Towards symmetry unrestricted Skyrme-HFB: Rotation of exotic shapes.

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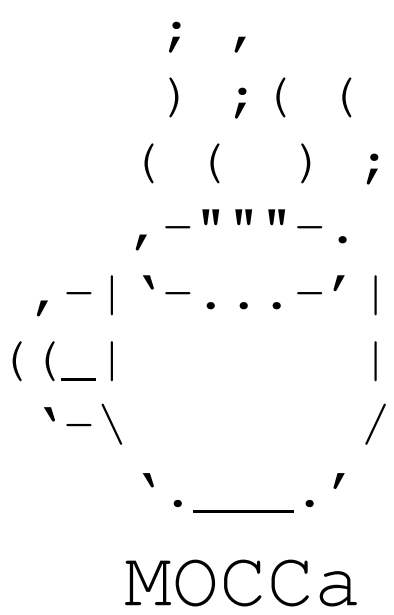
7th of November 2017

Introduction: DFT with MOCCa

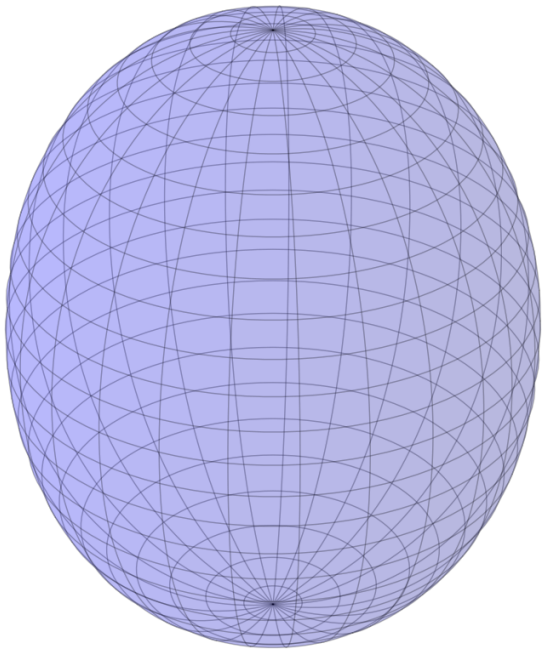


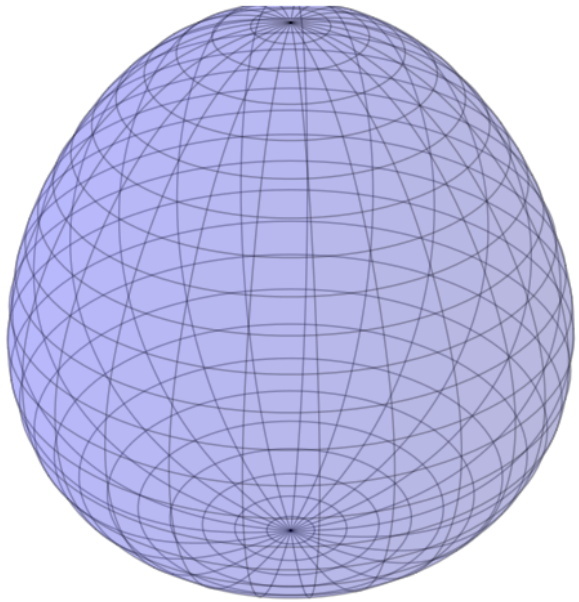
- Skyrme Density Functionals
  - Up to N3LO in Skyrme.
  - SLy5s1 here (mostly)
  - Adjusted on radii and binding energies of a few spherical nuclei
- 3D coordinate representation
  - Accuracy indepent of shape
  - Controllable accuracy
- Discrete symmetry breaking
  - Subgroups of $\mathcal{D}_{2h}^{TD}$
  - 16(!) different combinations
- Pairing: Full HFB
  - For every symmetry combination
  - Non-trivial for signature breaking

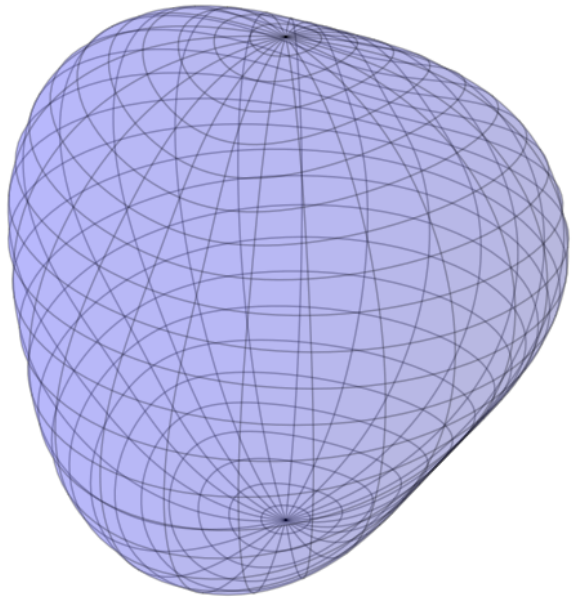
Exotic shapes

Less symmetries $\Rightarrow$ more shapes

Prolate	Octupole	Non-axial octupole







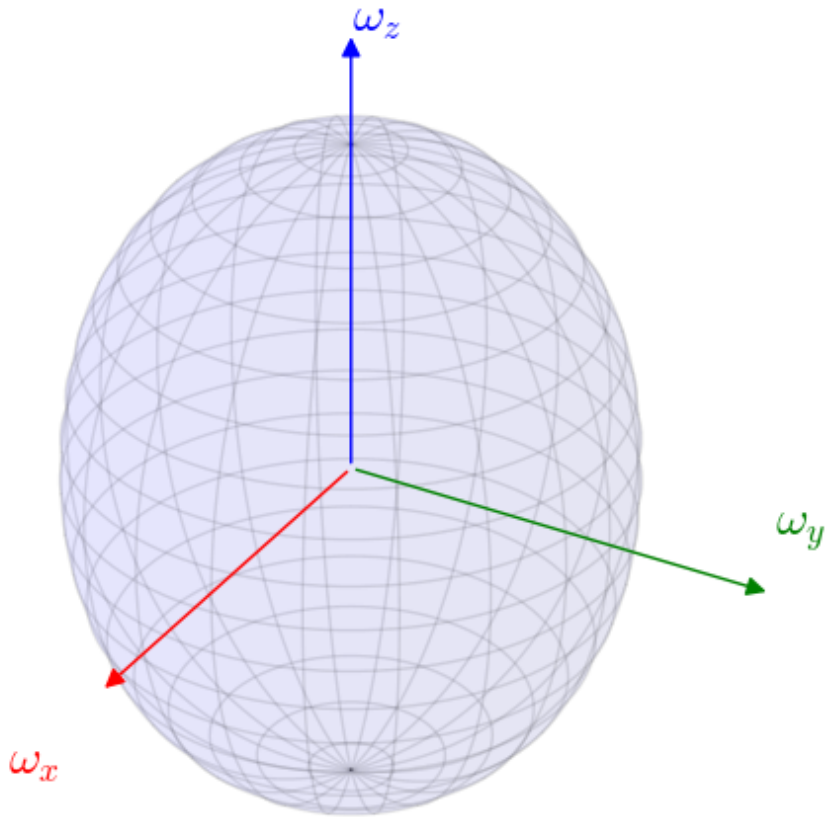
Angular momenta

Skyrme-HFB cranking Routhian.

$$R = E - \omega_x \hat{J}_x - \omega_y \hat{J}_y - \omega_z \hat{J}_z$$

Symmetries

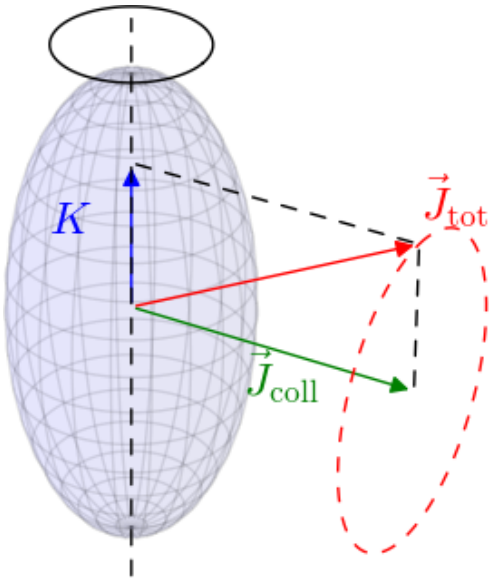
$\check{T}$	~~Time-reversal~~
$\hat{R}_y, \hat{R}_z$	~~y,z-signature~~
$\hat{R}_x, \hat{R}_z$	~~x,z-signature~~
$\hat{R}_x, \hat{R}_y$	~~x,y-signature~~



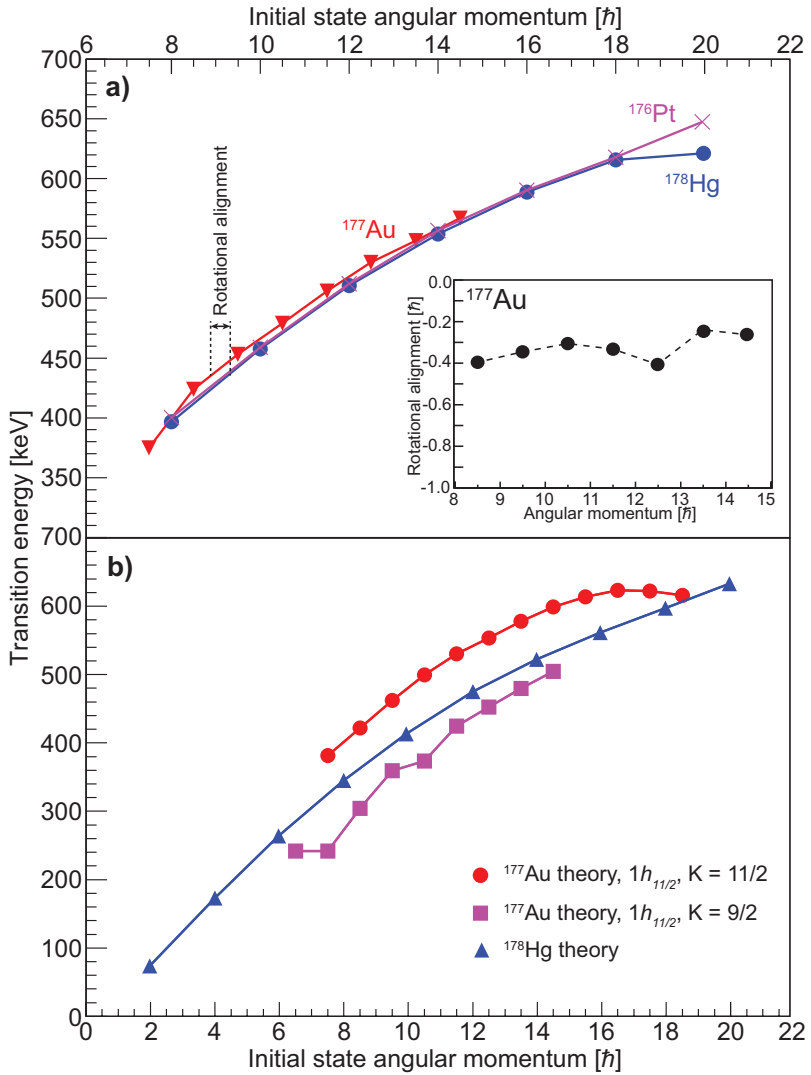
Strong coupling

Strong-coupling scheme (for ≈ axial nuclei)

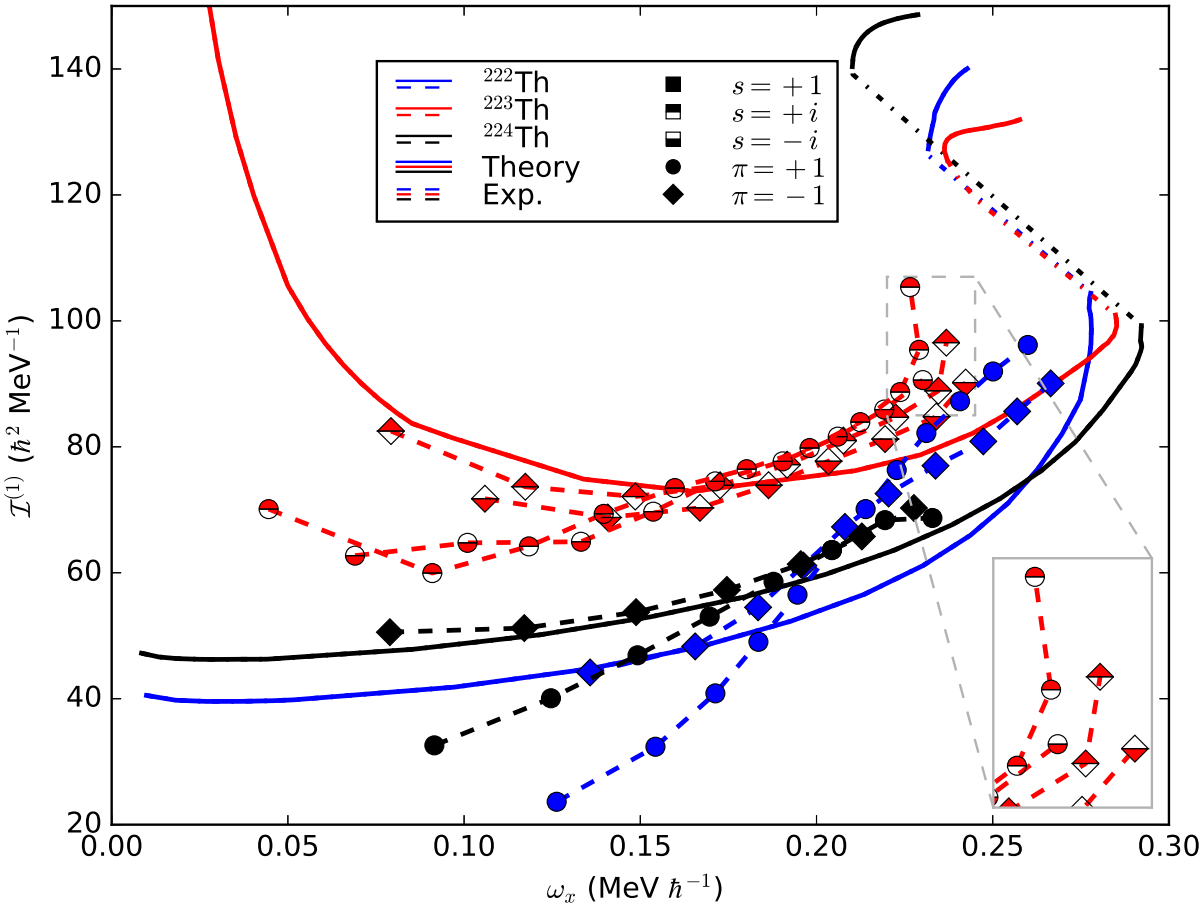
$$J(J+1) = |\vec{J}_{\text{tot}}|^2 = J^2_{\text{coll}} + K^2$$



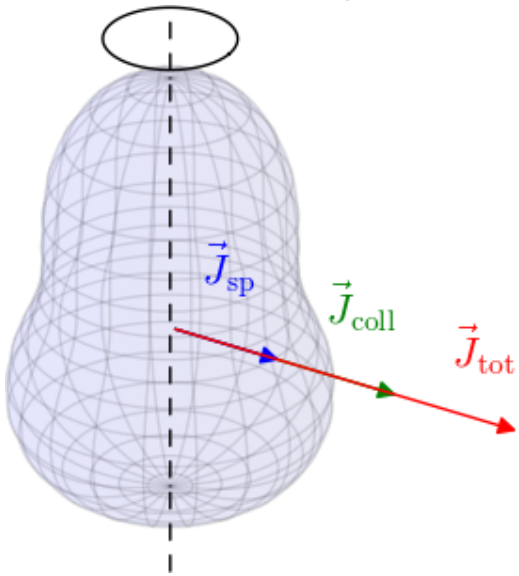
M. Venhart, W.R., M.B. P.-H.H, *et al.*
PRC 95, 061302 (2017)



Octupole rotation: ^{223}Th



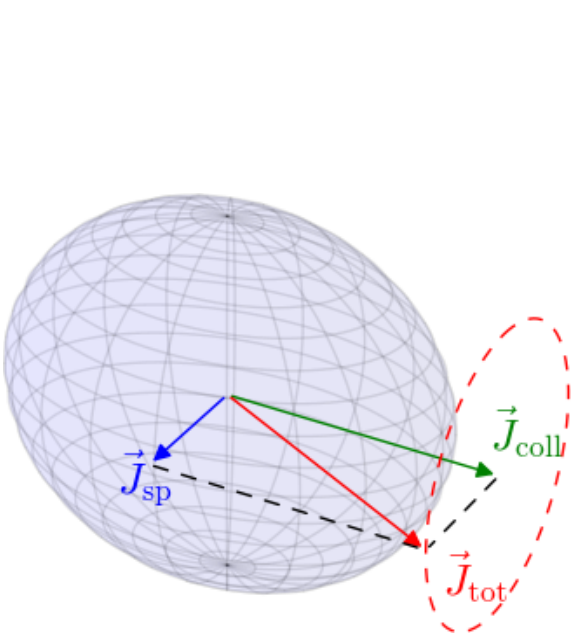
Complete alignment

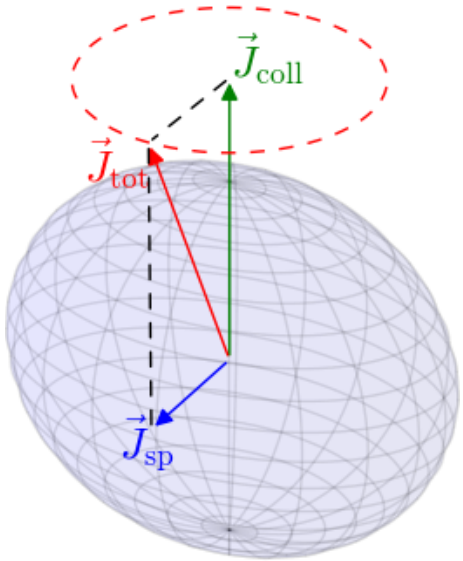


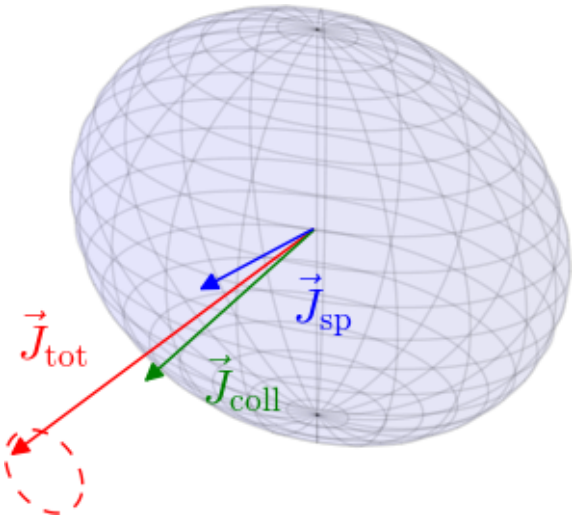
W.R., P.-H.H. and M.B.,
in preparation.

Triaxial ^{135}Pr: PAC

Principal **A**xis **C**ranking, based on $\pi(h11/2)$ odd proton.



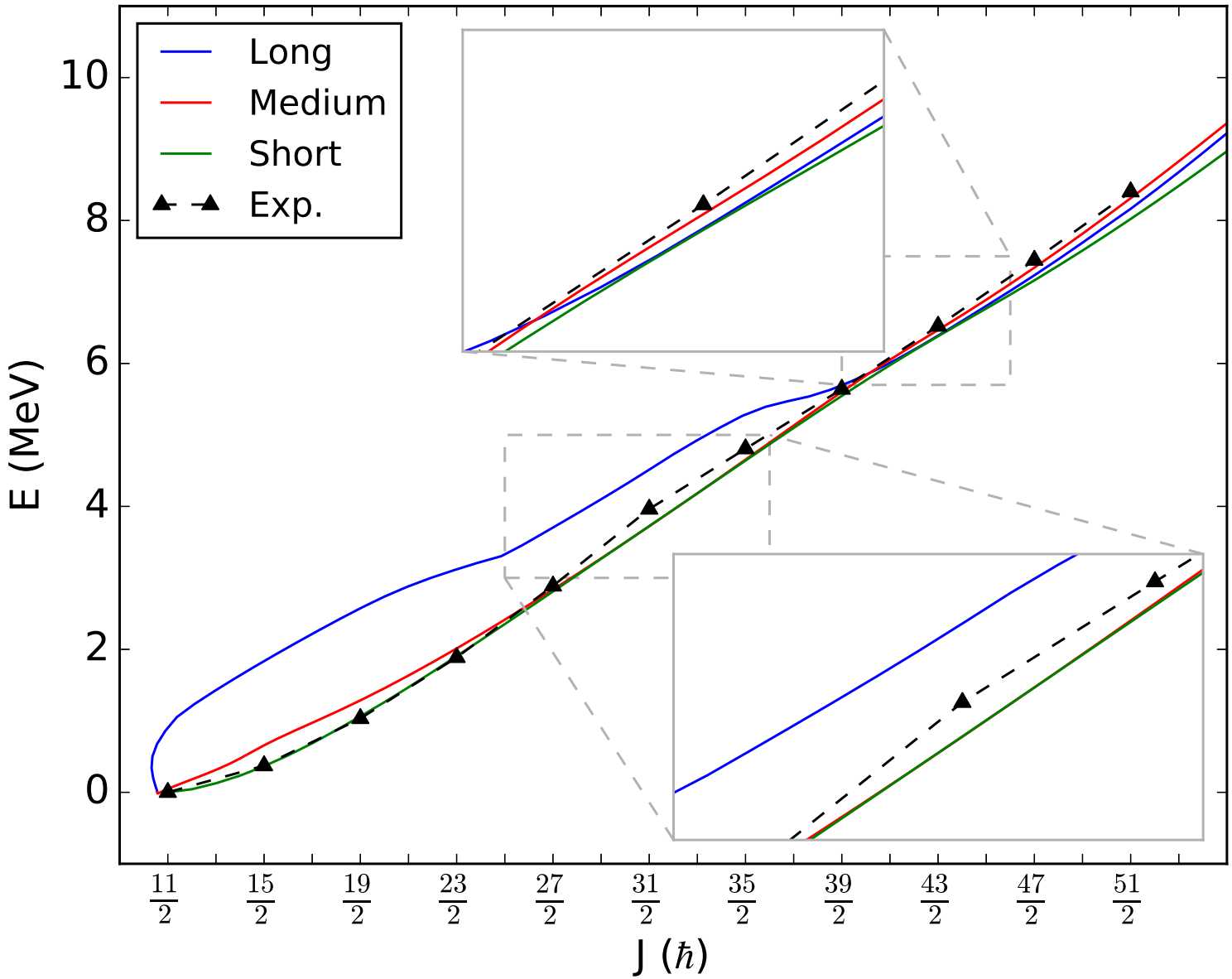




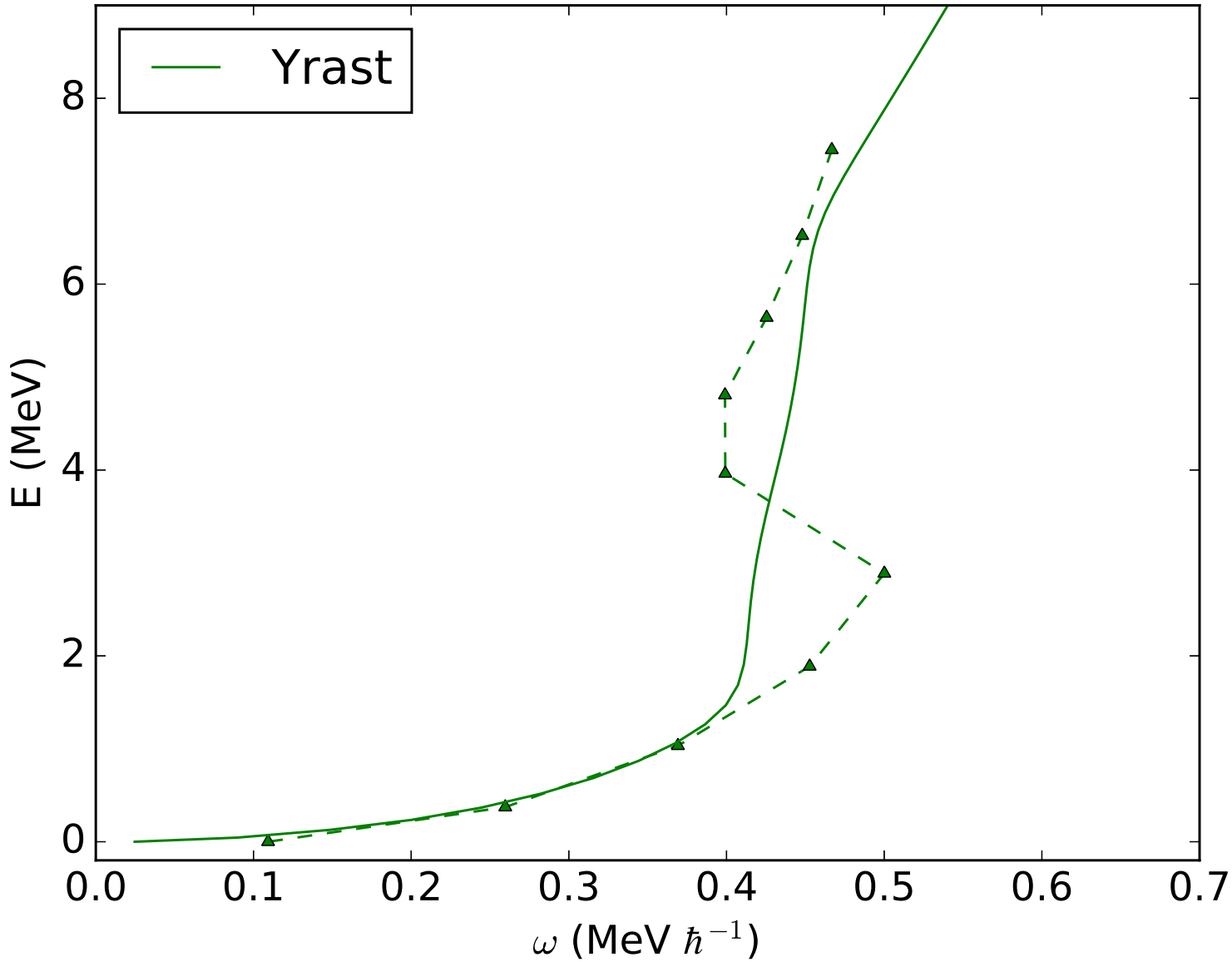
Long	Medium	Short

All experimental data from
J.T. Matta *et al*, Phys. Rev. Lett. **114**, 082501 (2015).

Negative parity yrast band in $^{135}_{59}$Pr



Backbending of the yrast band (PAC)



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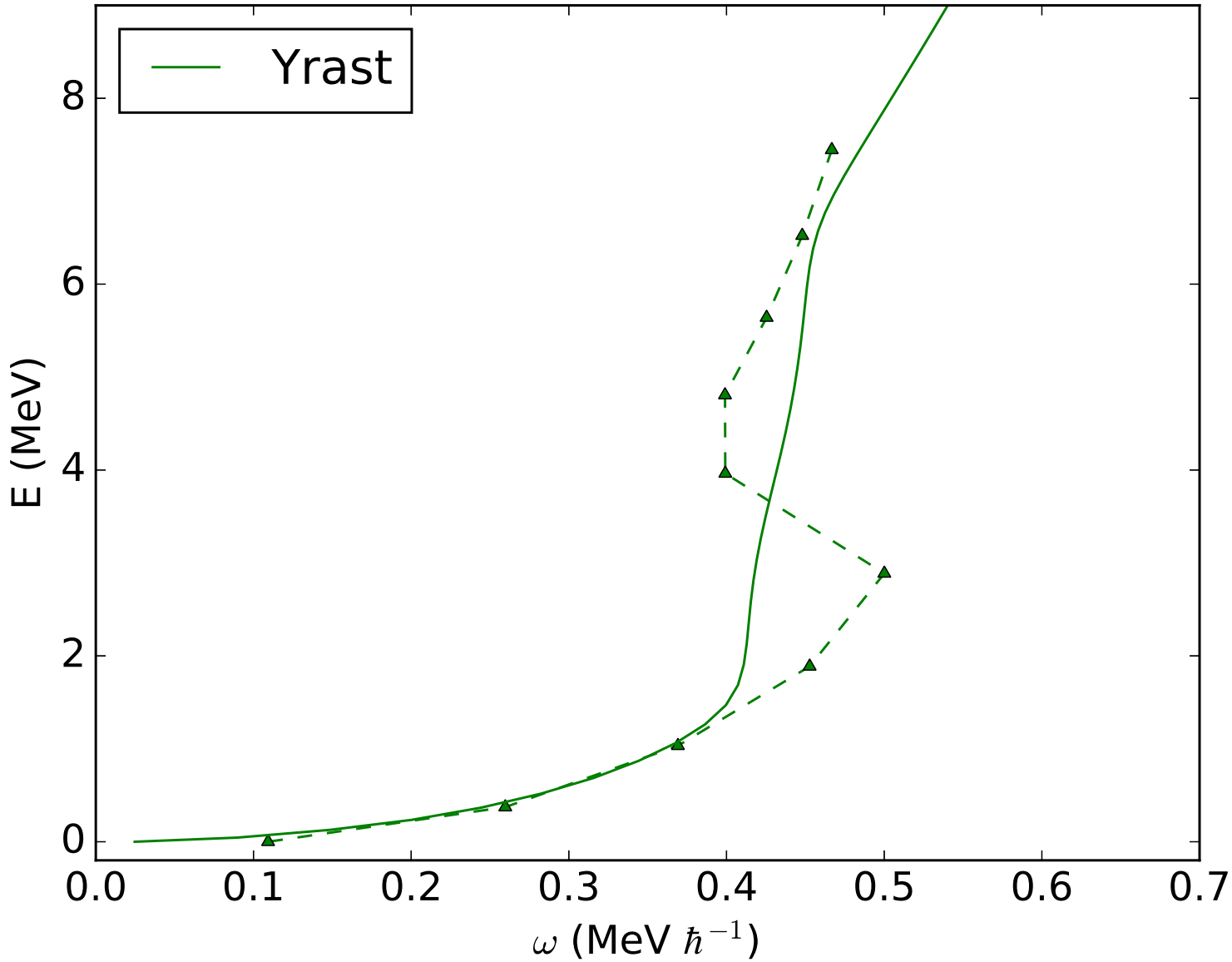

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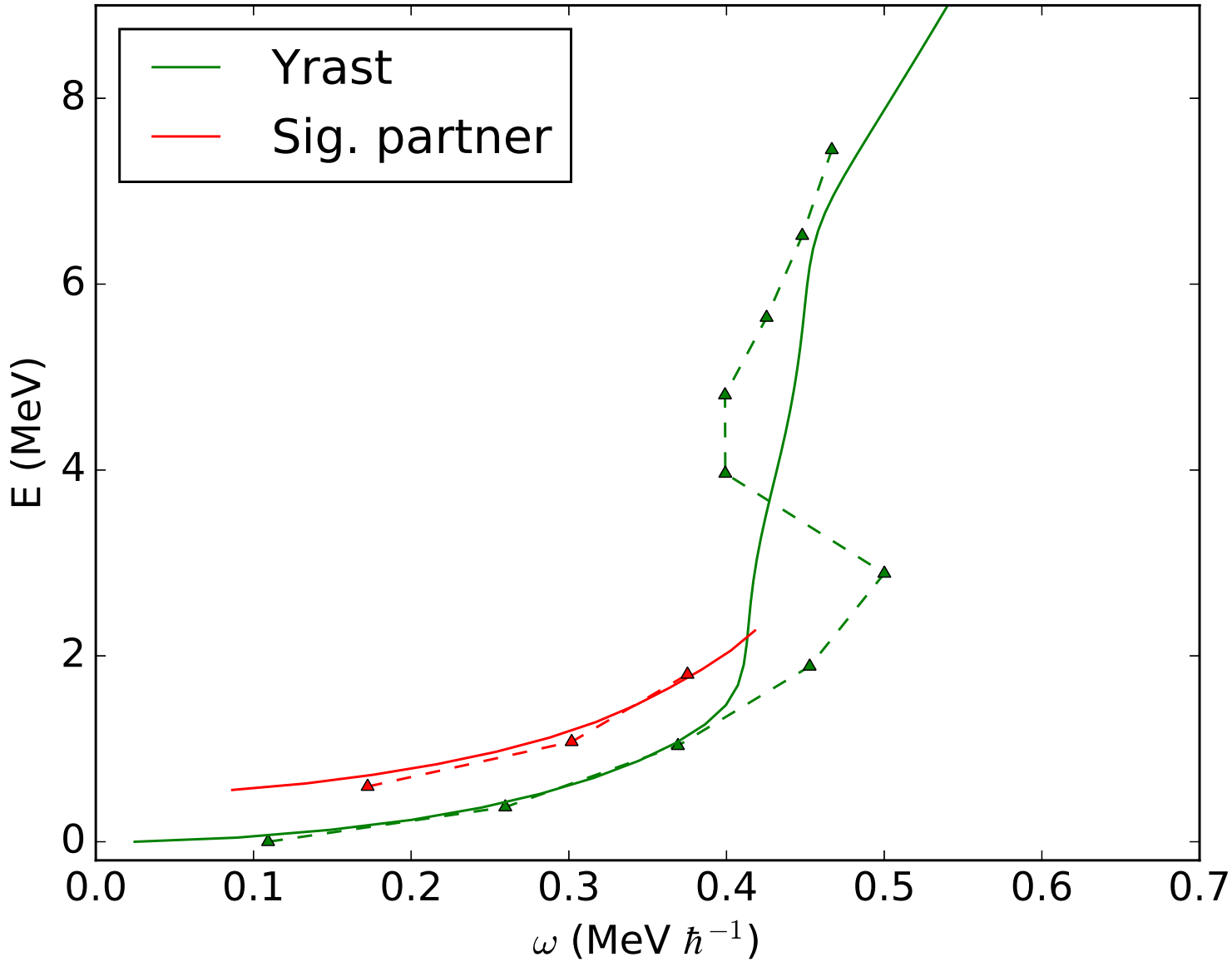
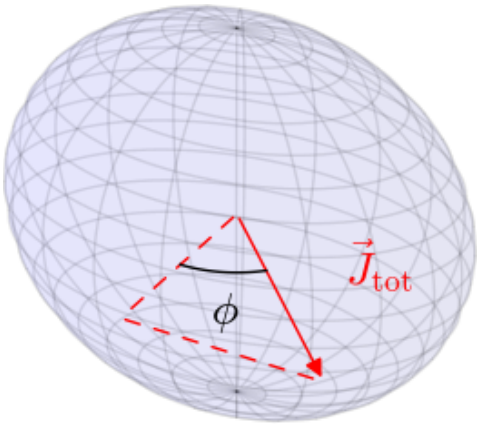
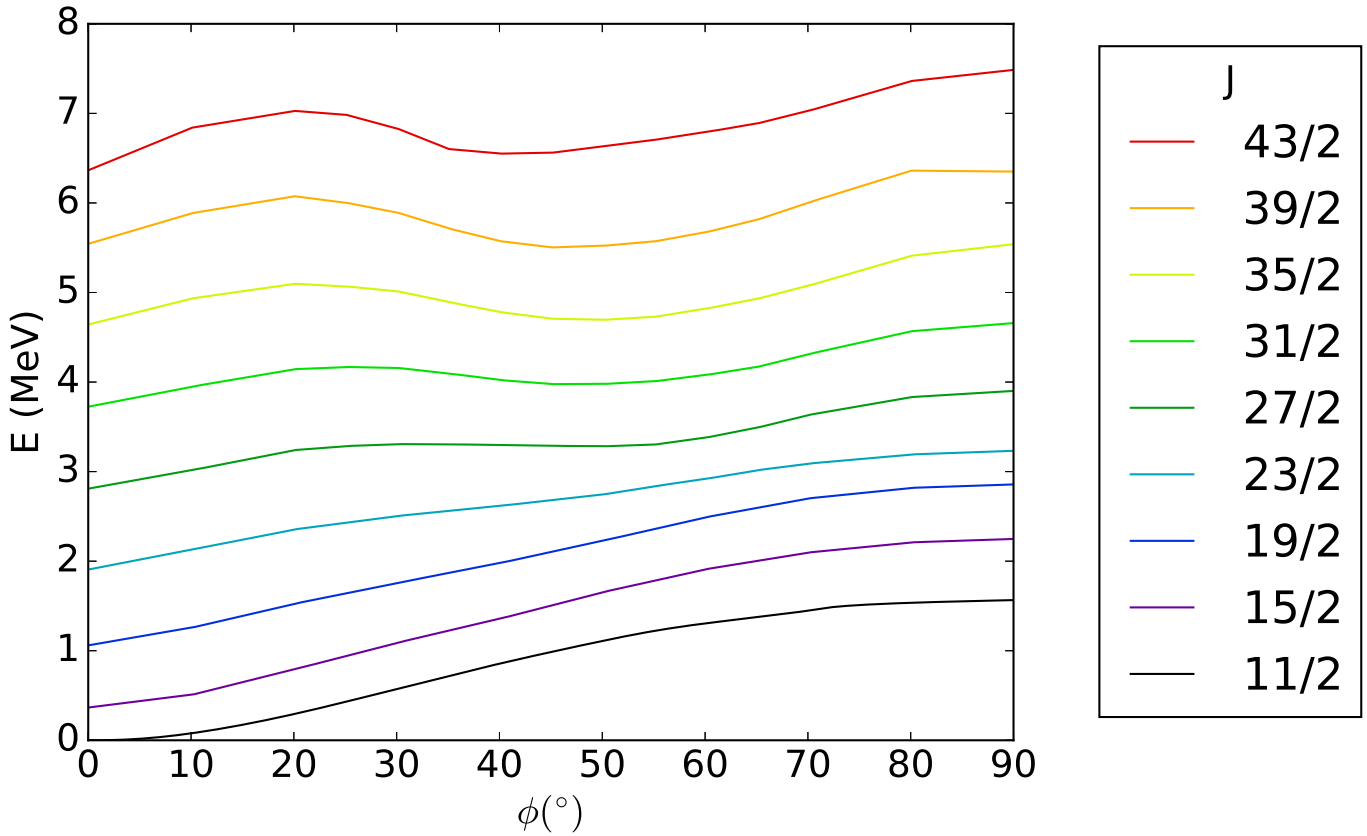


Tilted axis cranking (TAC): high spin





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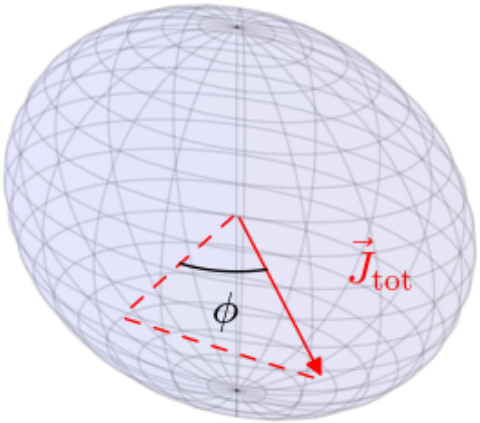
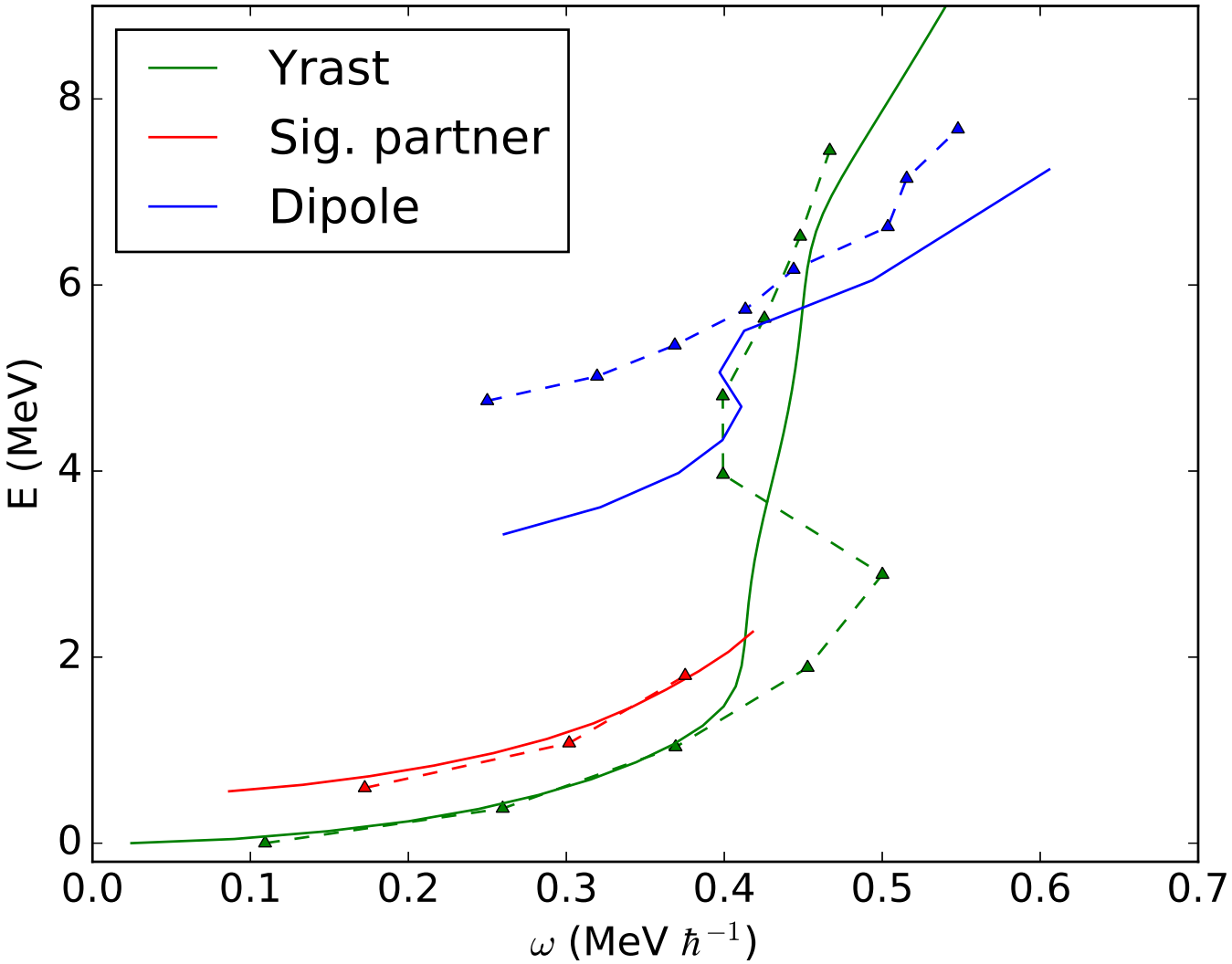
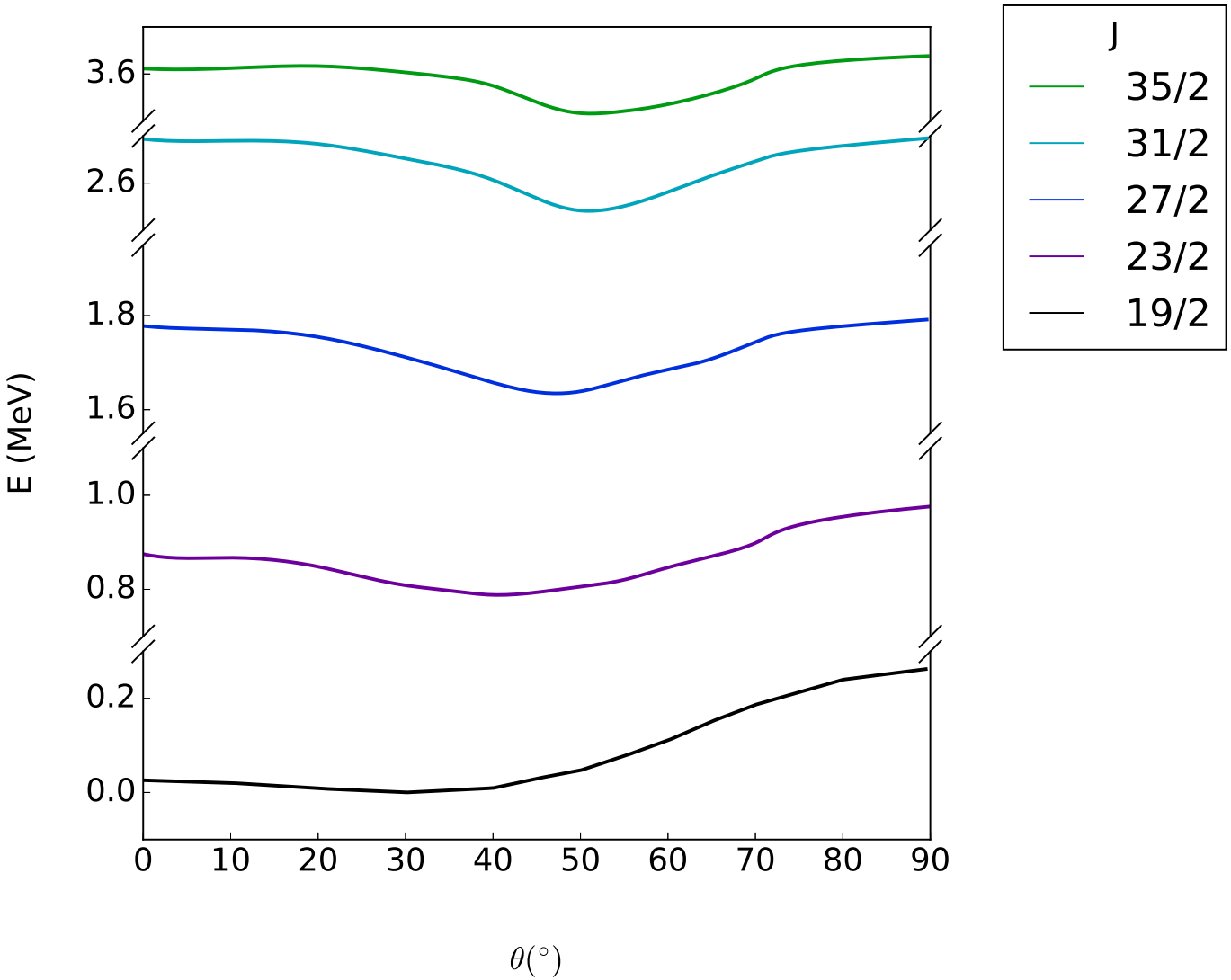
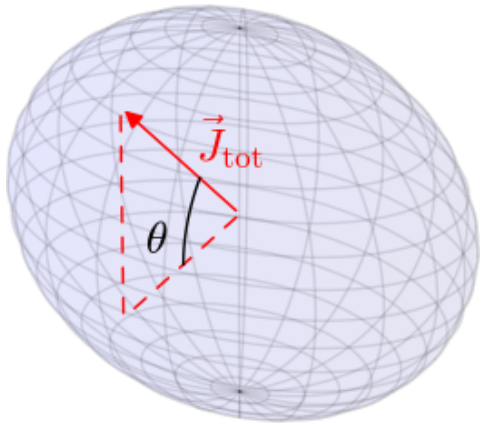




Tilted axis cranking (TAC): intermediate spin





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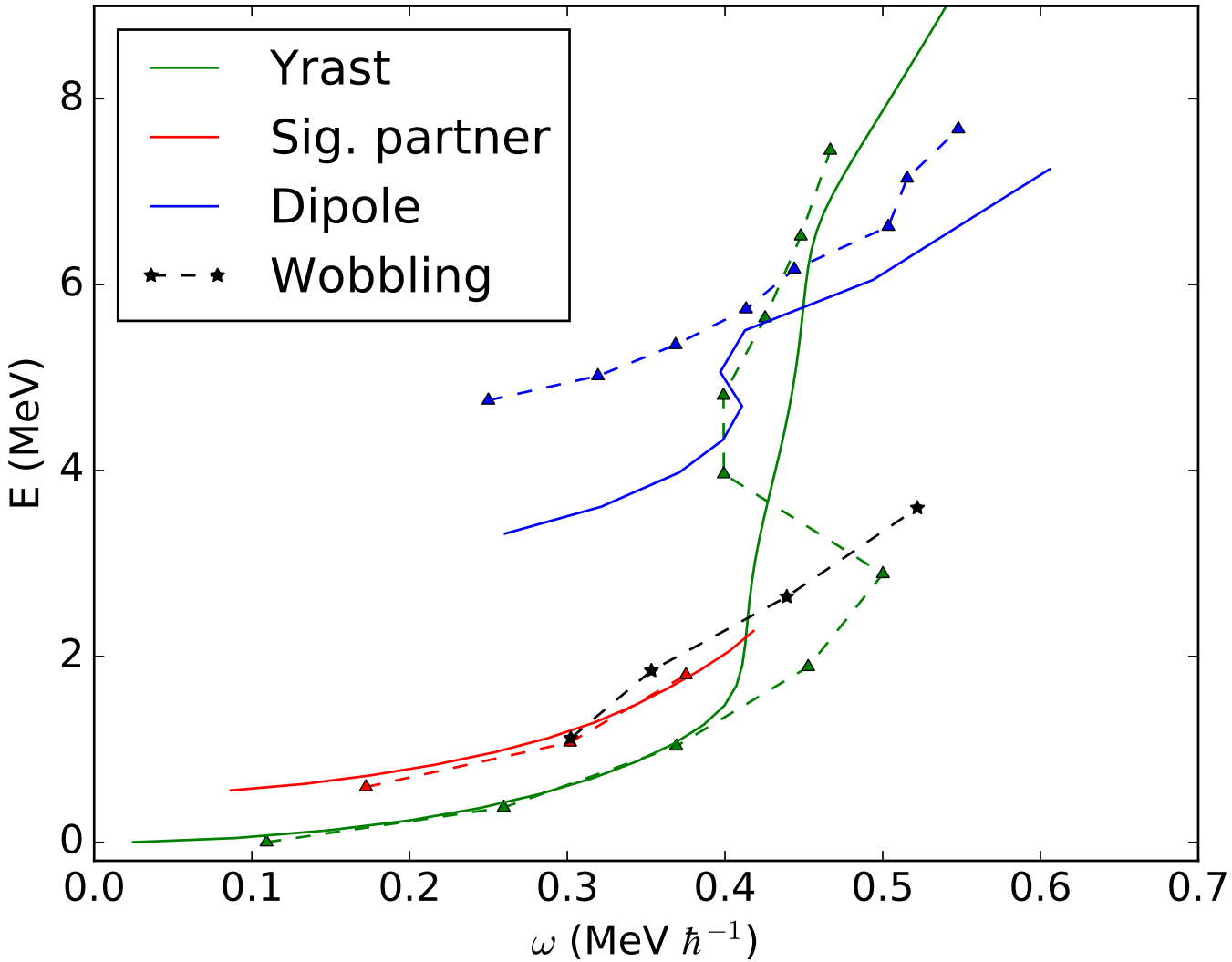

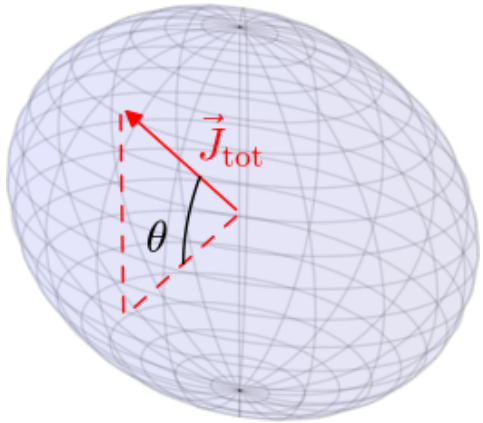

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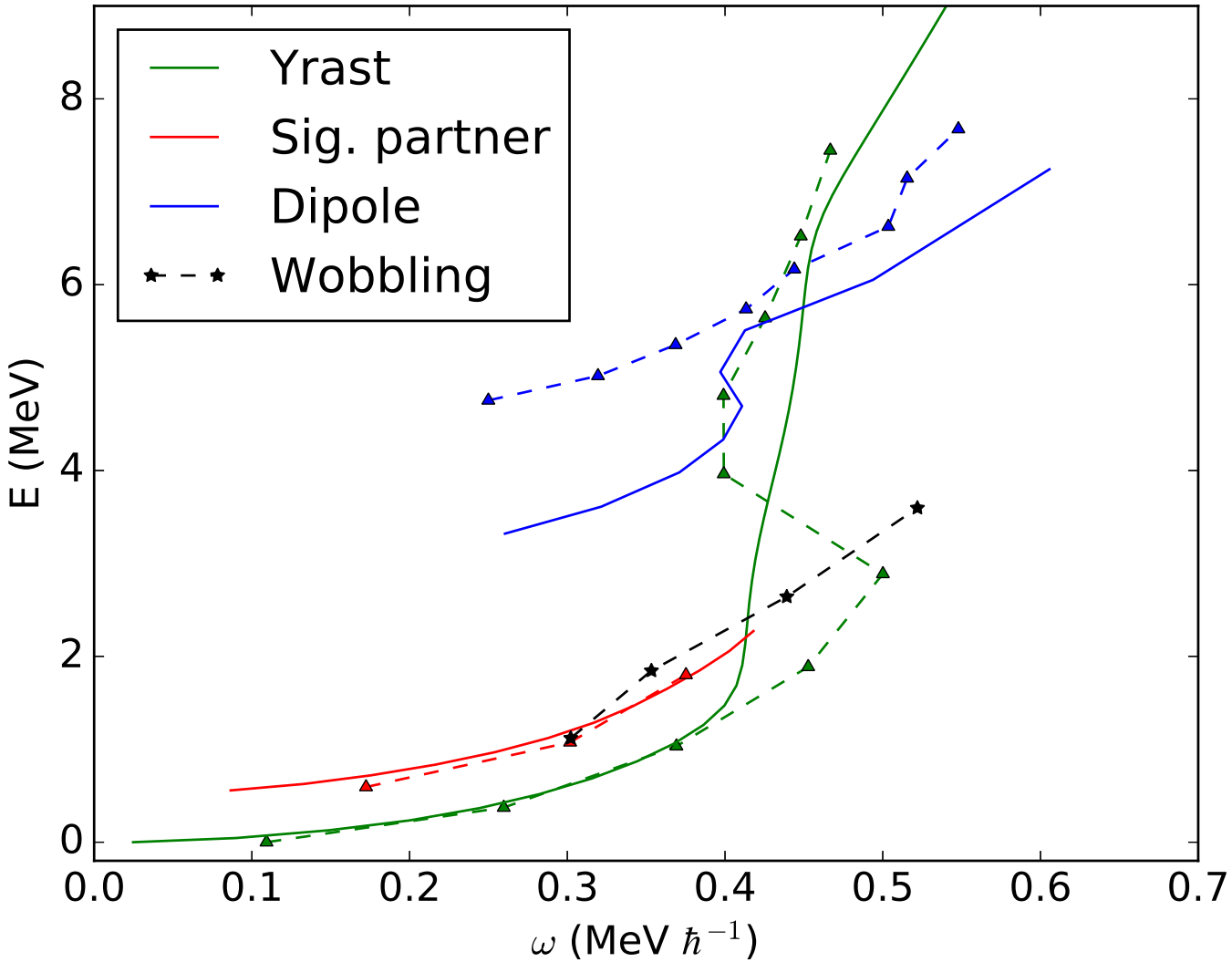

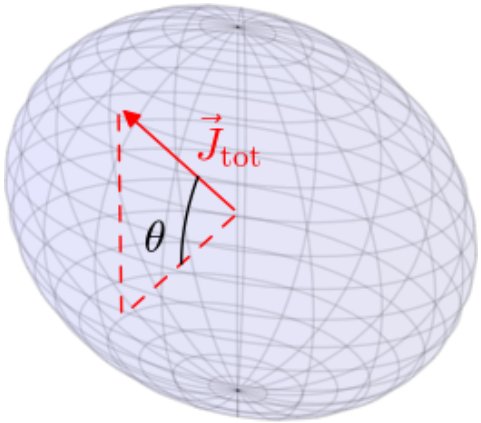

Symmetry restoration needed!

Conclusion

MOCCa is operational

- Unrestricted by symmetries
- Full HFB pairing

Rotational bands of odd nuclei

- Difficult to get J
- Can be modelled
- Alignment in ^{177}Au
- Octupole ^{223}Th

Reproduction of ^{135}Pr

- Correct band-head
- Yrast band
- Signature partner band
- Dipole band
- Possibility for wobbling

Thank you!

Collaborators

- M. Bender, CNRS/IPNL
- P.-H. Heenen, ULB
- K. Bennaceur, IPNL
- D. Davesne, IPNL
- B. Bally, UAM
- J. Meyer, IPNL
- V. Hellemans
- B. Avez

But also

- CC of the IN2P3, French computing resources.
- CECI, Belgian computing resources.
- You, for your attention.