Decay Characteristics of the Scissors Mode in the QPT and 0νββ-Partner Isotopes ^{150}Nd and ^{150}Sm*

TECHNISCHE UNIVERSITÄT DARMSTADT

9th Workshop on Quantum Phase Transitions in Nuclei and Many-body Systems – Padova 2018

J. Kleemann[1,✉], T. Beck[1], U. Gayer[1], N. Pietralla[1], V. Werner[1], M. Bhike[2], S. Finch[2], J. Isaak[1], Krishichayan[2], B. Löher[1], H. Pai[1,3], O. Papst[1], P. C. Ries[1], M. Schilling[1], D. Savran[4], W. Tornow[2], M. Weinert[5], and M. Zweidinger[1]

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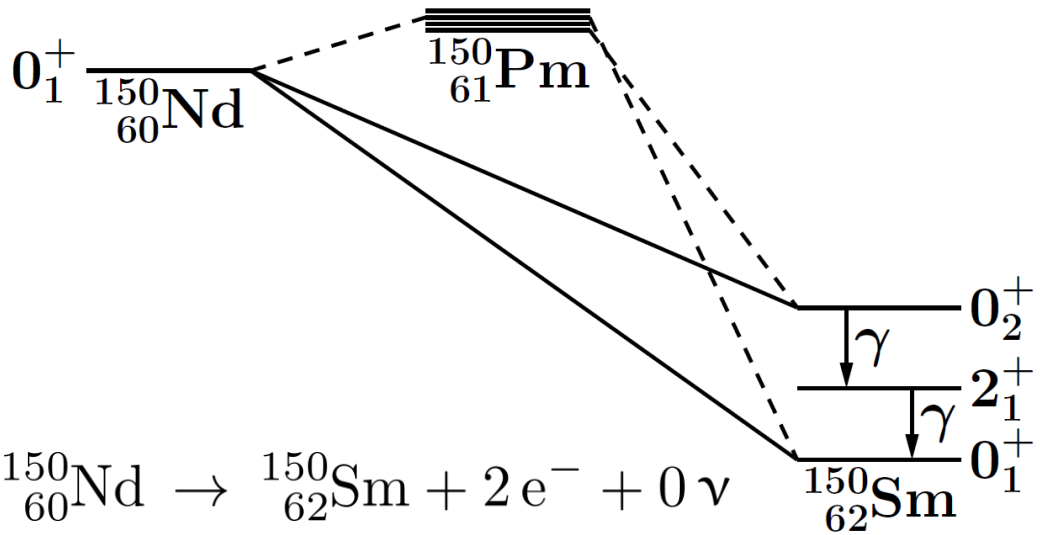

*Supported by DFG research grant CRC 1245

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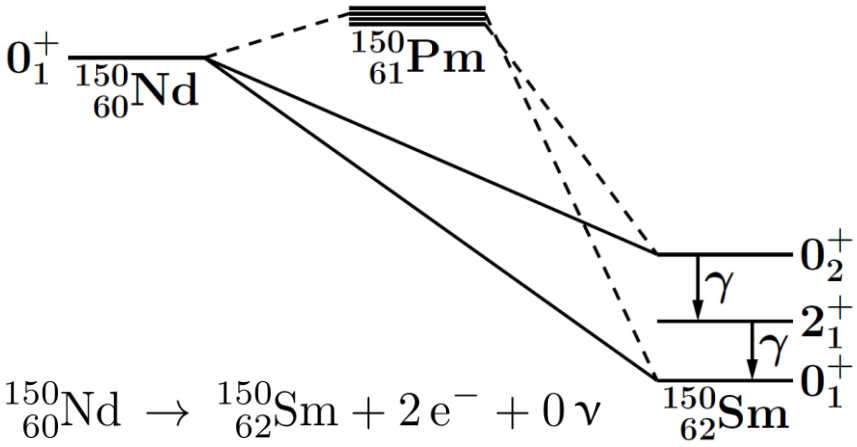
Potential 0νββ-decay ^{150}Nd → ^{150}Sm



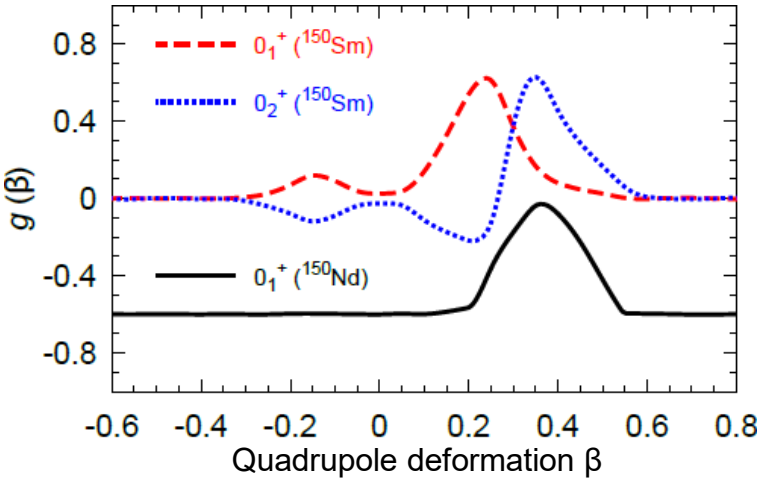
Neutrino mass

Kinematical factor

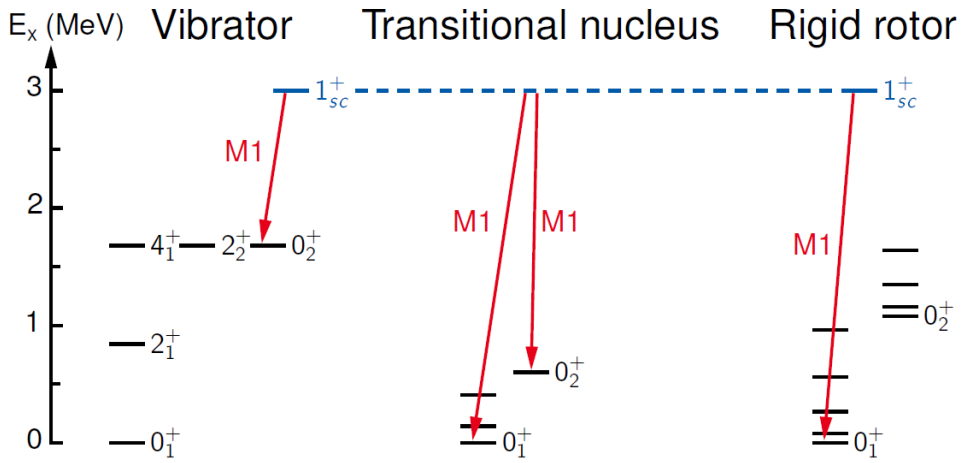
$$\lambda_{0\nu\beta\beta} = G_{0\nu} \left| M^{(0\nu)} \right|^2 \left(\frac{\langle m_\nu \rangle}{m_e} \right)^2$$

0νββ-decay rate

Nuclear matrix element

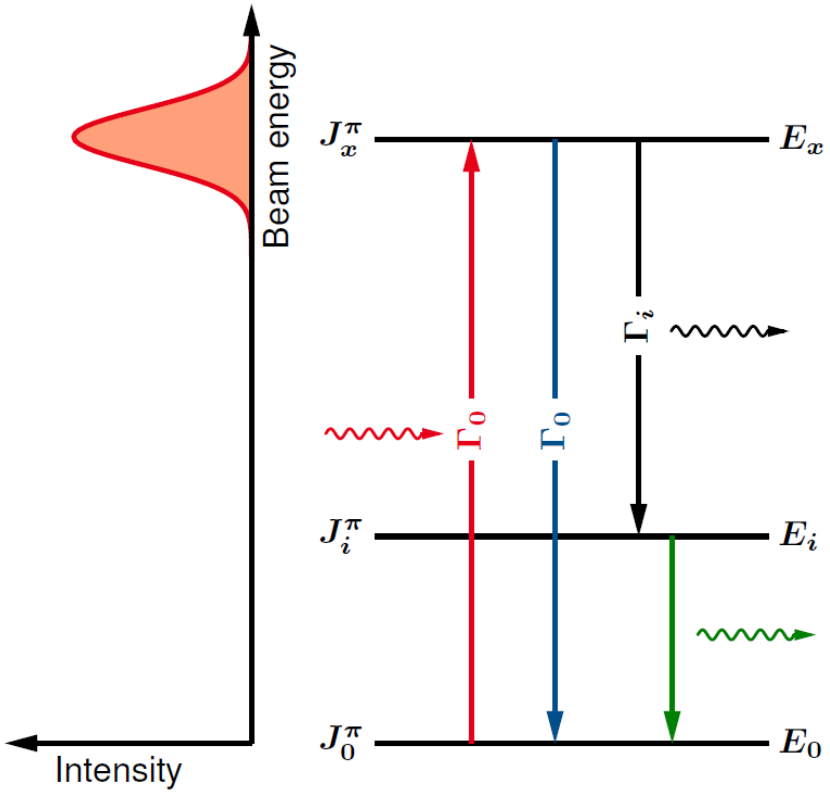


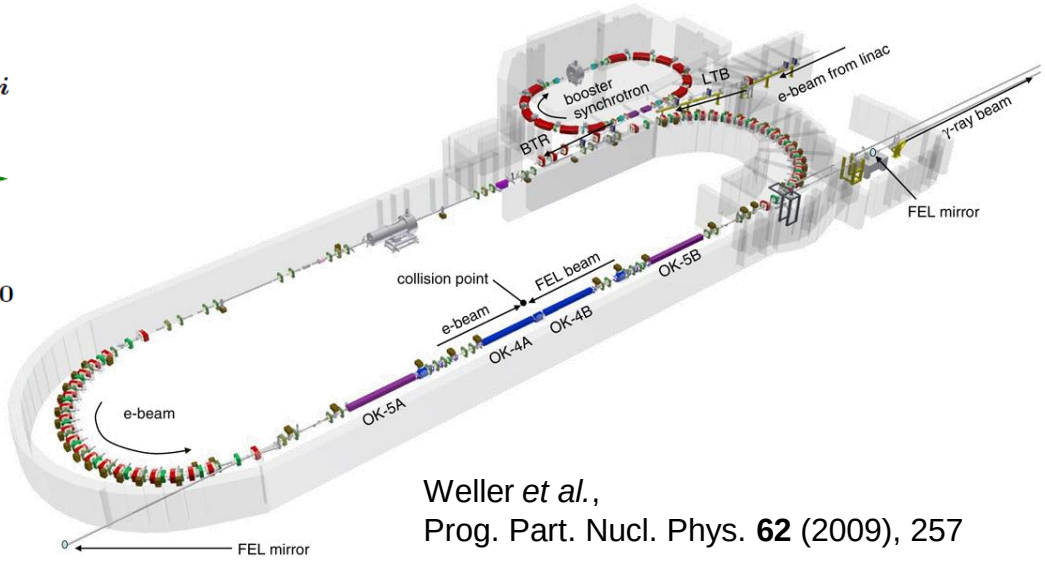
T. R. Rodríguez, private communication (2016)



J. Beller, Dissertation (2014), TU Darmstadt

Experimental technique: NRF at HIγS





Weller *et al.*,
Prog. Part. Nucl. Phys. **62** (2009), 257

Angular distribution of $0^+ \rightarrow 1^\pi \rightarrow 0^+$ cascades

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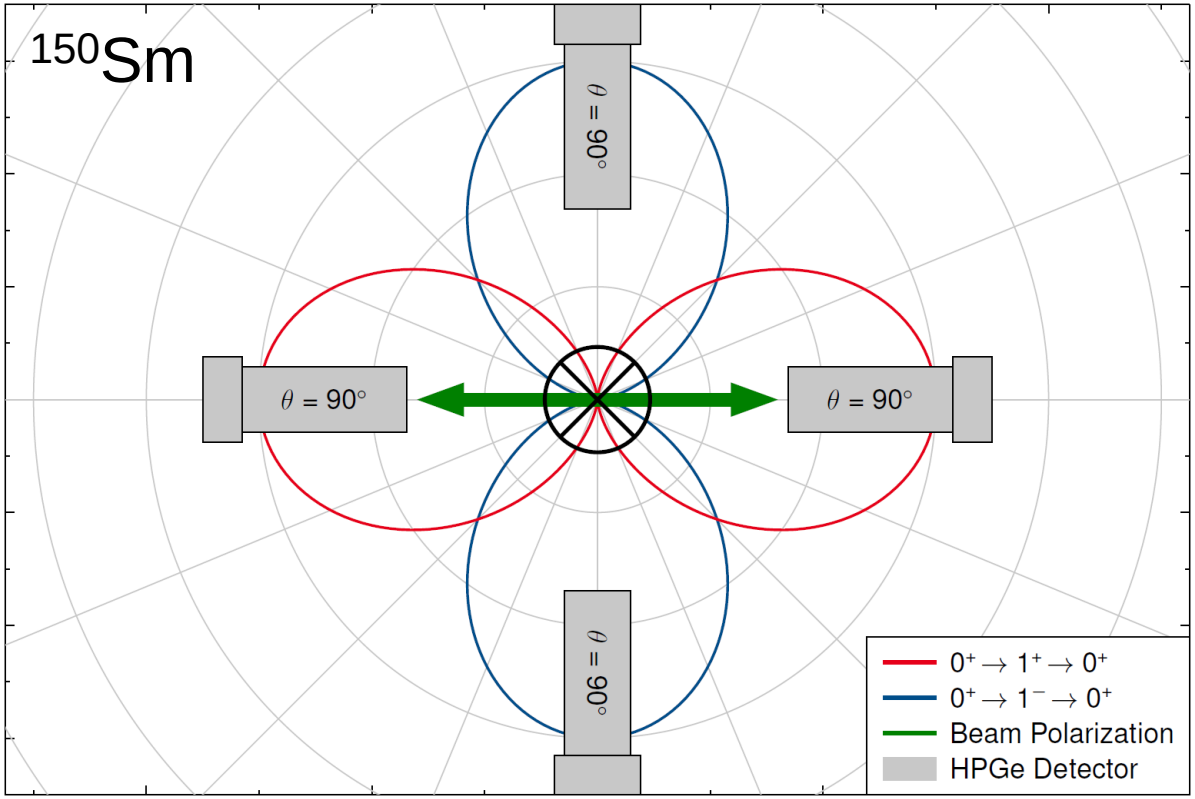
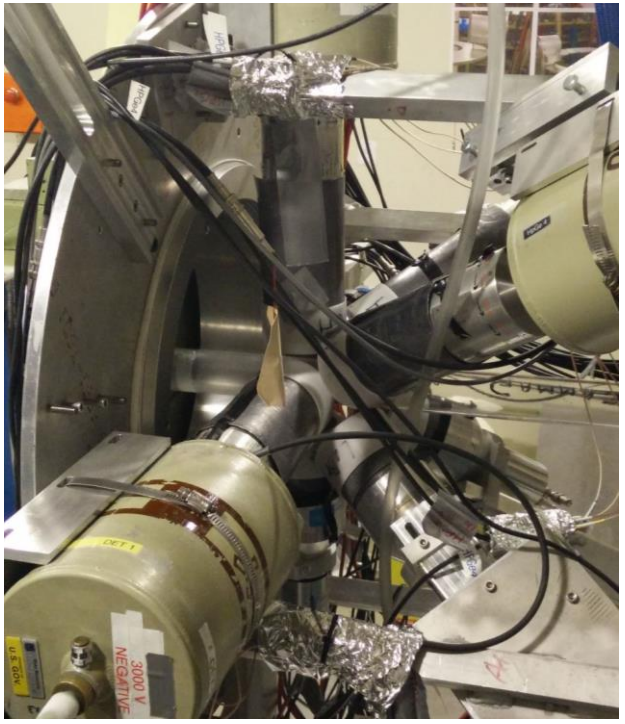
Using HIγS' polarized γ-beam: Determination of parities by angular distribution of ground-state transitions

N. Pietralla *et al.*, Phys. Rev. Lett. **88** (2001), 012502



γ^3-setup at HIγS

B. Löher *et al.*, Nucl. Instr. Meth. Phys. Res. A **723** (2013), 136



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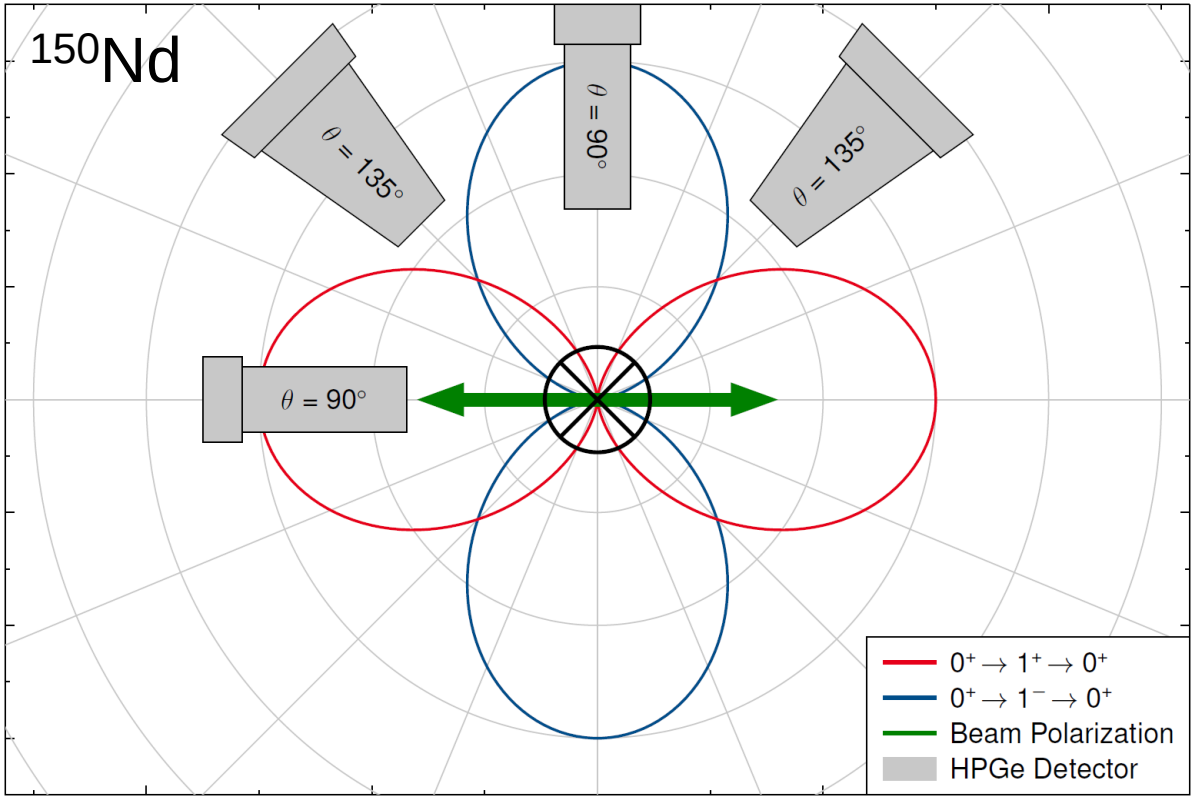

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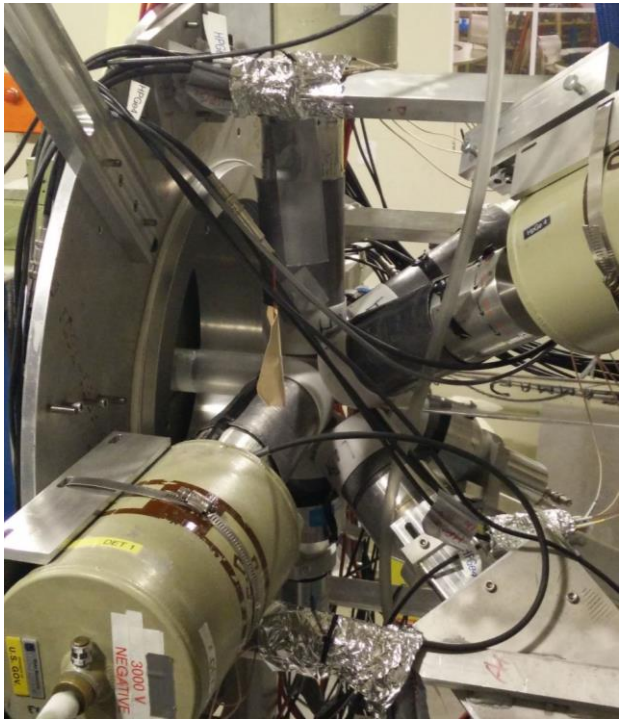

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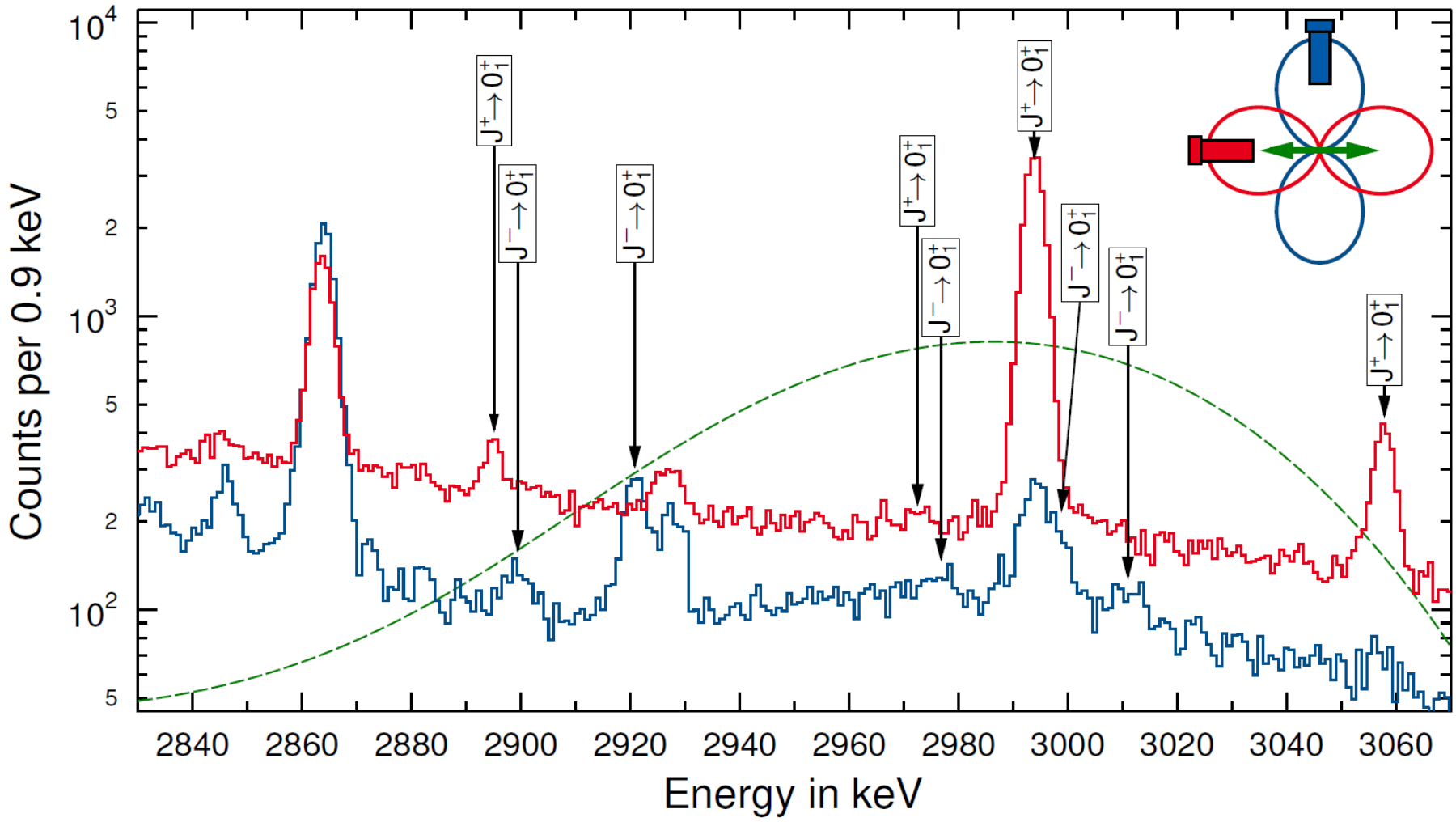
Extract of the ^{150}Nd spectra within the 2994 keV-beam's energy range



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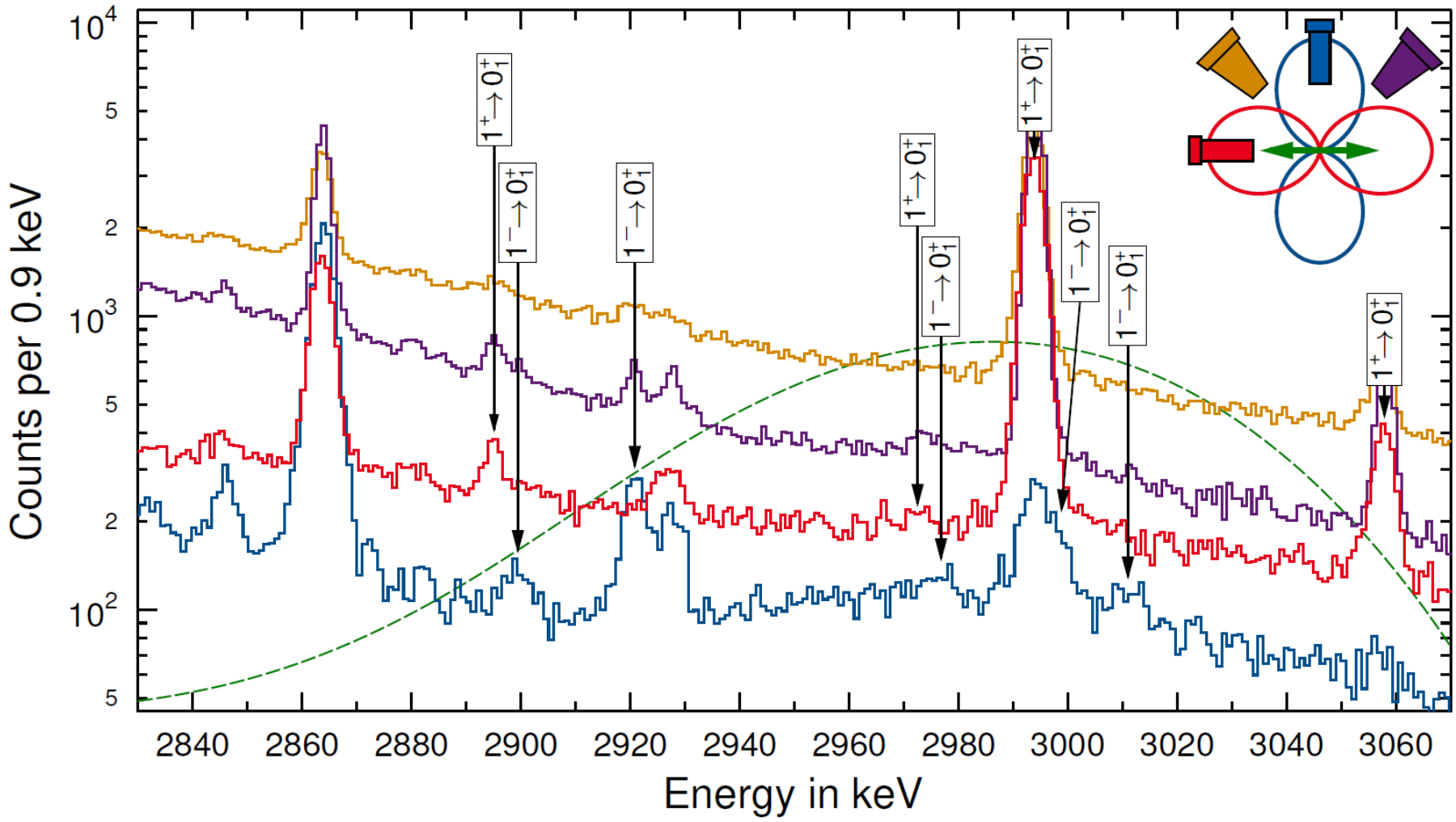

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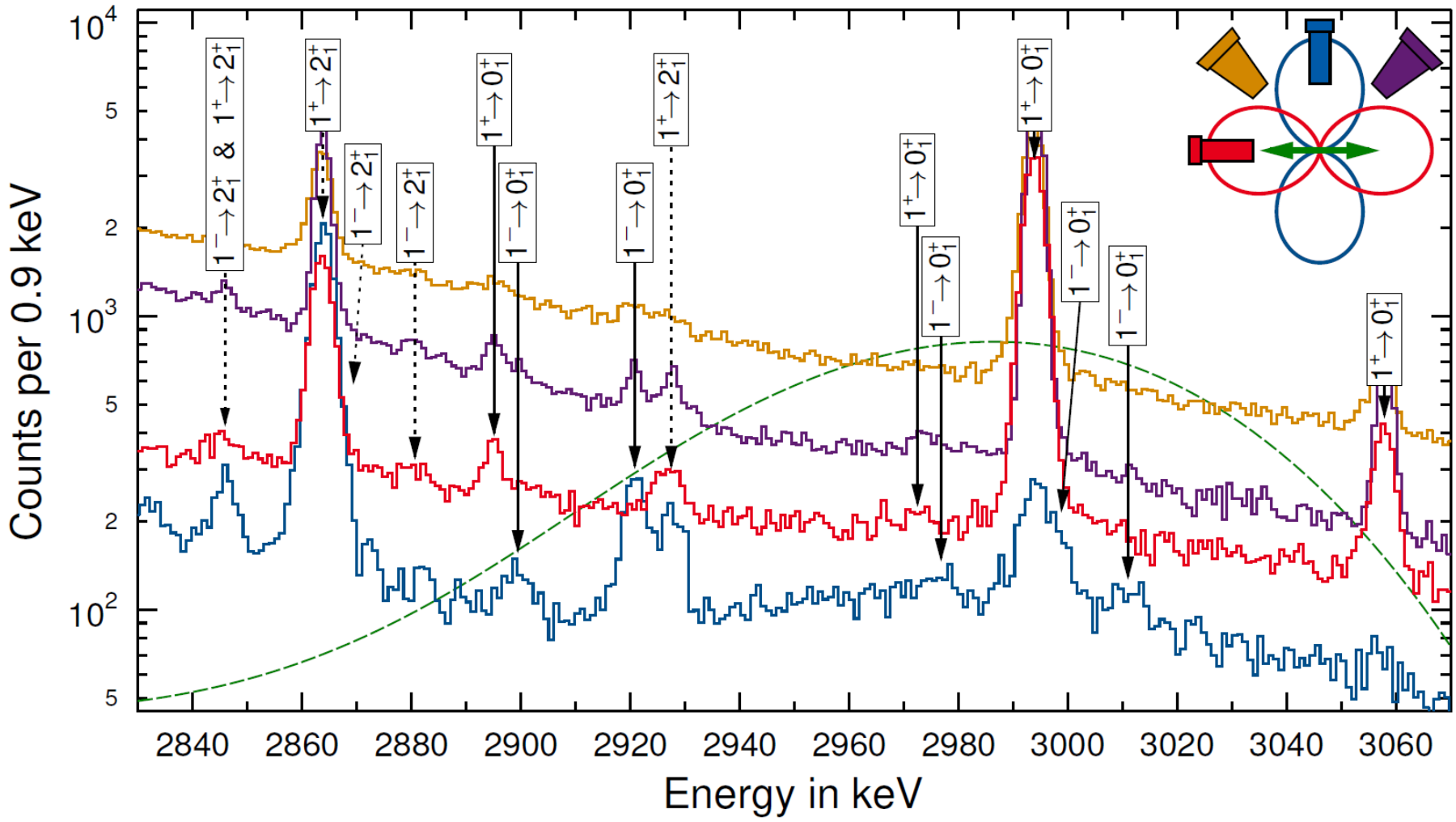

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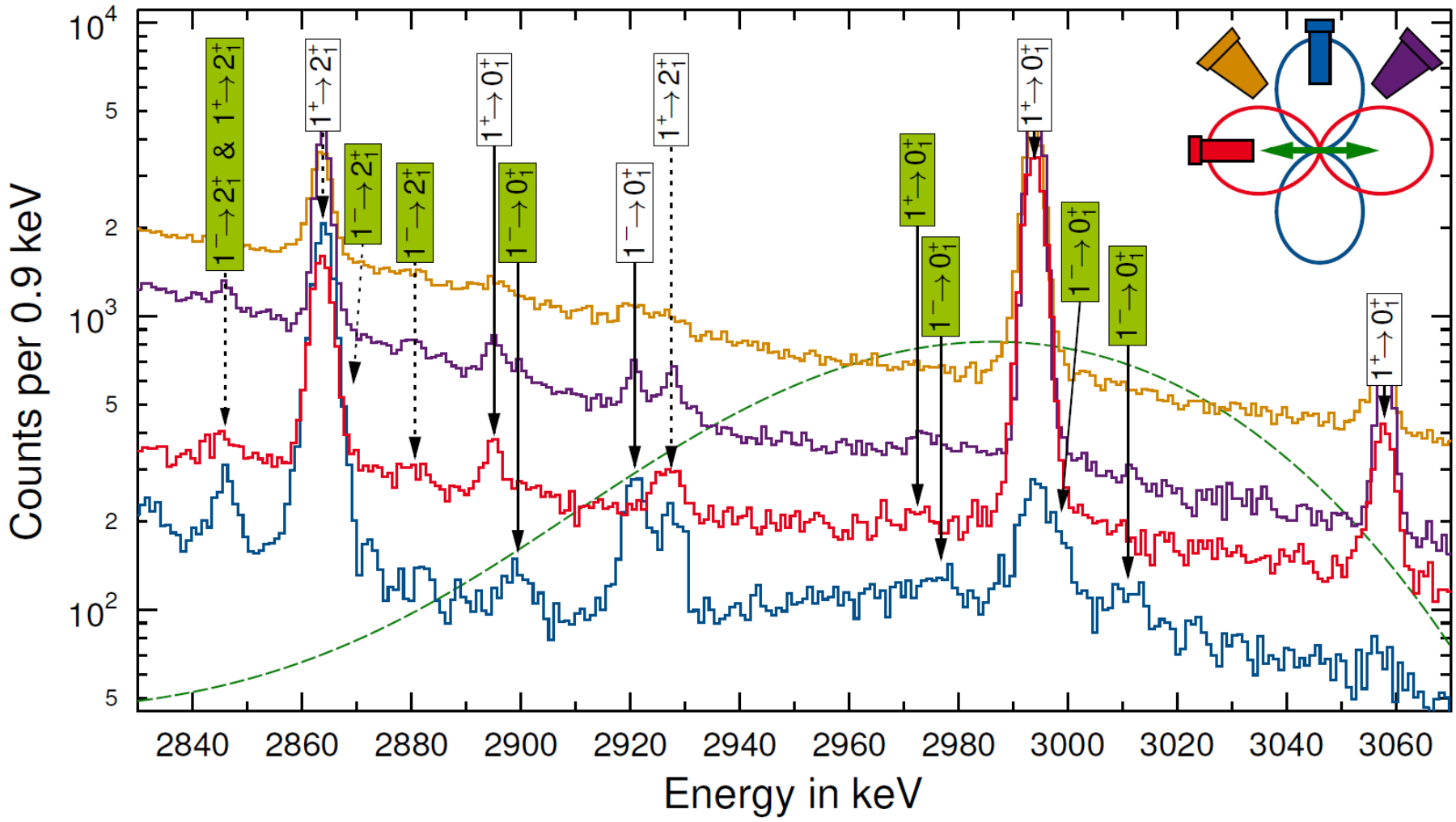

Preliminary results for ^{150}Nd

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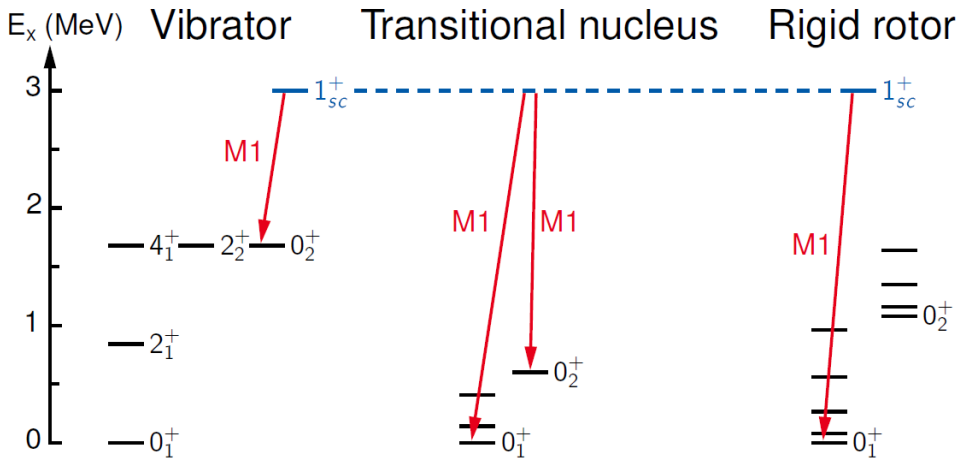
0νββ-decay mother ^{150}Nd:

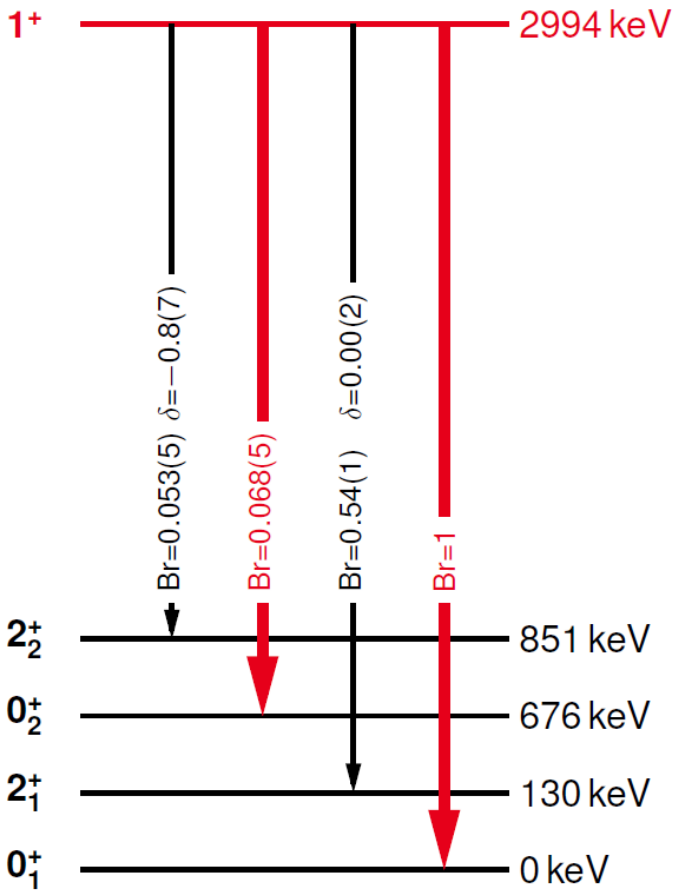
$$Br(1^+_{Sc} \rightarrow 0^+_2) = \frac{\Gamma_{0^+_2}}{\Gamma_{0^+_1}} = 0.068(5)$$

$$B(M1\,;\, 1^+_{Sc} \rightarrow 0^+_1) = 0.24(3)\ \mu_N{}^2$$

$$B(M1\,;\, 1^+_{Sc} \rightarrow 0^+_2) = 0.035(5)\ \mu_N{}^2$$



J. Beller, Dissertation (2014), TU Darmstadt



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Preliminary results for ^{150}Nd and ^{150}Sm

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0νββ-decay mother ^{150}Nd:

$$Br(1^+_{Sc} \rightarrow 0^+_2) = \frac{\Gamma_{0^+_2}}{\Gamma_{0^+_1}} = 0.068(5)$$

$$B(M1\,;\, 1^+_{Sc} \rightarrow 0^+_1) = 0.24(3)\ \mu_N{}^2$$

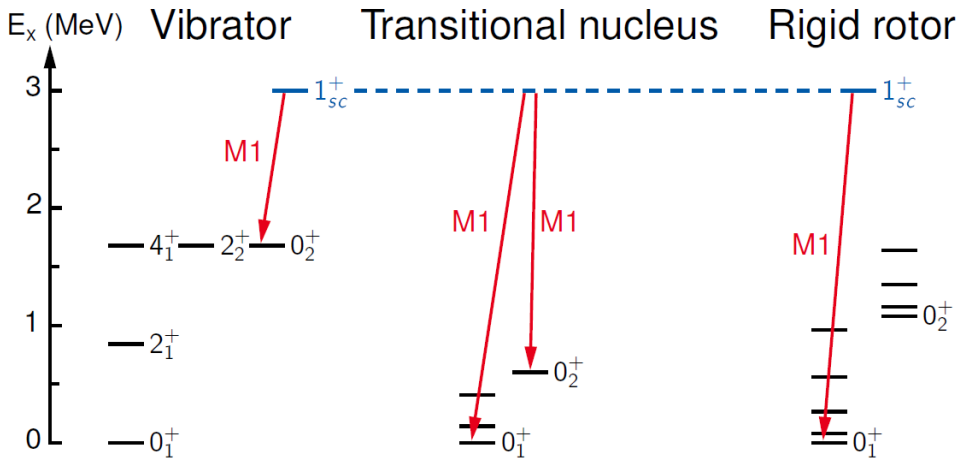
$$B(M1\,;\, 1^+_{Sc} \rightarrow 0^+_2) = 0.035(5)\ \mu_N{}^2$$

0νββ-decay daughter ^{150}Sm:

$$Br(1^+_{Sc} \rightarrow 0^+_2) = \frac{\Gamma_{0^+_2}}{\Gamma_{0^+_1}} = 0.19(5)$$

$$B(M1\,;\, 1^+_{Sc} \rightarrow 0^+_1) = 0.07(1)\ \mu_N{}^2$$

$$B(M1\,;\, 1^+_{Sc} \rightarrow 0^+_2) = 0.030(9)\ \mu_N{}^2$$



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^{150}Nd in the IBM-2

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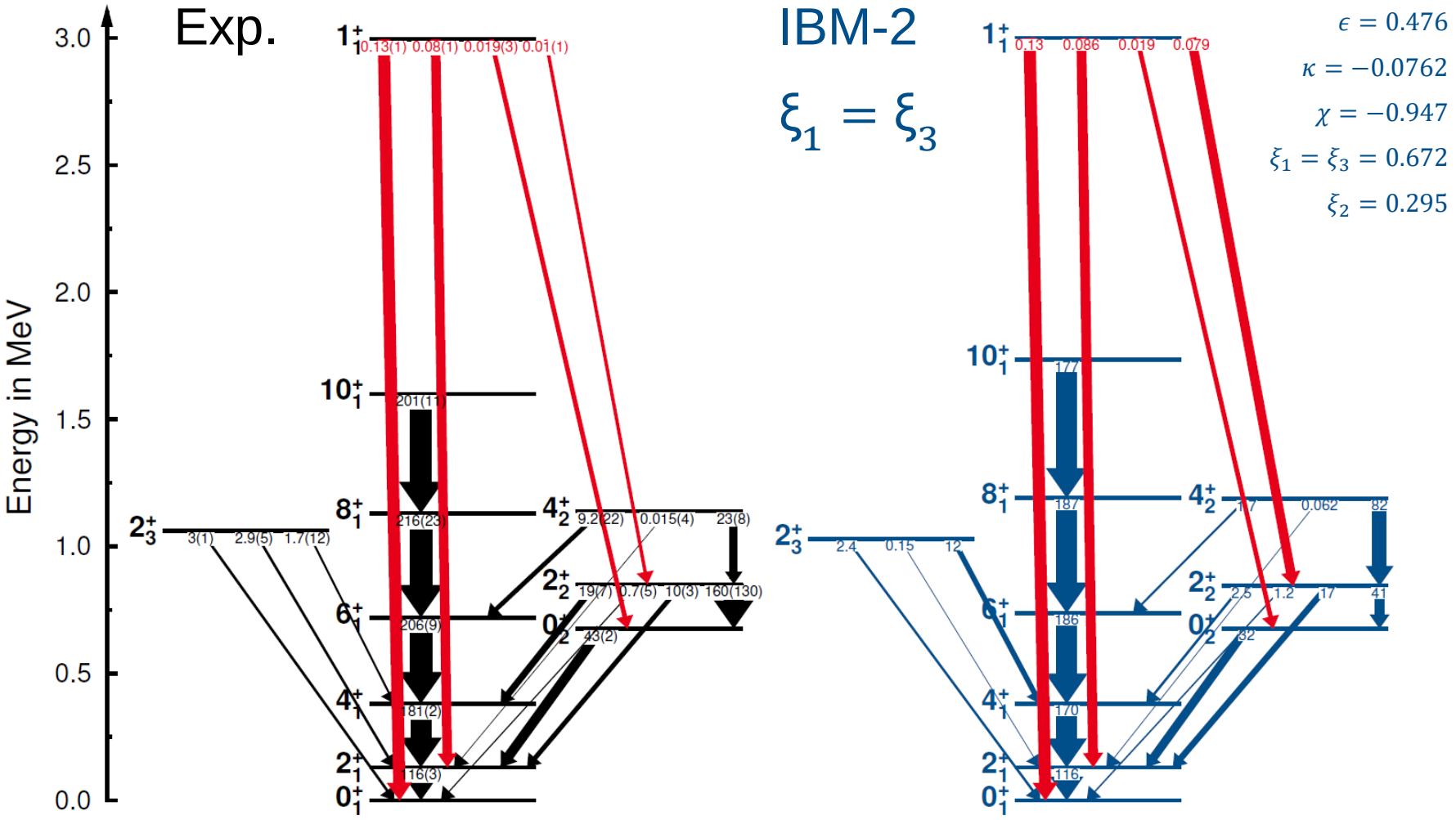
- Hamiltonian: $H = \epsilon\, \hat{n}_d + \kappa\, \hat{Q}^{\chi}_{\nu} \cdot \hat{Q}^{\chi}_{\pi}$
$$+ \frac{1}{2}\, \xi_2\, [d^{\dagger}_{\nu} s^{\dagger}_{\pi} - d^{\dagger}_{\pi} s^{\dagger}_{\nu}]^{(2)} \cdot [\tilde{d}_{\nu} \tilde{s}_{\pi} - \tilde{d}_{\pi} \tilde{s}_{\nu}]^{(2)}$$
$$+ \sum_{k=1,3} \xi_k\, [d^{\dagger}_{\nu} d^{\dagger}_{\pi}]^{(k)} \cdot [\tilde{d}_{\nu} \tilde{d}_{\pi}]^{(k)}$$
- Transition operators: Consistent Q-formalism
- $\chi_{\nu} = \chi_{\pi} = \chi$

^{150}Nd in the IBM-2



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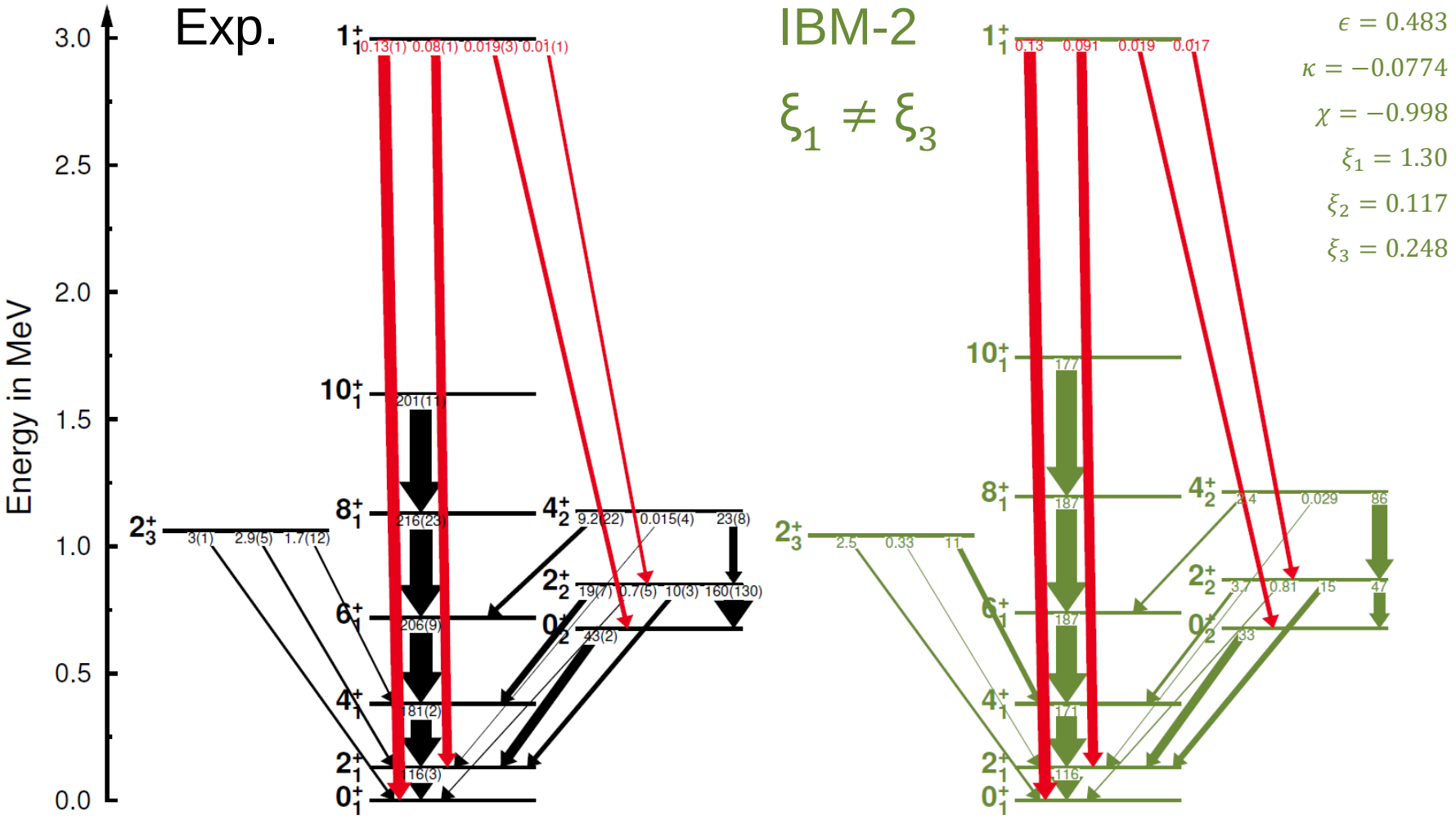
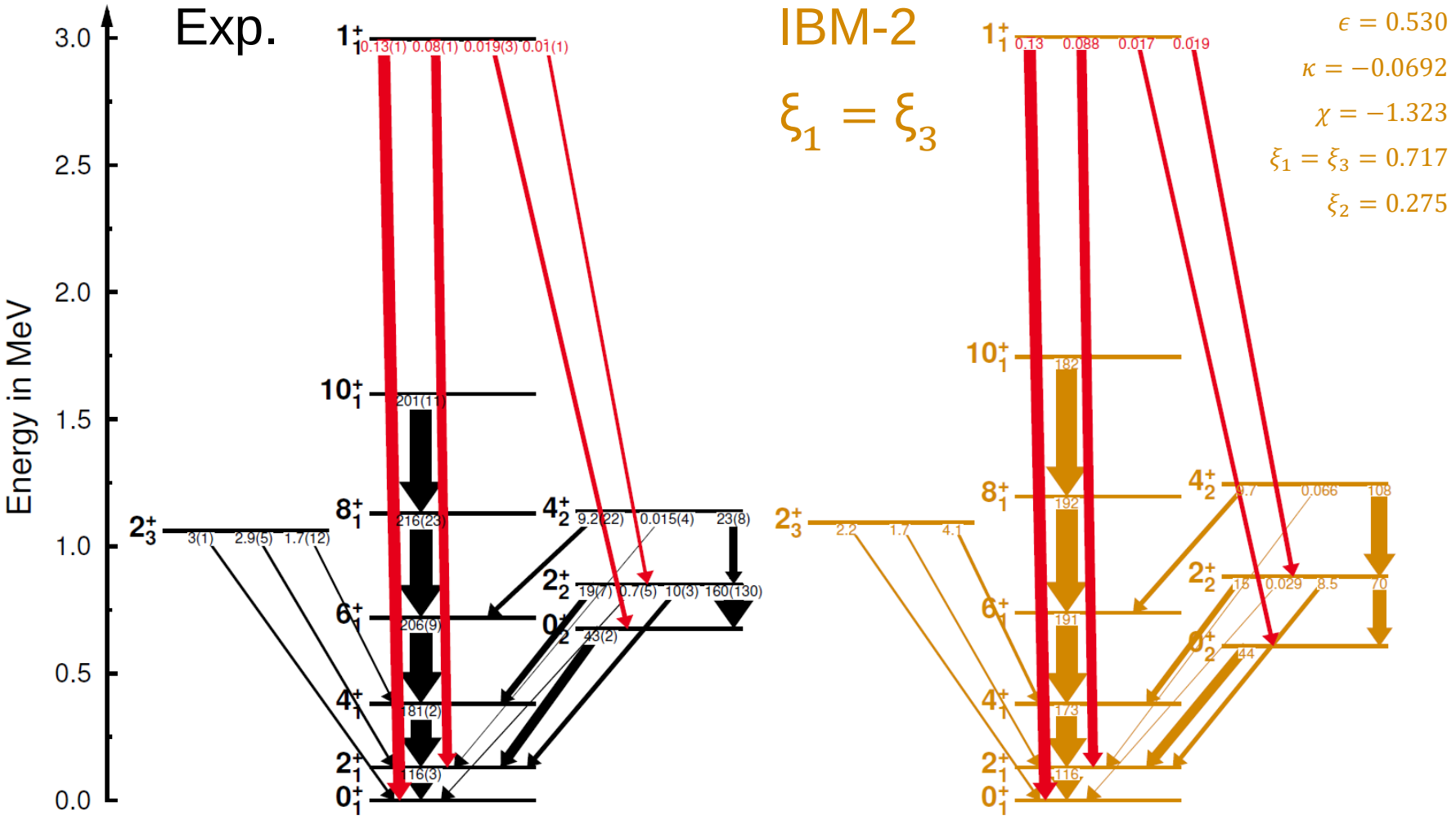


^{150}Nd in the IBM-2



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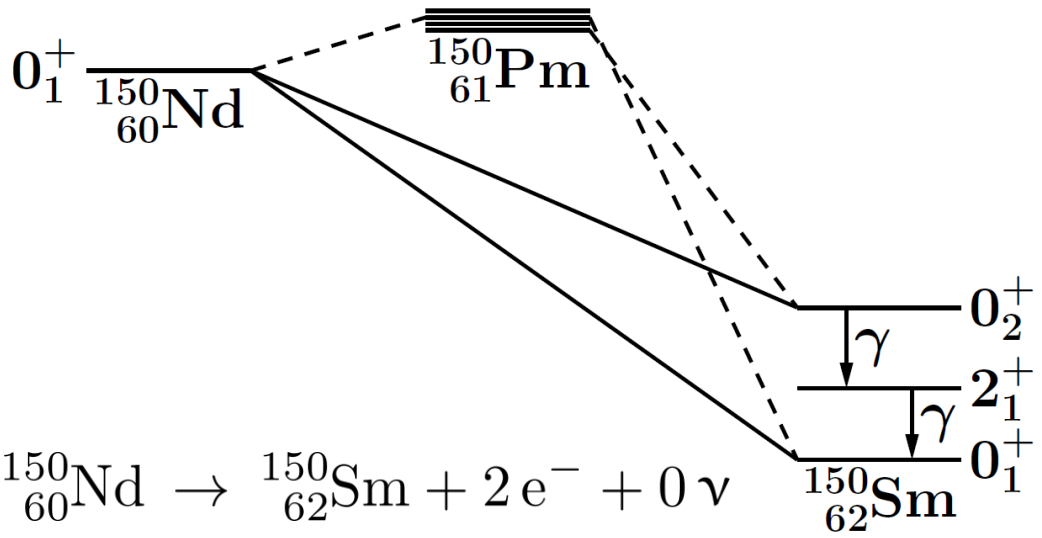

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