Shell-model progress in the investigation of ^{132}Sn mass region

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In Collaboration with **Frédéric NOWACKI**

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Amboise October 15-20, 2017

Introduction

G. S. Simpson et al., PRL 113, 132502 (2014)
H. Naïdja et al., J. Phys. Conf. Series 580, 012030 (2015)
H. Naïdja et al., Acta. Phys. Pol B 46, 669 (2015)
R. Lozeva et al., PRC 93,014316 (2016)

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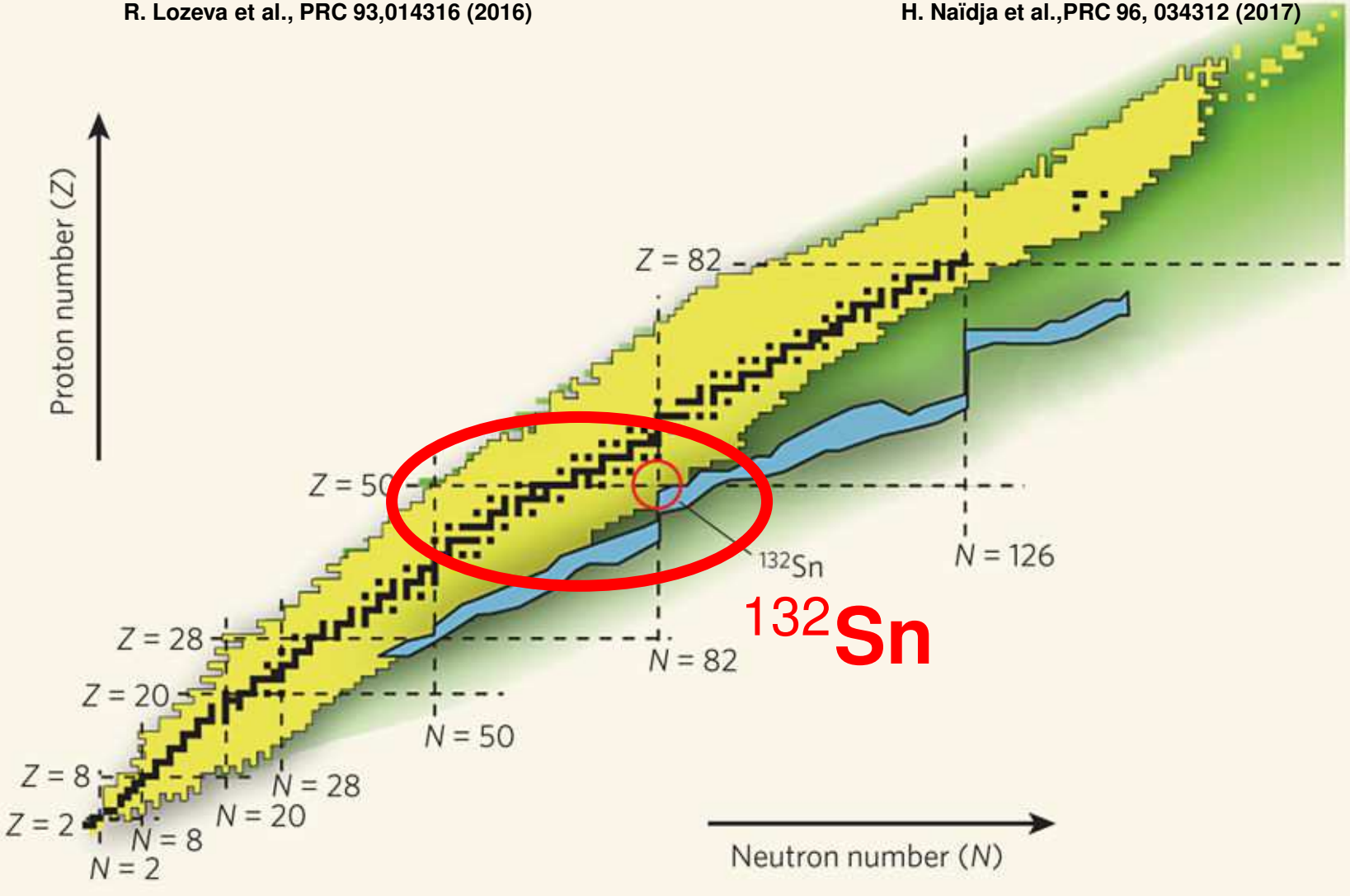
H. Naïdja et al.,PRC 96, 034312 (2017)



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Low-lying state energies and isomeric transitions in ^{134,136,138}Sn

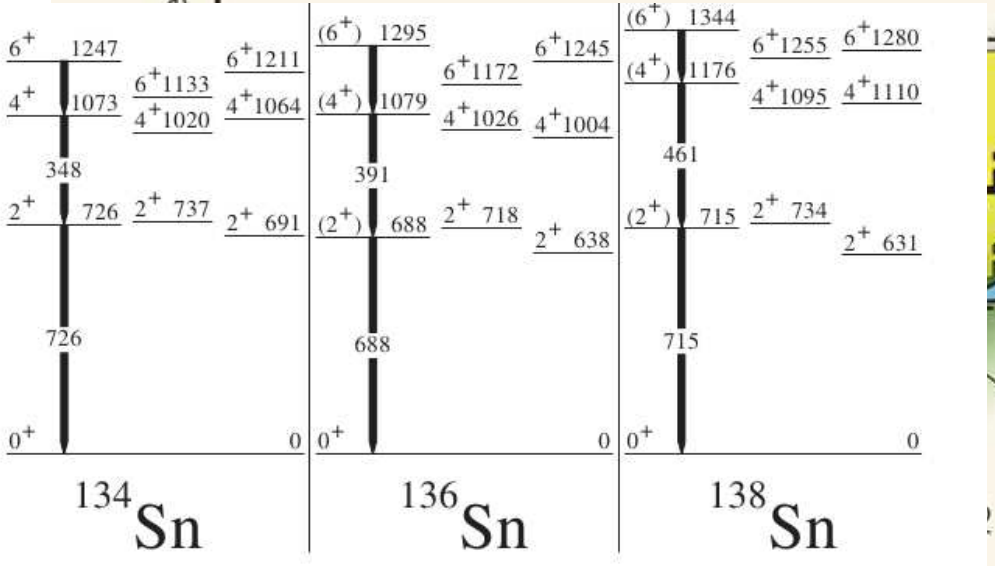
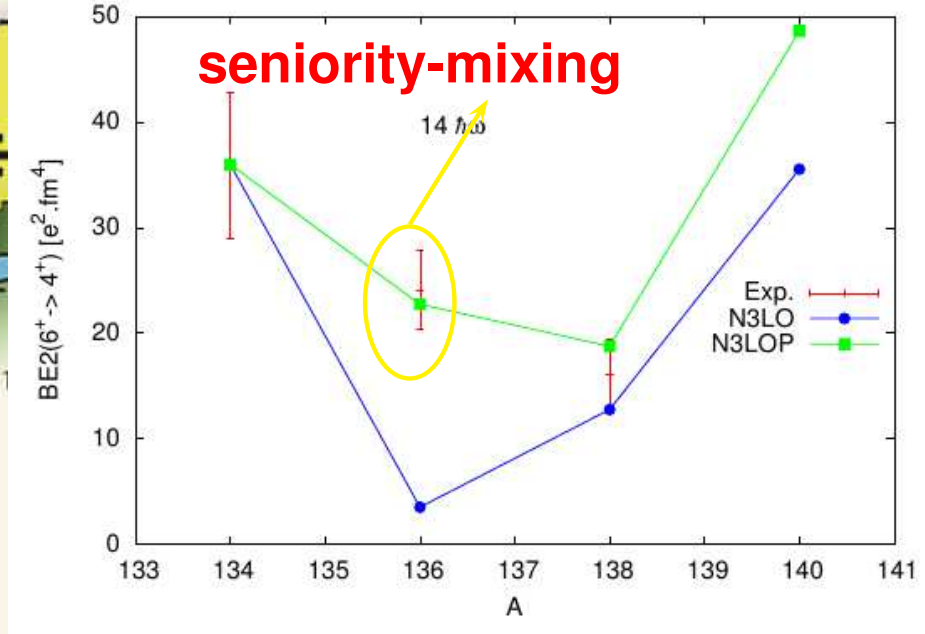
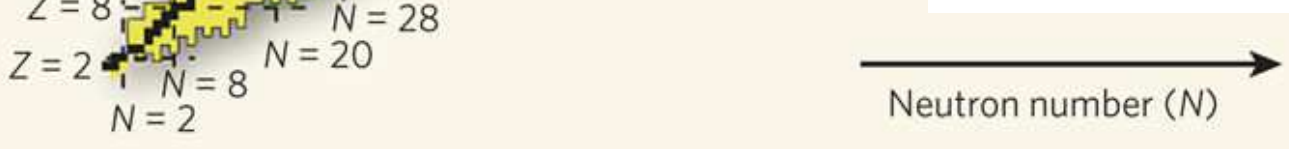


FIG. 4. Proposed level schemes of ^{136}Sn and ^{138}Sn, along with





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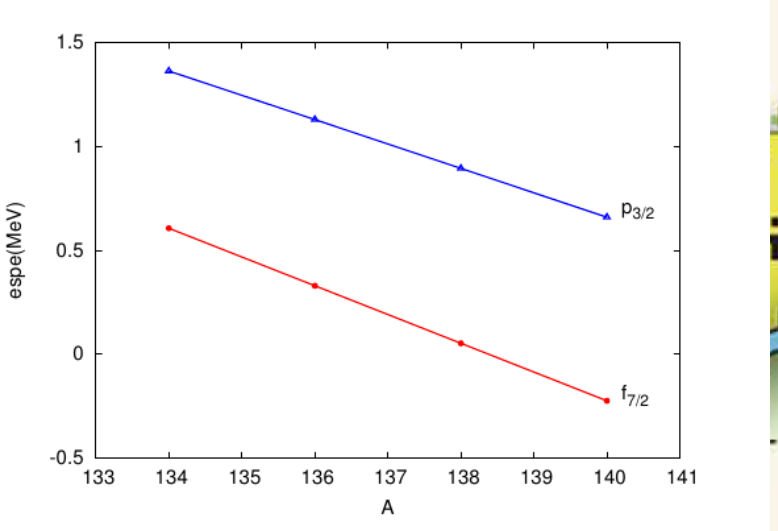
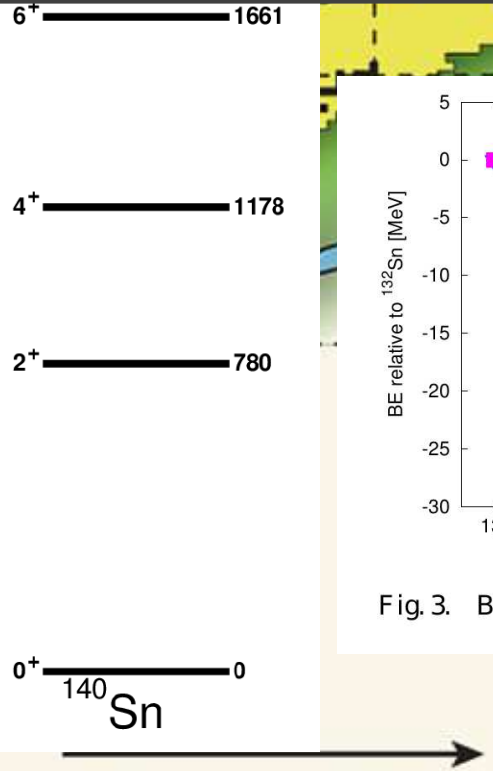
Non sub-shell closure at N=90, and the tins masses





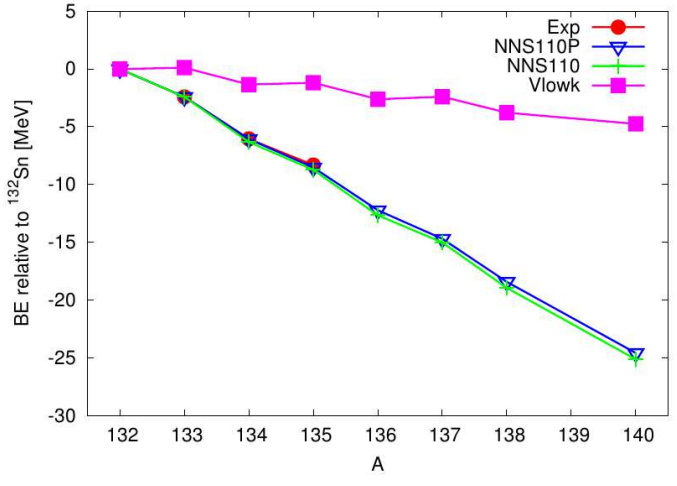
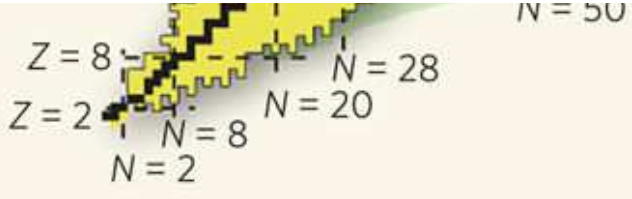


Fig. 3. Binding energies of tin isotopes relative to ^{132}Sn.



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Revised level scheme of ^{136}Sb, and the first spectroscopic information on ^{140}Sb

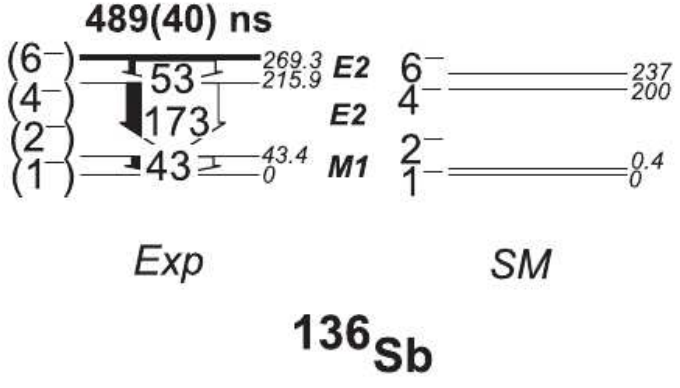


FIG. 2. Revised experimental level scheme of the 6^- isomer in ^{136}Sb compared to shell-model (SM) calculations.

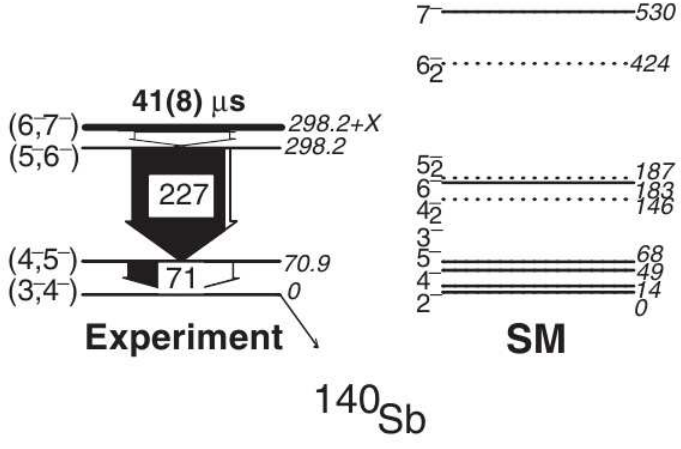
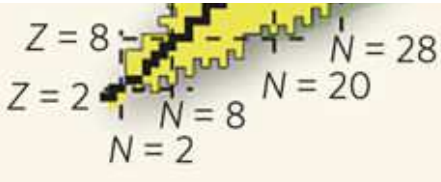
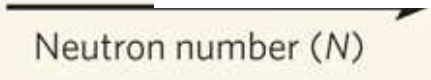


FIG. 2. Experimental level scheme of the observed isomer in ^{140}Sb compared to the results of SM calculations. Yrast and yrare states are represented by solid and dotted lines, respectively.





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High spin states and collectivity in ^{142}Ba and ^{144}Ce

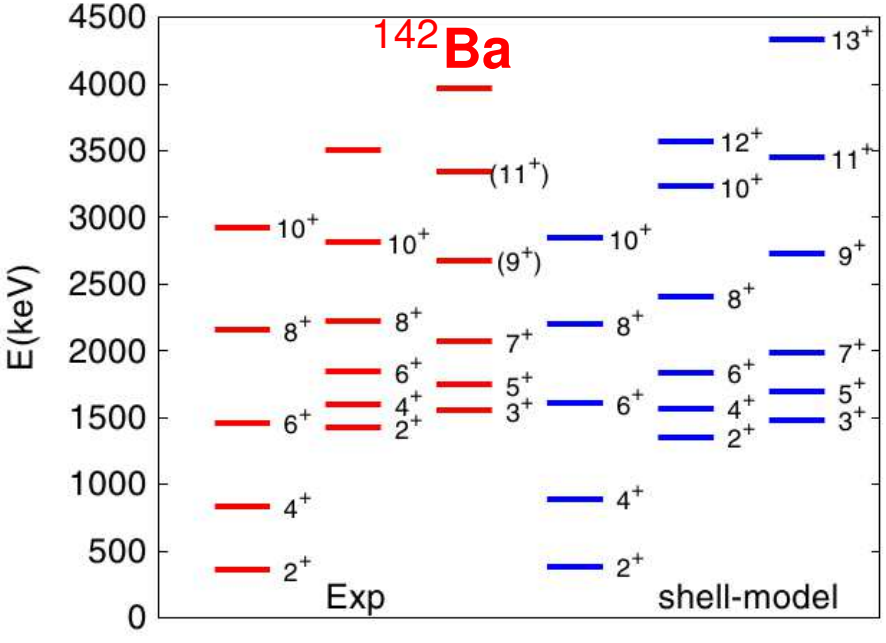

FIG. 9. Excited levels in ^{142}Ba calculated using the N3LOP effective interaction (blue lines), compared to the experimental scheme (red lines).

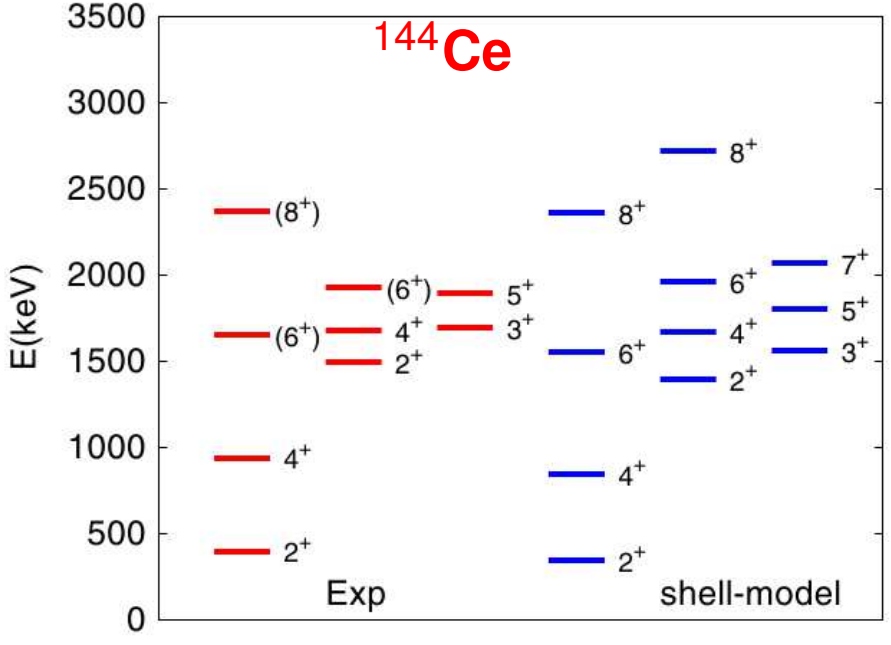

FIG. 10. Excited levels in ^{144}Ce calculated using the N3LOP effective interaction (blue lines), compared to the experimental scheme (red lines).

$N = 2$

Neutron number (N)

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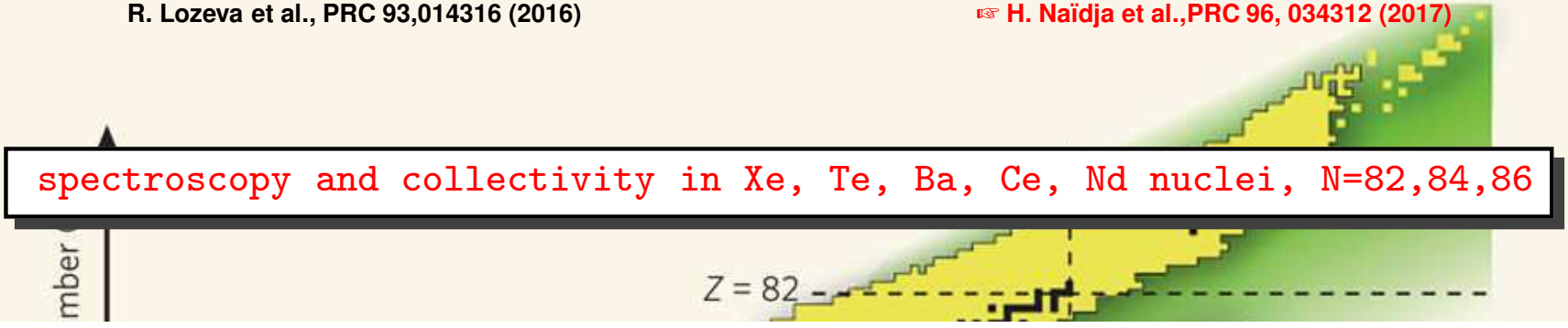
H. Naïdja et al., PRC 95, 064303 (2017)
☞ H. Naïdja et al.,PRC 96, 034312 (2017)

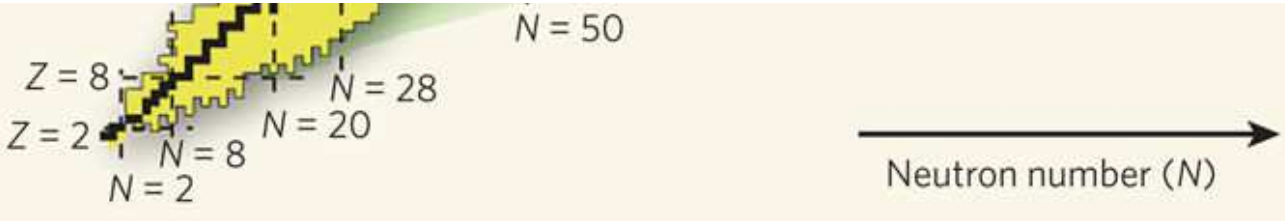
spectroscopy and collectivity in Xe, Te, Ba, Ce, Nd nuclei, N=82,84,86



PHYSICAL REVIEW C **96**, 034312 (2017)

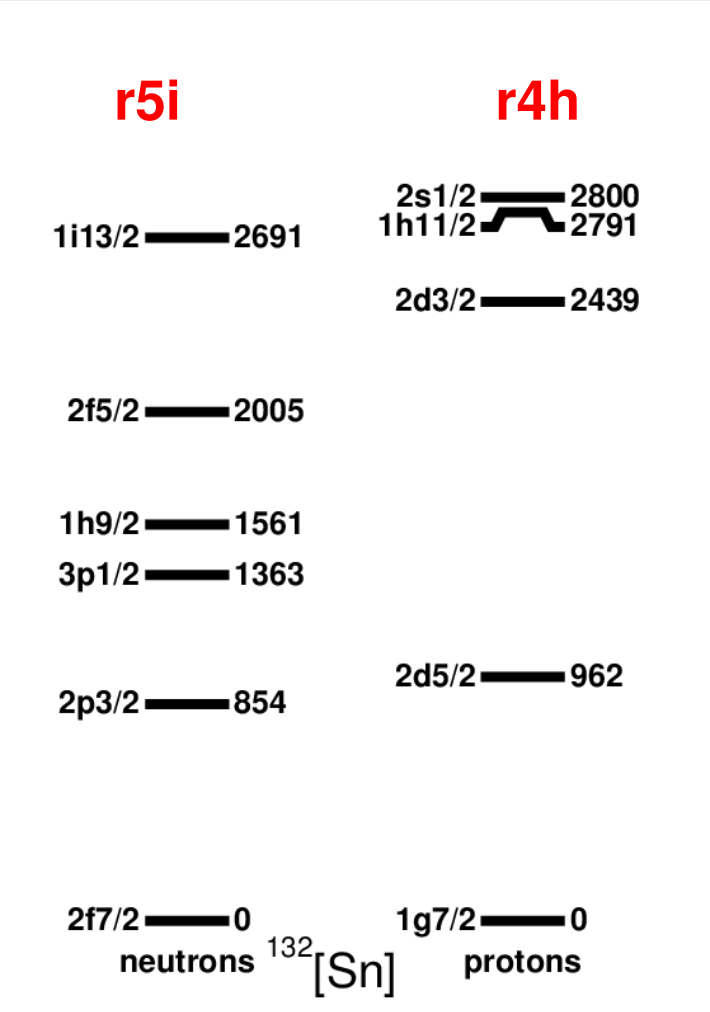
Shell-model investigation of spectroscopic properties and collectivity in the nuclei beyond ^{132}Sn

H. Naïdja,[1,2,3] F. Nowacki,[1] and B. Bounthong[1]
[1]*Université de Strasbourg, CNRS, IPHC UMR 7178, F-67000 Strasbourg, France*
[2]*GSI Helmholtzzentrum für Schwerionenforschung GmbH, 64291 Darmstadt, Germany*
[3]*Université Constantine 1, LPMS, route Ain El Bey 25000 Constantine, Algeria*
(Received 20 June 2017; published 13 September 2017)



Shell-model overview

Model space



☞Diagonalization with **Antoine** and **Nathan** Strasbourg SM codes.

Effective interaction

1. derived from realistic interaction N3LO
2. renormalised by V_{low-k} to exclude the repulsive short range (cutoff $\Lambda = 2.2 fm^{-1}$).
3. adapted to the model space by many body perturbation theory,

$$V_{eff} = \underbrace{V_{low} + V_{low}\frac{Q}{E-H_0}V_{low}}_{\text{second order}} + V_{low}\frac{Q}{E-H_0}V_{low}\frac{Q}{E-H_0}V_{low}$$

4. Monopole and Multipole adjutments to N3LO interaction

⇓

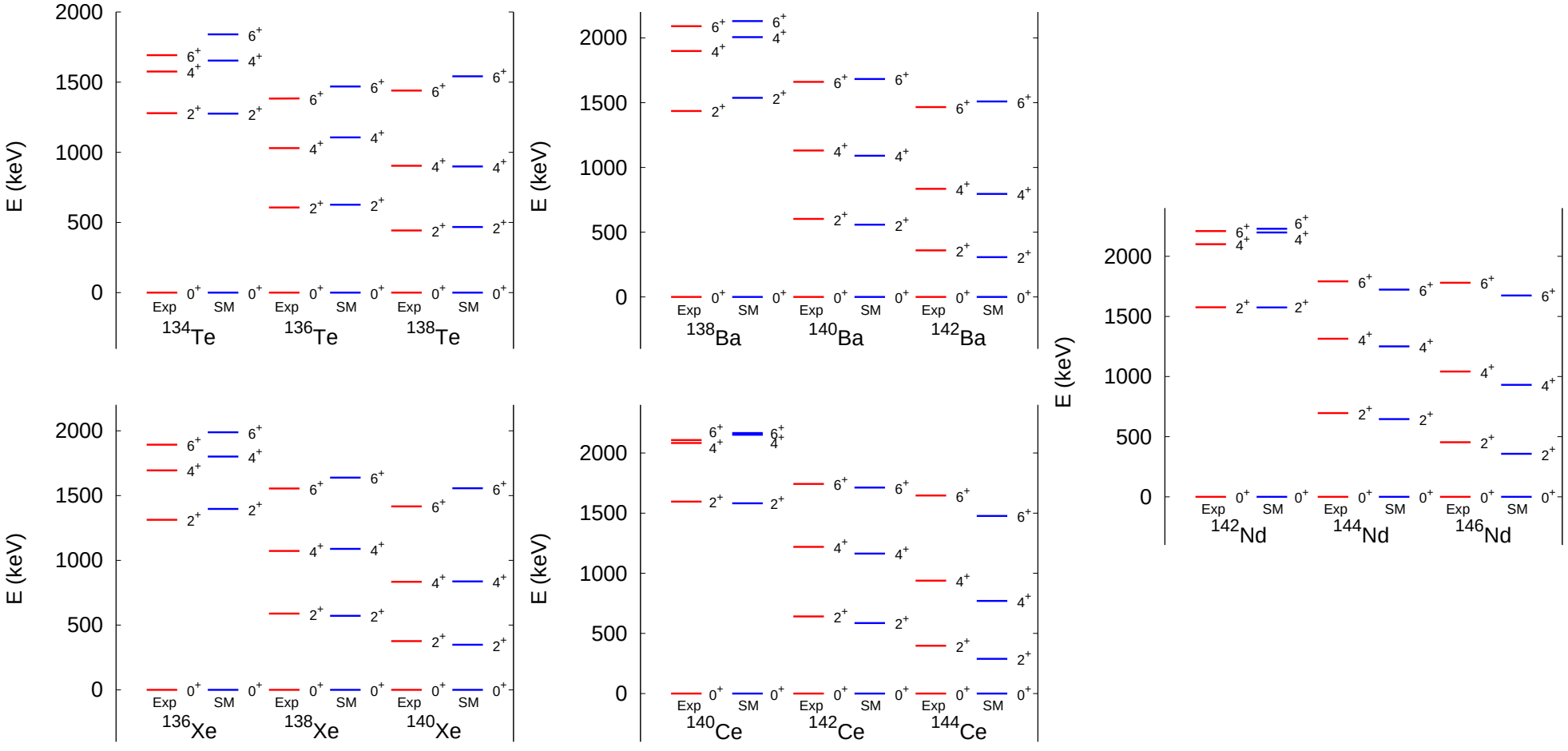
N3LOP interaction

Part I : Spectroscopy and collectivity in even-even nuclei

Te, *Xe*, *Ba*, *Ce*, *Nd* with $82 \leq N \leq 88$

Energy levels of Te, Xe, Ba, Ce, Nd $82 \leq N \leq 86$

H. Naïdja, F. Nowacki and B. Bounthong, PRC 96, 034312 (2017).



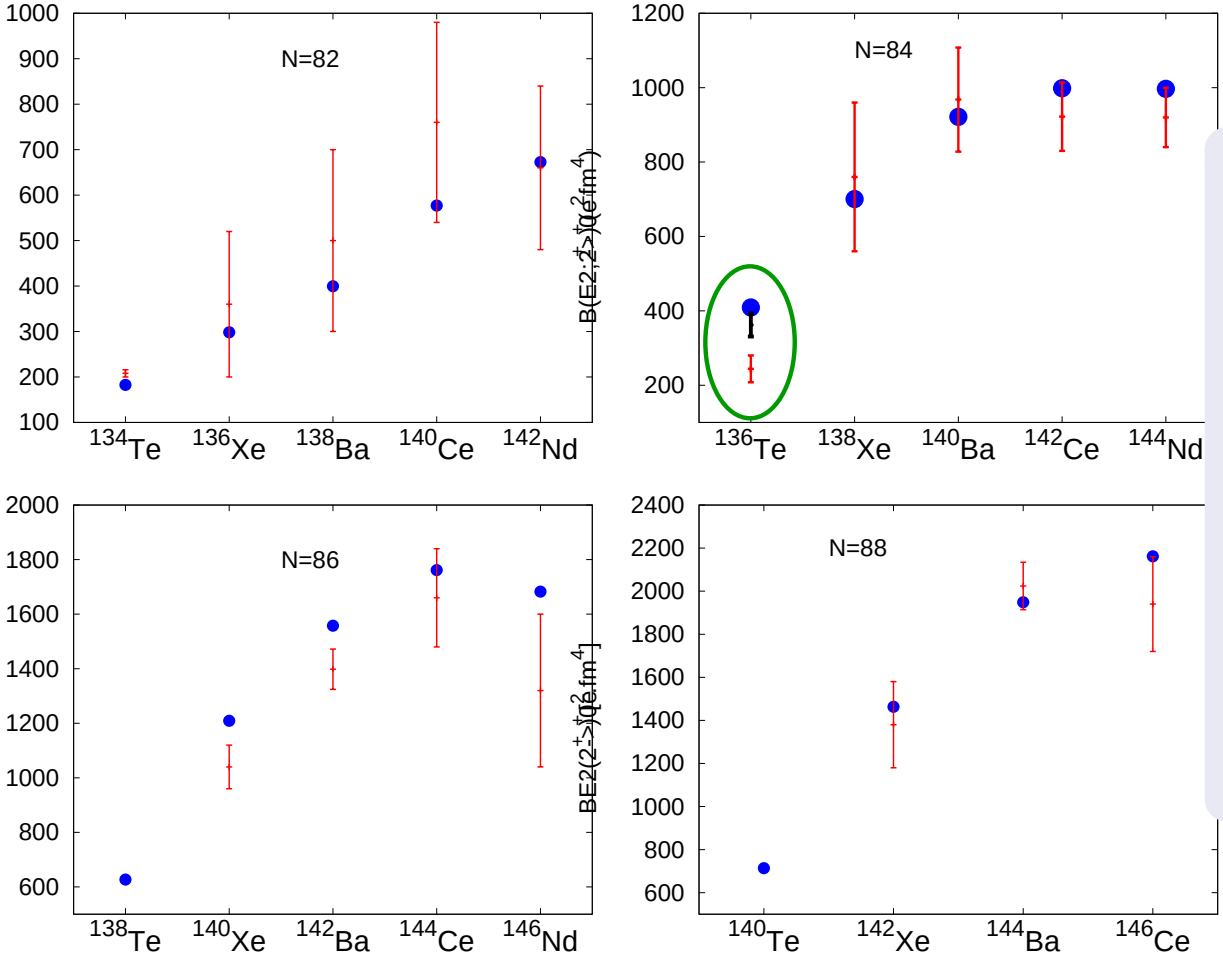
A compression in the level schemes from N=82 to N=86 isotones

⇓

sign of collectivity

E2 Transitions

H. Naïdja, F. Nowacki and B. Bounthong, PRC 96, 034312 (2017).



- ✓ The overestimated ^{136}Te strength is now consistent wit the new measurement

  J. M. Allmond *et al.* PRL. 118, 092503 (2017)
- ✓ small B(E2) in N=82 isotones due to spherical character
- ✓ strong B(E2) in N=86 and 88 isotones, reflecting the presence of collective character

$$(e_{eff(\nu)}, e_{eff(\pi)}) = (0.6e, 1.6e)$$

M1 Moments

H. Naïdja, F. Nowacki and B. Bounthong, PRC 96, 034312 (2017).

FREE $g-$FACTORS

$(g_\pi^s, g_\pi^l) = (5.5857, 1.0)$
$(g_\nu^s, g_\nu^l) = (-3.8263, 0.0)$

☞ overall bad agreement with the data

EFFECTIVE g-FACTORS

$(g_\pi^s, g_\pi^l) = (3.250, 1.069)$
$(g_\nu^s, g_\nu^l) = (-1.506, 0.019)$

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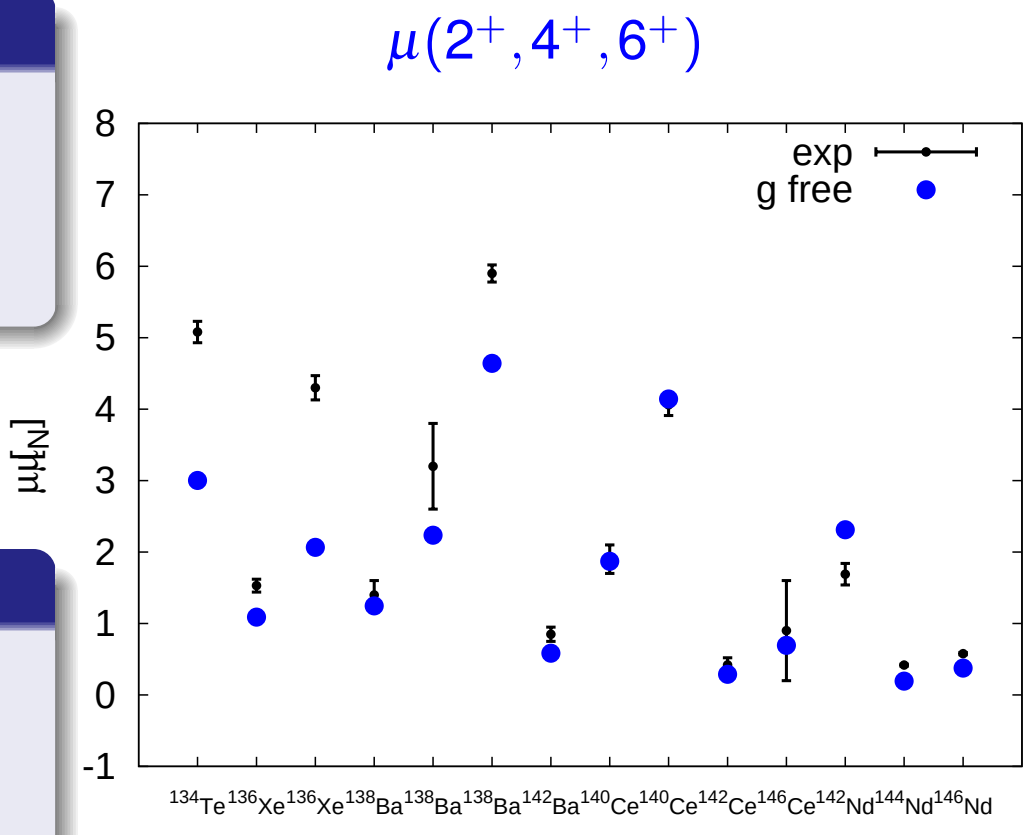

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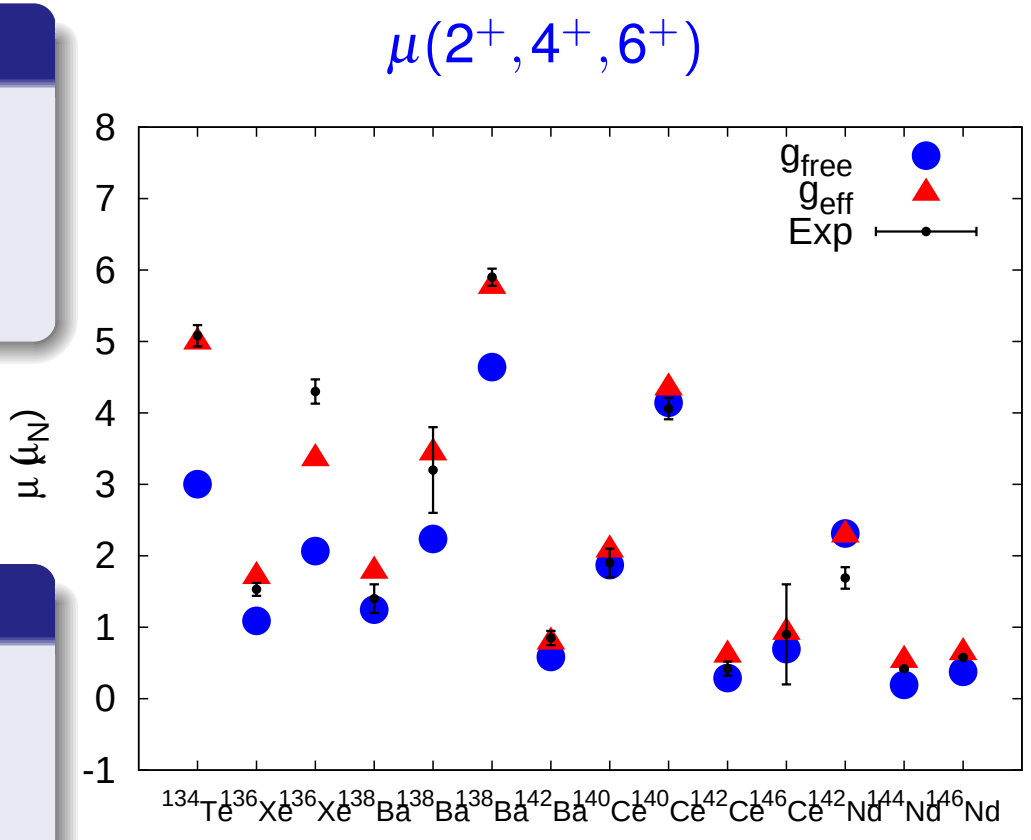
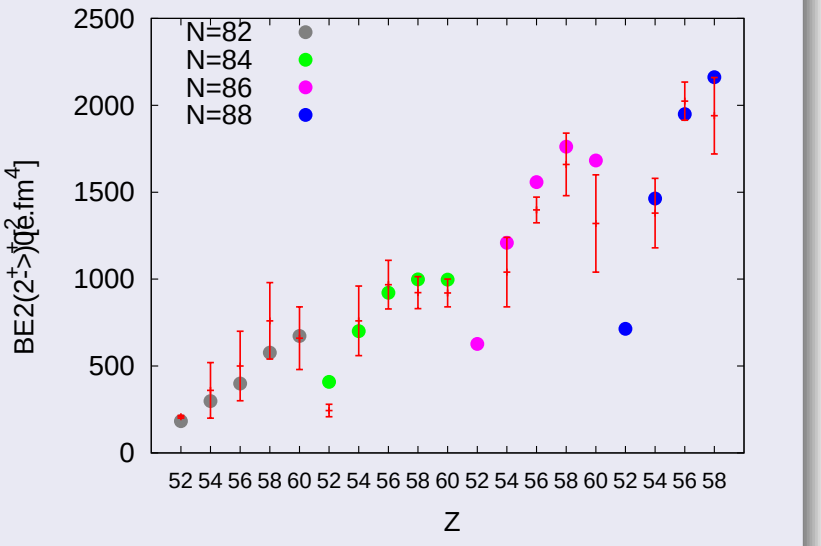
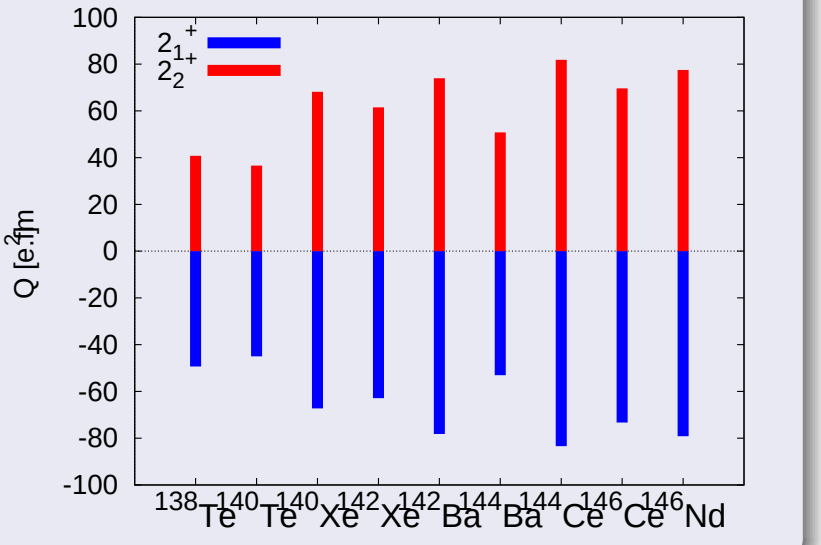
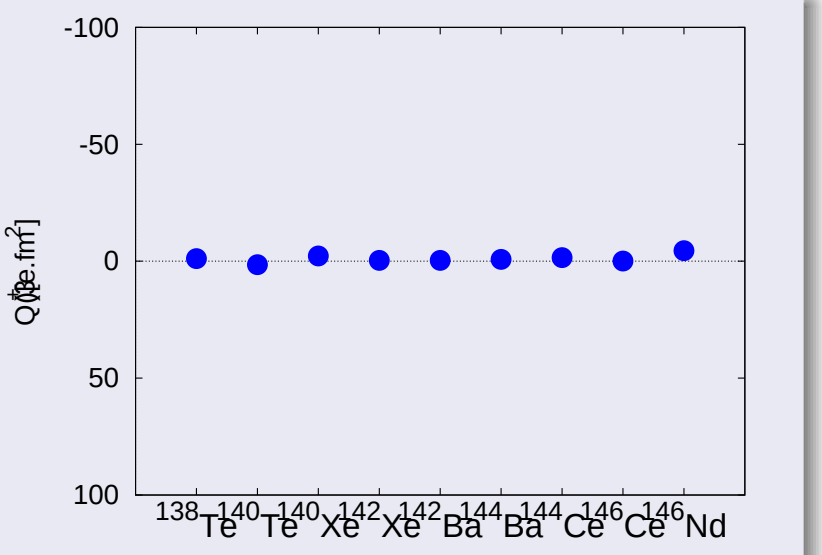


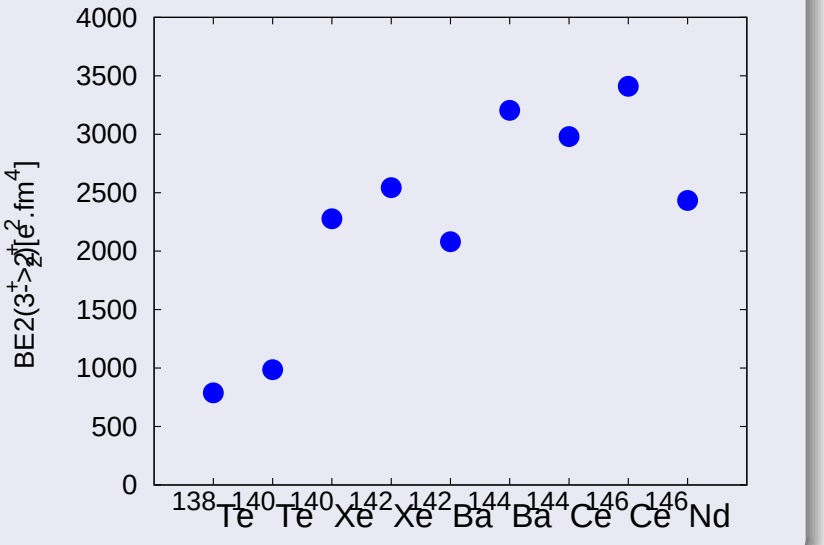
Signs of Collectivity in N=86, 88 isotones

H. Naïdja, F. Nowacki and B. Bounthong, PRC 96, 034312 (2017).









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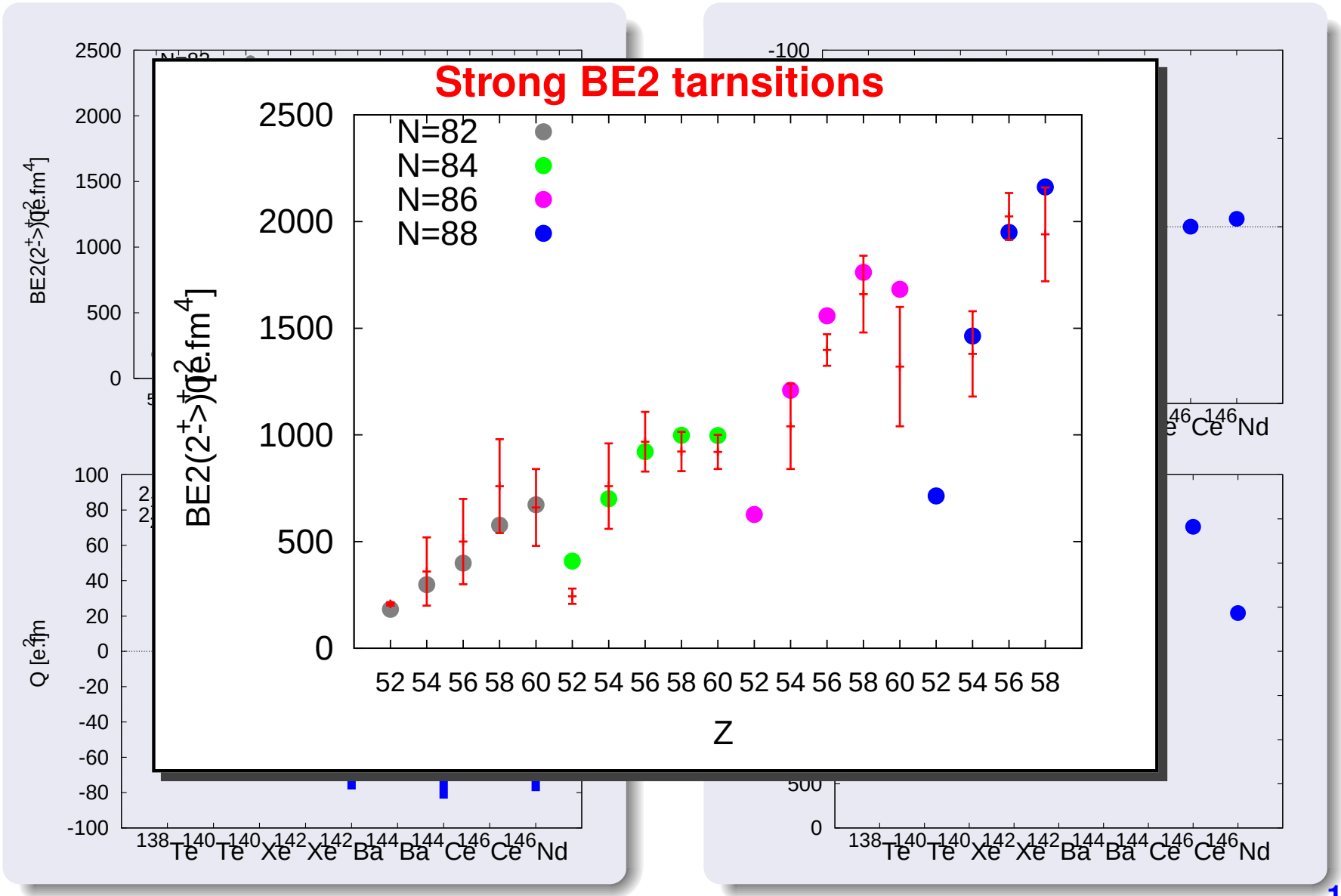

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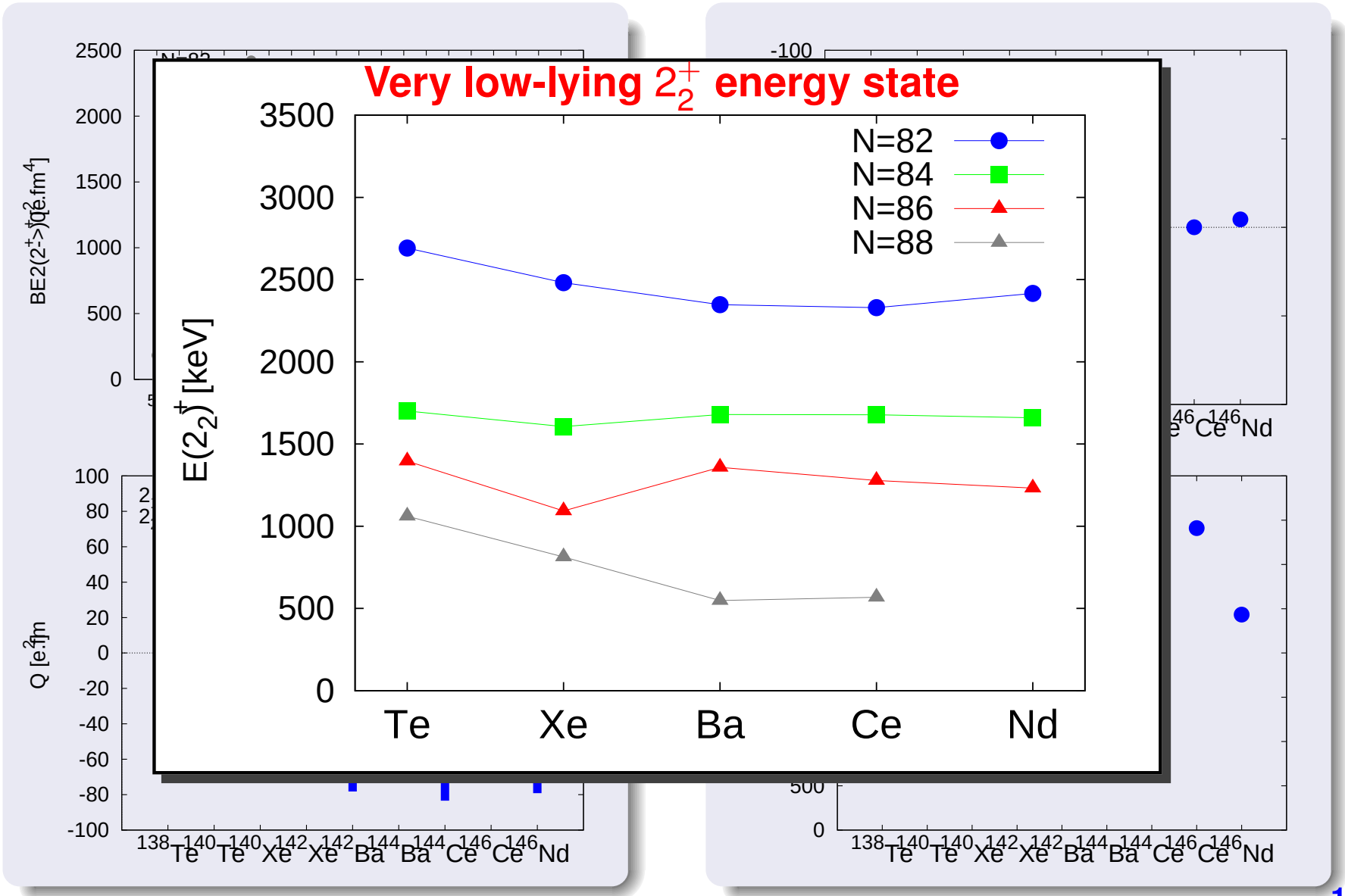

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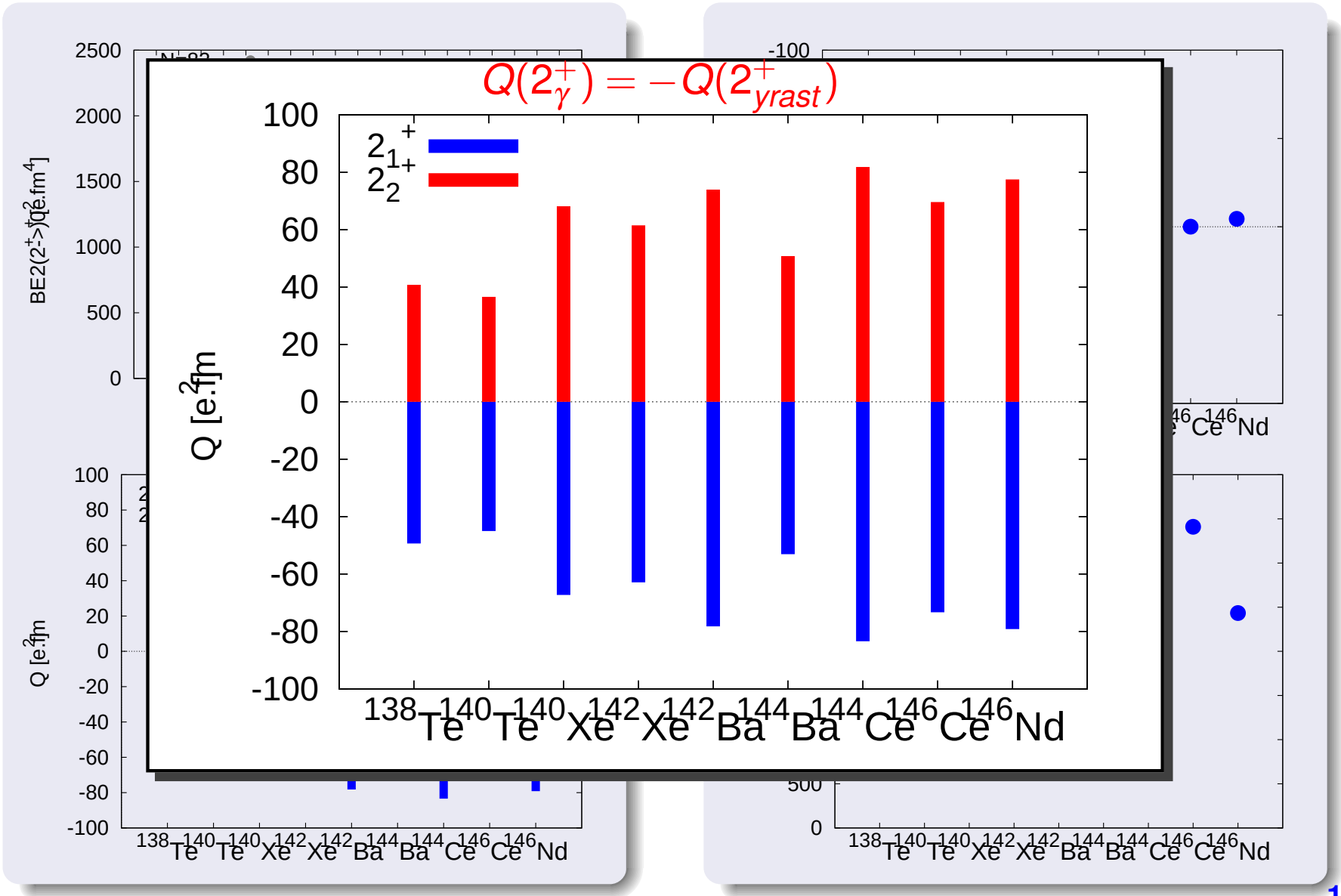

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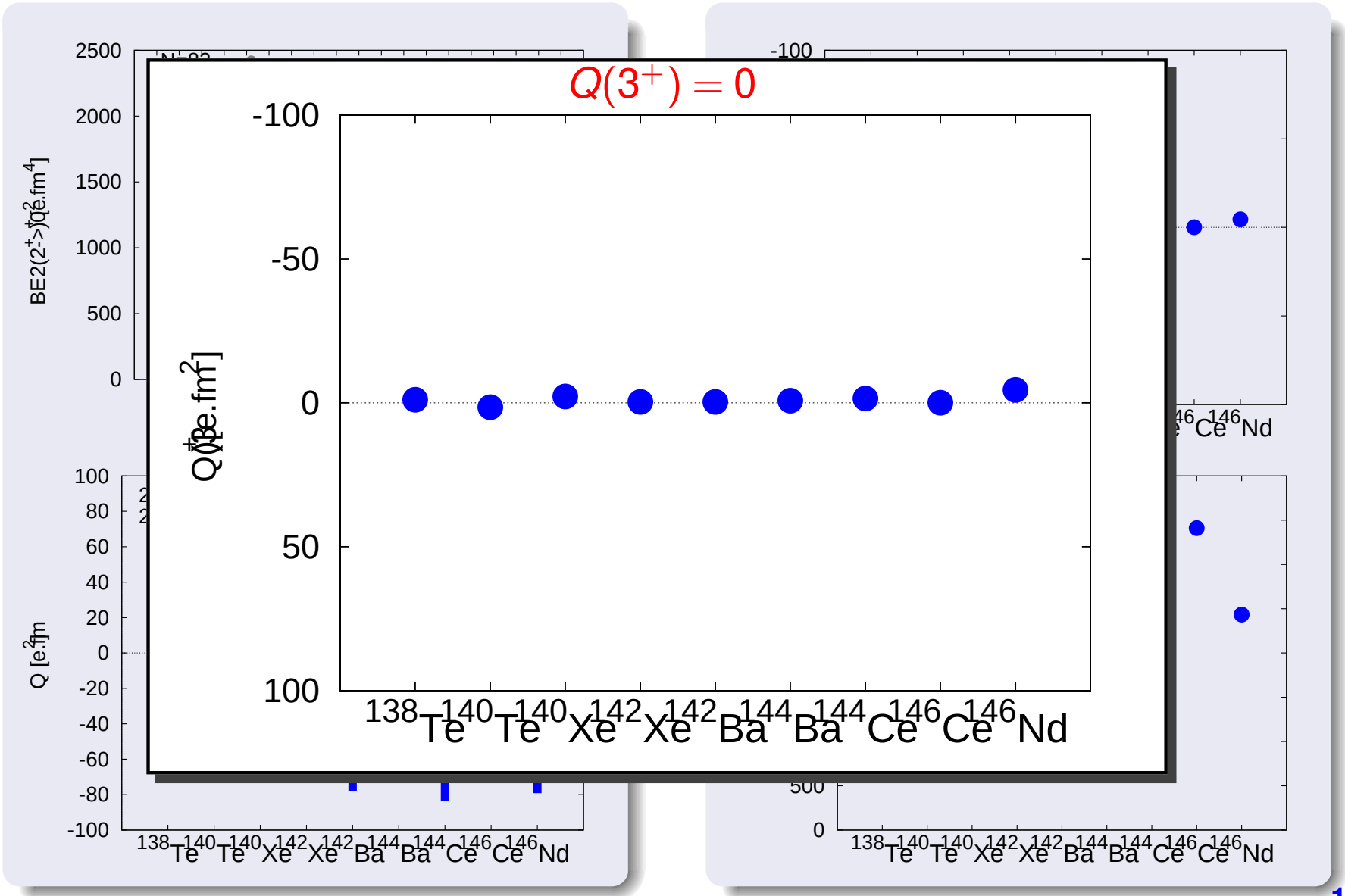

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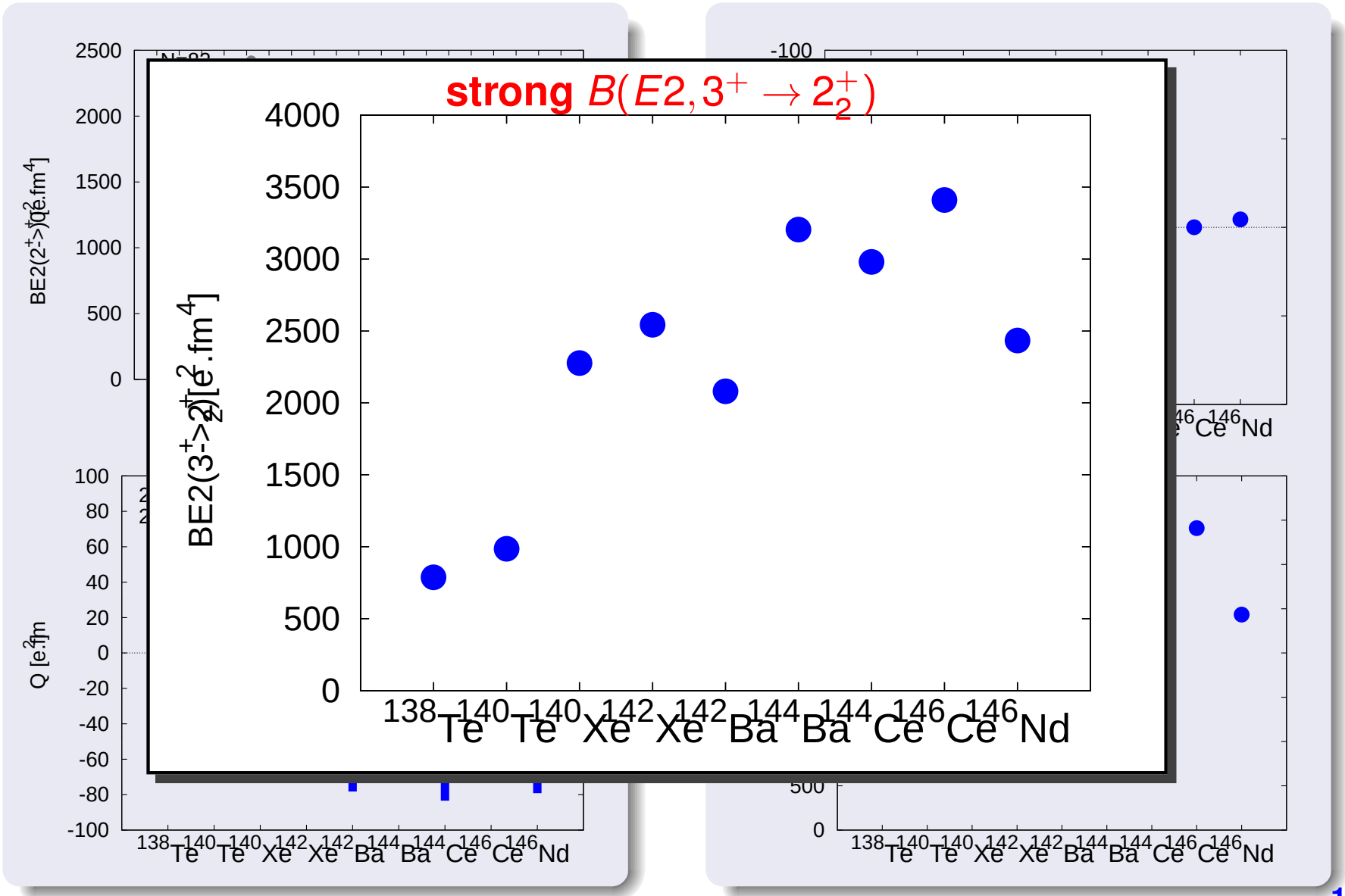

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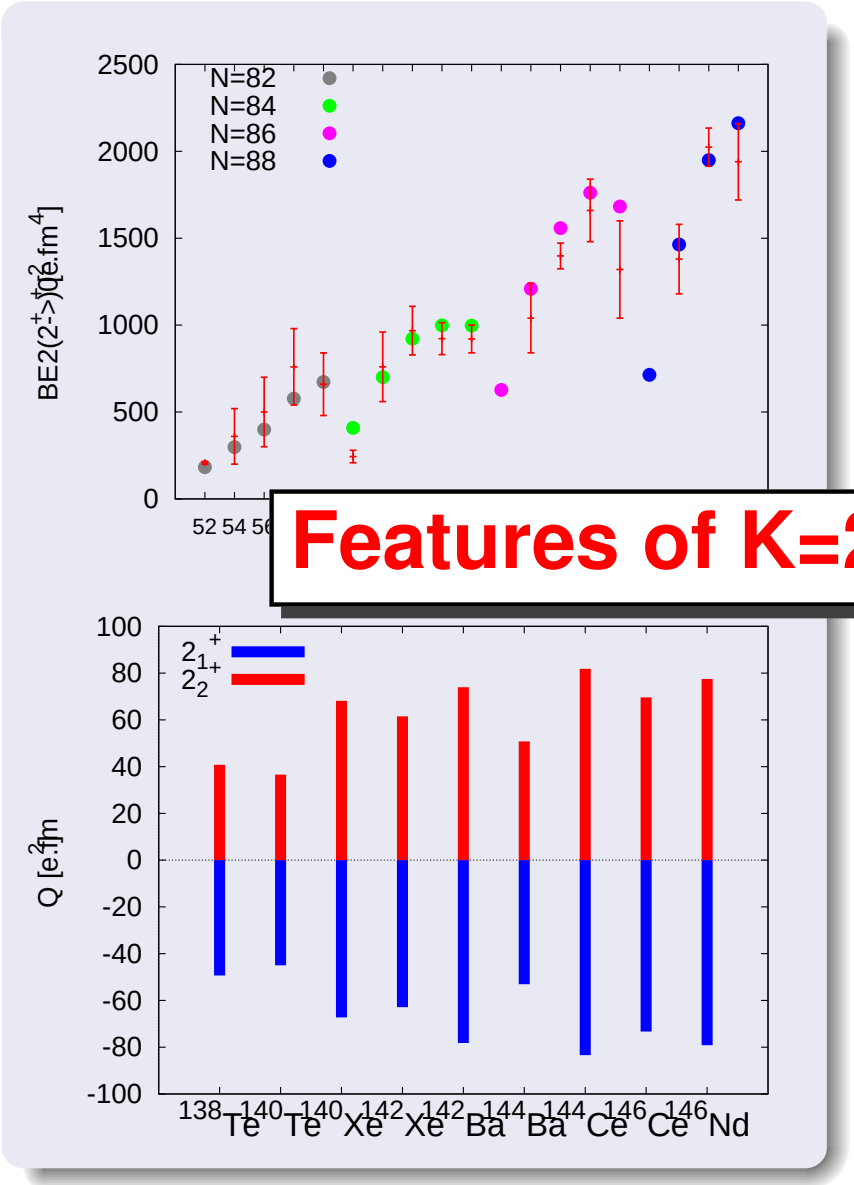
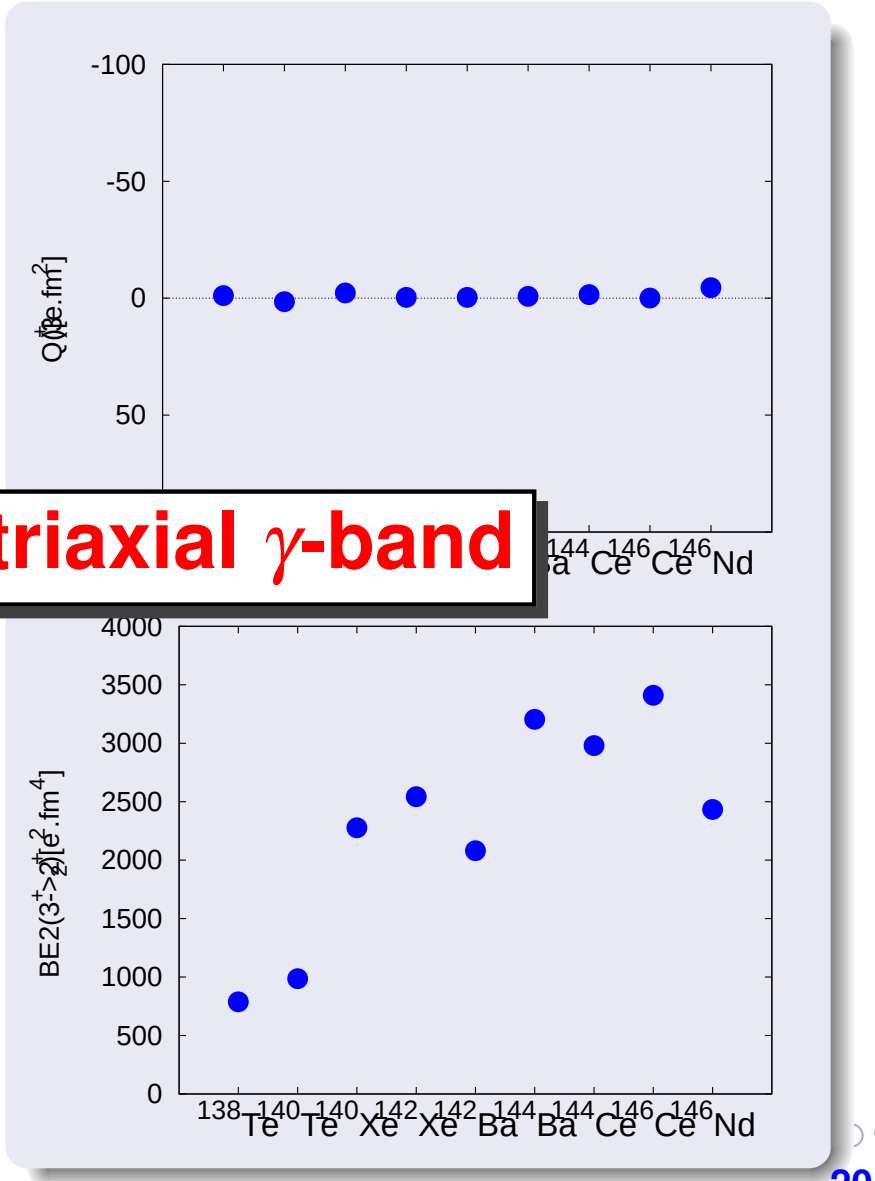
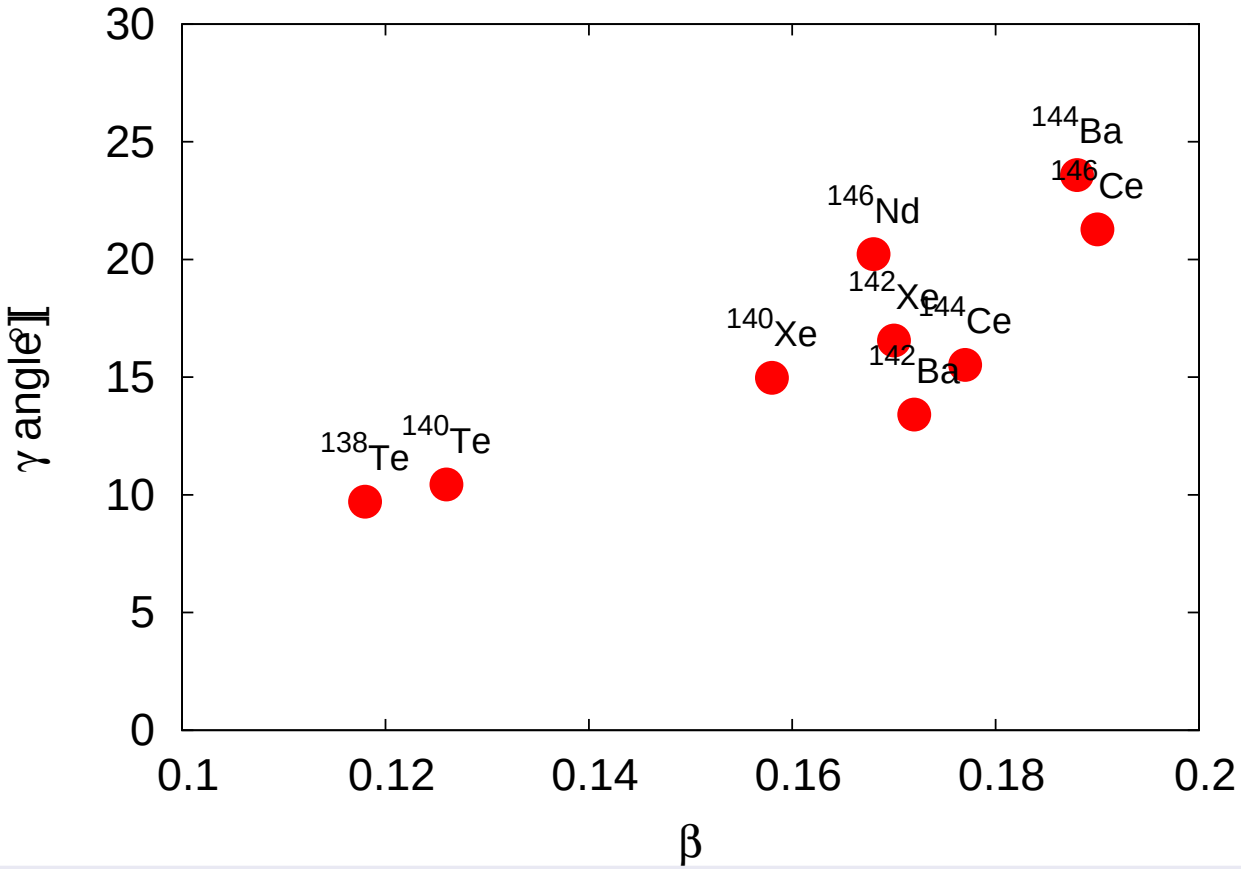


Features of K=2 triaxial γ-band



Deformation parameters

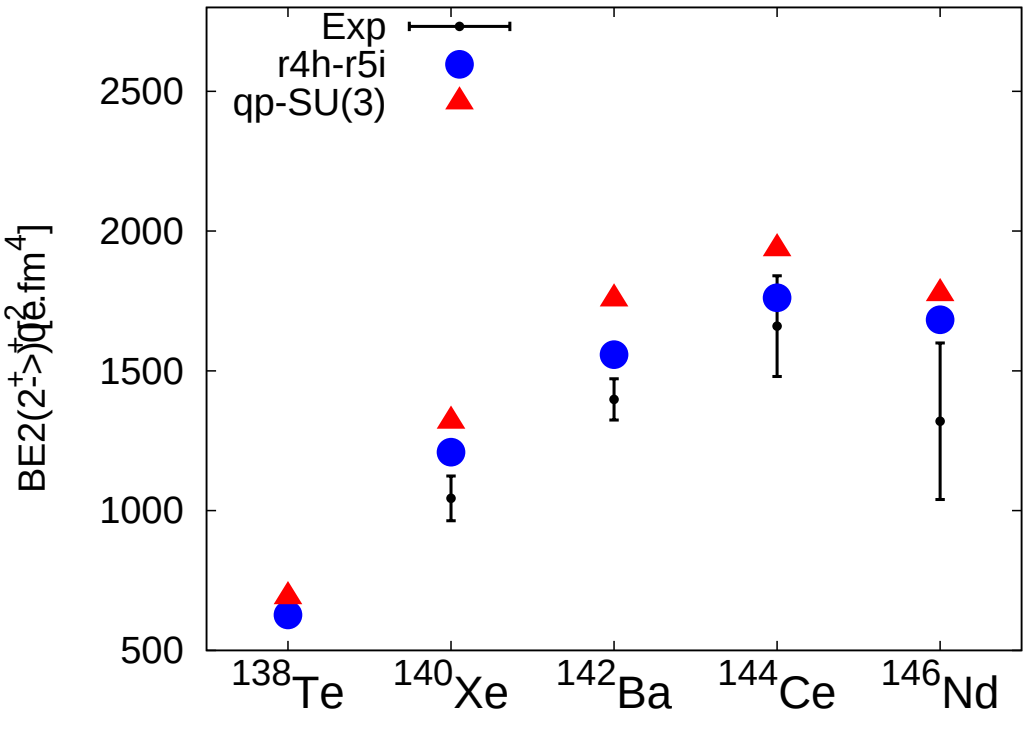
β deformation parameter and γ angle*

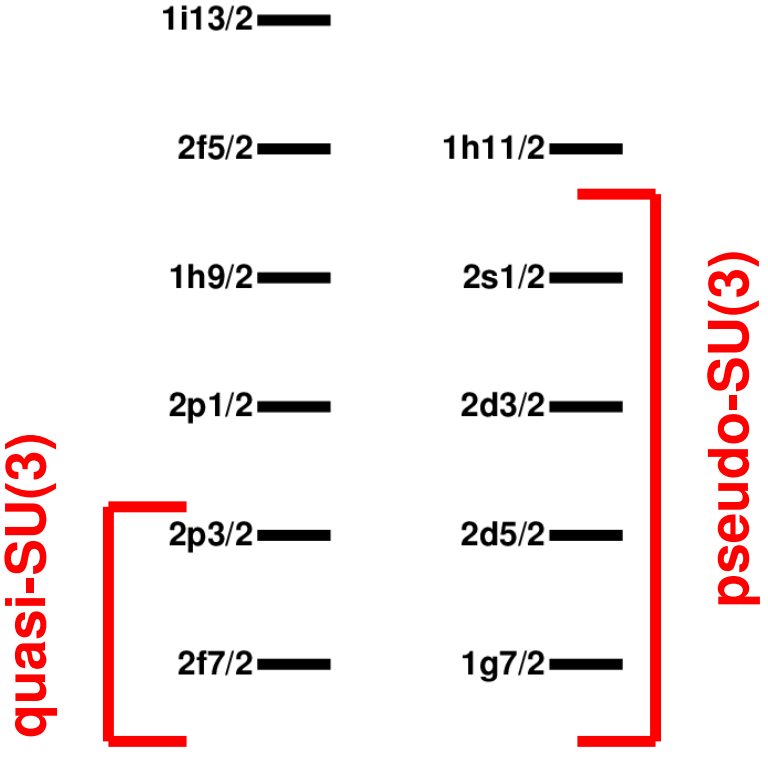


- Mild deformation in ^{138}Te and ^{140}Te.
- Increase in deformation with non-axiality from ^{140}Xe to ^{146}Nd.
- The maximum of the collectivity in ^{144}Ba and ^{146}Ce

(*) K. Kumar, PRL 28, 249 (1972)

SU(3) symmetries vs collectivity

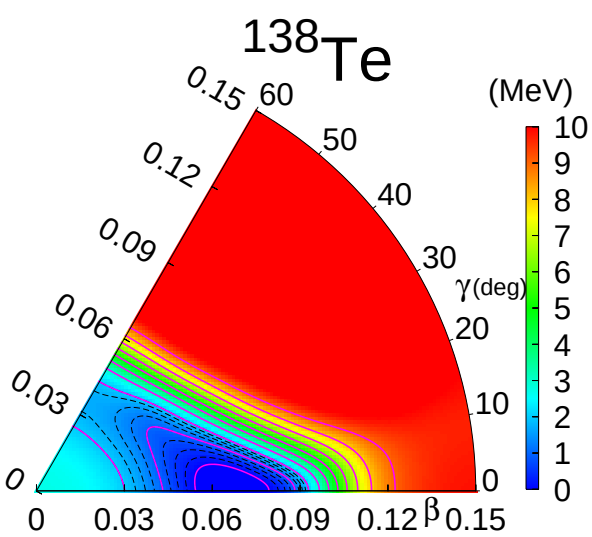


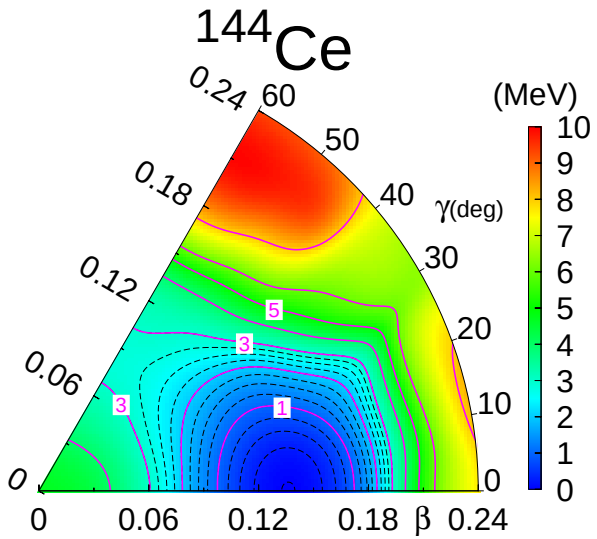


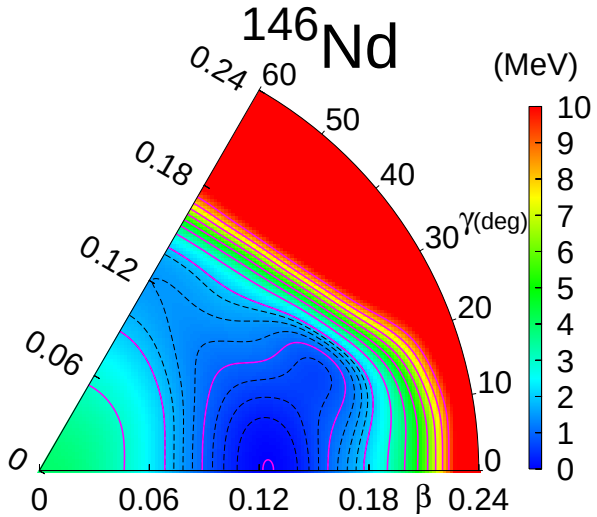
- minor impact of pseudo-SU(3) / quasi-SU(3)
- Excitations to $\pi h_{11/2}$ reduce the collectivity due to the pairing effect, which confirms our previous conclusion in ^{140}Sm analysis with ^{100}Sn core

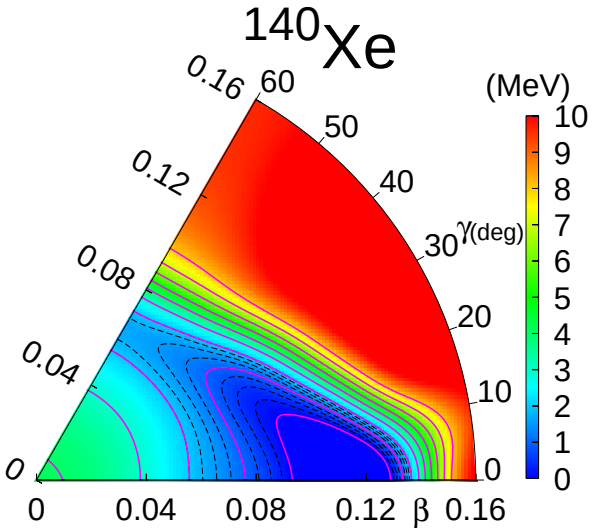
  M.Klintefjord, *et al*, PRC 93, 054303 (2016)

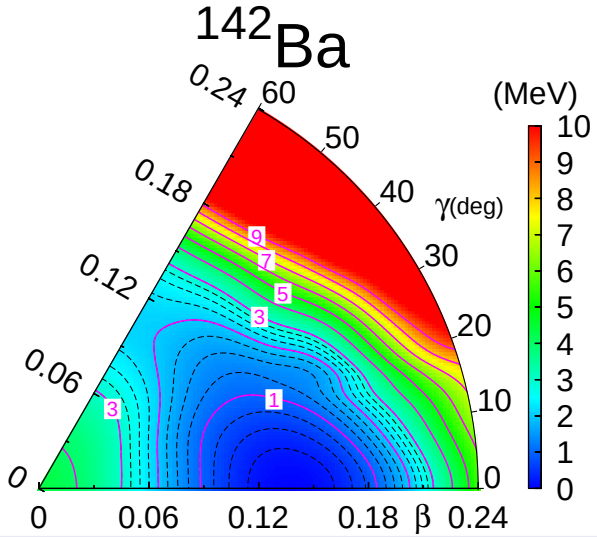
PES with CHFSM









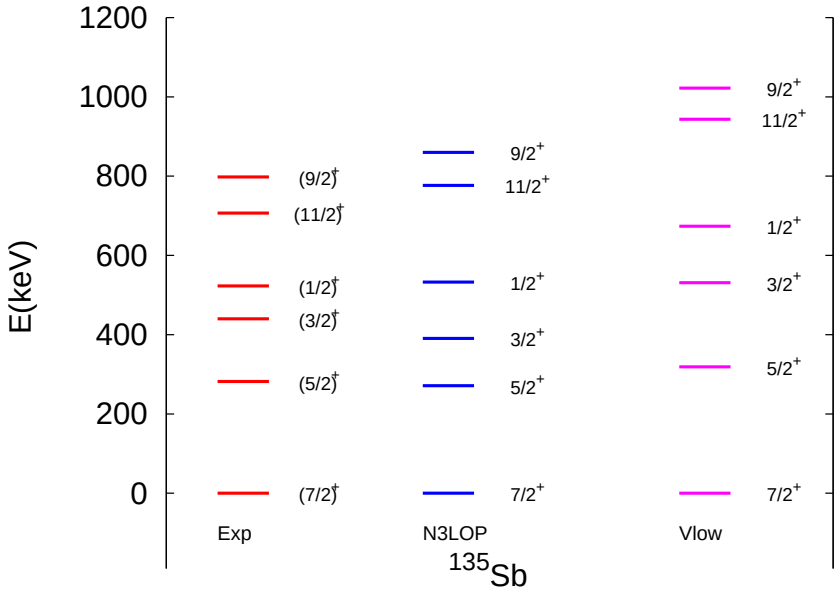


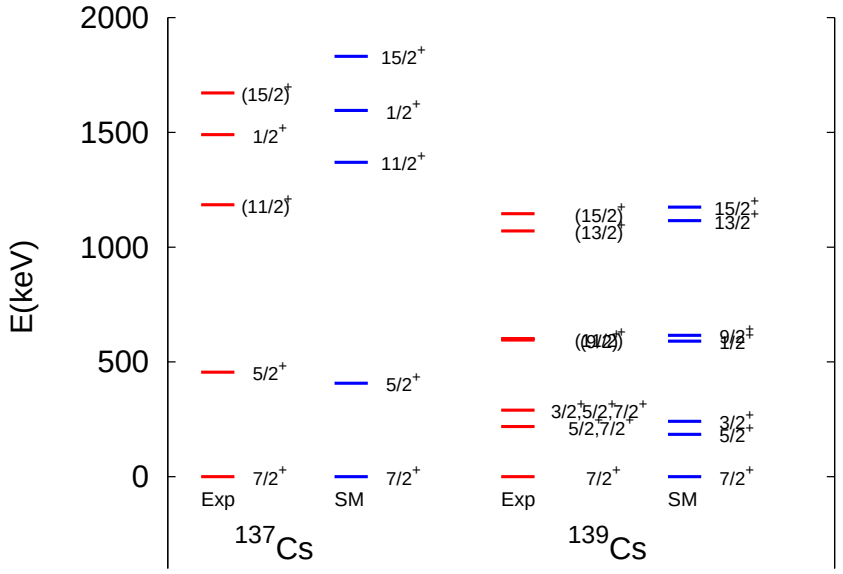
Presence of triaxial minima

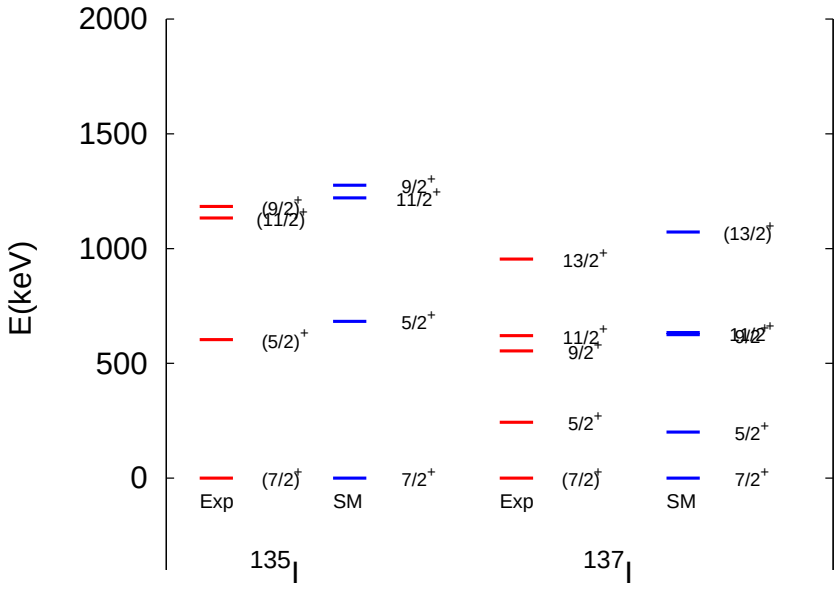
- CHFSM is an approach developped by Strasbourg SM group :
  B. Bounthong, PhD Thesis, Université de Strasbourg (2016)
- The same SM Hamiltonian (N3LOP) and the same model space (r4h-r5i) are used
- (β, γ) are consistent with Kumar

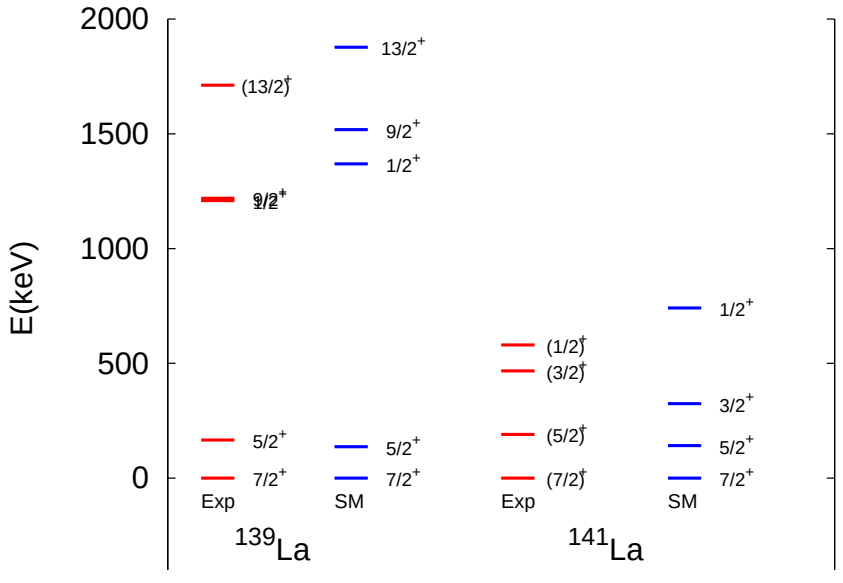
Part II : Even-odd and odd-even nuclei

odd-even nuclei : Sb, I, Cs, La

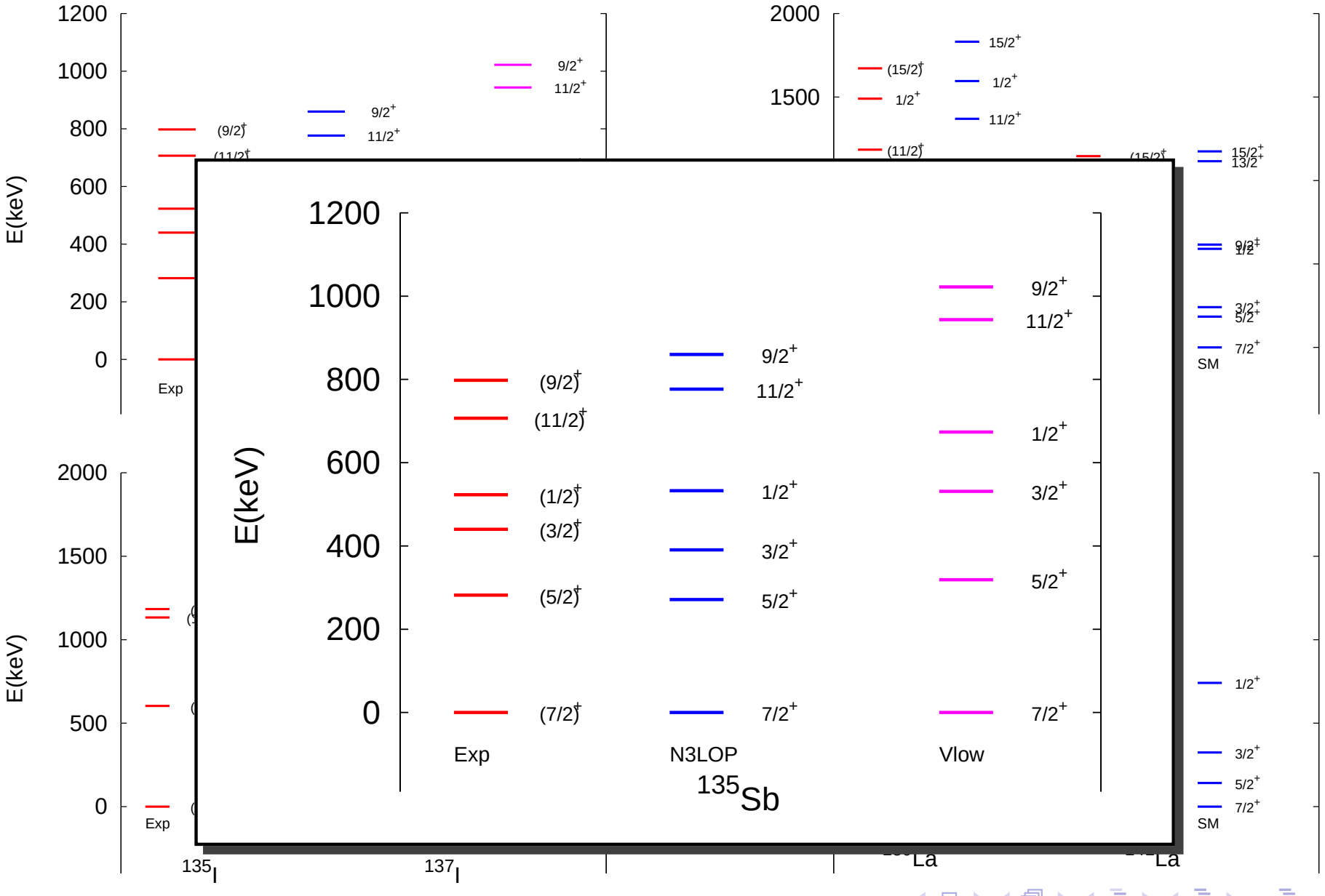




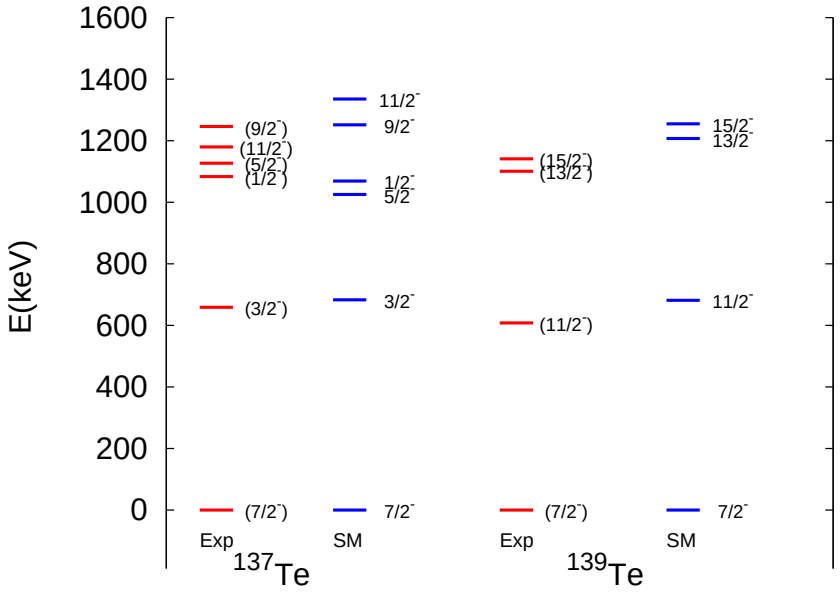


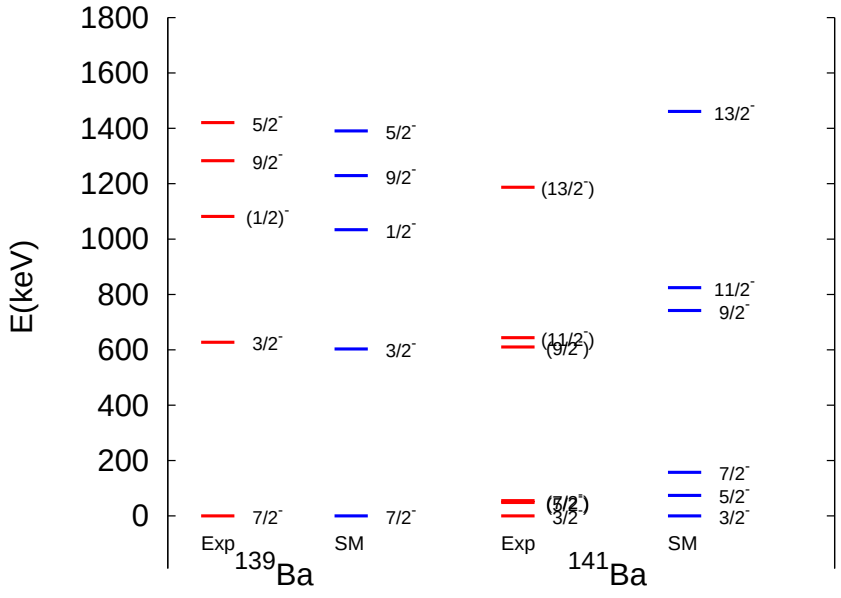


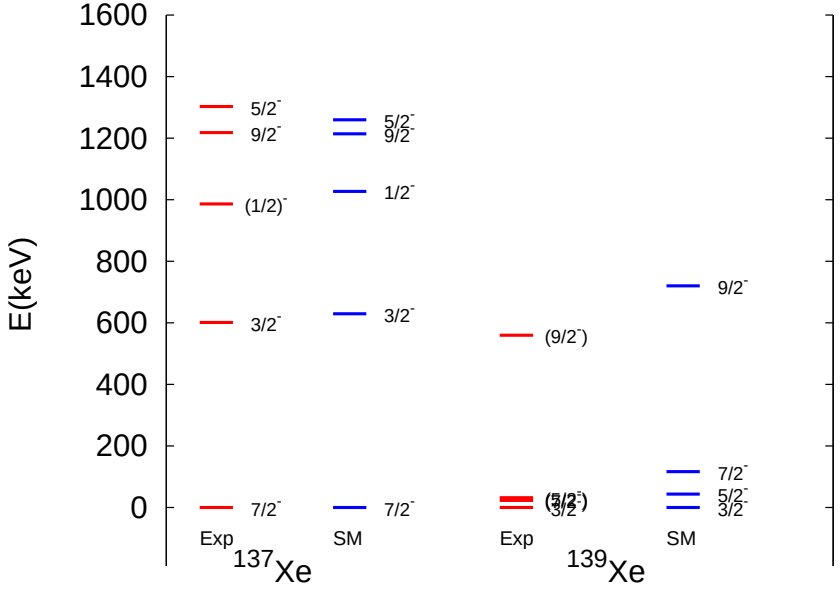
odd-even nuclei : Sb, I, Cs, La

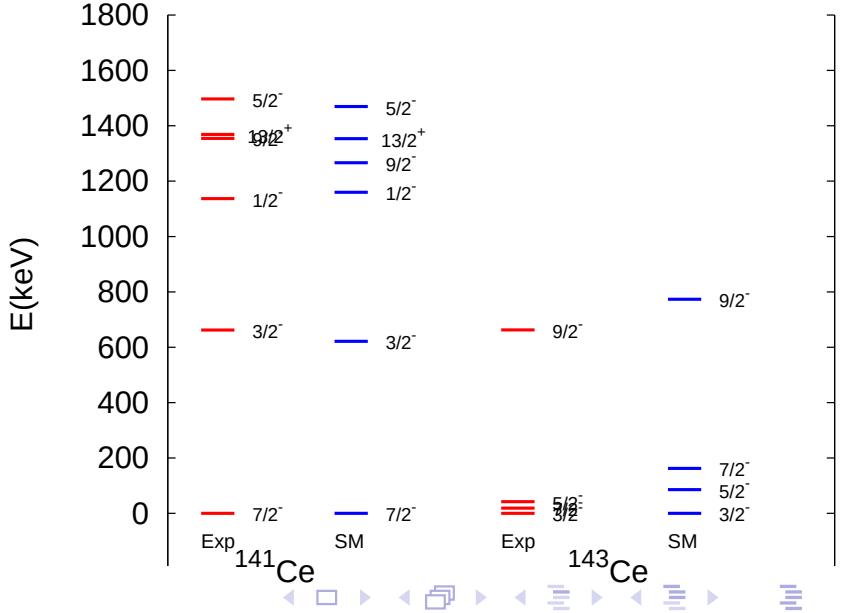


even-odd nuclei : Te, Xe, Ba, Ce



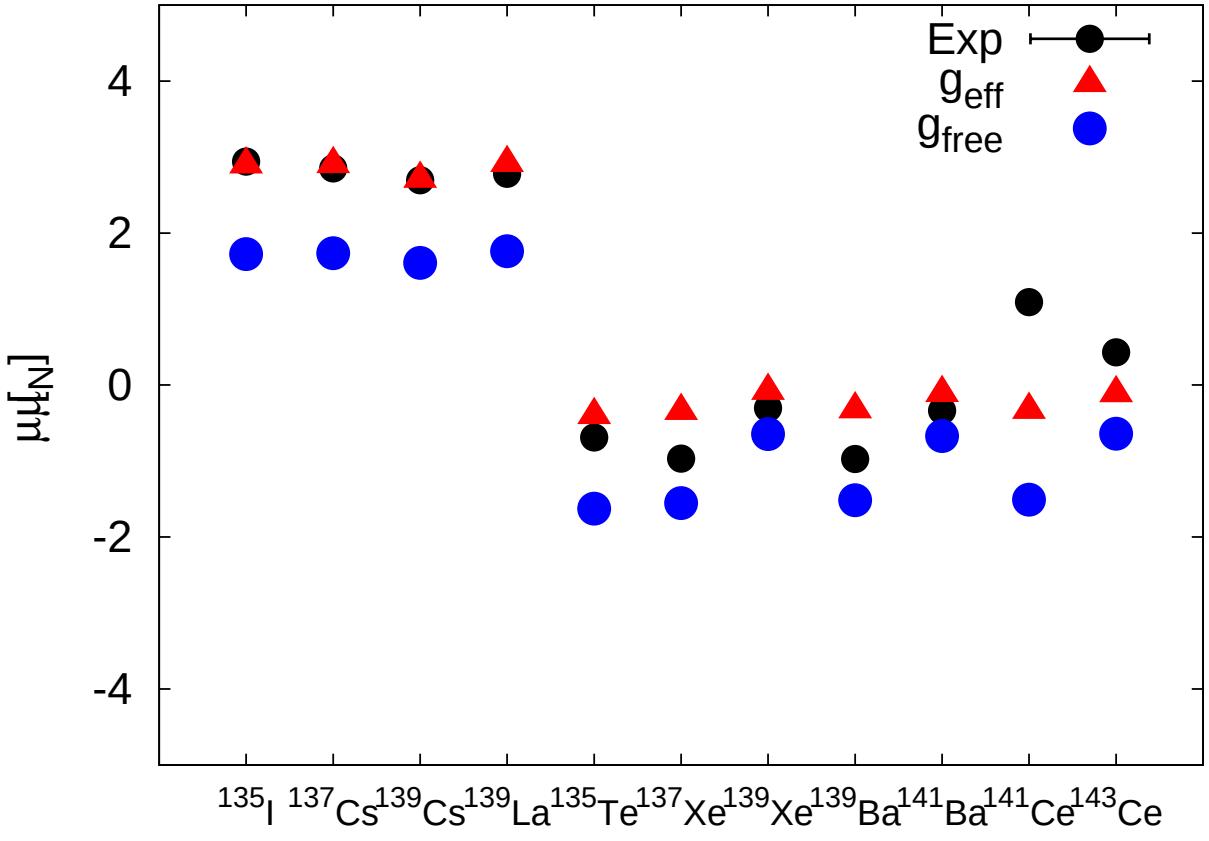






Magnetic dipole moment

$\mu_{GS}(7/2^+, 7/2^-, 3/2^-)$



- using the effective g factors the agreement with the data is far more satisfying than using the free g factors.
- a disagreement in $\mu(7/2^-)$ of ^{141}Ce remains unexplained.

Conclusions and Perspectives

- ✓ Our results achieved using N3LOP are in good agreement compared to the data.
- ✓ First signs of the collectivity in the N=86,88 isotones was shown, with the signature of triaxial γ band.
- ✓ Evolution of the collectivity is sensitive to SU(3) symmetries of neutrons and protons orbits sequence and to the excitations to $h_{11/2}$
- ✓ These applications constitute a stringent test of N3LOP interaction, and our predictions are a benchmark for future experimental measurements.

☞ Extension of the calculations to higher mass number along isotopic and isotonic chains

☞ Explore the octupole correlations