Structure of $^{73,75}Zn$ nuclei

Introduction

Structure evolution in the Zn neighborhood

Island of inversion in the Fe and Cr isotopes - intruder states as g.s.

Spherical semi magic Ni isotope g.s. <u>however</u>

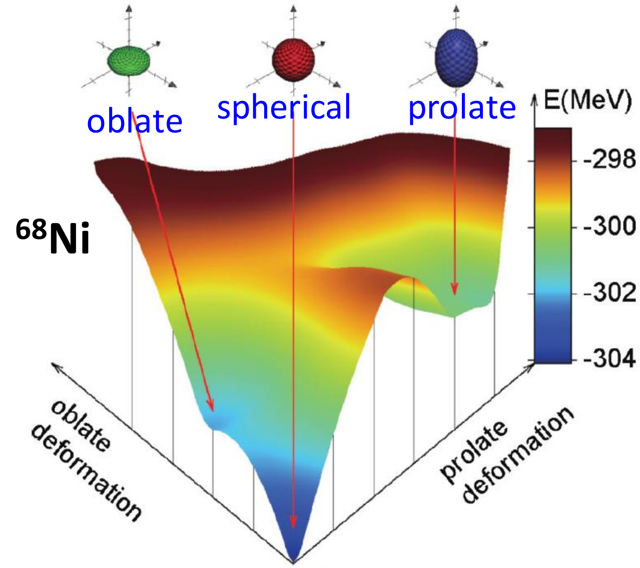
- shape coexistence was exhibited in ^{68}Ni
  three 0^+ states below 3 MeV
  R. Broda et al., Phys. Rev. C 86, 064312 (2012)
  F. Recchia et al., Phys. Rev. C 88, 041312(R) (2013)
  S. Suchyta et al., Phys. Rev. C 89, 021301(R) (2014)

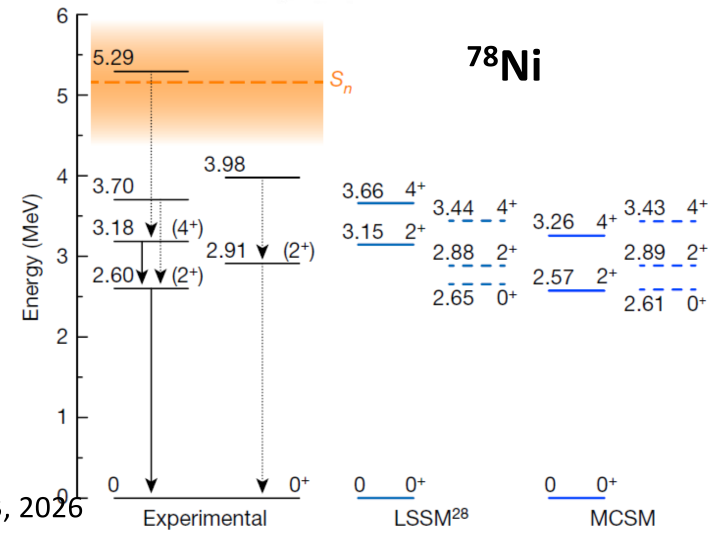
- confirmed in ^{68,70,74}Ni by Monte-Carlo Shell-Model MCSM calculations
  Y. Tsunoda et al., Phys. Rev. C 89, 031301(R) (2014)

- recently evidenced at low excitation energy in ^{78}Ni
  R. Taniuchi et al., Nature (London) 569, 53 (2019)

Ge isotopes are known to present shape evolution

M. Lebois et al., Phys. Rev. C 80, 044308 (2009)
A.D. Ayangeakaa et al., Phys. Rev. C 107, 044314 (2023)

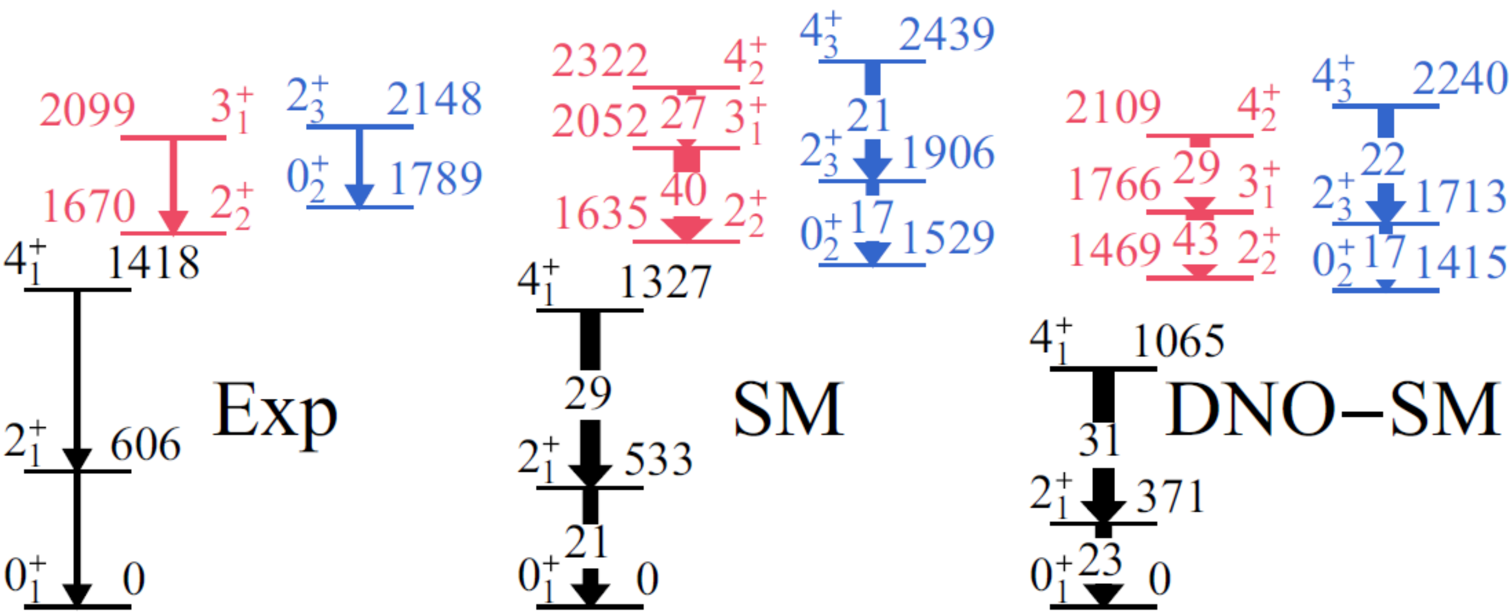




Structure evolution in the Zn neighborhood

Very recently, ^{74}Zn was investigated and two new excited bands K=0 and K=2 were observed (*M. Rocchini et al., Phys. Rev. Lett. 130, 122502 (2023)*)

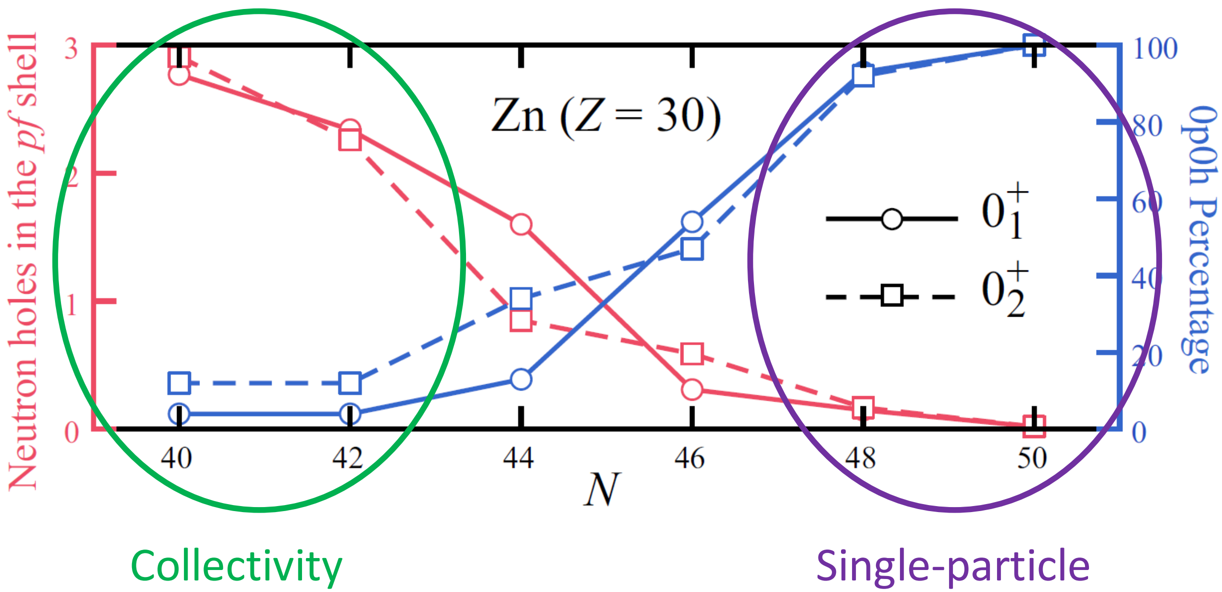
Large-scale shell-model (SM) calculations were performed with an excellent agreement with experimental data



Structure evolution in the Zn neighborhood

These calculations predict in Zn isotopes **a drastic reduction of the pf-to-dg ν excitations from N=40 to N=50**

M. Rocchini et al., Phys. Rev. Lett. 130, 122502 (2023)



Fission26, Chamrousse, March 09-13, 2026

Structure evolution in the Zn neighborhood

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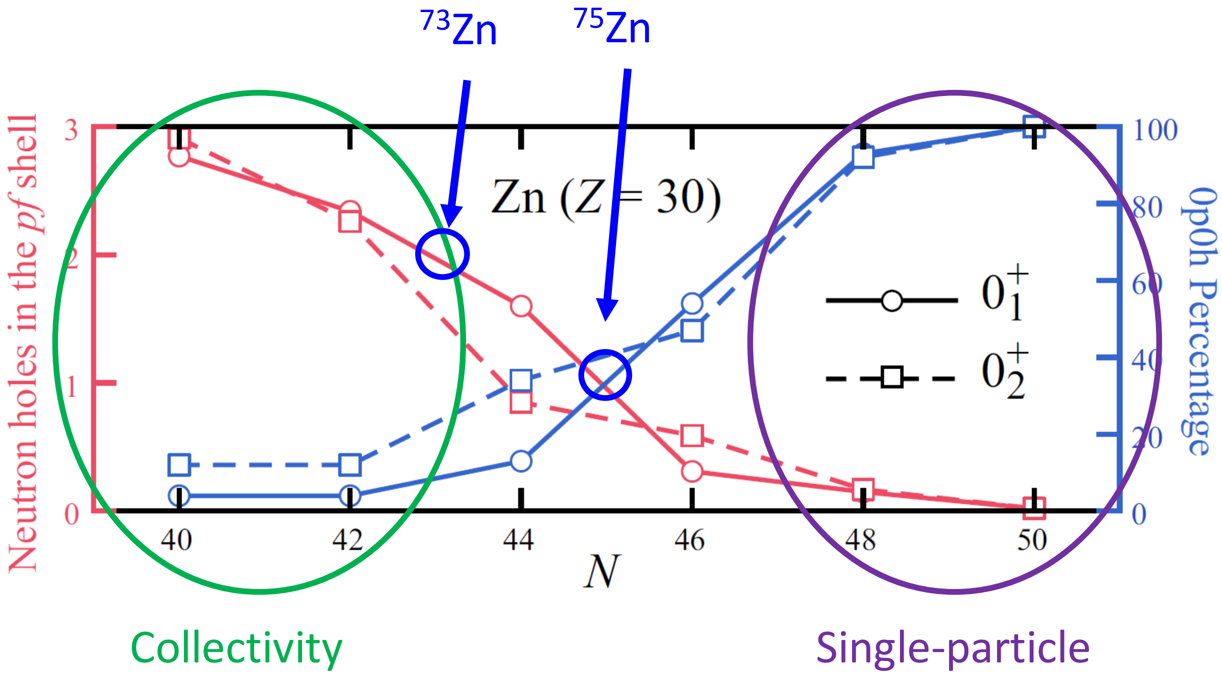


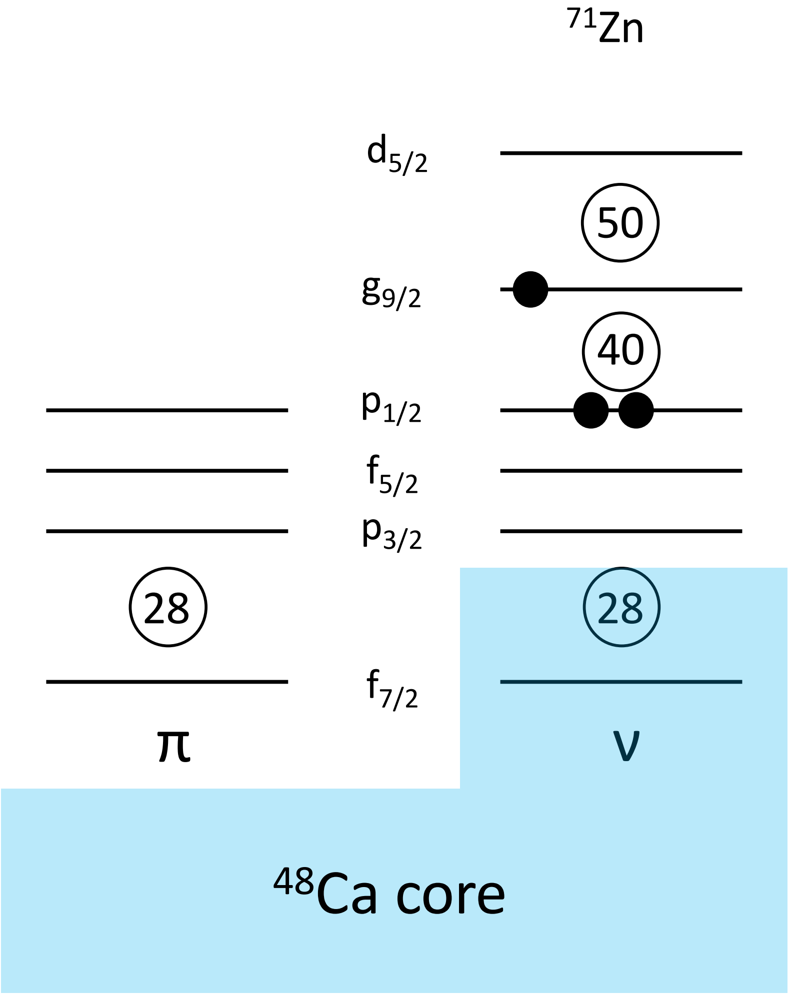
Fission26, Chamrousse, March 09-13, 2026

Single-particule structure at low energy in the Zn isotopes

Shell-model calculations LNPS-U interaction
(F. Nowacki)

^{48}Ca core
Valence space:
π full pf
$\nu\ p_{3/2}f_{5/2}p_{1/2}d_{5/2}g_{9/2}$

Up to 11p – 11h excitations



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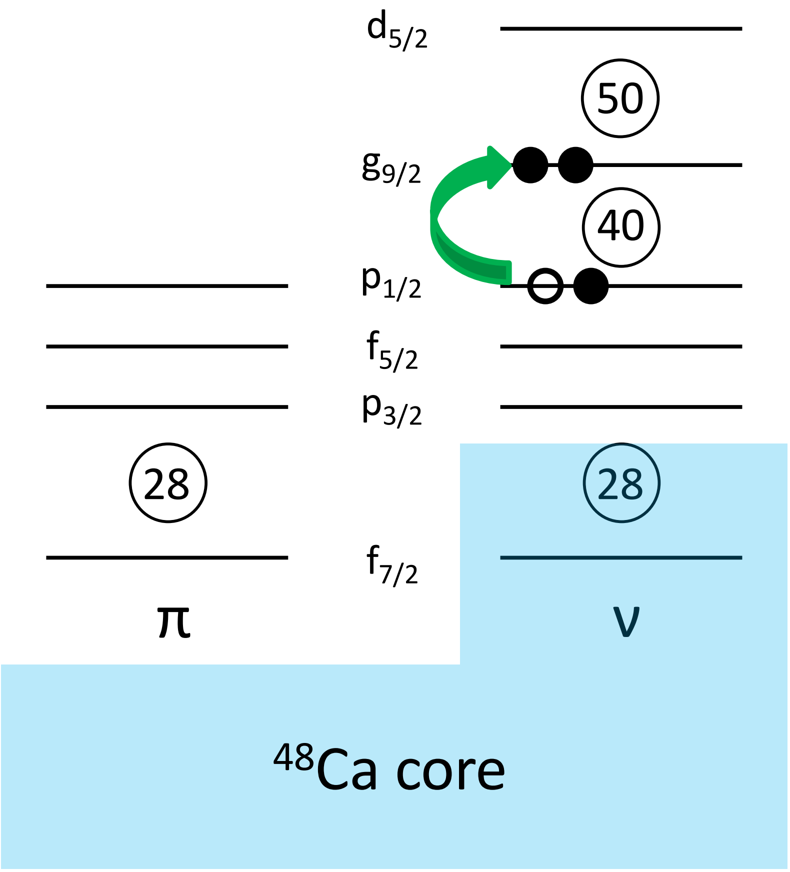


Experimental setup and data analysis method

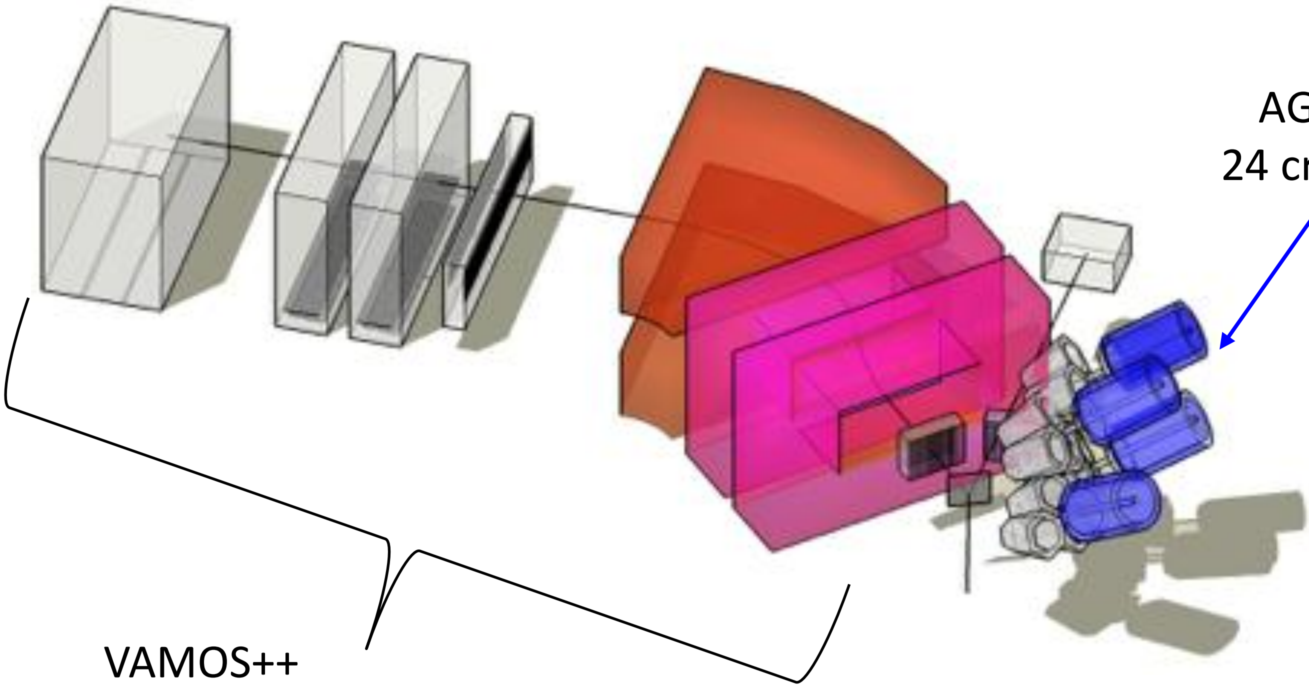
Experimental setup

Fusion-fission reaction in inverse kinematics – ^{238}U(6.2 MeV/n) + ^{9}Be – at GANIL (**e680**)

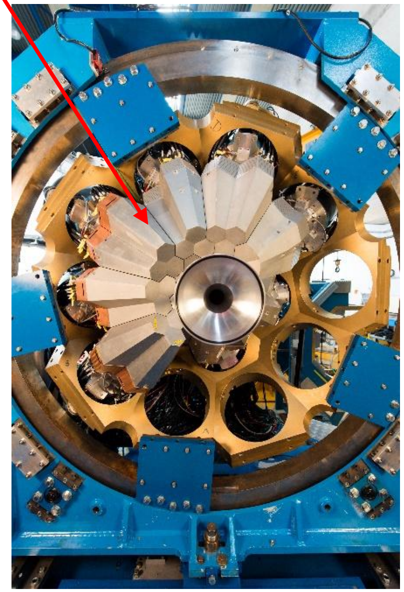
AGATA (8 ATC) was coupled to the recoil spectrometer VAMOS++

Threshold around 60 keV and limited to decays from states with $T_{1/2}$ < few ns

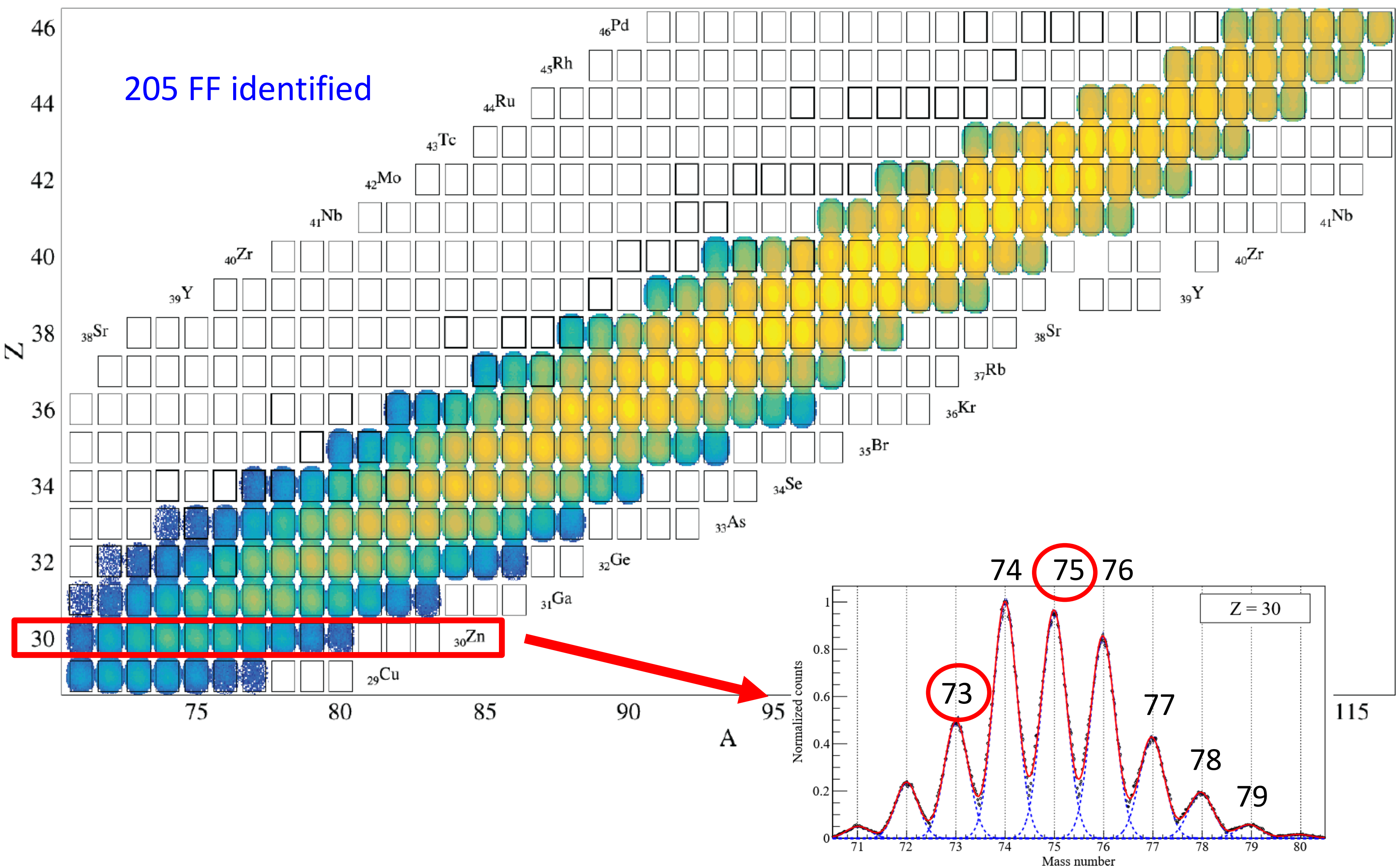
AGATA
24 crystals



VAMOS++
θ_{Vamos}= 28°, Bρ = 1.05

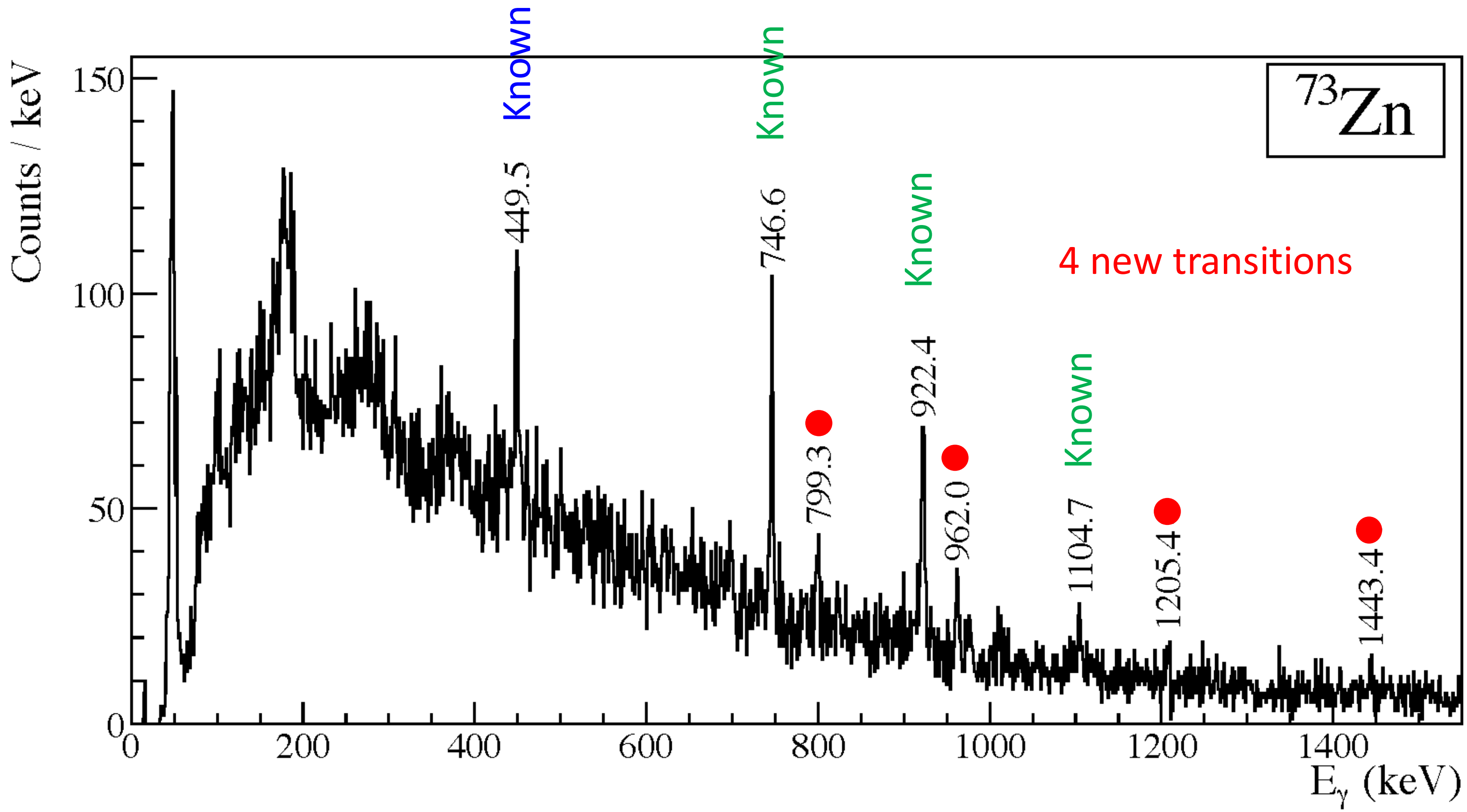


Fission-fragments selection



Study of ^{73}Zn isotope experimental data

^{73}Zn structure

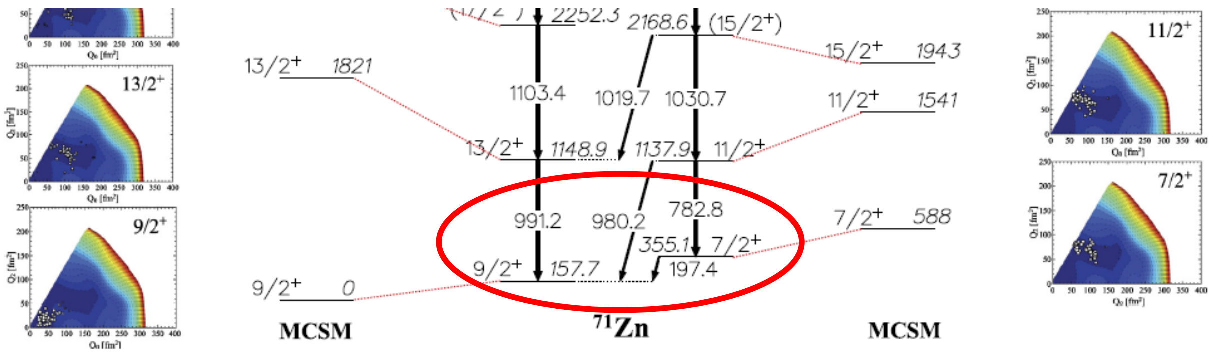


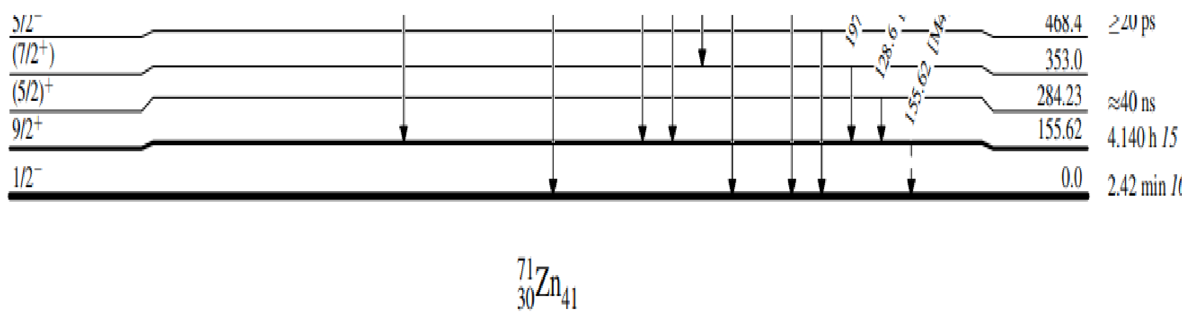
No ϒϒ coincidences between them

Structure of ^{71}Zn

Observation of two parallel cascades based on an isomeric $9/2^{+}$ state and a $7/2^{+}$ state

MCSM calculations indicate that the dominant component of the wave function is concentrated in the oblate-deformed region for all the states except for the $9/2^{+}$ which is spherical

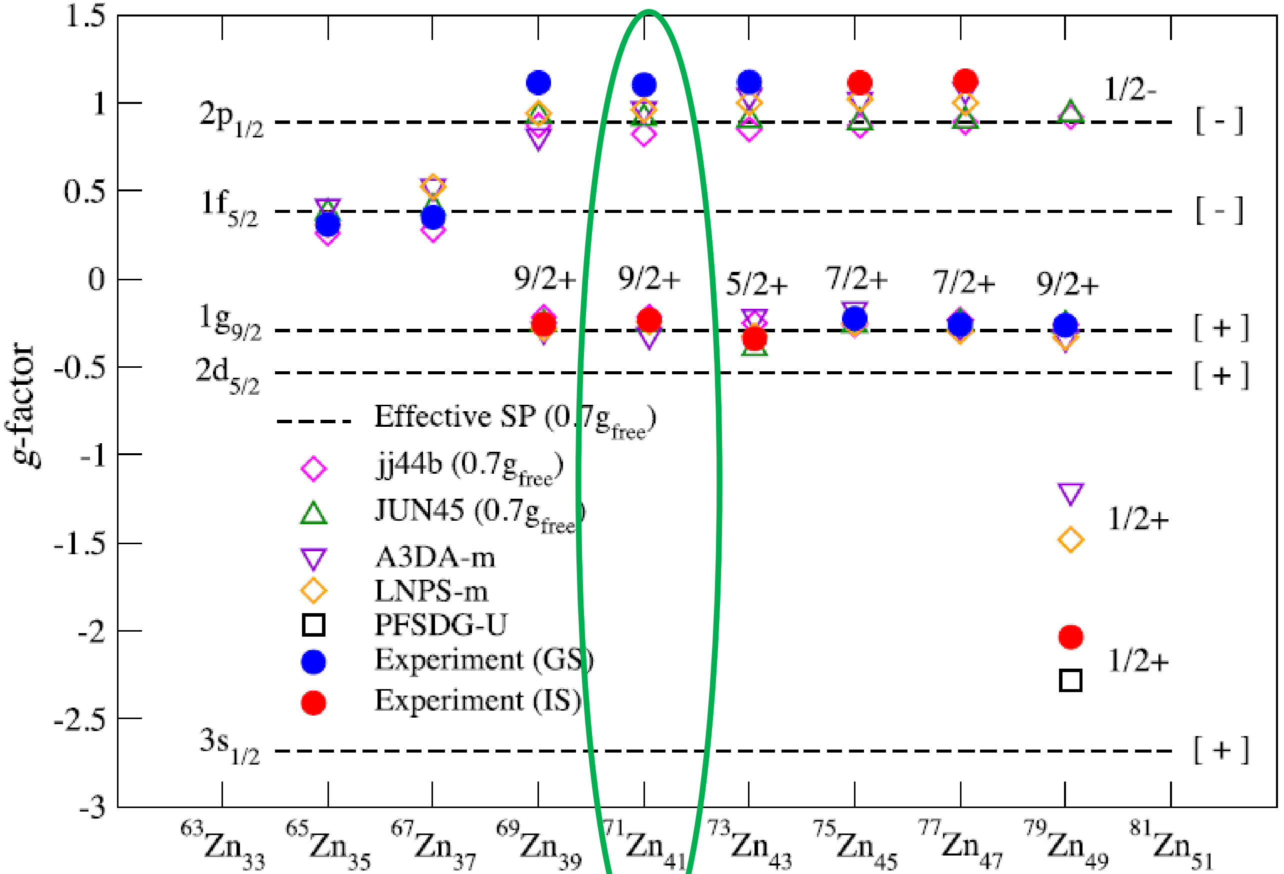




S. Bottoni et al., Phys Lett. B 775 (2017) 271

^{73}Zn structure

From laser spectroscopy studies, in ^{71}Zn:
- g.s. $1/2^-$
- Isomeric state $9/2^+$



C. Wraith et al., Phys. Lett. B 771, 385 (2017)
X.F. Yang et al., Phys. Rev. C 97, 044324 (2018)

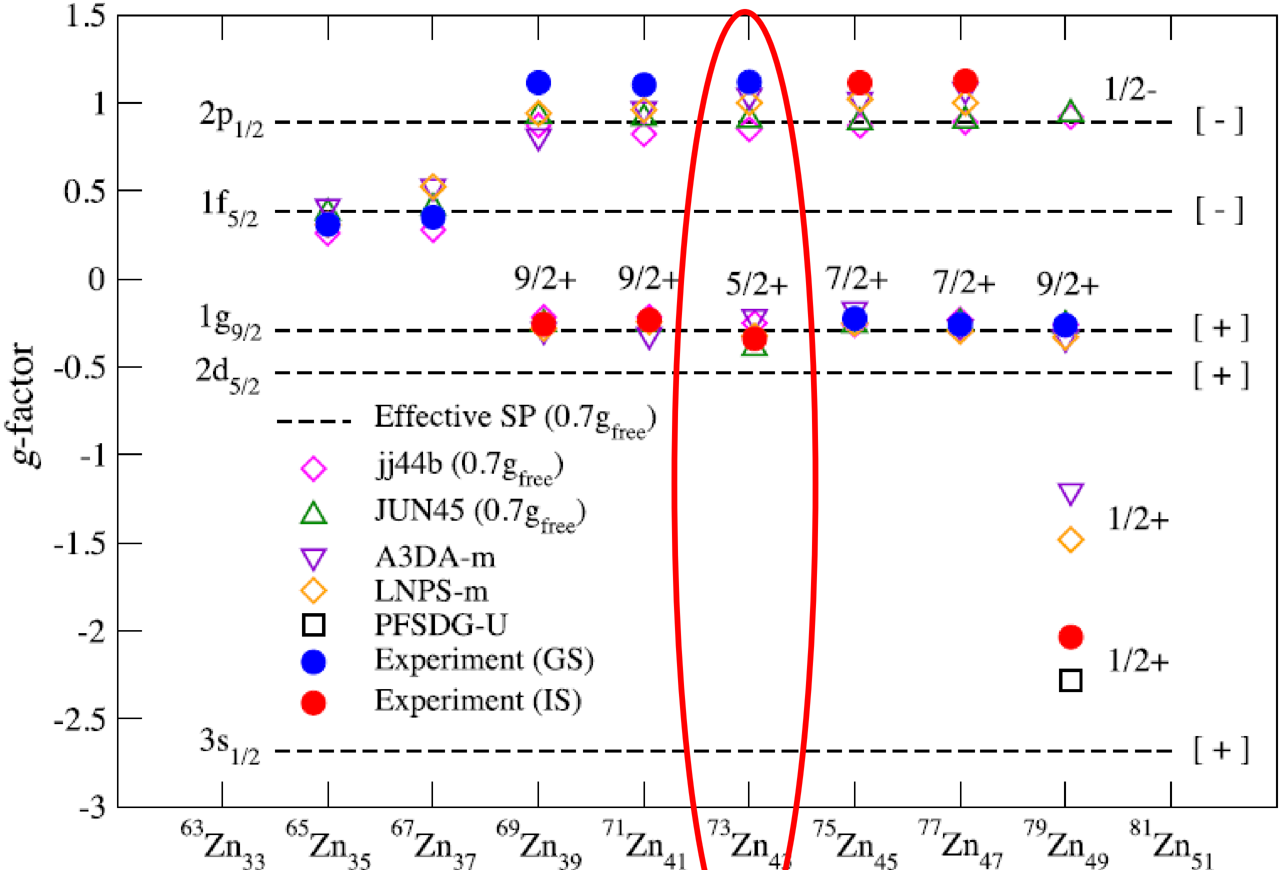
^{73}Zn structure

From laser spectroscopy studies:
- g.s. $1/2^-$
- Isomeric state $5/2^+$

No evidence of $9/2^+$ isomeric state in ^{73}Zn
$T_{1/2} < 1$ ms

In e680 experiment, isomeric states with $T_{1/2} >$ few ns cannot be observed

We suggest the existence of the existence of a $9/2^+$ isomeric state in ^{73}Zn with
few ns < $T_{1/2} < 1$ ms



C. Wraith et al., Phys. Lett. B 771, 385 (2017)
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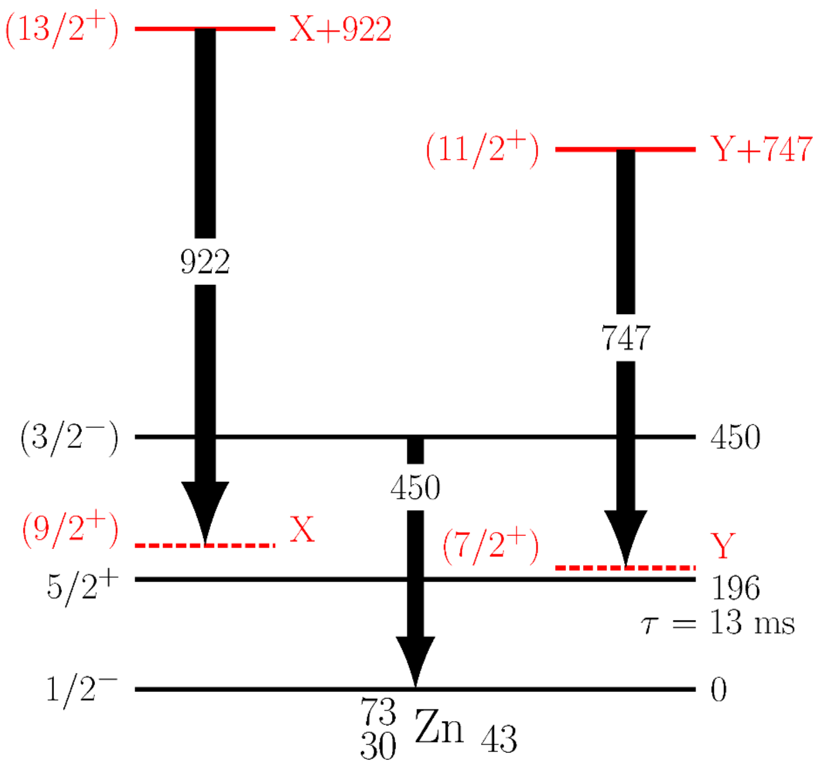
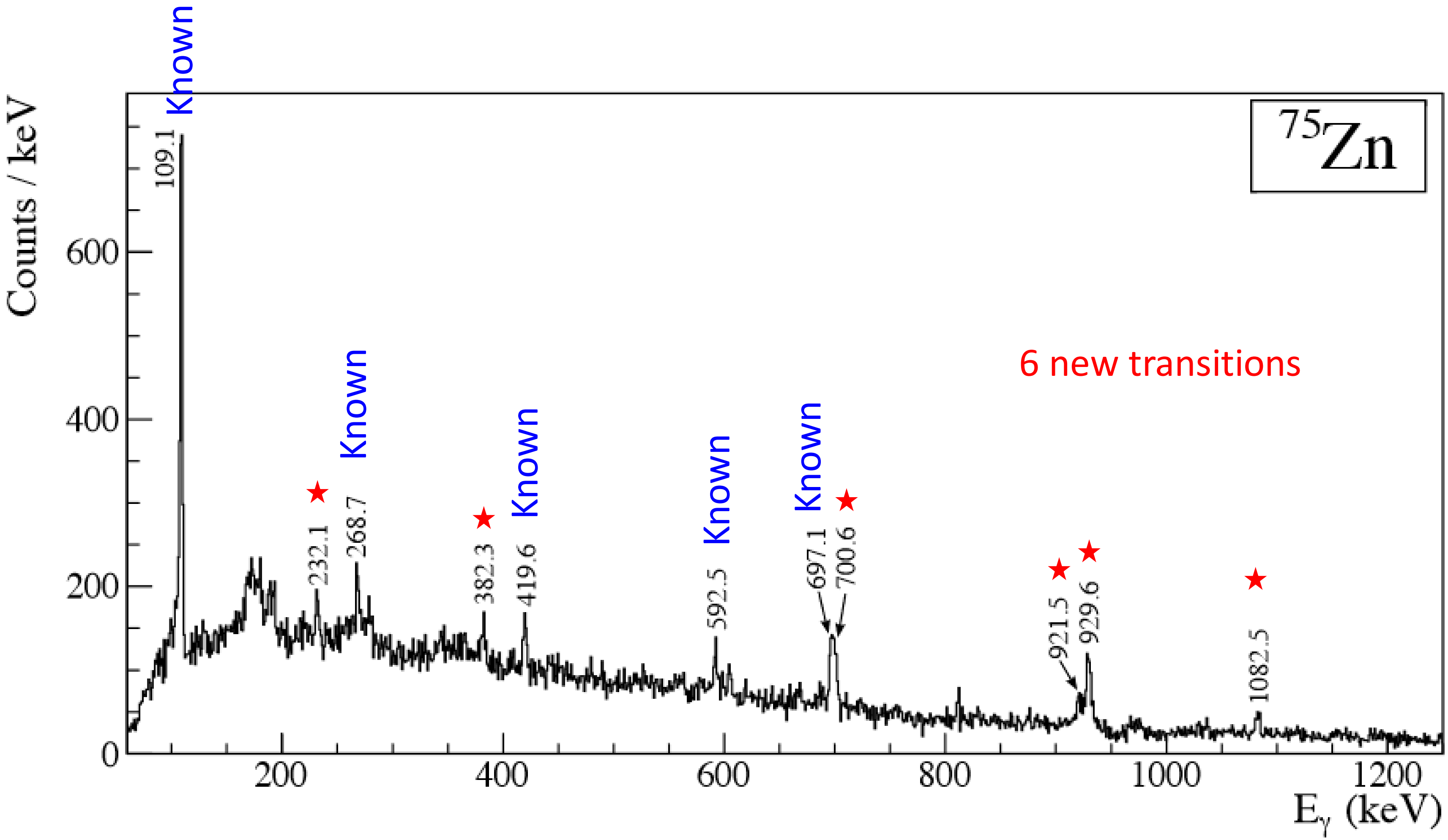
^{73}Zn structure – level scheme

The proposed level scheme for ^{73}Zn with isomeric $9/2^+$ and $7/2^+$ states (2 ns $< T_{1/2} <$ 1 ms)

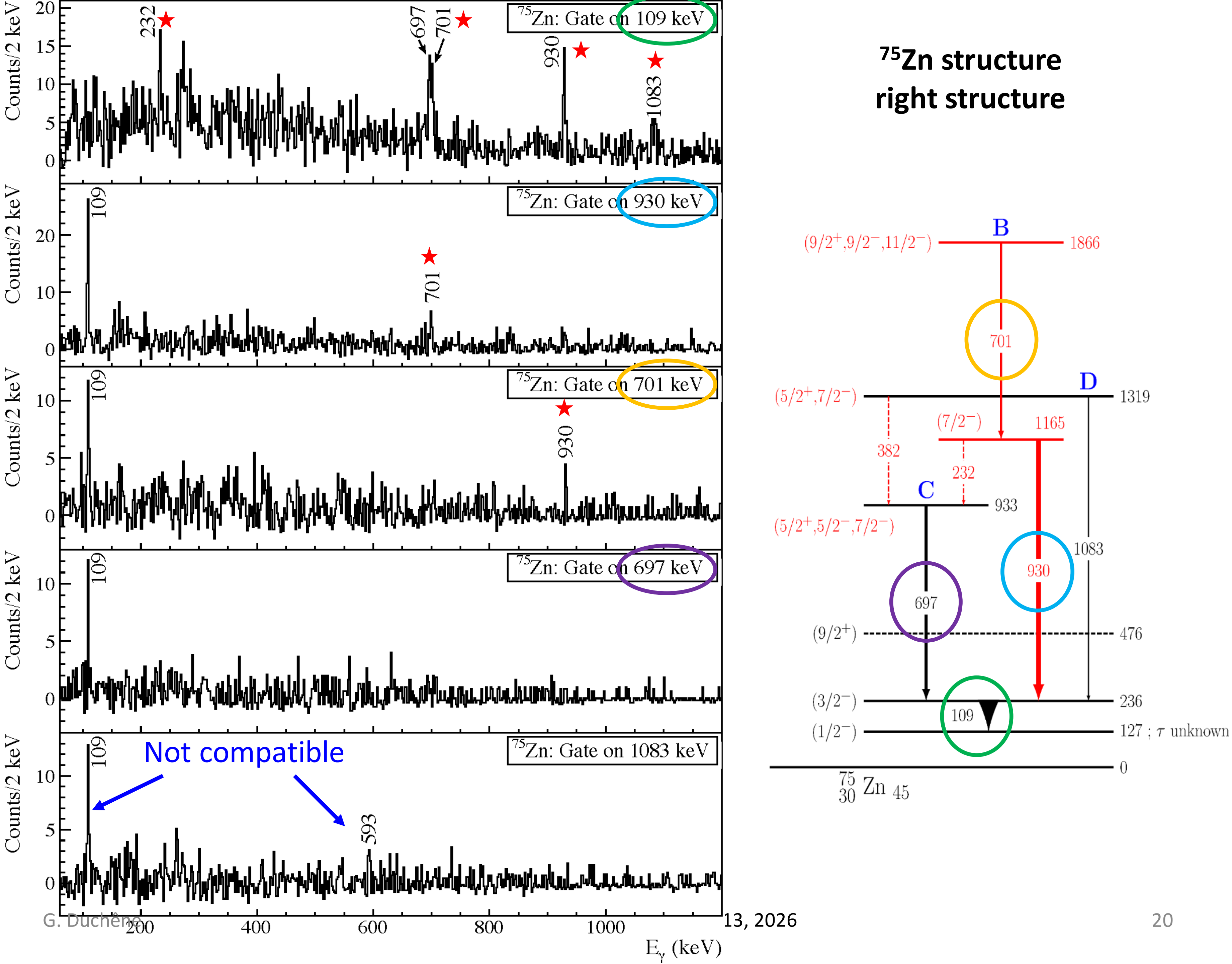


Study of ^{75}Zn isotope experimental data

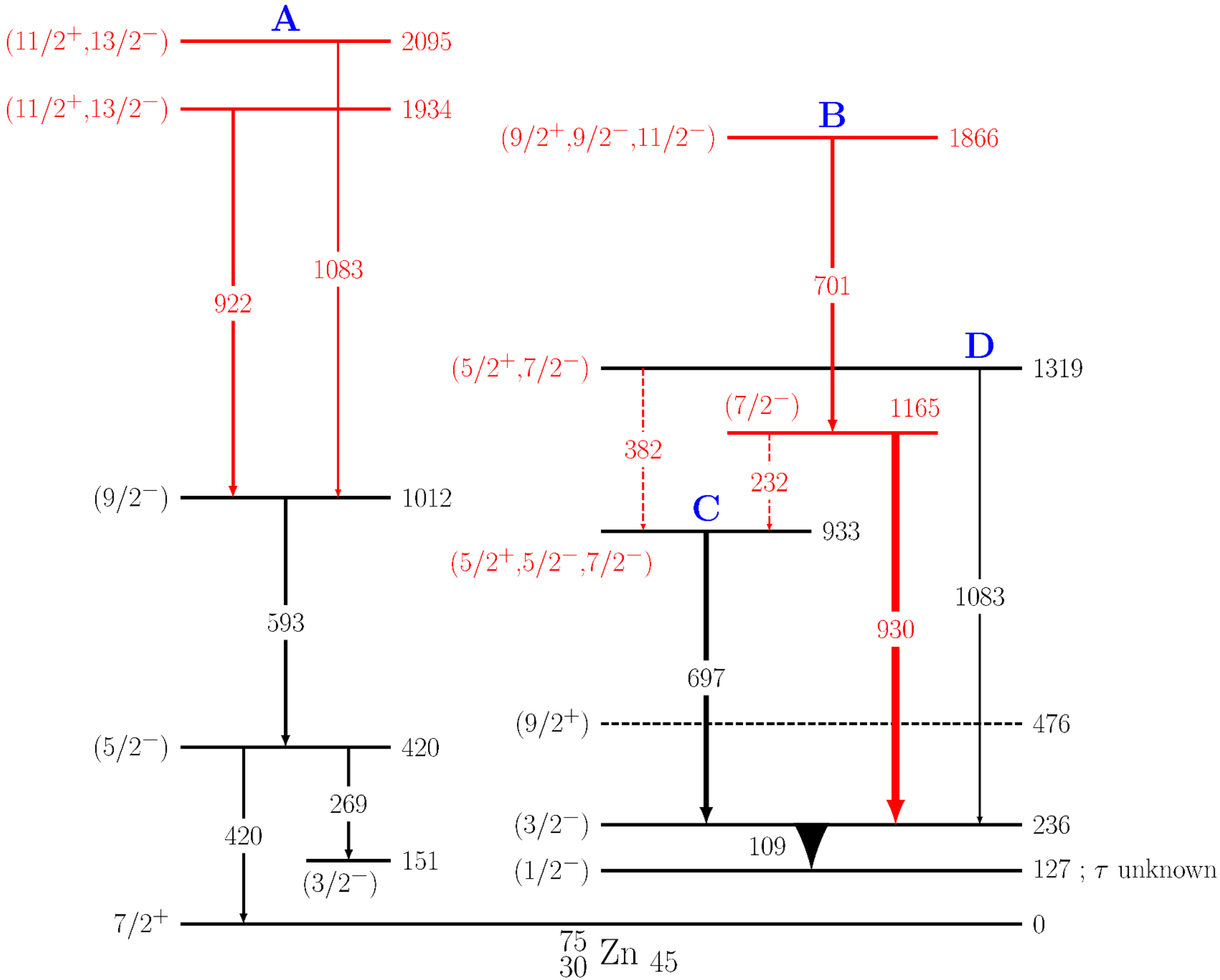
^{75}Zn structure



^{75}Zn structure right structure

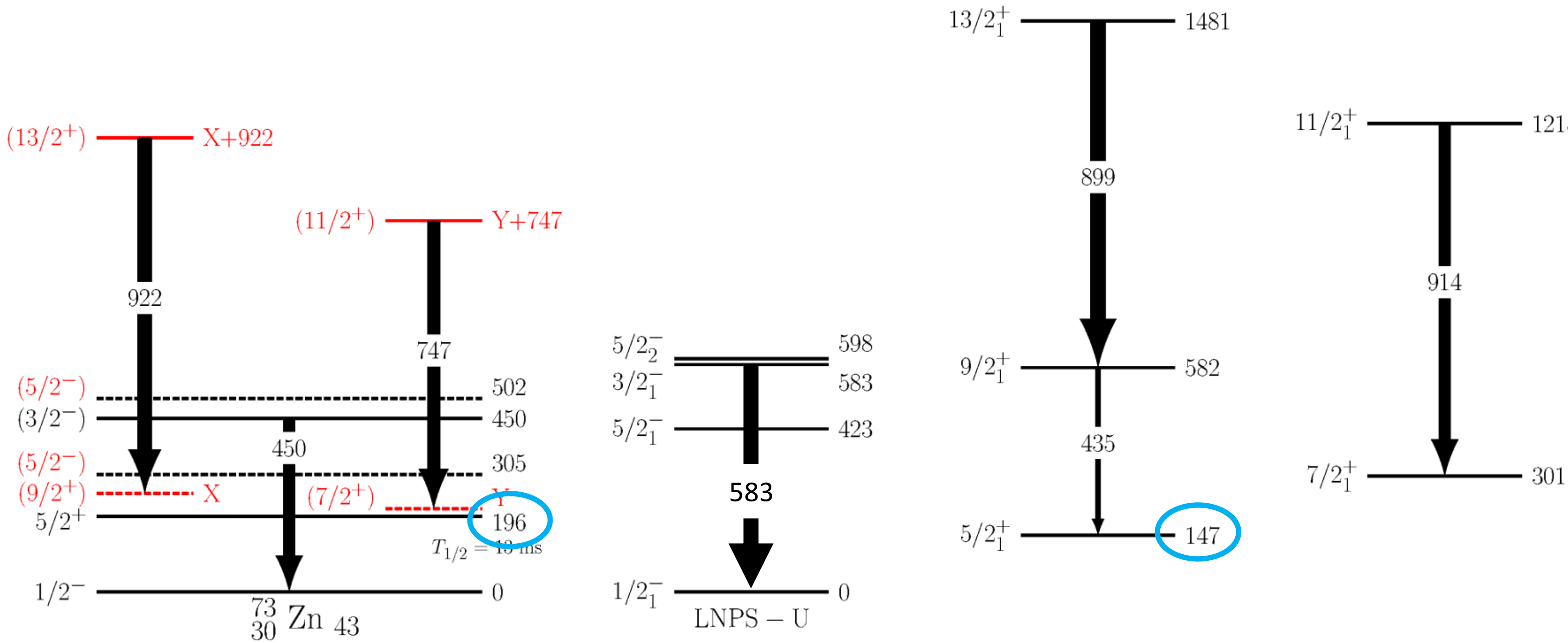


^{75}Zn structure – level scheme

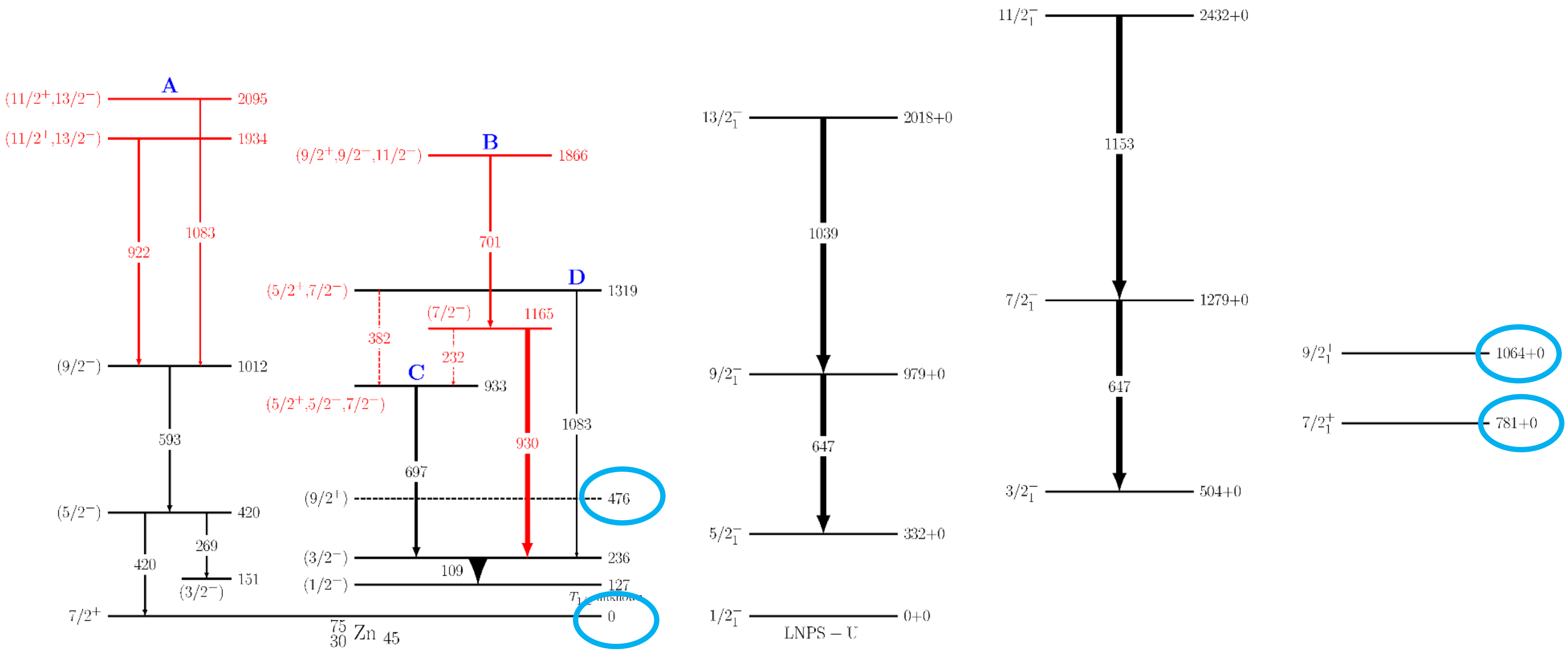


Theoretical approach and interpretation

^{73}Zn isotope



^{75}Zn isotope

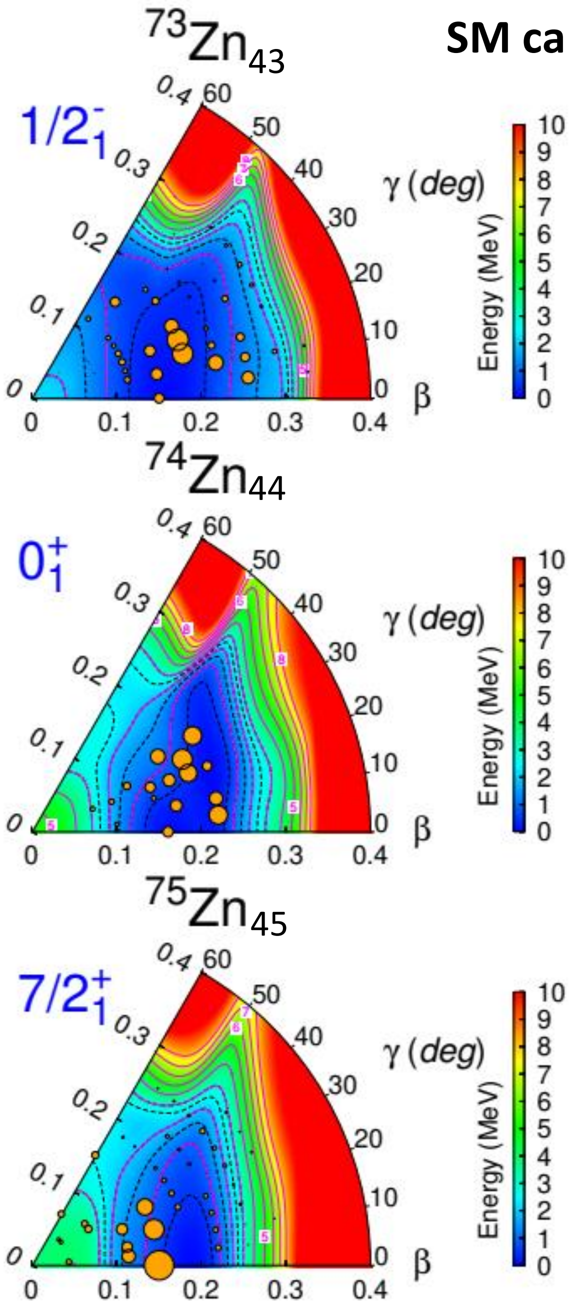


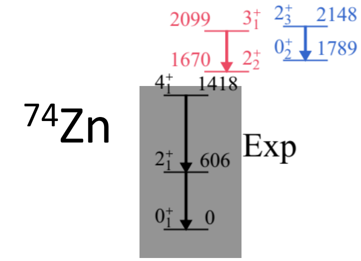
SM calculations - ground states

triaxial

triaxial

axial

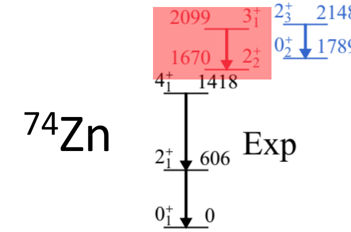




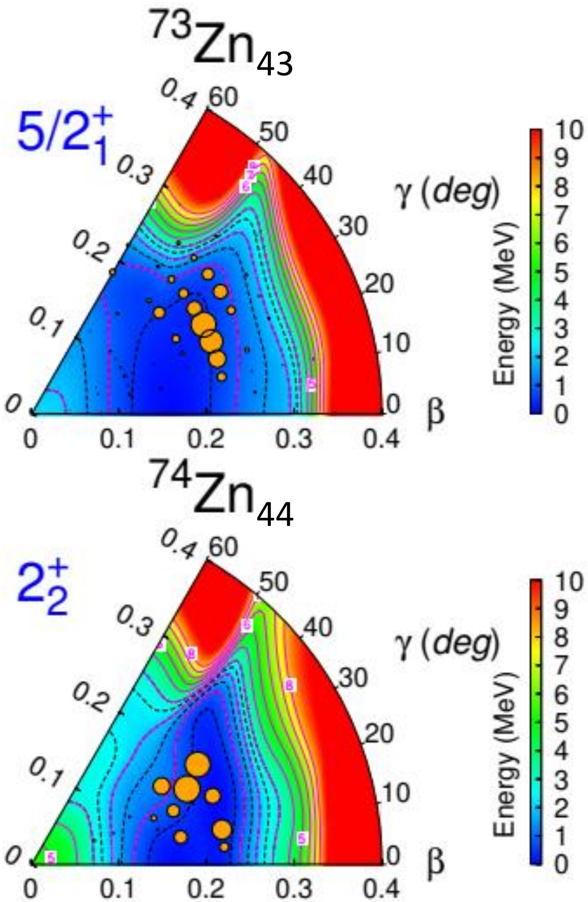
28 50

		$1f_{\frac{7}{2}}$	$2p_{\frac{3}{2}}$	$1f_{\frac{5}{2}}$	$2p_{\frac{1}{2}}$	$1g_{\frac{9}{2}}$	$2d_{\frac{5}{2}}$		$\Delta n^{\nu}(1g_{\frac{9}{2}}+2d_{\frac{5}{2}})$
^{73}Zn	$1/2^-$ g.s.	7.41	0.94	1.32	0.34				
		8.00	3.91	5.40	1.19	4.09	0.41	**intruder**	1.50
	$5/2^+$	7.24	1.03	1.32	0.42				
		8.00	3.85	5.35	0.76	4.56	0.48		2.04
^{74}Zn	0^+_1 g.s.	7.25	0.93	1.45	0.37				
		8.00	3.89	5.42	1.09	5.13	0.47	**intruder**	1.60
	2^+_2	6.96	1.07	1.60	0.38				
		8.00	3.87	4.99	1.13	5.46	0.55		2.01
	0^+_2	7.44	0.82	1.39	0.35				
		8.00	3.92	5.75	1.48	4.35	0.50		0.85
^{75}Zn	$7/2^+$ g.s.	7.48	0.71	1.47	0.34				
		8.00	3.96	5.85	1.79	4.90	0.49	**not intruder**	0.39
	$1/2^-$	7.33	0.80	1.46	0.41				
		8.00	3.94	5.76	1.21	5.60	0.50		1.10

SM calculations – excited states



triaxial



triaxial

28 50

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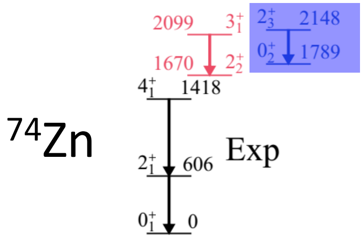
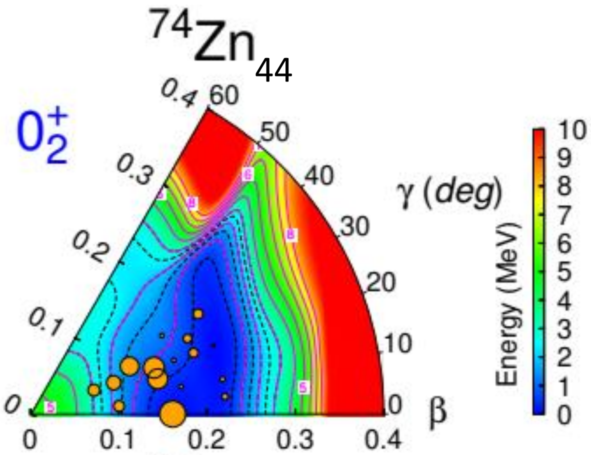
intruder

intruder

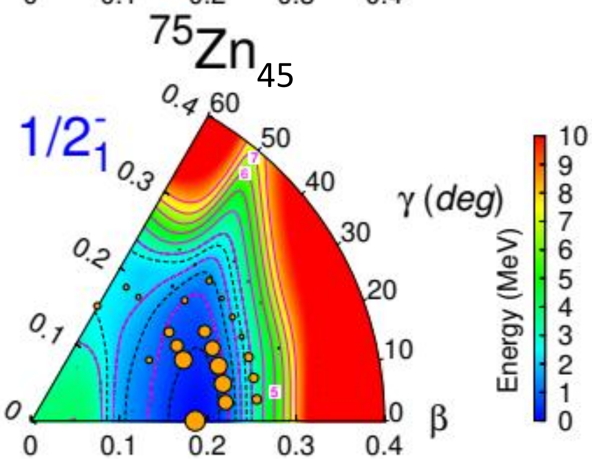
SM calculations – excited states



axial



axial



28 ↓ (between $1f_{7/2}$ and $2p_{3/2}$), 50 ↓ (between $2p_{1/2}$ and $1g_{9/2}$)

		$1f_{\frac{7}{2}}$	$2p_{\frac{3}{2}}$	$1f_{\frac{5}{2}}$	$2p_{\frac{1}{2}}$	$1g_{\frac{9}{2}}$	$2d_{\frac{5}{2}}$		$\Delta n^{\nu}(1g_{\frac{9}{2}}+2d_{\frac{5}{2}})$
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Conclusion

- There is a clear shape evolution from triaxial to axial in Zn isotopes from N=40 to N=46 (*M. Rocchini et al., Phys. Rev. Lett. 130, 122502 (2023), A. Illana et al., Phys. Rev. C 108, 044305 (2023)*)
- The ground-state bands in ^{73}Zn and ^{74}Zn are based on intruder configurations which is not the case for ^{75}Zn
- The 5/2^{+} band in ^{73}Zn is related to the 2^{+}_{2} band in ^{74}Zn both based on an intruder configuration associated to triaxiality.
- The 1/2^{-} band in ^{75}Zn is related to the 0^{+}_{2} band in ^{74}Zn both based on a mixed configuration 0p-0h/2p-2h associated to axial deformation
- ^{73}Zn may possess a low-lying 9/2^{+} isomer built on top of the 5/2^{+} isomeric state with $T_{1/2}$ between several ns to several µs

For both ^{73}Zn and ^{75}Zn, a large statistics dataset with spin alignment for firm spin assignments is need.

Collaboration

G. Duchêne,[1,*] J. Dudouet,[2] F. Didierjean,[1] D. D. Dao,[1] F. Nowacki,[1] E. Clément,[3] A. Lemasson,[3] C. Andreoiu,[4] G. de Angelis,[5] A. Astier,[6] C. Delafosse,[7] I. Deloncle,[6] B.Z. Dombradi,[8] C. Ducoin,[9] G. de France,[3] A. Gadea,[10] A. Gottardo,[5] D. Guinet,[9] B. Jacquot,[3] P. Jones,[11] T. Konstantinopoulos,[6] A. Korichi,[6] I. Kuti,[8] F. Le Blanc,[6,1] S.M. Lenzi,[12,13] G. Li,[14,15] C. Lizarazo,[16] R. Lozeva,[6,1] G. Maquart,[9] C. Michelagnoli,[17,3] B. Million,[18] D.R. Napoli,[5] A. Navin,[3] R.M. Pérez-Vidal,[10] C.M. Petrache,[6] N. Pietralla,[16] D. Ralet,[19,16] M. Ramdhane,[20] N. Redon,[2] M. Rejmund,[3] K. Rezynkina,[12,1] O. Stezowski,[9] C. Schmitt,[1,3] D. Sohler,[8] and D. Verney[6]

[1] *Université de Strasbourg, CNRS, IPHC UMR 7178, F-67000 Strasbourg, France*
[2] *Université Claude Bernard Lyon, CNRS/IN2P3, IP2I Lyon, F-69622, Villeurbanne, France*
[3] *GANIL, CEA/DRF-CNRS/IN2P3, BP 55027, 14076 Caen Cedex 5, France*
[4] *Department of Chemistry, Simon Fraser University, Burnaby, British Columbia V5A 1S6, Canada*
[5] *INFN, Laboratori Nazionali di Legnaro, Viale dell'Università 2, I-35020 Legnaro (PD), Italy*
[6] *Université Paris-Saclay, CNRS/IN2P3, IJCLab, 91405 Orsay, France*
[7] *ESRIG, University of Groningen, Zernikelaan 25, 9747 AA Groningen, The Netherlands*
[8] *Institute for Nuclear Research of the Hungarian Academy of Sciences, Pf.51, H-4001, Debrecen, Hungary*
[9] *Université Lyon, Université Claude Bernard Lyon, CNRS/IN2P3, IP2I Lyon, F-69622, Villeurbanne, France*
[10] *Instituto de Física Corpuscular, CSIC-Universitat de València, E-46980 Valencia, Spain*
[11] *iThemba LABS, National Research Foundation, P.O.Box 722, Somerset West,7129 South Africa*
[12] *INFN Sezione di Padova, I-35131 Padova, Italy*
[13] *Dipartimento di Fisica e Astronomia dell'Università di Padova, I-35131 Padova, Italy*
[14] *GSI, Helmholtzzentrum für Schwerionenforschung GmbH, D-64291 Darmstadt, Germany*
[15] *Institute of Modern Physics, Chinese Academy of Sciences, Lanzhou, 73000, China*
[16] *Institut für Kernphysik, Technische Universität Darmstadt, D-64289 Darmstadt, Germany*
[17] *Institut Laue-Langevin, 71 avenue des Martyrs, 38042 Grenoble Cedex 9, France*
[18] *INFN, Sezione di Milano, I-20133 Milano, Italy*
[19] *MIRION Technologies Canberra, 1 Chemin de la Roseraie, 67380 Lingolsheim, France*
[20] *LPSC, Université Grenoble-Alpes, CNRS/IN2P3, 38026 Grenoble Cedex, France*

Thank you for your attention