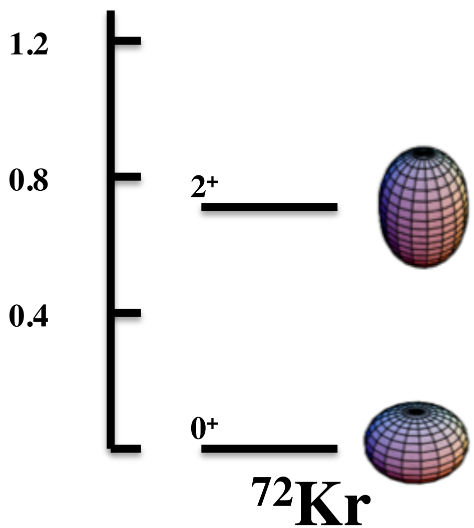
Low-energy Coulomb excitation study of ^{72}Kr at the MINIBALL set-up



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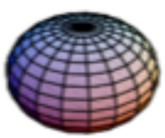
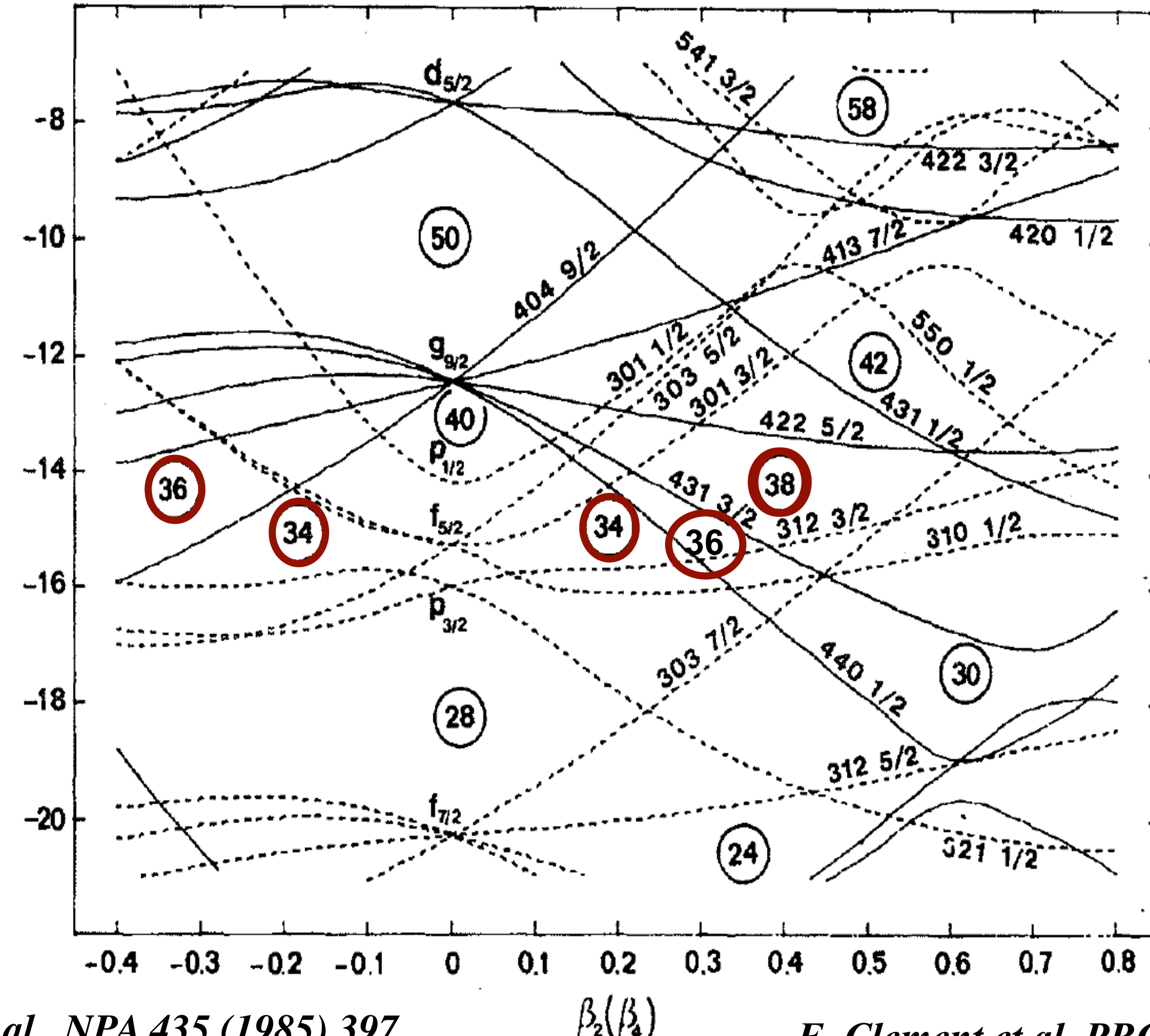
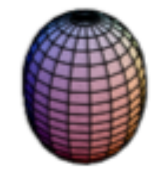
European Gamma and Ancillary detectors Network
AGATA
ADVANCED GAMMA TRACKING ARRAY

Preliminary results indicate prolate configurations for the 2_1^+ state

Shape co-existence expected for Kr, Se isotopes



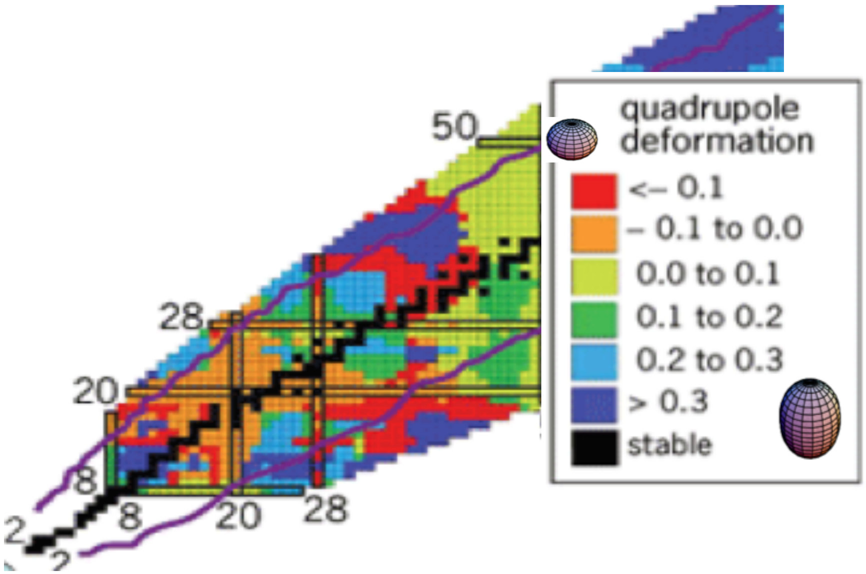


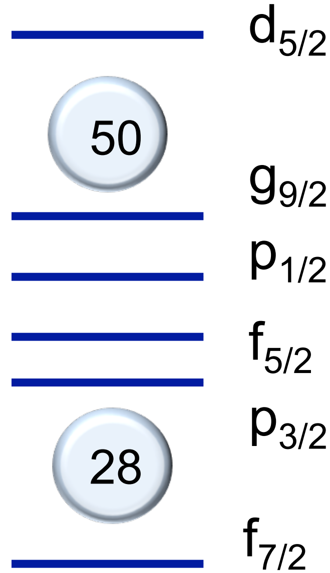


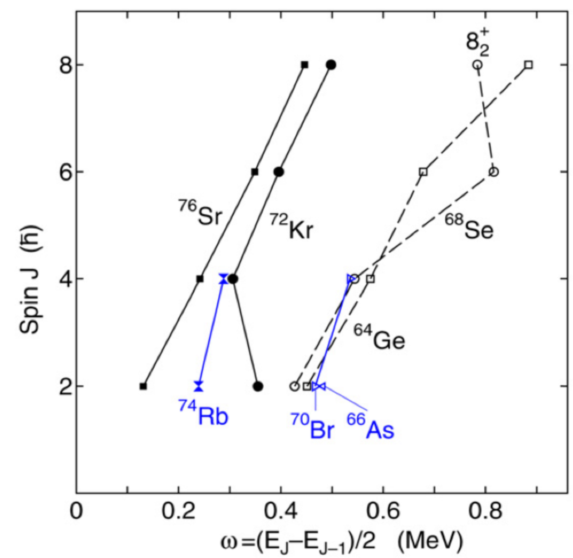
W. Nazarewicz et al., NPA 435 (1985) 397

E. Clement et al, PRC 75, 054313 (2007)

Physics case - ^{72}Kr





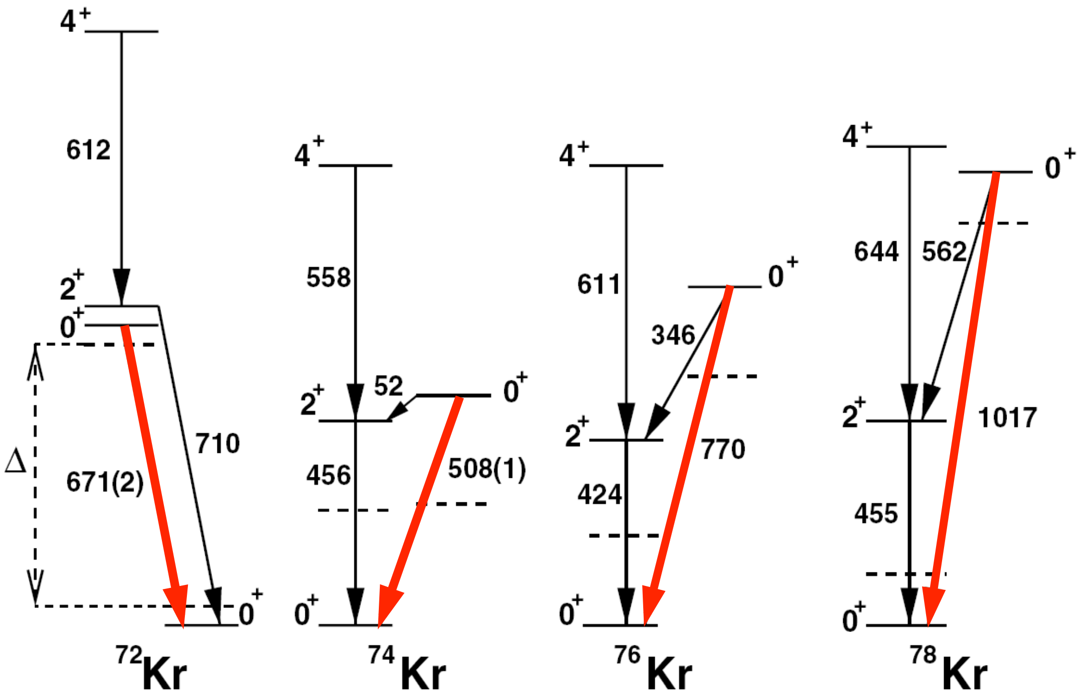


- **Oblate shape is predicted for ^{72}Kr (gd. state) that is a rarity which gives a deeper understanding of effective nucleon-nucleon interaction, *P. Moller et al., At. Data Nucl. Data Tables (1995)*.**
- **A sudden jump of nucleons to $g_{9/2}d_{5/2}$ at N=Z=36, a decisive change in the mean-field – phase transition?, *M. Hasegawa et al.. PLB 2007, A.J.Nichols et al. PLB 2014*.**
- **E0 Strengths are very sensitive to the T=0 matrix elements involving $f_{5/2}$, $f_{7/2}$ and $g_{9/2}$ orbitals and room for understanding the deformation driving role of proton-neutron interaction –larger overlap of the neutron and proton w.f, *E. Bouchez et al., PRL (2003), A. Petrovici et al. PPNP (1999)*.**
- **A waiting point nucleus in the rp process – 1p capture produces unbound ^{73}Rb nucleus resulting in a competition between two proton capture and beta decay.**

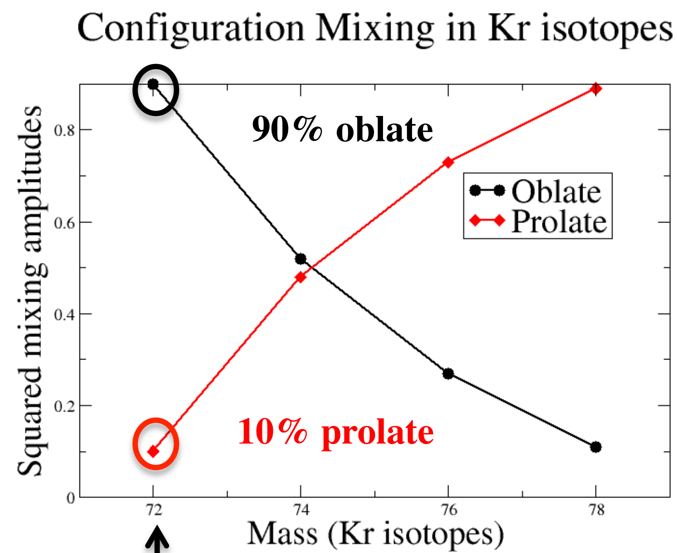
Experimental studies – ^{72}Kr

Level structures, EM, E0 strengths

E. Bouchez et al., PRL 90 (2003)
G. de Angelis et al., PLB 415, 217 (1997)



Nuclide	^{78}Kr	^{76}Kr	^{74}Kr	^{72}Kr
$\tau(0_2^+)$	11(3) ps	61(9) ps	18.8(10) ns	38(3) ns
$\frac{T(E2)}{T(E0)}$	3360(150)	490(19)	1.2(5)	0
ρ^2_{exp}	0.047(13)	0.079(11)	0.085(19)	0.072(6)
ρ^2_{HFB}	···	···	~0.035	~0.063

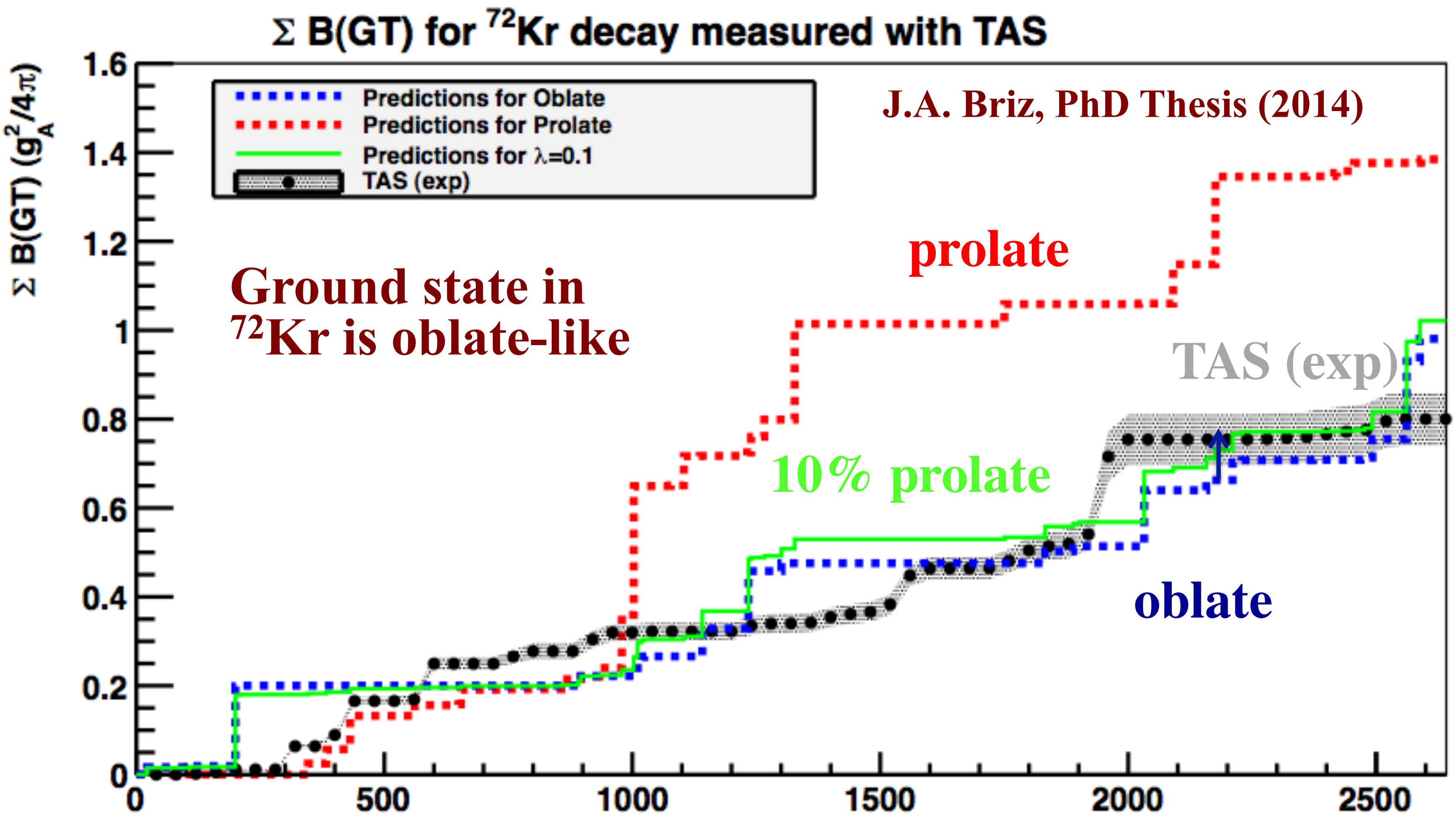


Ground state in ^{72}Kr is oblate-like

Experimental studies – ^{72}Kr

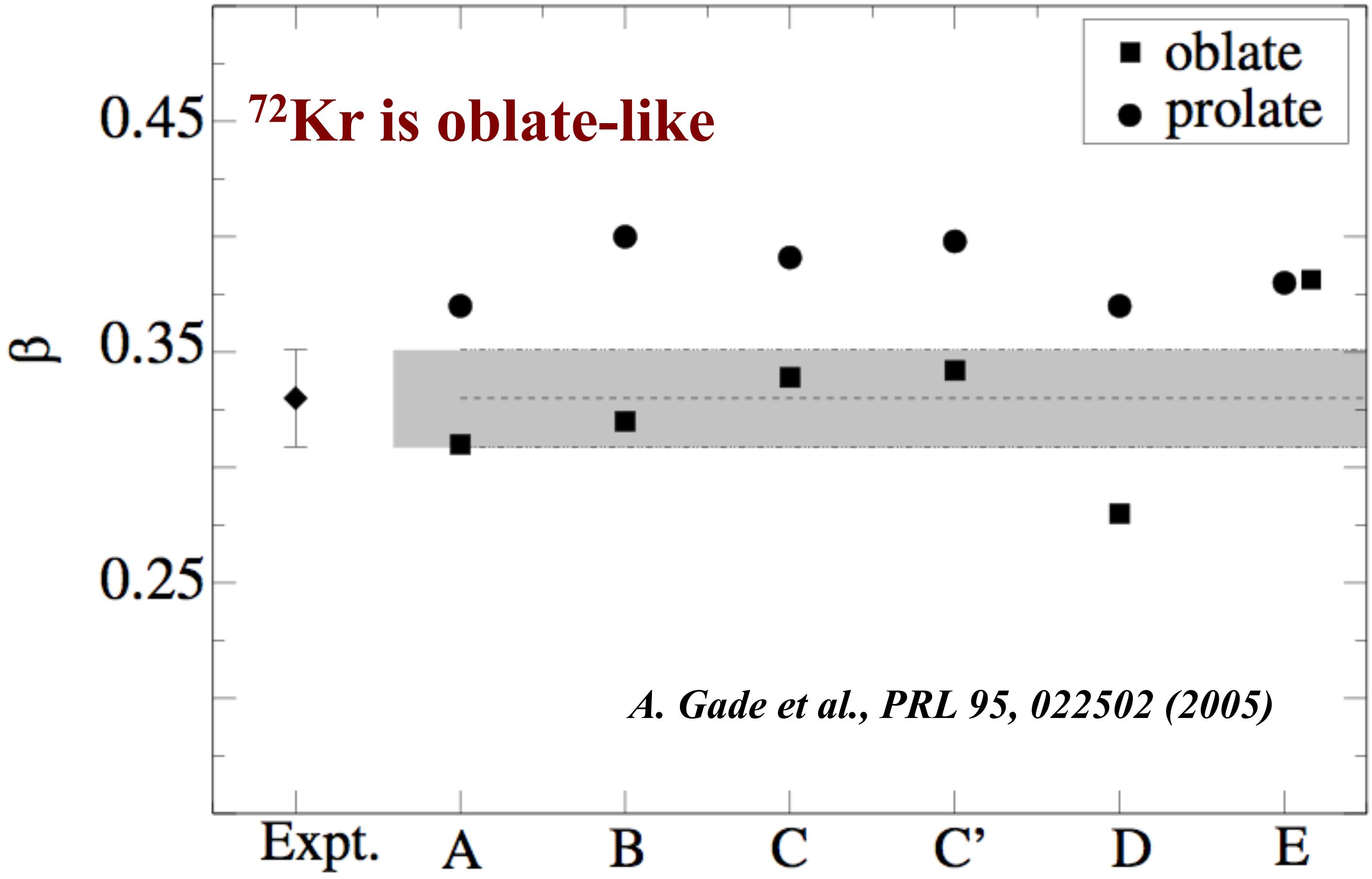
β-decay

A comparison between the calculated and the experimental B(GT) indicate oblate dominated ground state however, a prolate mixure higher than 10% cannot be excluded.

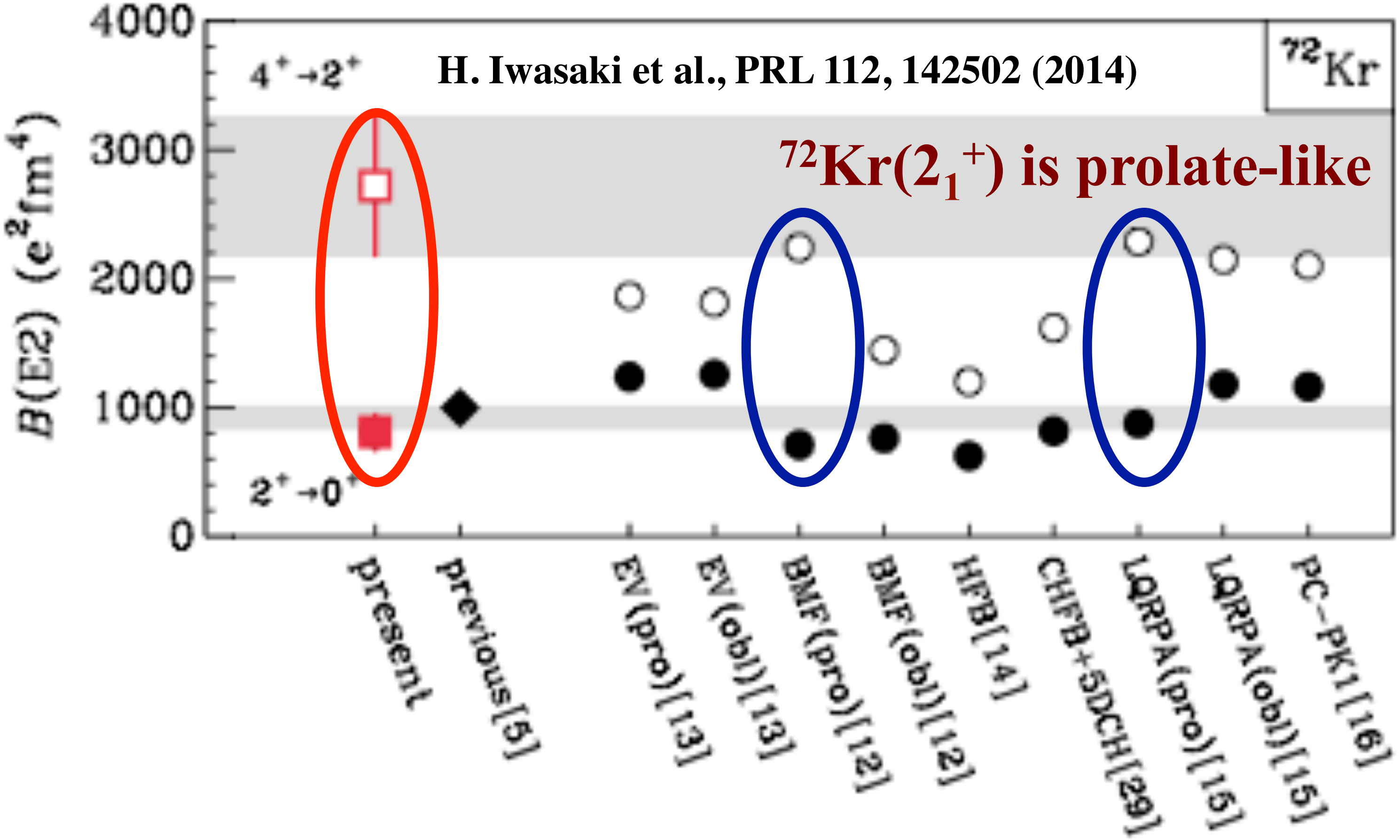


Experimental studies – ^{72}Kr
Intermediate Coulomb excitation

B(E2:2_1^+->0_1^+) strength/deformation



Experimental studies – ^{72}Kr
New life-time measurements

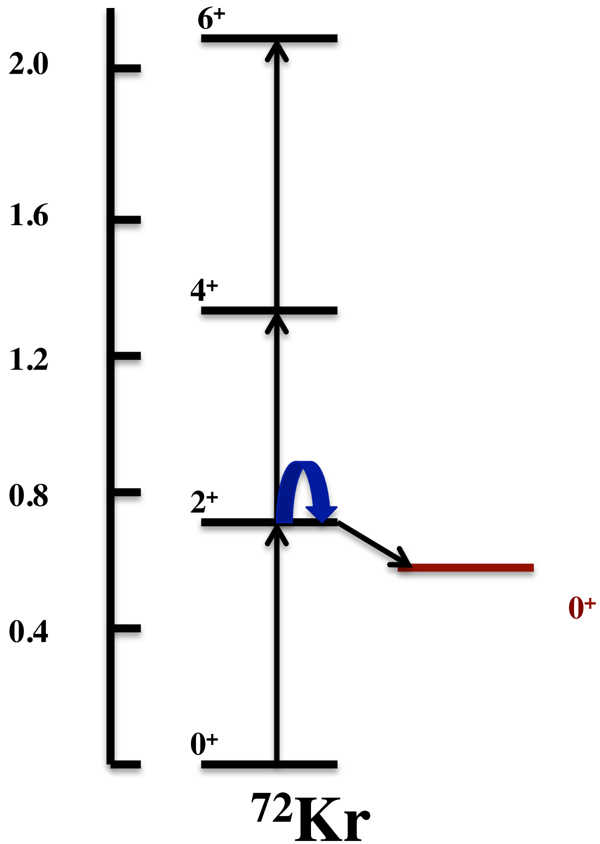


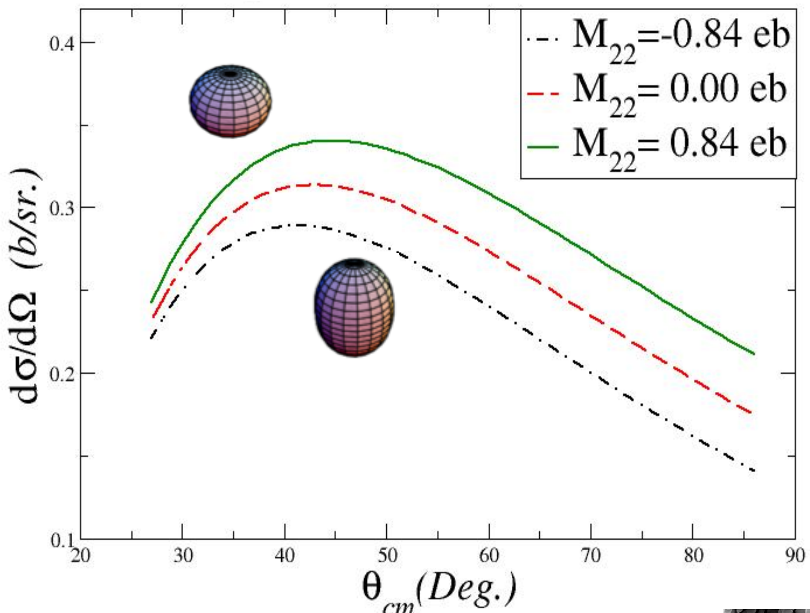
B(E2:4_1^+->2_1^+)/B(E2:2_1^+->0_1^+)=3.36, away both from rotor (1.43) and vibrational (2) limits, also indicate weak coupling between 2_1^+ and 0_1^+ compared to that for 4_1^+ and 2_1^+

This is based on the prolate nature for the 4$^+$ state, but no direct information ….

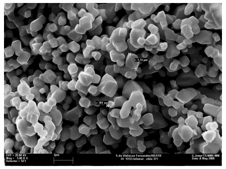
The Coulomb excitation technique

Coulomb excitation cross section to the 2^+ state depends on its shape, whether prolate or oblate

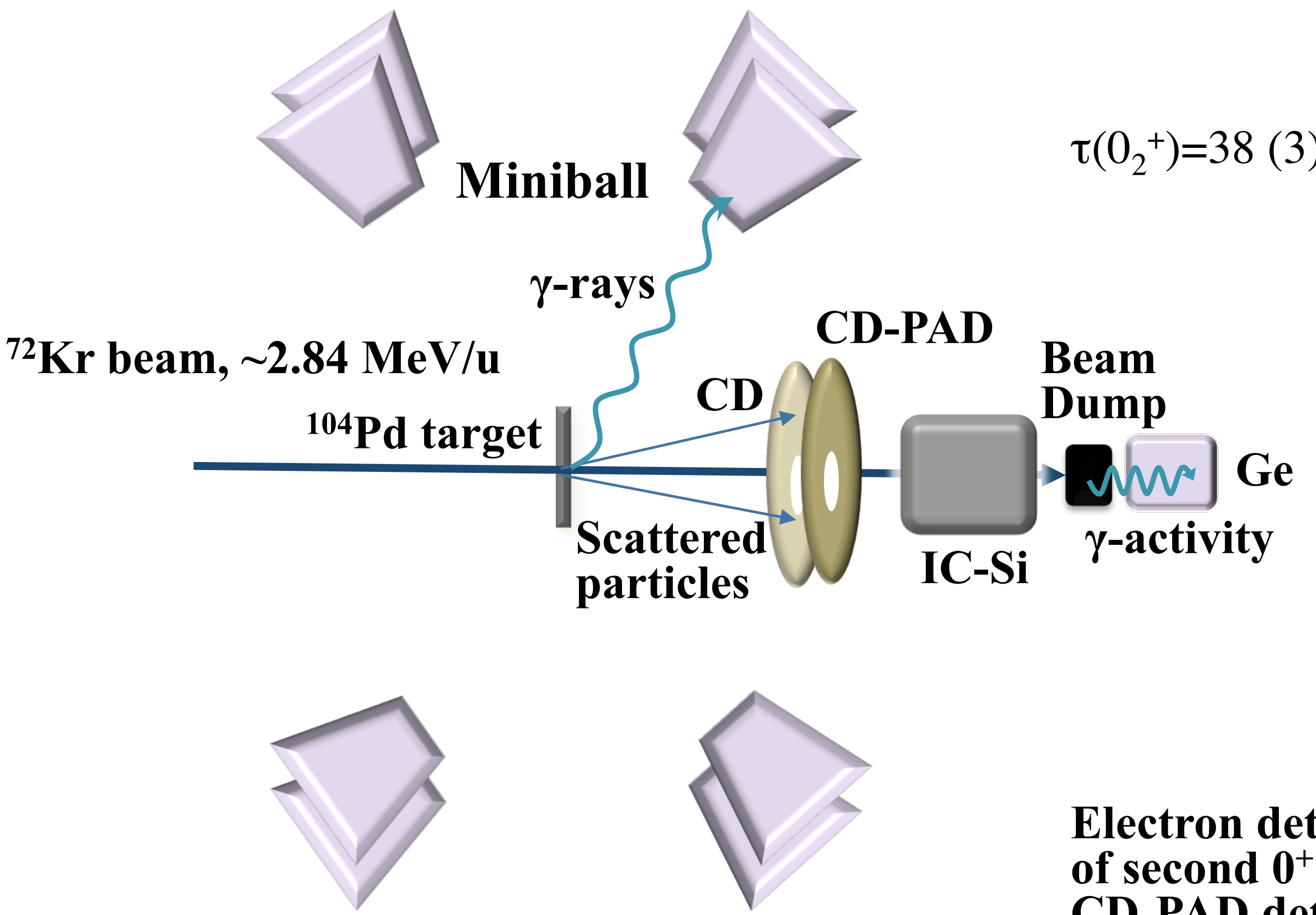




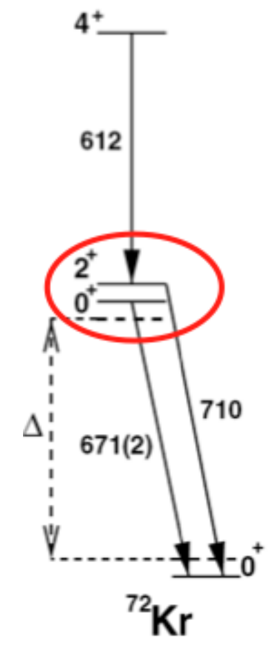
Thanks to the beam development team – T. Stora et al. NIMB 2013



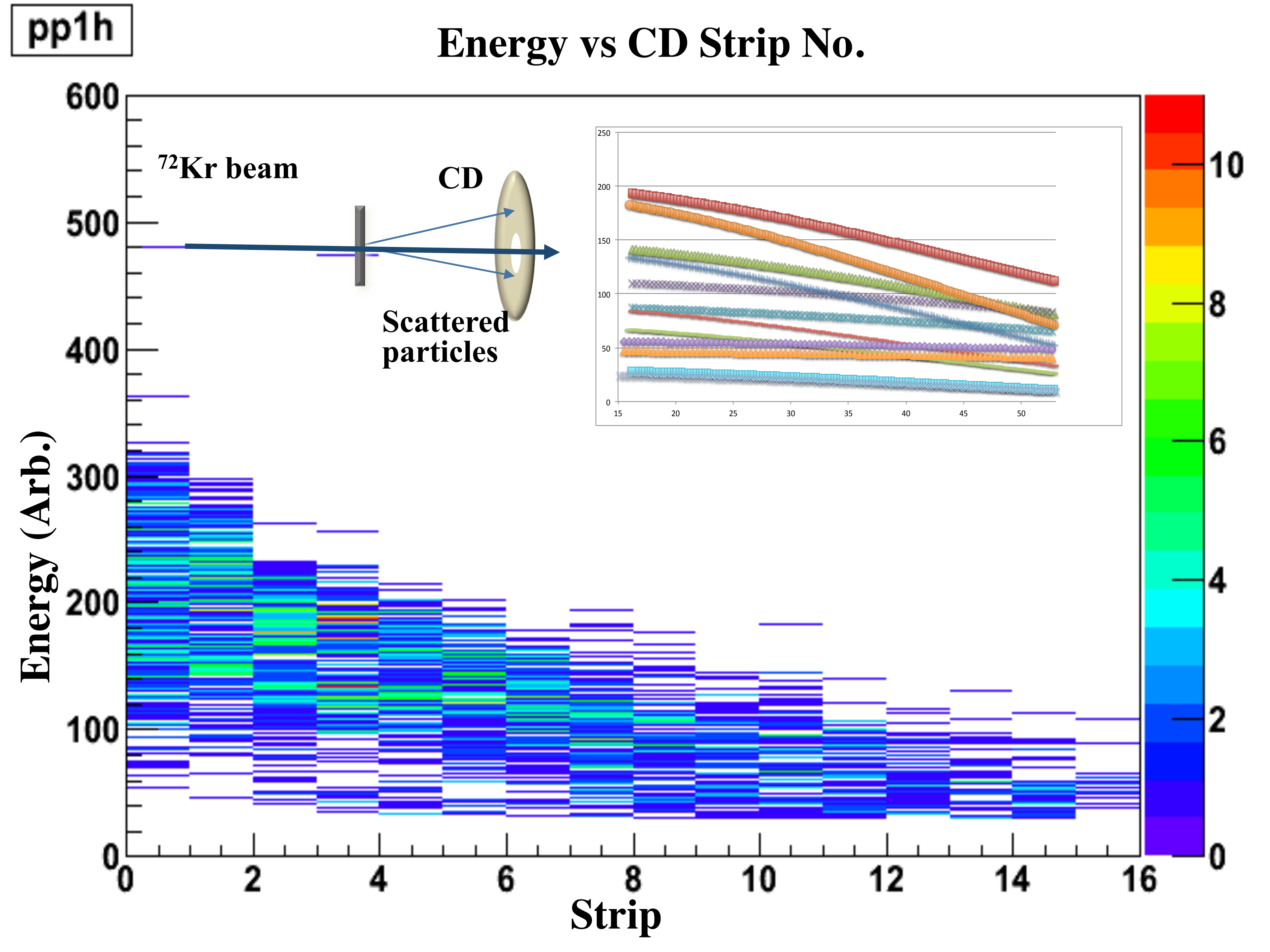
IS478 with Miniball + CD + PAD Setup



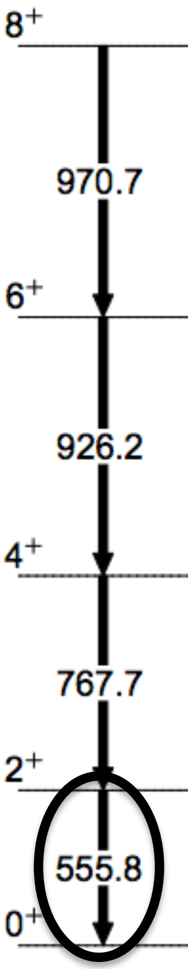
$\tau(0_2^+)$=38 (3) ns



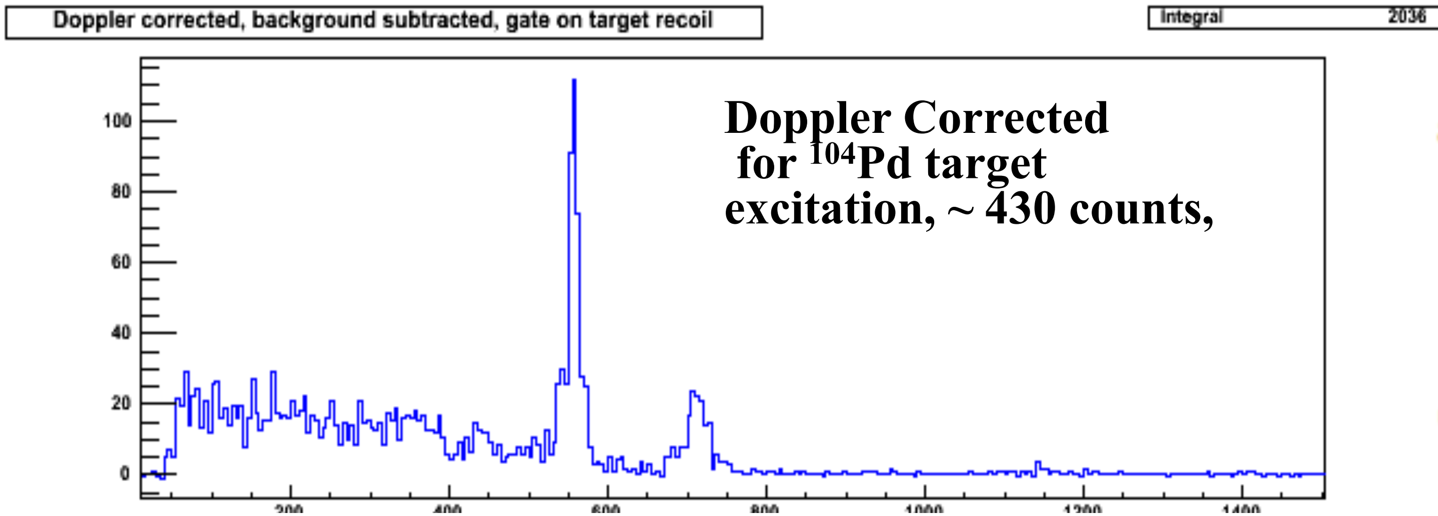
Electron detection from the decay of second 0^+ state in ^{72}Kr using a CD-PAD detector – No electron events detected


pp1h
Energy vs CD Strip No.
72Kr beam
CD
Scattered particles
Energy (Arb.)
Strip

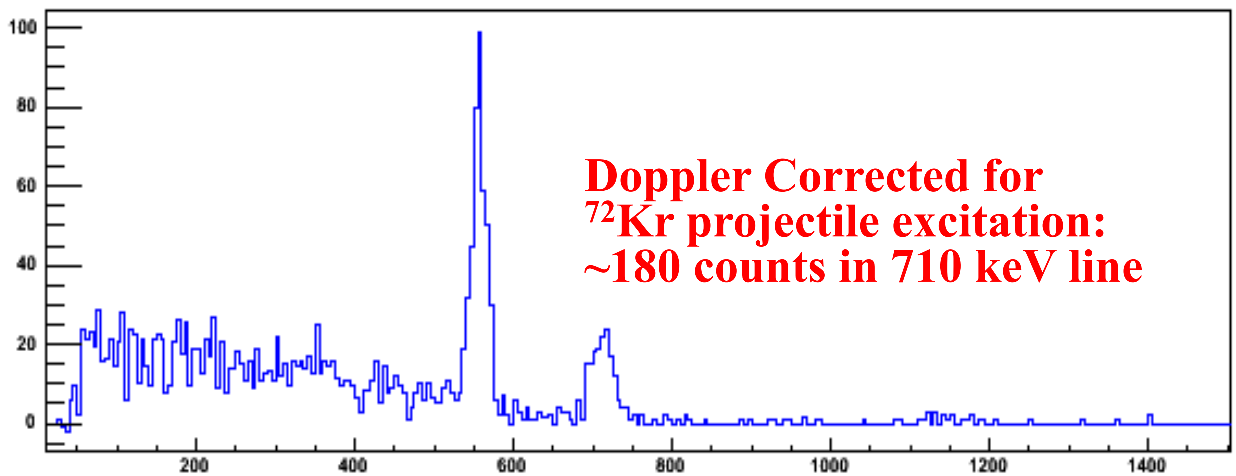
CD gated gamma spectra

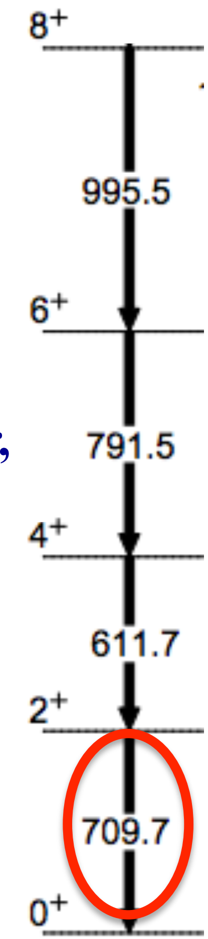


^{104}Pd



Corrected for excitations due to Contaminations using Ion Chamber, beta decay and Y555/Y709 evolution during the run

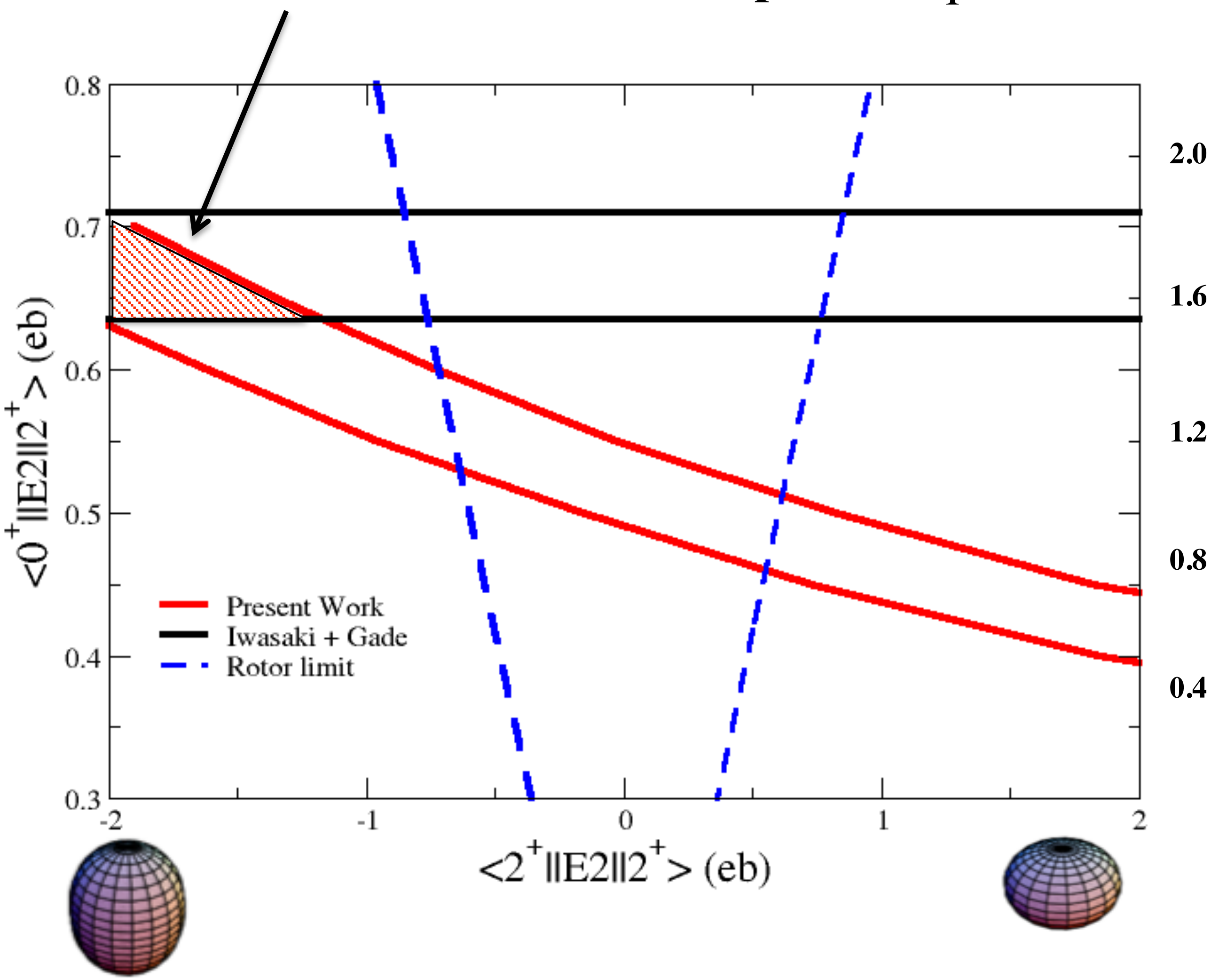


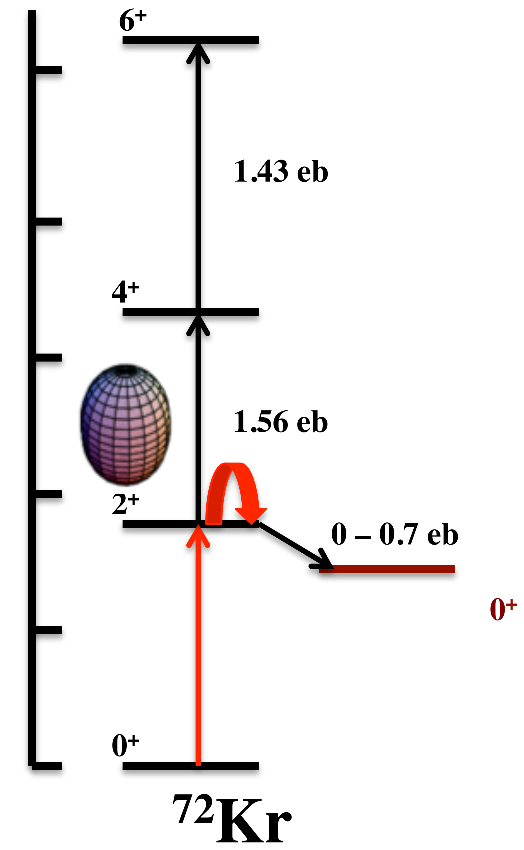


^{72}Kr

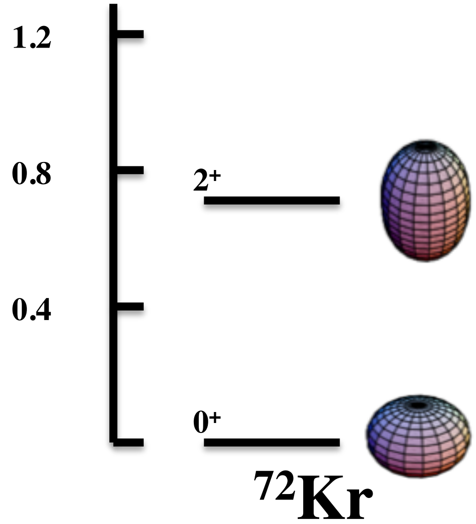
Matrix Elements (GOSIA)– Preliminary

First Direct Evidence for the prolate 2_1^+ state



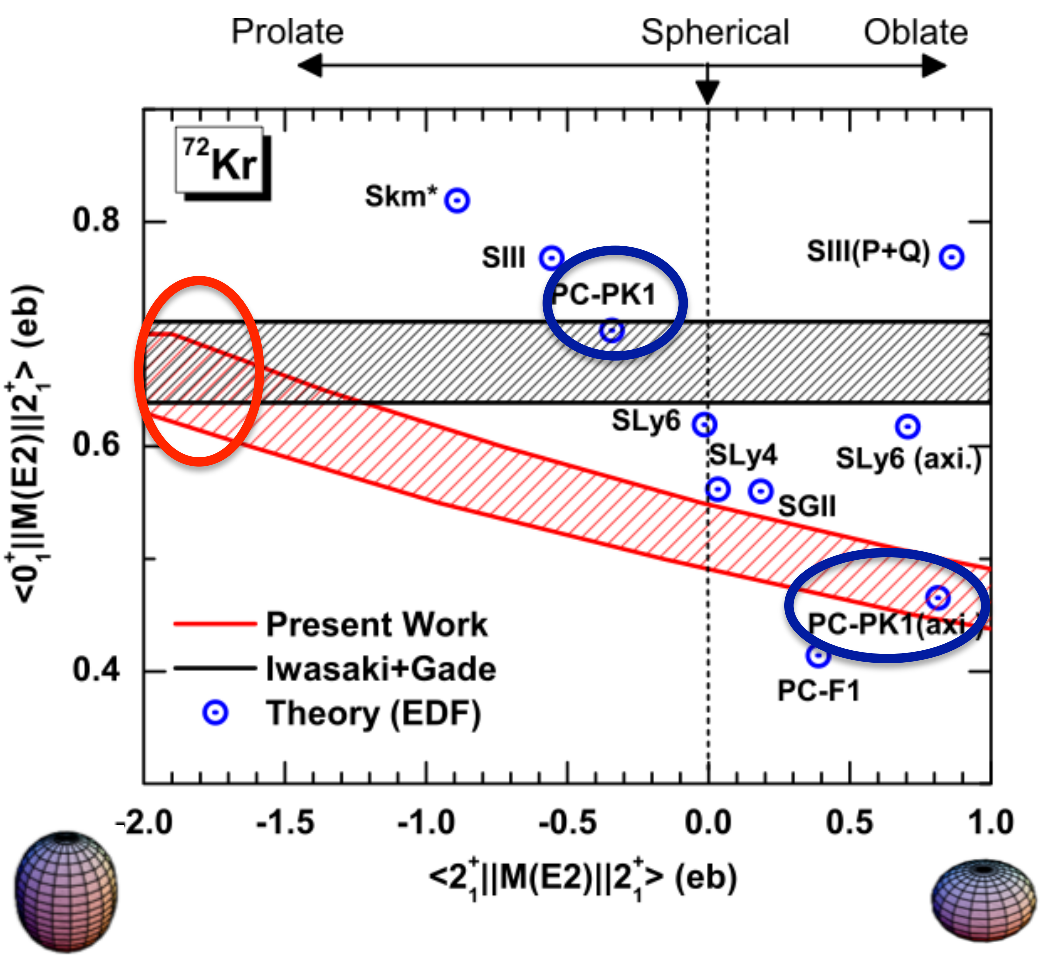


Rapid change in the shape from 0^+ to 2^+



B.S. Nara Singh et al., to be submitted.

Comparison with calculations – Preliminary



Calculations by J.M. Yao:

Stae-of-the-art 5DCH calculations based on several popularly used non-relativistic and relativistic EDF. Role of triaxiality can be seen for the calculations using the relativistic Lagrangian PC-PK1 and the Skyrme force SLy6

Conclusion: **Theoretical calculations are non conclusive, possibly far from having predictability and the experiments such as this and those to look for the second 2^+ state will play crucial roles.**

IS478 Collaboration
Spokesperson: B.S. Nara Singh

Considerable efforts over 5 years
– beam development and several attempts

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M. Seidlitz, N. Warr, Koln

and the Miniball collaboration and the REX-ISOLDE collaboration

Thank You!