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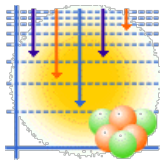
Configurations and Hindered Decays of K-Isomers in deformed nuclei with A>100

with G.D. Dracoulis & T. Kibedi (ANU)



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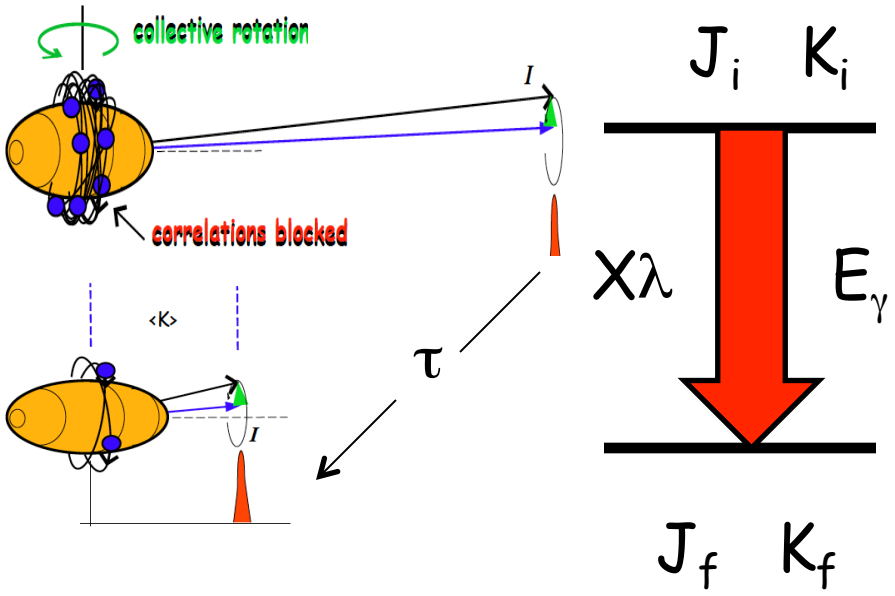
K-Isomers Evaluation (Horizontal)

- completed and submitted for publication in ADNDT
- data available in ENSDF format - implications for ENSDF format development - K quantum number in deformed nuclei
- implications for nuclear reactions modeling at low excitation energies (NRF, astrophysics …), e.g. level densities, strength functions, RIPL, etc.
- new processing codes development – modification of ruler (a nightmare) & new python code (from scratch) … it is not that complicated …
- a short letter is under preparation
- a detailed review of Nuclear Isomers – invited article in Prog. Rep. Physics – under preparation with P.M. Walker, U. Surrey, UK

K hindered decays



- ✓ hindrance $F_w = \tau_\gamma / \tau_W$
- ✓ reduced hindrance $f_\nu = F_w^{1/\nu}$

typically f_ν = 20 – 300, but many exceptions…

- ✓ transition of multipolarity λ can only change the K projection by at most λ.
- ✓ the shortfall is the degree of "forbiddenness" $\nu = \Delta K - \lambda$.

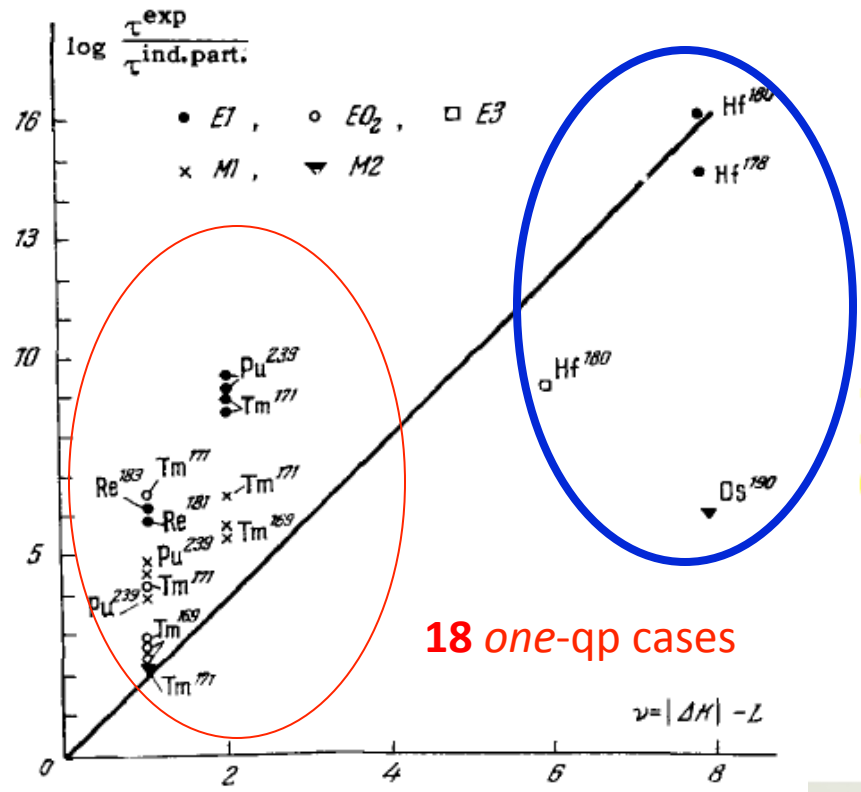
Rusinov systematics

SOVIET PHYSICS USPEKHI VOLUME 4, NUMBER 2 SEPTEMBER-OCTOBER 1961

NUCLEAR ISOMERISM

L. I. RUSINOV*

Usp. Fiz. Nauk **73**, 615-630 (April, 1961)



only **4** *two*-qp cases

18 *one*-qp cases

small in all other instances. The experimental data on K-forbidden transitions show that increase of K forbiddenness by one degree represents the reduction of transition intensity by a factor of about 100. A sep-

$$\log F_W = 2(|\Delta K| - L)$$

Lobner systematics

Volume 26B, number 6 PHYSICS LETTERS 19 February 1968

SYSTEMATICS OF ABSOLUTE TRANSITION PROBABILITIES OF K-FORBIDDEN GAMMA-RAY TRANSITIONS

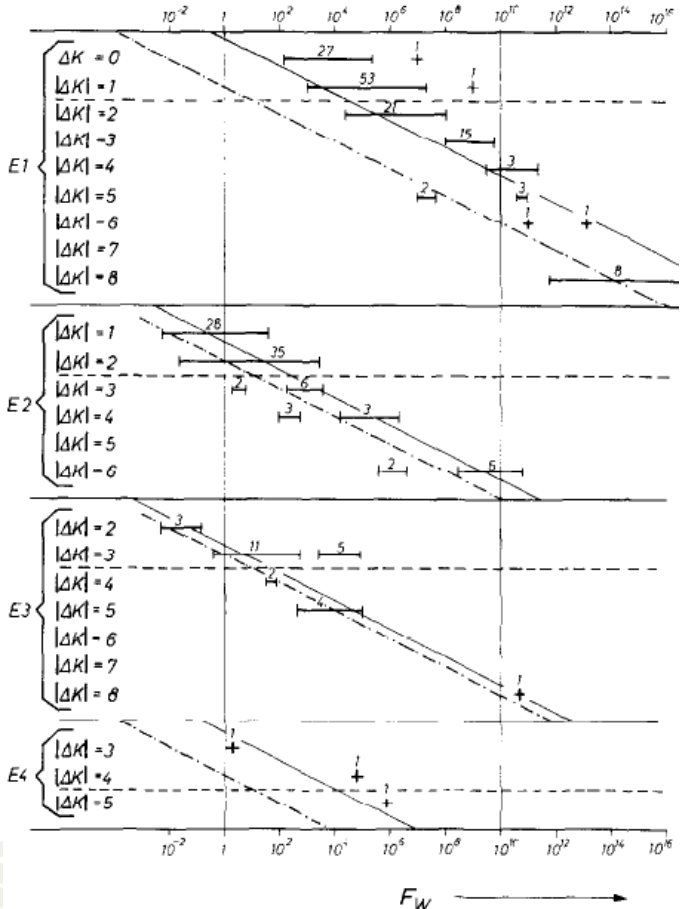
K. E. G. LÖBNER
Department of Physics, Technical University, Munich, Germany

250 cases- both *one*- and *two*- and higher mqp isomers

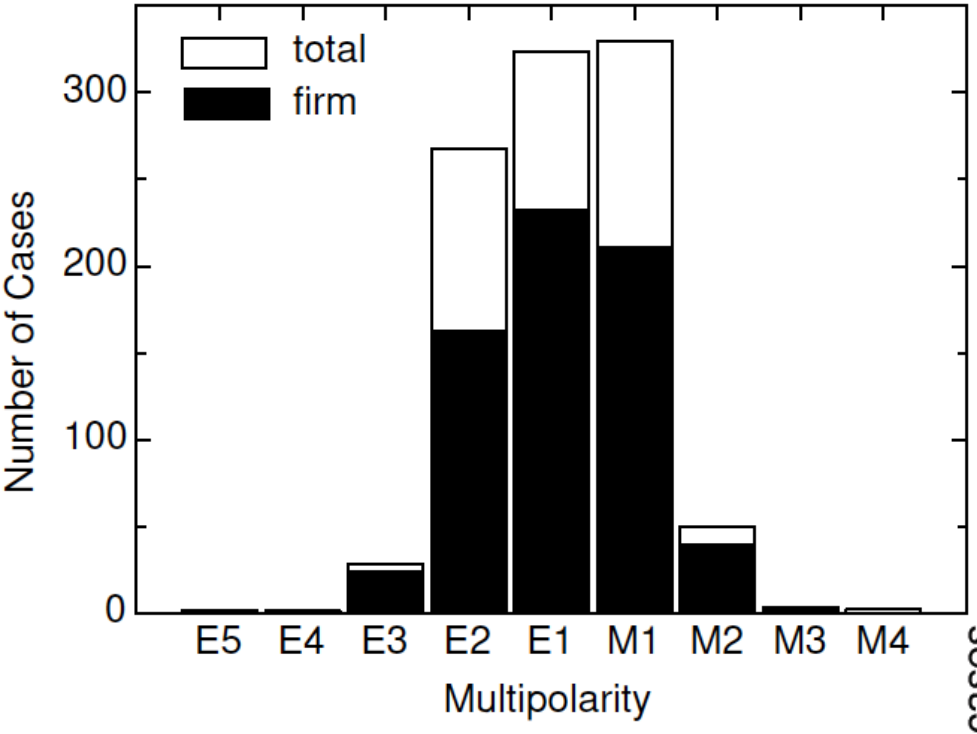
✓ sloping lines given in fig. 1 and fig. 2. It is found that the reduced transition probabilities decrease approximately by a factor of 100 per degree of K-forbiddenness in agreement with

✓ The frequently used "empirical rule" of Rusinov [1]: $\log F_W = 2(|\Delta K| - L)$ is in general not true, especially not for the E1 and E4 transi-

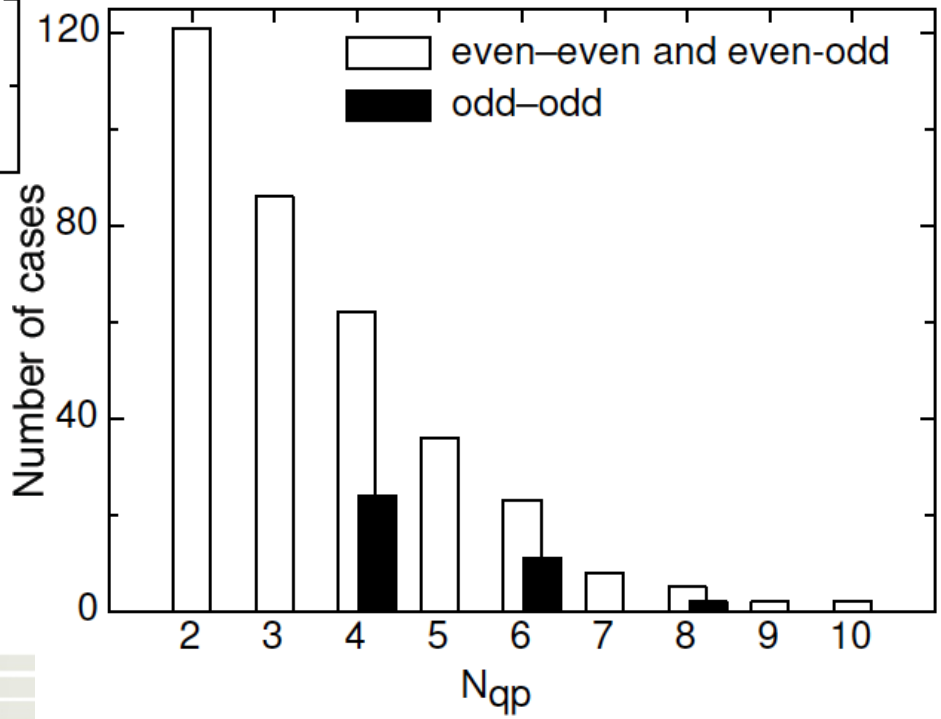
✓ It must be emphasized that the F_W values scatter considerably. Therefore, care should be taken if K values of levels are deduced from measured γ-ray transition probabilities.



New systematic studies

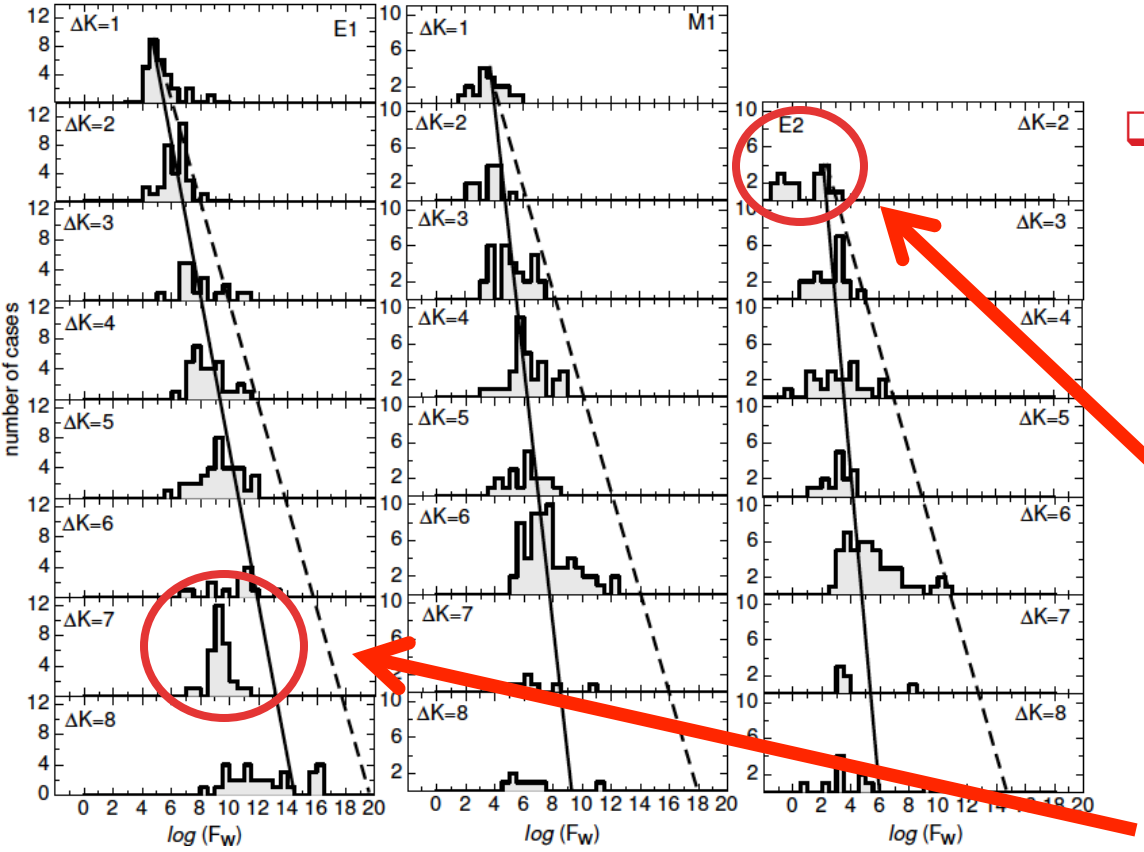


- ❑ examined **373** isomeric decays
- ❑ determined **1050** K-forbidden transitions
  - ✓ compare to **250** (Lobner)
  - ✓ compare to **22** (Rusinov)
- ❑ self-consistent fashion
  - ✓ ensdf files, Mult., ICC, etc.



- ✓ considered only mqp states
- ✓ established rotational bands (70% of cases)
- ✓ established configurations

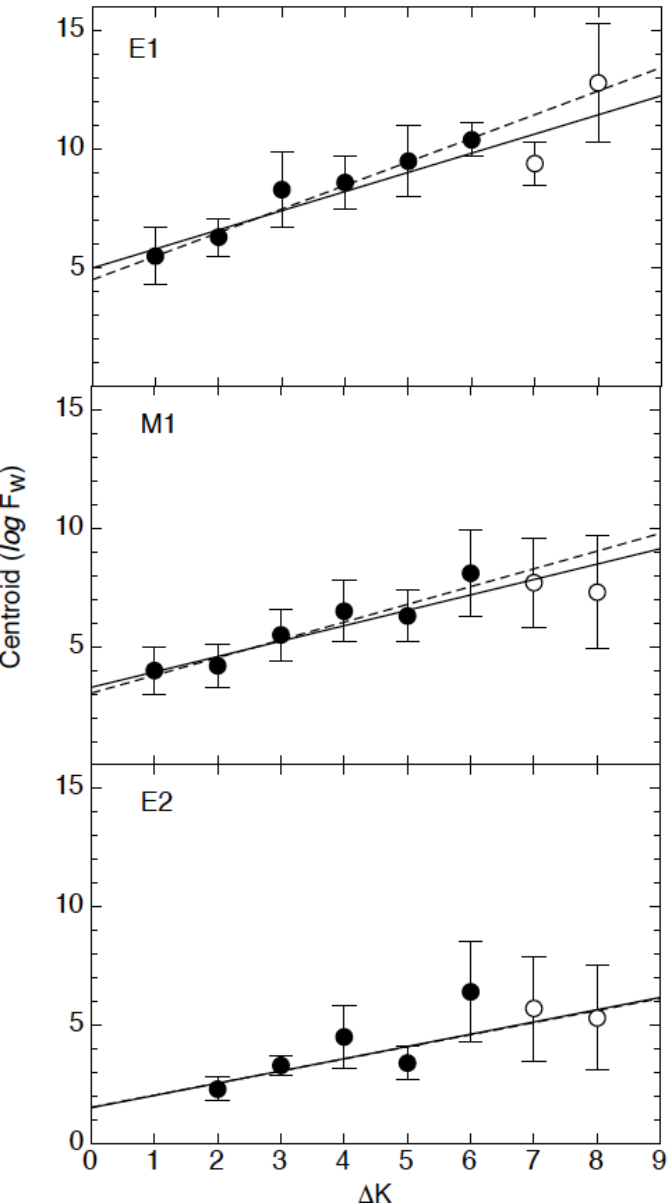
K-hindrance distributions



- distributions are not symmetrical – role of different mixing mechanisms
- centroids increase much more slowly than what would be expected from the rule of thumb, e.g. ~100 per degree of K-forbiddenness (dashed lines)
- ΔK=2 (allowed) E2 has two peaks
  - ✓ non-intrinsic states – transitions between rotational-aligned structures in transitional nuclei, e.g. $I^{\pi}=12^{+}$ state in ^{192}Os
- ΔK=7 E1 is strongly peaked, but at low value compared to the trend
  - ✓ multiple transitions from a single isomer, e.g. $K^{\pi}=7^{-}$ in ^{180}Os – five E1 transitions

✓ hindrance $F_w = \tau_\gamma / \tau_W$

K- hindrance classification



K forbidden

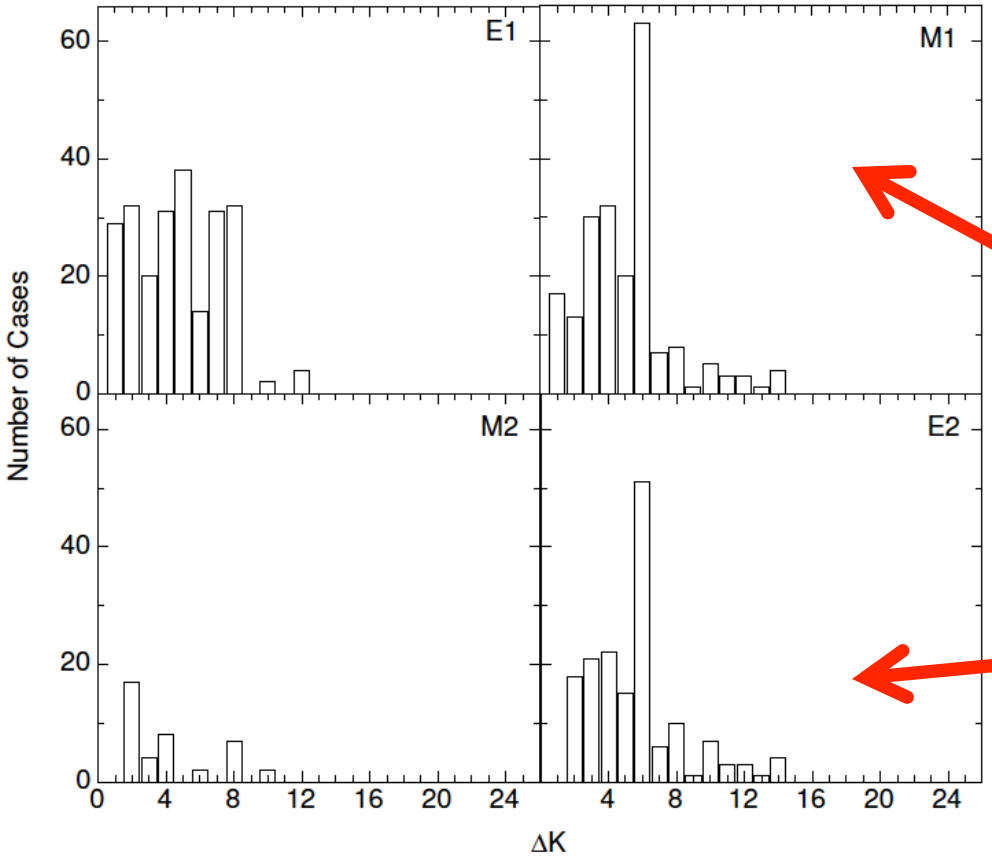
$$F = F_0 \times f_0^{\nu}$$

intrinsic

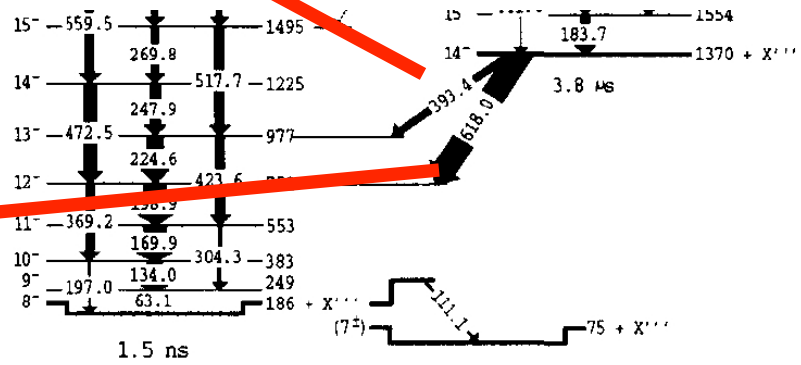
$\sigma\lambda$	F_0	f_0	χ^2
all points			
E1	$2.0^{+65}_{-15}\times10^5$	6.4^{+32}_{-21}	2.2
M1	$2.9^{+71}_{-6}\times10^3$	4.5^{+27}_{-17}	1.0
E2	$1.2^{+17}_{-7}\times10^2$	2.8^{+15}_{-10}	1.2
selected points: see Fig. 15			
E1	$1.0^{+37}_{-8}\times10^5$	12.5^{+124}_{-62}	0.3
M1	$1.7^{+55}_{-3}\times10^3$	6.7^{+65}_{-33}	0.3
E2	$1.2^{+17}_{-7}\times10^2$	3.2^{+28}_{-15}	0.9

- ✓ less than the ~100 per degree of K forbiddenness
- ✓ it is multipolarity dependent
- ✓ no need to divide by arbitrary factor of ~10^5 for E1

M1-E2 correlations …



consequence of the K-selection rule →
decay proceed stepwise by minimizing ΔK



Conclusions & Outlook

- completed and submitted for publication in ADNDT
- data available in ENSDF format – easy to add new cases – will continue updating
- a short letter for Phys. Rev. Letts is under preparation
- a detailed review of Nuclear Isomers (including those in spherical nuclei & those that have potential for applications) – invited article in Rep. Prog. in Phys. together with P.M. Walker, University of Surrey, UK – to be submitted by April 2015