Multiple chiral doublet bands in ^{104}Rh

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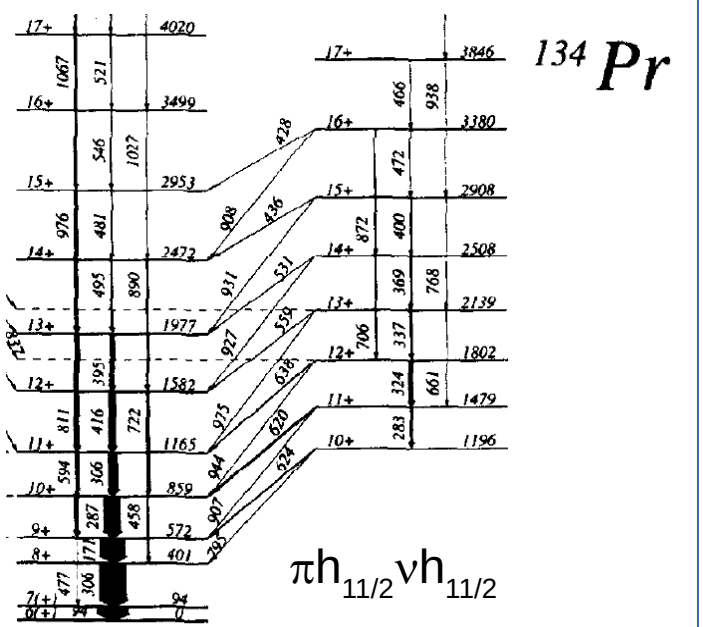
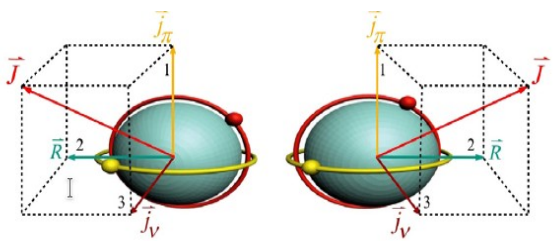
Nuclei chirality: First evidence



C. M. Petrache et al., Nucl. Phys. A597, 106 (1996).

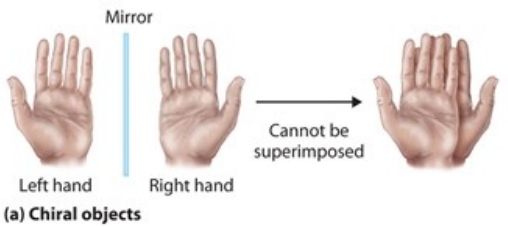


ELSEVIER
Nuclear Physics A 617 (1997) 131–147
NUCLEAR PHYSICS A

Tilted rotation of triaxial nuclei

S. Frauendorf, Jie Meng [1]
Institut für Kern- und Hadronenphysik, Forschungszentrum Rossendorf e.V., PF 510119, 01314 Dresden, Germany

Received 14 November 1996



(a) Chiral objects

Chirality apear in triaxial nuclei at high spin, chiral doublets have:

- ΔI=1 near degenerate pair
- Same configuration
- Same parity
- Similar electromagnetic behavior
- Small energy difference

Multiple chiral doublet bands

Possible existence of multiple chiral doublets in ^{106}Rh

J. Meng,[1,2,3,*] J. Peng,[1] S. Q. Zhang,[1] and S.-G. Zhou[2,3]
[1]*School of Physics, Peking University, Beijing 100871, China*
[2]*Institute of Theoretical Physics, Chinese Academy of Science, Beijing 100080, China*
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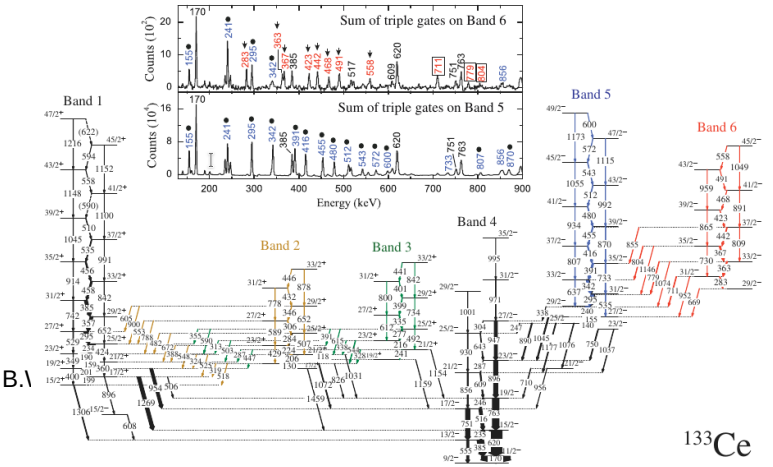
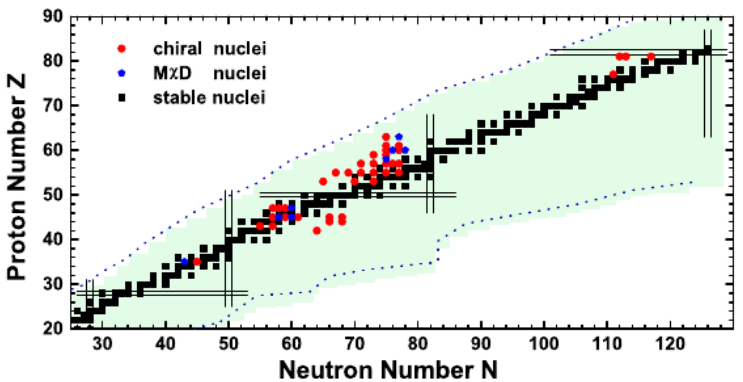
(Received 30 March 2005; published 15 March 2006)

Adiabatic and configuration-fixed constrained triaxial relativistic mean field (RMF) approaches are developed for the first time. A new phenomenon, the existence of multiple chiral doublets (MχD), i.e., more than one pair of chiral doublet bands in one single nucleus, is suggested for ^{106}Rh based on the triaxial deformations and their corresponding proton and neutron configurations.



B.\



Evidence for Multiple Chiral Doublet Bands in ^{133}Ce

A. D. Ayangeakaa,[1] U. Garg,[1] M. D. Anthony,[1] S. Frauendorf,[1] J. T. Matta,[1] B. K. Nayak,[1,*] D. Patel,[1] Q. B. Chen (陈启博),[2] S. Q. Zhang (张双全),[2] P. W. Zhao (赵鹏巍),[2] B. Qi (亓斌),[3] J. Meng (孟杰),[2,4,5] R. V. F. Janssens,[6] M. P. Carpenter,[6] C. J. Chiara,[6,7] F. G. Kondev,[8] T. Lauritsen,[6] D. Seweryniak,[6] S. Zhu,[6] S. S. Ghugre,[9] and R. Palit[10,11]
[1]*Department of Physics, University of Notre Dame, Notre Dame, Indiana 46556, USA*
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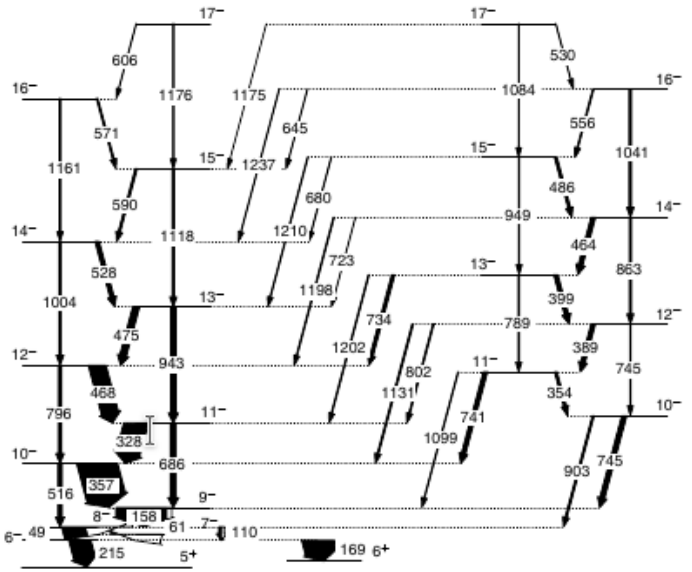
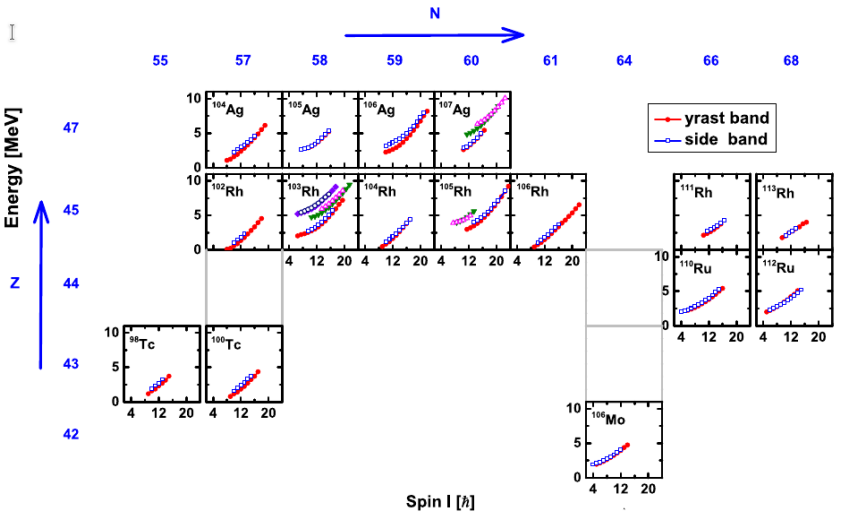
[8]*Nuclear Engineering Division, Argonne National Laboratory, Argonne, Illinois 60439, USA*
[9]*UGC-DAE Consortium for Science Research, Kolkata 700 098, India*
[10]*Tata Institute of Fundamental Research, Mumbai 400 005, India*
[11]*The Joint Institute for Nuclear Astrophysics, University of Notre Dame, Notre Dame, Indiana 46556, USA*
(Received 31 January 2013; published 24 April 2013)

Two distinct sets of chiral-partner bands have been identified in the nucleus ^{133}Ce. They constitute a multiple chiral doublet, a phenomenon predicted by relativistic mean field (RMF) calculations and observed experimentally here for the first time. The properties of these chiral bands are in good agreement with results of calculations based on a combination of the constrained triaxial RMF theory and the particle-rotor model.

Chirality in A~100 mass region



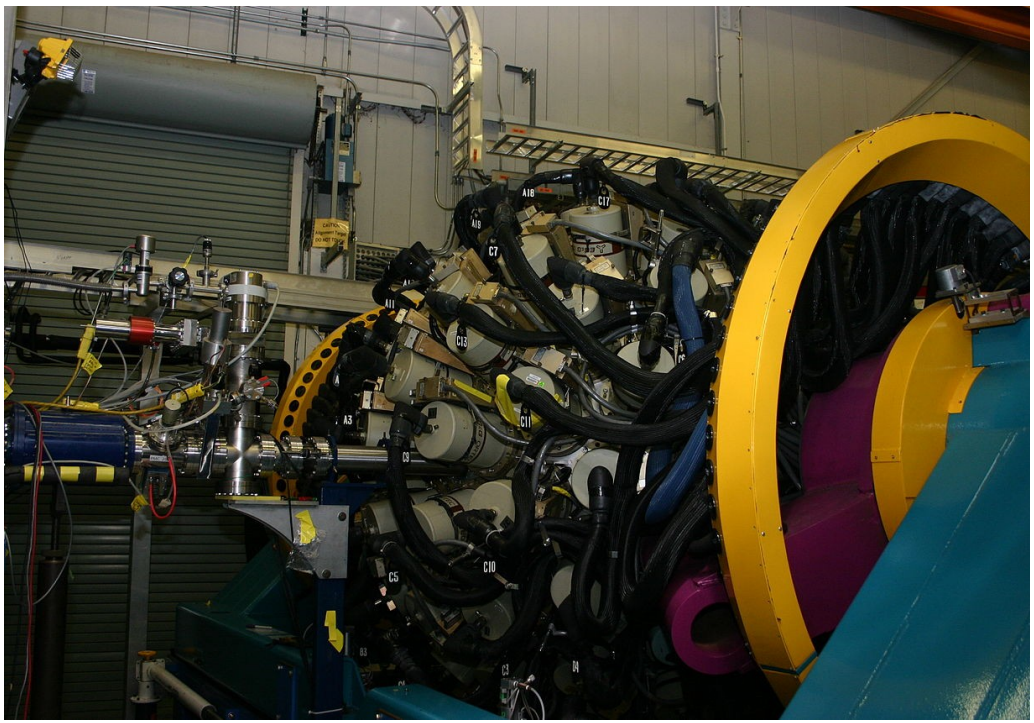
Vaman et al., Phys. Rev. Lett. 92 (2004)



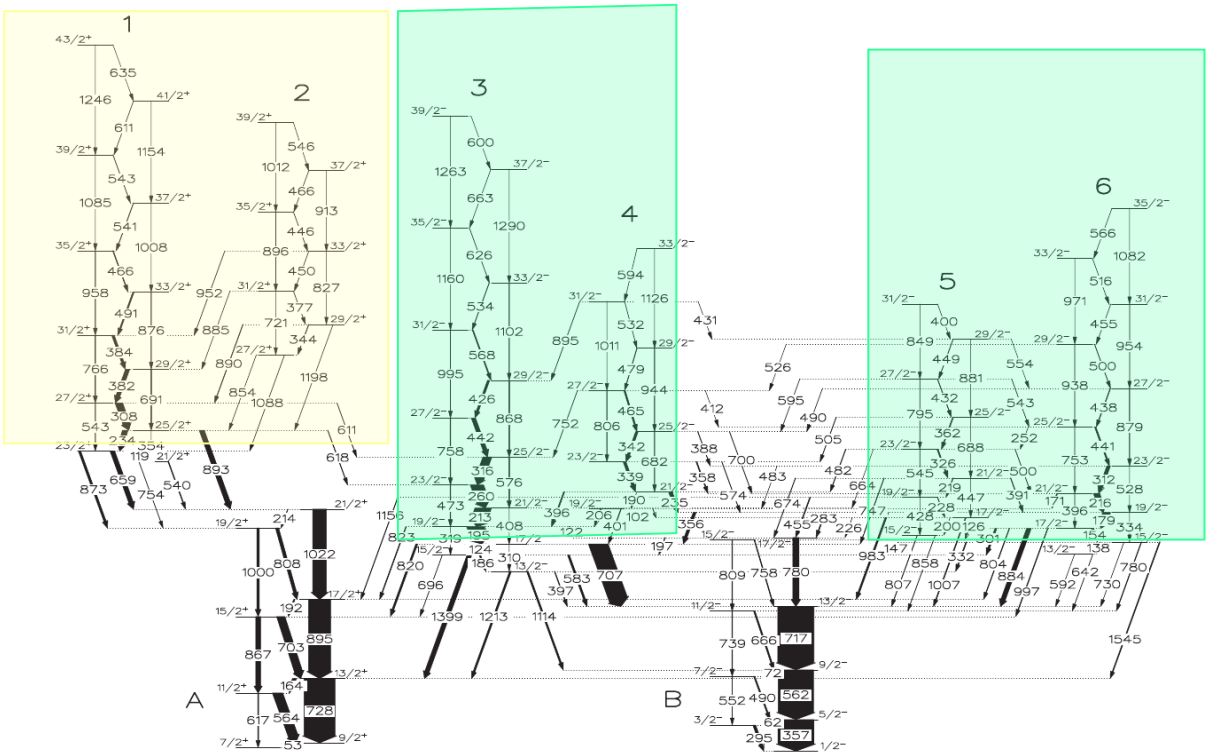
B.W. Xiong, Y.Y. Wang./Atomic Data and Nuclear Data Tables 125 (2019)

Experiment

- Heavy-ion fusion-evaporation reaction: ^{11}B beam with 40 MeV energy on ^{96}Zr target
- Trigger: gggg-coincidence, ~9 x 10^8 event
- GAMMASPHERE: more than 100 HPGe detector in spherical symmetry



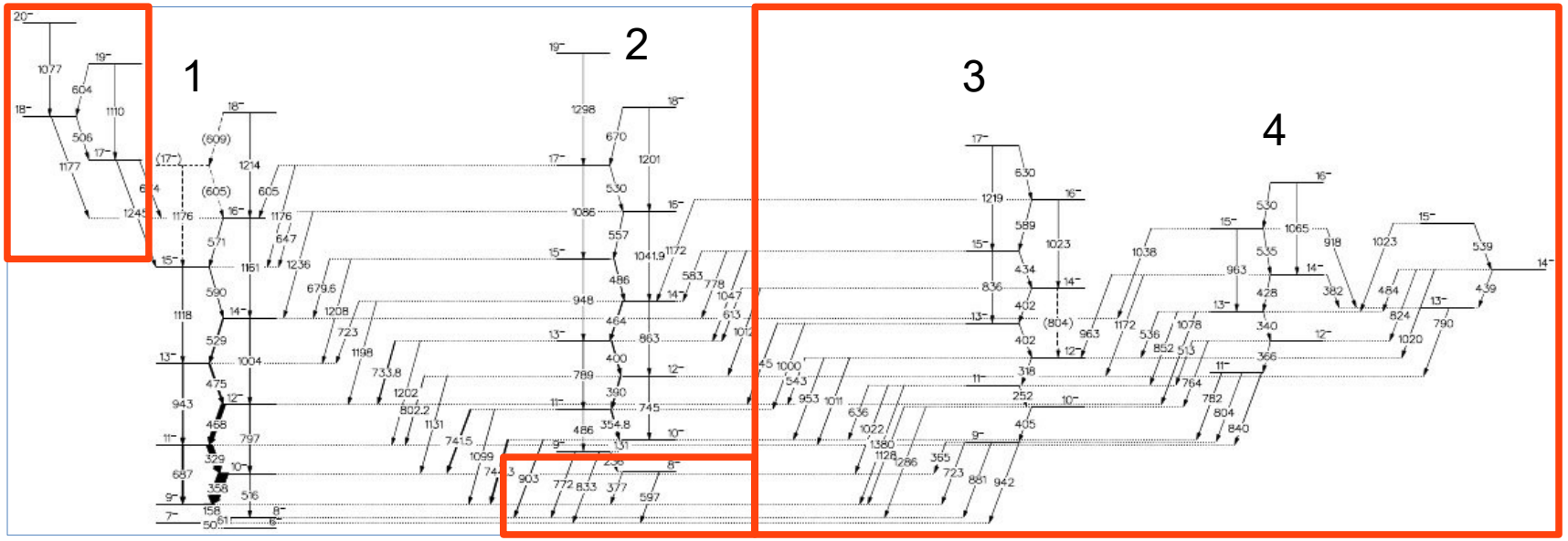
Multiple chiral doublet bands in ^{103}Rh

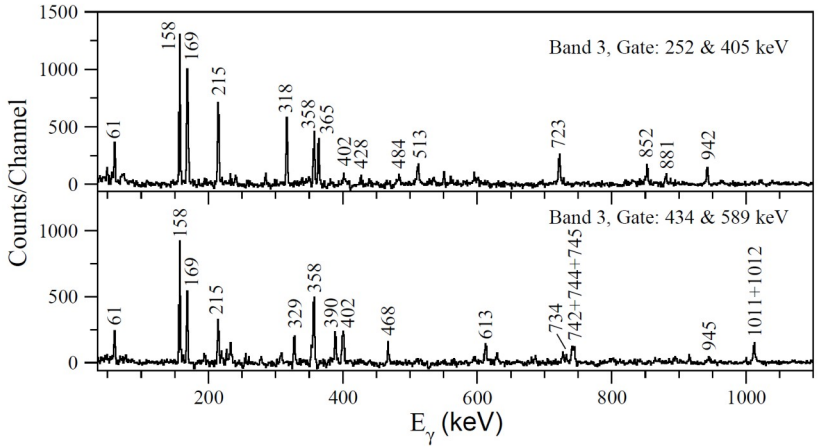


- Chiral doublet bands for the positive parity bands with $\pi(1g_{9/2})^{-1} \otimes \nu\,(1h_{11/2})^{2}$
- Two chiral doublet bands for the negative parity bands with $\pi(1g_{9/2})^{-1} \otimes \nu\,(1h_{11/2})^{1}\,(1g_{7/2})^{1}$

I. Kuti et al., PRL 113, 032501 (2014)

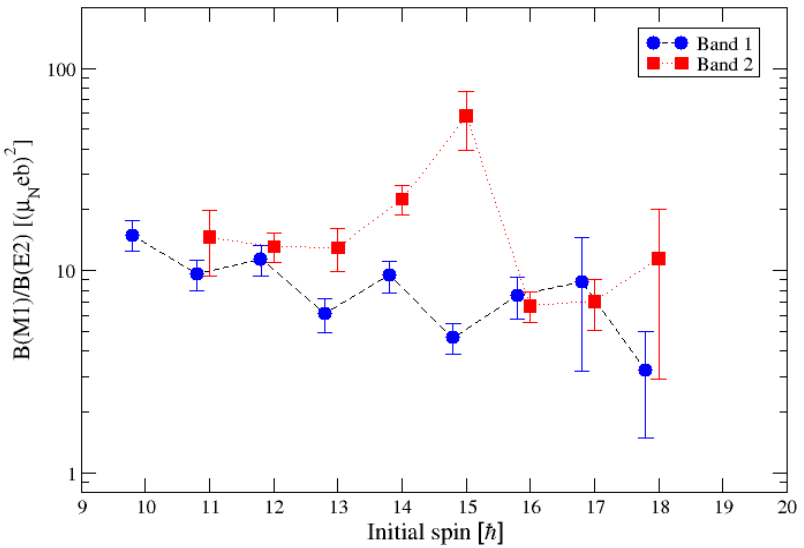
Negative-parity bands of the ^{104}Rh



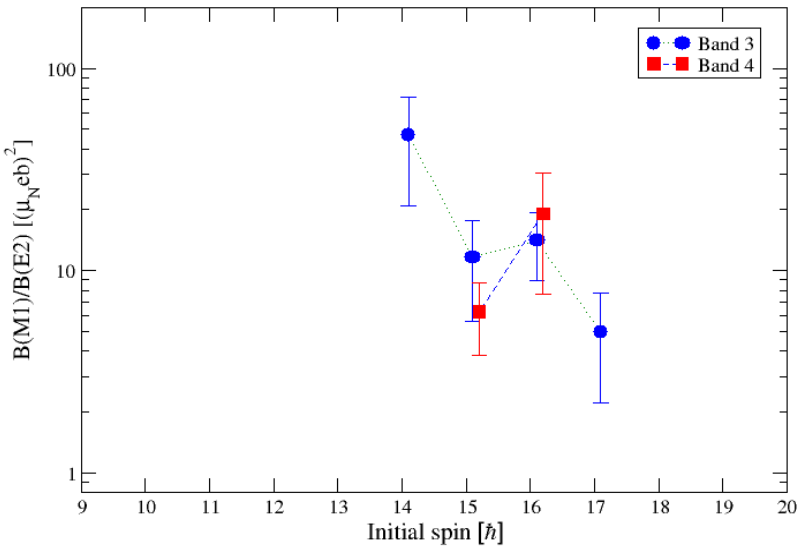


Experimental B(M1)/B(E2) values

B(M1)/B(E2) values for band 1-2

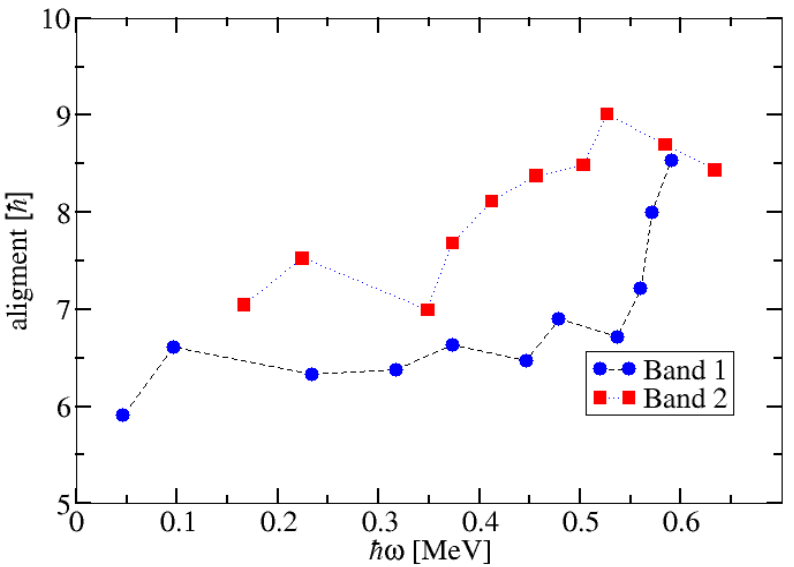


B(M1)/B(E2) values for band 3-4

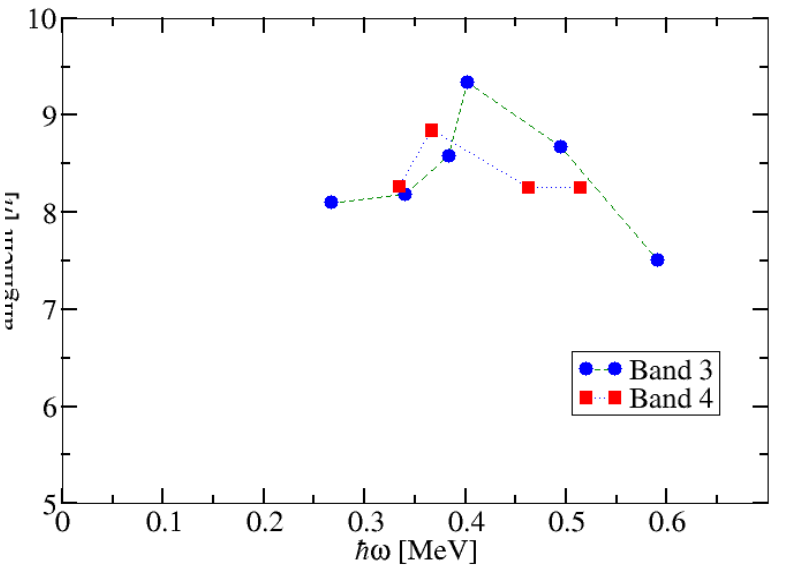


Experimental aligment values

Aligment values for band 1-2



Aligment values for band 3-4



Intrinsic quantum number K=4

Harris formula $\mathfrak{I} = \mathfrak{I}_0 + \mathfrak{I}_1\omega^2$, $\mathfrak{I}_0 = 8.9\ \hbar^2/\mathrm{MeV}$, $\mathfrak{I}_1 = 15.7\ \hbar^4/\mathrm{MeV}^3$

Configuration-fixed constrained triaxial calculation

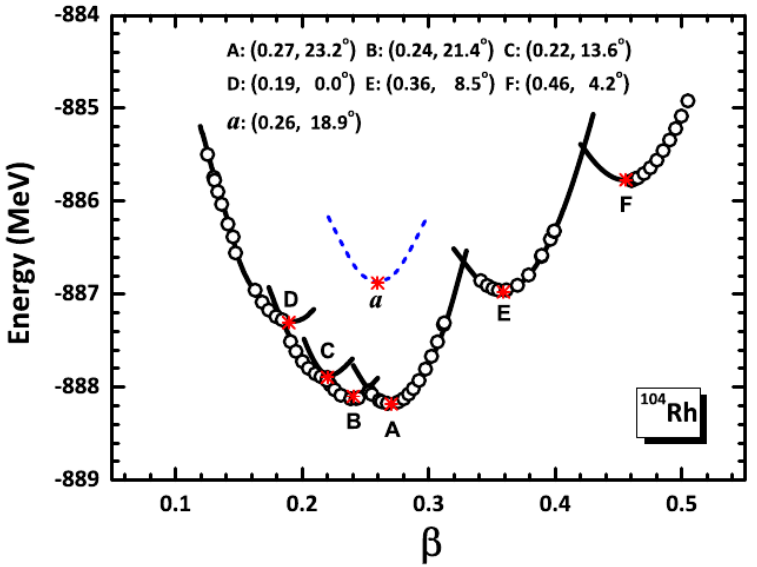
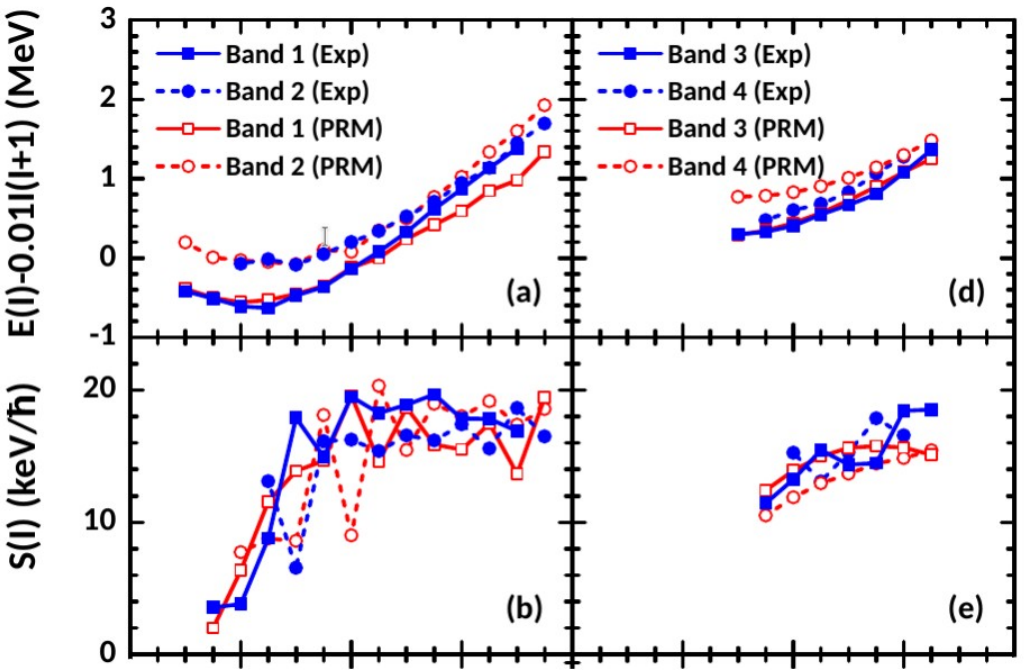


Table 1
The excitation energies E_x, deformation parameters β and γ, and their corresponding configurations (valence nucleon and unpaired nucleon) as well as the parities of minima for states A-F and a in the configuration-fixed constrained triaxial CDFT calculations.

State	E_x	(β, γ)	Unpaired configuration	π
A	0.00	$(0.27, 23.2°)$	$\pi(1g_{9/2})^{-1} \otimes \nu(1h_{11/2})^{1}$	−
B	0.08	$(0.24, 21.4°)$	$\pi(1g_{9/2})^{-1} \otimes \nu(1g_{7/2})^{-1}$	+
C	0.29	$(0.22, 13.6°)$	$\pi(2p_{1/2})^{1} \otimes \nu(1g_{7/2})^{-1}$	−
D	0.87	$(0.19, 0.0°)$	$\pi(1g_{9/2})^{1} \otimes \nu(1g_{7/2})^{-1}$	+
E	1.21	$(0.36, 8.5°)$	$\pi(1g_{7/2})^{1} \otimes \nu(1h_{11/2})^{1}$	−
F	2.41	$(0.46, 4.2°)$	$\pi(2p_{3/2})^{-1} \otimes \nu(1g_{9/2})^{-1}$	−
a	1.30	$(0.26, 18.9°)$	$\pi(1g_{9/2})^{-1} \otimes \nu(1g_{7/2})^{-2}(1h_{11/2})^{1}$	−

Particle rotor model calculations



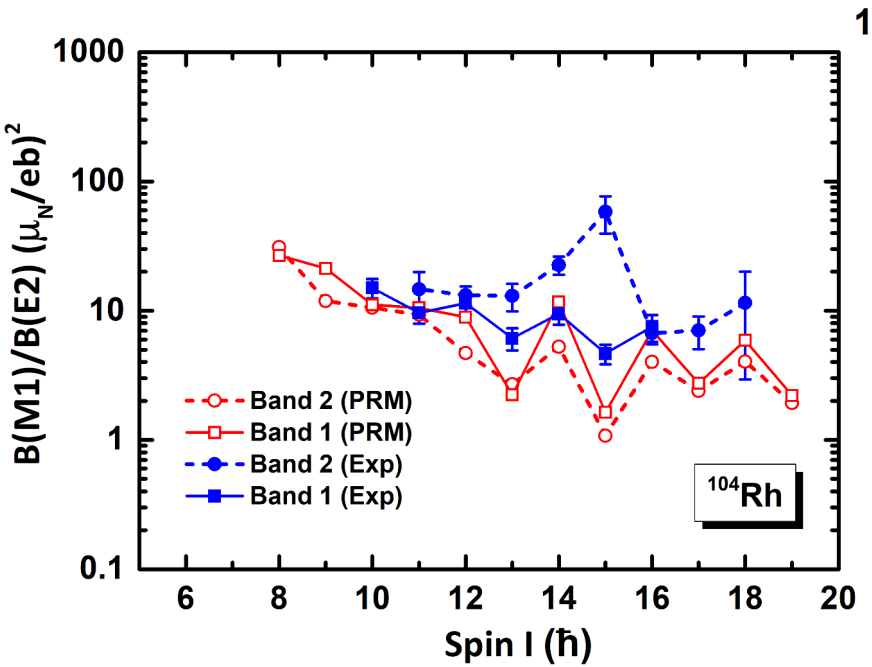
S(I)= [E(I) – E(I-1)]/2I
staggering parameter

β=0.27, γ=23.2°
$\pi(1g_{9/2})^{-1} \otimes \nu\,(1h_{11/2})^{1}$
configuration

β=0.26, γ=18.9°
$\pi(1g_{9/2})^{-1} \otimes \nu(1g_{7/2})^{-2}\,(1h_{11/2})^{1}$ configuration

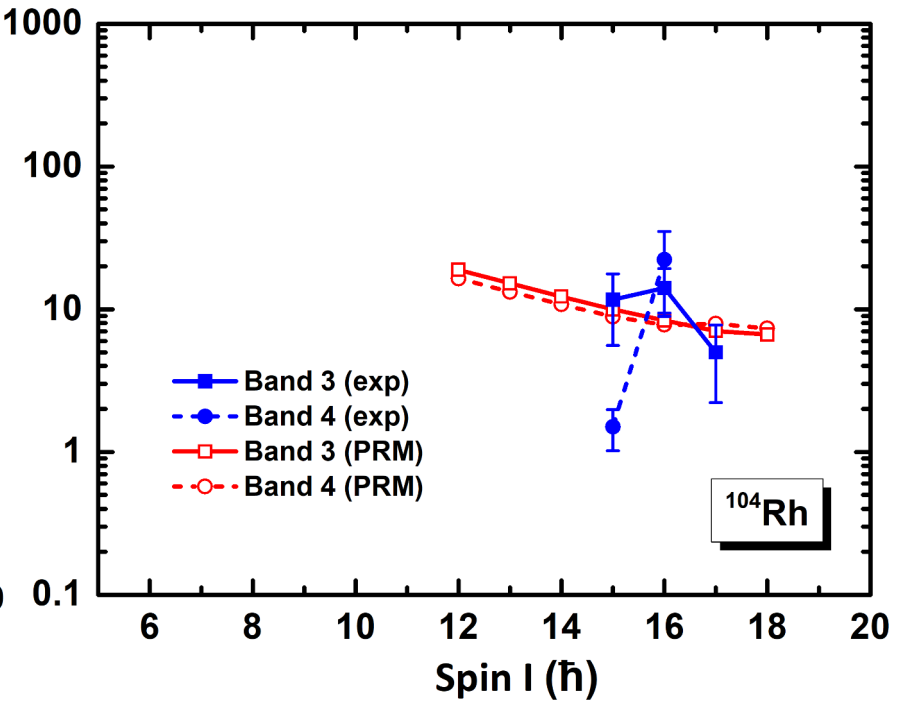
Electromagnetic properties

B(M1)/B(E2) values for band 1-2



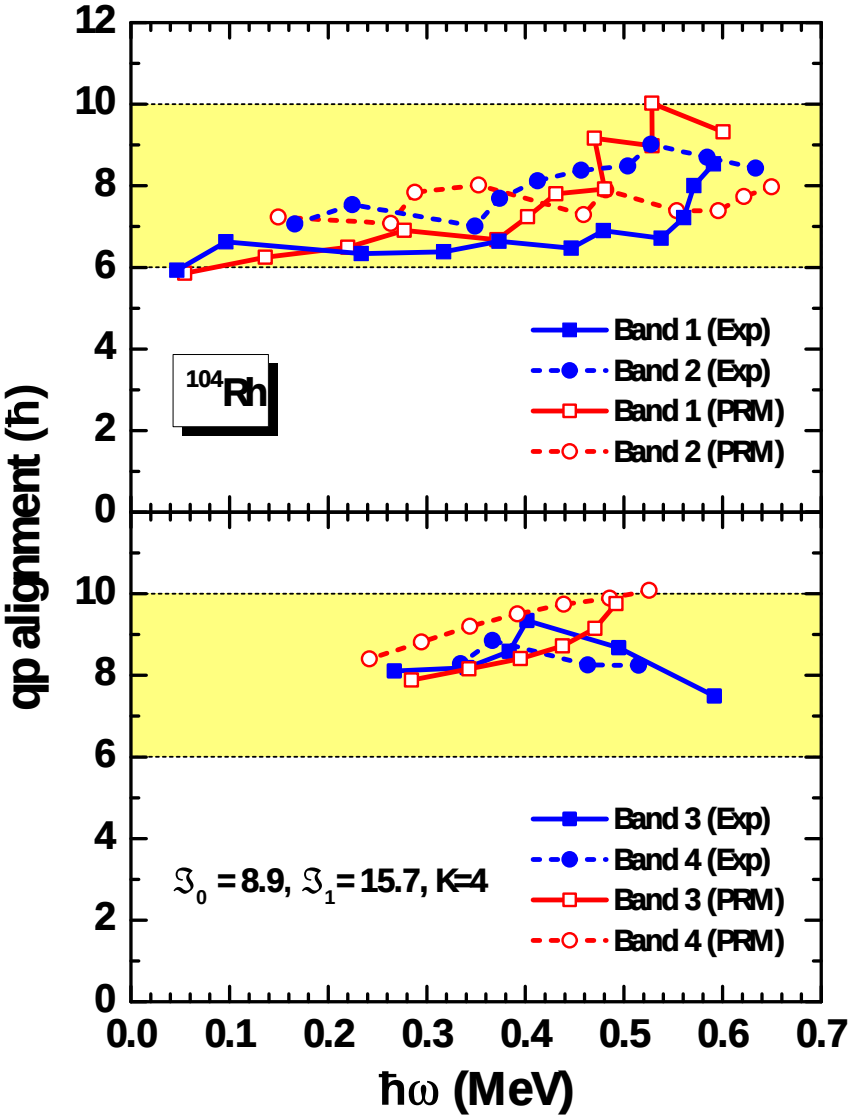
β=0.27, γ=23.2°

B(M1)/B(E2) values for band 3-4



β=0.26, γ=18.9°

Experimental and theoretical aligment values



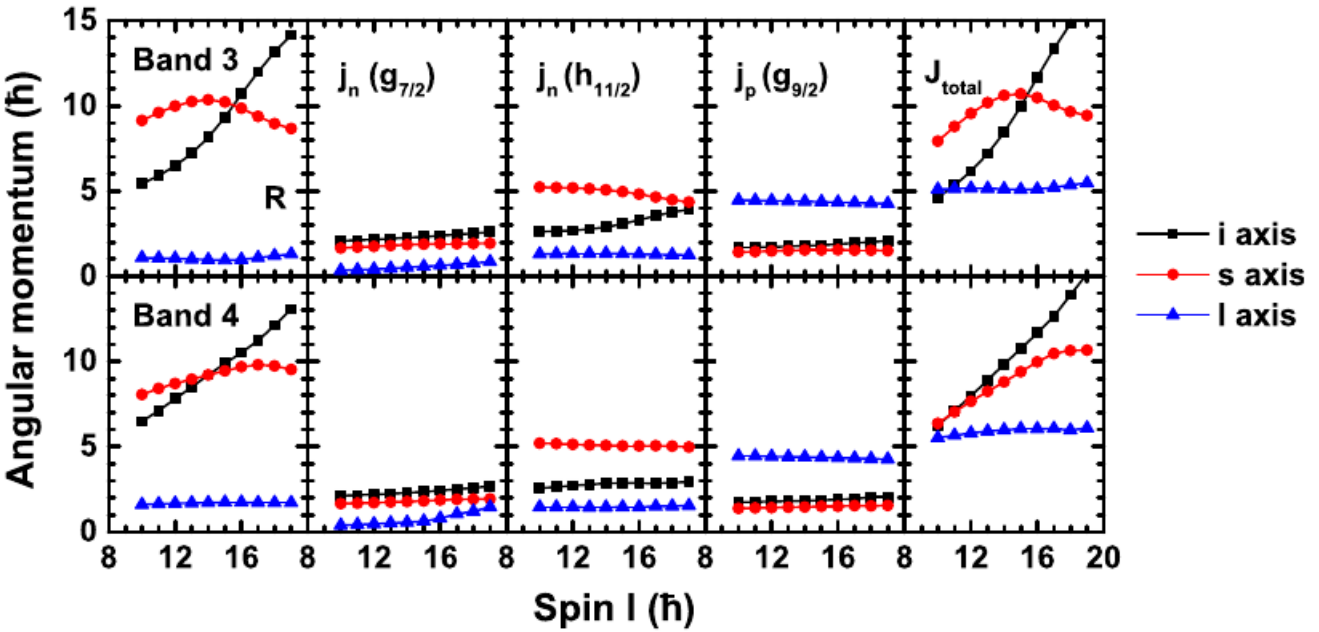
The 1st and 2nd have $\pi(1g_{9/2})^{-1} \otimes \nu(1h_{11/2})^{1}$ configuration

β=0.27, γ=23.2°

The 3rd and 4th have $\pi(1g_{9/2})^{-1} \otimes \nu(1g_{7/2})^{-2}\ (1h_{11/2})^{1}$ configuration

β=0.26, γ=18.9°

Angular momentum components



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Letter

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A. Krakó [a,b], D. Sohler [a,*], J. Timár [a], I. Kuti [a], Q.B. Chen [c], S.Q. Zhang [d], J. Meng [d], K. Starosta [e], T. Koike [f], E.S. Paul [g], D.B. Fossan [h,1], C. Vaman [h]

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