Project B02: Experimental exploration of electroweak interactions in nuclei

TECHNISCHE UNIVERSITÄT DARMSTADT

Low-lying dipole strength of rare-earth isotopes investigated by nuclear resonance fluorescence method

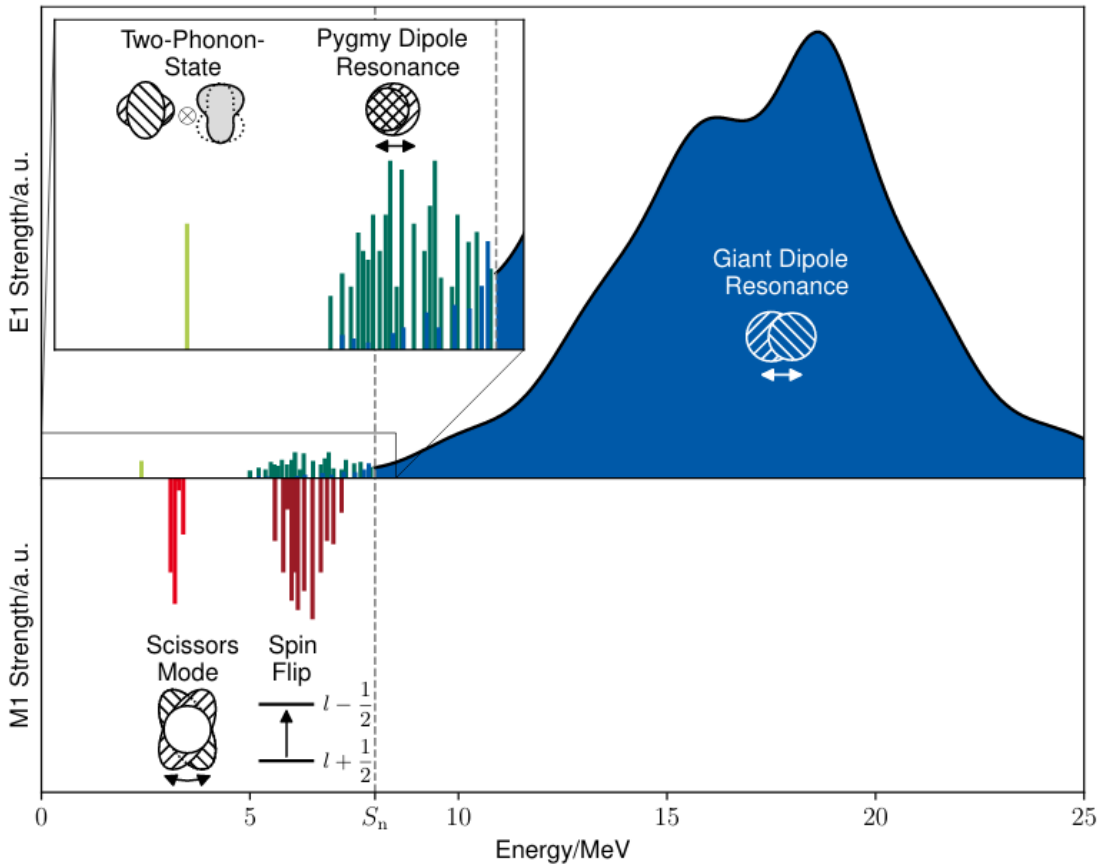
T. Beck *et al.*, Phys. Rev. Lett. **125**, 092501 (2020)

O. Papst *et al.*, Phys. Rev. C **102**, 034323 (2020)

K. E. Ide *et al.*, under peer-review by Phys. Rev. C

DFG SFB 1245

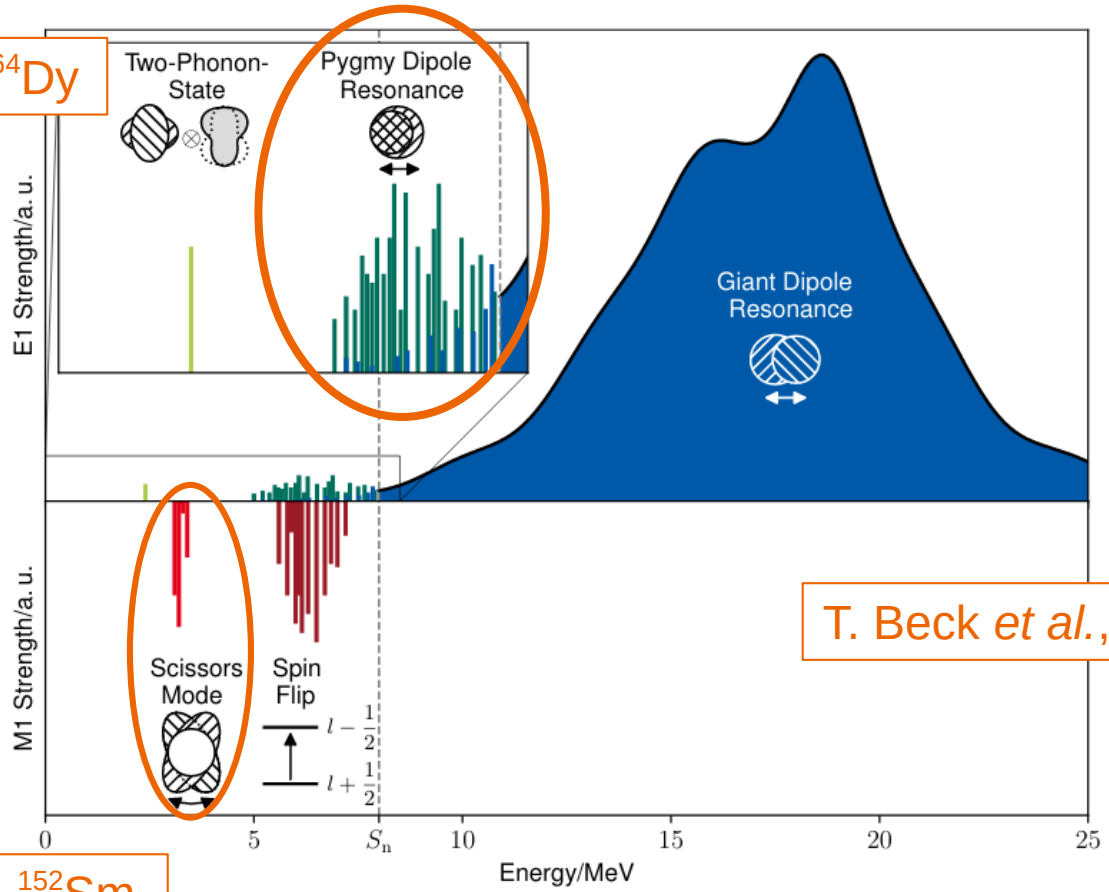
Dipole strength distribution



O. Papst, private communication (2020)

Dipole strength distribution

O. Papst *et al.*, ^{164}Dy



T. Beck *et al.*, ^{164}Dy

K. E. Ide *et al.*, ^{152}Sm

O. Papst, private communication (2020)

(γ,γ‘) Experiments @ HIγS

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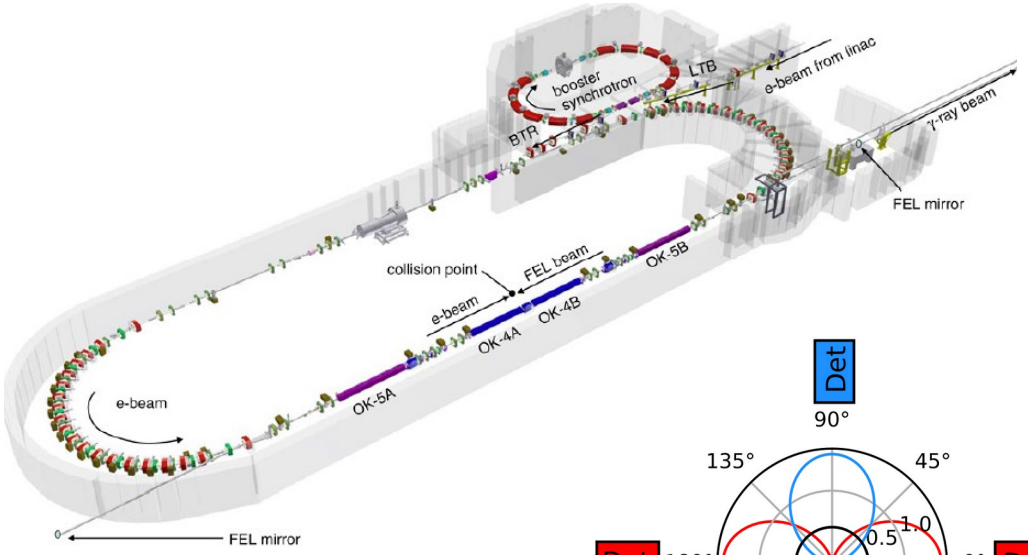
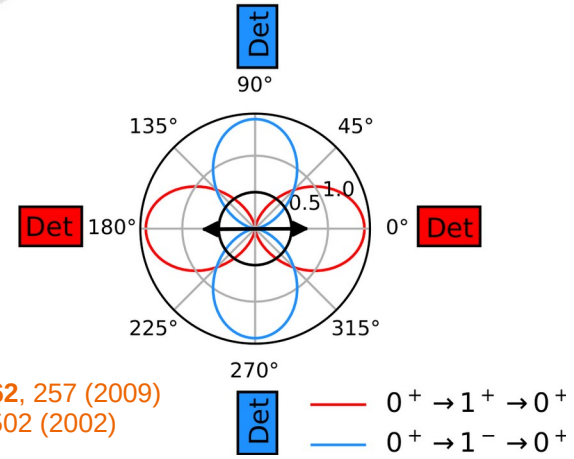
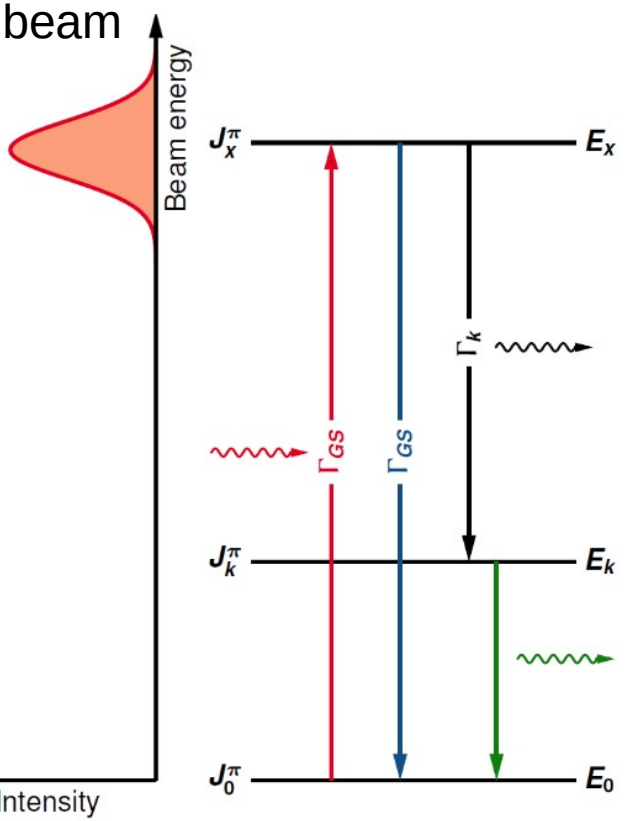
- High-Intensity Gamma-Ray Source (HIγS) @ Duke University
  → Quasi-monoenergetic, linearly polarized photon beam







H. R. Weller *et al.,* Prog. Part. Nucl. Phys. **62**, 257 (2009)
N. Pietralla *et al.*, Phys. Rev. Lett. **88,** 012502 (2002)

J. Kleemann, private communication (2019)

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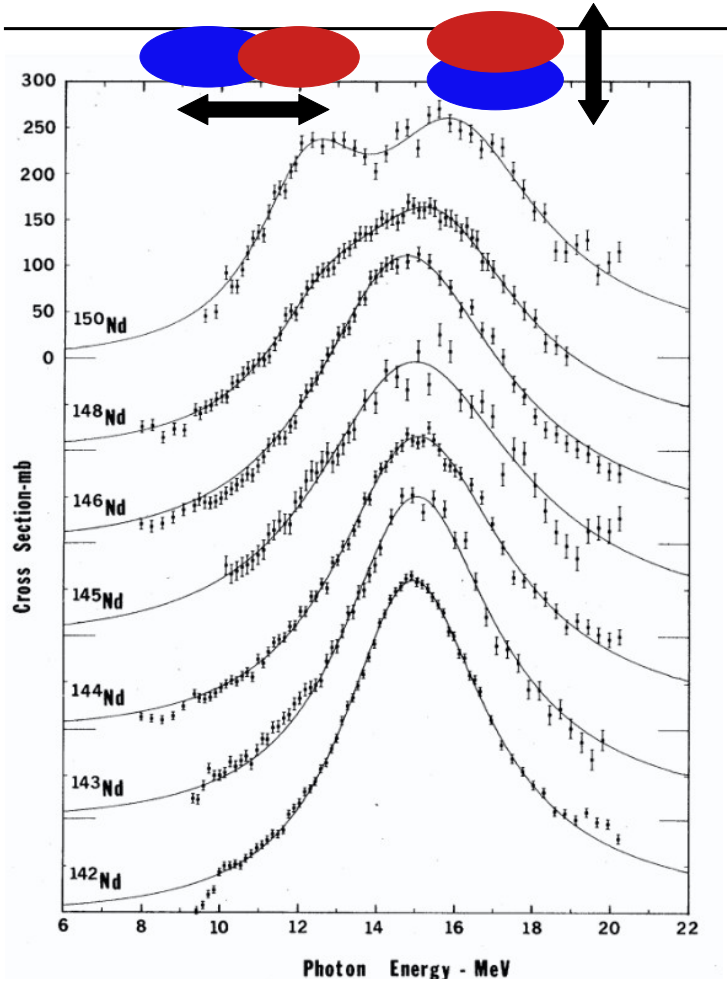
Pygmy dipole resonance



B. L. Berman and S. C. Fultz,
Rev. Mod. Phys. **47**, 713 (1975)

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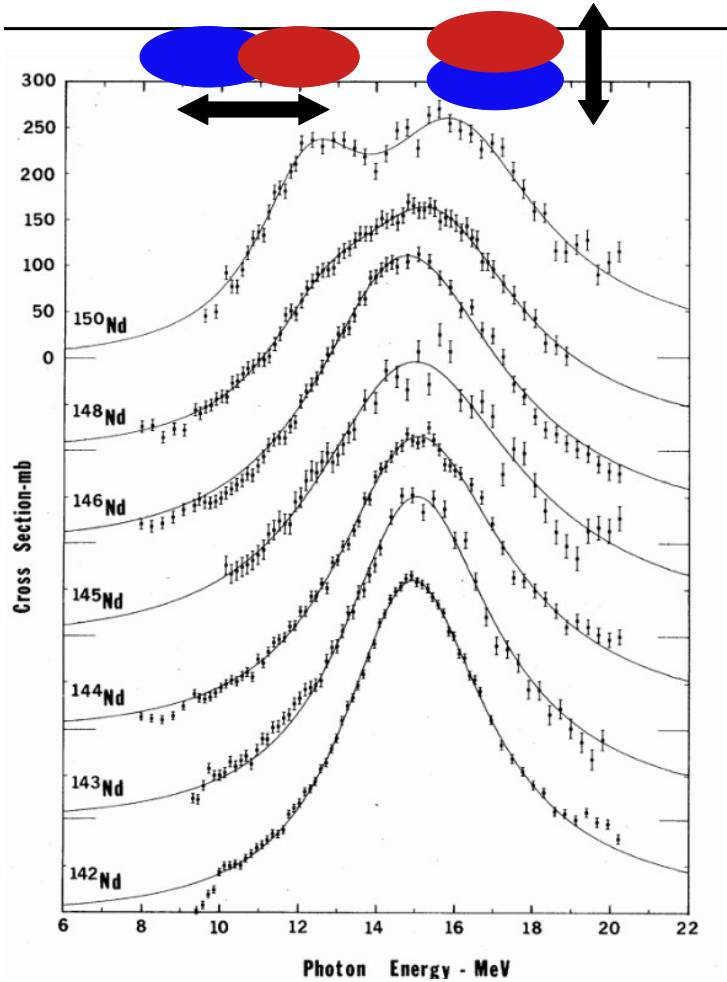

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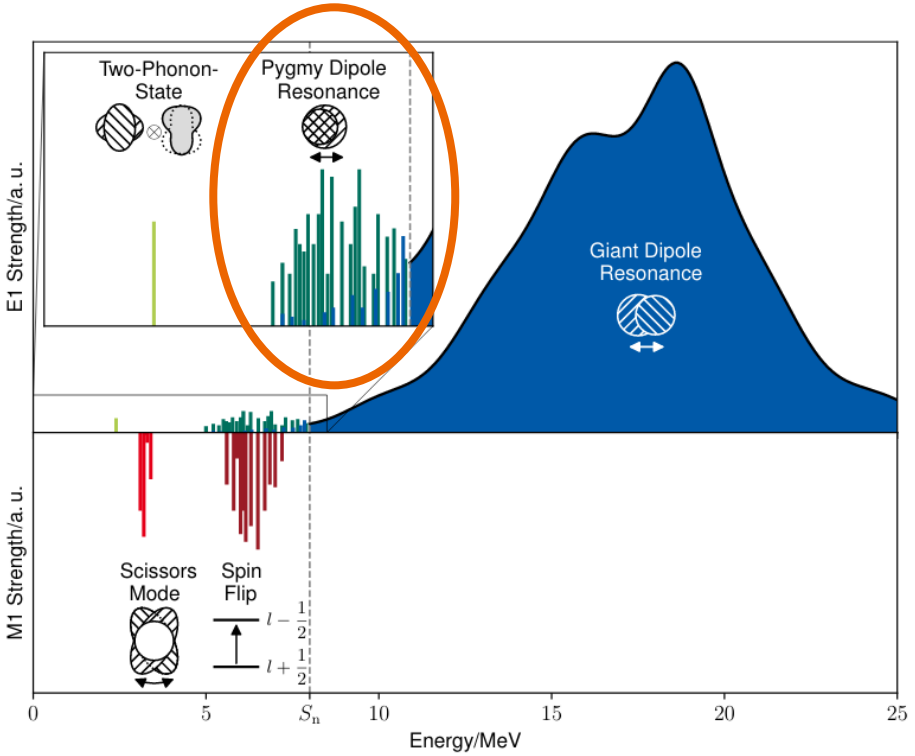
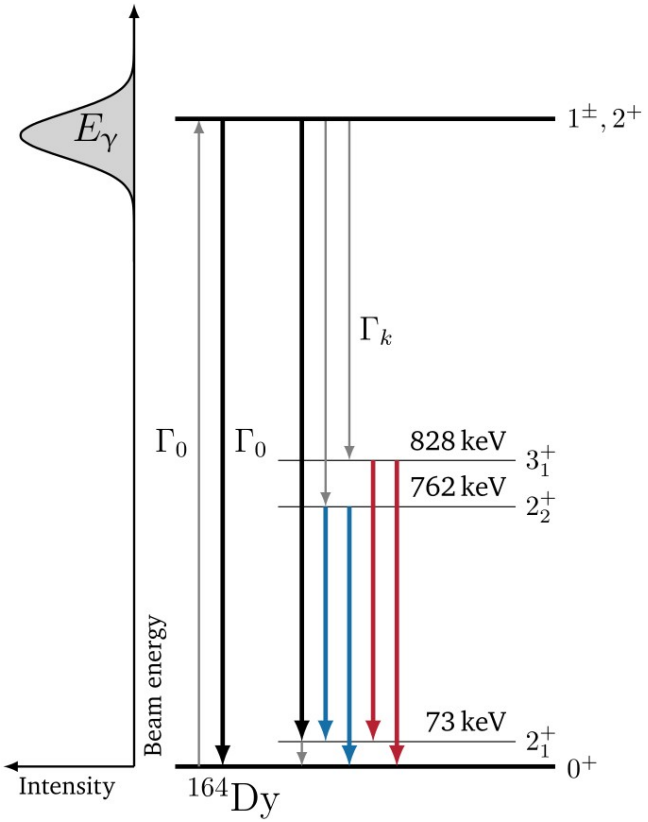
O. Papst *et al.*, ^{164}Dy



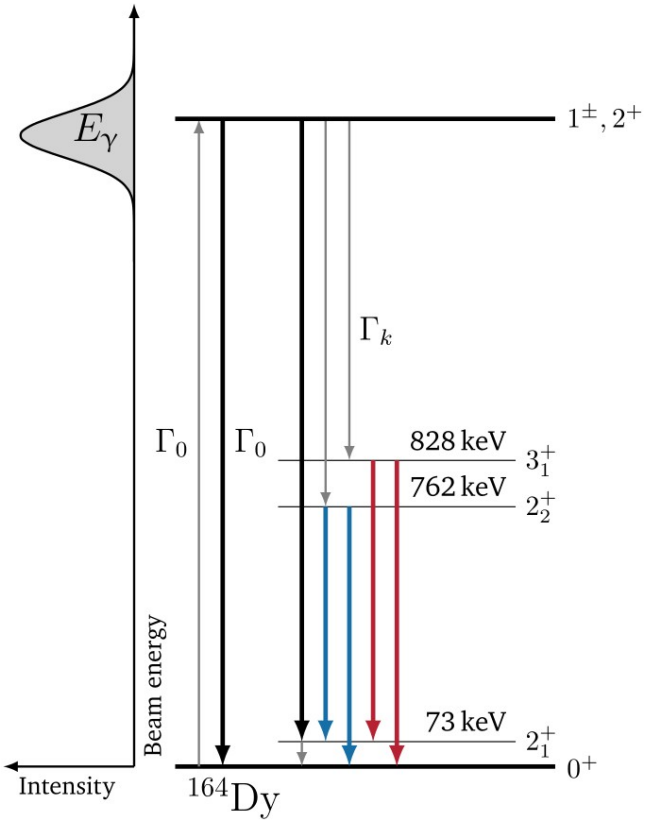
O. Papst, private communication (2020)

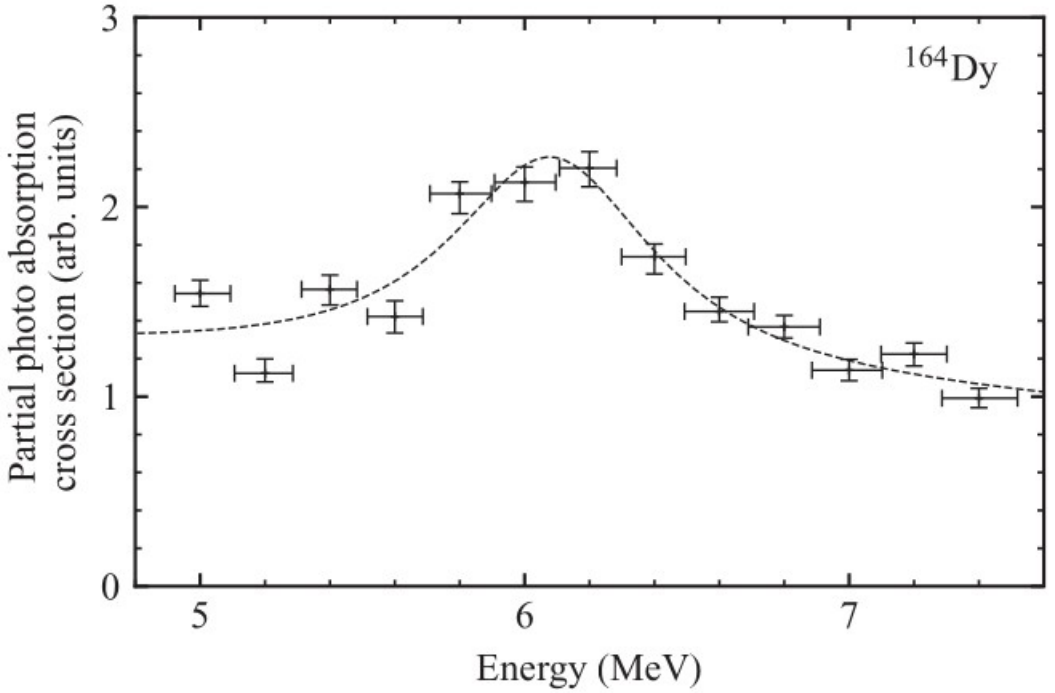
^{164}Dy – Pygmy dipole resonance



O. Papst *et al.*, Phys. Rev. C **102**, 034323 (2020)

^{164}Dy – Pygmy dipole resonance





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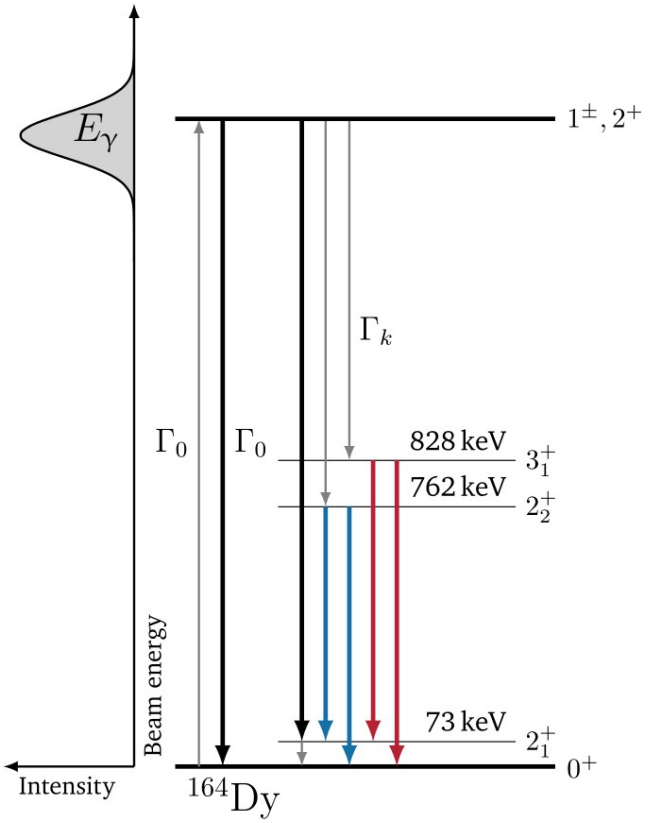
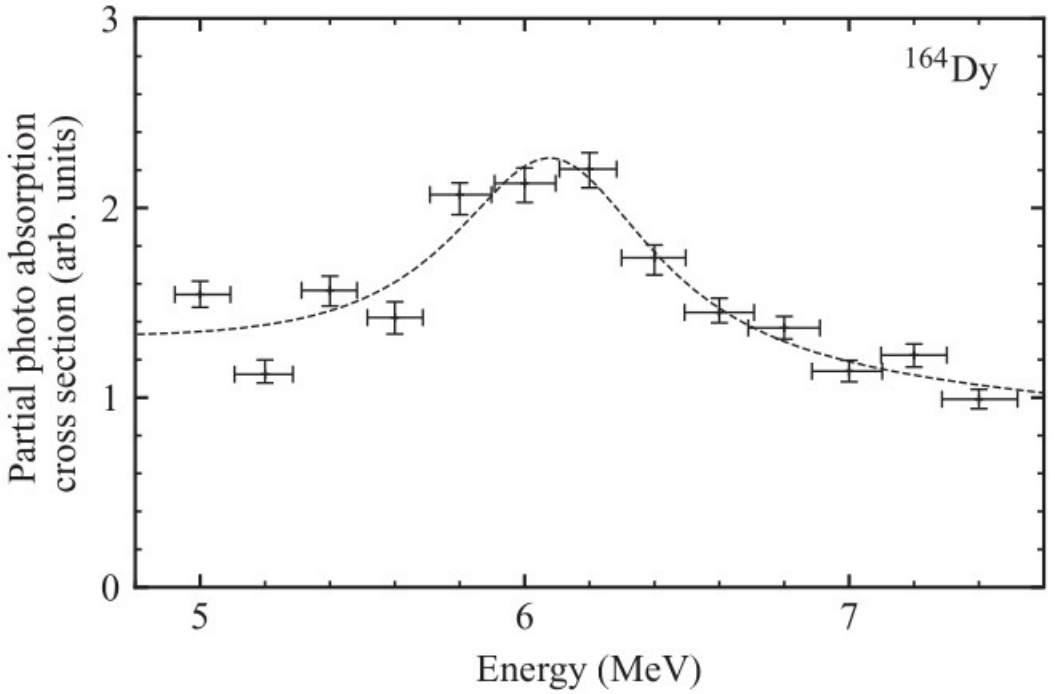
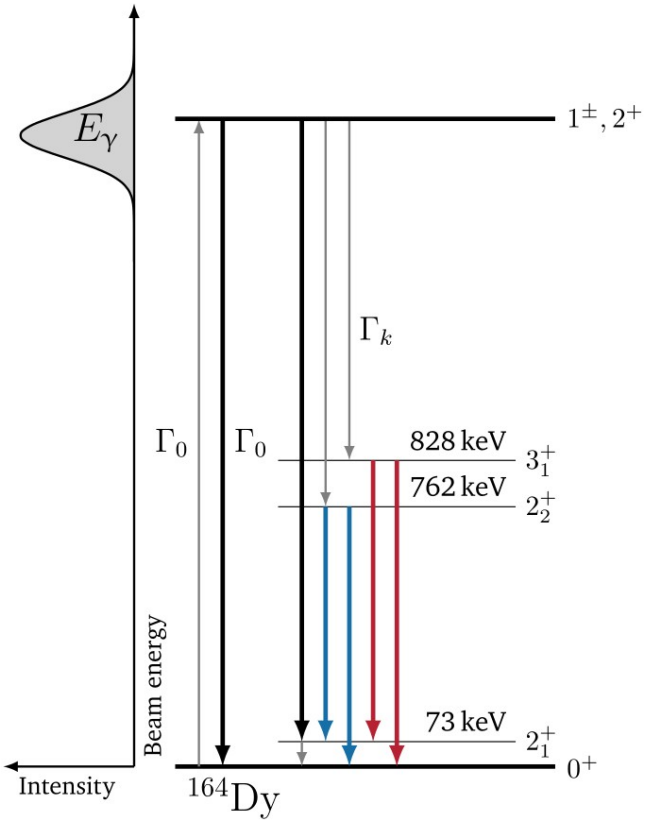


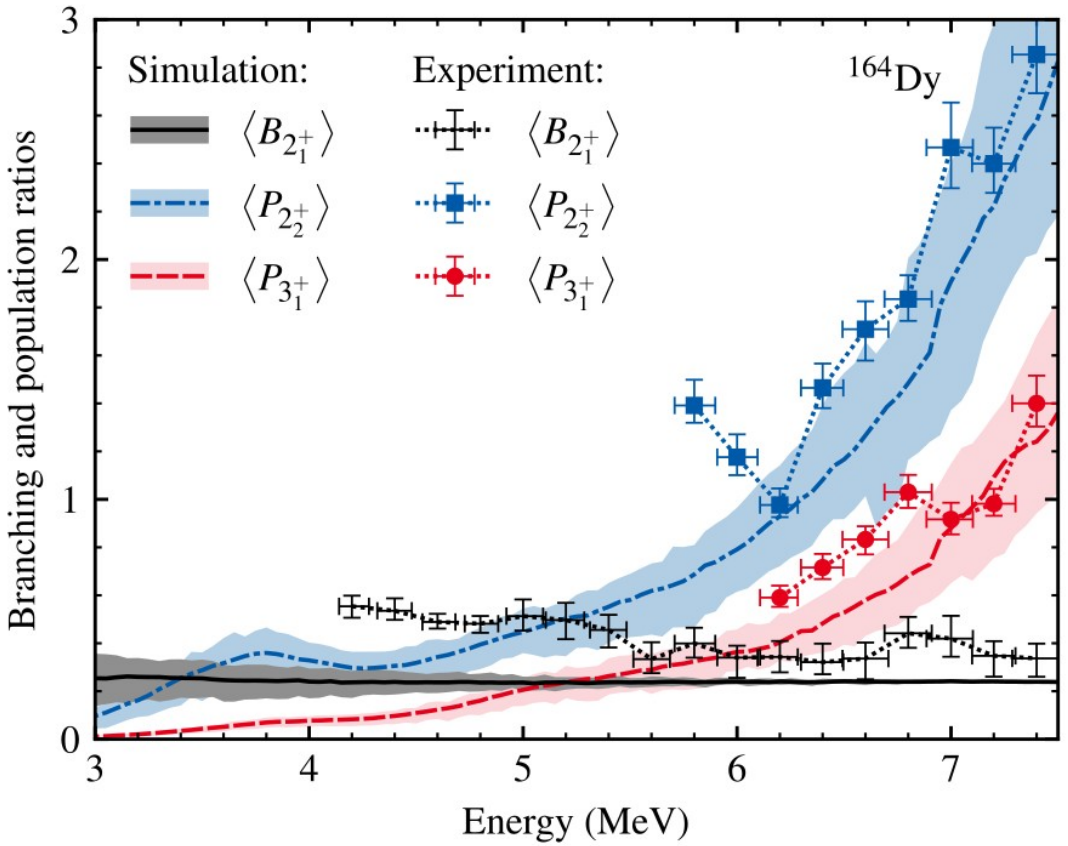


Only transitions to the 0^+_{gs} and 2^+_1
→ full strengths need to be observed

O. Papst *et al.*, Phys. Rev. C **102**, 034323 (2020)

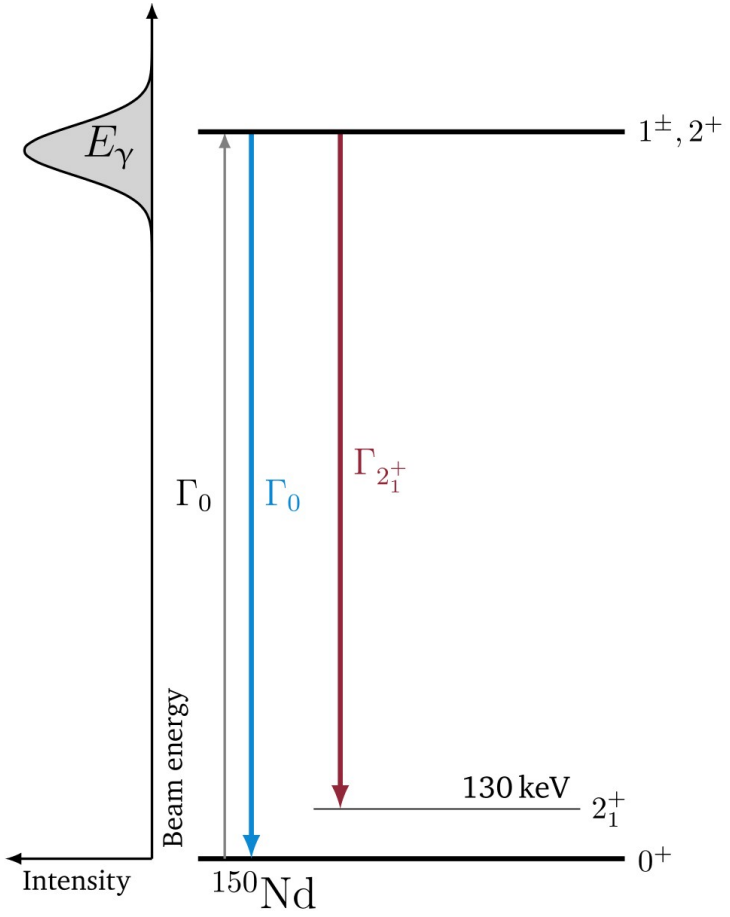
^{164}Dy – Pygmy dipole resonance

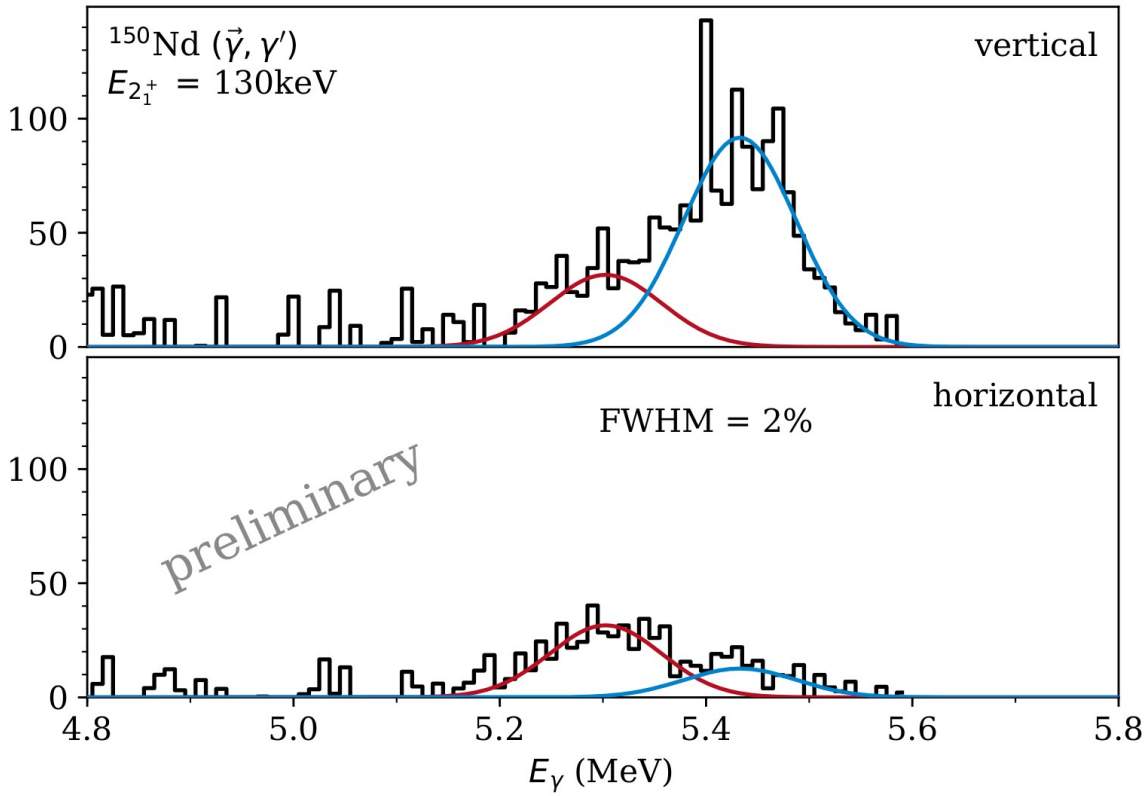




O. Papst *et al.*, Phys. Rev. C **102**, 034323 (2020)

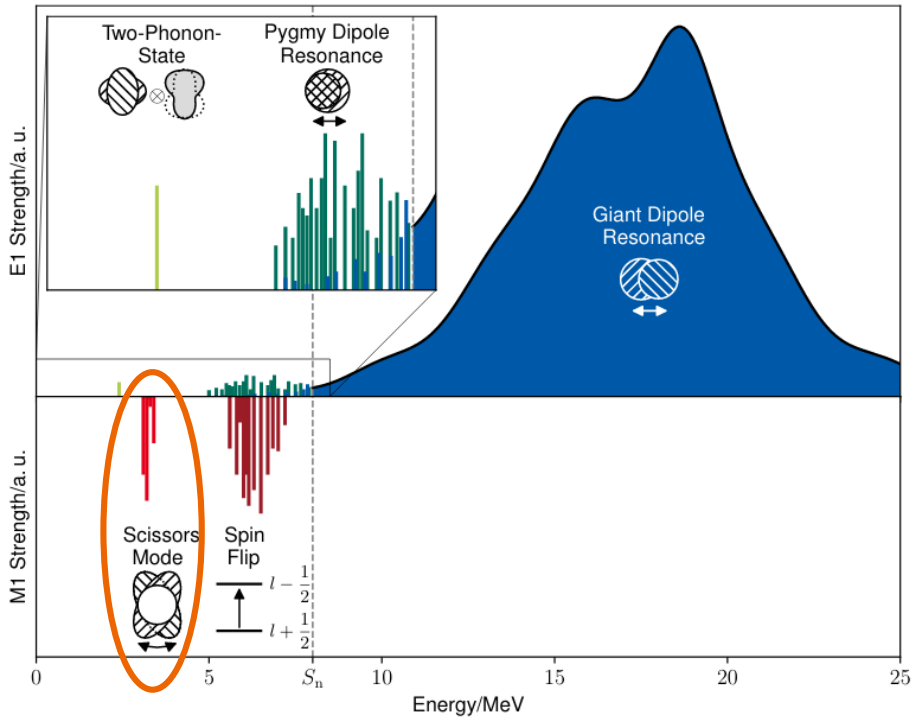
^{150}Nd – Pygmy dipole resonance

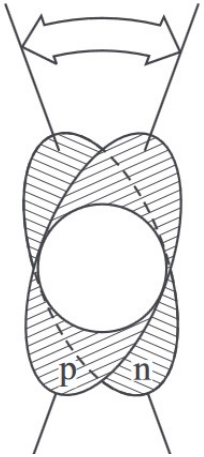




O. Papst, private communication (2021)

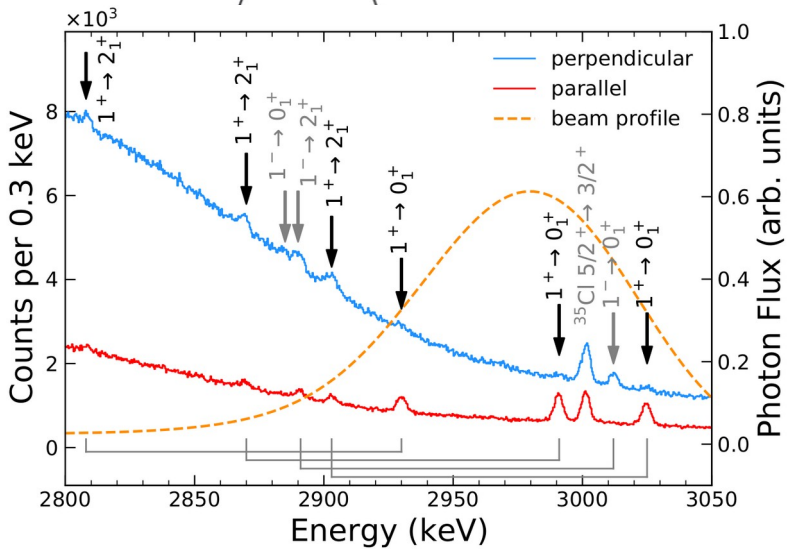
Scissors mode





K. Heyde *et al.*,
Rev. Mod. Phys. **82**, 2365 (2010)

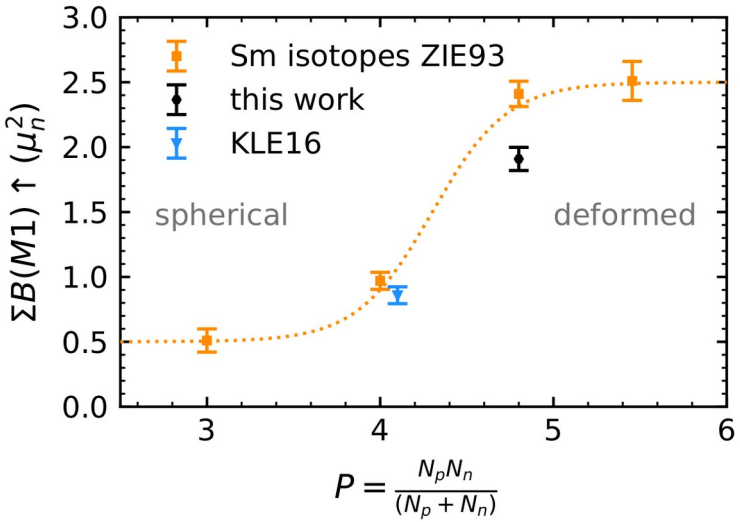
D. Bohle, A. Richter *et al.*,
Phys. Lett. B **137** (1984), 27



K. E. Ide *et al.*, ^{152}Sm

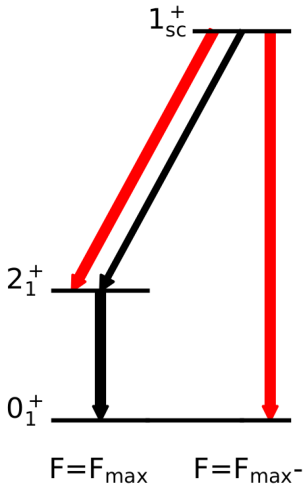
O. Papst, private communication (2020)

^{152}Sm – Scissors mode

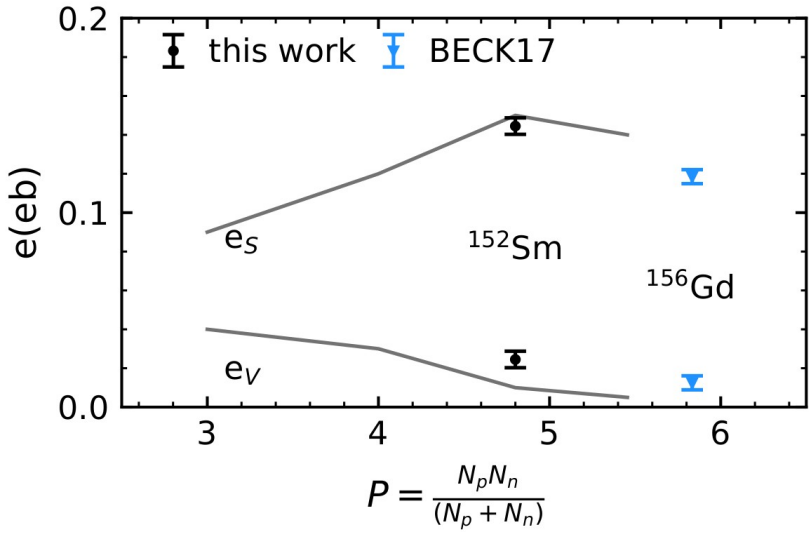


$$\Sigma B(E2; 1^+_{sc} \rightarrow 2^+_1) = 1.25^{+0.29}_{-0.50} \text{ W.u.}$$

$$e^B_\nu = 0.169\, eb$$
$$e^B_\pi = 0.120\, eb$$

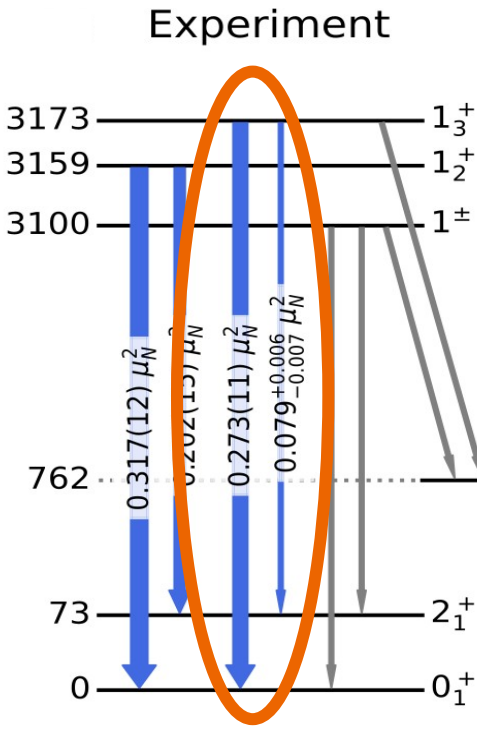


$$T(E2)_s = \frac{e_\nu + e_\pi}{2}(Q_\pi + Q_\nu)$$
$$T(E2)_v = \frac{e_\nu - e_\pi}{2}(Q_\pi - Q_\nu)$$



K. E. Ide *et al.*, submitted to Phys. Rev. C

^{164}Dy – $1^+_{K=0}$-state



Expected branching ratio for $1^+_{K=1}$: 0.5

exp. Value for 1^+_3 : 0.29(3)

T. Beck *et al.*, Phys. Rev. Lett. **125**, 092501 (2020)

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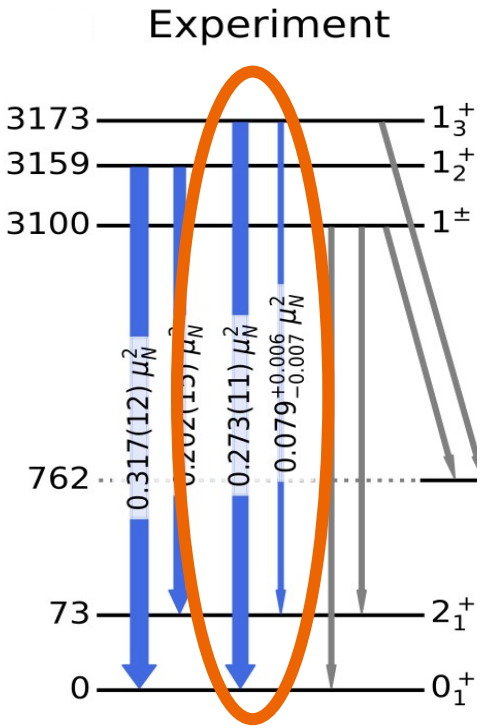

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➡ **First exp. Information on $1^+_{K=0}$**

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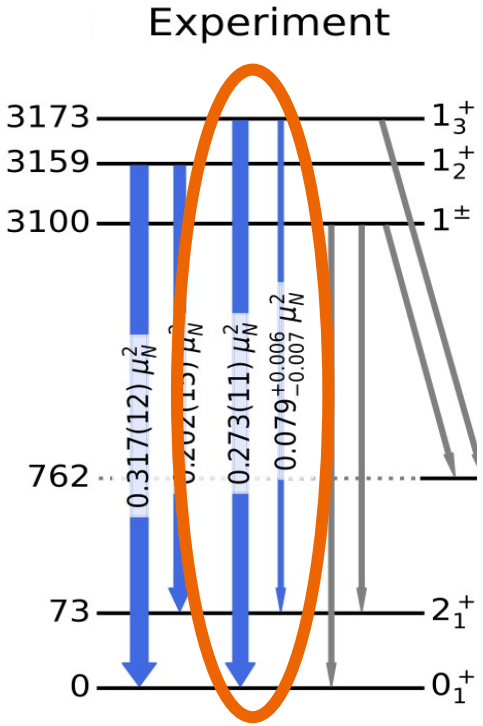

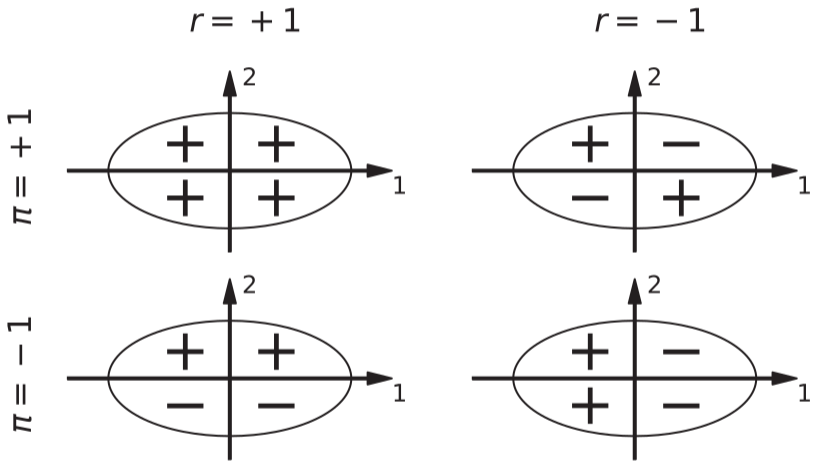

for $K^\pi = 0^+$:

$$J = \begin{cases} 0^+, 2^+, 4^+, \ldots & \text{for } \pi = +1 \wedge r = +1 \\ 1^+, 3^+, 5^+, \ldots & \text{for } \pi = +1 \wedge r = -1 \end{cases}$$

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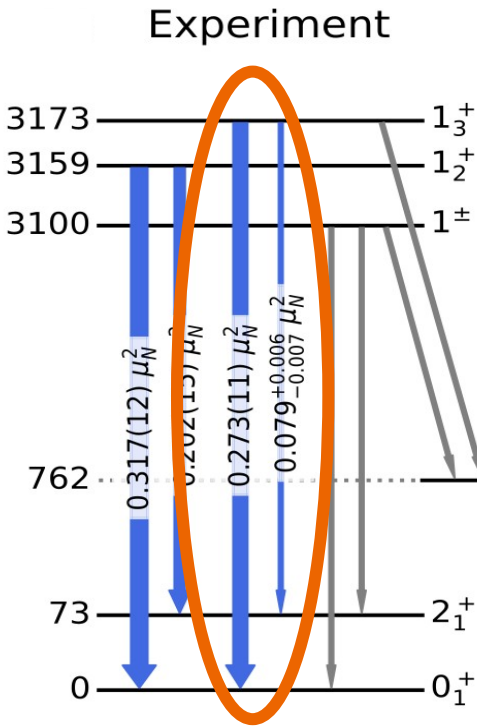

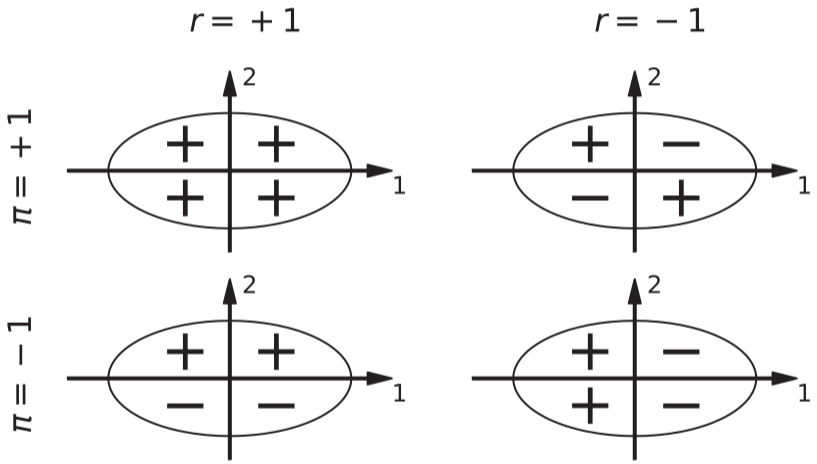

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Expected branching ratio for $1^+_{K=1}$: 0.5

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$$B(M1; 0^+_1 \rightarrow 1^+_{K=0}) = 0.008(1)\,\mu_N^2$$

➡ **First exp. Information on $1^+_{K=0}$**

T. Beck *et al.*, Phys. Rev. Lett. **125**, 092501 (2020)

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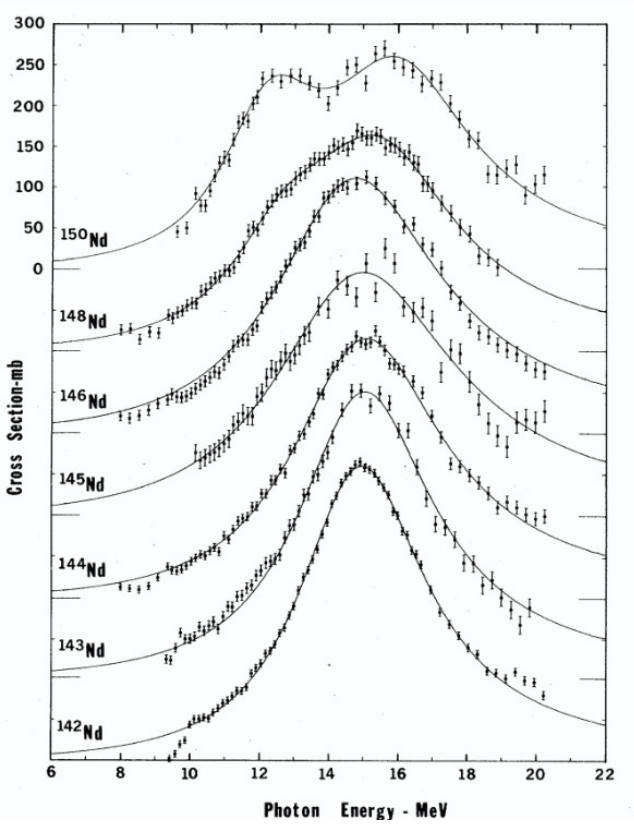
Upcoming Experiments

- ^{154}**Sm**: *K*-splitting of the GDR @HIγS
- ^{96}**Mo:** dipole strength between 4 and 8 MeV @HIγS
- ^{11}**B:** RSA (resonant self-absorption)

  measurment @ DHIPS

  → photon flux calibration standard



B. L. Berman and S. C. Fultz,
Rev. Mod. Phys. **47**, 713 (1975)

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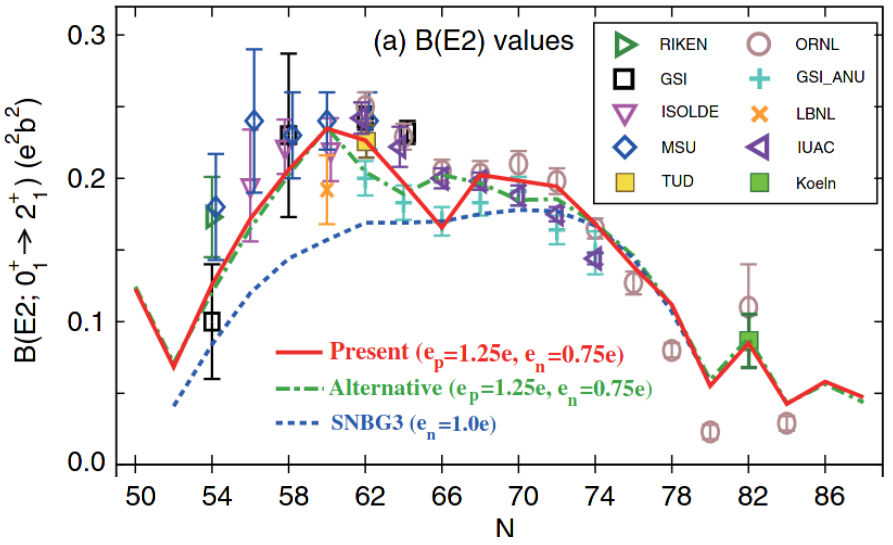

T. Togashi *et al.*, Phys. Rev. Lett. **121**, 062501 (2018)

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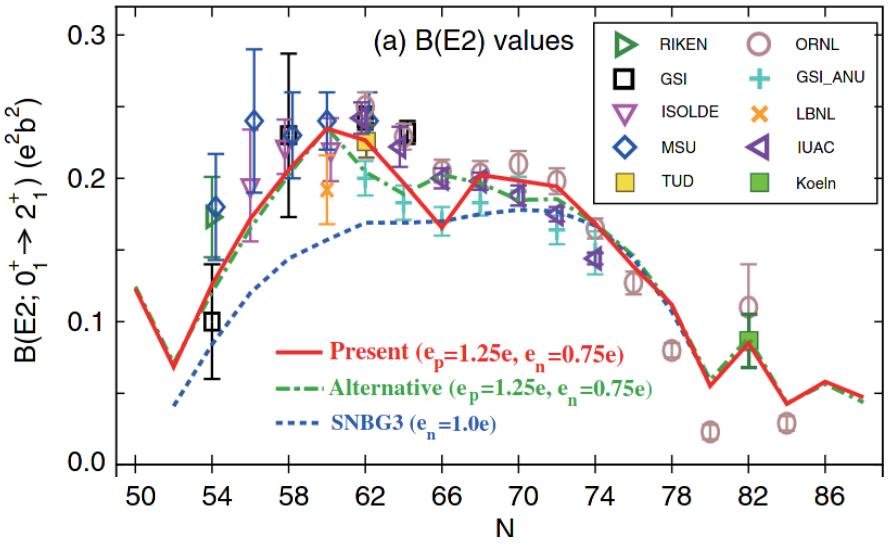

T. Togashi *et al.*, Phys. Rev. Lett. **121**, 062501 (2018)

Thank you for your attention!