Proton-neutron interactions in heavy nuclei

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- P. Georgoudis: SUSYQM in Davidson, Kratzer
- S. Karampagia: SU(3) QDS for arc
  p-n interactions
- V. Blatzios: Quantum superintegrable systems
- A. Martinou: Parafermions in Bose Einstein Condensates
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Collaborators

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δVpn

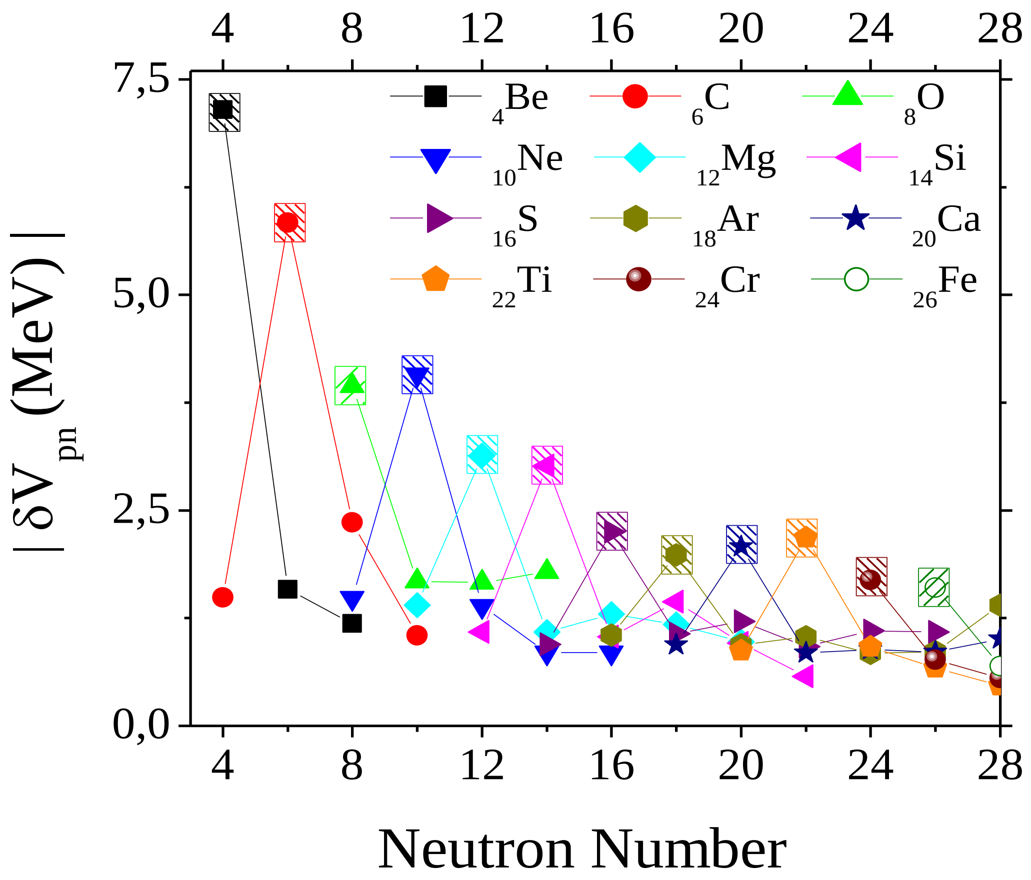
δVpn(Z,N)=

[B(Z,N)+B(Z-2,N-2)-B(Z,N-2)-B(Z-2,N)]/4

Average interaction between
last two protons
with last two neutrons

s

Spikes in δVpn in light N = Z nuclei



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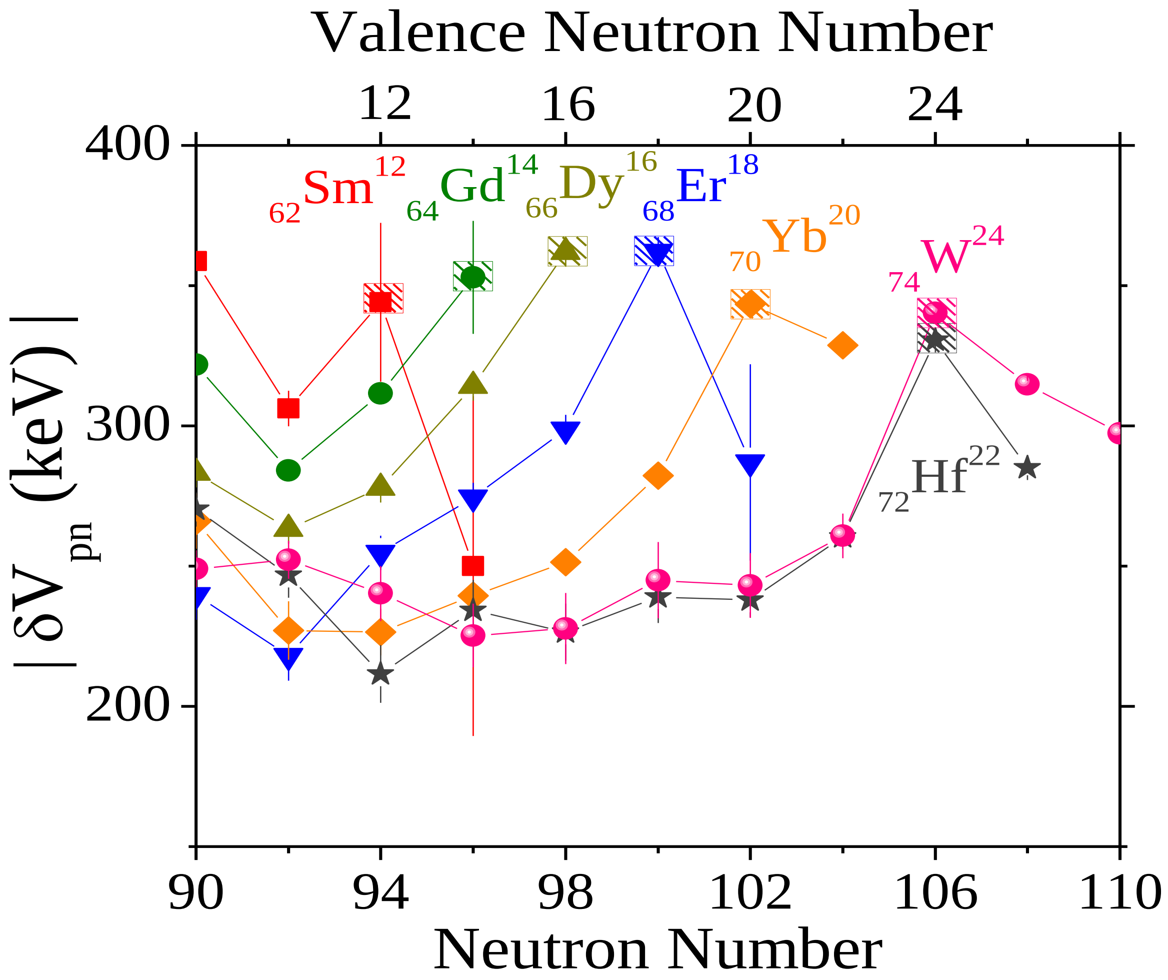
Heavy nuclei: spikes at Nval=Zval



Explain δV_{pn} maxima

- Light nuclei: SU(4) Wigner supermultiplet
- Heavy nuclei: strong spin-orbit interaction
- Pseudo SU(3) scheme
- New coupling scheme

Nilsson model

$$H = \frac{p^2}{2m} + \frac{1}{2} m\left[\omega_x\left(x^2 + y^2\right) + \omega_z z^2\right] + C\mathbf{l}\cdot\mathbf{s} + D\mathbf{l}^2$$

typical Nilsson orbit: $K[N\ n_z\ \Lambda]$

K projection of total angular momentum on the z-axis
N principal quantum number of the major shell
n_z number of nodes of the wavefunction in the z-direction
Λ projection of orbital angular momentum on the z-axis

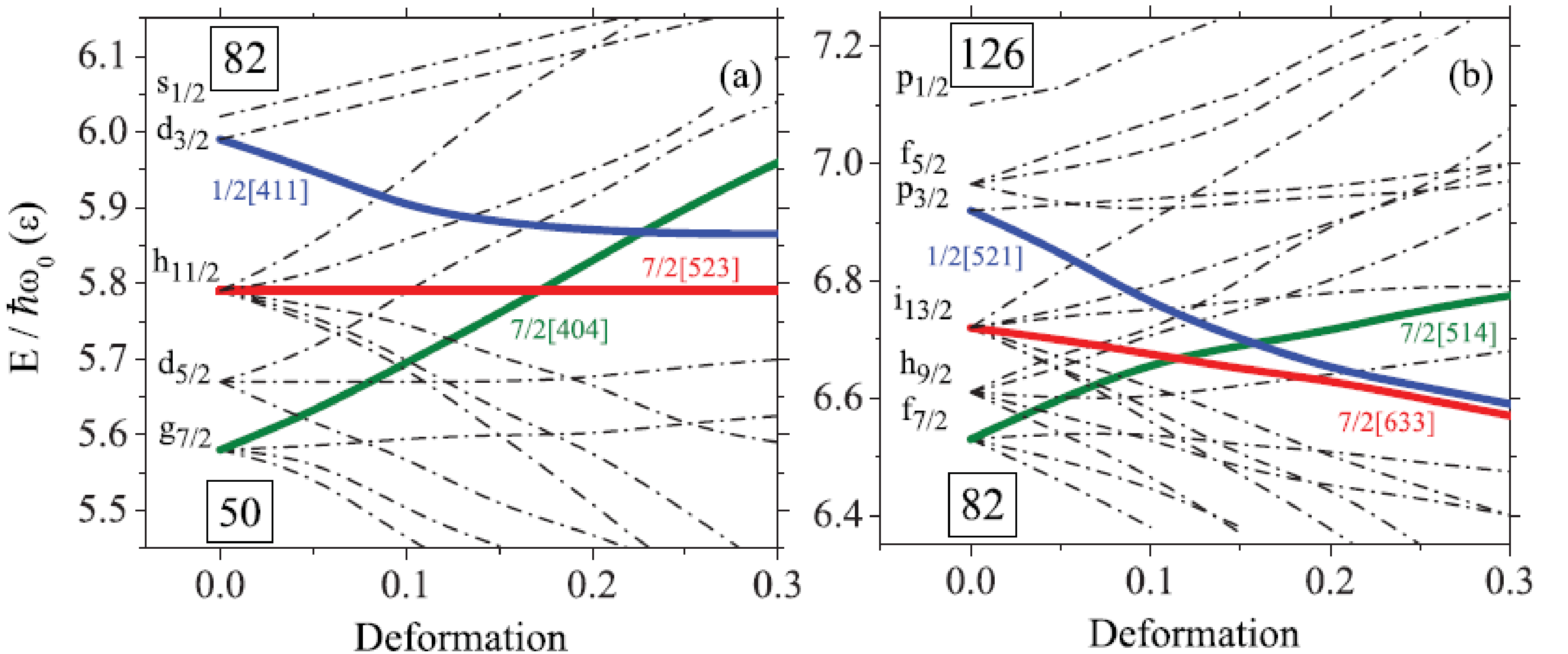
$K=\Lambda\pm1/2$

$N= n_x + n_y + n_z$

0[110] pairs

- **168 Er: p 7/2 [523]; n 7/2 [633]**
- **172 Yb: p 1/2 [411]; n 1/2 [521]**
- **178 Hf: p 7/2 [404]; n 7/2 [514]**
- **180 W: p 7/2 [404]; n 7/2 [514]**

$\Delta K[\Delta N\ \Delta n_z\ \Delta\Lambda]=0[110]$



$\Delta K[\Delta N\ \Delta n_z\ \Delta\Lambda]=0[110]$

Since $\Delta K[\ \Delta N\ \Delta n_z\ \Delta\Lambda]=0[110]$,

N and n_z differ by one.

Since $N= n_x + n_y + n_z$, $n_x + n_y$ is concerved.

Sister orbits differ only by a single quantum in the z direction.

Expect large spatial overlaps for sister orbits and large p-n interactions.

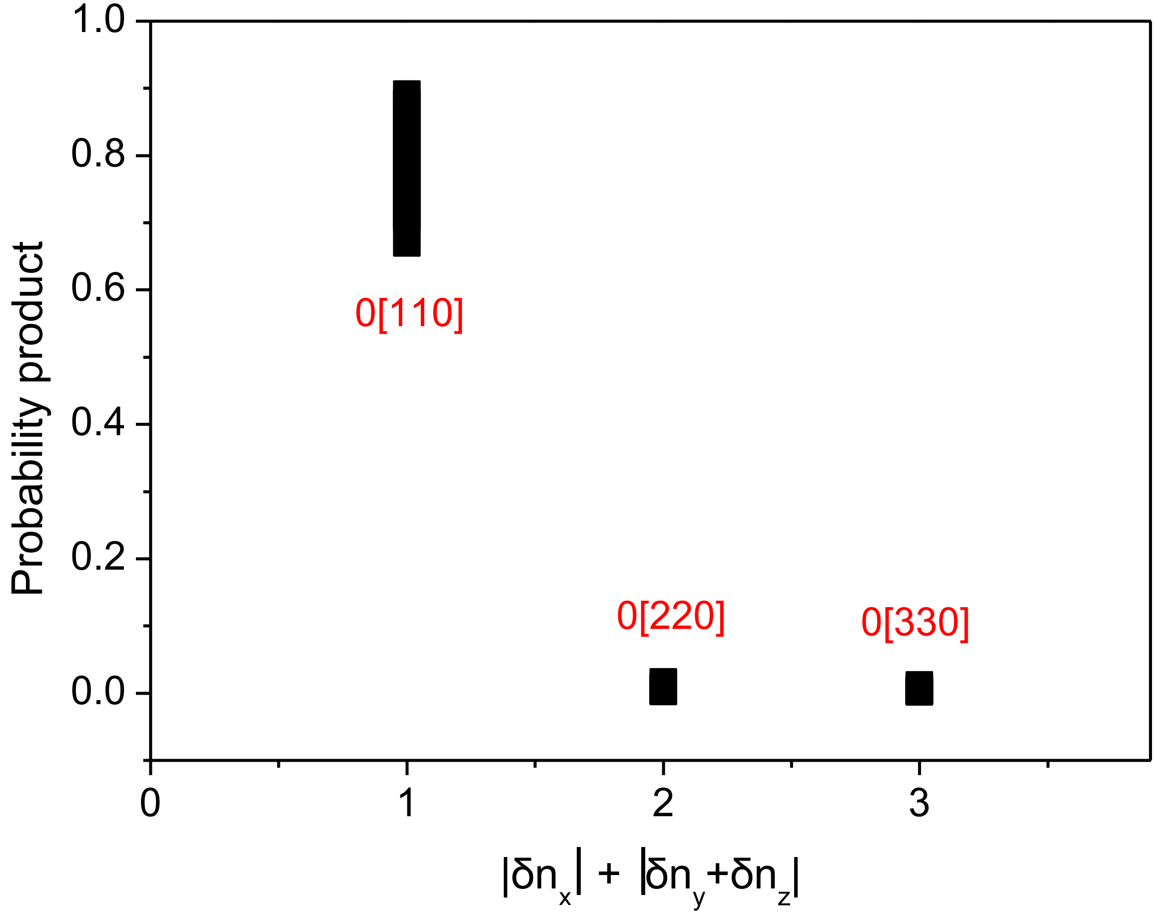
Measure of overlaps

Create probability overlaps of Nilsson wavefunctions

$$\int \sqrt{\Psi_1^* \Psi_1} \cdot \sqrt{\Psi_2^* \Psi_2} \, dV$$

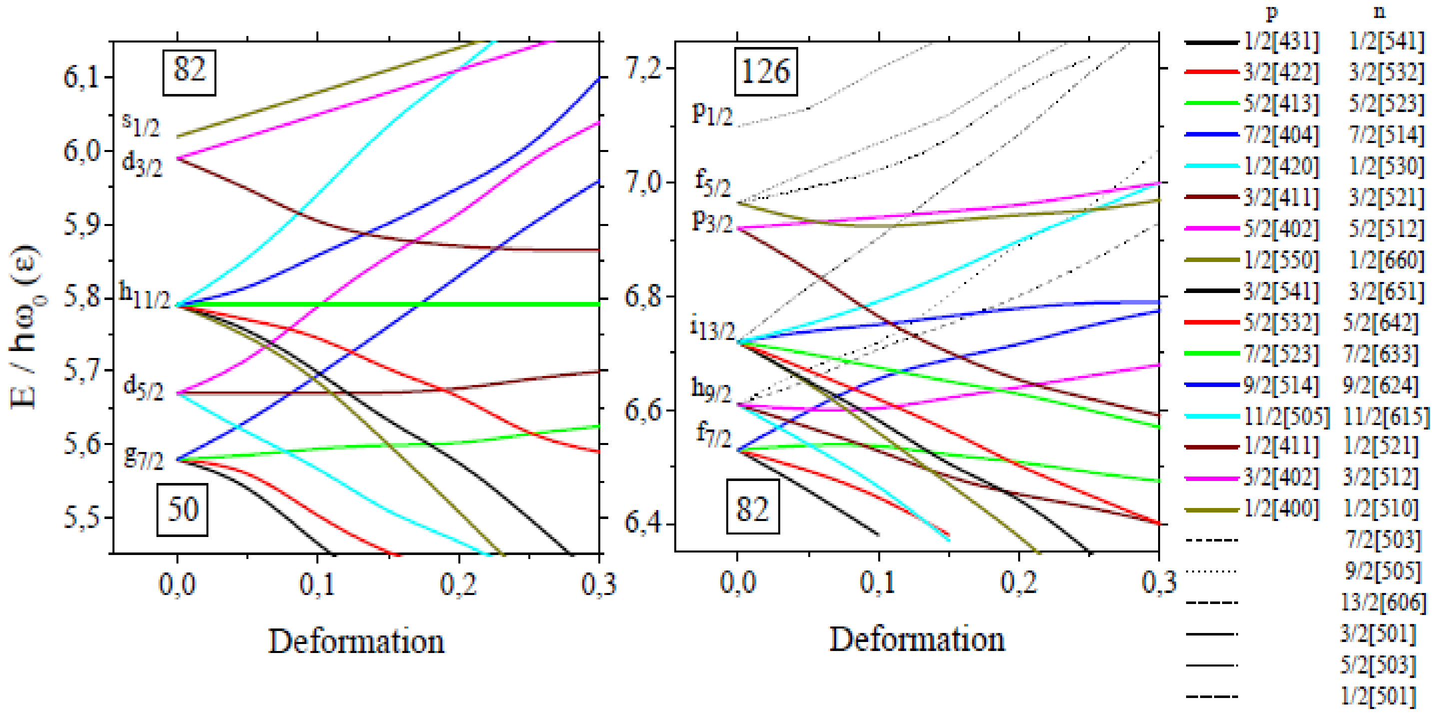
- If $\Psi_1 = \Psi_2$, the integral is 1.
- If $\Psi_1 \neq \Psi_2$, the integral takes larger values when the two wave functions are similar.

Probability overlaps for Nilsson wave functions differing by $\Delta K[\Delta N\ \Delta n_z\ \Delta\Lambda]$=0[110], 0[220], 0[330]

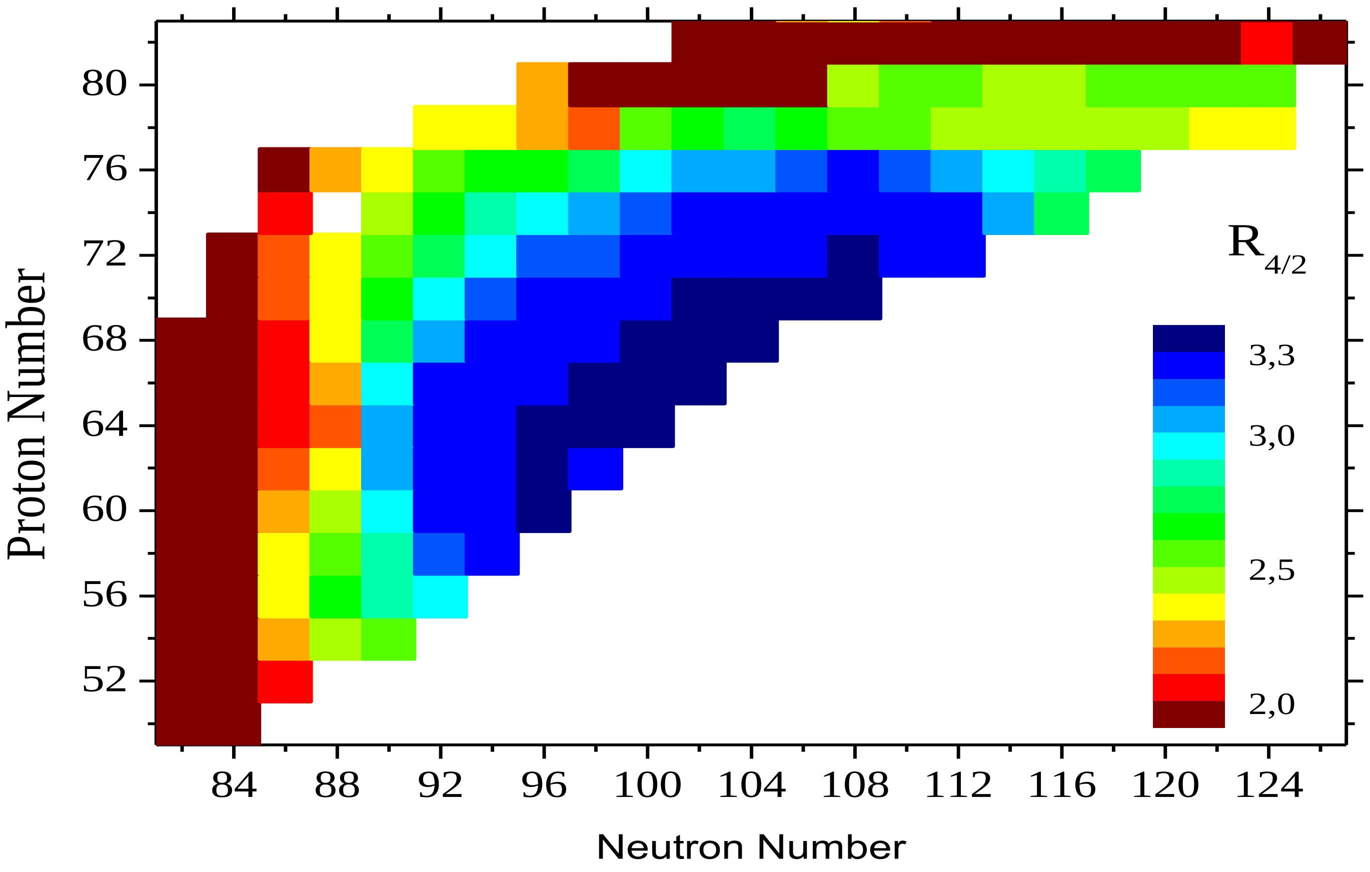


The highest overlaps occur for the case of 0[110] Nilsson orbit pairs

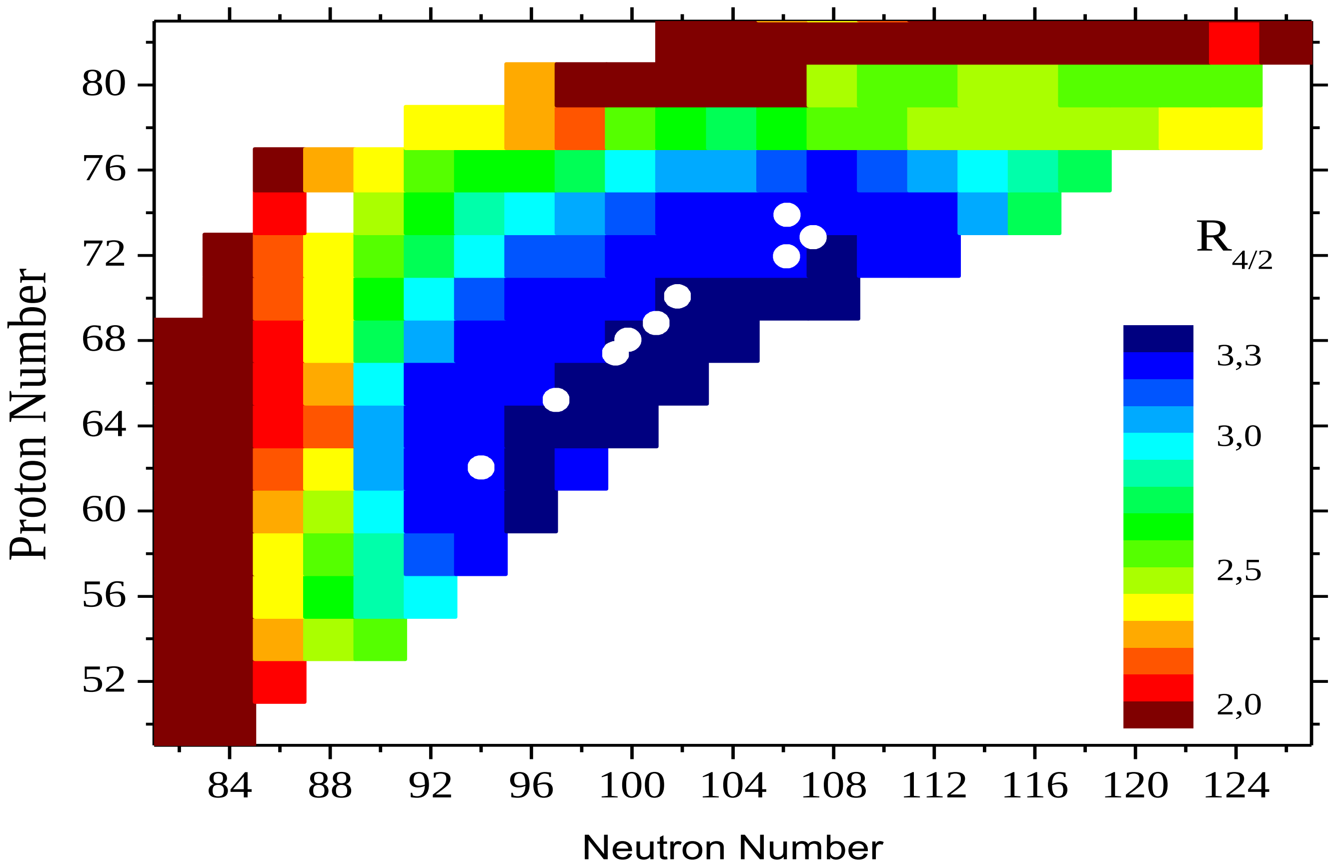
0[110] orbits filled in synch



Locus of collectivity



Collectivity and maxima in δVpn



Maxima in δVpn and Nval=Zval