



# Low-lying structure of neutron-rich A=73 Zn and Ga isobars

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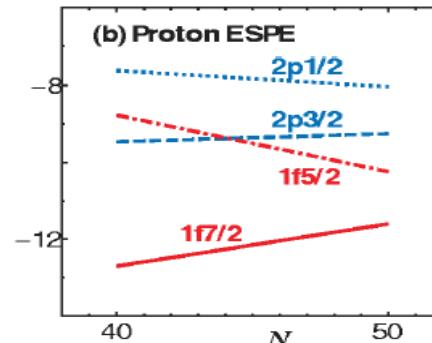
INTC meeting, 8<sup>th</sup> February 2017, CERN

# Nuclear structure of neutron-rich nuclei

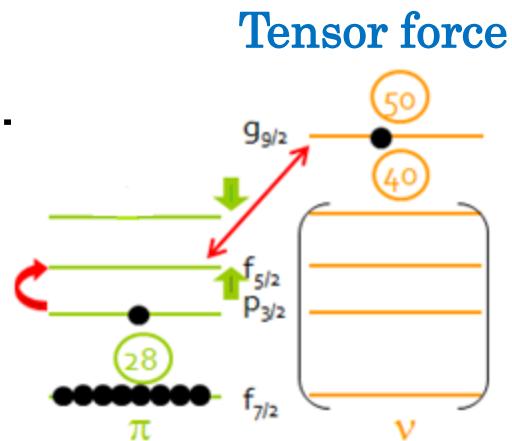
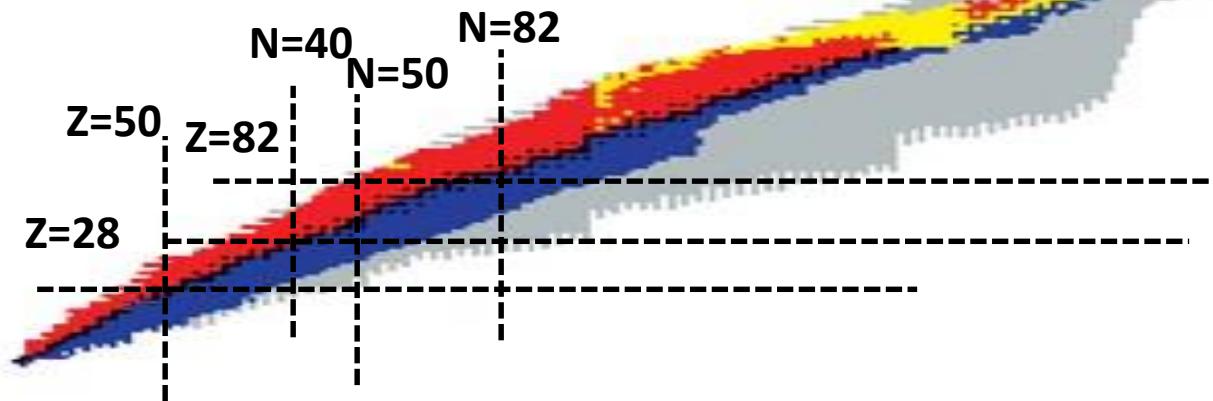
$N=40$  ( $^{68}\text{Ni}$ ) and  $N=50$  ( $^{78}\text{Ni}$ ) magic numbers

Important role of the  $\nu g_{9/2}$  orbital

Z=28 shell gap evolution

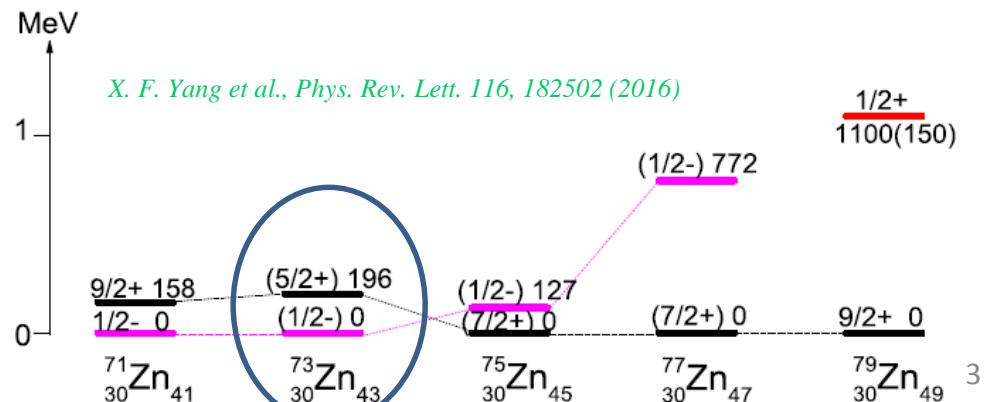
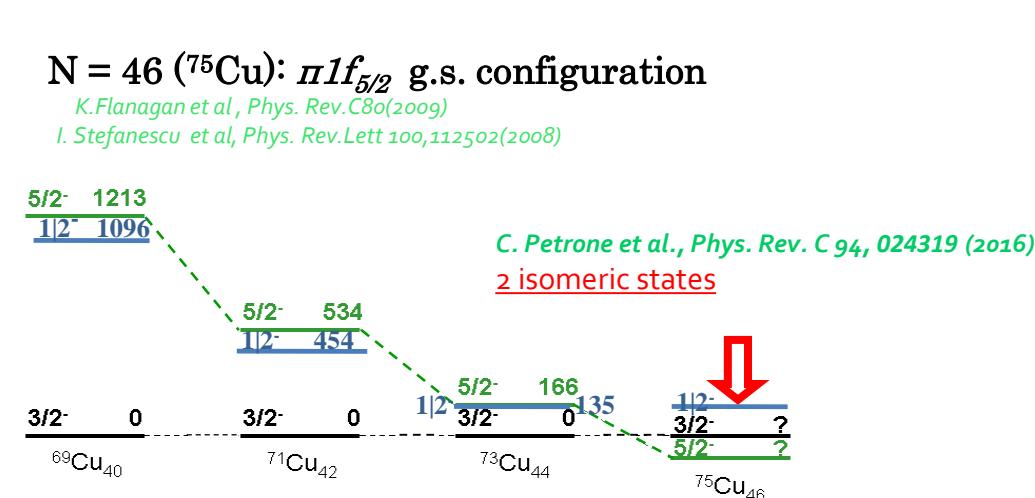


T. Otsuka et al., Phys. Rev. Lett. 95, 23502 (2005)



# Cu versus Zn isotopic chain

- 1  $\pi$  outside Z=28
- gradual reduction of the  $1/2^-$  and  $5/2^-$  energy with N
- 2  $\pi$  outside Z=28 (more complex structure)
- N>40 normal g.s configuration:  $9/2^+$

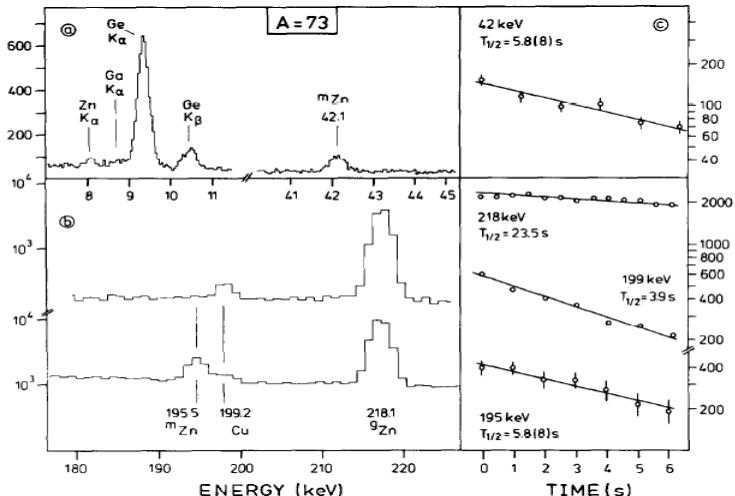


# $^{73}\text{Zn}$ : previous studies

E. Runte et al., Nucl. Phys. A 441, 237 (1985)

➤ Multinucleon transfer ( $^{82}\text{Se}$  beam on W target)

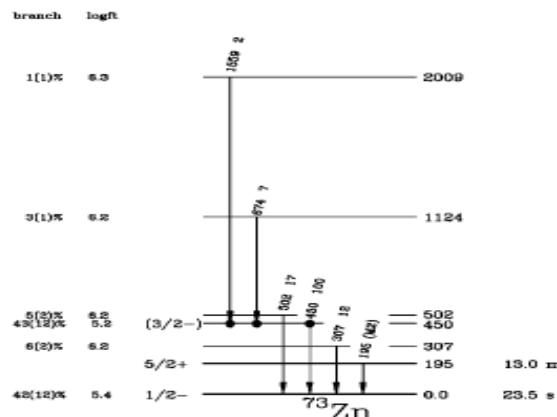
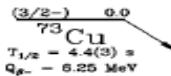
- $T_{1/2}$  of 42 and 195.5 keV is 5.8(8)s
- 42 keV from  $^{73}\text{Ga}$
- 199keV is from  $\beta-$ decay of  $^{73}\text{Cu}$



M. Huhta et al., Phys. Rev. C 58, 6 (1998)

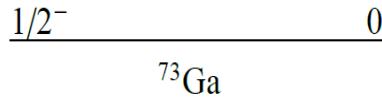
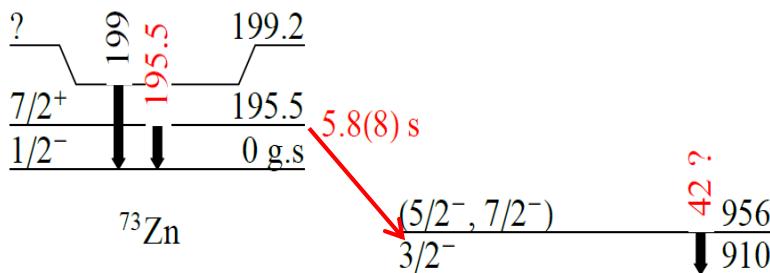
➤ Fragmentation reaction ( $^{76}\text{Ge}$  on Be target)

- 195.5 keV with  $T_{1/2}=13.0(2)$  ms
- 42 and 199 keV transitions not observed



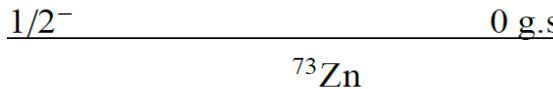
# $^{73}\text{Zn}$ & $^{73}\text{Ga}$ possible scenarios

E. Runte et al., Nucl. Phys. A 441, 237 (1985)  
 E. Runte et al., Nucl. Phys. A 399, 163 (1983)

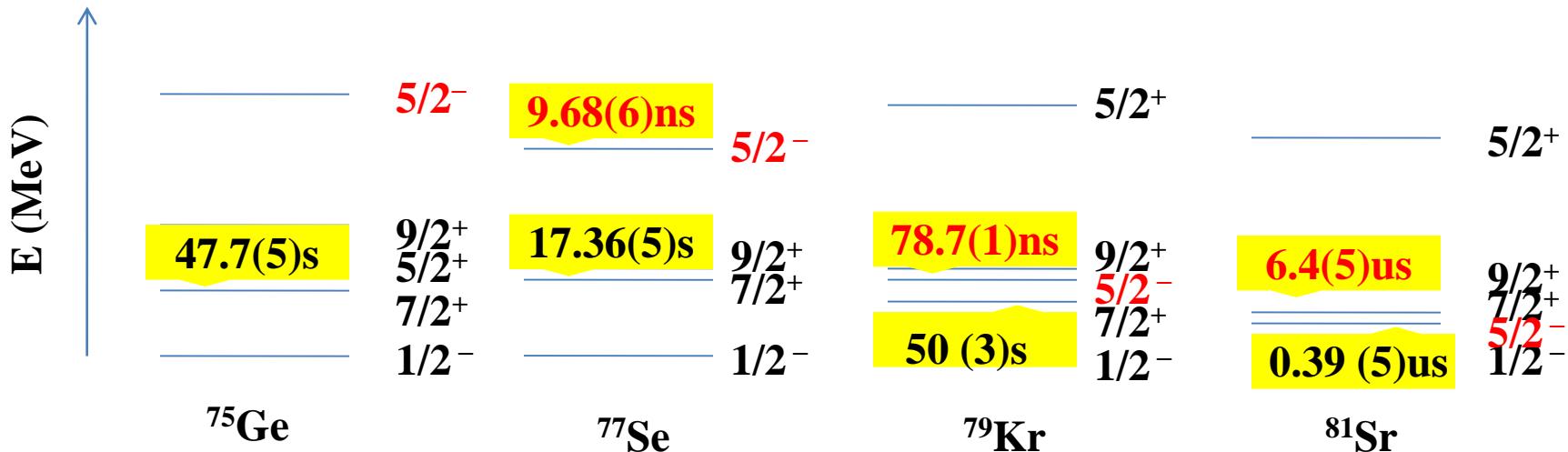


M. Huhta *et al.*, Phys. Rev. C 58, 6 (1998)  
 Fragmentation reaction ( $^{76}\text{Ge}$  on Be target)

- The 42 keV transition is from  $^{73}\text{Zn}$
- Probably the  $9/2^+$  level
- 199 keV level from  $^{73}\text{Zn}$  or  $^{73}\text{Ga}$ ?



# Low energy systematics for odd-A N=43 isotones



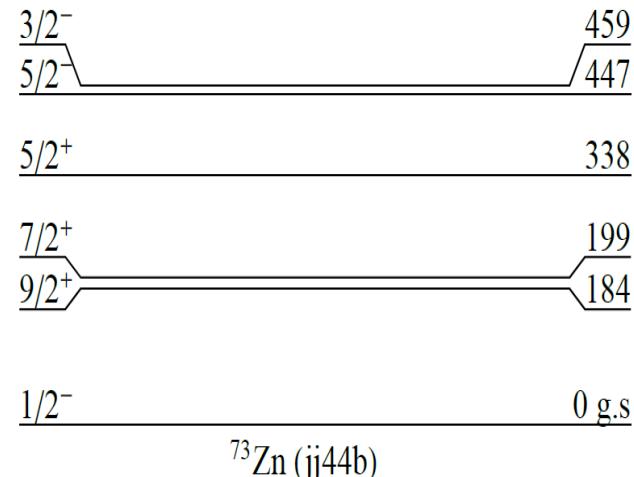
- E3( $7/2^+ \rightarrow 1/2^-$ ) transition observed for all N=43 isotones
- Low energy positive parity states
- Gradual reduction in energy of the  $5/2^-$  state
- What is the value of  $T_{1/2}$  of  $5/2^-$  in  $^{73}\text{Zn}$ ?

# Shell model predictions

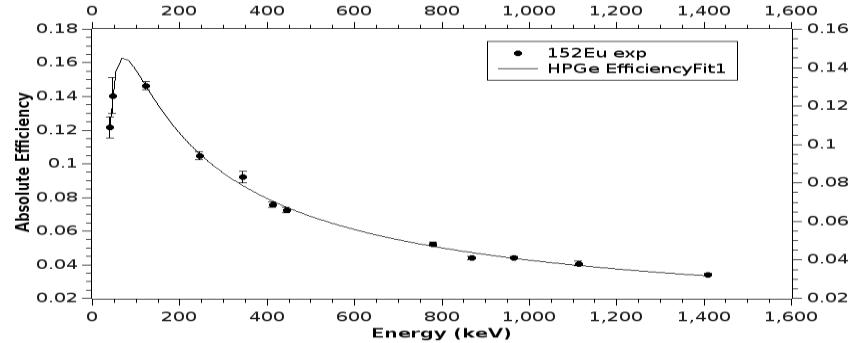
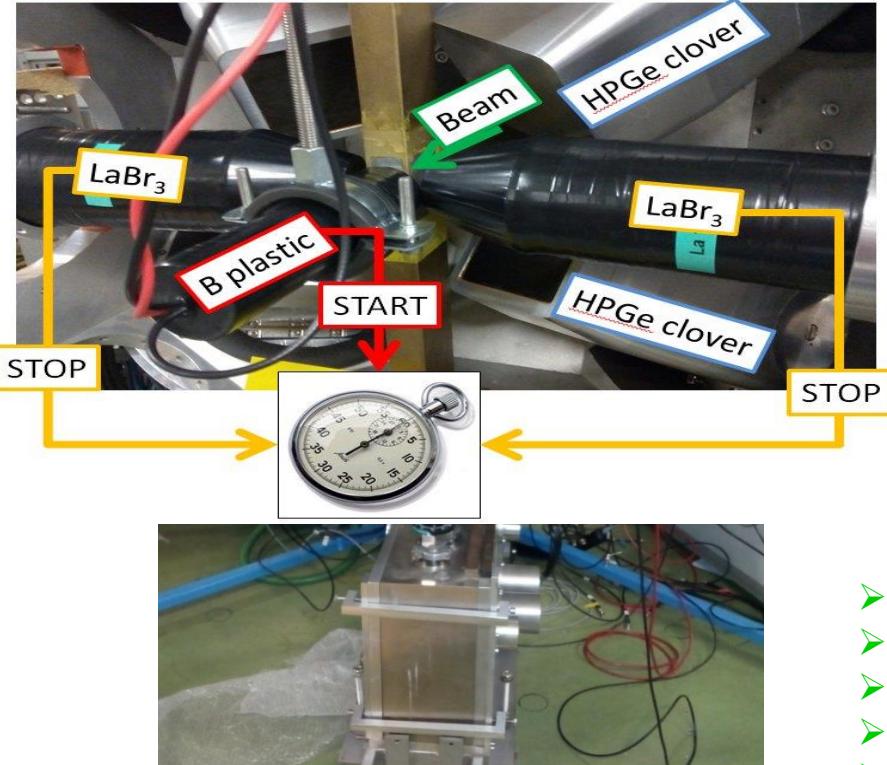
- NuShell code
- jj44b interaction,  $^{56}\text{Ni}$  core,  $\text{pf}_{5/2}\text{g}_{9/2}$  valence space  
B.A. Brown and A. Lisetskiy unpublished
- $T_{1/2} = 5.8 \text{ s} \Rightarrow B(E3) = 4.6 \cdot 10^{-2} \text{ W.u}$
- $B_{\text{theor}}(E3, 7/2^+ \rightarrow 1/2^-) = 10^{-2} \text{ W.u}$

## Fast-timing measurement::

- $5/2^-$  at the energy of 477 keV
- $[\pi f_{5/2}^1 \nu g_{9/2}^3]$  configuration
- Experimentally the 502 keV state?
- $B(E2, 5/2^- \rightarrow 1/2^-) = 4.9 \text{ W.u}$
- $T_{1/2} \sim 0.8 \text{ ns}$



# The ISOLDE Decay Station(IDS) set-up



- 4 HPGe clovers
- 1 LEPS
- 2 LaBr<sub>3</sub> scintillators. (Timing resolution ~ 120 ps)
- 1 beta plastic scintillator (Eff~25%)
- Tape to remove the unwanted radioactivity

# Objectives

- clarify the puzzling situation of the 199 and 42 keV transitions by studying separately the  $\beta$  decay of  $^{73}\text{Cu}$  and  $^{73,73\text{m}}\text{Zn}$ . **What role plays the  $v1g_{9/2}$  orbital in the evolution of the nuclear structure in neutron-rich Zinc isotopes?**
- determining the half-life of the 195.5 keV isomer of  $^{73}\text{Zn}$
- measuring the half-life of the  $5/2^-$  state with fast-timing technique. **Important for determining the degree of collectivity of negative parity states in  $^{73}\text{Zn}$ !**
- to extend the knowledge about the level scheme of  $^{73}\text{Zn}$  and  $^{73}\text{Ga}$  (take advantage of the unique features of IDS set-up and large production rates available at ISOLDE)

# Expected count rates

- Laser ion source (RILIS), HRS and quartz line are required to suppress the Rb and Ga contaminants
- An additional LEPS detector
- Lower implantation rates to avoid pile-up effects and dead time issues of DAQ

Isotope	T <sub>1/2</sub> [s]	Ions implanted [ions/s]	Target	Expected count rate $\beta\text{-}\gamma_{\text{Ge}}\text{-}\gamma_{\text{Ge}}$ [counts/shift]	Expected count rate $\beta\text{-}\gamma_{\text{Ge}}\text{-}\gamma_{\text{LaBr}}$ [counts/shift]	Shifts
<sup>73</sup> Cu	3.9	5X10 <sup>5</sup>	UC <sub>x</sub>	1.3 x10 <sup>2</sup>	2.3 x10 <sup>2</sup>	4
<sup>73.73m</sup> Zn	23.5/5.8/ 0.018	5X10 <sup>5</sup>	UC <sub>x</sub>	2.1 x10 <sup>2</sup>	-	4

**Summary of requested shifts:** We request 8 shifts: 8 shifts for <sup>73</sup>Cu and <sup>73</sup>Zn and 2 shifts for in-beam calibrations for fast-timing detection system (<sup>138</sup>Cs).

# IDS collaboration

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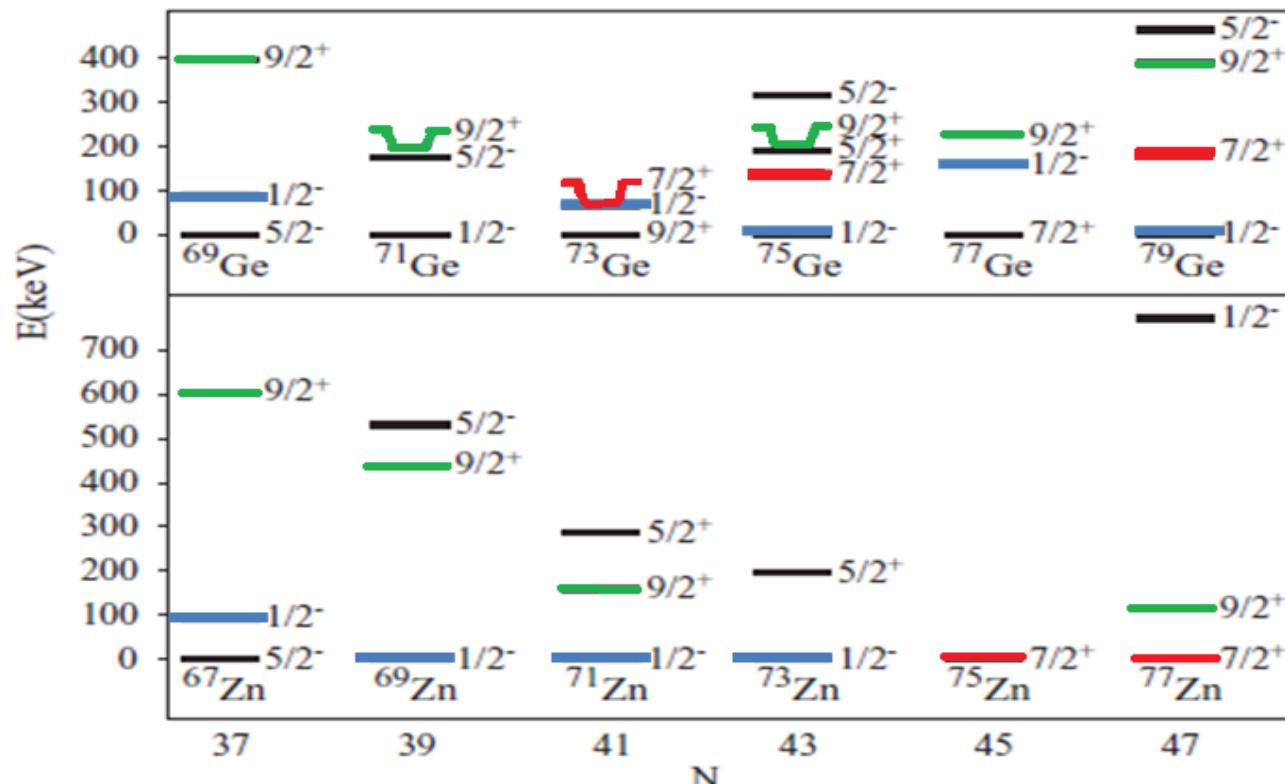
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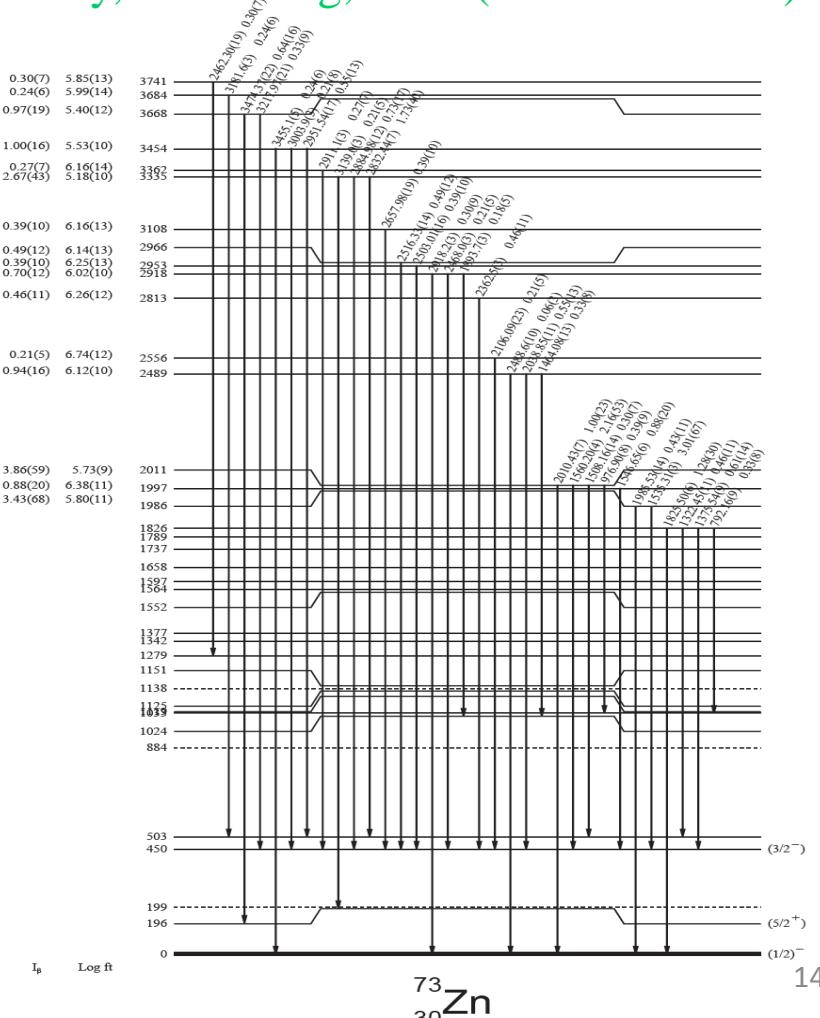
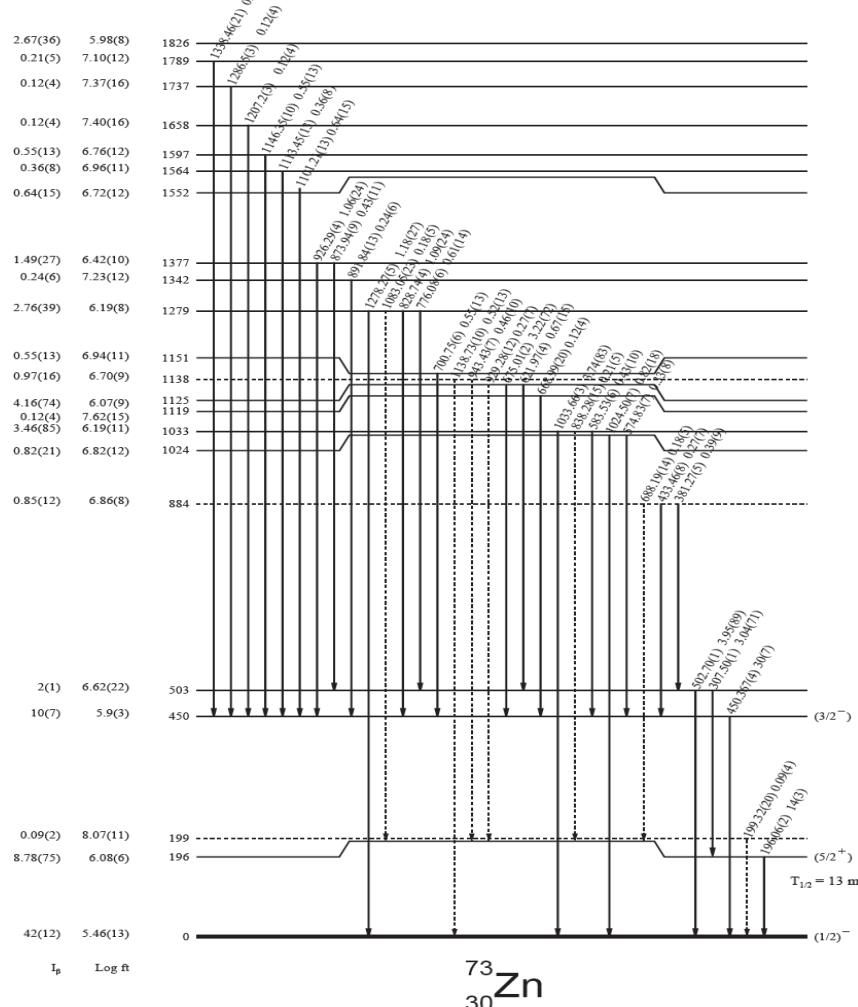
<sup>14</sup> Institut für Kernphysik, Universität zu Köln, Köln, Germany

*Thank you!*

# Low energy systematics for neutron-rich Zn and Ge isotopes



# T. Faul, PhD Thesis, Louis Pasteur University, Strasbourg, 2007 (data from 1998)



# What is known about $^{73}\text{Ga}$ level scheme?

- J. Diriken et al., Phys. Rev. C 82, 064309 (2010)
- B. Cheal et al., Phys. Rev. Lett. 104, 252502 (2010)
- I. Stefanescu et al., Phys. Rev. C 79, 064302 (2010)
- G. Rotbard et al., Phys. Rev. C 21, 2293 (1980)

