Check for Chirality in real nuclei

Limits 04, Argonne, 26-30 July 2004

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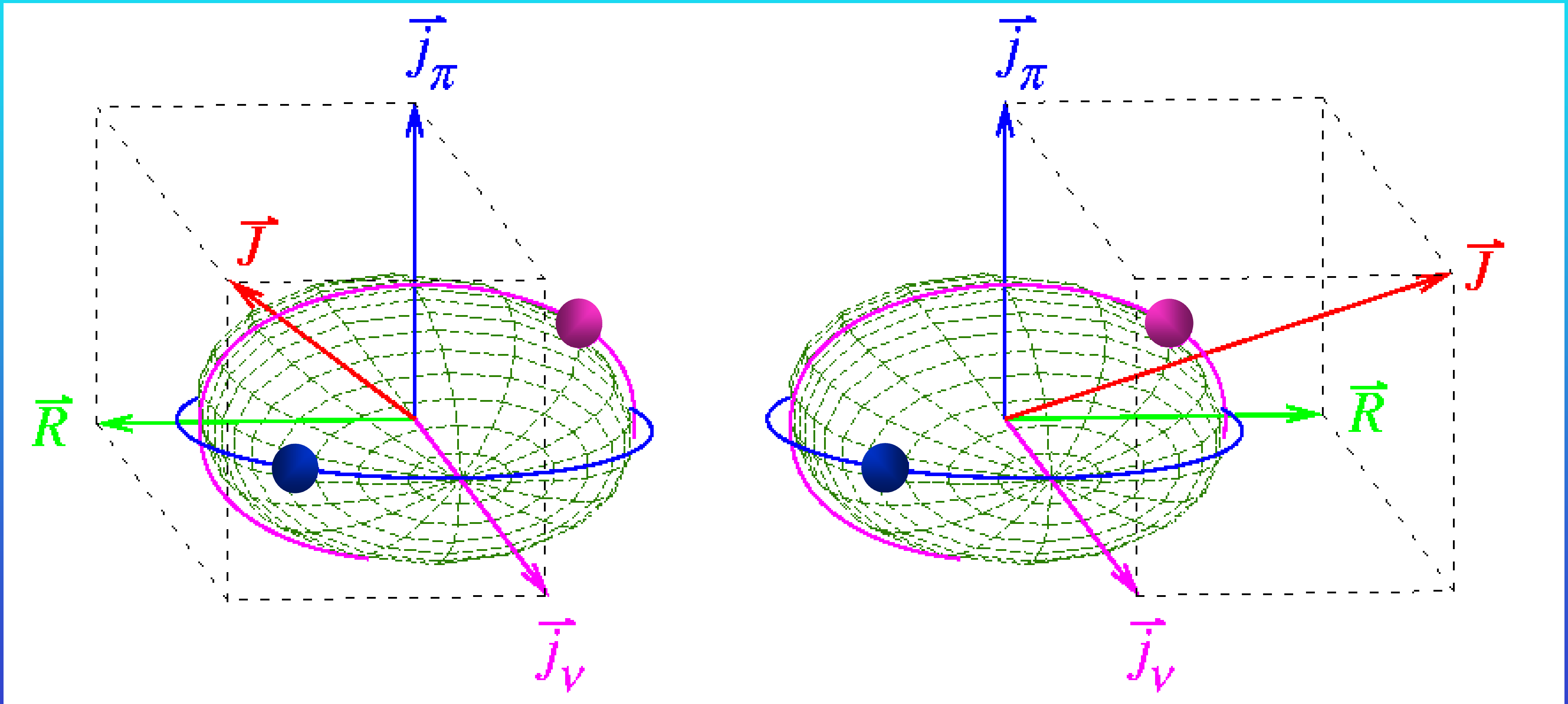
Does Chiral symmetry exists in nuclei ?

"I call any geometrical figure, or group of points, chiral, and say it has chirality, if its image in a plane mirror, ideally realized, cannot be brought to coincide with itself." - Lord Kelvin 1904

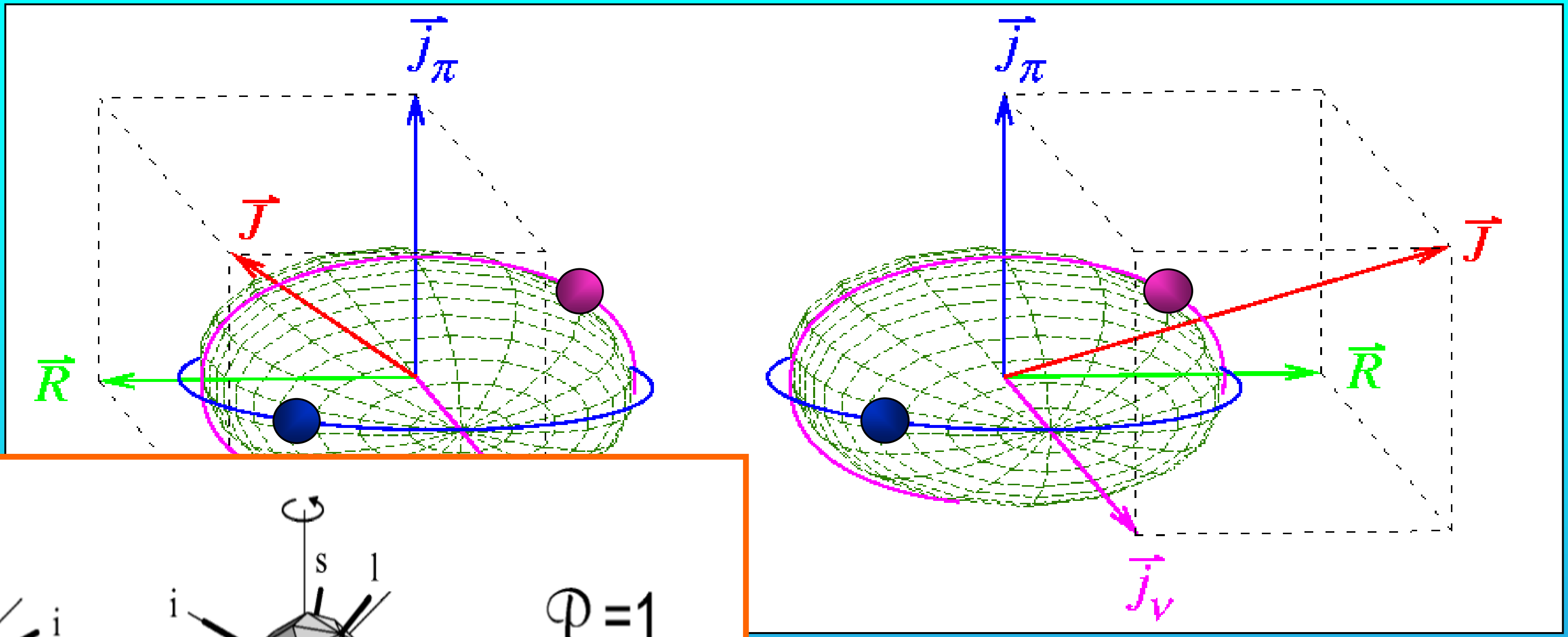
Examples of chiral systems are found in :

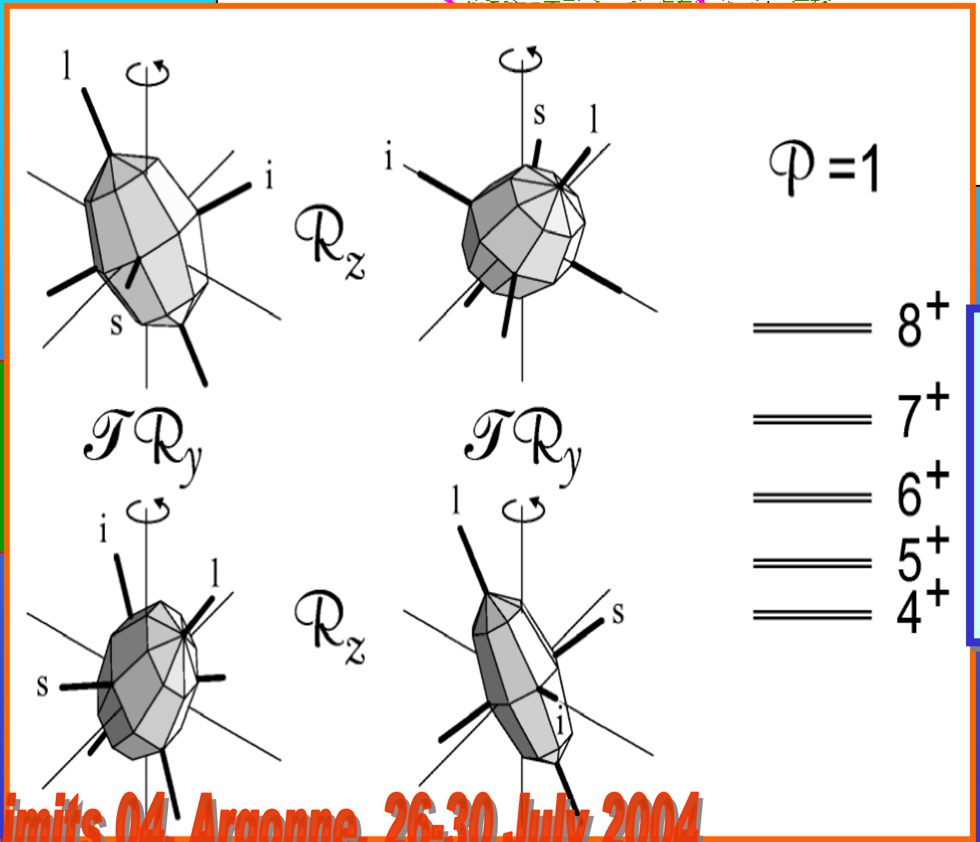
- Chemistry: molecules with opposite handedness react differently in similar environments
- Biology: DNA has right and left-handed "screws"
- Particle Physics

Triaxial odd-odd nuclei result in three perpendicular angular momenta for particle-hole configurations built on high-j orbitals



•Nuclear Physics: Current distributions in nuclei



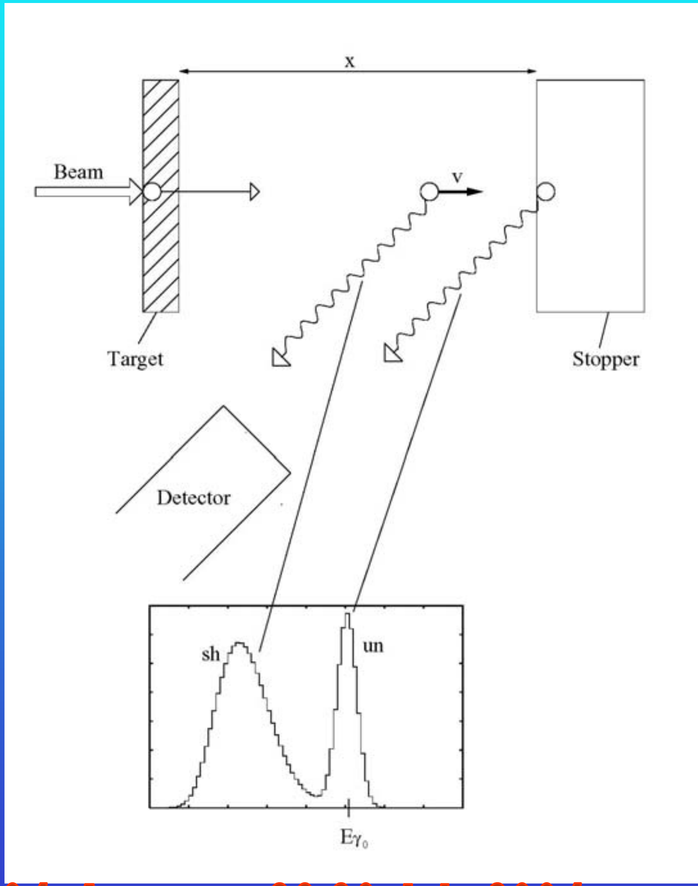


The energies of the excited states for the left-handed and right-handed systems should be identical

V. I. Dimitrov et al, PRL 84 (2000) 5732

Lifetime experiements:

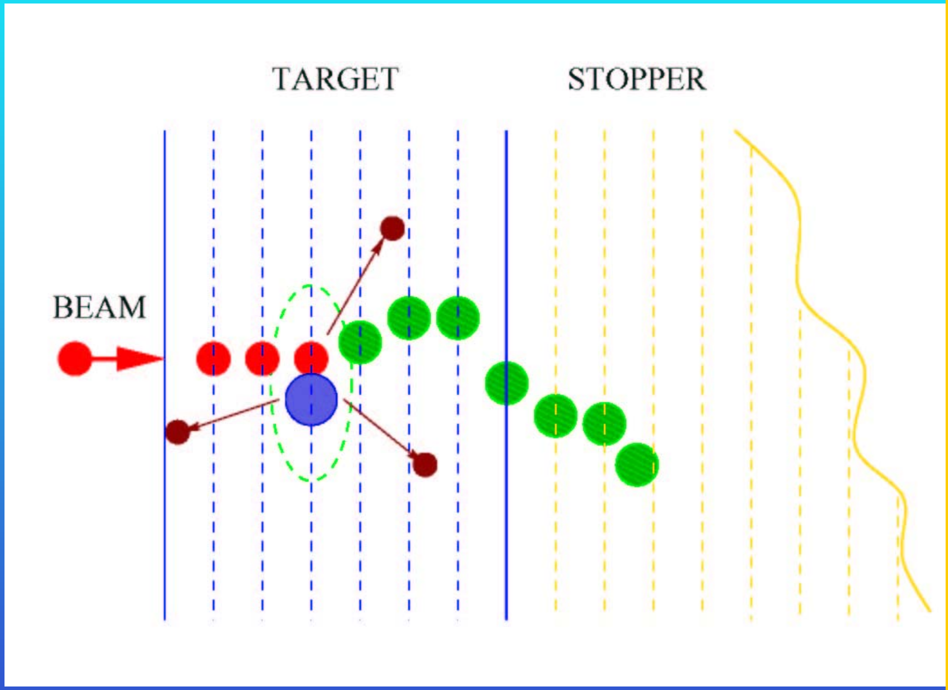
Recoil distance Doppler-shift experiment



Details:

- Euroball experiment at IReS Strasbourg, Vivitron accelerator
- Cologne plunger device
- Reaction: $^{119}Sn(^{19}F,4n)^{134}Pr$
- ^{19}F beam with an energy of 87MeV
- Target: 0.5 mg/cm^2 ^{119}Sn (enriched to 90%) evaporated on a 1.8 mg/cm^2 ^{181}Ta backing
- Stopper: 6 mg/cm^2 thick ^{197}Au
- 20 measured distances from 0.1 to 2500 microns
- 10 days measurement
- v/c ~ 1.1 %

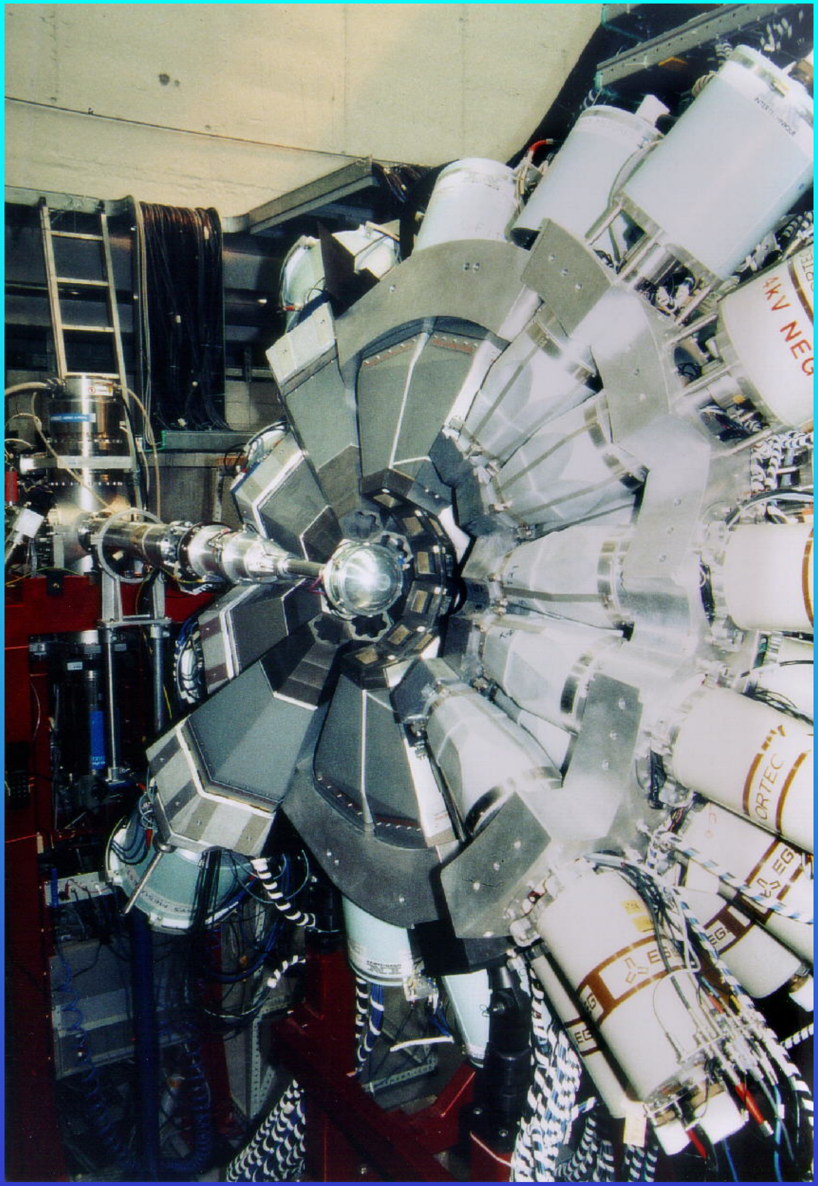
Lifetime experiements:
Doppler-shift attenuation method



Details:

- Euroball experiment at IReS Strasbourg, Vivitron accelerator
- Reaction: $^{119}Sn(^{19}F,4n)^{134}Pr$
- ^{19}F beam with an energy of 83 MeV
- Target: 0.7 mg/cm^2 ^{119}Sn (enriched to 90%) evaporated on a 9.5 mg/cm^2 ^{181}Ta backing
- 4 days measurement
- v/c ~ 1.1 %

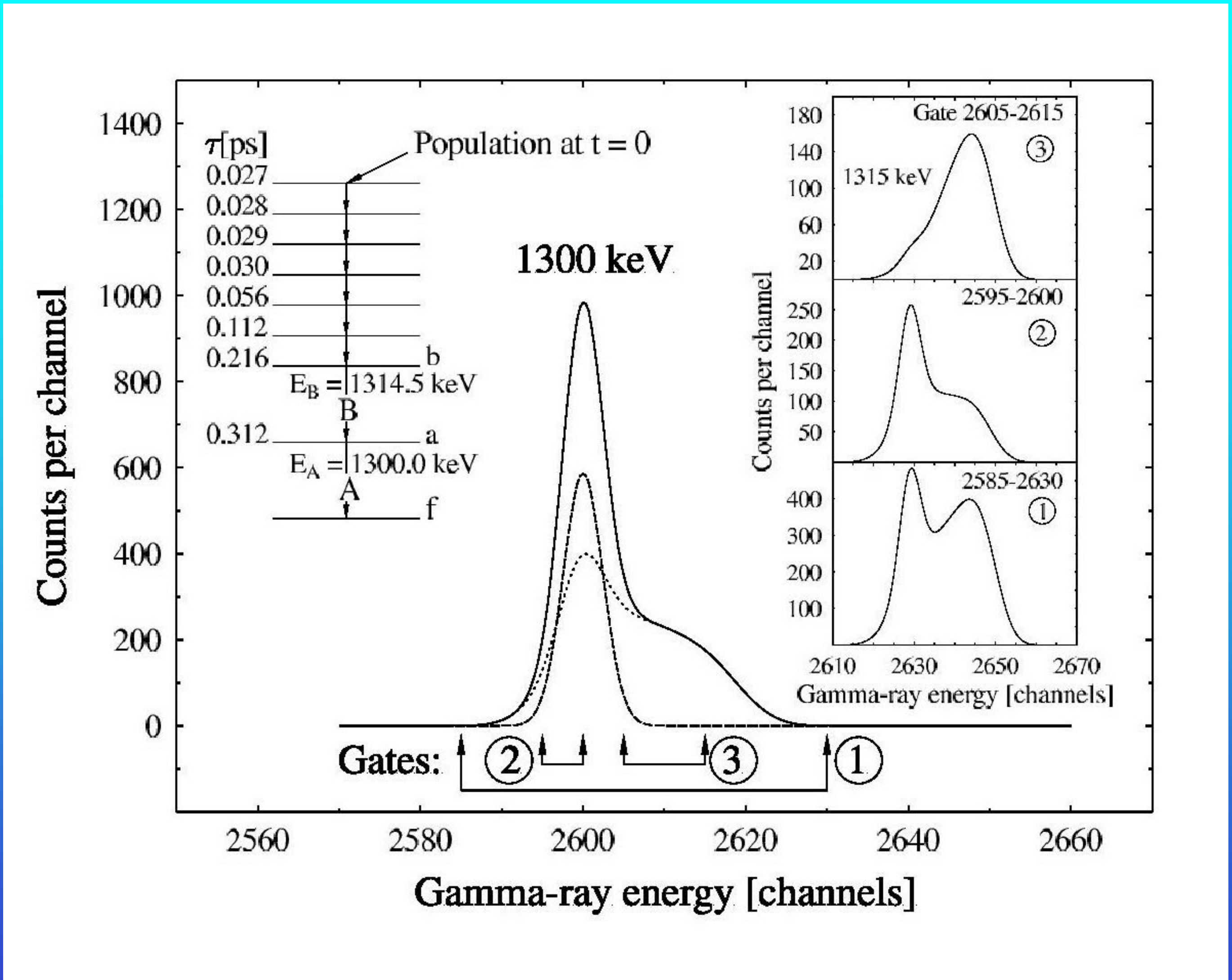
Euroball IV array with Cologne plunger device



Analysis details:

- 10 rings of detectors.
- 1 h subruns.
- Detectors selection.
- Stopping power is fixed from RDDS part.
- DSAM effects included in RDDS analysis
- Comparison with the previous lifetime measurements.

Lifetime analysis with a gate on depopulating transition



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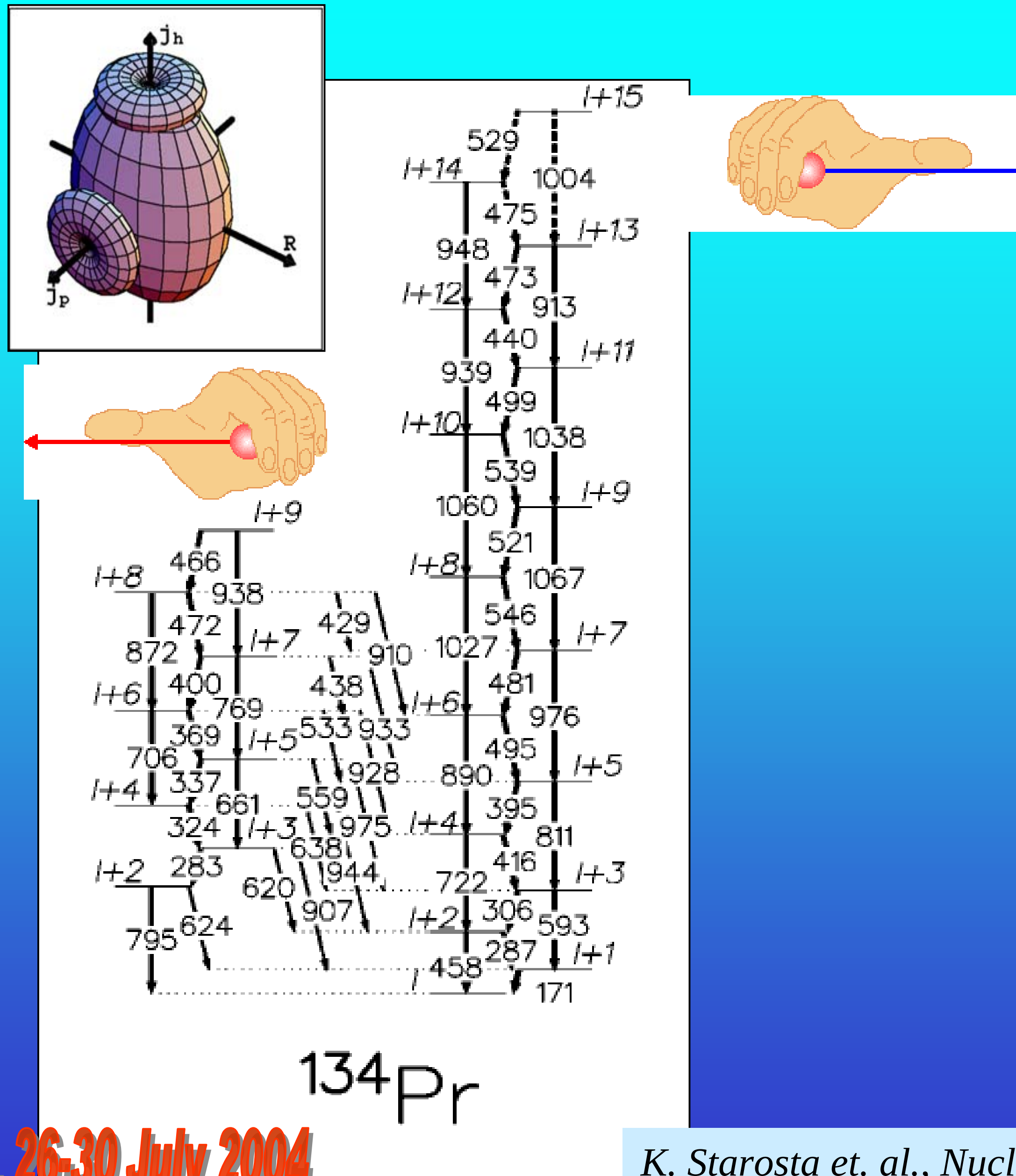
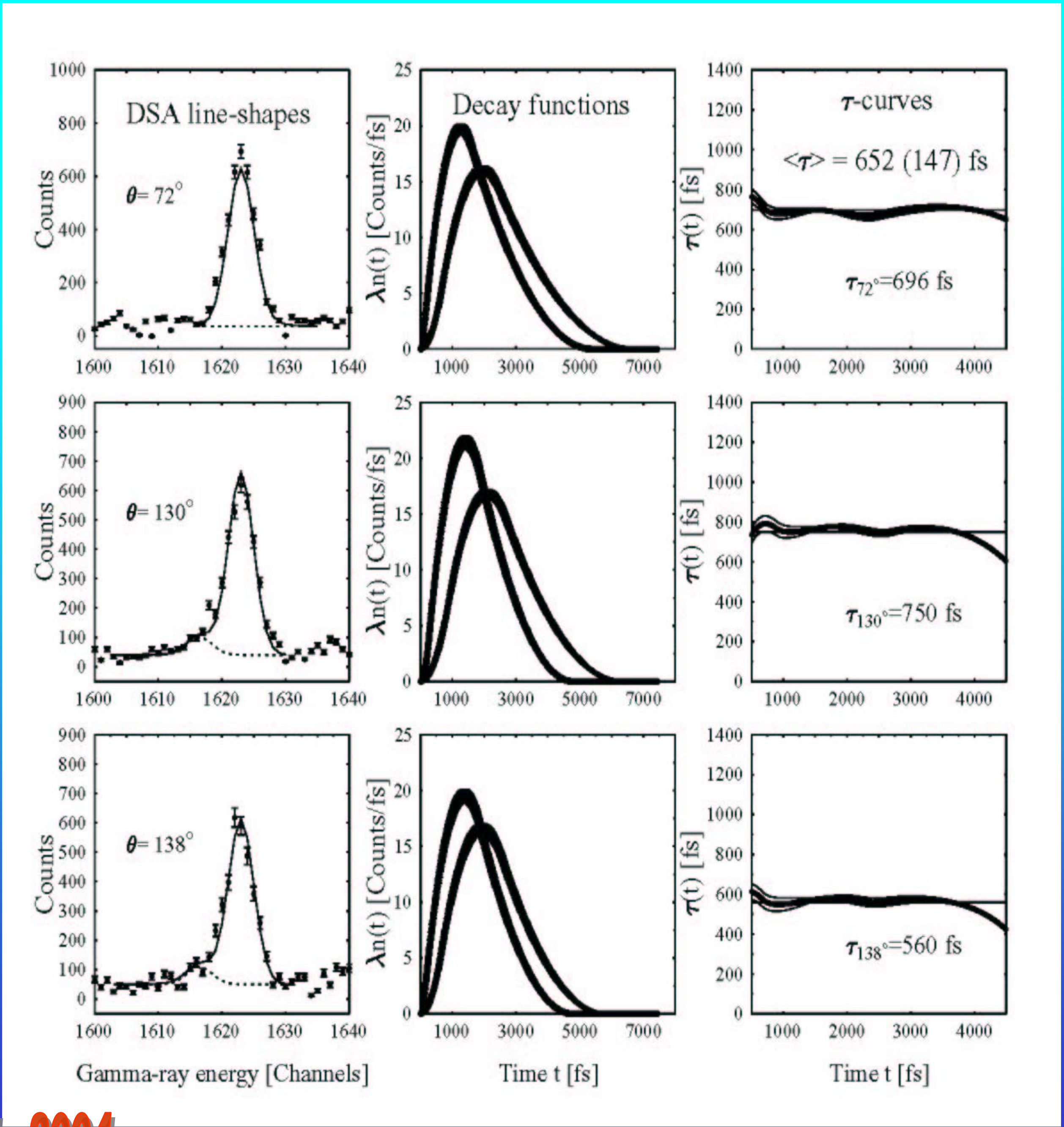
P. Petkov et. al., Nucl. Instrum. Meth. A 488 (2002) 555.

Partial level scheme of ^{134}Pr

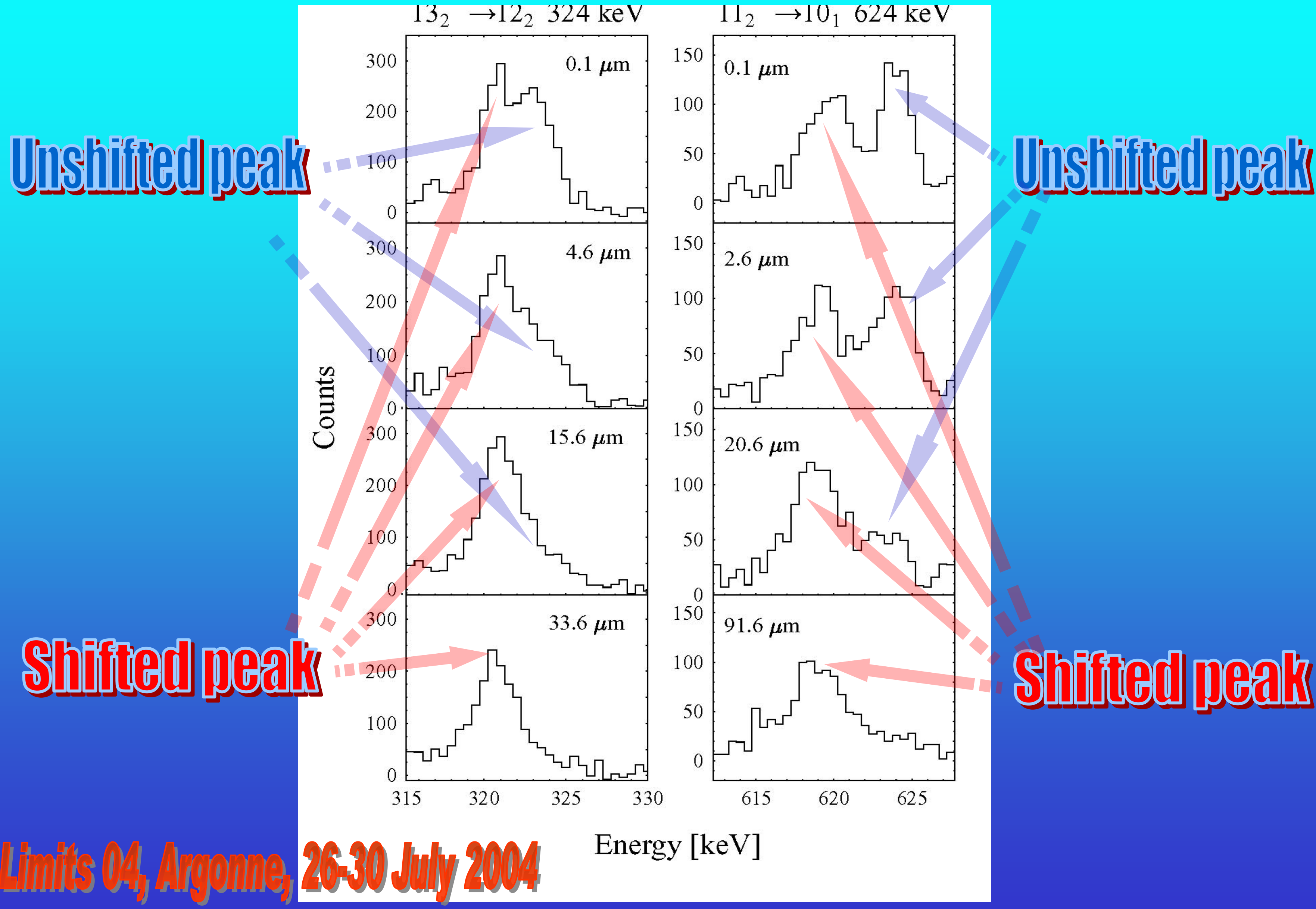


K. Starosta et. al., Nucl. A 682 (2001) 375c.

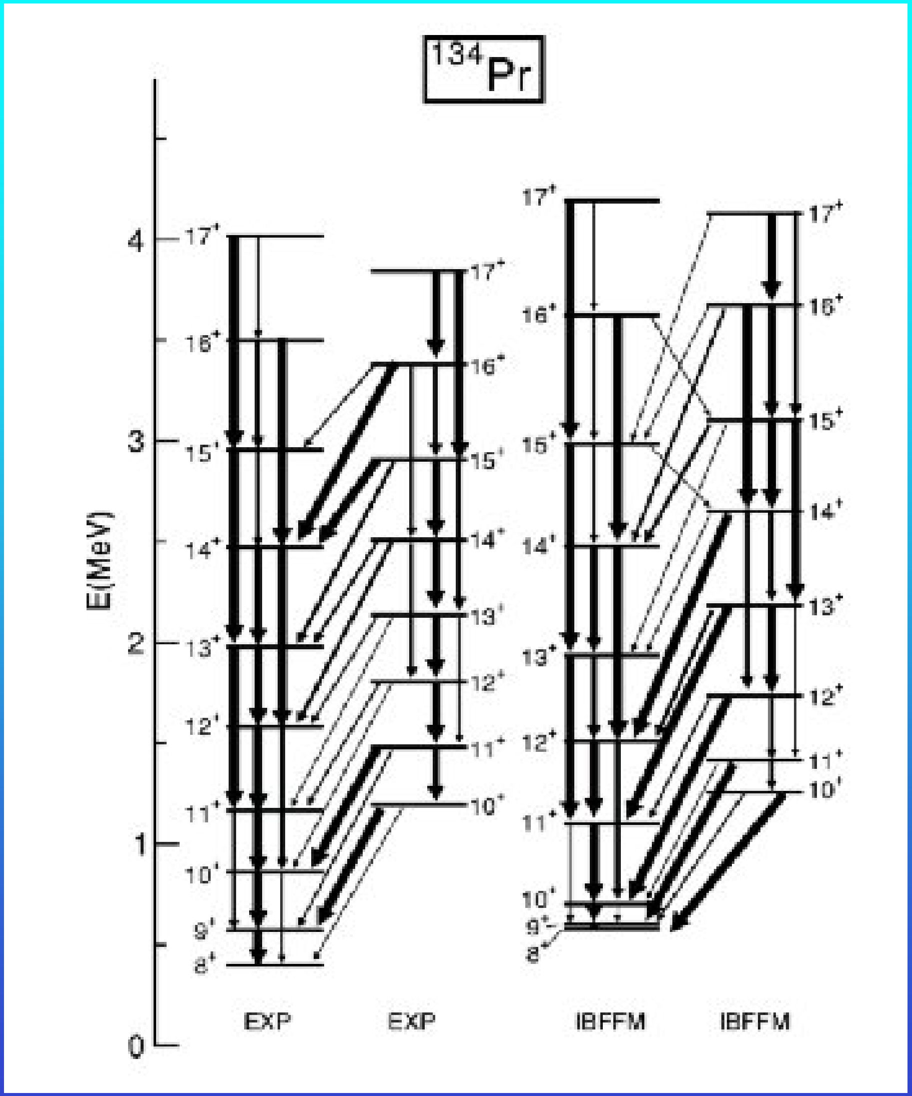
Line shape analysis of the 812 keV transition in the first chiral-candidate band and determination of the lifetime of the $I^{\pi} = 14^{+}$ level according to DDCM.



Evolution of the lineshapes of the transitions $13_2^+ \rightarrow 12_2^+$ and $11_2^+ \rightarrow 10_2^+$ with the distance



Comparison of the experimental doublet of nearly degenerate positive-parity bands in ^{134}Pr with the predictions of the IBFFM



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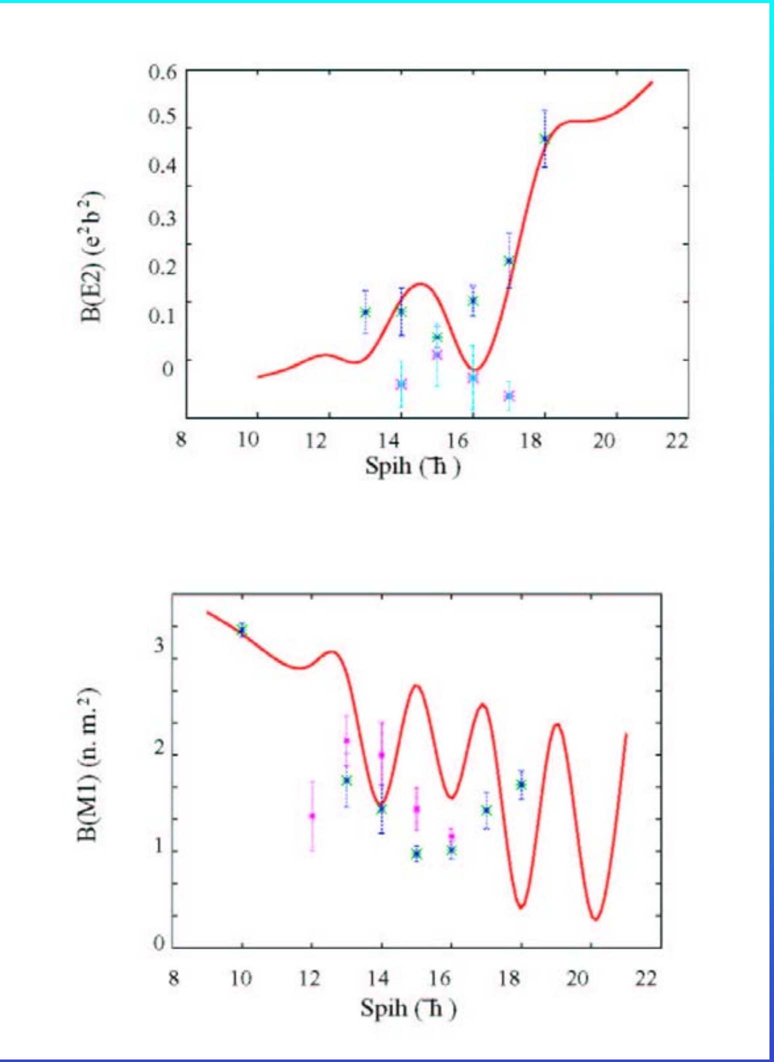
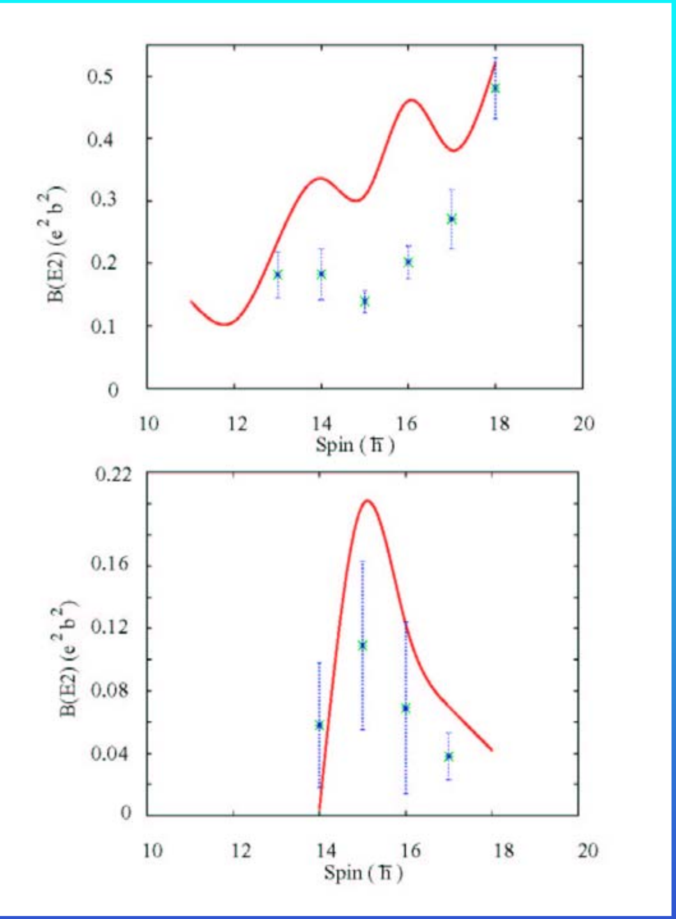
S. Brant et al, PRC 69 (2004) 017304

Comparison of experimentally determined B(E2) and B(M1) values of the two chiral-candidate bands with the predictions of Frauendorf



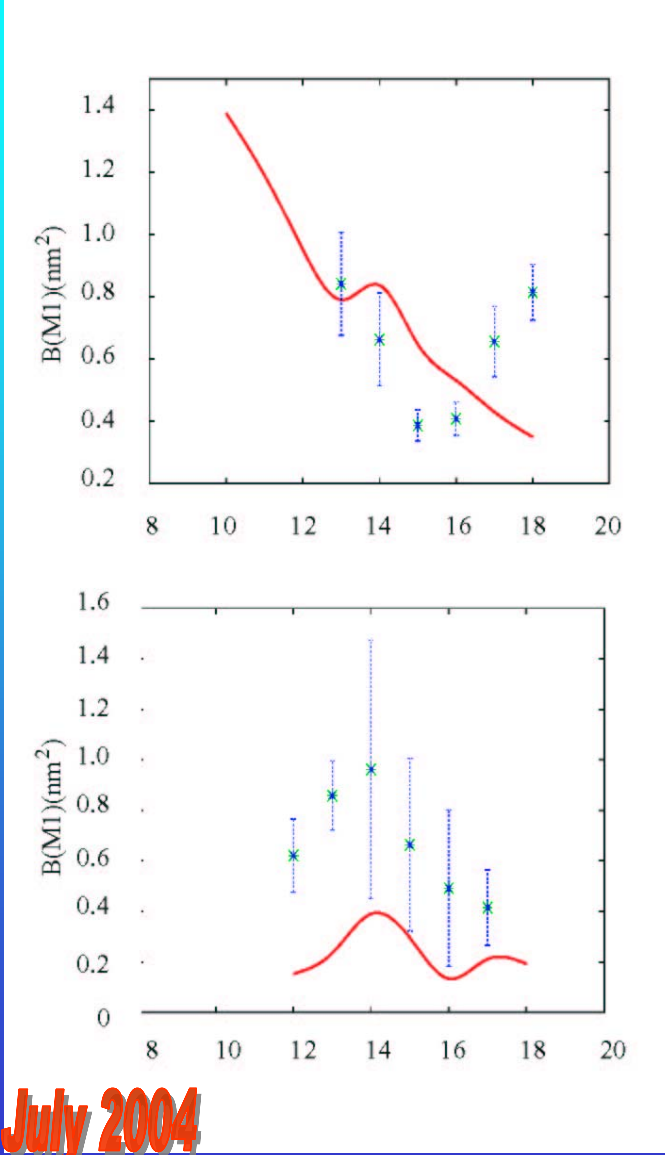
S. Frauendorf, Private communication.

Comparison of experimentally determined B(E2)'s of the two chiral-candidate bands with the predictions of IBFFM



S. Brant, Private communication.

Comparison of experimentally determined B(M1)’s of the two chiral-candidate bands with the predictions of IBFFM



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S. Brant, Private communication.

Conclusions:

RDDS and DSAM lifetimes experiments were performed with the Euroball spectrometer.

Using advanced methods for lifetime analysis 12 lifetimes are determined in the both chiral candidate bands.

Obtained absolute transition probabilities are compared with the existing theoretical predictions.

More theoretical effort is needed in order to understand experimentally obtained B(M1) and B(E2) values of both chiral-candidate bands.