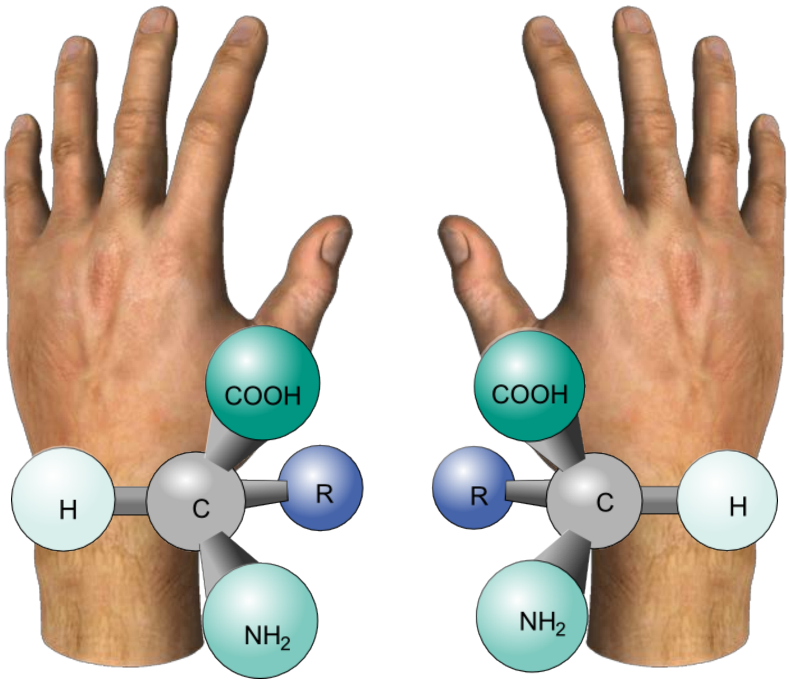
Multiple chirality in ^{103}Rh

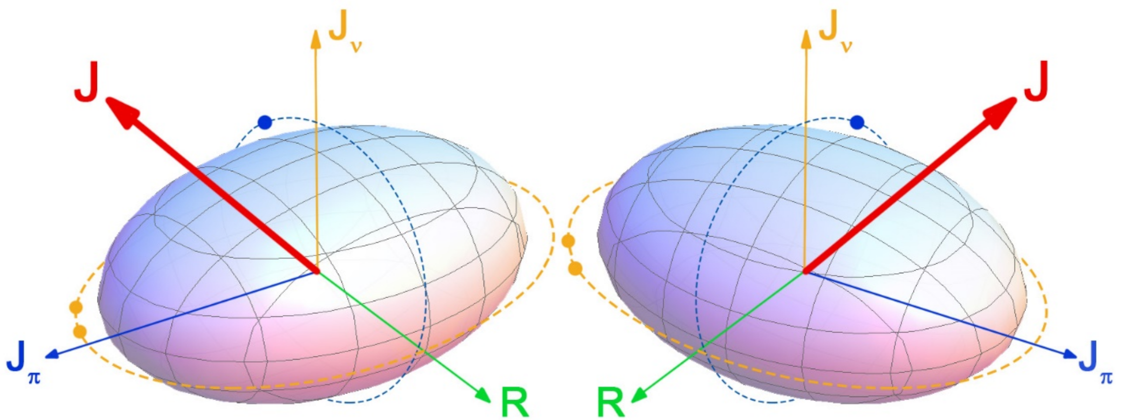
and possible chiral cases in region A~130

I. Kuti, J. Timár, D. Sohler

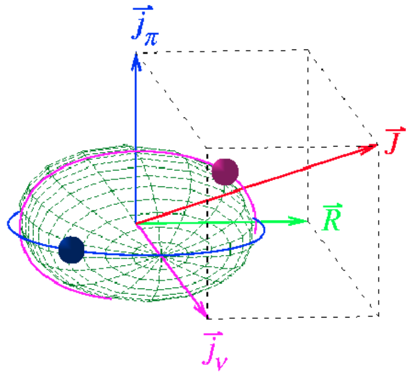
Chiral Bands in Nuclei – Nordita, Stockholm, 20-22 April 2015

Nuclear chirality





Fingerprints of chirality – ideal case



Ideal case (three perpendicular vectors):

- maximally triaxial nuclear shape (γ=30)
- π and ν in high-J particle and hole states

- degenerate ΔI=1 bands with the same parity
- similar transition probabilities (B(M1), B(E2))
- small odd-spin even-spin energy staggering
- B(M1) staggering?

Chiral fingerprints in real nuclei – motivation

Eur. Phys. J. A (2012) 48: 118
DOI 10.1140/epja/i2012-12118-2

THE EUROPEAN PHYSICAL JOURNAL A

Regular Article – Theoretical Physics

Identifying chiral bands in real nuclei

O. Shirinda[1,2,a] and E.A. Lawrie[1,b]

[1] iThemba LABS, National Research Foundation, P.O. Box 722, 7129 Somerset West, South Africa
[2] University of the Western Cape, Private Bag X17, 7525 Bellville, South Africa

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Abstract. The application of the presently used fingerprints of chiral bands (originally derived for strongly broken chirality) is investigated for real chiral systems. In particular the chiral fingerprints concerning the $B(M1)$ staggering patterns and the energy staggering are studied. It is found that both fingerprints show considerable changes for real chiral systems, a behaviour that creates a significant risk for misinterpretation of the experimental data and can lead to a failure to identify real chiral systems.

O. Shirinda et al., EPJ A 48, 118 (2012)

Physics Letters B 689 (2010) 66–71

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Physics Letters B

www.elsevier.com/locate/physletb

Reaching degeneracy in two-quasiparticle chiral bands

E.A. Lawrie[a,*], O. Shirinda[a,b]

[a] iThemba LABS, PO Box 722, 7129 Somerset West, South Africa
[b] University of the Western Cape, Private Bag X17, 7535 Bellville, South Africa

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ABSTRACT

The conditions for reaching degeneracy in chiral partner bands built on two-quasiparticle configurations are examined using the two-quasiparticle-plus-triaxial-rotor model. It is shown that in order for degeneracy to occur it is not sufficient to have an aplanar orientation of the total angular momentum, but the angular momenta of the two valence particles need to be completely aligned along the short and long nuclear axes. Such perfect alignment seems impossible to reach with realistic parameters within this model. These results suggest that two-quasiparticle chiral bands may be formed in suitable nuclei, but perfect degeneracy between the partner bands is unlikely to be found.

E. Lawrie et al., Phys. Lett. B 689, 66 (2012)

No simple set of fingerprints!

Study of nuclei with controversial chiral fingerprints should cover their whole band structure, not only the chiral candidate band-pairs.

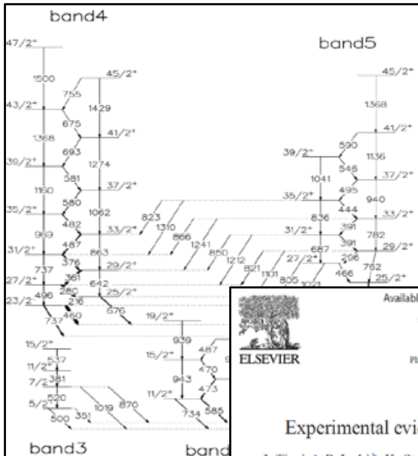
Chiral fingerprints in real nuclei – motivation

Study of nuclei with controversial chiral fingerprints should cover their whole band structure, not only the chiral candidate band-pairs.

A≈100 mass region:
Expected multiple chirality

A≈130 mass region:
Chiral candidate band pairs with different B(E2) values

Chirality in ^{103}Rh



^{105}Rh

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PHYSICS LETTERS B

Physics Letters B 598 (2004) 178–187

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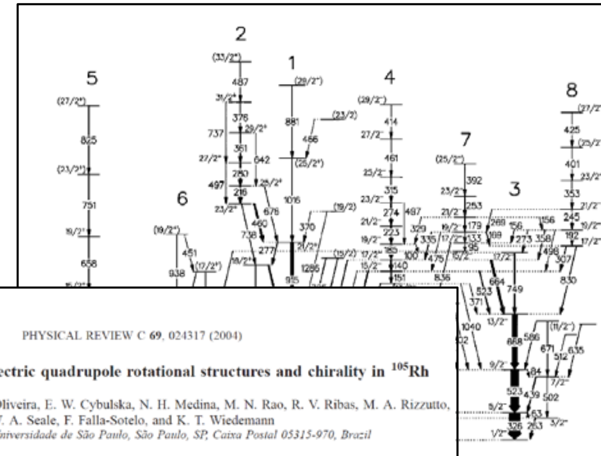
Experimental evidence for chirality in the odd-A ^{105}Rh

J. Timár[a], P. Joshi[b], K. Starosta[c,d], V.I. Dimitrov[e], D.B. Fossan[d,◇], J. Molnár[a], D. Sohler[a], R. Wadsworth[b], A. Algora[a,f], P. Bednarczyk[g], D. Curien[g], Zs. Dombrádi[a], G. Duchene[g], A. Gizon[h], J. Gizon[h], D.G. Jenkins[b], T. Koike[d], A. Krasznahorkay[a], E.S. Paul[i], P.M. Raddon[b], G. Rainovski[i,d,1], J.N. Scheurer[j], A.J. Simons[b], C. Vaman[d], A.R. Wilkinson[b], L. Zolnai[a], S. Frauendorf[e,k]

Timár et al., Phys. Lett. B 598, p.178 (2004)



PHYSICAL REVIEW C **69**, 024317 (2004)

Magnetic dipole and electric quadrupole rotational structures and chirality in ^{105}Rh

J. A. Alcántara-Núñez, J. R. B. Oliveira, E. W. Cybulska, N. H. Medina, M. N. Rao, R. V. Ribas, M. A. Rizzutto, W. A. Seale, F. Falla-Sotelo, and K. T. Wiedemann
Instituto de Fisica, Universidade de São Paulo, São Paulo, SP, Caixa Postal 05315-970, Brazil

V. I. Dimitrov* and S. Frauendorf
Department of Physics, University of Notre Dame, Notre Dame, Indiana 46556, USA
and Institute for Nuclear and Hadronic Physics, Research Center Rossendorf, P.O. Box 51 01 19, 01314 Dresden, Germany
(Received 14 July 2003; published 27 February 2004)

Alcántara-Núñez et al., Phys. Rev. C 69 024317 (2004)

th. calc.: Frauendorf *et al.*

MχD bands in ^{105}Rh are expected:

PHYSICAL REVIEW C **83**, 037301 (2011)

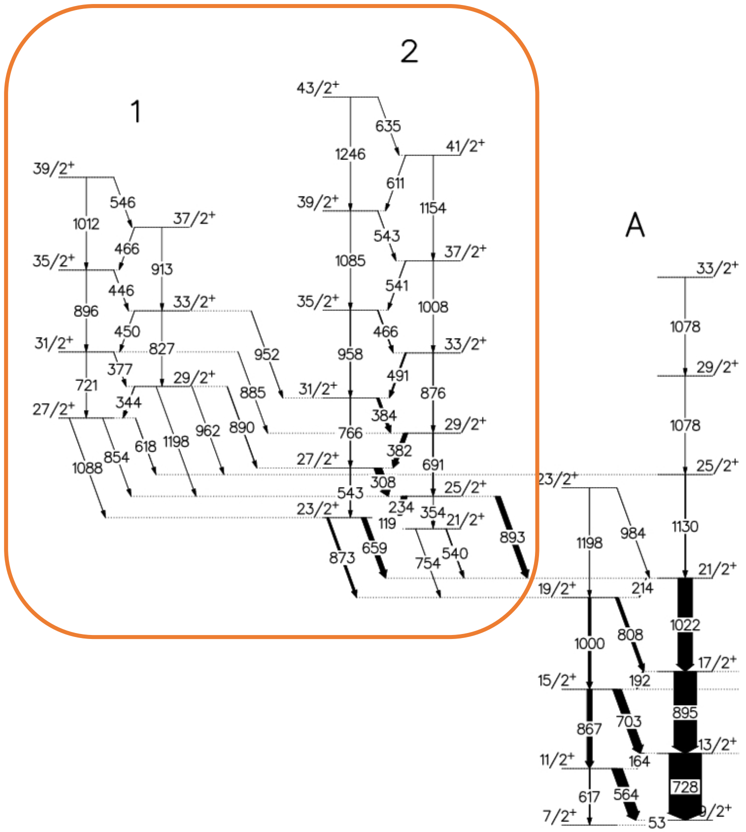
Multiple chiral doublet candidate nucleus ^{105}Rh in a relativistic mean-field approach

Jian Li (李剑) and S. Q. Zhang (张双全)
School of Physics, State Key Laboratory of Nuclear Physics and Technology, Peking University, Beijing 100871, China

J. Meng (孟杰)*
School of Physics and Nuclear Energy Engineering, Beihang University, Beijing 100191, China,
School of Physics, State Key Laboratory of Nuclear Physics and Technology, Peking University, Beijing 100871, China and
Department of Physics, University of Stellenbosch, Stellenbosch, South Africa
(Received 7 January 2011; published 10 March 2011)

th. calc.: Meng *et al.*

Chirality in ^{103}Rh



Timár et al., Phys. Rev. C 73, 011301(R) (2006)

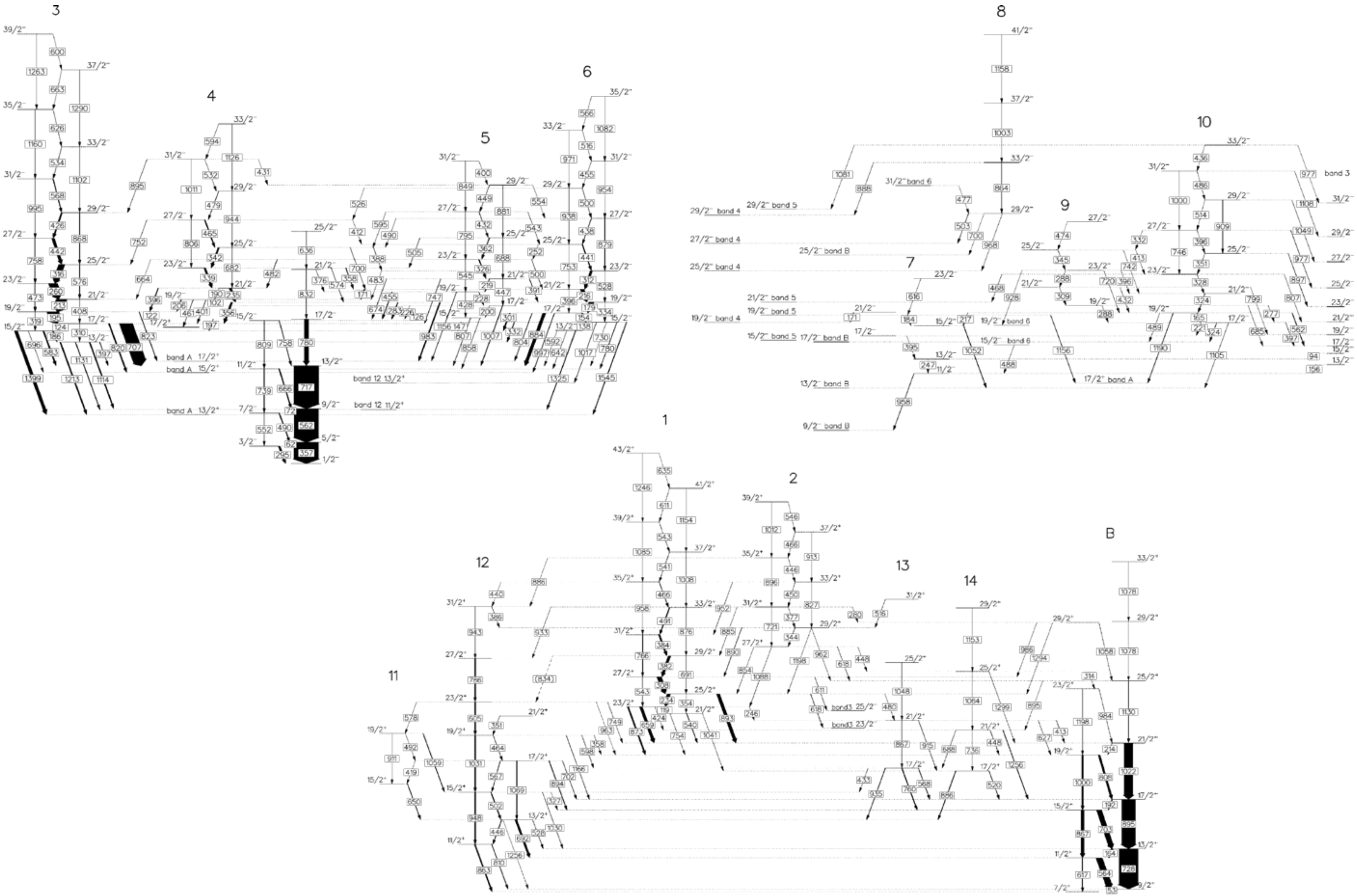
GAMMASPHERE experiment

(K. Starosta)

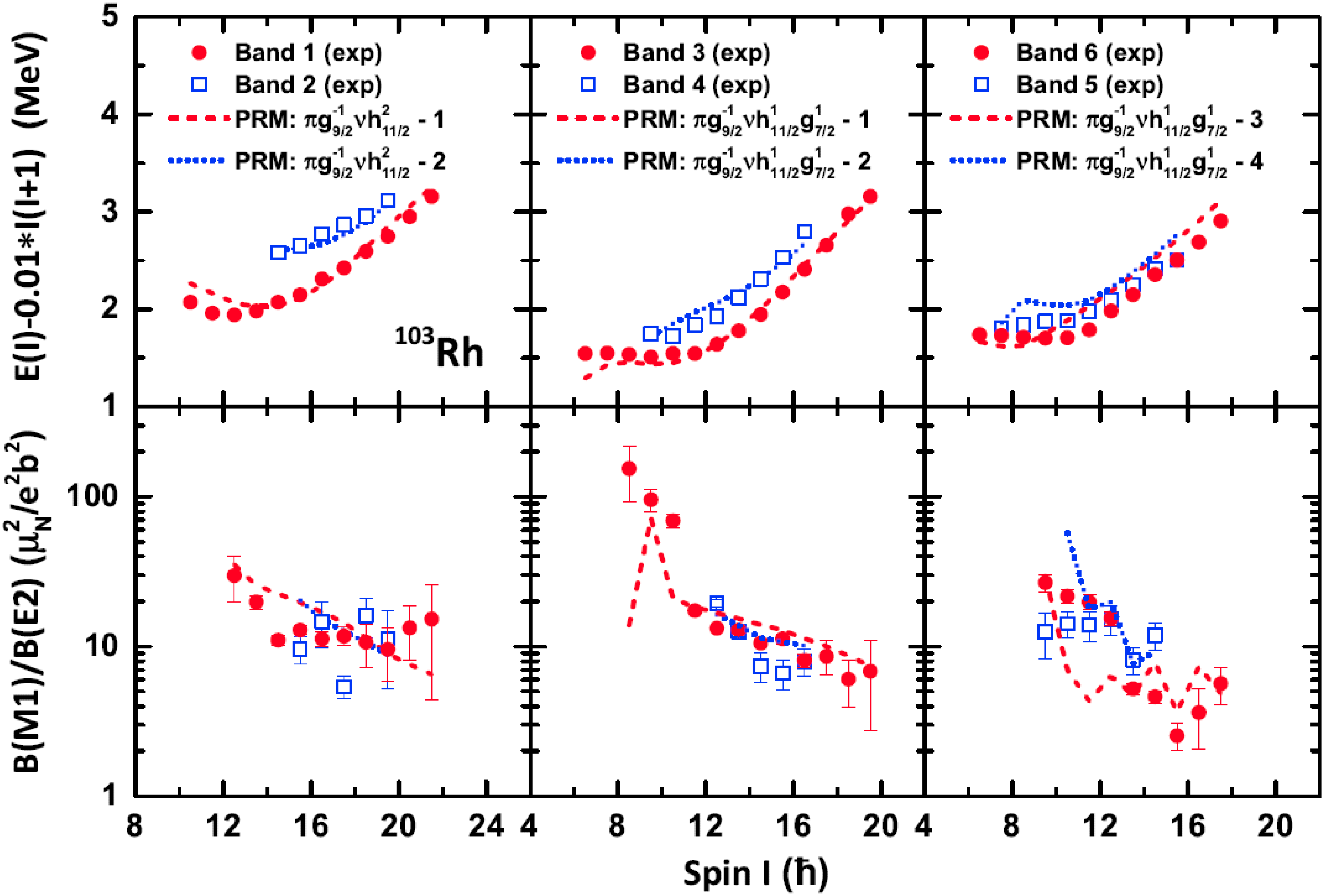
- $^{96}Zr(^{11}B,5n)^{103}Rh$

  fusion-evaporation reaction
- 40MeV beam energy
- ~9x10^8 quadruple- and higher-fold events
- strongest reaction channel: ^{103}Rh

Chirality in ^{103}Rh

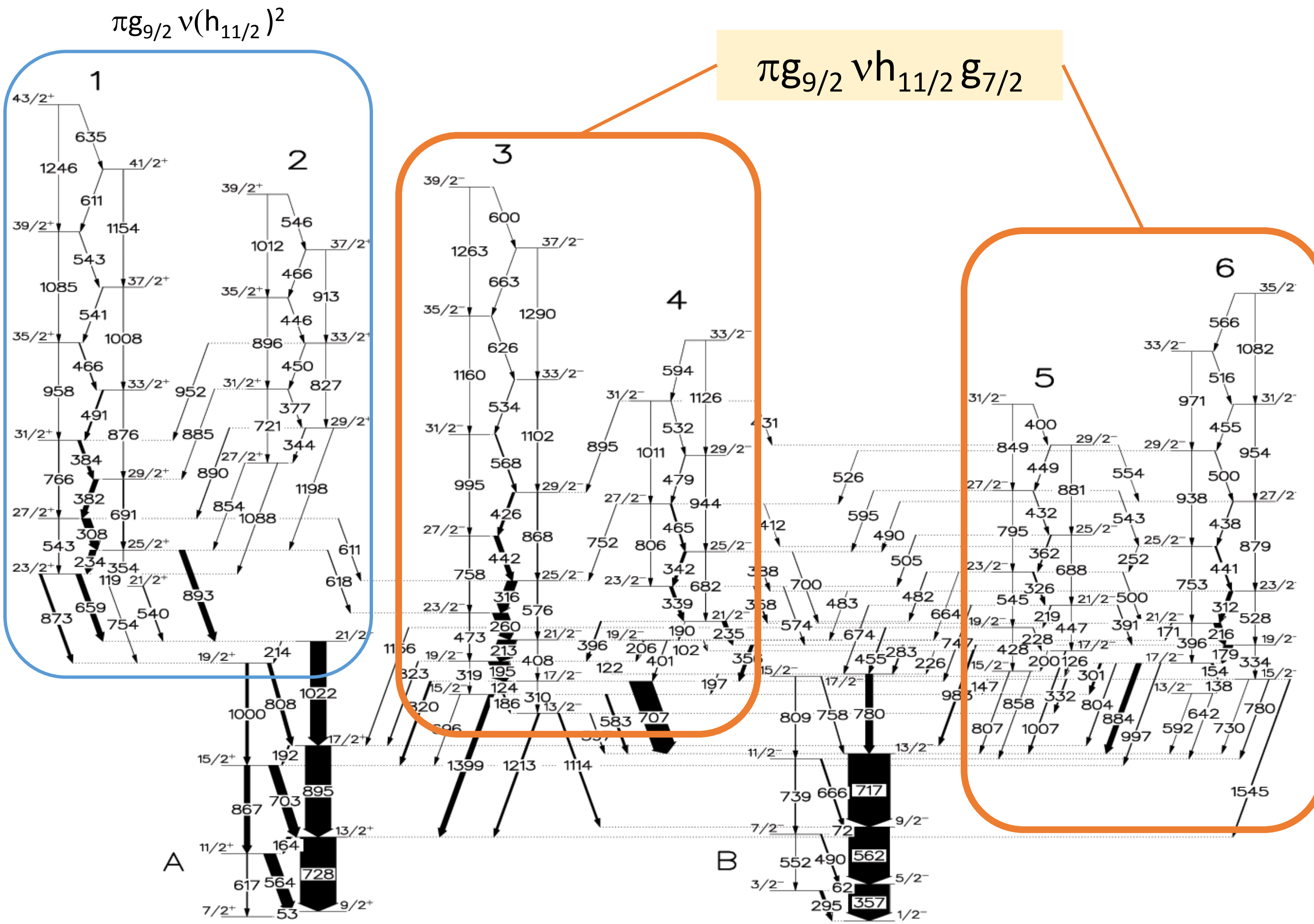


Chirality in ^{103}Rh



th. calc.: J. Meng *et al.*

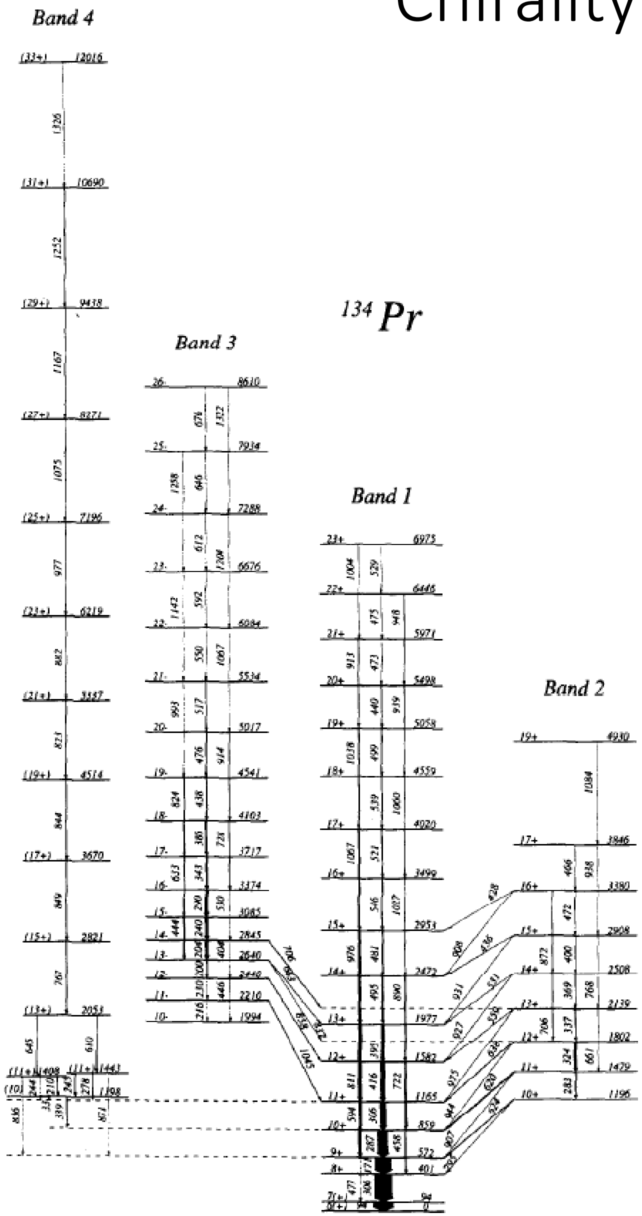
Chirality in ^{103}Rh



Kuti et al., Phys. Rev. Lett. 113, 032501 (2014)

Chirality in A≈130 mass region

^{134}Pr



Petrache et al., Nucl. Phys. A 597, 106 (1996)

GAMMASPHERE experiment

(K. Starosta)

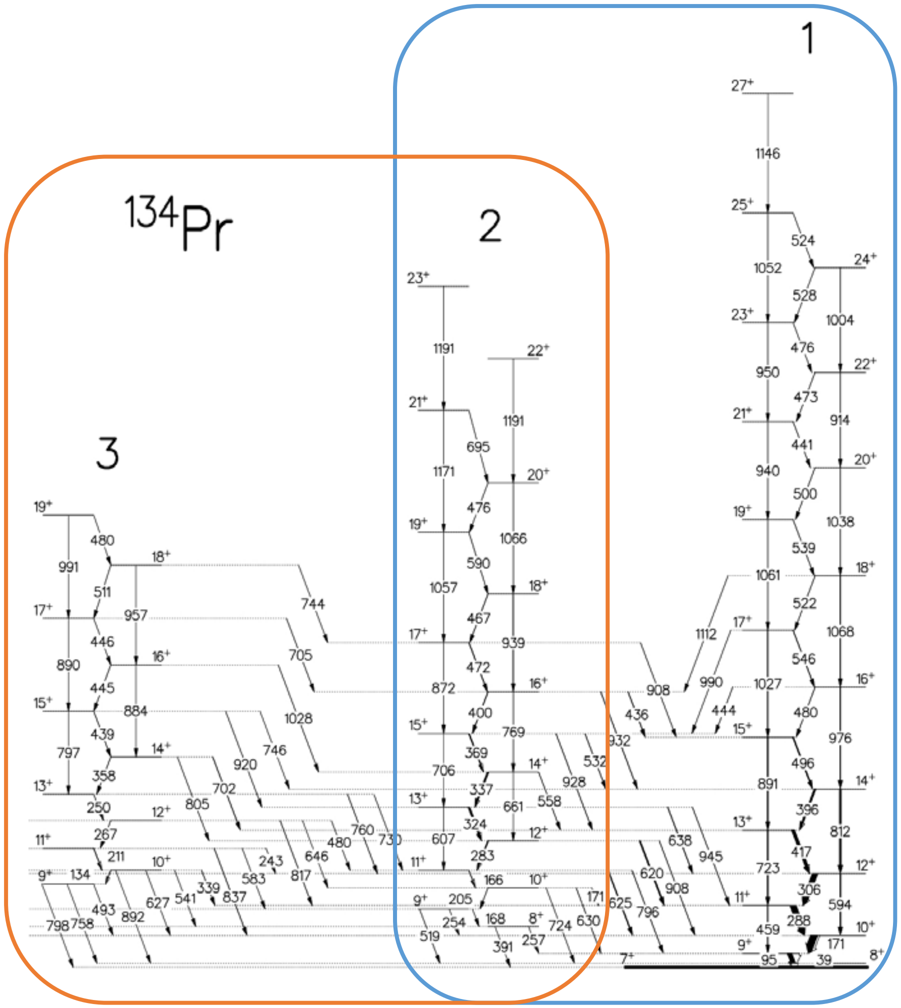
- 99 HPGe detectors
- ^{116}Cd(^{23}Na,5n)^{134}Pr fusion-evaporation reaction
- 115MeV beam energy
- ~7x10^{9} triple coincidence events

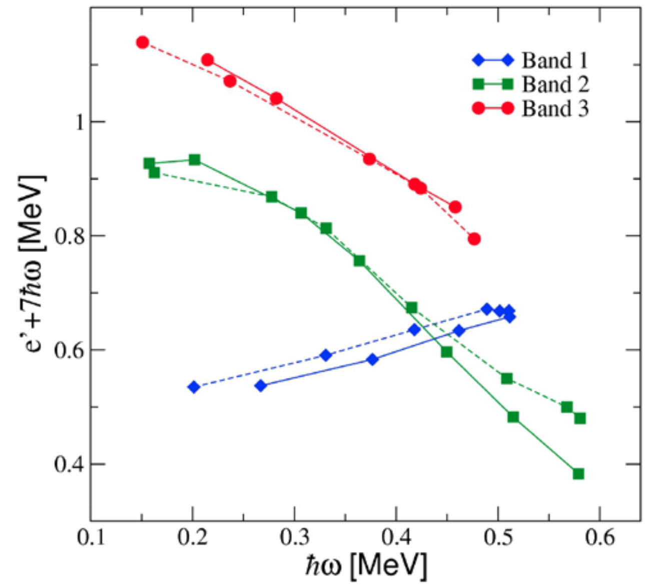
Chirality in A≈130 mass region

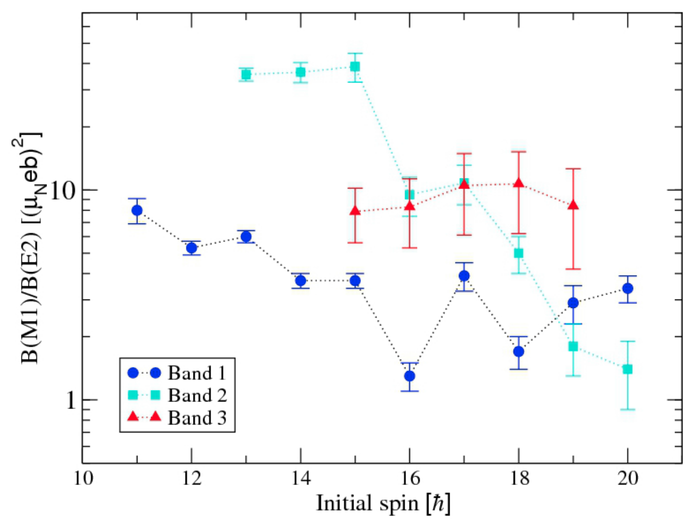
^{134}Pr

Chirality in A≈130 mass region

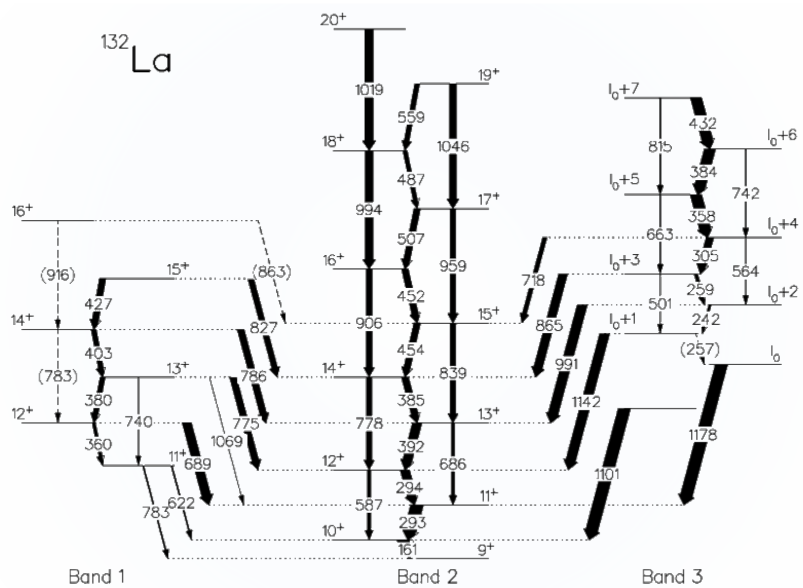
^{134}Pr







Chirality in A≈130 mass region
^{132}La



Srebrny et al., Acta Phys. Pol. B 36, 1063 (2005)

GAMMASPHERE experiment
(K. Starosta)

- 99 HPGe detectors
- ^{116}Cd(^{23}Na,α3n) reaction
- 115MeV beam energy

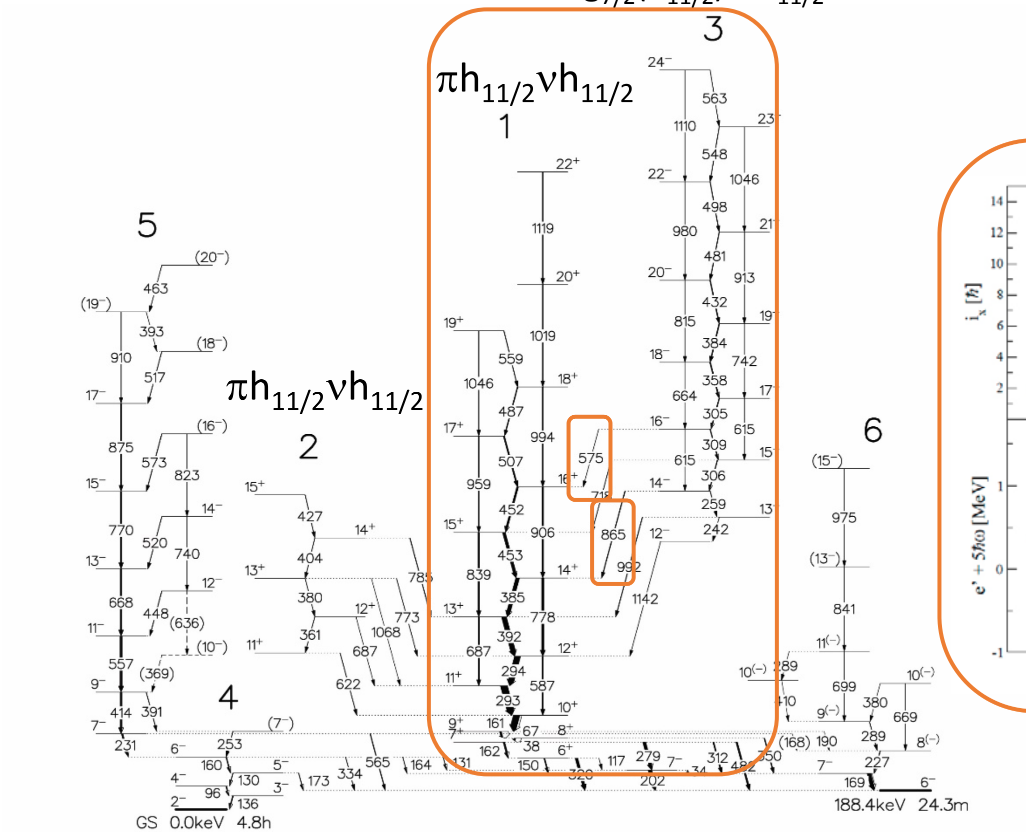
EUROBALL IV experiment

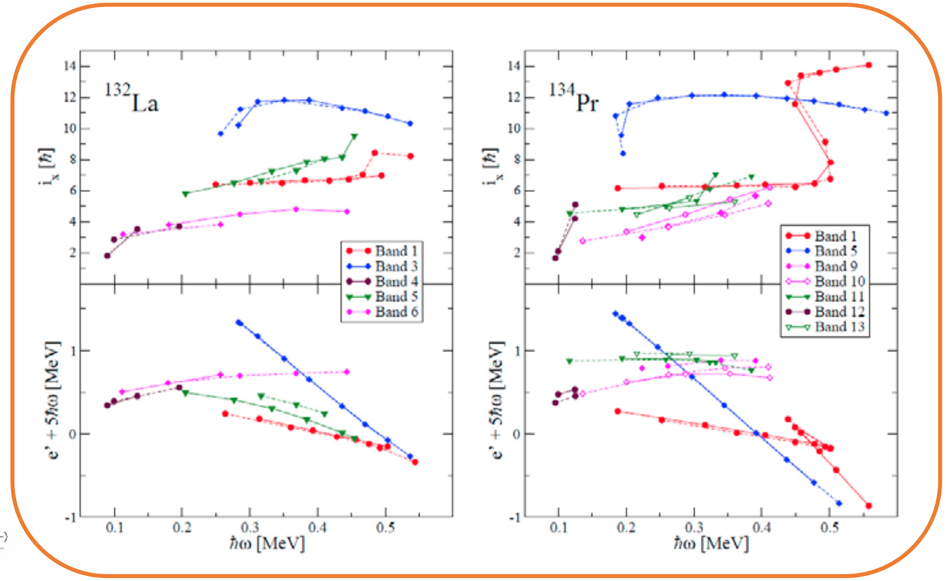
- 16 clusters, 26 clovers, 30 tapered
- ^{100}Md(^{36}Sn,p3n) reaction
- 160MeV beam energy

Chirality in A≈130 mass region

^{132}La

$\pi g_{7/2}(h_{11/2})^2\nu h_{11/2}$





Different configuration:
Chiral scenario ruled out for Band 3

Similarities with ^{134}Pr:
Possible third $\pi h_{11/2}\nu h_{11/2}$ band

High statistics experiments needed!

Summary

A≈100 mass region:
^{103}Rh

Two observed doublet bands with an identical configuration of $\pi g_{9/2} \nu h_{11/2} g_{7/2}$.

A≈130 mass region:
^{132}La and ^{134}Pr

New candidate band; chirality in these nuclei is not yet answered.

Outlook

^{104}Rh

^{132}La ^{134}Pr ^{128}Cs

Thank you for your attention!

Mult.	DCO	Pol.
M1(ΔI=1)	~1	-
M1(ΔI=0)	~2	+
E1(ΔI=1)	~1	+
E1(ΔI=0)	~2	-
E2	~2	+

Energy	DCO	Pol.
575 keV	2.14(28)	-0.4(3)
865 keV	2.08(19)	-0.5(2)