第十七届全国核物理大会

Structural change and lineshape investigation in ^{101}Pd isotope

Palladium
46
Pd

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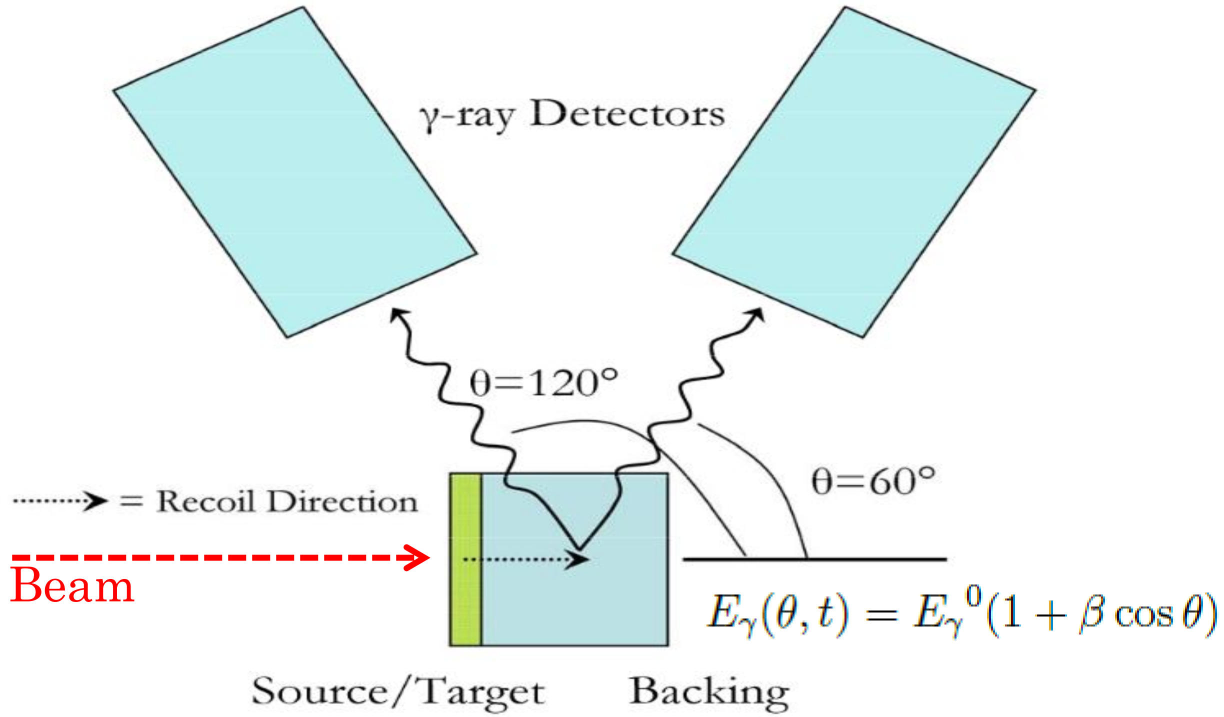
Contents:

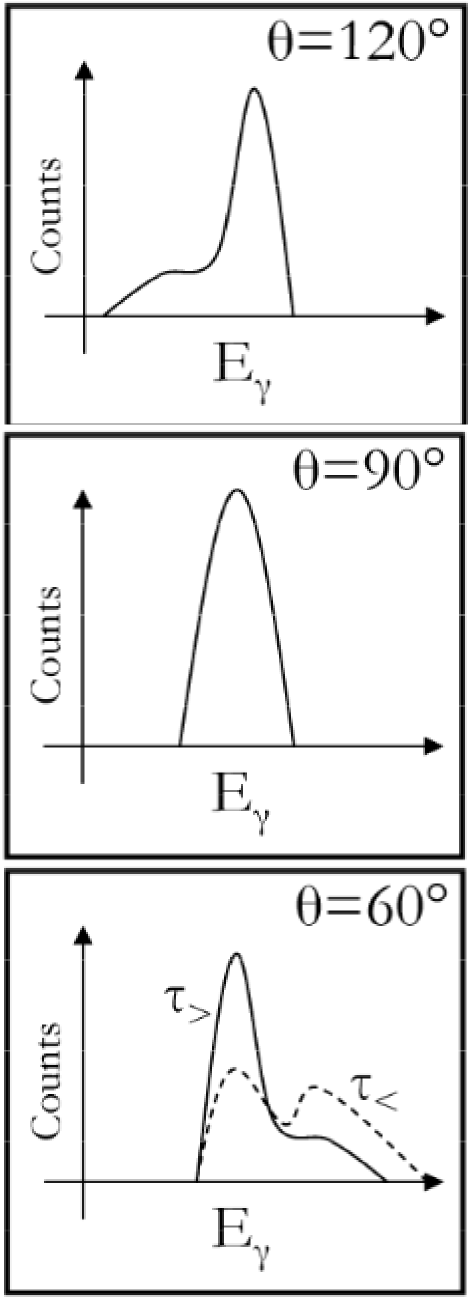
Objective:

- Lifetime measurement based on DSAM
- Studying antimagnetic character
- Shears Mechanism
- Deformation study for Pd-isotopes
- Investigating structural change

Discussed with results

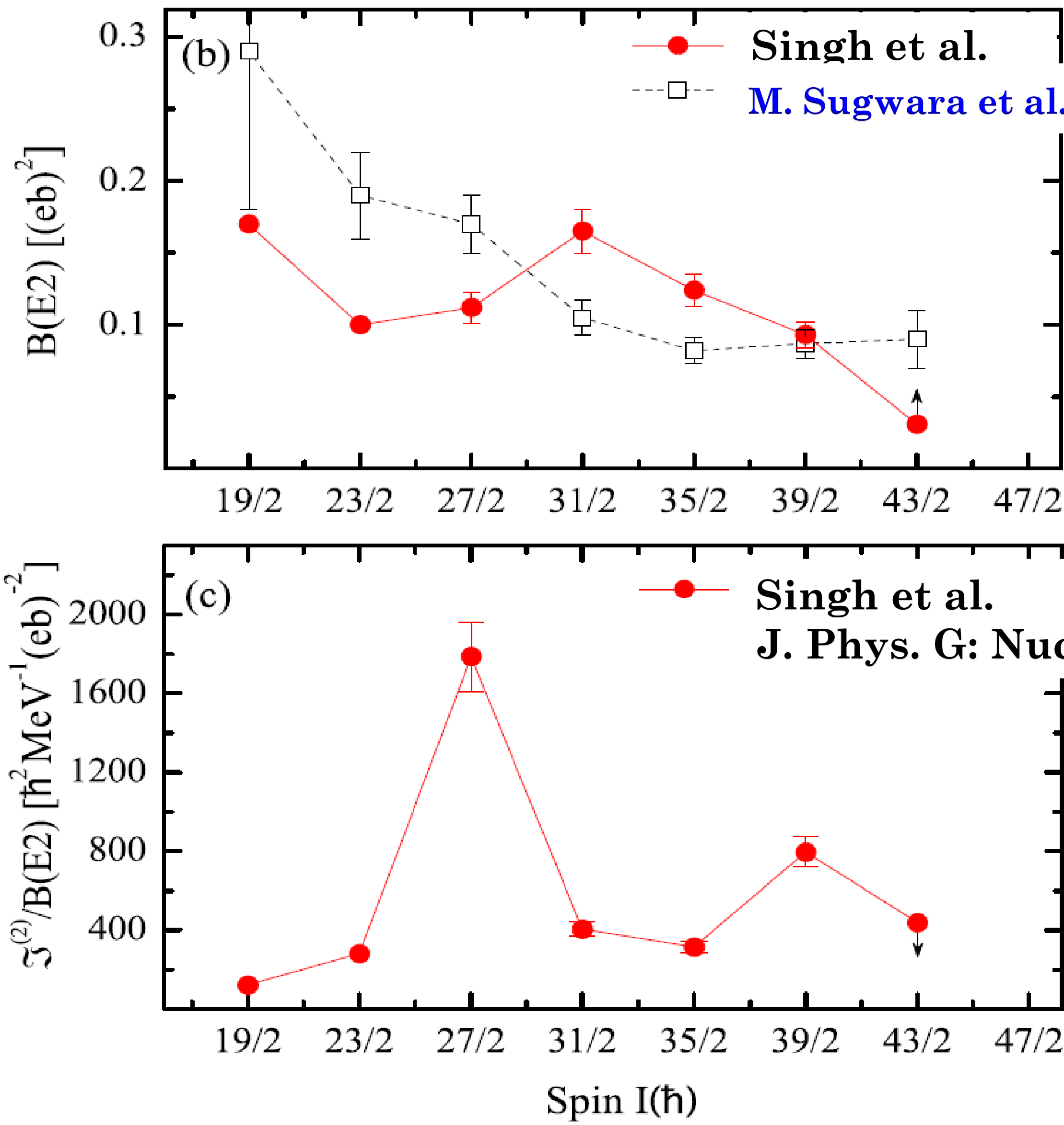
DSAM technique: ps –fs lifetimes





- 'Target with thick backing'
  - Recoil is slowed to a stop
  - v/c decreases as a function of distance (∴ time)
  - Peak is no longer Gaussian.
  - The shape of the peak gives lifetime information

Antimagnetic rotation: (Around shell closures)

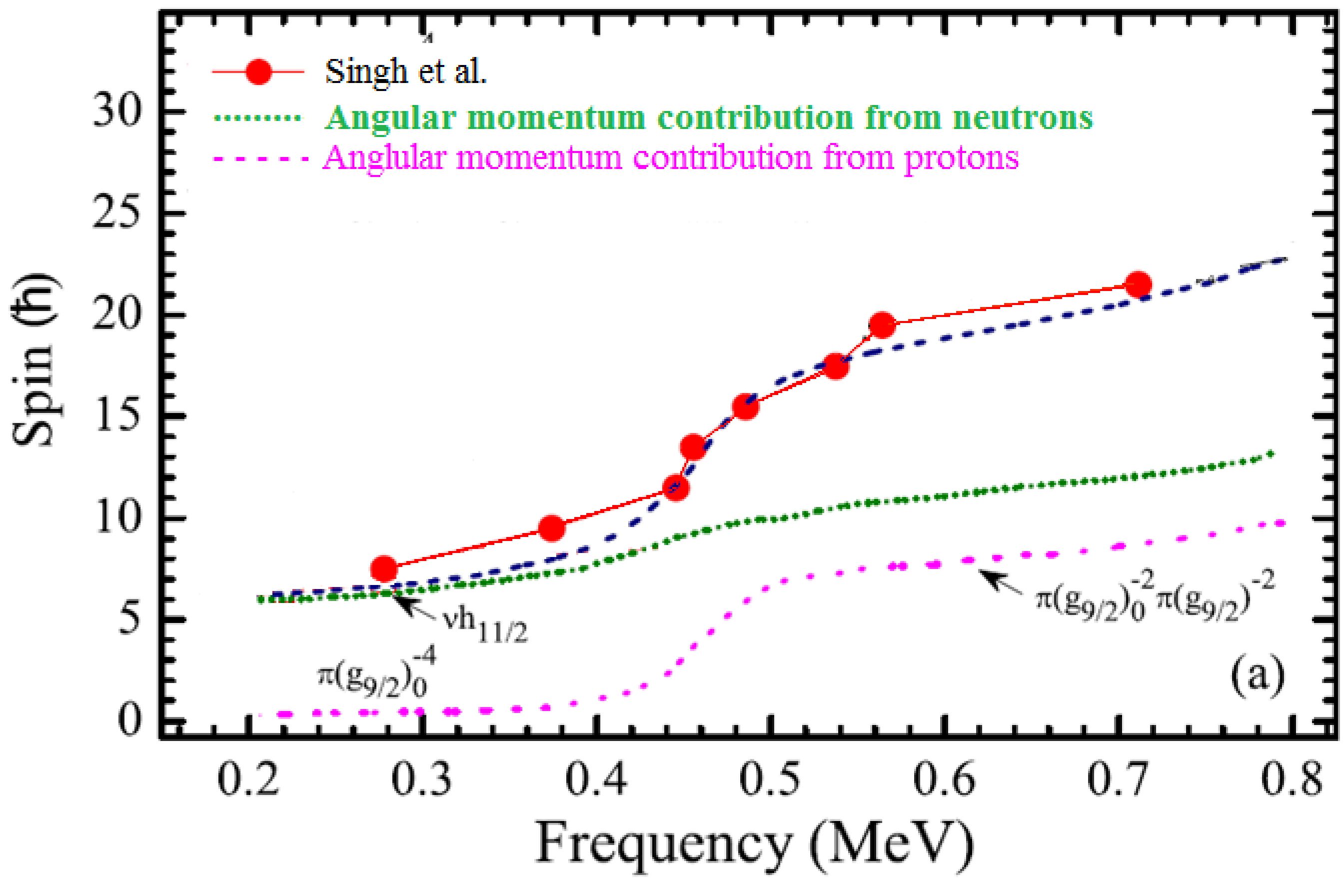


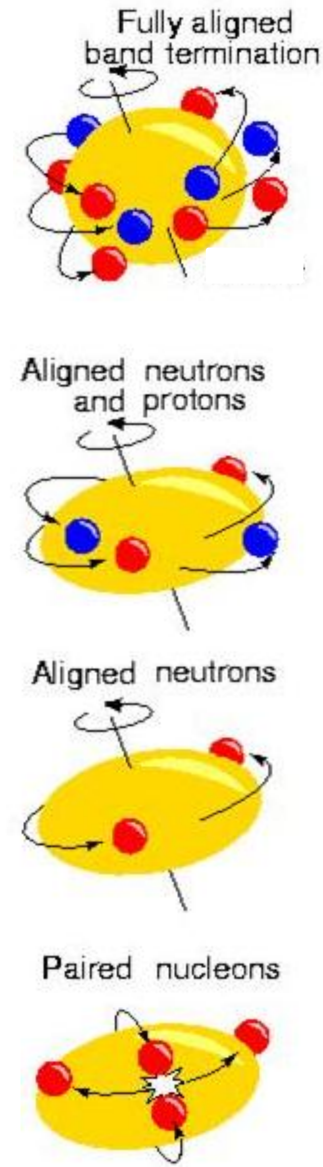
Key for AMR:

- decreasing trend of B(E2) values

- large MOI/B(E2) ratio at least in lower part

Shears Mechanism (SM) :



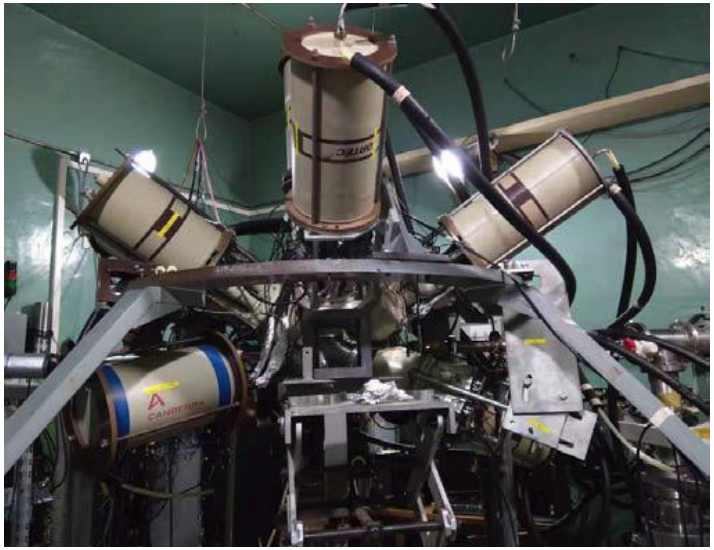


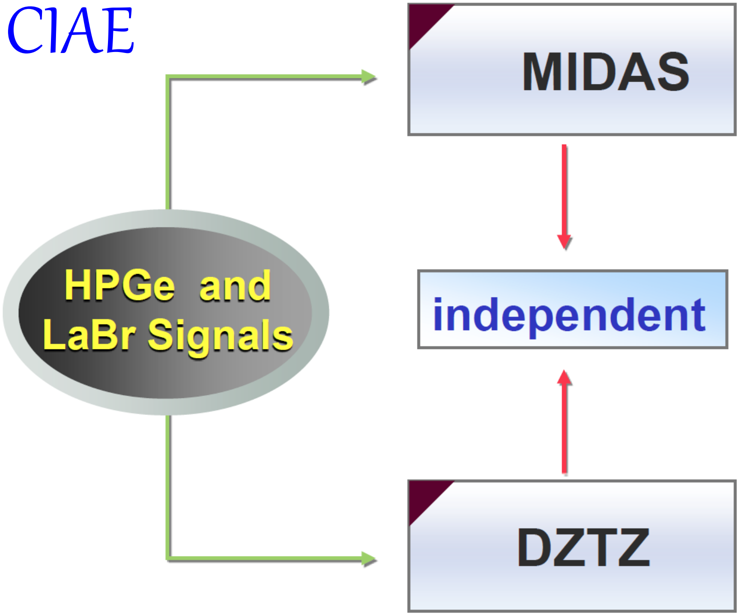
Blue dashed line represents the total angular momentum contribution from neutrons and protons.

Shears Mechanism

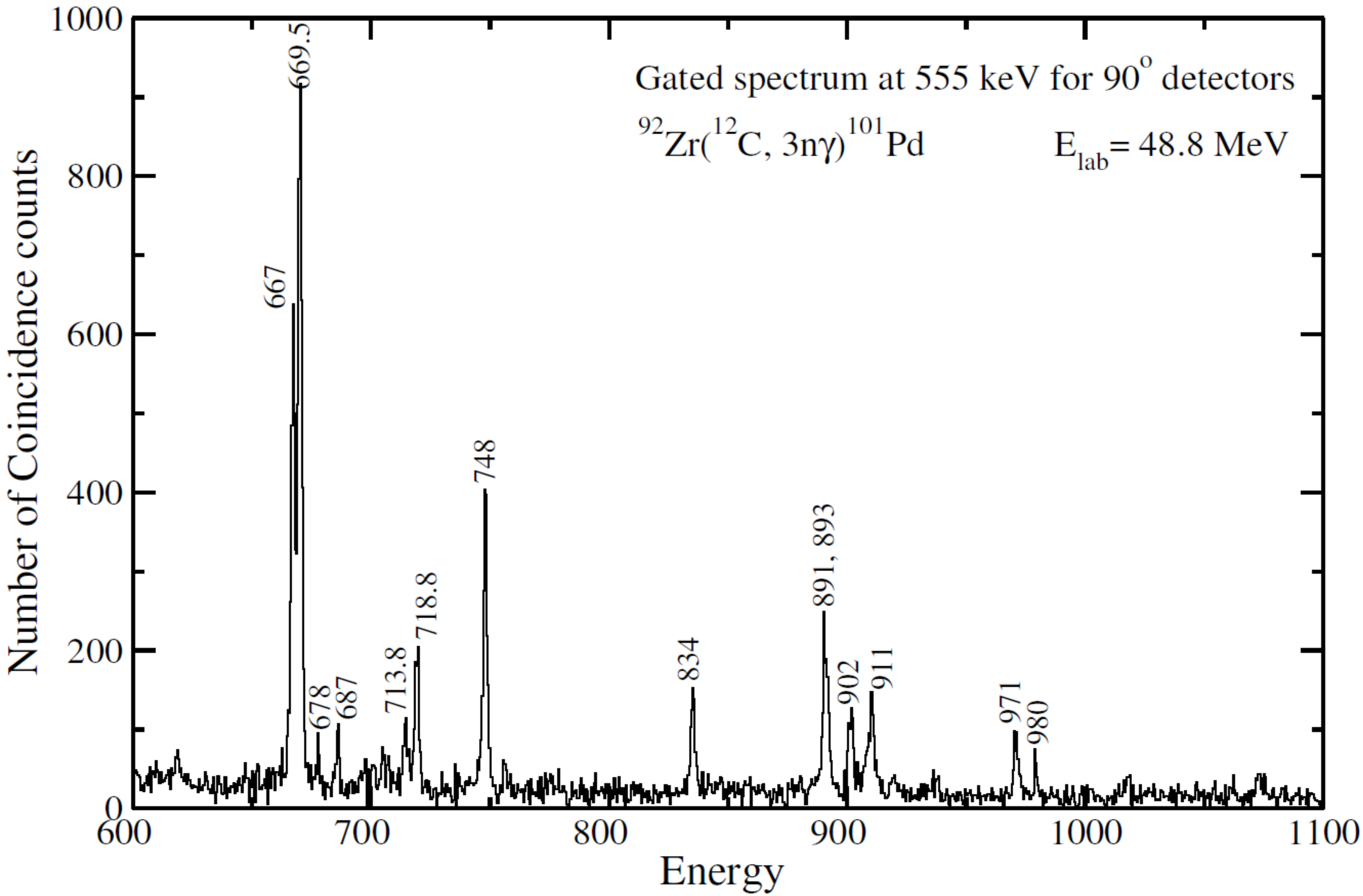
Experimental Details:

1. Reaction: ${}^{92}Zr\ ({}^{12}C, 3n\gamma)\,{}^{101}Pd$
2. Target: ${}^{92}Zr$ (1.1 mg/cm^2)
3. Backing: Pb (11.1 mg/cm^2)
4. Beam Energy: 48.8 MeV
5. Cross-section: 508 mb (70 % of 725 mb)
6. Detectors: 6 HPGe + 1 Clover (42°, 90°, 140° and 150°)
7. Acquisition System: XIA Digitizer (DZTZ)
8. Accelerator: HI-13 Tandem, CIAE



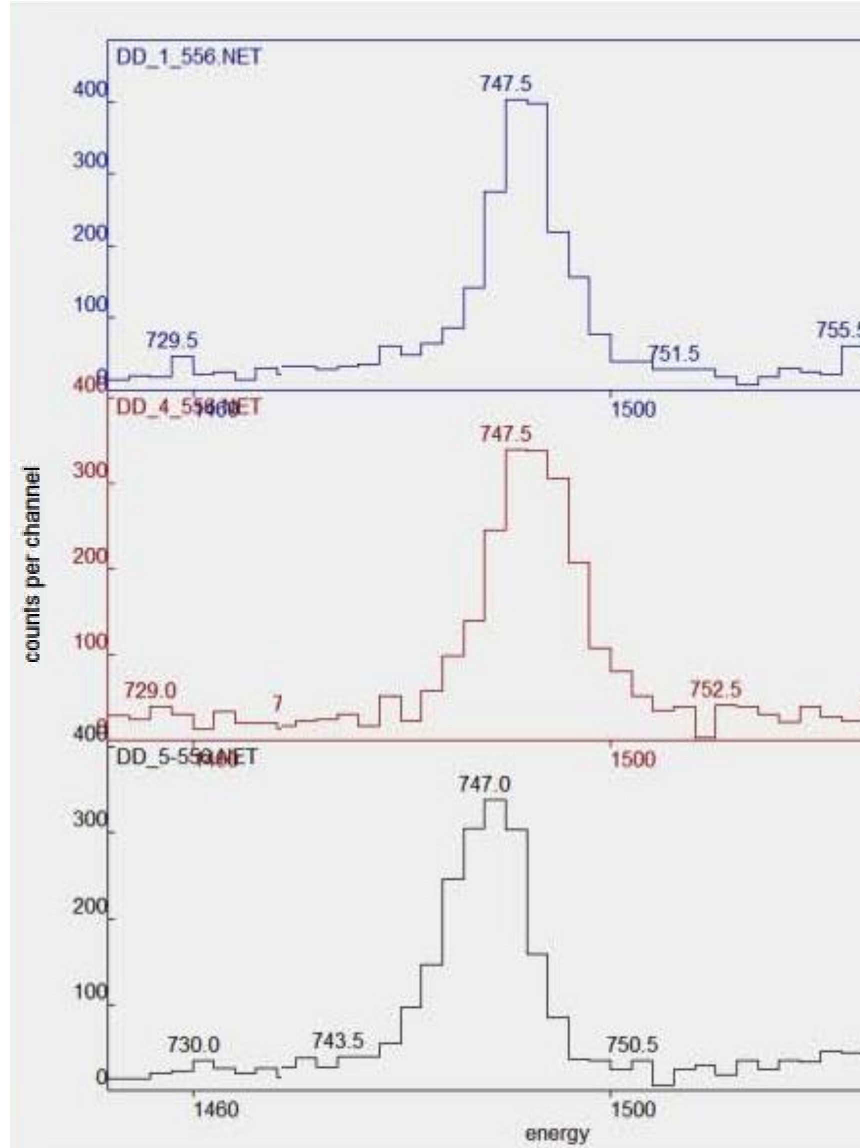


Gated Spectrum

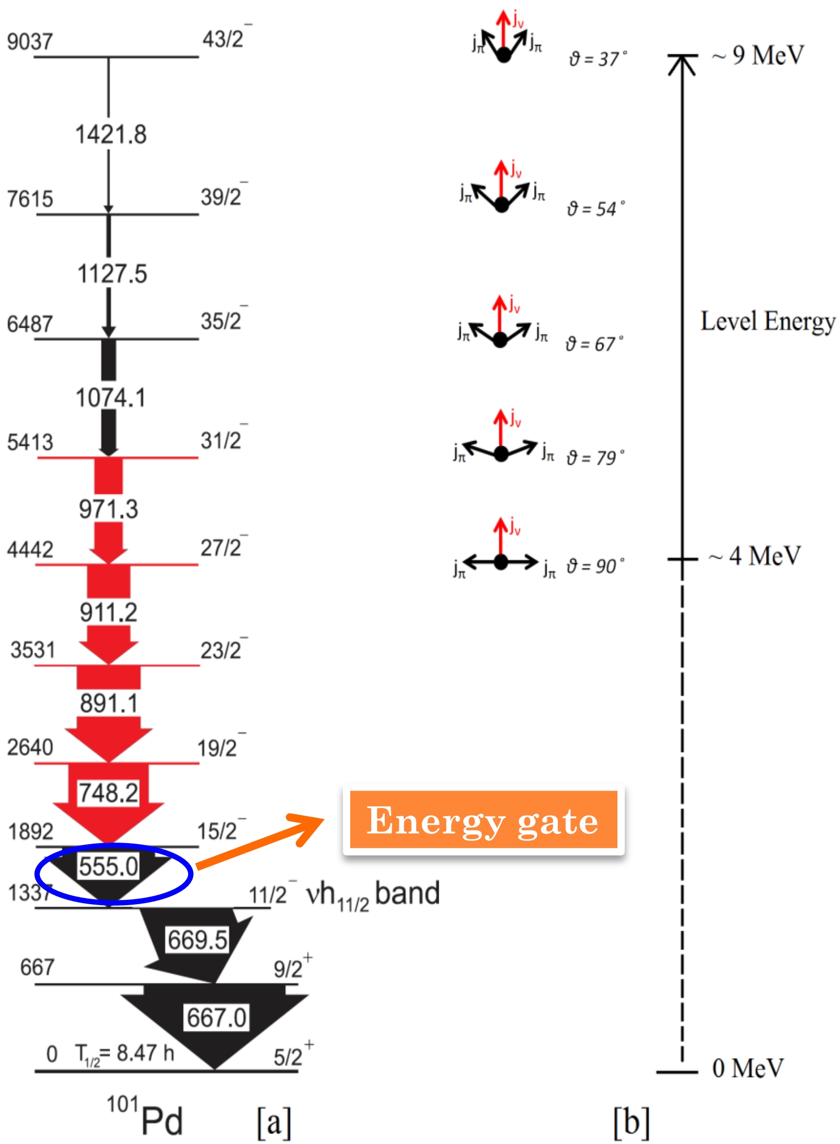


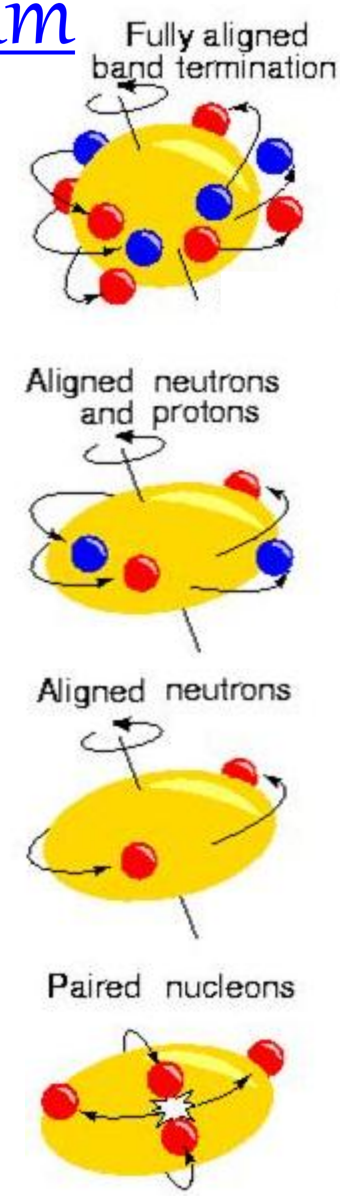
Data Analysis:

1. Three Asymmetric matrices:
    - Small angle (42^o) vs all
    - Large (140^o or 150^o) vs all
    - 90^o vs all
2. Matrices were gated with 555 keV transition at three angles.
3. Three angle dependent spectra were made for using as input for LINSHAPE code
4. Input info. required for DECHIST (info. about detector geometry, details about Target and backing i.e. Z, A and density, beam energy etc.) and HISTAVER (time step= 0.01 ps and history = 5000).



Level Scheme and angular momentum

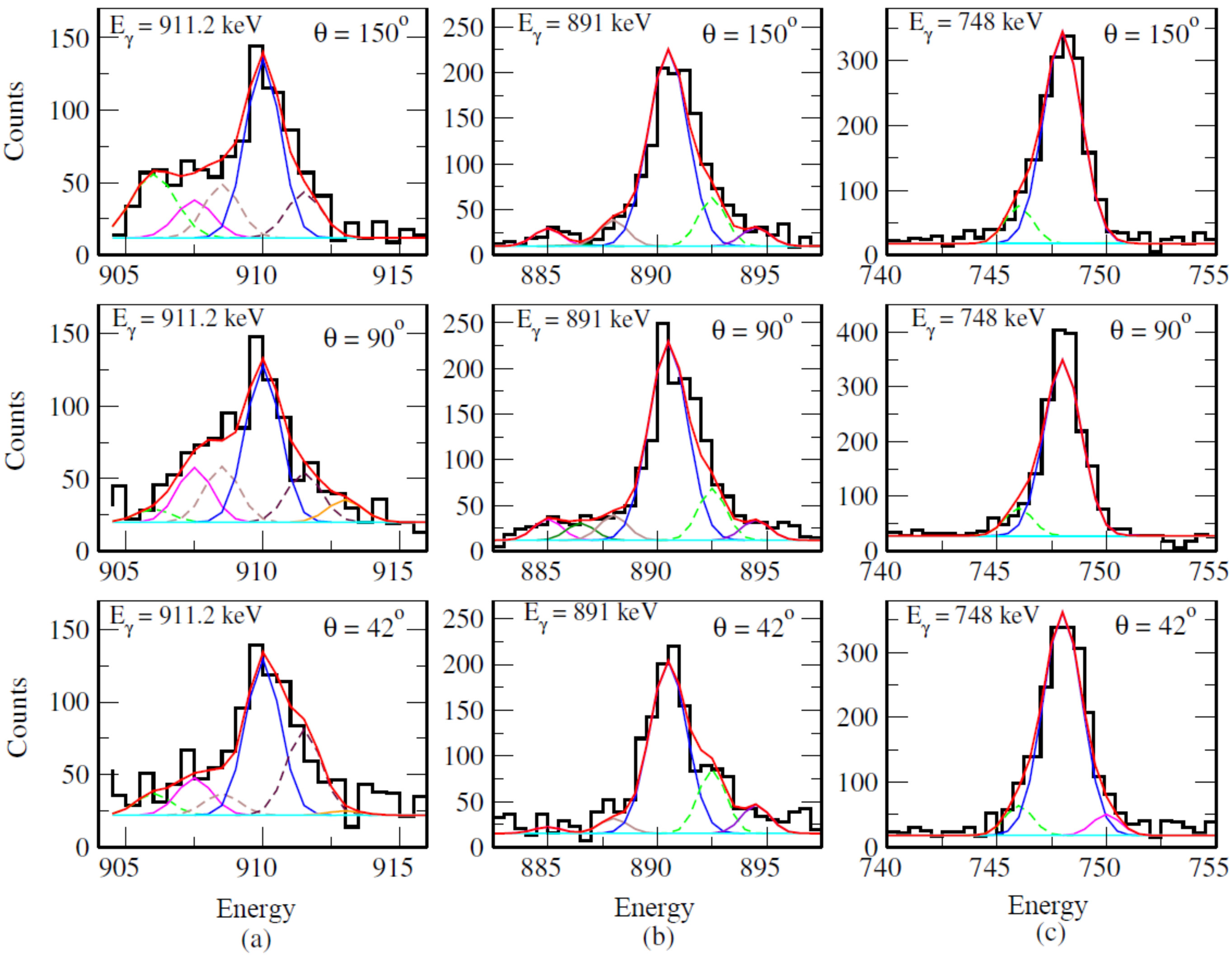


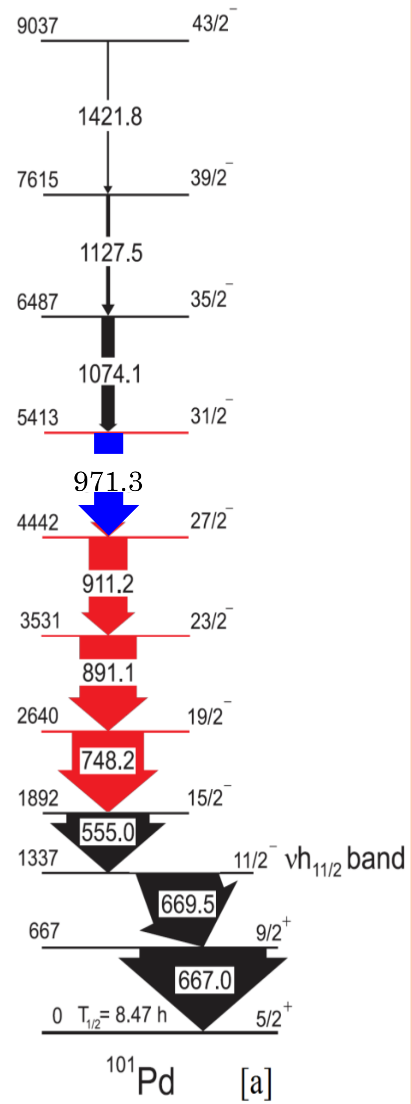


Shears Mechanism

14. V. Singh, et al. Jour. Phys. G: Nucl. Part. Phys. 44, 075105 (2017).

Results: DSAM calculated lineshapes





Results: DSAM calculated lifetimes

Table 1 The results of the present experiment for different $\gamma-$ ray transitions in the $\nu h_{11/2}$ band of ^{101}Pd.

Energy (keV)	Spin ($\hbar$) $I_i \rightarrow I_f$	Lifetime τ (ps)	$B(E2)$ (e^2b^2)	Q_t (eb)	$B(E2)$ (e^2b^2) [8]	$B(E2)$ (e^2b^2) [13]
748	$19/2^- \rightarrow 15/2^-$	2.34 (12)	0.148 (9)	3.386 (90)	~ 0.17	0.29 (11)
891	$23/2^- \rightarrow 19/2^-$	1.37 (10)	0.106 (9)	2.355 (85)	~ 0.10	0.19 (3)
911	$27/2^- \rightarrow 23/2^-$	1.26 (8)	0.103 (9)	2.101 (71)	0.112 (11)	0.17 (2)
971	$31/2^- \rightarrow 27/2^-$	~ 0.64	~ 0.144	~ 2.355	0.165 (15)	0.105 (12)
1074	$35/2^- \rightarrow 31/2^-$				0.124 (11)	0.082 (9)
1127 .5	$39/2^- \rightarrow 35/2^-$				0.093 (9)	0.087 (10)
1421.8	$43/2^- \rightarrow 35/2^-$				~ 0.031	0.09 (2)

α values used in the calculation of $B(E2)$ values are taken from the http://bricc.anu.edu.au/

$$B(E2) = \frac{0.08156}{\tau E_\gamma^5(1+\alpha_\tau)} \mid e^2b^2 \mid$$

and,

$$Q_t^2 = \left(\frac{16\pi}{5}\right) \frac{B(E2; I \rightarrow I-2)}{\langle I2K0 \mid I-2\,K\rangle^2}$$

8. V. Singh et al. Phys. Rev. C **95**, 064312 (2017).

13. M. Sugwara et al. Phys. Rev. C **92**, 024309 (2015).

$$\langle I2K0 \mid I-2K\rangle = \sqrt{\frac{3(I-K)(I-K-1)(I+K)(I+K-1)}{(2I-2)(2I-1)I(2I+1)}} \quad (3)$$

In the present calculations, $K = 11/2$ has been used for the $\nu h_{11/2}$ band.

Here τ, the level lifetime (in pico-seconds), E_γ, the gamma energy (in MeV), α, the conversion coefficient, and $\langle I2K0 \mid I-2\,K\rangle$, the Clebsch-Gordon coefficient, given by

B(E2)'s: evidence for SM and core rotation

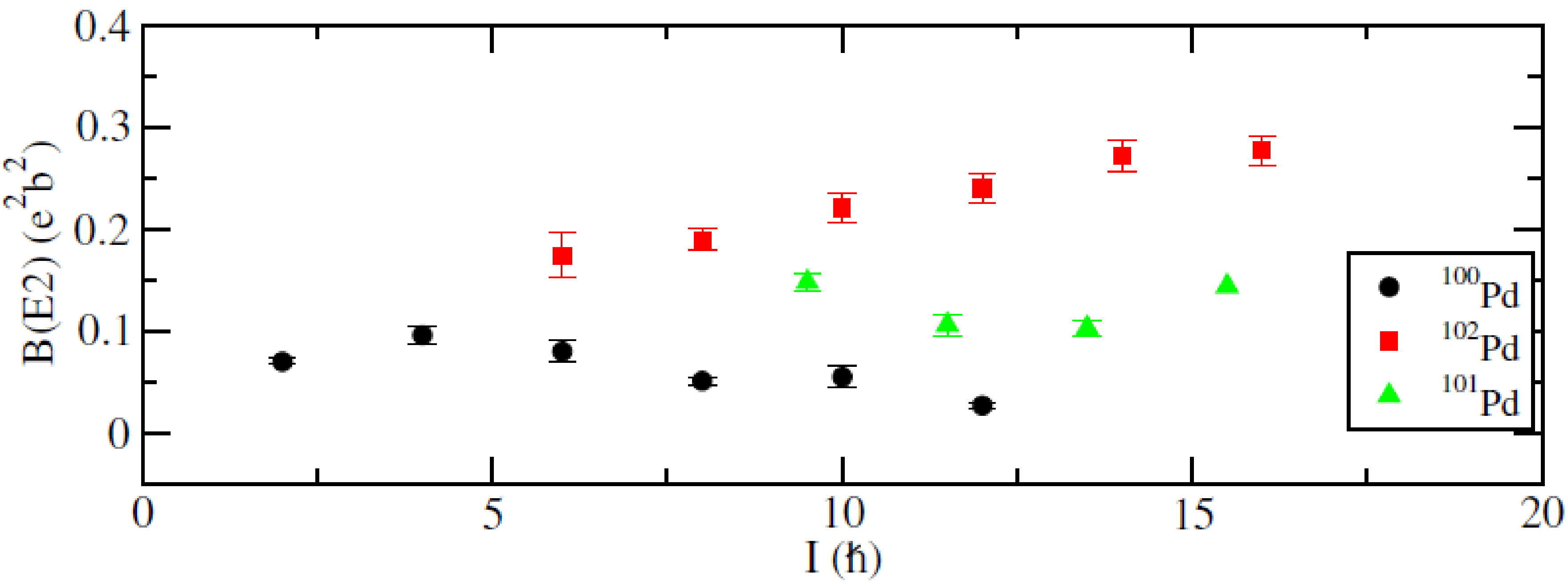


Fig. 5 The reduced transitional probabilities plotted for ^{100}Pd [27], ^{101}Pd (present work) and ^{102}Pd [28] with increasing spin.

27. D. Radeck et. al. Phys. Rev. C **80**, 044331 (2009).
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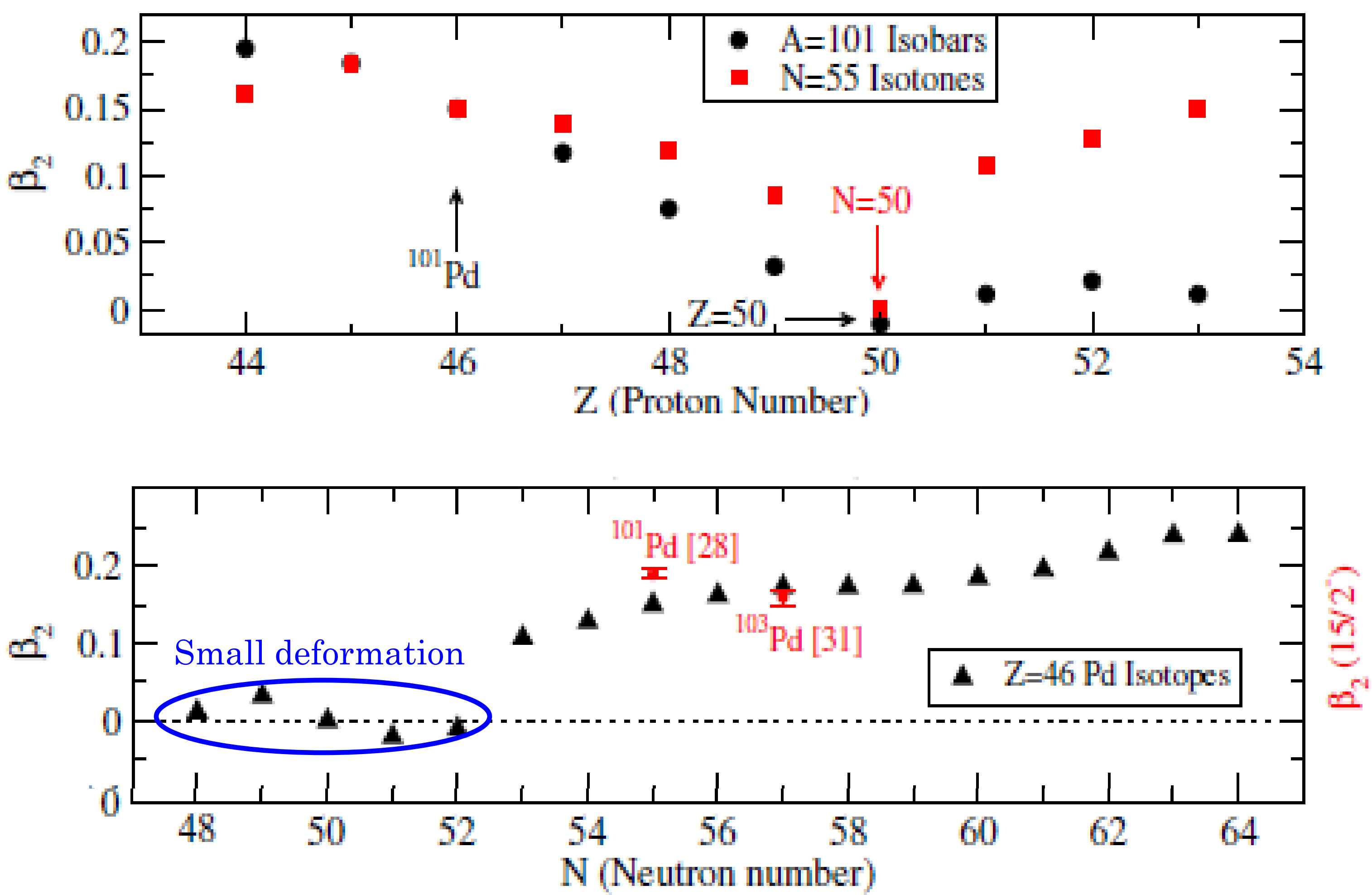
Study of deformation (β_2) around N=Z=50



22. P. Möller et al. At. and Nucl. Data Tab. **109-110**, 1-204 (2016).

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Investigating structural change

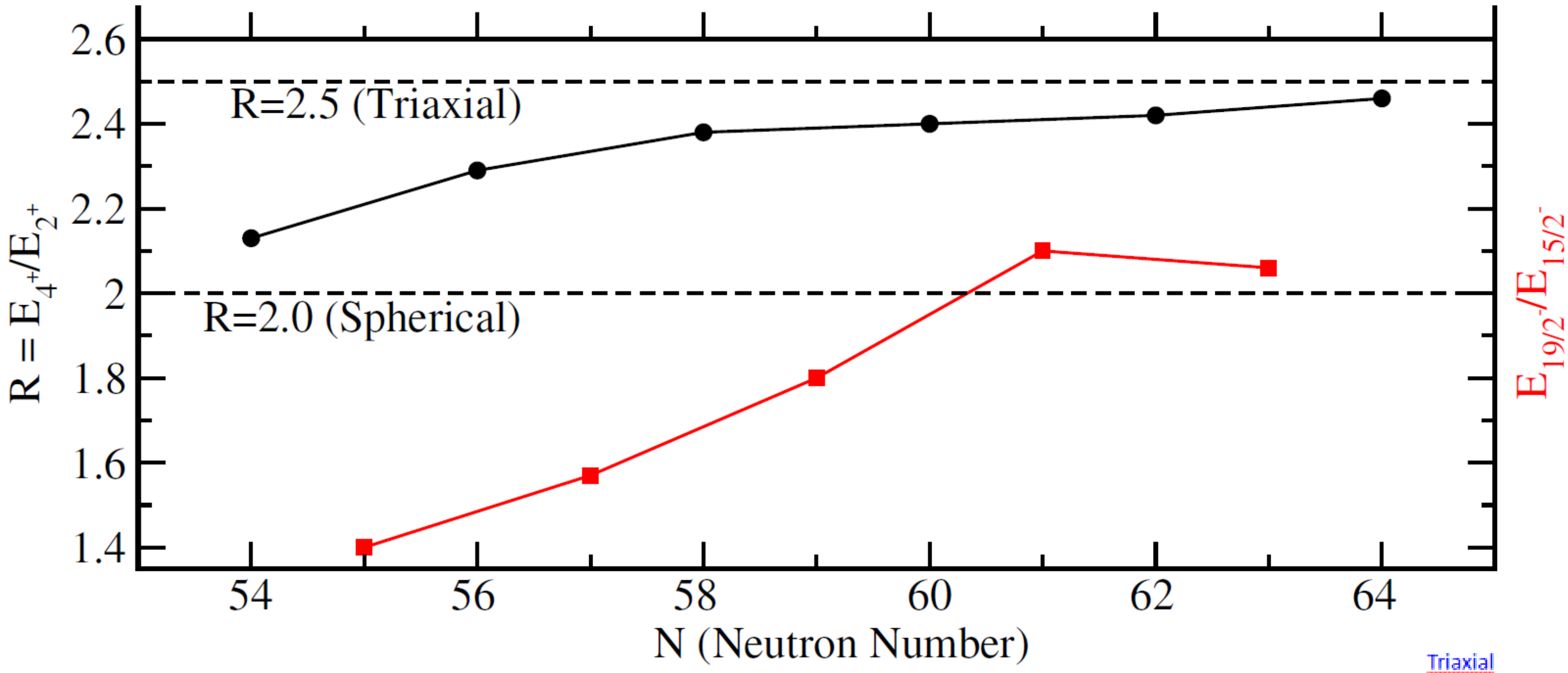
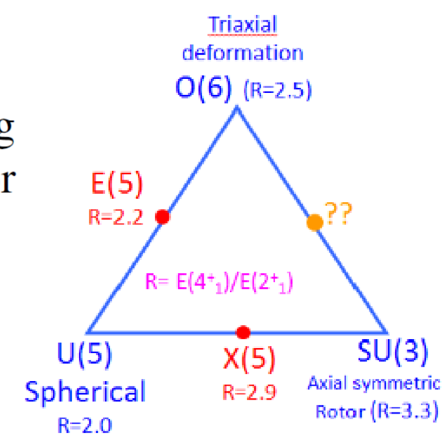
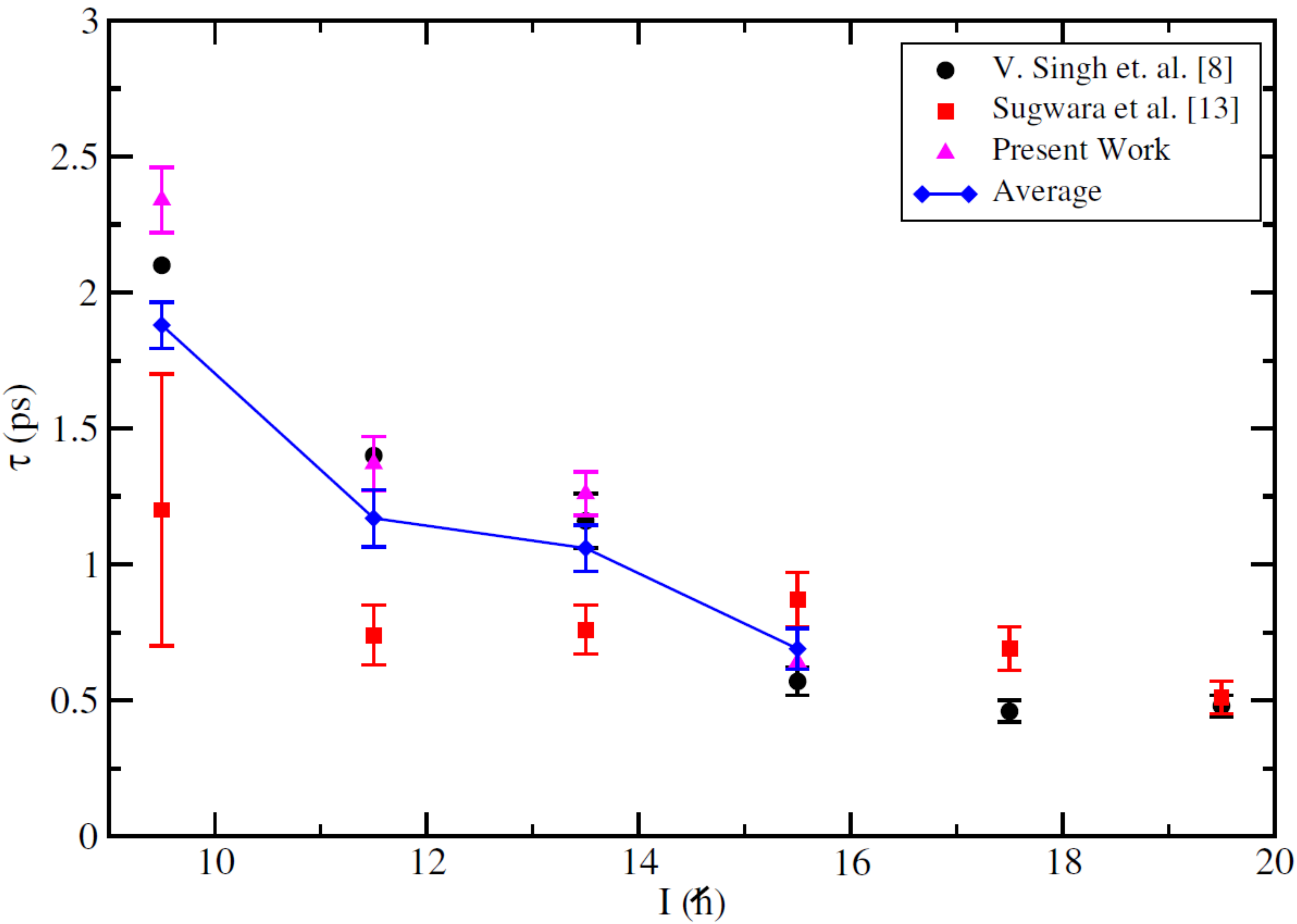


Fig. 8 (Color online) The ratio of E_4^+/E_2^+ are plotted with increasing neutron number for Z=46 even-A *Pd*−isotopes and $E_{19/2^-}/E_{15/2^-}$ for odd-A *Pd* isotopes



Conclusion:



8. V. Singh et al. Phys. Rev. C **95**, 064312 (2017).
13. M. Sugwara et al. Phys. Rev. C **92**, 024309 (2015).

Summary:

1. DSAM based lifetime measurements are performed.
2. ^{92}Zr (^{12}C, $3n\gamma$)^{101}Pd reaction is used.
3. Lineshapes are calculated to study AMR character based on measured B(E2) values.
4. Shape change from spherical to triaxial rotor is observed (with small triaxiality observed).
5. IBM and TPSM based calculations are needed to give more theoretical verification for AMR character.

Thanks for your attention!

Nuclear Structure Group @ IMP-CAS

- Prof. Zhou Xiaohong , Prof. Minliang Liu,
- Dr. Fang Yongde, Dr. Guo Song, Dr. Guangshun Li, Dr. Jianguo Wang, Dr. Yunhua Qiang,
- Dr. Kumar M. Raju (post-doc), Mrs. KuanKuan (Pursuing Doctorate)