High-K isomers and the role of β_6 deformation

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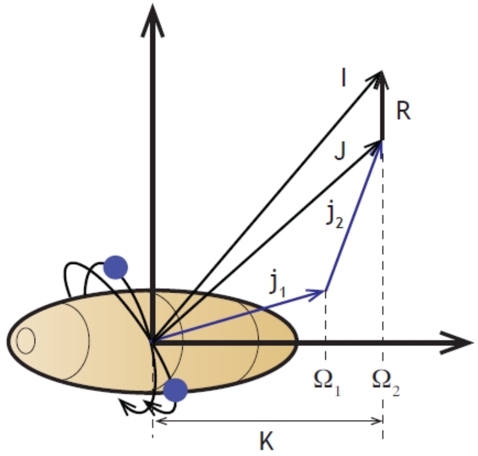
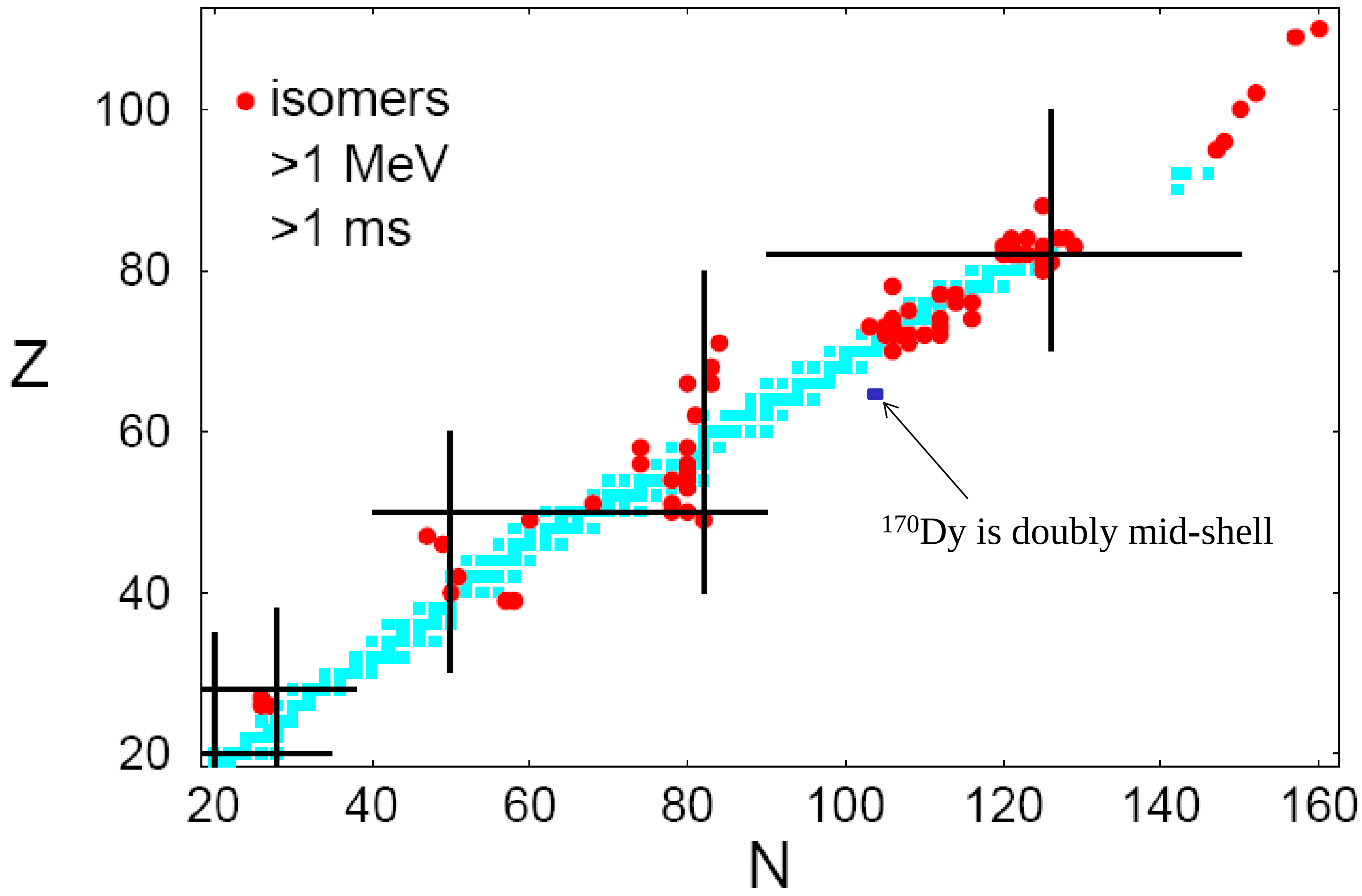
K-isomer issues



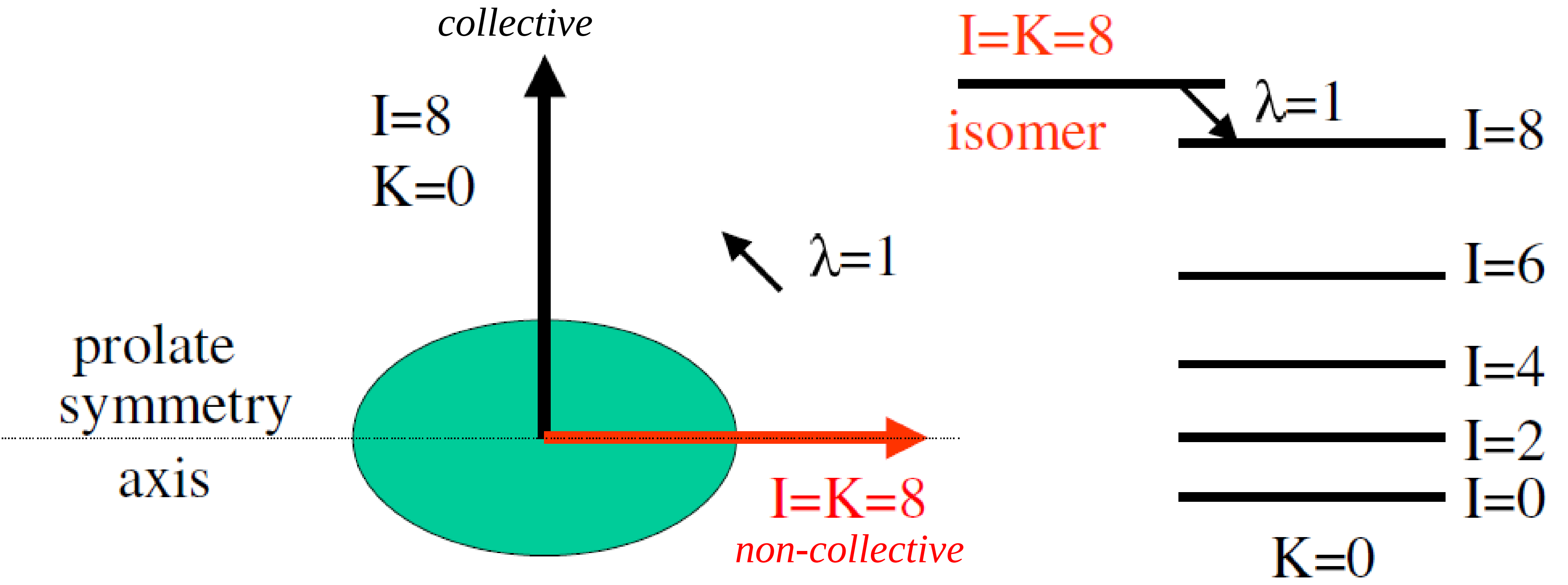
- quasiparticle structure => *understanding the nuclear potential*
- exploitation => *population of excited states far from stability*
- astrophysics => *r-process path and the A ~ 160 abundance peak*
- decay rates => *enhanced stability at the limits of binding*

nuclear chart with >1 MeV isomers



adapted from Walker and Dracoulis, Nature 399 (1999) 35

K-forbidden γ-ray transitions



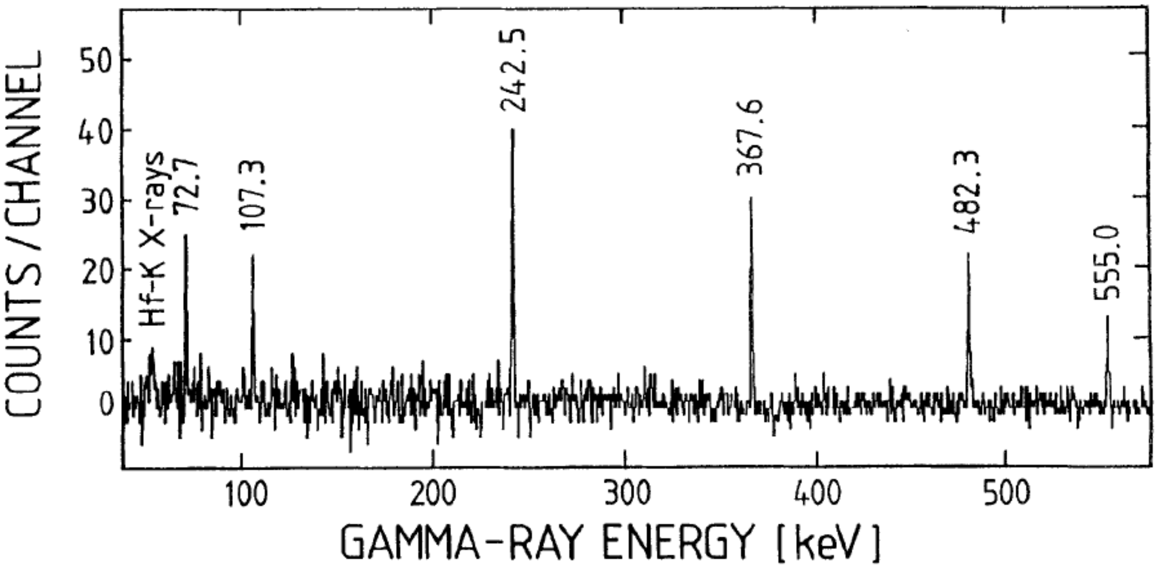
λ=1 transition is 7-fold K-forbidden

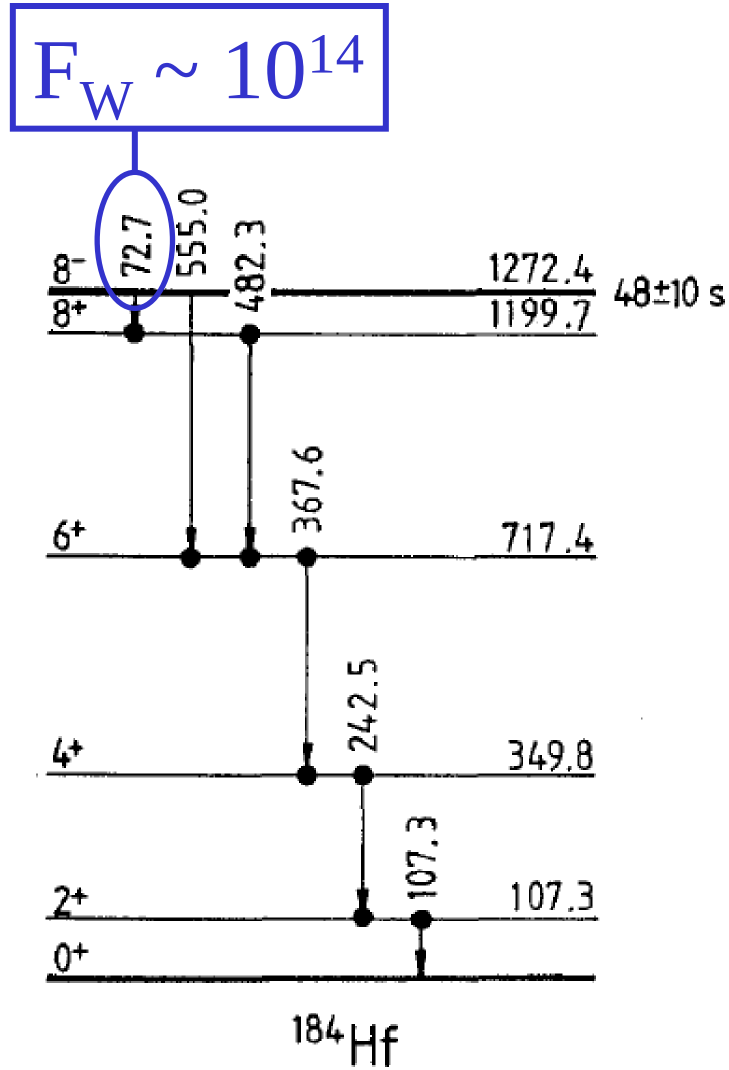
Walker, Karlsruher Nuklidkarte 50th Anniversary Commemorative Edition (2008) 154

^{184}Hf isomer

$T_{1/2}$ = 48 s

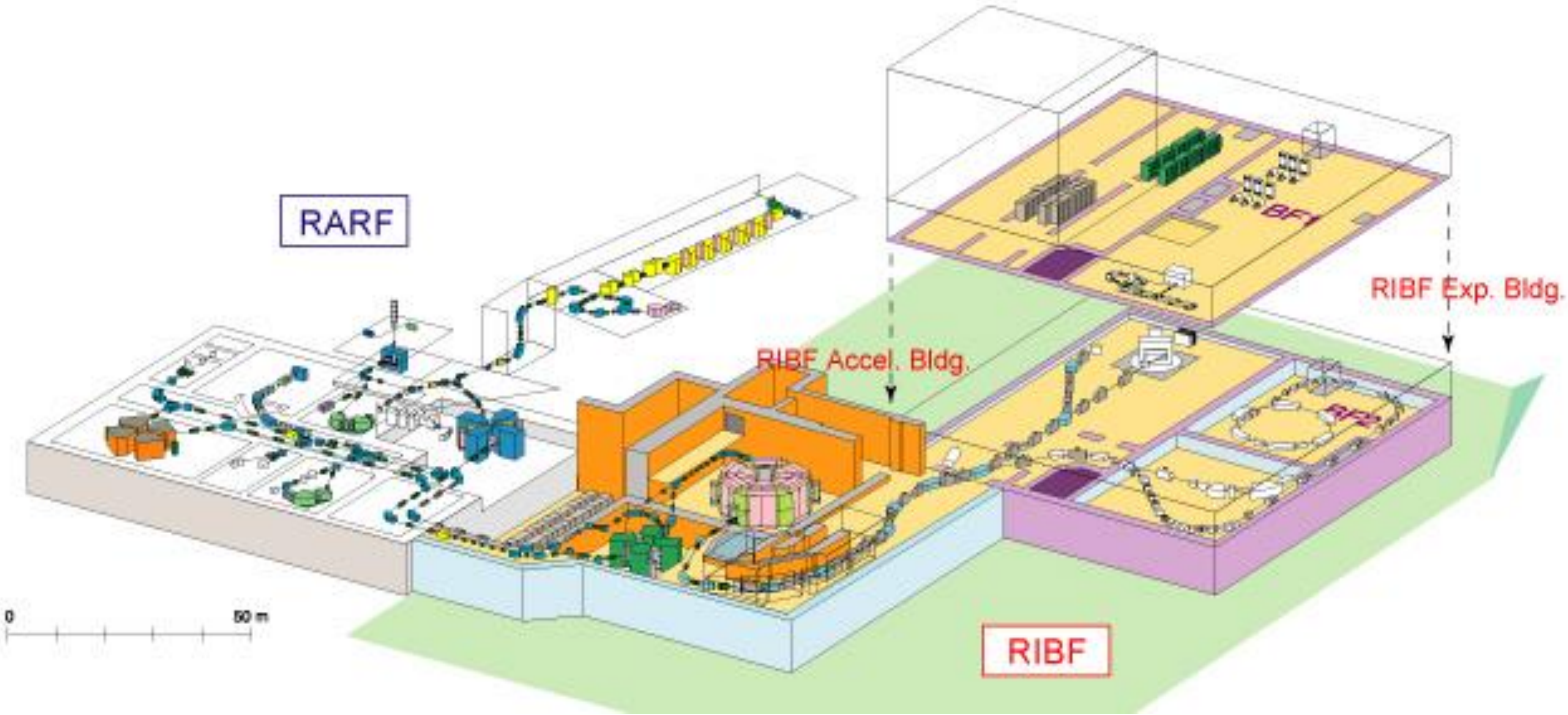
GSI isotope separator: ^{136}Xe on ^{186}W



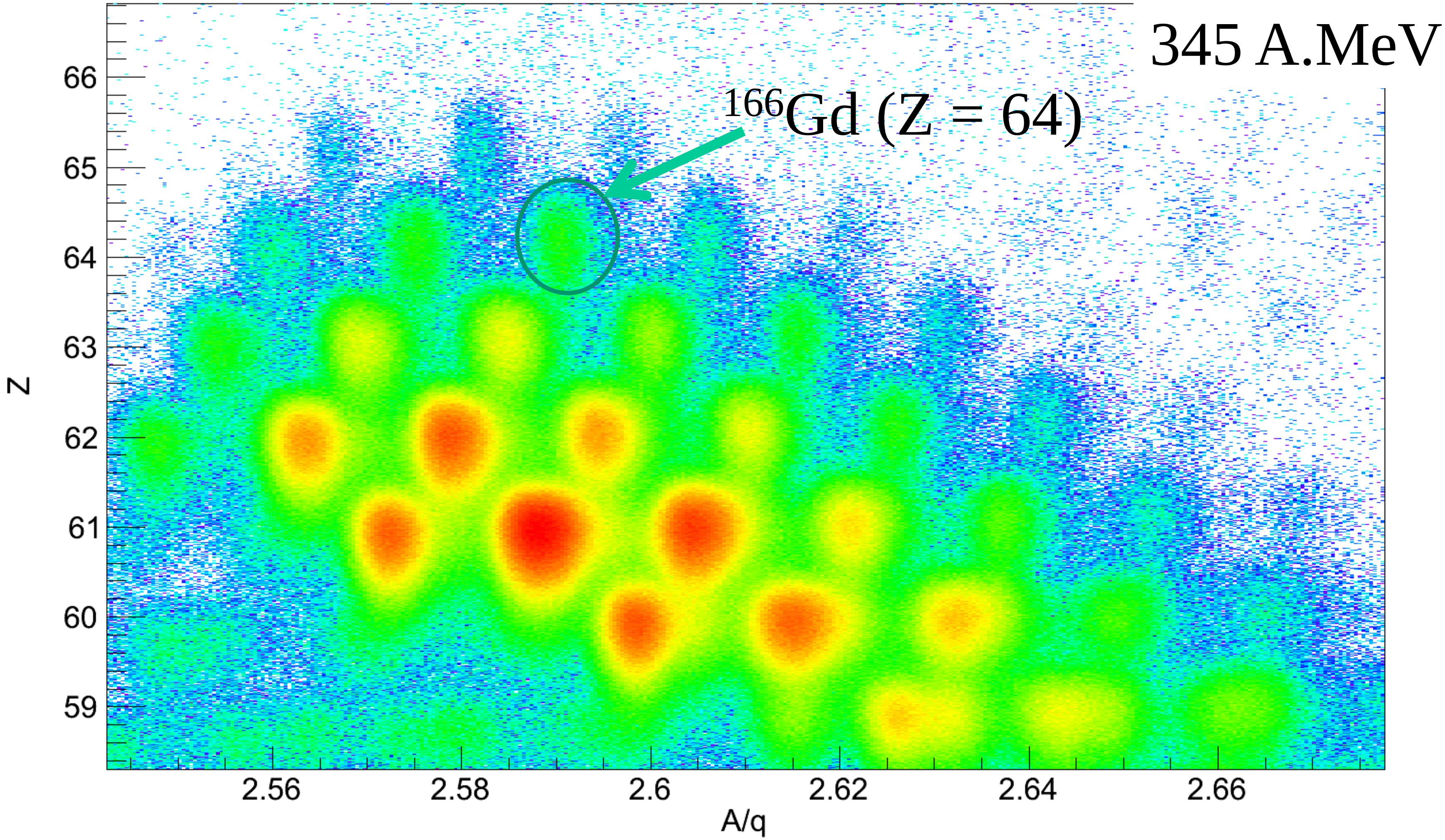


Krumbholz et al., Z. Phys. A351 (1995) 11

RIKEN accelerator complex



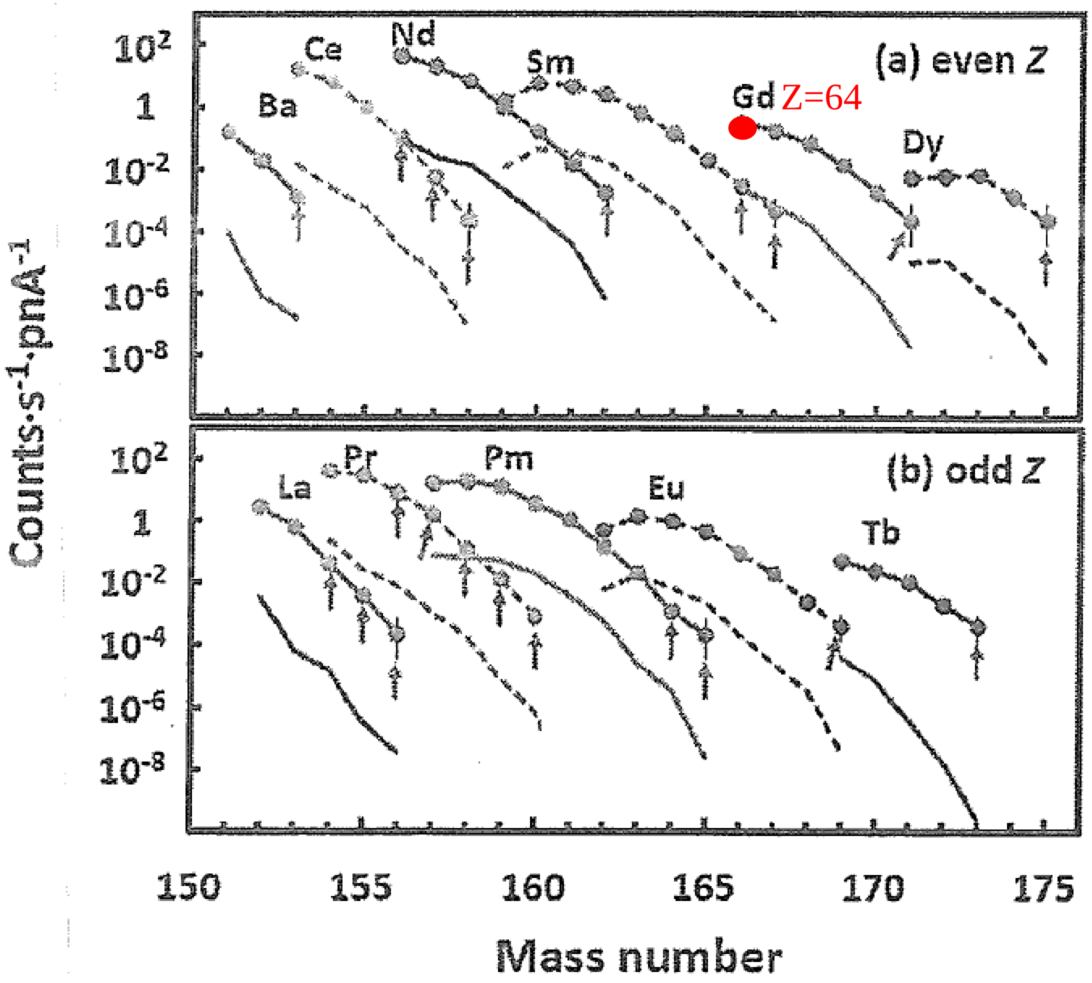
^{238}U fission yields at RIKEN



slide from Zena Patel

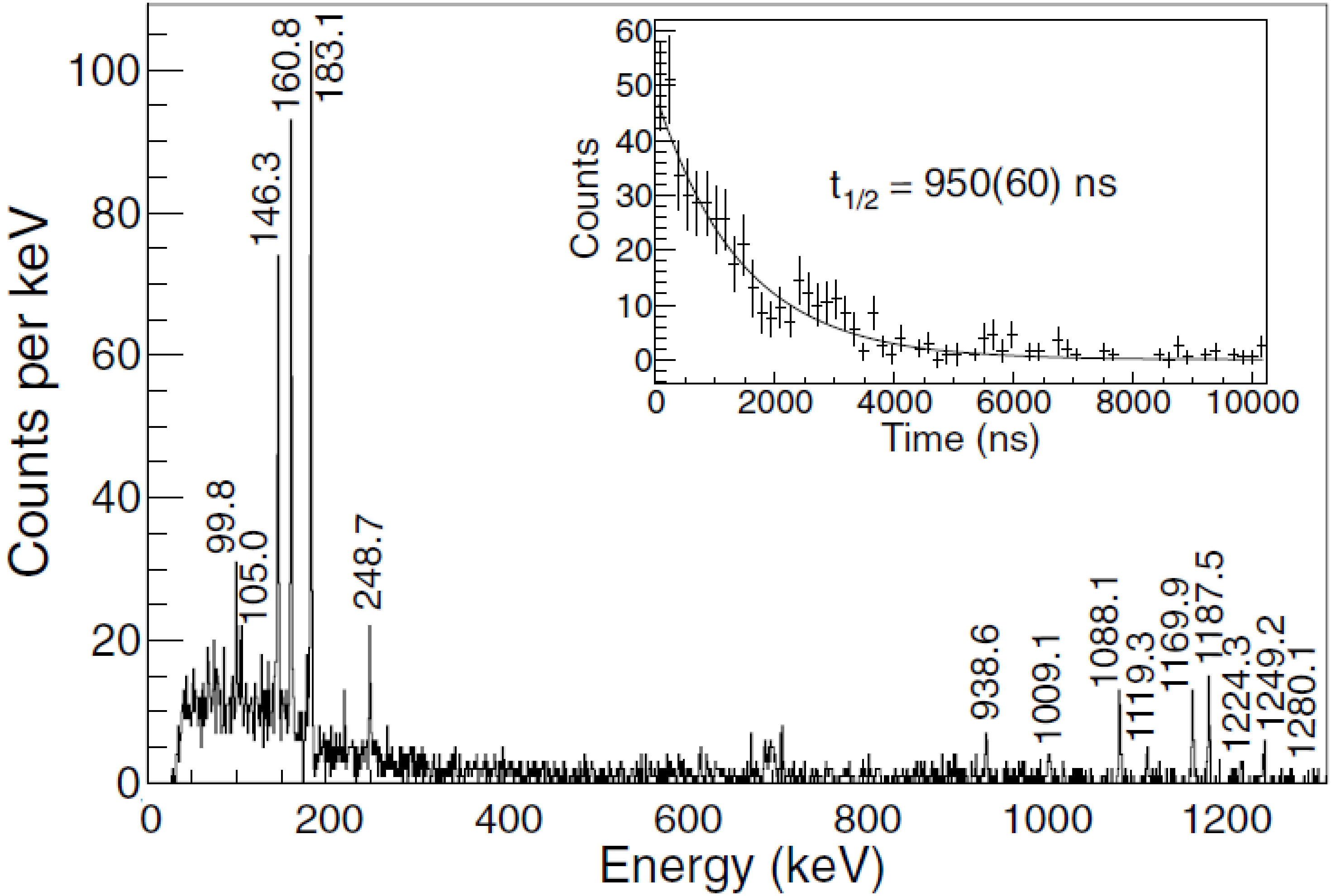
^{238}U fission yields at RIKEN

345 A.MeV



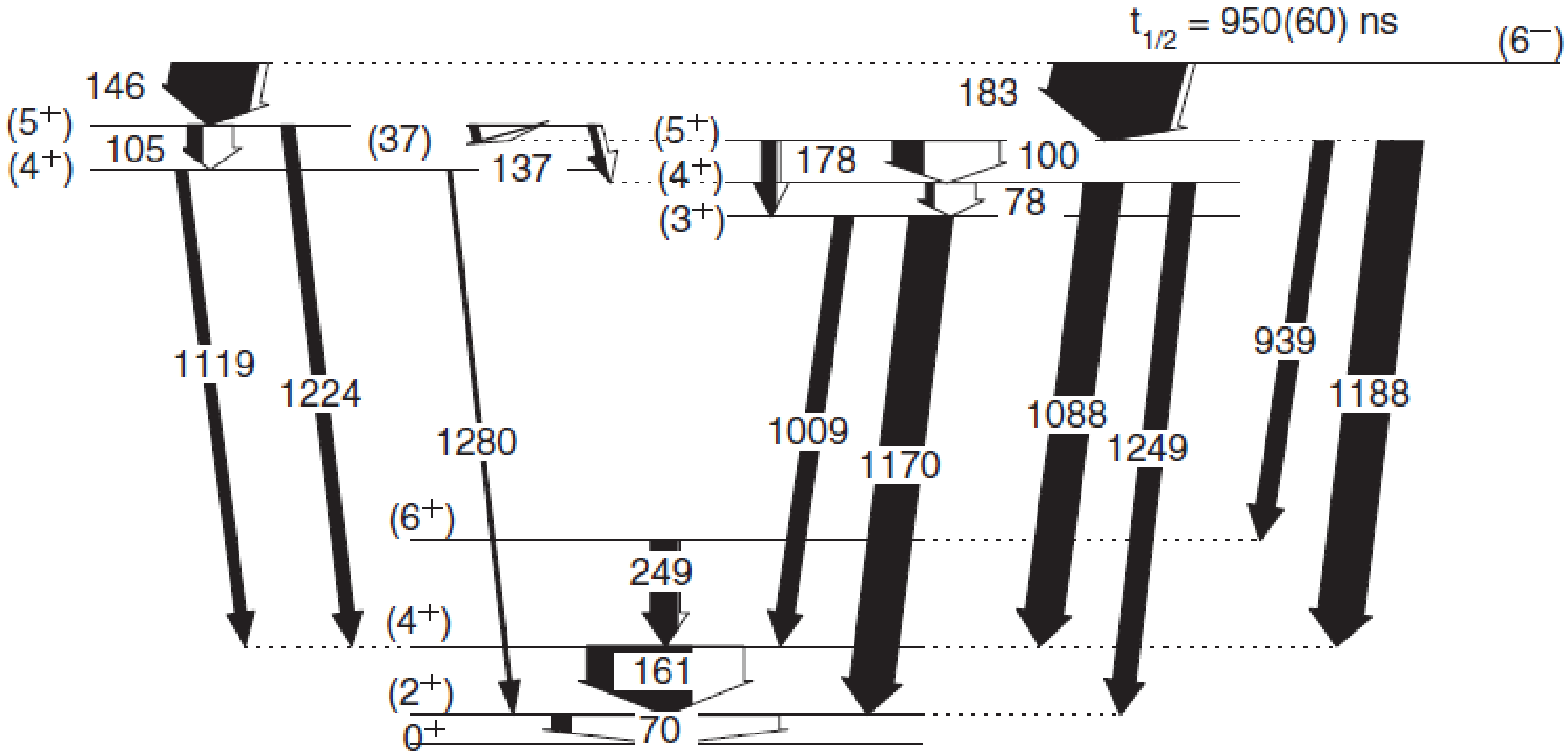
Kameda et al. RIKEN Accel. Prog. Rep. 47 (2014) viii

^{166}Gd from ^{238}U fragmentation at RIKEN



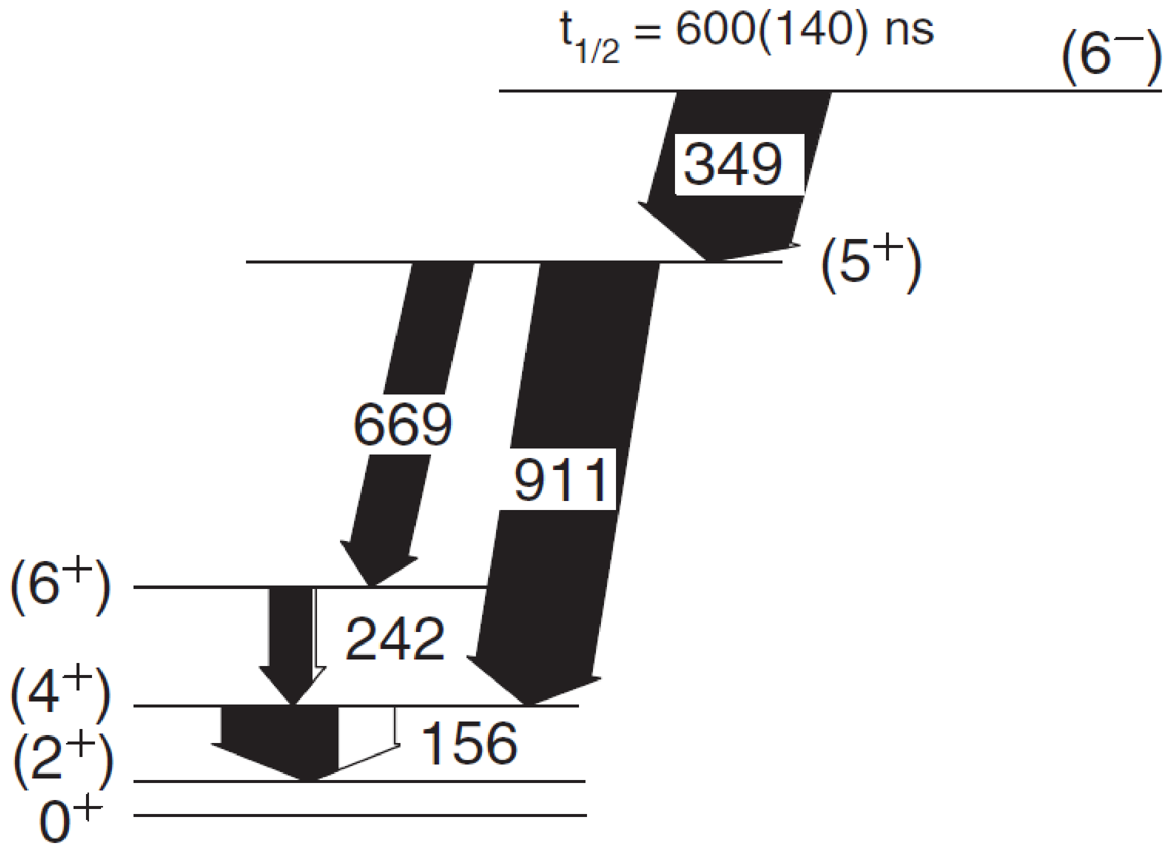
Patel et al. Phys. Rev. Lett. 113 (2014) 262502

^{166}Gd from ^{238}U fragmentation at RIKEN



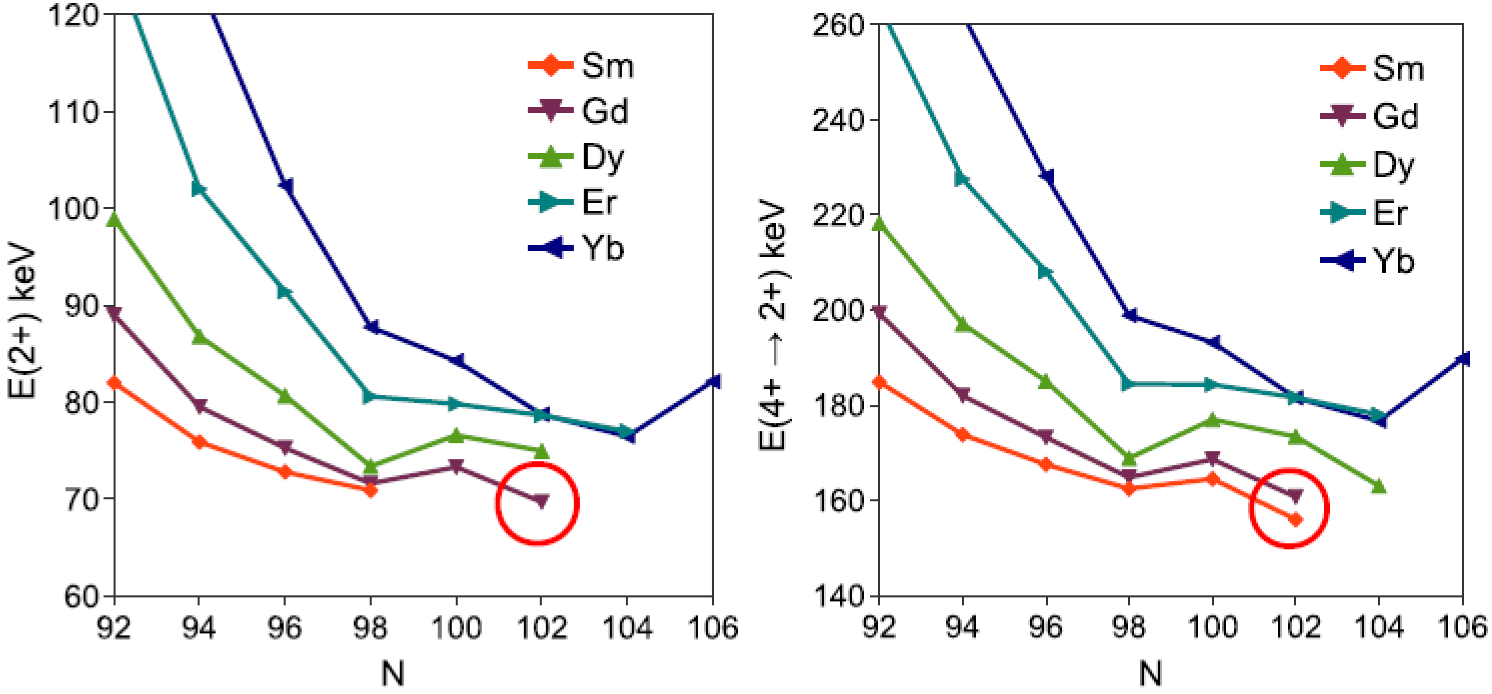
Patel et al. Phys. Rev. Lett. 113 (2014) 262502

^{164}Sm from ^{238}U fragmentation at RIKEN



Patel et al. Phys. Rev. Lett. 113 (2014) 262502

^{166}Gd and ^{164}Sm from ^{238}U fragmentation at RIKEN



Patel et al. Phys. Rev. Lett. 113 (2014) 262502

^{166}Gd and ^{164}Sm from ^{238}U fragmentation at RIKEN

Mid-shell (N ~ 104) structure:

- Possible sub-shell gap at N = 102
- Influence of β_6 deformation
- Influence on A ~ 160 r-process abundance peak

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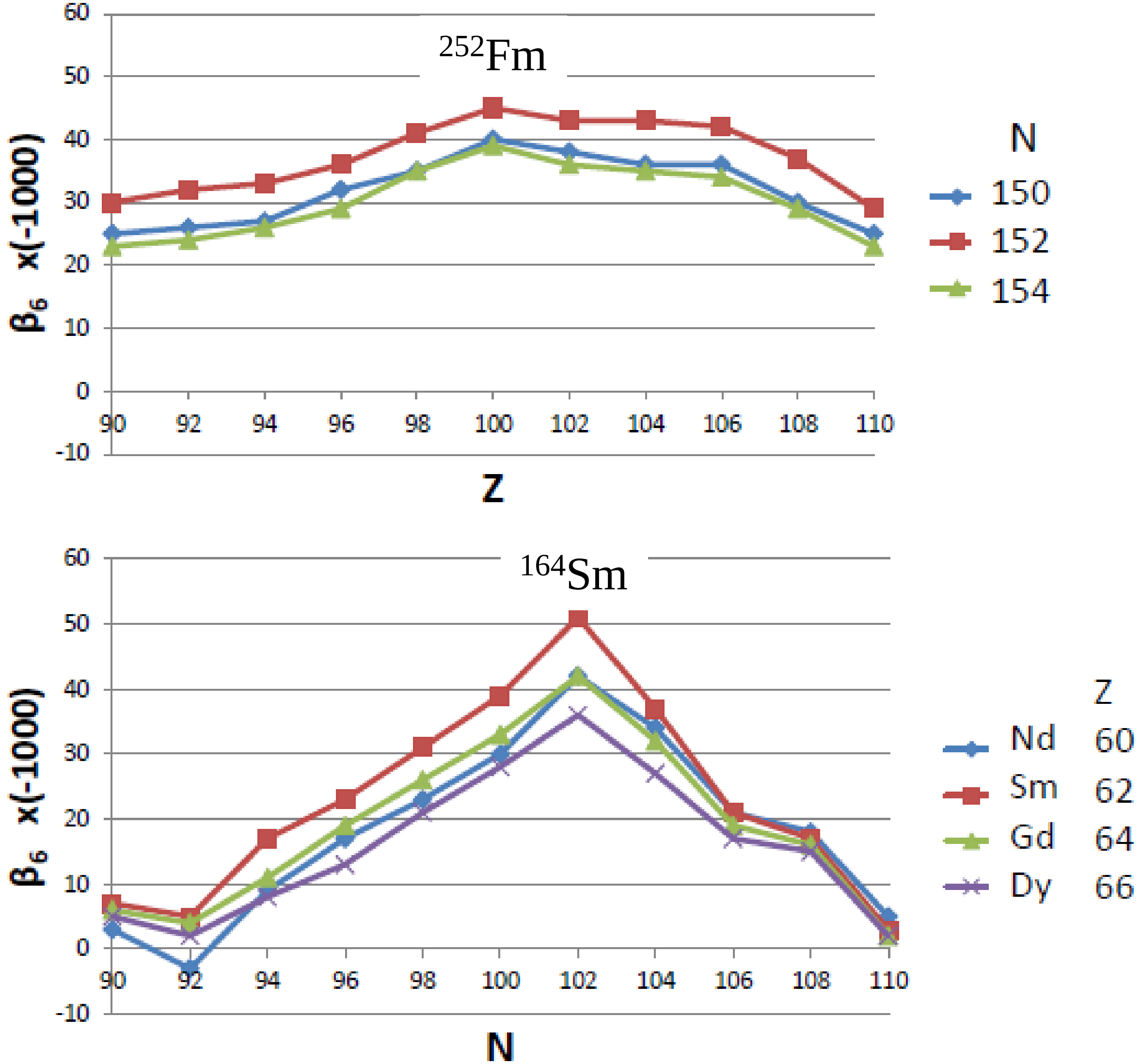
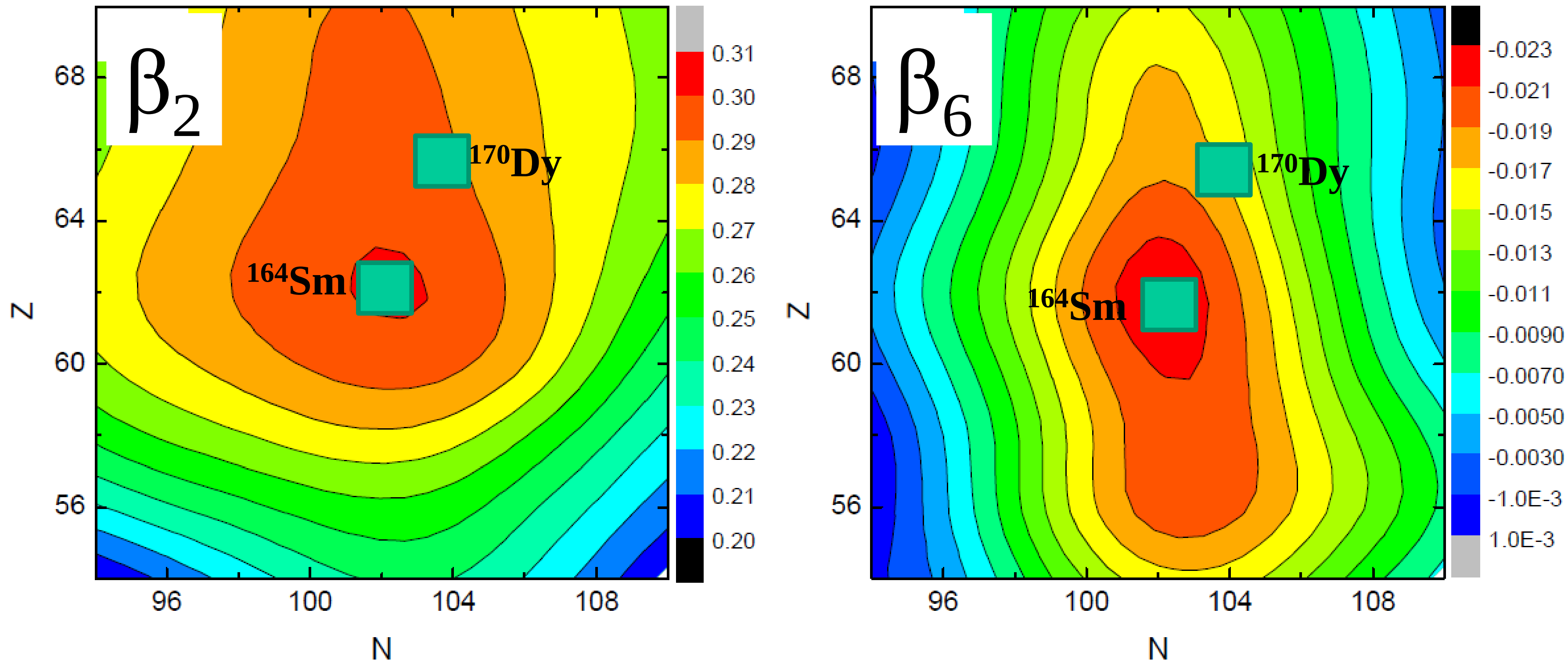
β_6 variation

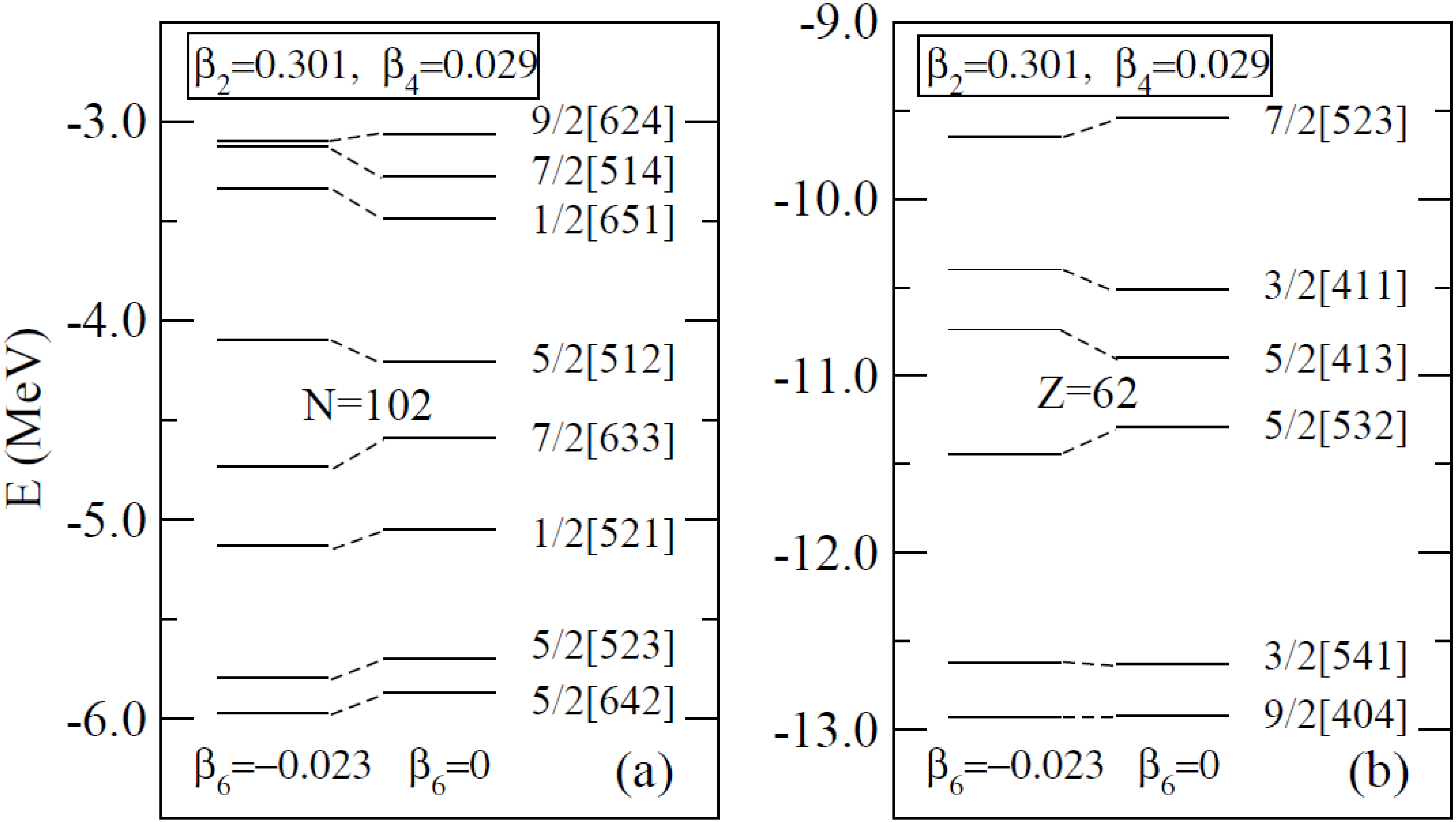


values from Möller et al., ADNDT59 (1995) 185

Deformations of A ~ 170 nuclei



calculations performed by Hongliang Liu

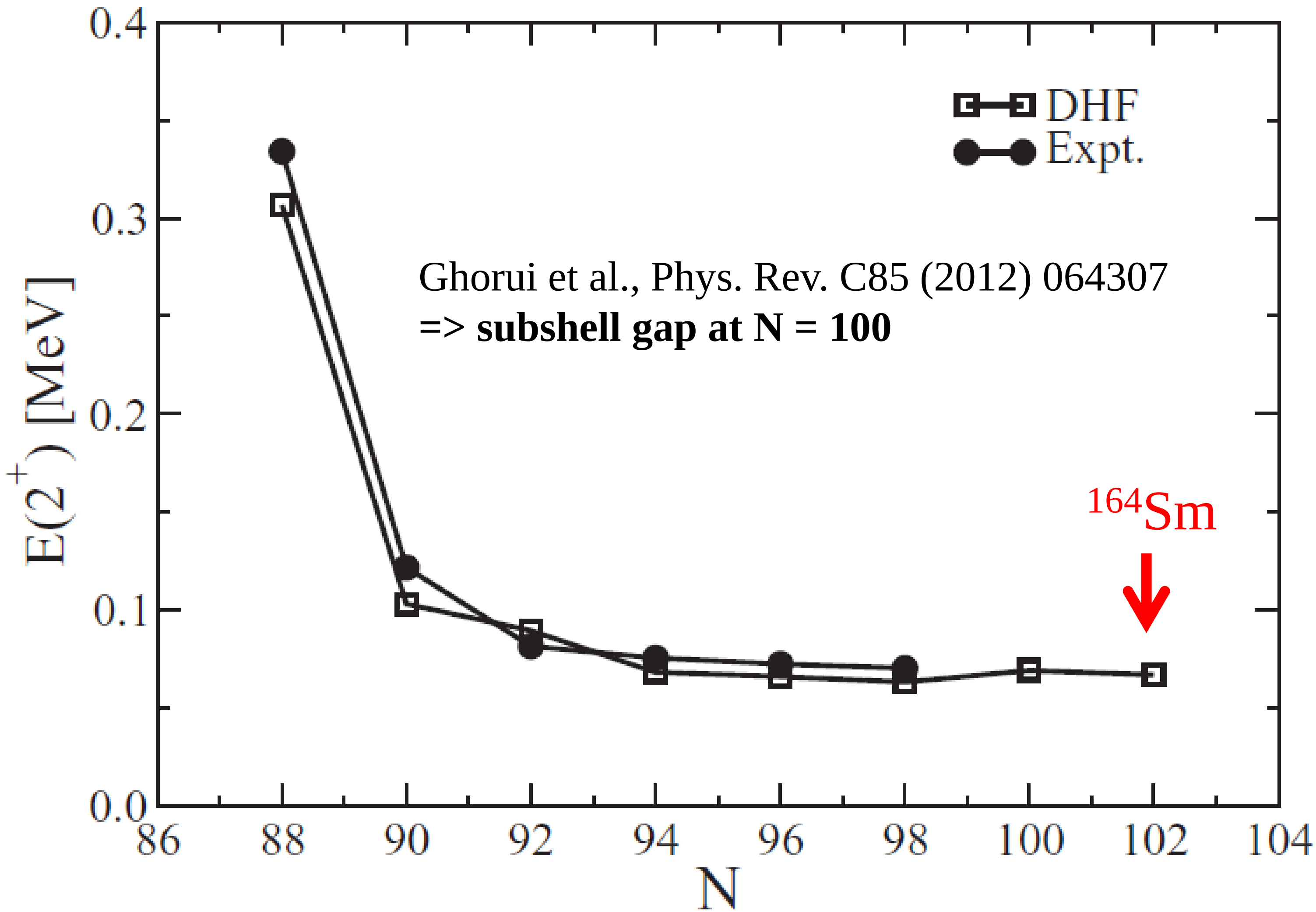


calculations performed by Hongliang Liu

Deformations of ^{166}Gd and ^{164}Sm

K^π	configuration	β_2	β_6	E (MeV)	$E(\beta_6 = 0)$ (MeV)	ΔE (keV)
^{166}Gd						
g.s.		0.30	−0.020			
6^-	$\nu\frac{5}{2}^-[512] \otimes \nu\frac{7}{2}^+[633]^*$	0.29	−0.017	1.288	1.237	−51
4^+	$\pi\frac{3}{2}^+[411] \otimes \pi\frac{5}{2}^+[413]$	0.30	−0.022	1.300	1.369	+69
3^+	$\nu\frac{1}{2}^-[521] \otimes \nu\frac{5}{2}^-[512]$	0.29	−0.018	1.400	1.516	+116
4^-	$\nu\frac{1}{2}^-[521] \otimes \nu\frac{7}{2}^+[633]$	0.28	−0.013	1.684	1.524	−160
4^-	$\pi\frac{3}{2}^+[411] \otimes \pi\frac{5}{2}^-[532]^*$	0.29	−0.015	1.769	1.652	−117
5^-	$\pi\frac{5}{2}^+[413] \otimes \pi\frac{5}{2}^-[532]$	0.29	−0.017	1.826	1.749	−77
^{164}Sm						
g.s.		0.30	−0.023			
6^-	$\nu\frac{5}{2}^-[512] \otimes \nu\frac{7}{2}^+[633]^*$	0.30	−0.020	1.301	1.241	−60
5^-	$\pi\frac{5}{2}^+[413] \otimes \pi\frac{5}{2}^-[532]$	0.29	−0.020	1.411	1.356	−55
4^-	$\pi\frac{3}{2}^+[411] \otimes \pi\frac{5}{2}^-[532]^*$	0.30	−0.021	1.907	1.872	−35
4^-	$\pi\frac{5}{2}^+[413] \otimes \pi\frac{3}{2}^-[541]$	0.29	−0.020	2.195	2.141	−54
4^+	$\pi\frac{5}{2}^-[532] \otimes \pi\frac{3}{2}^-[541]^*$	0.28	−0.016	2.502	2.356	−146

calculations performed by Hongliang Liu



Comparison of theoretical and experimental energies of 2^+ states of Sm nuclei. Experimental values are taken from NNDC.

Summary

- new data for ^{166}Gd and ^{164}Sm in doubly-mid-shell region
- prediction that β_6 maximises for ^{164}Sm
- β_6 influences single-particle and two-quasiparticle energies
- "smoking gun" for β_6 deformation remains elusive
- possible subshell gap at $N = 100$ or $N = 102$

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