

# Determination of electromagnetic moments within nuclear DFT

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Advances in Radioactive Isotope Science (ARIS)  
4-9 Jun 2023, Palais des Papes - Avignon - France



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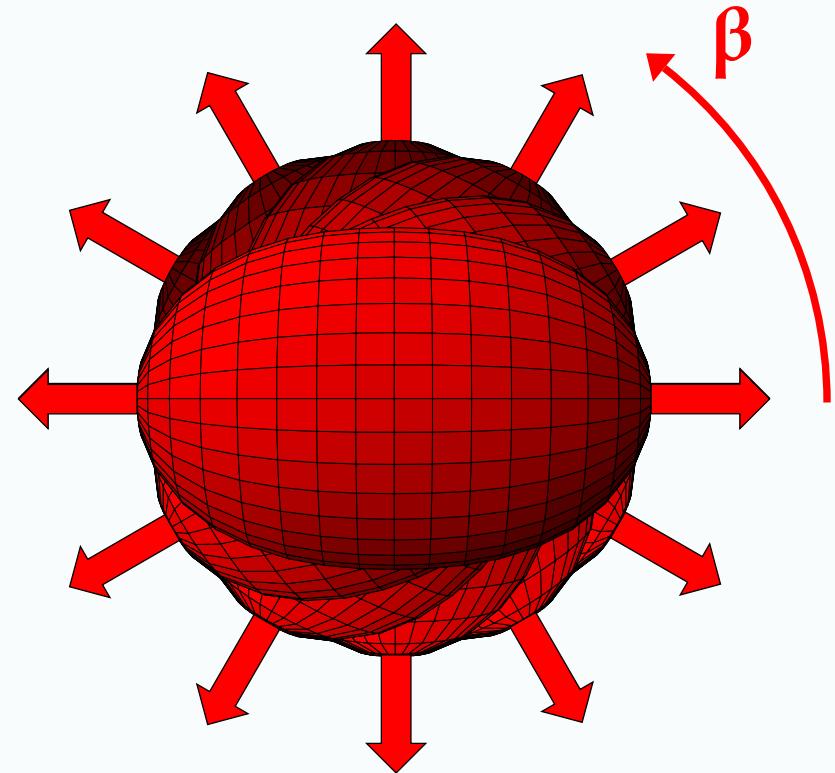
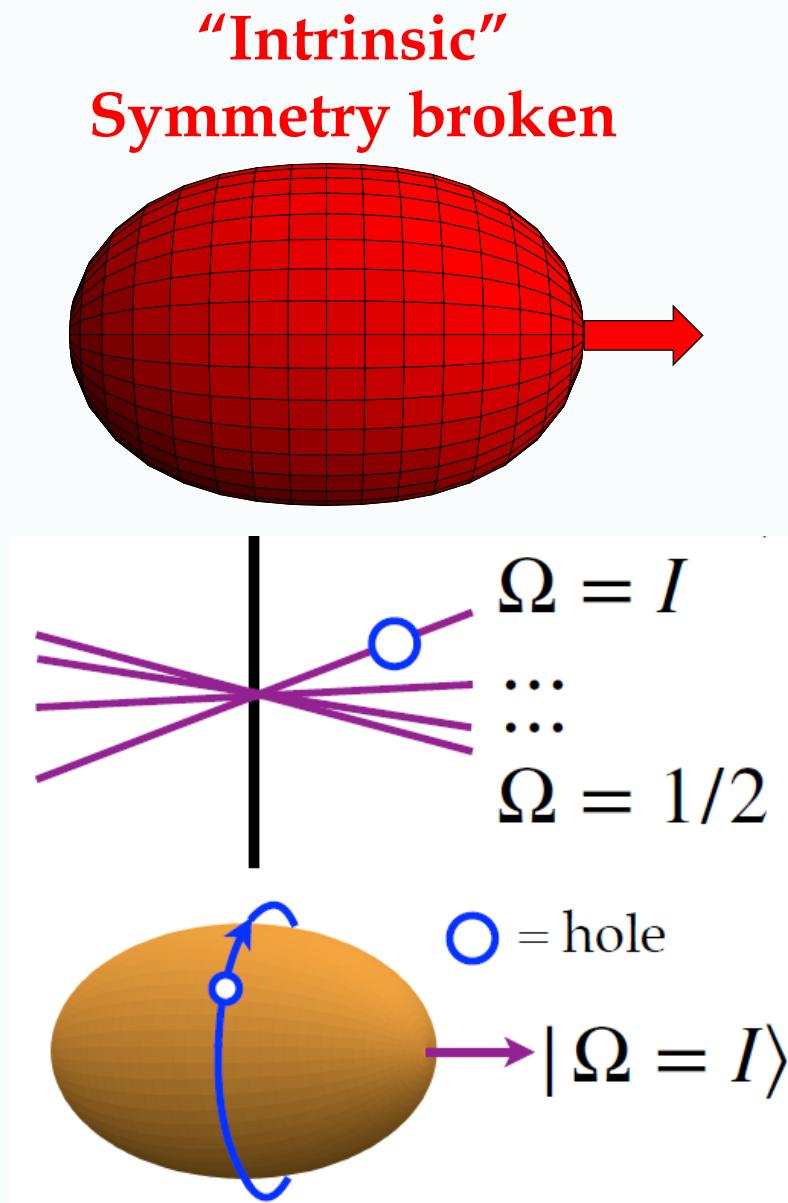
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# Time-odd spin alignment & symmetry restoration



$$|IM\rangle = \mathcal{N}_I \int_{\beta=0}^{\pi} d\beta d_{M\Omega}^I(\beta) |\Omega, \beta\rangle$$

J. A. Sheikh et al., J. Phys. G48, 123001 (2021)



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# Nuclear electromagnetic moments

Spectroscopic electric quadrupole  $Q$  and magnetic dipole  $\mu$  moments are :

$$Q = \sqrt{\frac{16\pi}{5}} \langle II | \hat{Q}_{20} | II \rangle \quad \text{and} \quad \mu = \sqrt{\frac{4\pi}{3}} \langle II | \hat{M}_{10} | II \rangle .$$

P. Ring and P. Schuck, *The Nuclear Many-Body Problem*

$$\hat{Q}_{20} = \sqrt{\frac{5}{16\pi}} e \sum_{i=1}^A \left( \frac{1}{2} - t_3^{(i)} \right) \{3z_i^2 - r_i^2\}; \quad \hat{M}_{10} = \sqrt{\frac{3}{4\pi}} \mu_N \sum_{i=1}^A \left\{ g_s^{(i)} s_{zi} + g_\ell^{(i)} \ell_{zi} \right\}; \quad \begin{aligned} g_s^{(i)} &= g_p(g_n) = 5.59(-3.83) \\ g_\ell^{(i)} &= 1(0) \end{aligned}$$

**Intrinsic moments**      = moments of the symmetry-broken state  
**Spectroscopic moments** = moments of the symmetry-restored state

**Spectroscopic moments** = moments measured experimentally

**Particle-core spin & shape polarization selfconsistently included**  
**No effective g-factors or effextive chares needed or used**



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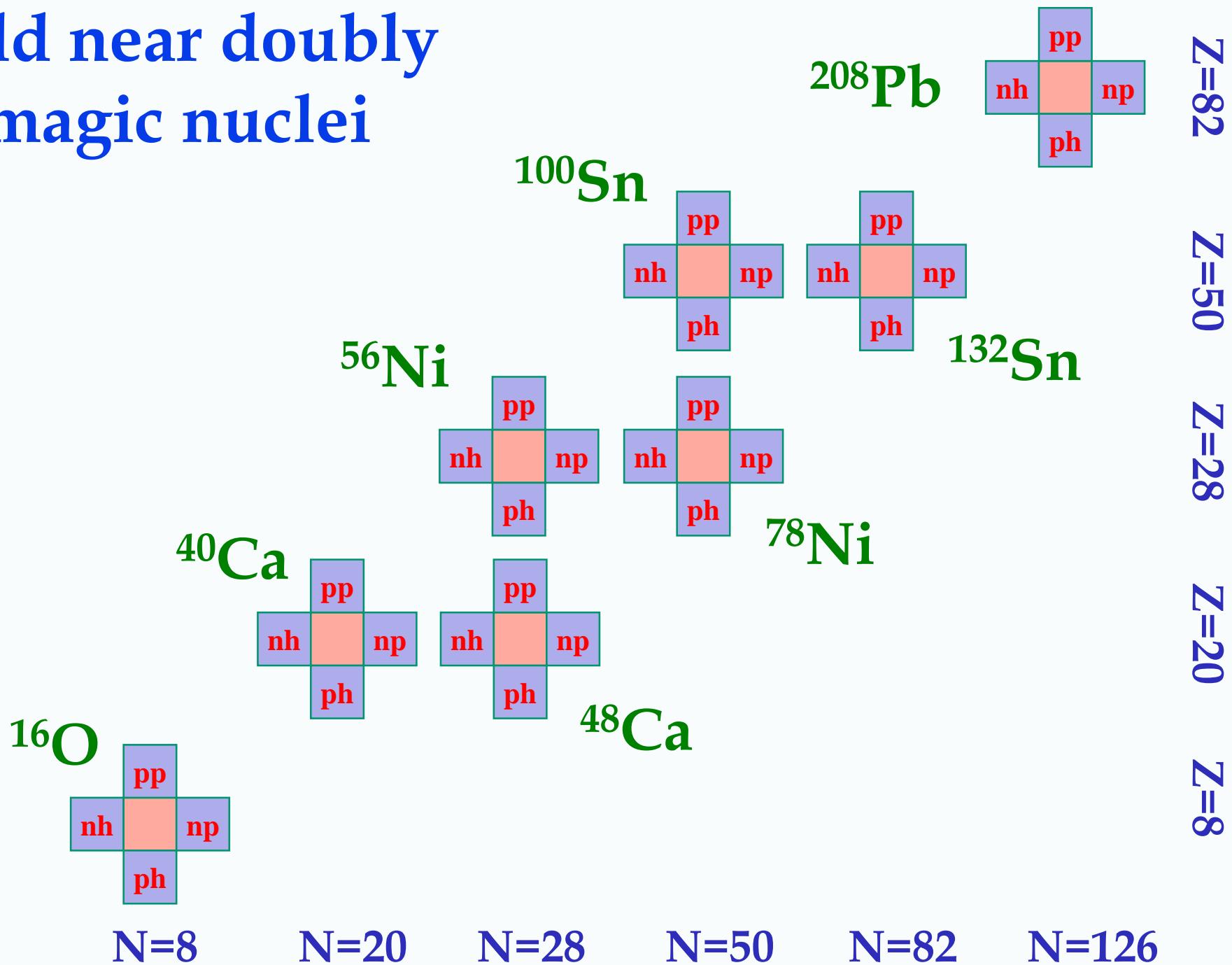
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# Odd near doubly magic nuclei



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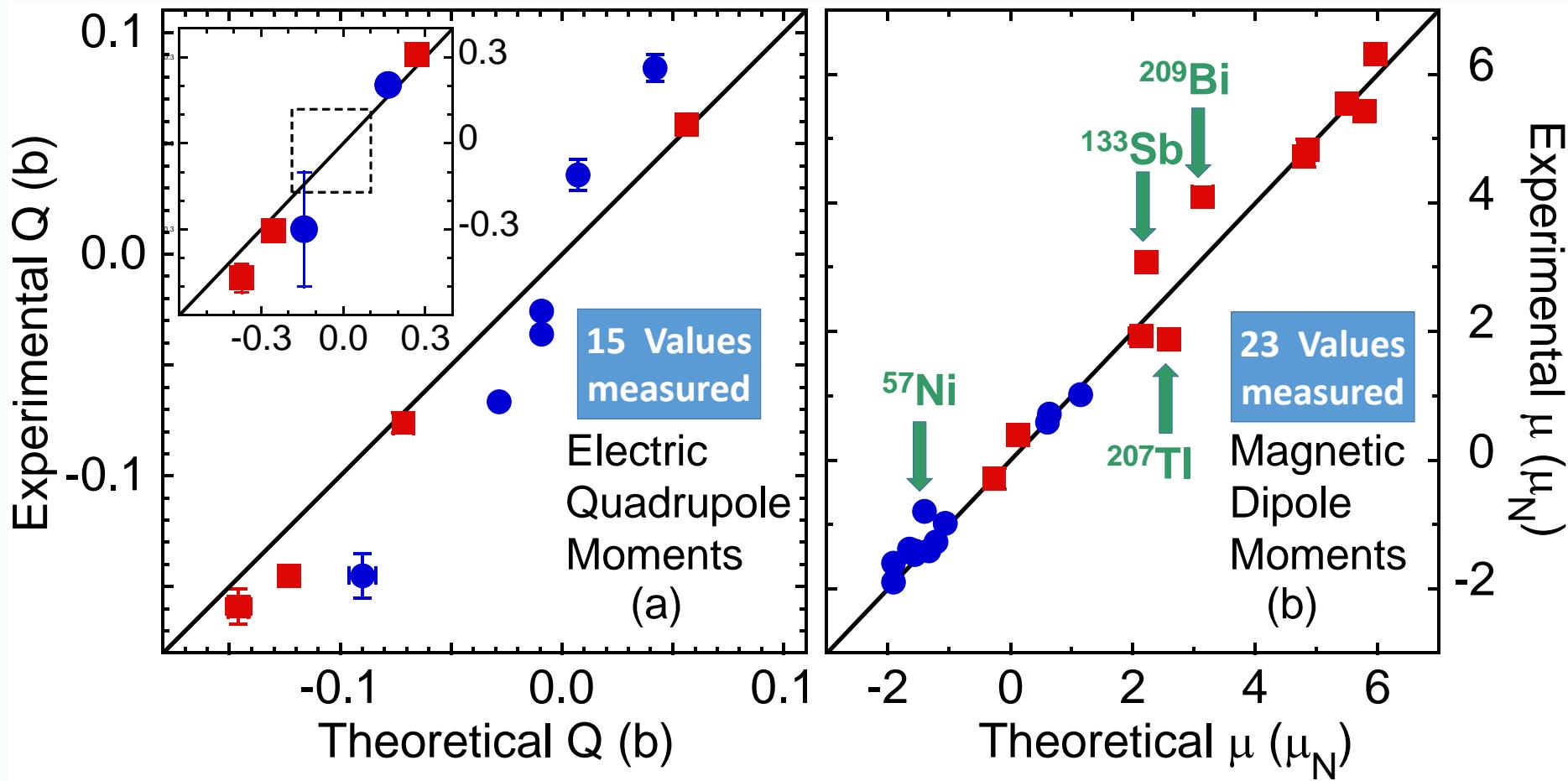
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# Quadrupole & dipole moments



- Proton-odd (squares) & neutron-odd (circles) nuclei
- The isovector Landau parameter  $g'_0$  adjusted to data



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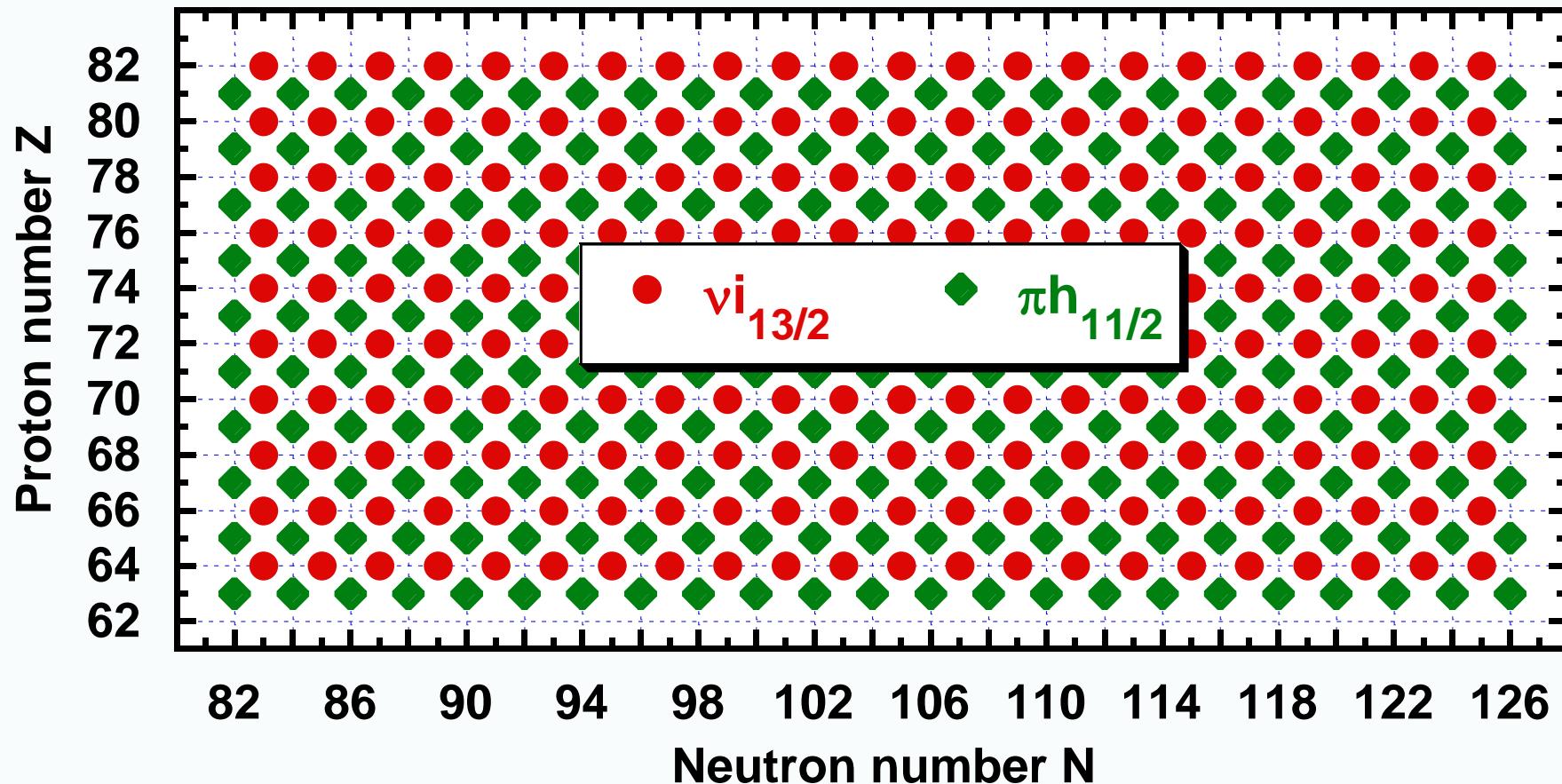
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# First systematic nuclear-DFT analysis of the electromagnetic moments in heavy deformed open-shell odd nuclei



Blocked quasiparticles were tagged by the neutron  $i_{13/2}$  ( $\Omega=+13/2$ ) or proton  $h_{11/2}$  ( $\Omega=+11/2$ ) single-particle orbitals



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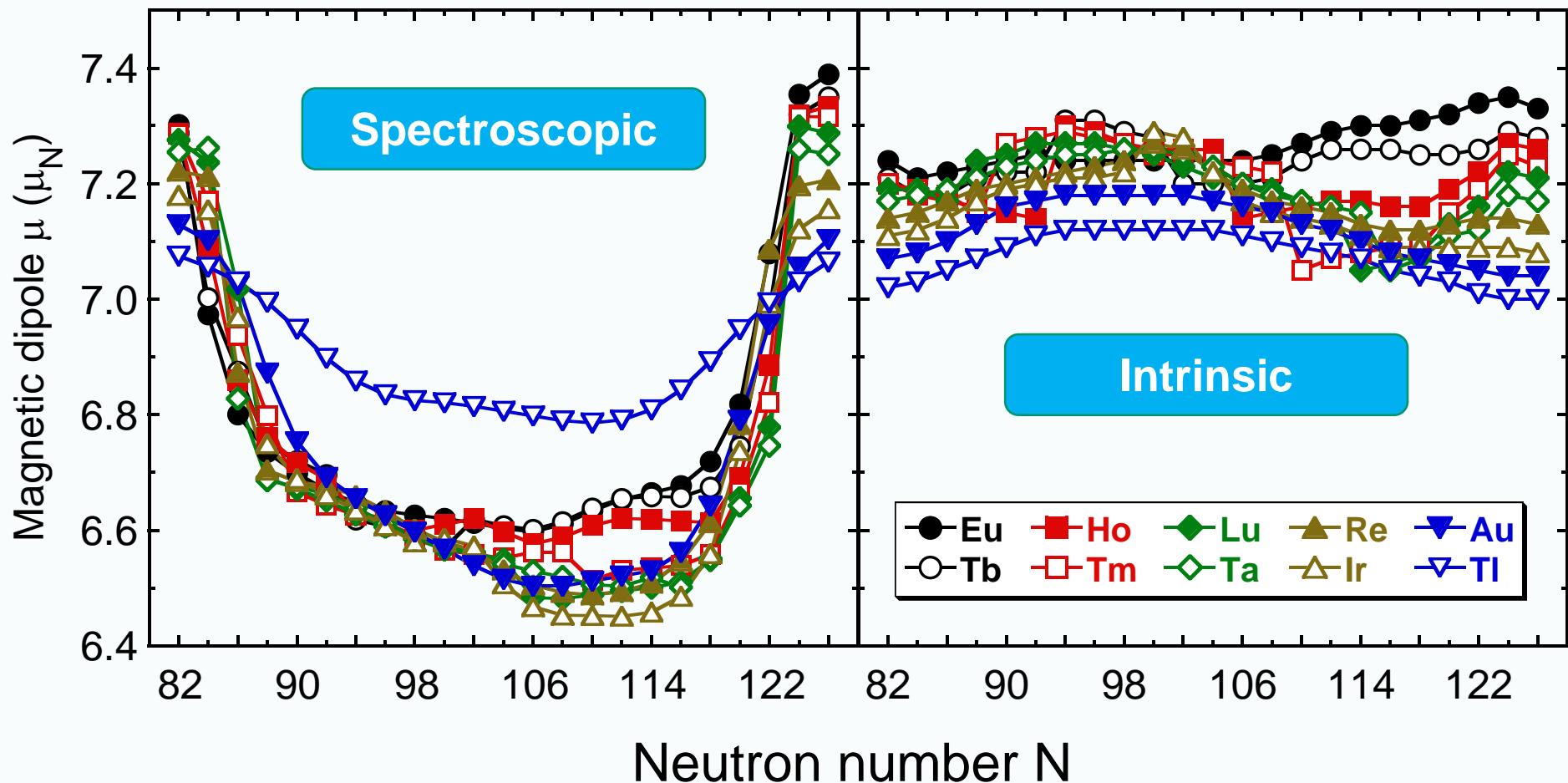
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# Heavy deformed $\pi 11/2^-$ odd-Z nuclei



J. Bonnard *et al.* arXiv:2209.09156

**Conclusion:**  
Spectroscopic magnetic dipole moments  
cannot be inferred from the intrinsic ones



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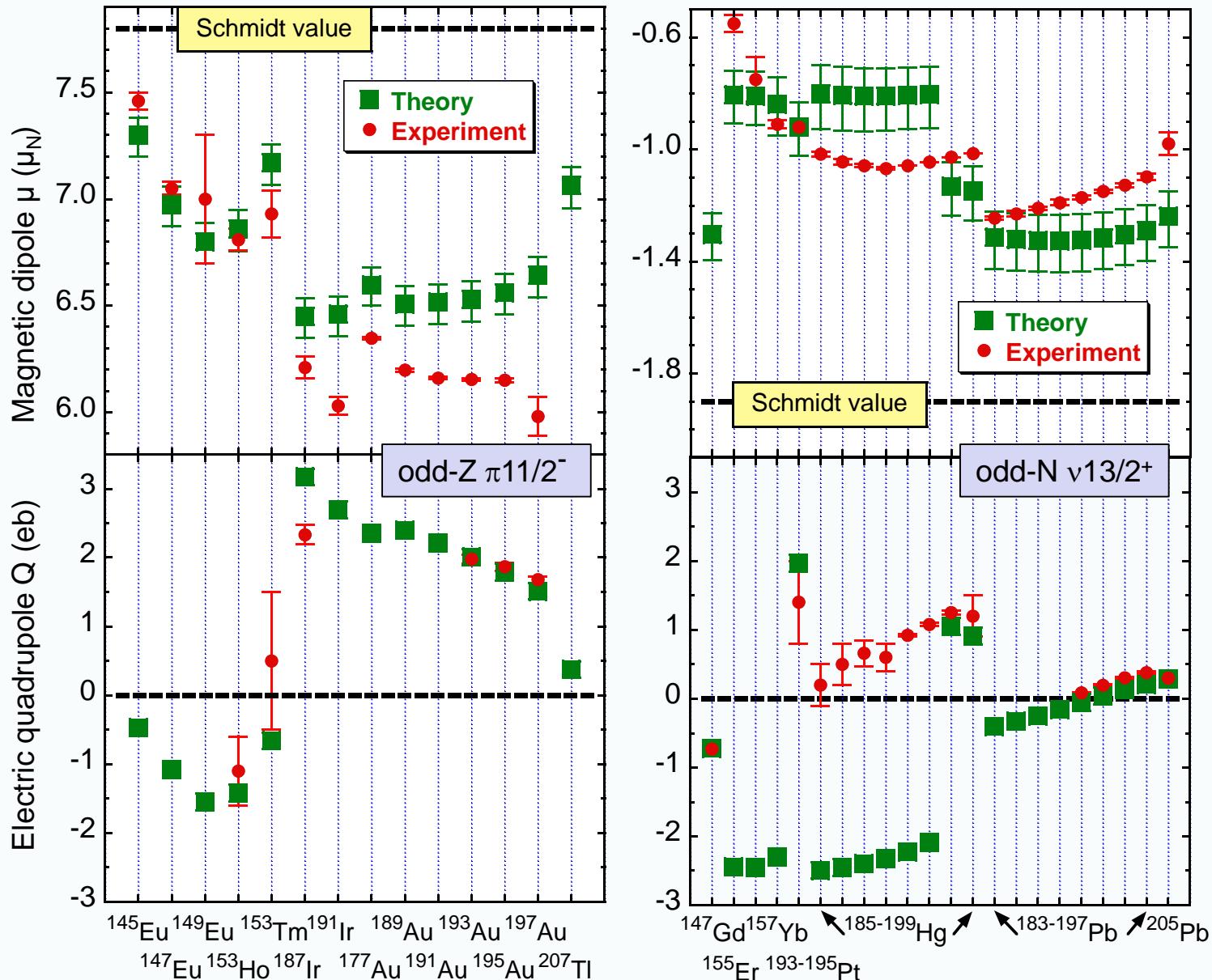
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# Spectroscopic moments vs. experiment



J. Bonnard *et al.* arXiv:2209.09156



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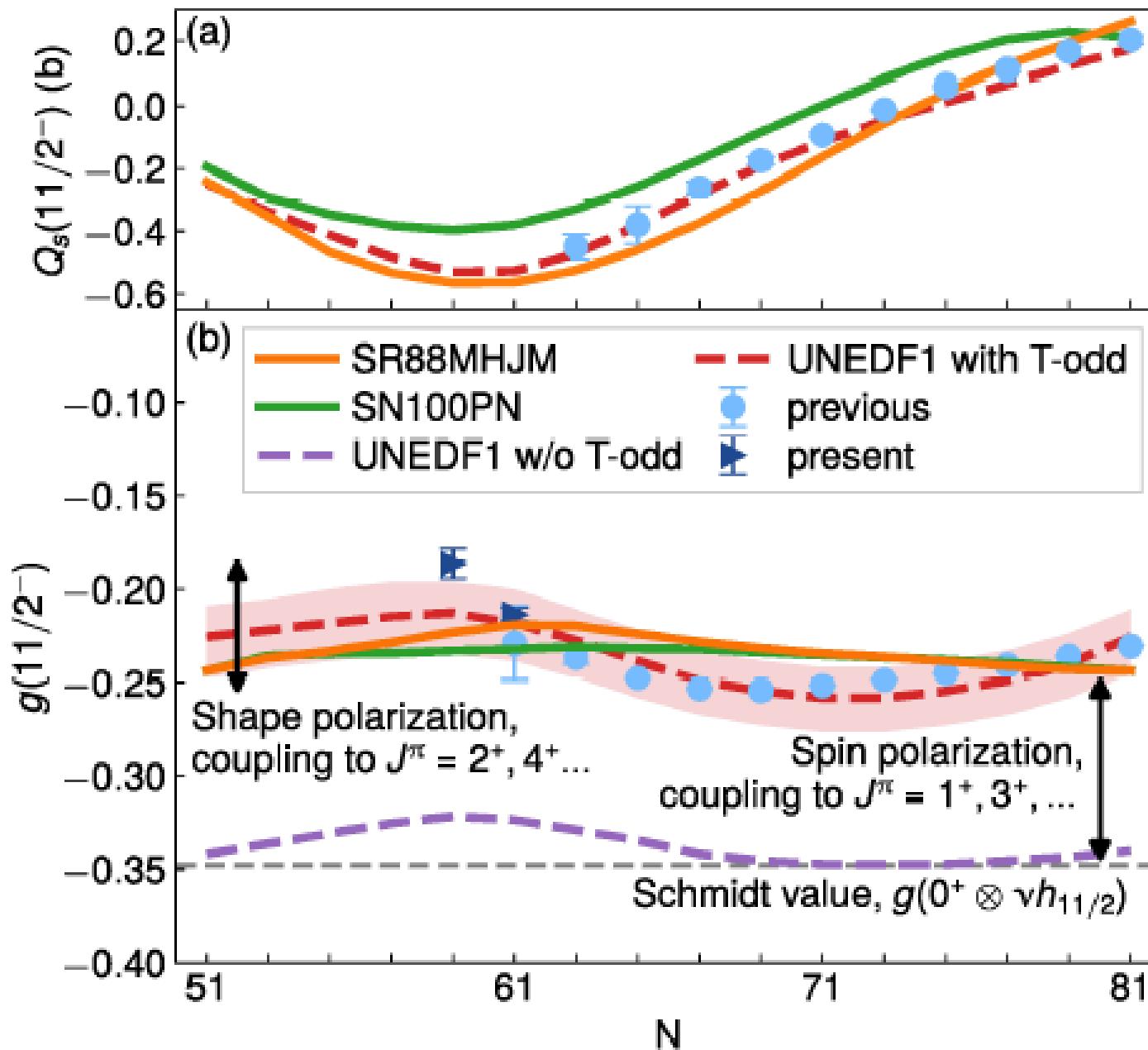
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# Moments of the $\nu h_{11/2}$ isomers in Sn



T.J. Gray *et al.*, submitted



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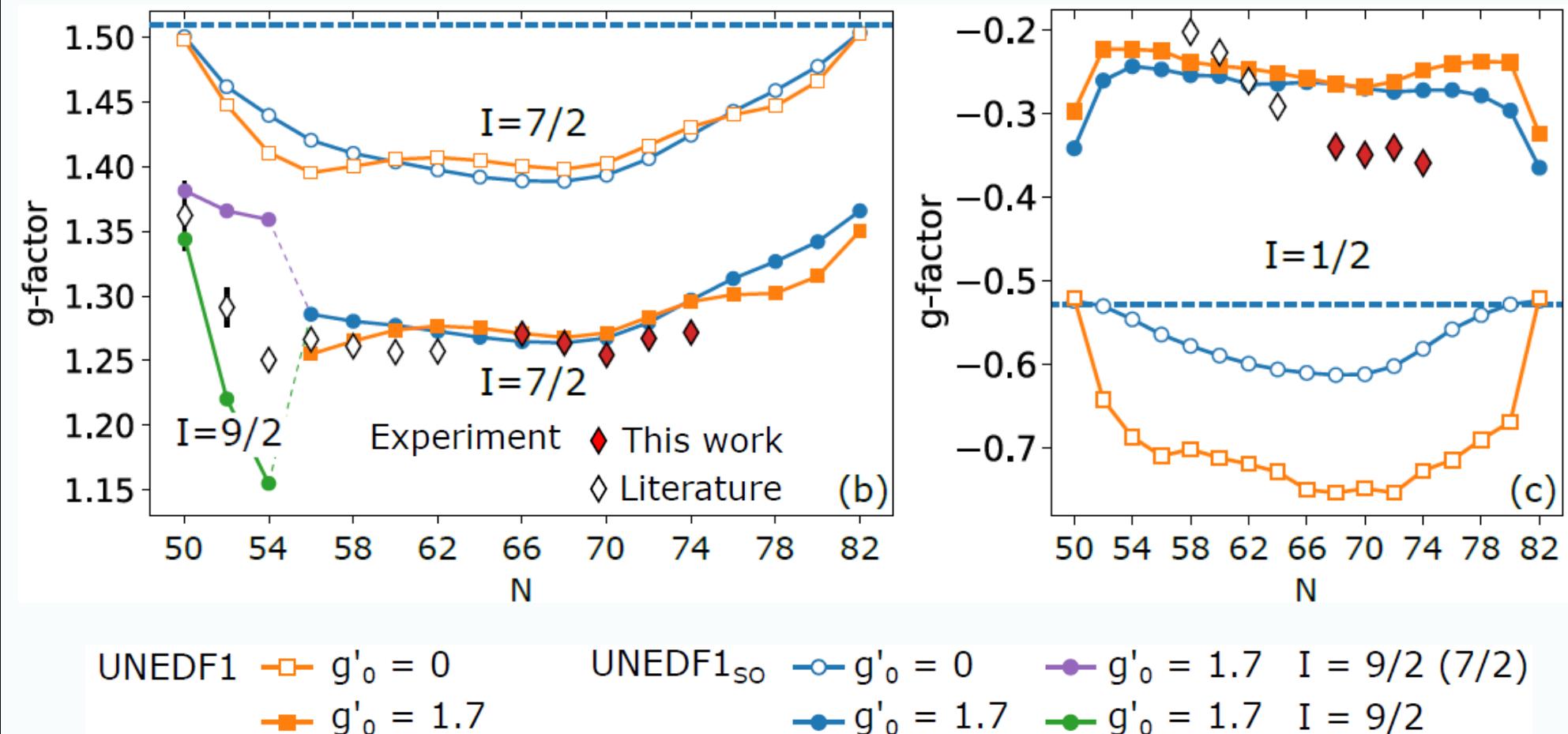
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# Moments of the 1/2, 7/2 & 9/2 states in Ag



R. P. de Groote *et al.*, submitted



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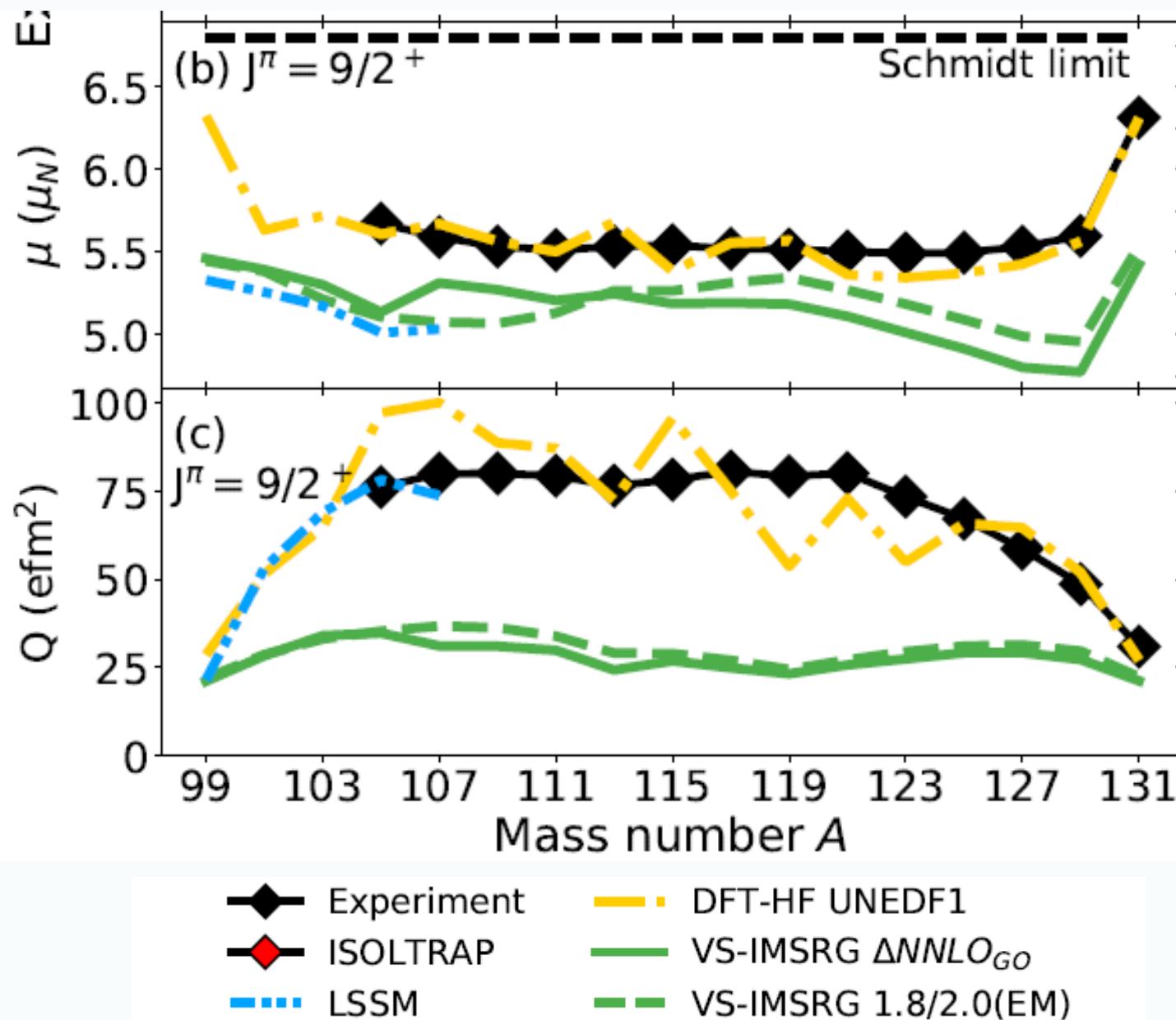
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# Moments of the $9/2$ states in In



A.R. Vernon *et al.*, Phys. Rev. Lett., 260 (2022)

L. Nies *et al.*, Nature 607, 260 (2022)



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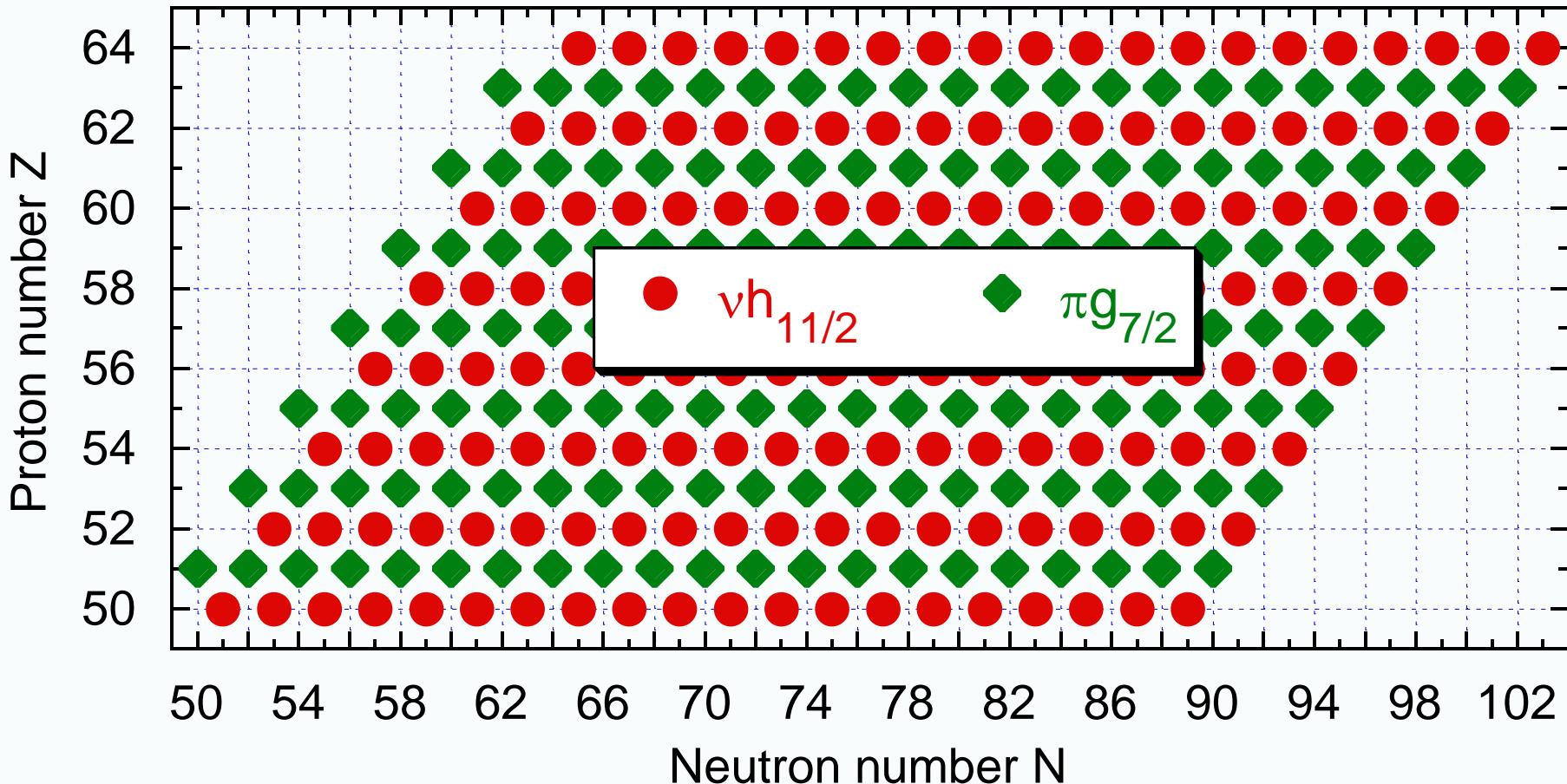
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# Nuclear-DFT analysis of electromagnetic moments between Sn and Gd isotopes



Herlik Wibowo, poster 100, abstract 468



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## What's next to consider

**Segré chart of electromagnetic moments**

**More advanced functionals**

**Octupole deformation**

**Triaxiality**

**Configuration interaction**

**K-mixing**

**Quadrupole/octupole collectivity**

**Two-body meson-exchange currents**



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# The bottom line

The nuclear electromagnetic moments  
are all about:

- **Polarization**
- **Self-consistency**
- **Symmetry restoration**



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# Thank you



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