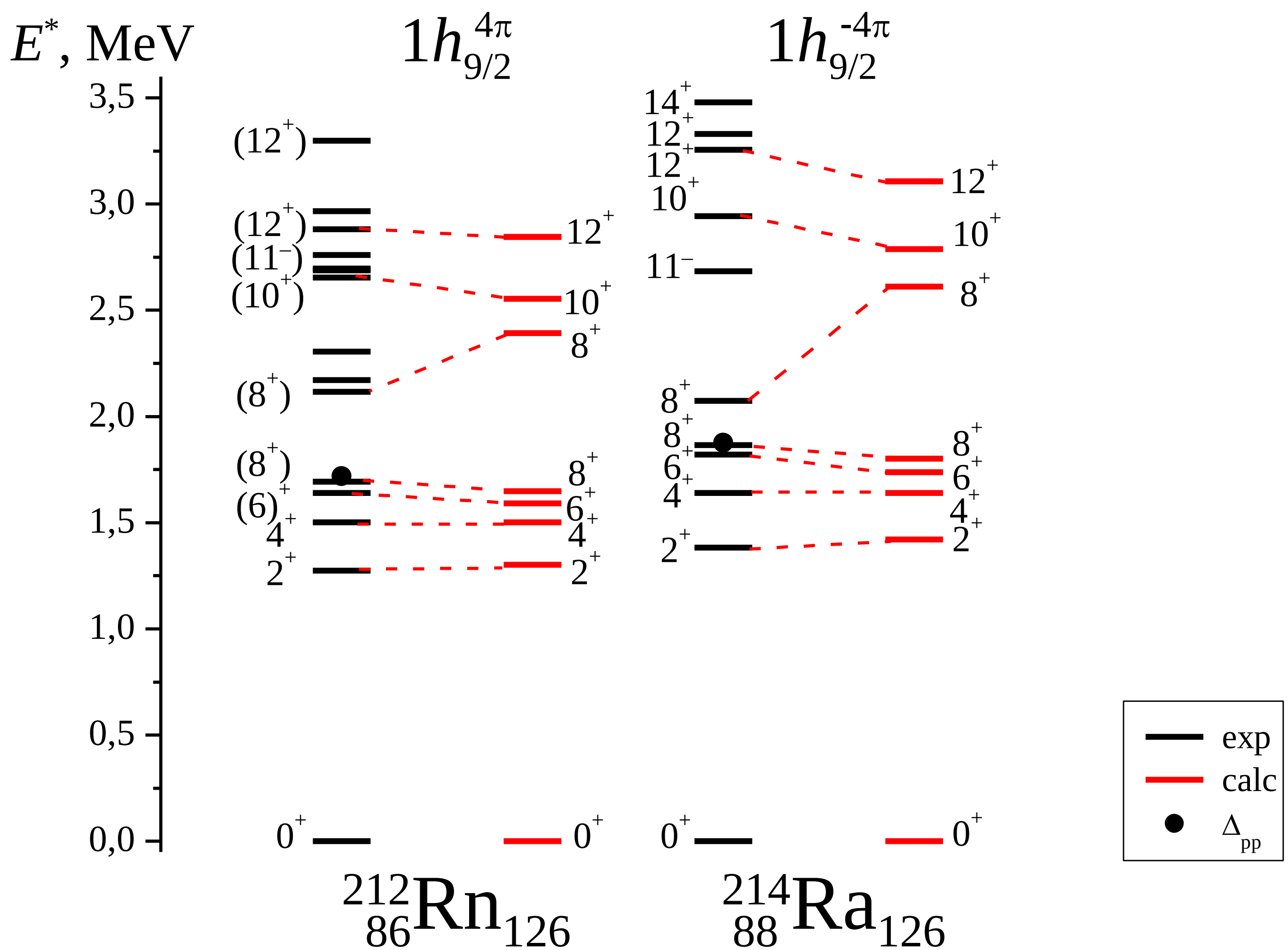
Results. Seniority = 3



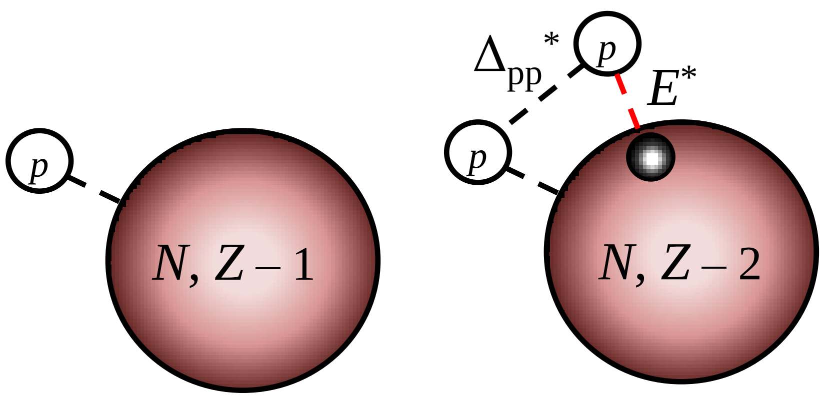
Results. Seniority = 3



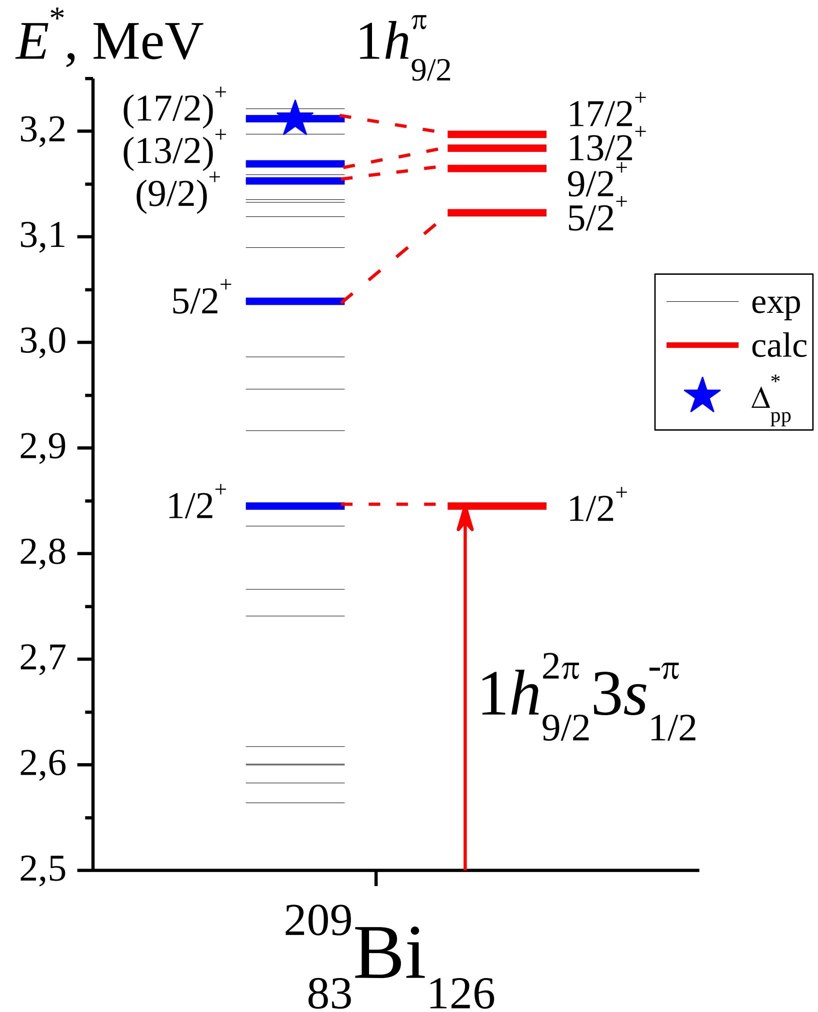
Results. Seniority = 4



Multiplet on excited state



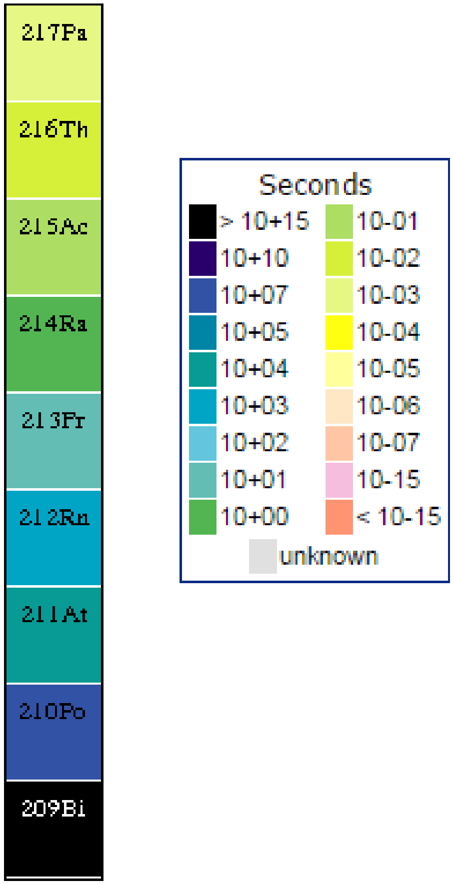
$$\Delta_{pp}^{*}(N,Z) = \Delta_{pp}(N,Z) - $$
$$- (2E^{*}(N,Z-1) - E^{*}(N,Z))$$



Conclusions

The systematics of the GSM for $N = 126$ isotones is considered in this work .

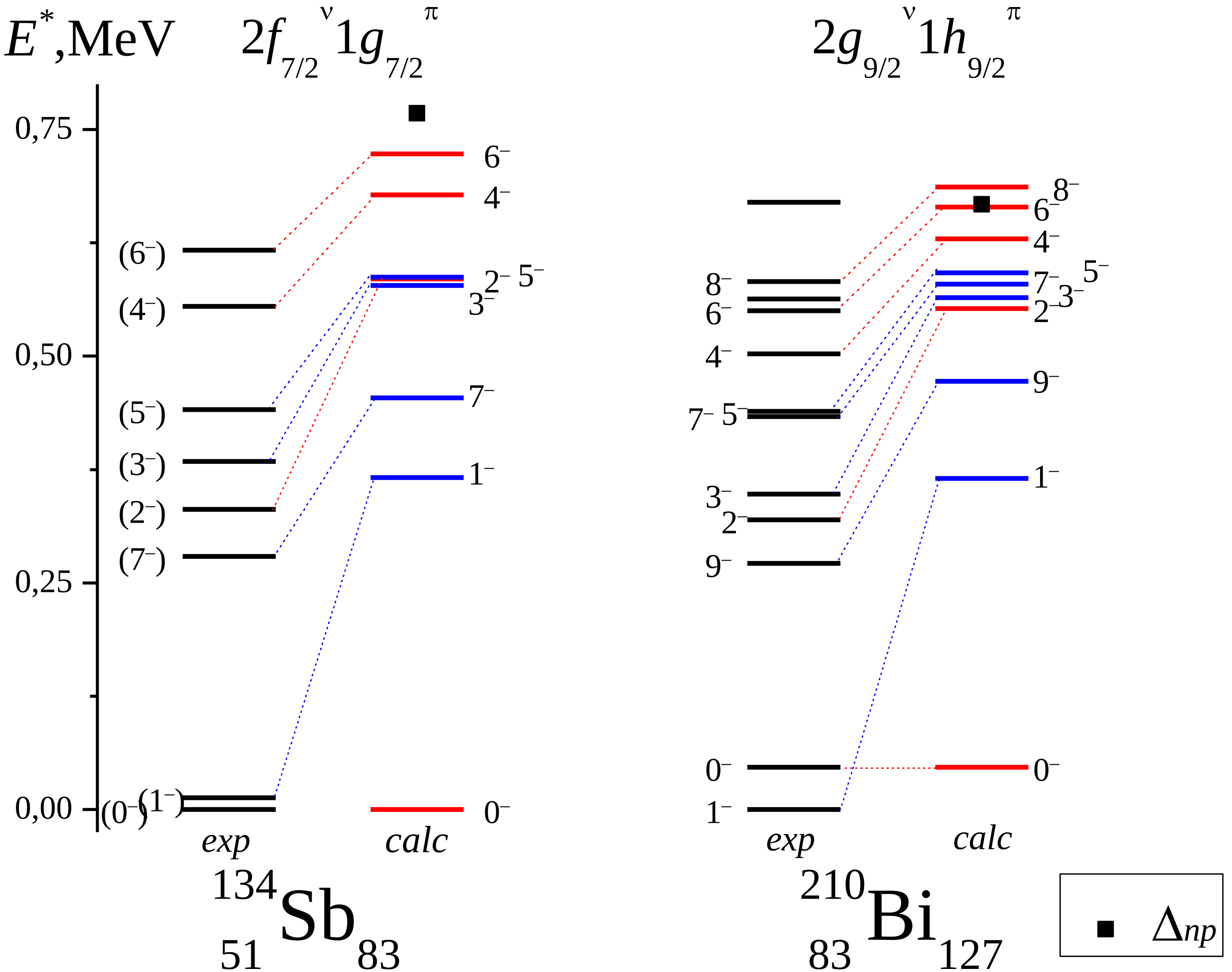
1. Multiplets with value of a seniority $\nu = 2, 3, 4$ have been clearly marked in the considered nuclei. There are multiplets on the excited states here too. Therefore, the excited states in even-even and even-odd nuclei can be interpreted using this model.
2. Values of multiplet splitting correspond to pairing energy, which can be defined from the mass of nuclei.
3. Comparison of the pairing energy Δ_{NN} and the excitation energy for maximum angular momentum $E^{*}(J_{max})$ gives information about the level excitement mechanism.



Thanks for your attention

Backup slides

$l_1 \neq l_2$


E*,MeV
2f7/2 ν 1g7/2 π
2g9/2 ν 1h9/2 π
0,75
0,50
0,25
0,00
(6⁻)
(4⁻)
(5⁻)
(3⁻)
(2⁻)
(7⁻)
(1⁻)
(0⁻)
6⁻
4⁻
2⁻ 5⁻
3⁻
7⁻
1⁻
0⁻
8⁻
6⁻
4⁻
7⁻ 5⁻
3⁻
2⁻
9⁻
0⁻
1⁻
8⁻
6⁻
4⁻
7⁻
5⁻
3⁻
2⁻
9⁻
1⁻
0⁻
exp
calc
exp
calc
134 Sb 51 83
210 Bi 83 127
Δnp