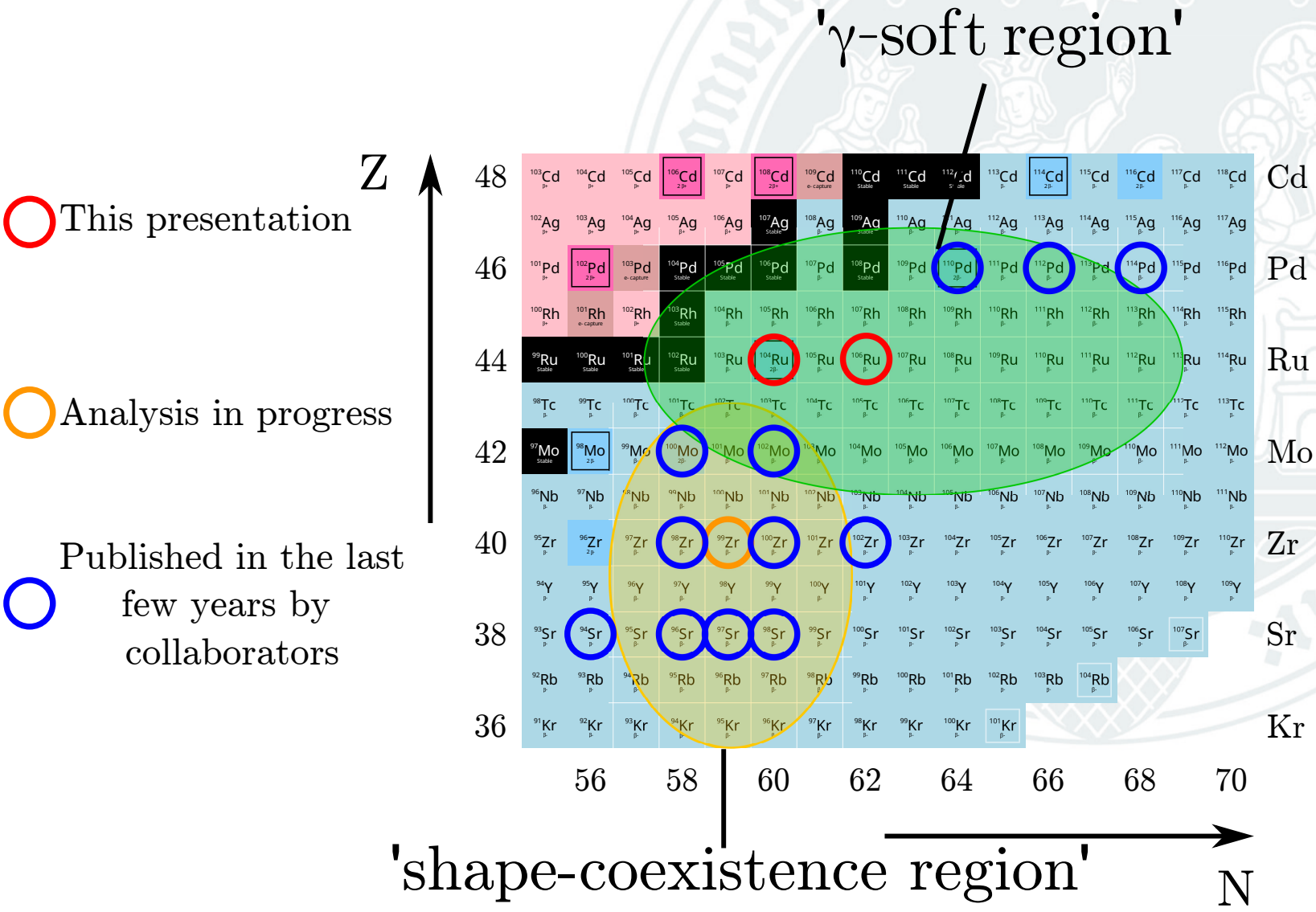
Investigation of γ-softness: Lifetime measurements in ^{104,106}Ru

Arwin Esmaylzadeh

Universität zu Köln
Institut für Kernphysik

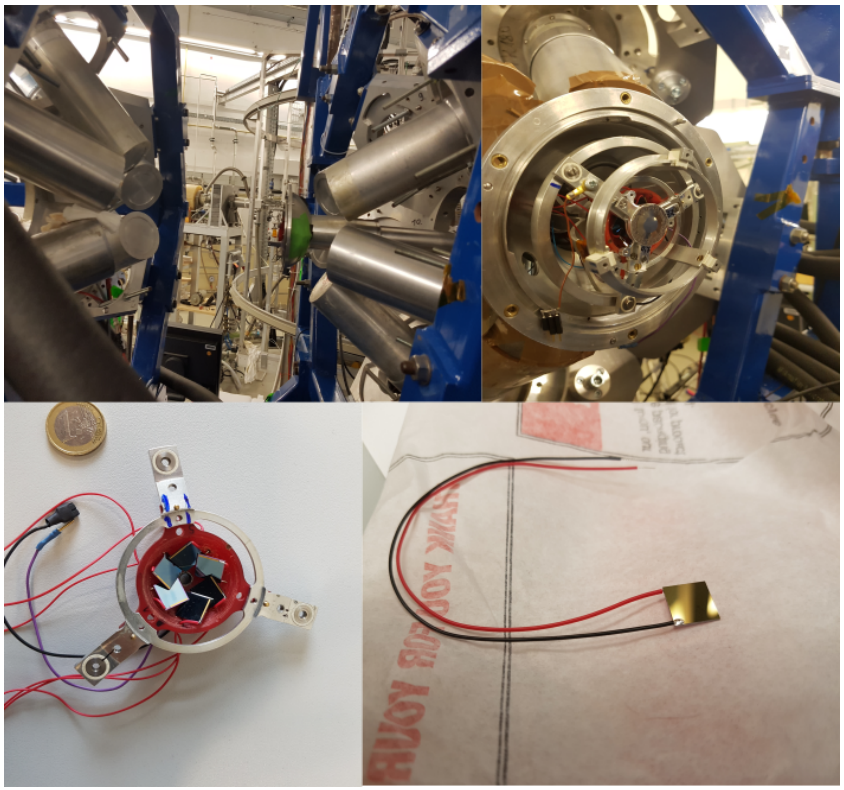
July 21, 2023

Motivation



Arwin Esmaylzadeh
Institute for Nuclear Phyiscs
Faculty of Mathematics and Natural Sciences
University of Cologne

Cologne Plunger setup

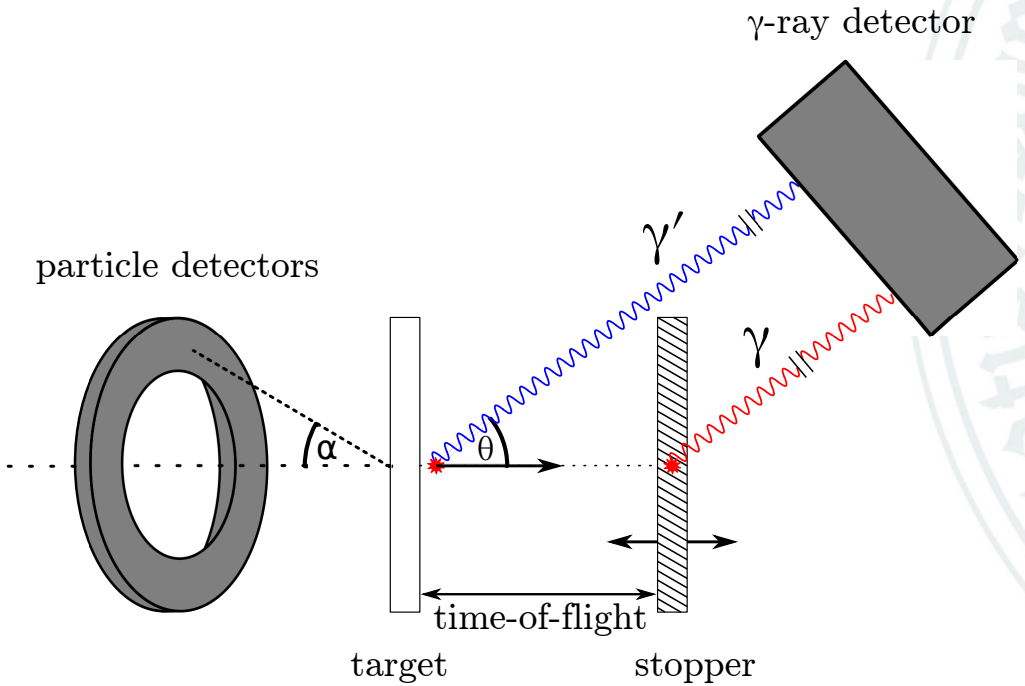


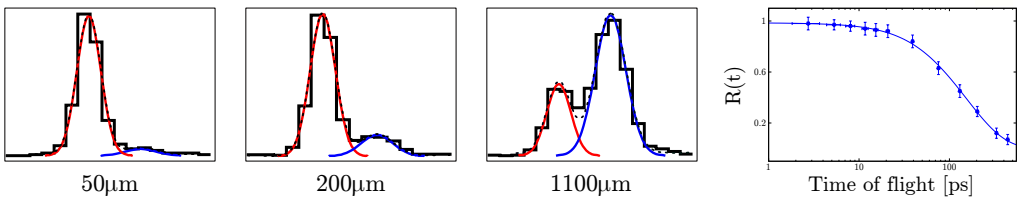
- 11 high-purity germanium (HPGe) detectors
  - 5 backward detectors (142°)
  - 6 forward detectors (45°)

- 6 solar cells backward angles

Arwin Esmaylzadeh
Institute for Nuclear Phyiscs
Faculty of Mathematics and Natural Sciences
University of Cologne

Recoil Distance Doppler Shift (RDDS) Method

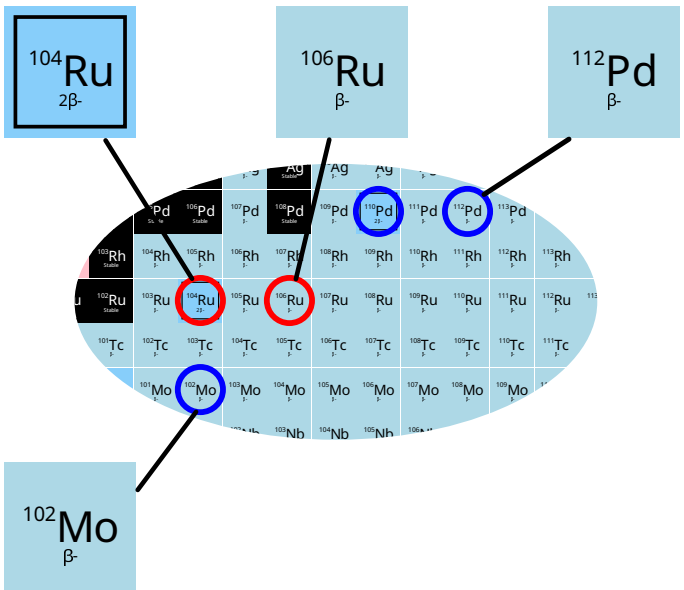




- Measurement of shifted to unshifted ratio R(t)
- Bateman equation
- Differential Decay Curve Method (DDCM)
- 7-10 target-to-stopper distances

Arwin Esmaylzadeh
Institute for Nuclear Phyiscs
Faculty of Mathematics and Natural Sciences
University of Cologne

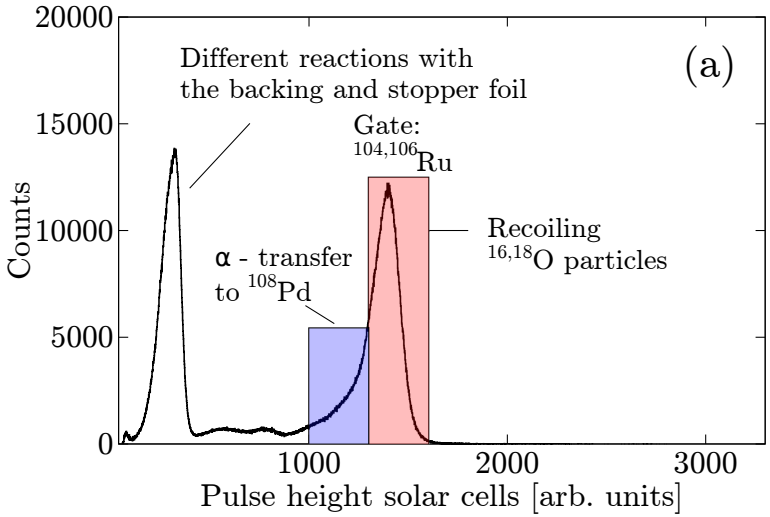
‘γ-soft region’

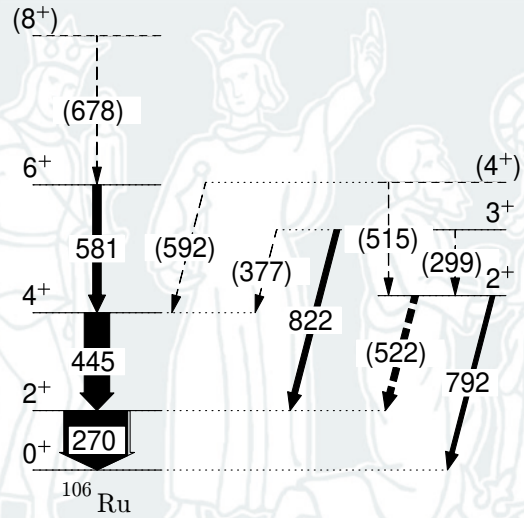


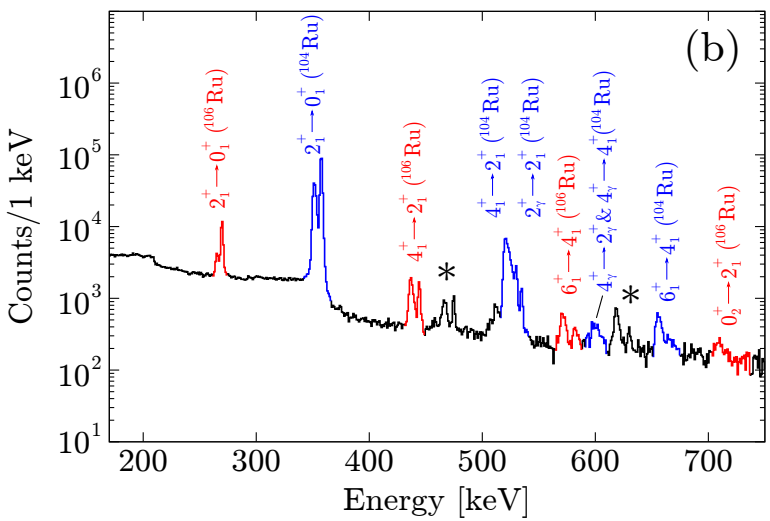
- Cologne 10MV FN Tandem:
- $^{104}Ru(^{18}O,^{18}O^{*})^{104}Ru^{*}$ @ 57 MeV
- $^{104}Ru(^{18}O,^{16}O)^{106}Ru$ @ 57 MeV
- Experimental properties:
  - 0.15mg/cm^2 ^{104}Ru target
  - 0.78mg/cm^2 nat. V fronting
  - 3.1mg/cm^2 nat. V stopper
  - $v/c = 2.10(6)$ % (^{104}Ru)
  - $v/c = 2.01(10)$ % (^{106}Ru)

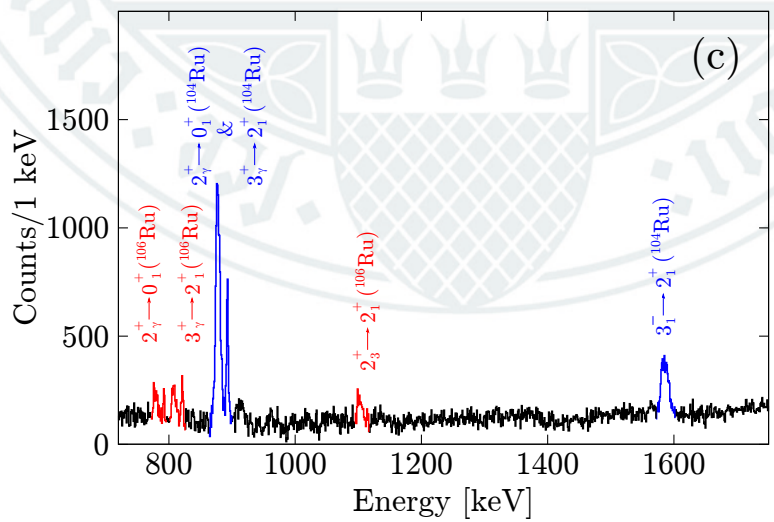
Arwin Esmaylzadeh
Institute for Nuclear Phyiscs
Faculty of Mathematics and Natural Sciences
University of Cologne

^{104}Ru(^{18}O,^{16}O)^{106}Ru



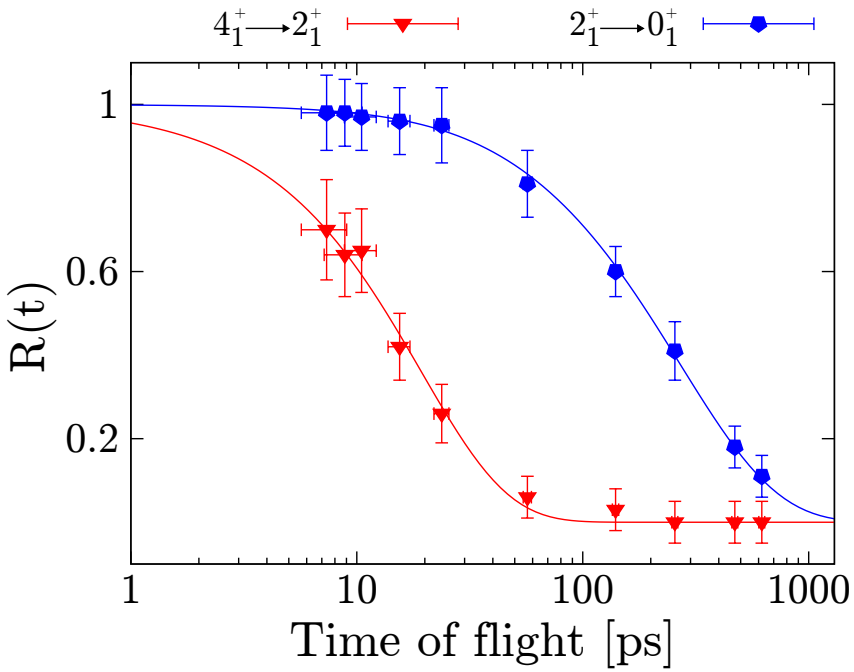






Arwin Esmaylzadeh
Institute for Nuclear Phyiscs
Faculty of Mathematics and Natural Sciences
University of Cologne

Lifetime Results ^{104}Ru

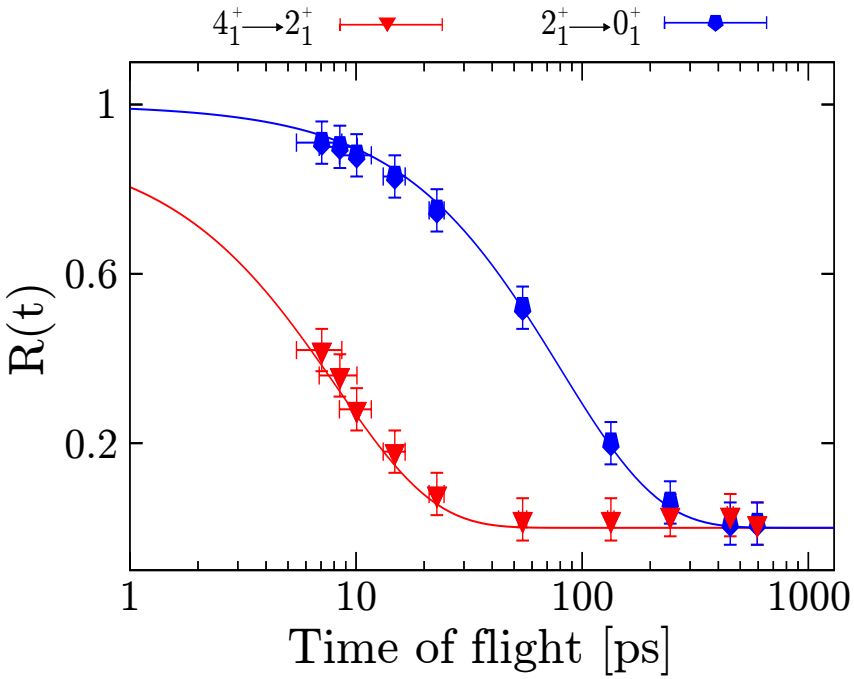


State	τ[ps]	τ_{Lit}[ps]
2_1^+	80.2(66)	81.5(14)[a]
4_1^+	8.4(13)	8.1(9)[a]
6_1^+	<5	1.92^{17}_{-6}
2_γ^+	8.9(18)	7.2(7)[a]
3_γ^+	7.3^{+23}_{-57}	-
4_γ^+	<5	3.9(4)[a]
3_1^-	<5	-

[a] J. Blachot, Nucl. Data Sheets 108, 2035 (2007)

Arwin Esmaylzadeh
Institute for Nuclear Phyiscs
Faculty of Mathematics and Natural Sciences
University of Cologne

Lifetime Results ^{106}Ru



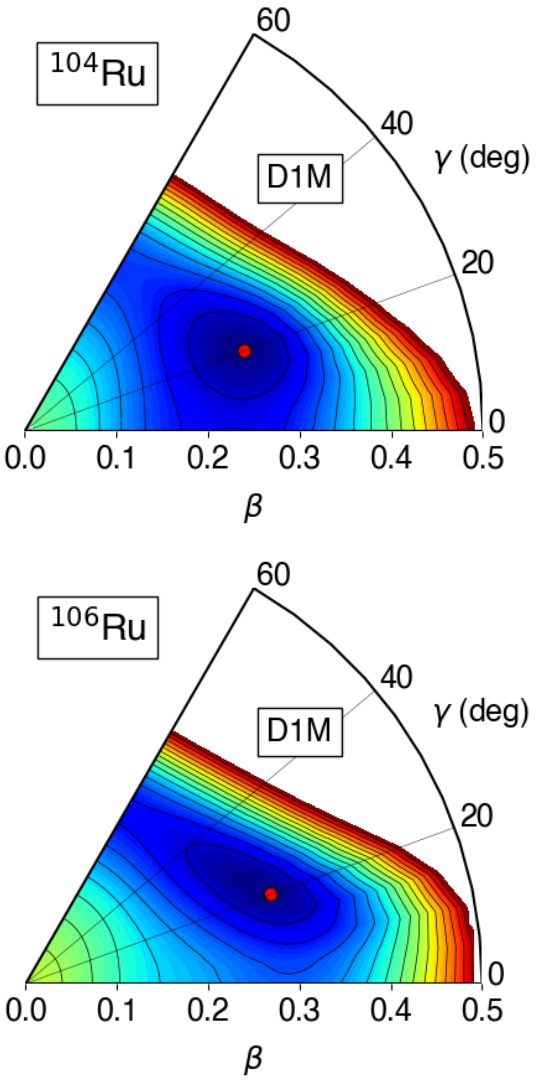
State	τ[ps]	τ_{Lit}[ps]
2_1^+	274(23)	264(4)[a], 375(101)[b]
4_1^+	13.5(15)	<20[a]
6_1^+	10.0^{+55}_{-25}	-
2_γ^+	13.9^{+52}_{-48}	10.8(43)[a]
3_γ^+	17.3^{+52}_{-99}	<38[a]
0_2^+	<5	<8.7[a]
2_3^+	<5	<19[a]

[a] M. Sanchez-Vega et al., Eur. Phys. J. A 35, 159 (2008)

[b] S. Schoedder et al., Z. Phys. A Hadrons Nucl. 352. 237 (1995)

Arwin Esmaylzadeh
Institute for Nuclear Phyiscs
Faculty of Mathematics and Natural Sciences
University of Cologne

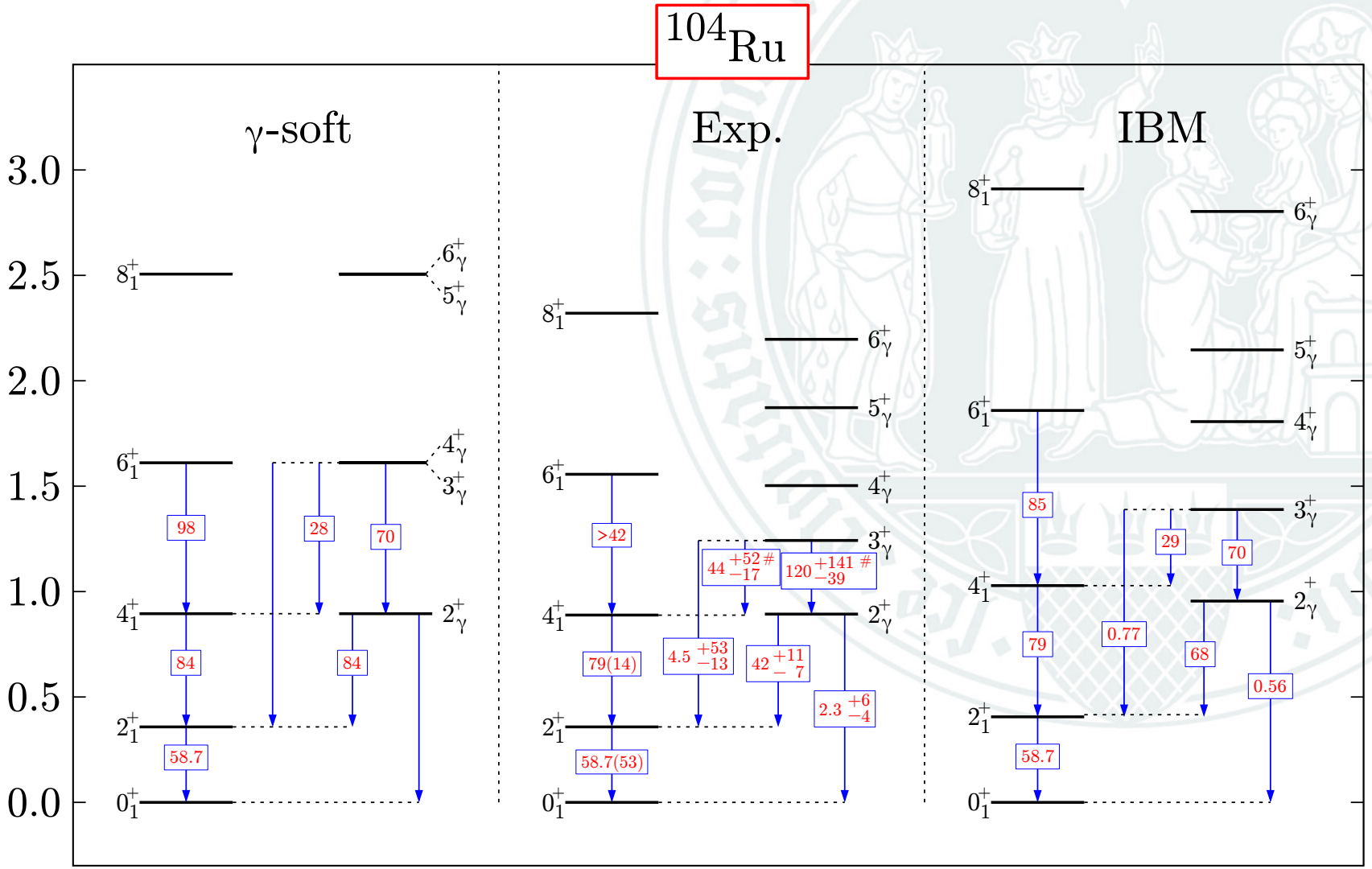
Calculations for ^{104,106}Ru



- Determination of IBM-2 parameters by mapping the deformation-energy surface
- Constrained Gogny D1M SCMF calculations
- Shell closures at $Z = N = 50$ ($N_\pi = 3$ and $N_\nu = 5, 6$)
- Description of even-even nuclei in A≈100 region
- More details in Phys. Rev. C 94, 044314 (2016)

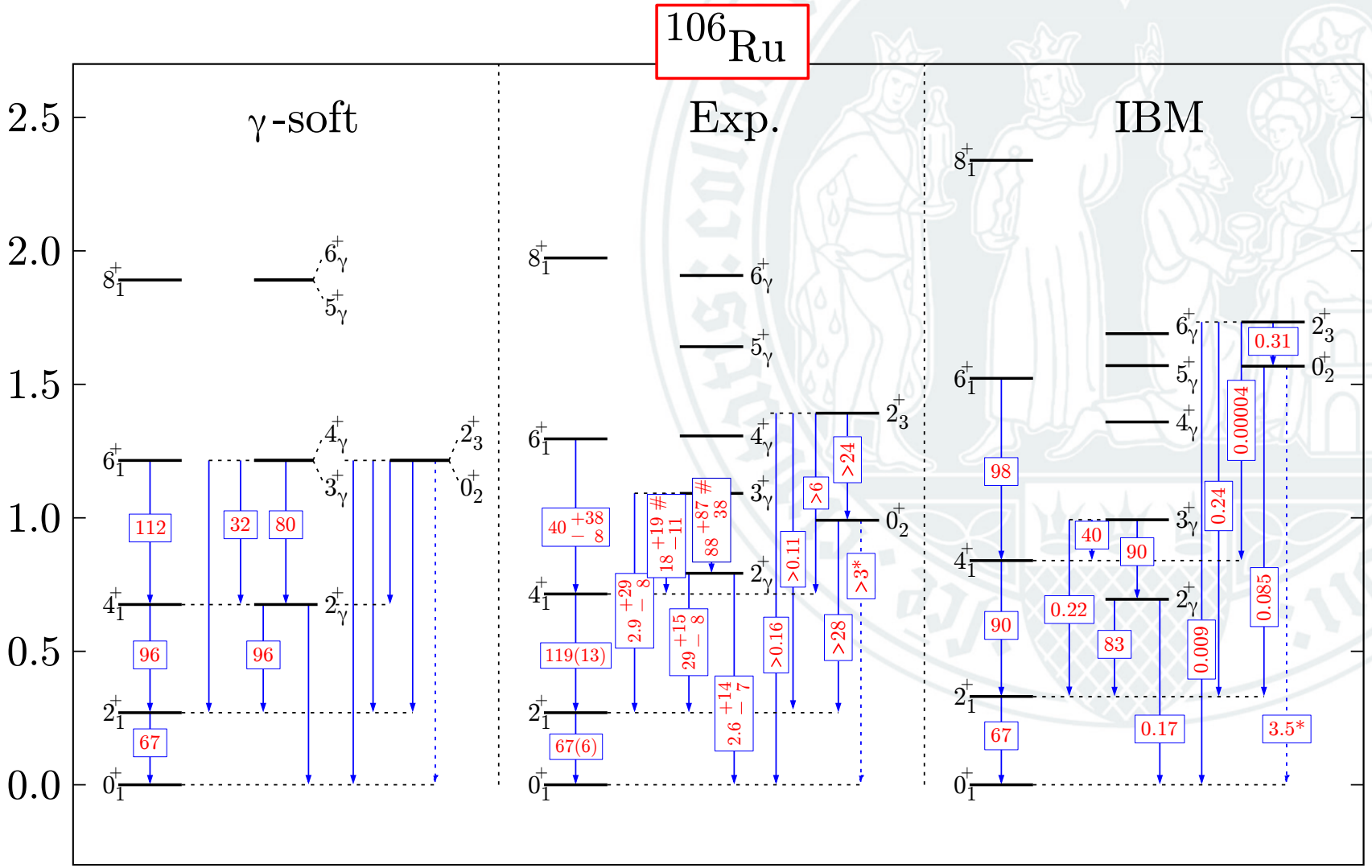
Arwin Esmaylzadeh
Institute for Nuclear Phyiscs
Faculty of Mathematics and Natural Sciences
University of Cologne

Energy levels and transition probabilities for ^{104}Ru



Arwin Esmaylzadeh
Institute for Nuclear Phyiscs
Faculty of Mathematics and Natural Sciences
University of Cologne

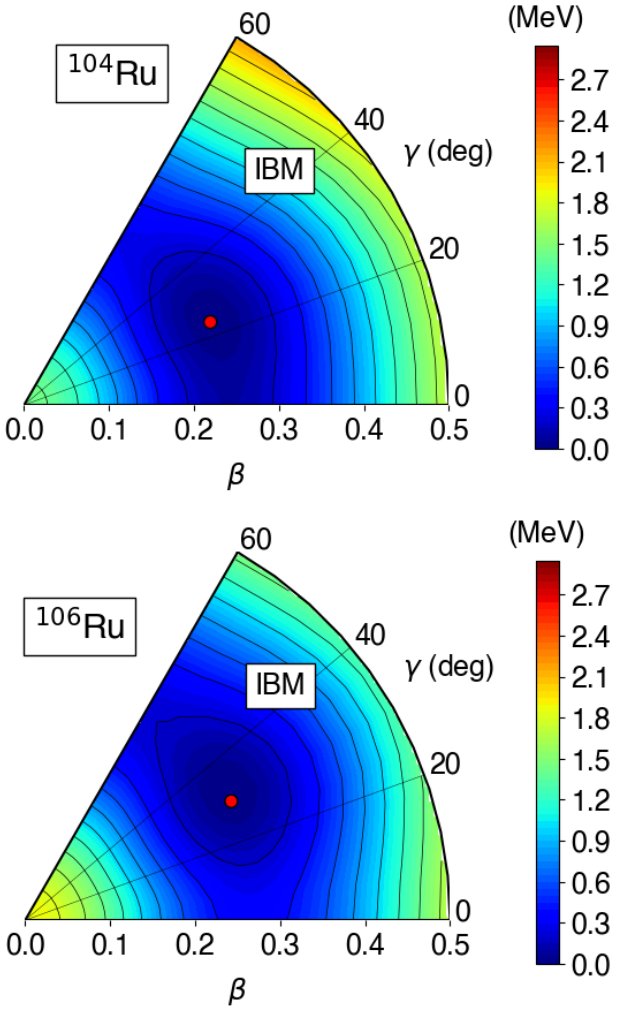
Energy levels and transition probabilities for ^{106}Ru



Arwin Esmaylzadeh
Institute for Nuclear Phyiscs
Faculty of Mathematics and Natural Sciences
University of Cologne

Conclusion ^{104,106}Ru

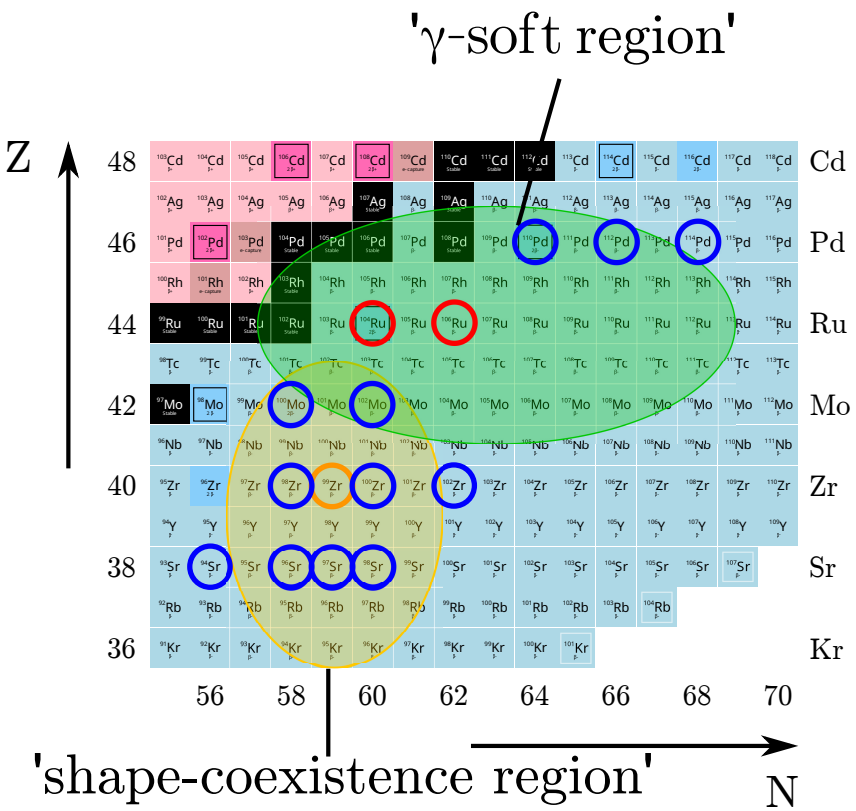
γ softness



- PES with broad minimum centered around $\gamma = 30°$
- Clustering of states in the γ-band resemble more a γ-soft nucleus
- Staggering parameter indicator for γ-soft or rigid nucleus
- Staggering parameter suggests γ-soft, holds also for ^{102,108}Ru

Arwin Esmaylzadeh
Institute for Nuclear Phyiscs
Faculty of Mathematics and Natural Sciences
University of Cologne

Conclusion & Outlook



- Measurement of lifetimes in ^{104,106}Ru
- Manifestation of γ-softness in ^{104,106}Ru
- Part of our systematic investigation in this region

Arwin Esmaylzadeh
Institute for Nuclear Phyiscs
Faculty of Mathematics and Natural Sciences
University of Cologne

Thank you for your attention!

Bundesministerium
für Bildung
und Forschung

Arwin Esmaylzadeh
Institute for Nuclear Phyiscs
Faculty of Mathematics and Natural Sciences
University of Cologne

Arwin Esmaylzadeh
Institute for Nuclear Phyiscs
Faculty of Mathematics and Natural Sciences
University of Cologne