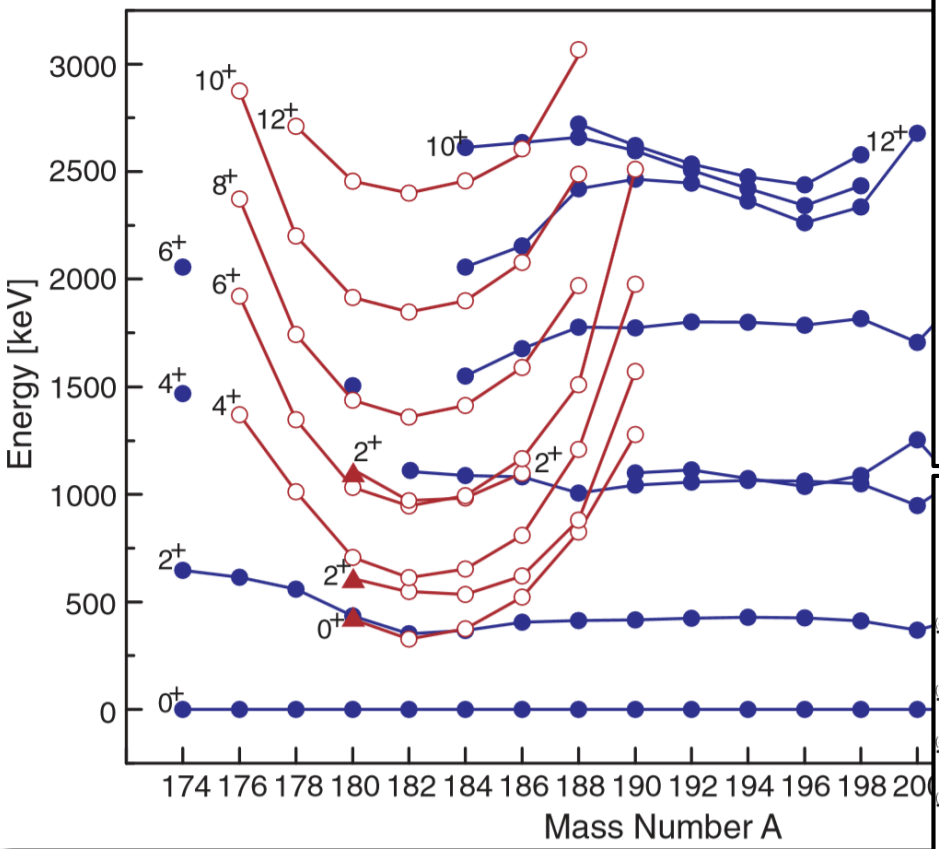
Shape coexistence in the ^{68}Ni region

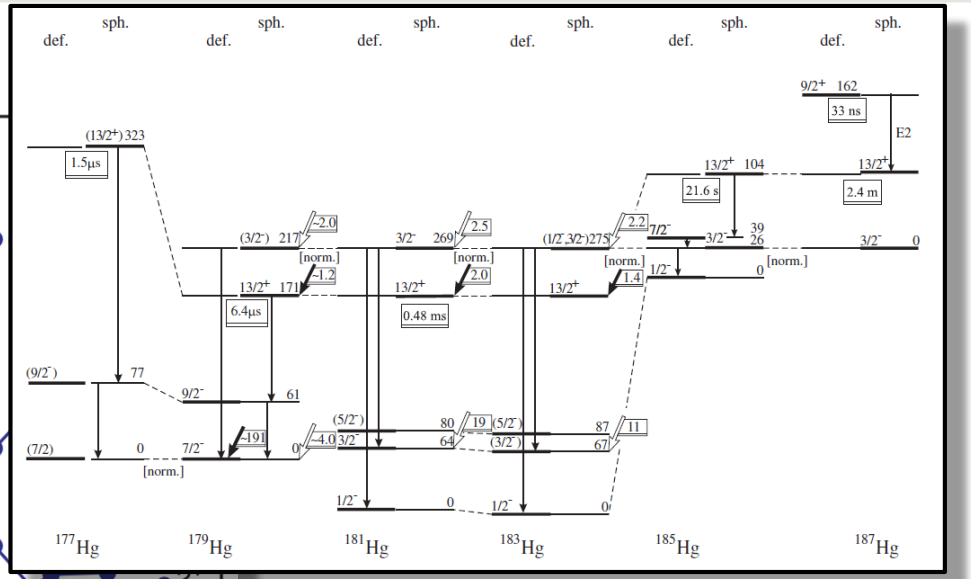
global survey of measurements in this mass region: energy levels, electromagnetic moments (B(E..), B(M..), g factors, Qs), masses, radii, delta_r², reaction cross sections, and of course E0 transition strengths

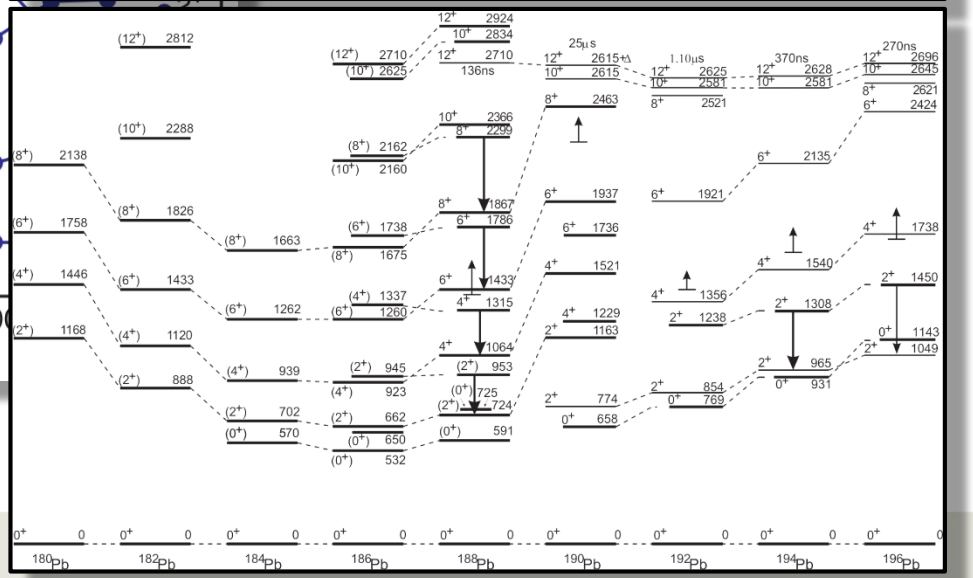
S.N. Liddick

Oct. 24, 2017

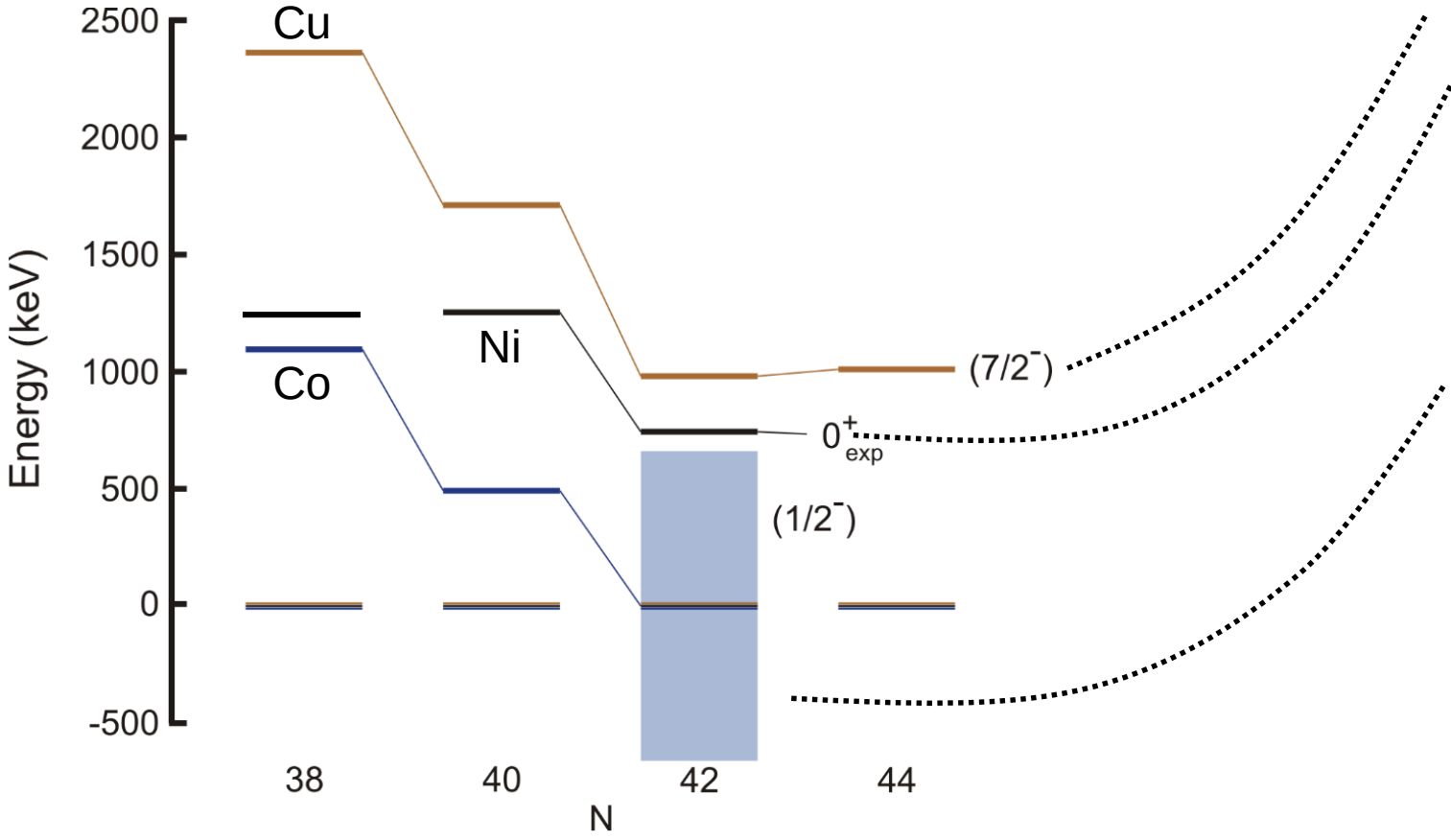
States in neutron-deficient Hg isotopes





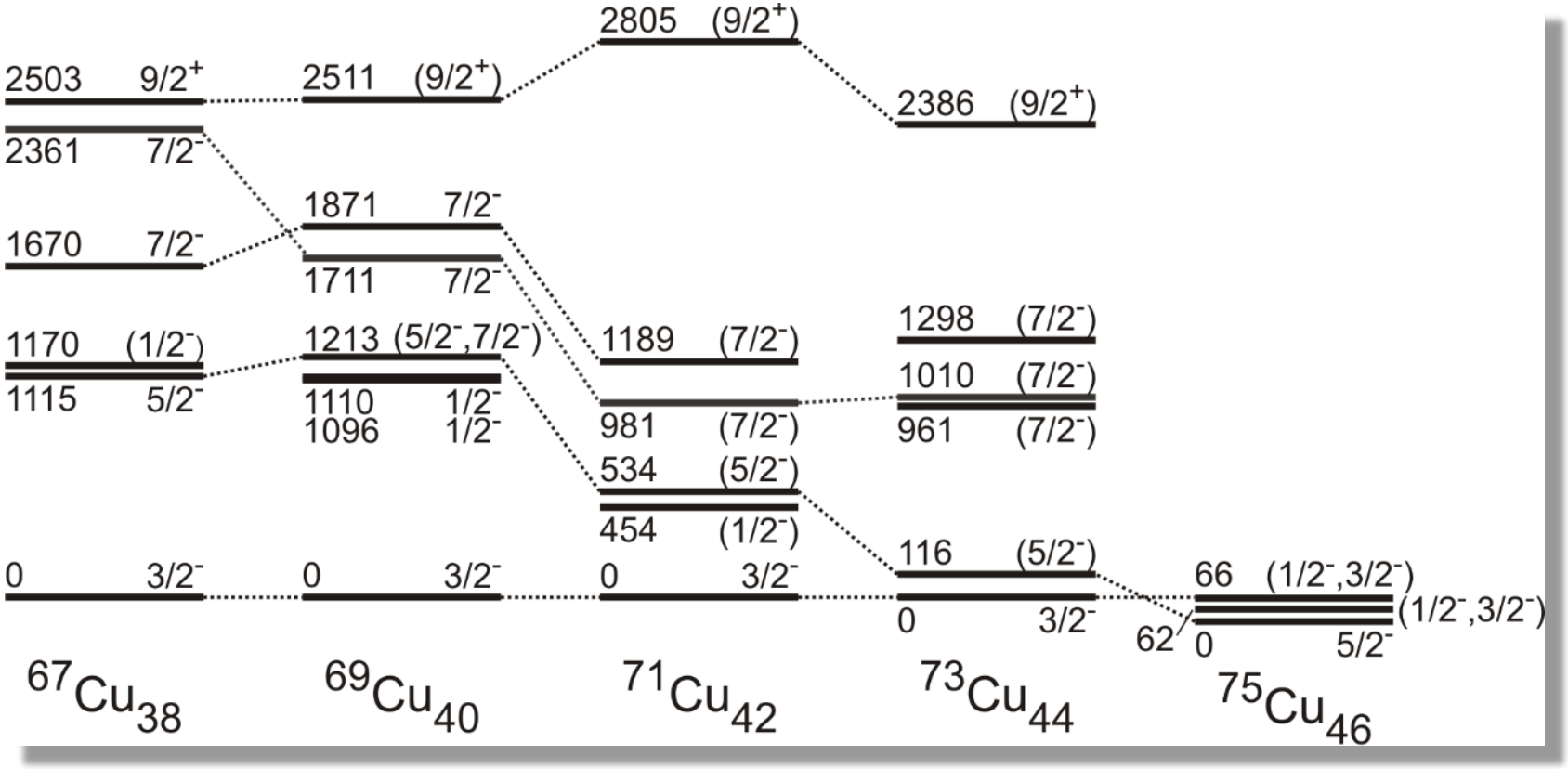


Proton Intruder systematics near ^{68}Ni



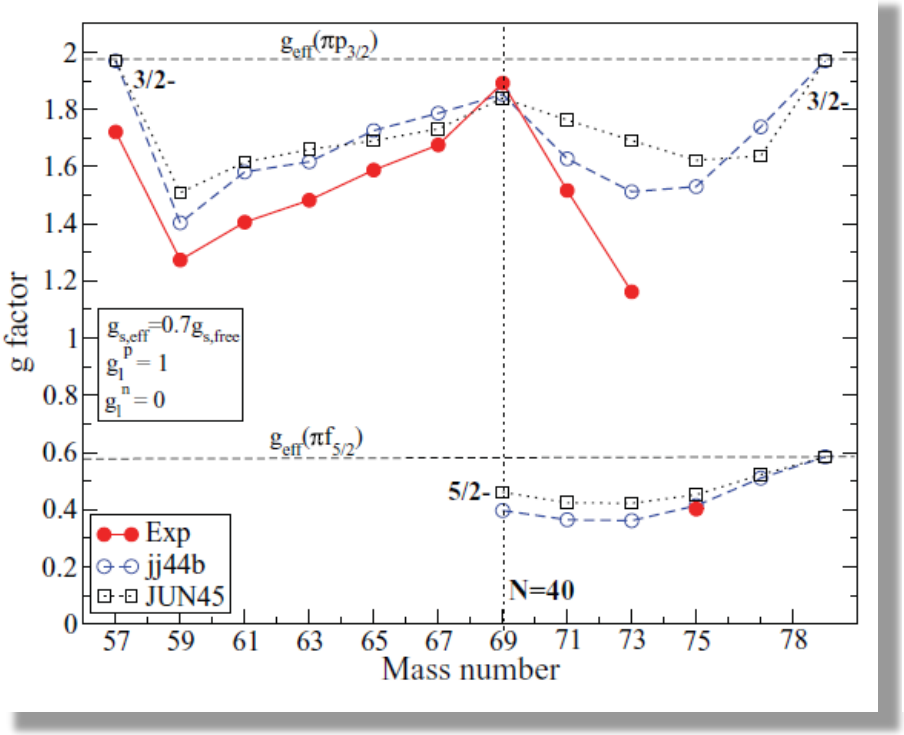
Cu energy systematics

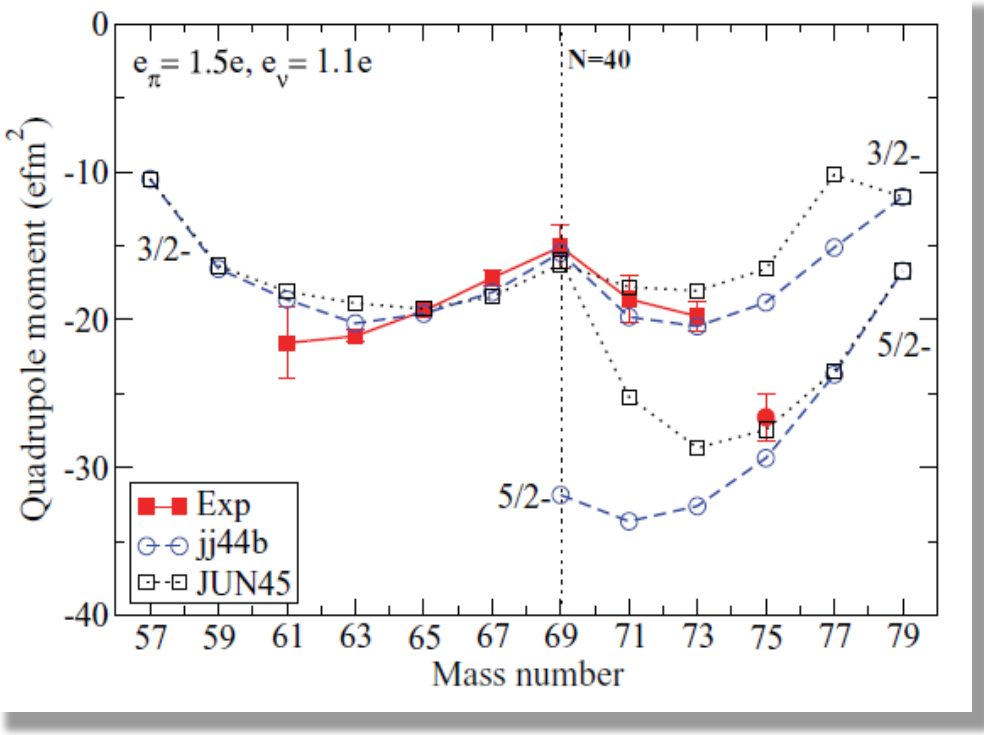
- Selected levels in Cu isotopes.
- Multiple characteristics are present.



Cu

- g-factor and magnetic moments across the Cu isotopic chain.

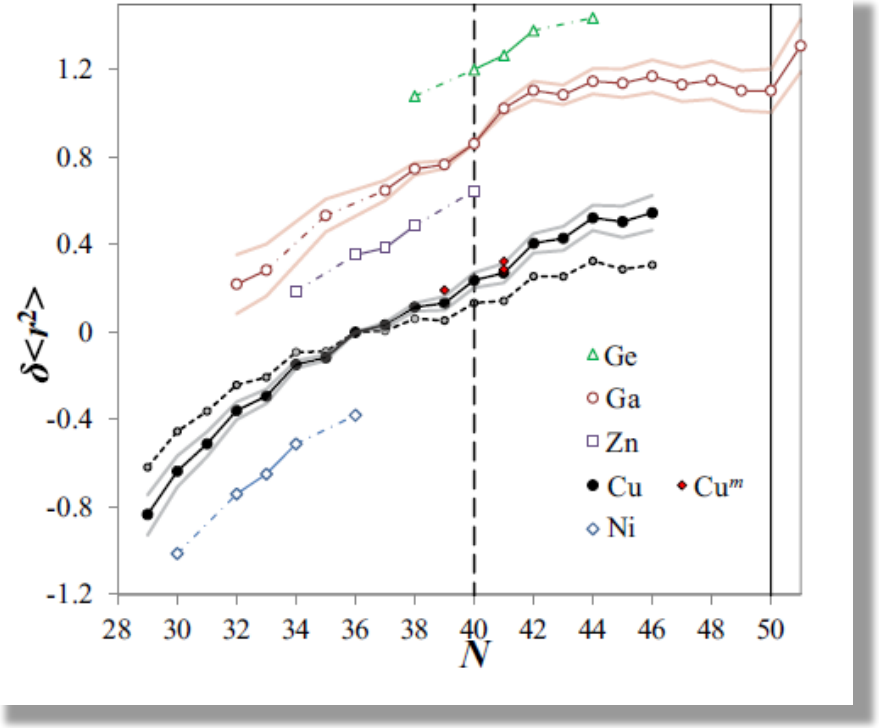


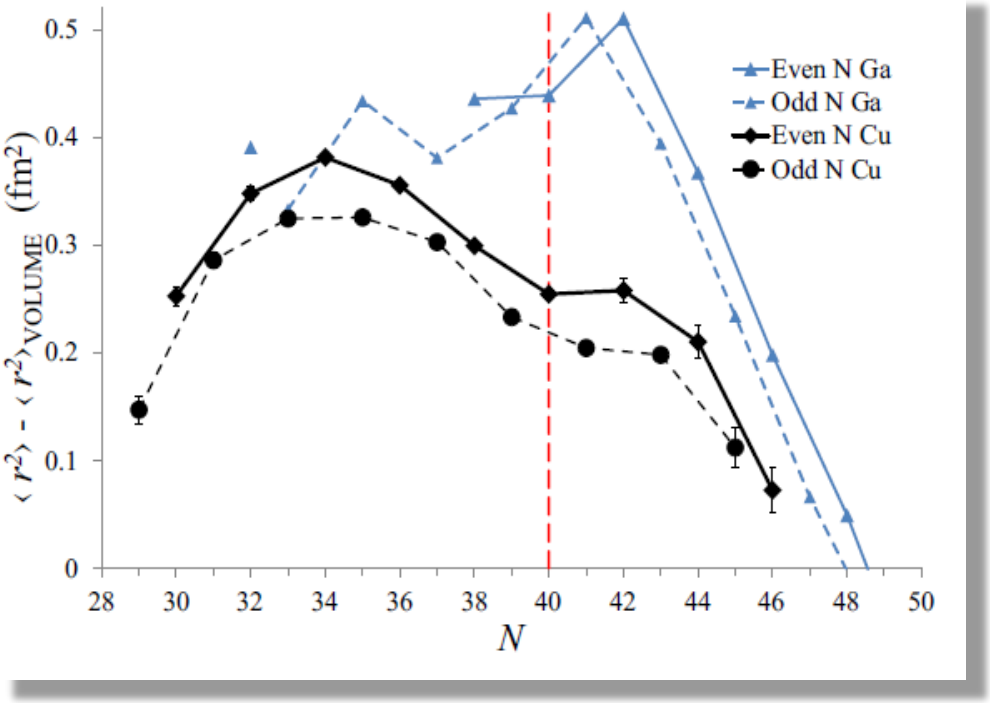


Vingerhoets *et al.*, PRC **82**, 064311 (2010)

Cu charge radii

- Weak indication for N = 40 sub shell closure
- Interesting next step would be Ni isotopes.

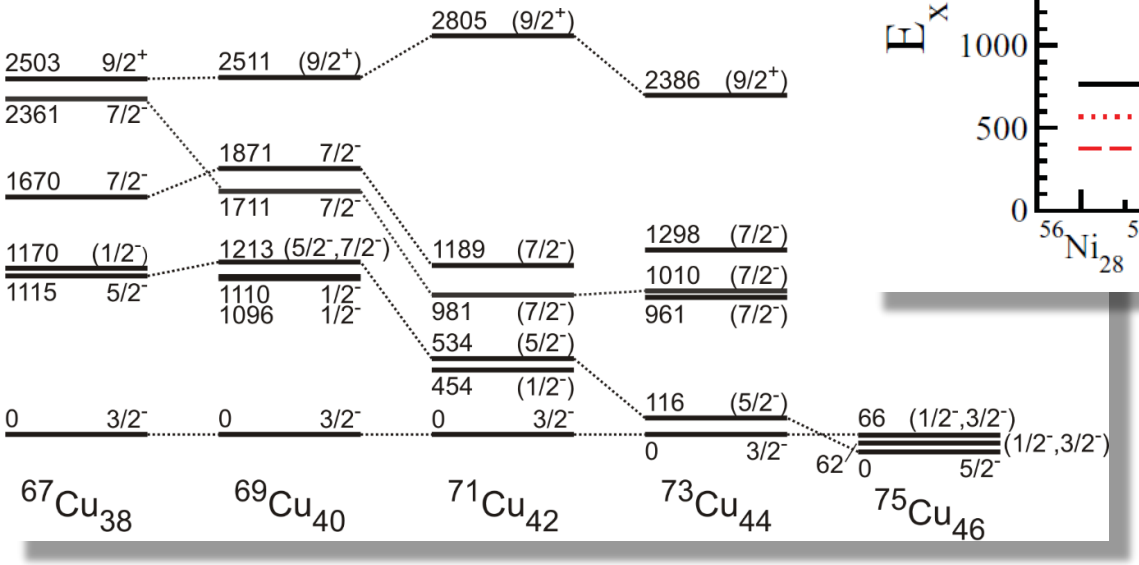


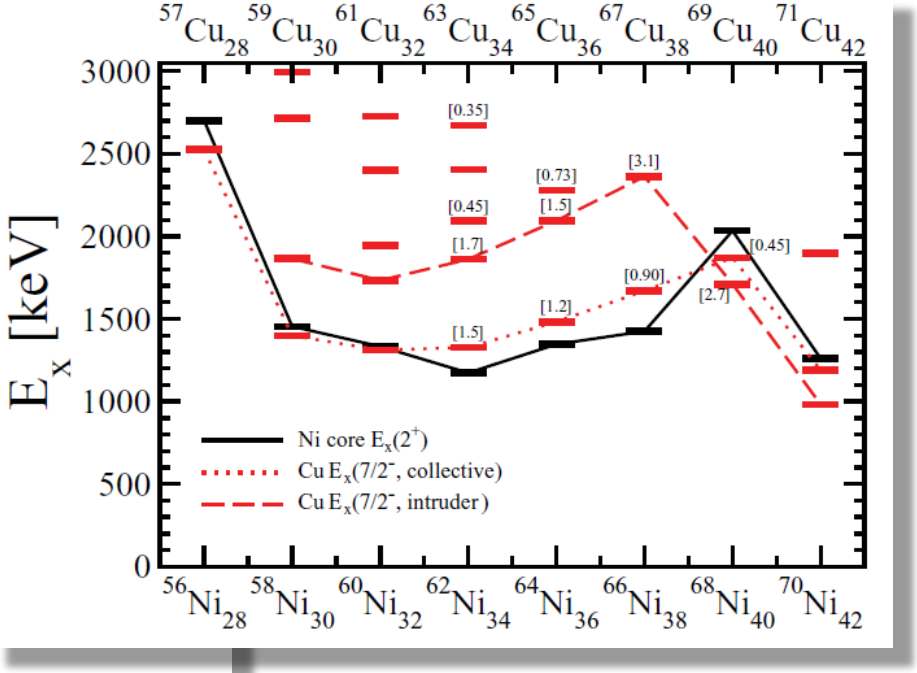


M.L. Bissell et al., PRC **93**, 064318 (2016)

Cu energy systematics

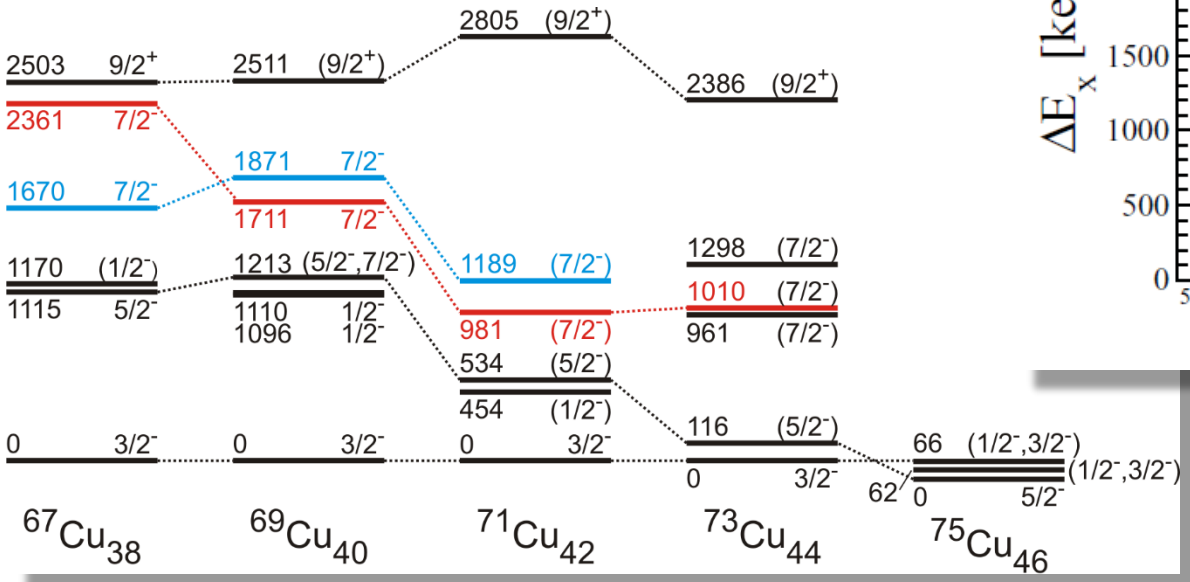
- Multiple 7/2- states present in odd-Cu isotopes

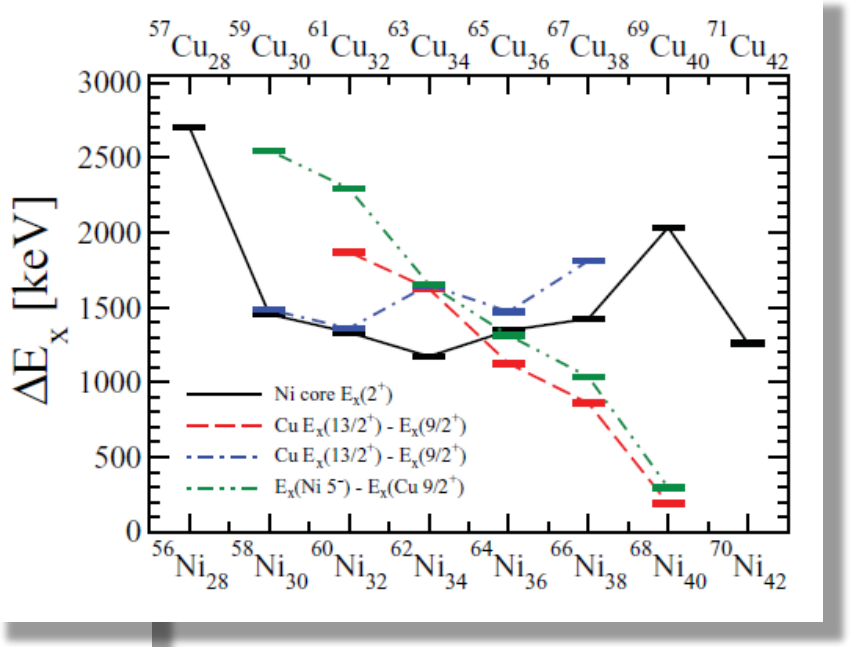




Cu energy systematics

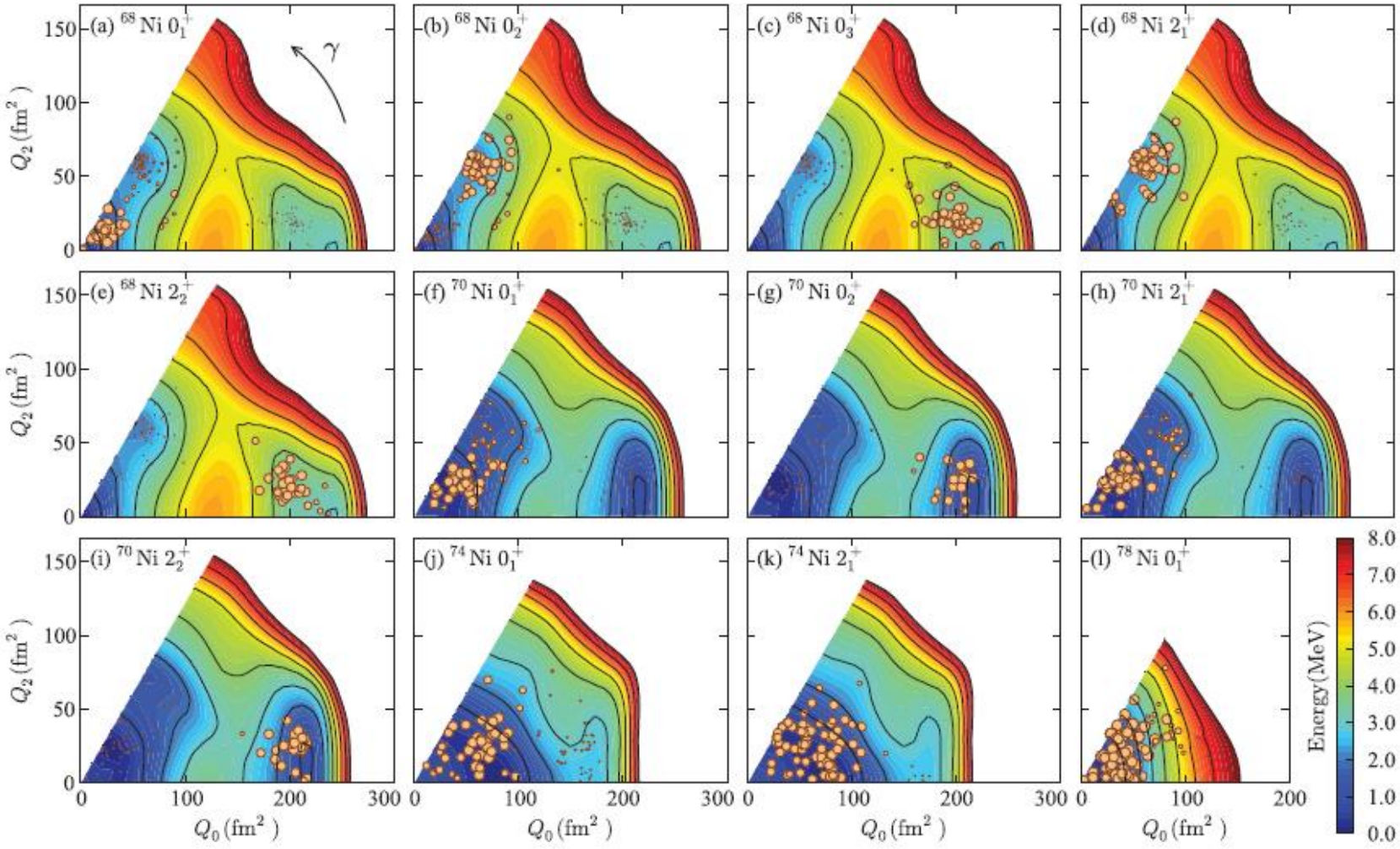
- One set of positive parity 9/2+ states carry significant strength in (^{3}He,d) reactions.



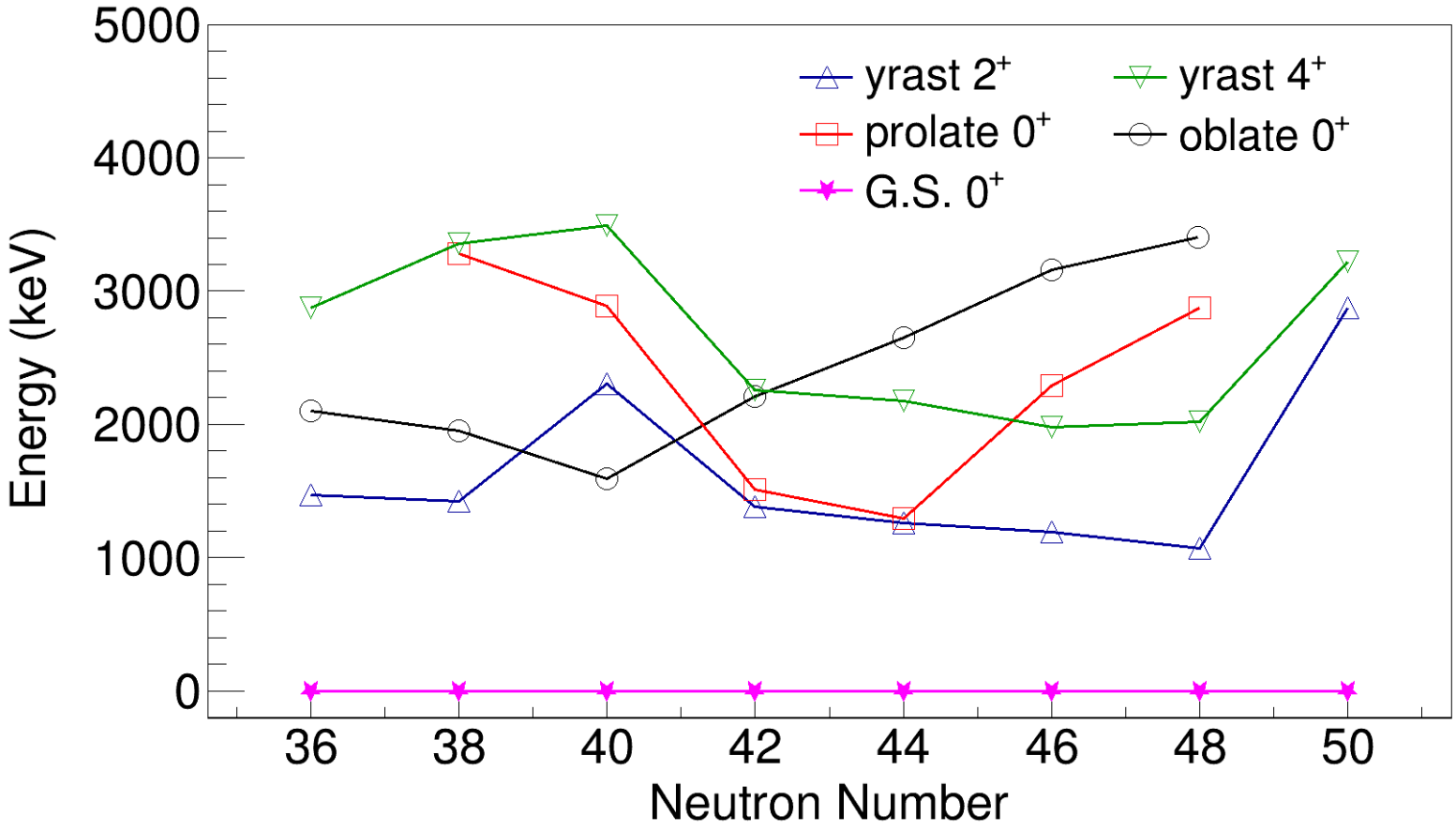


R.M. Britton and D.L. Watson, NPA **272**, 91 (1976)
C.J. Chiara *et al.*, PRC **85**, 024309 (2012)

Potential Energy Surfaces along the Ni elemental chain

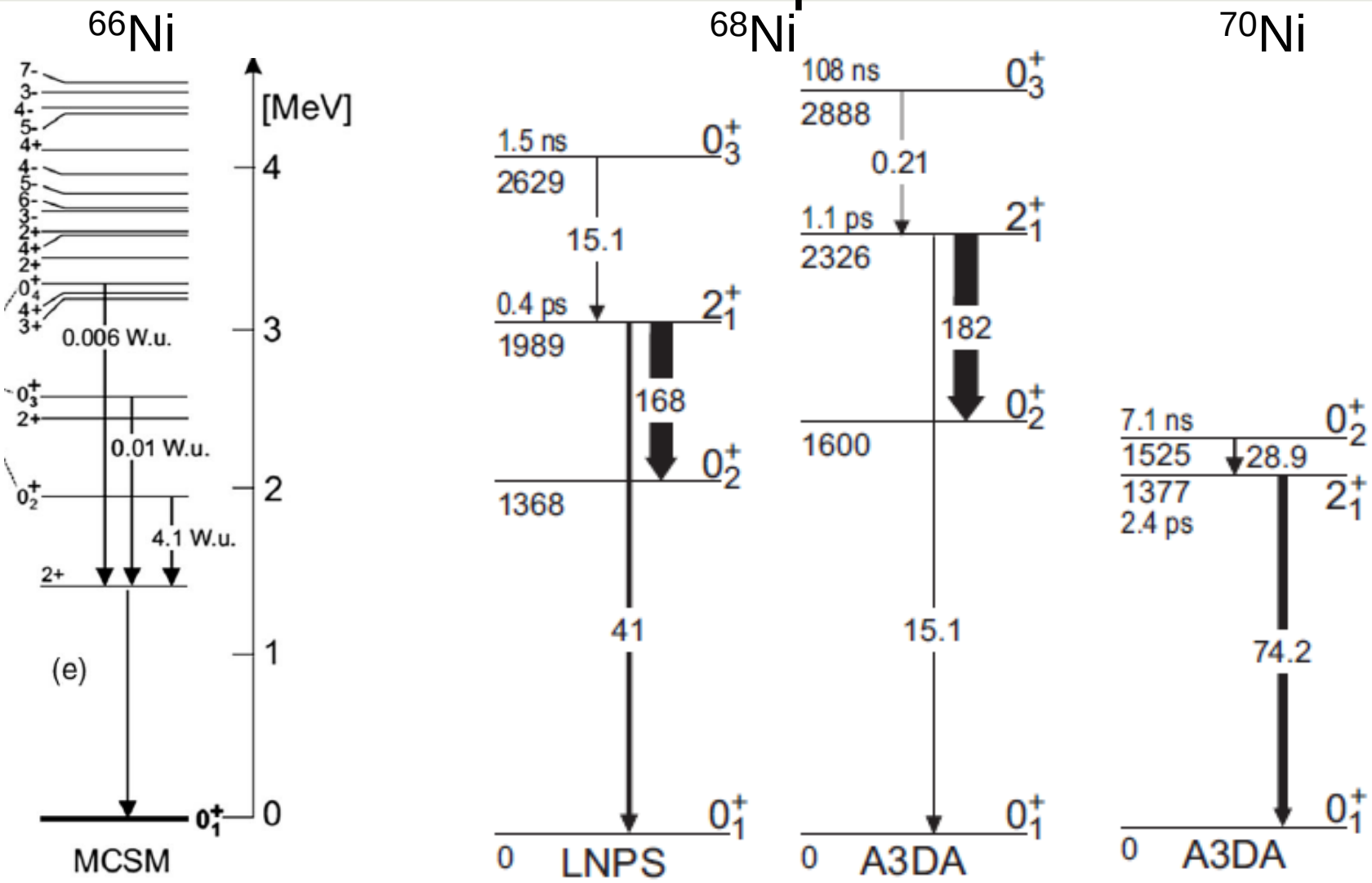


Expected Energy Systematics in the Ni isotopes



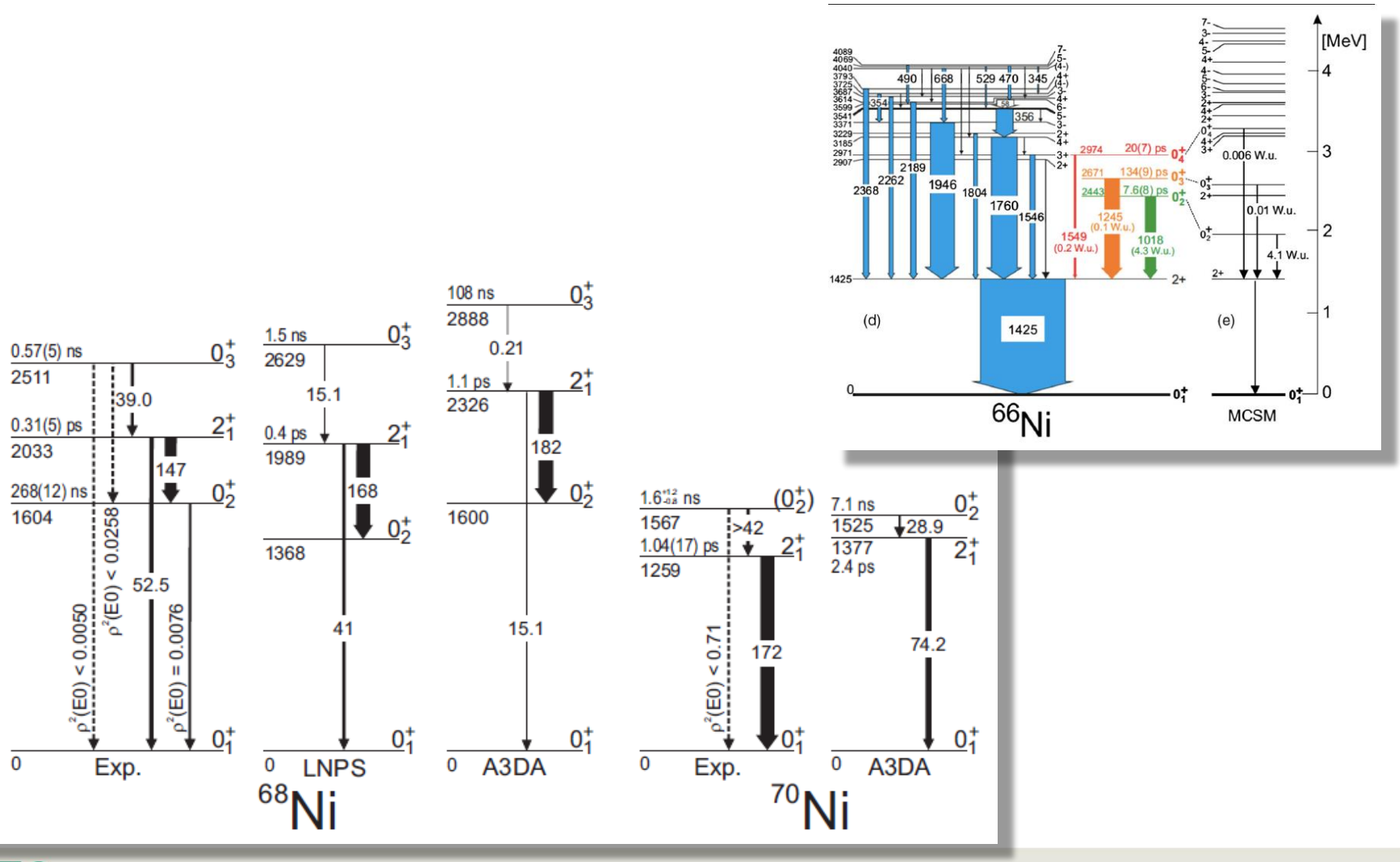
Y. Tsunoda *et al*., Phys. Rev. C **89**, 031301 (2014).

Expected Branching ratios and lifetimes in the Ni isotopes

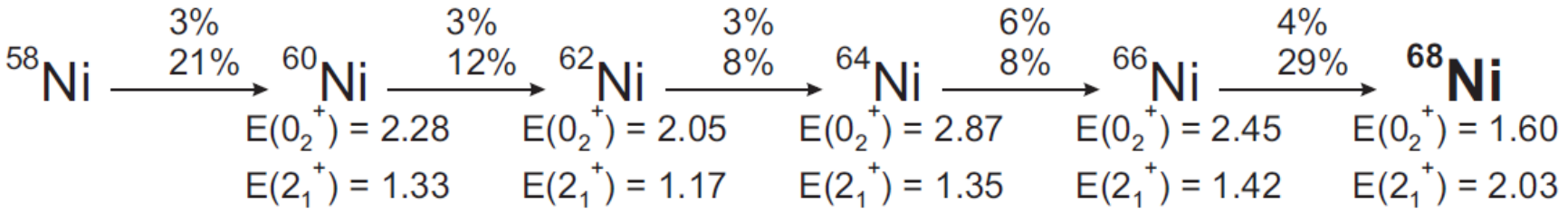


S. Leoni et al., PRL **118**, 162502 (2017)
B.P. Crider et al., PLB **764**, 108 (2016)

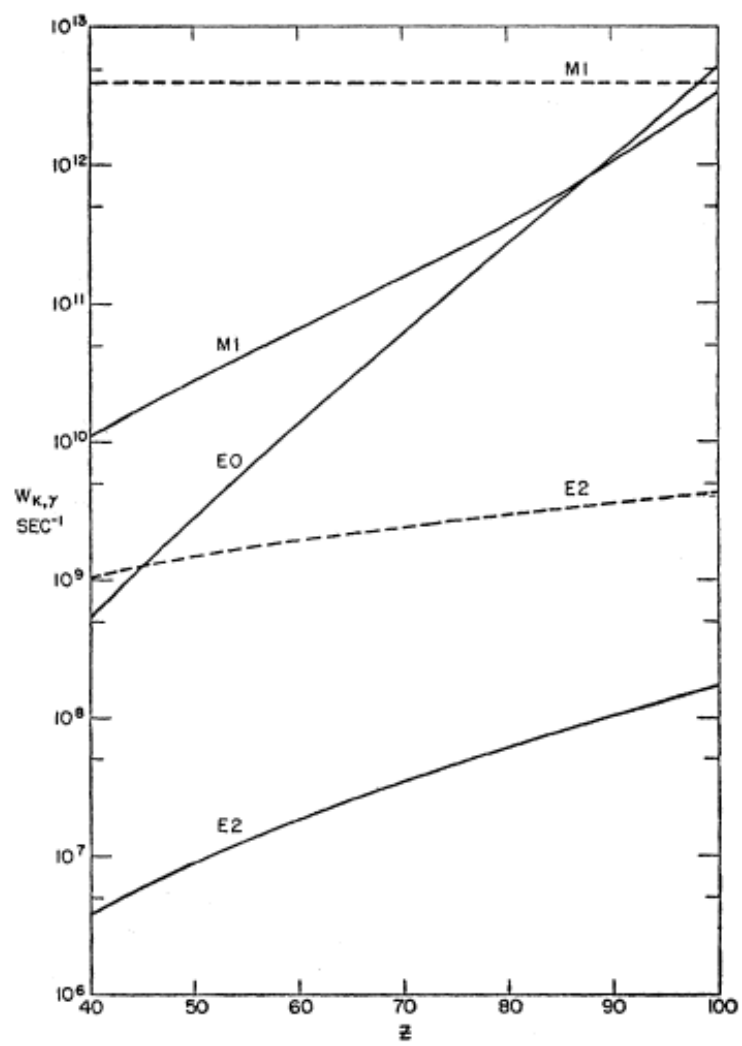
Level Schemes for ^{66,68,70}Ni isotopes



(t,p) reactions to Ni isotopes

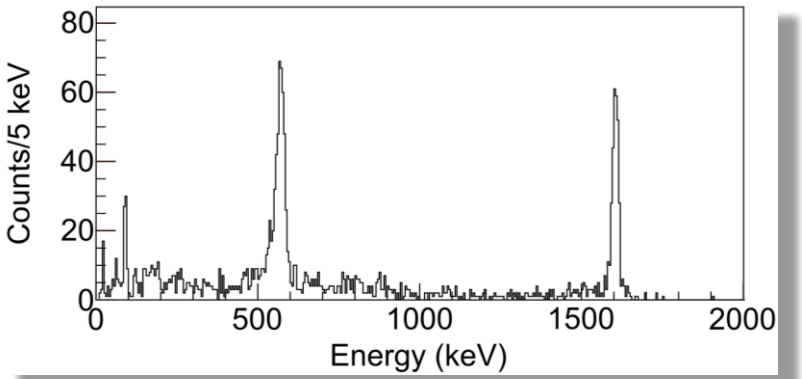


and of course E0 transition strengths



Z = 28

- There's only one: ^{68}Ni
- $0^+_2 \rightarrow 0^+_1$:
  - $\rho^2(E0) = 7.5(2)*10^{-3}$

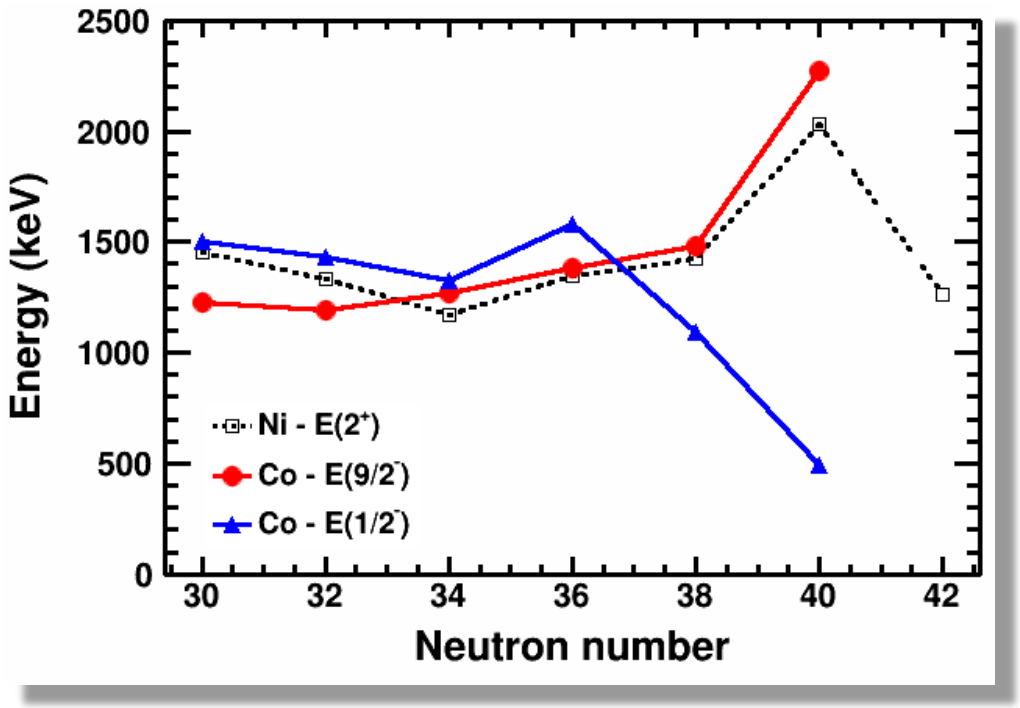


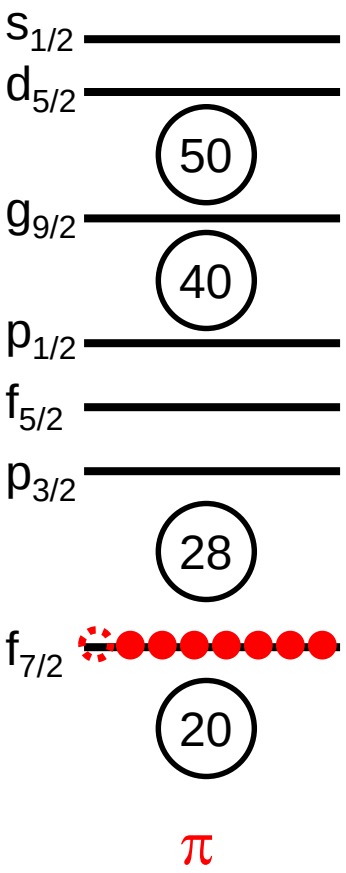
- Room for improvement

S. Suchyta *et al.*, PRC **89**, 021301 (2014)
E.L Church and J. Weneser PR **103**, 1035 (1956)

Co isotopes

- Excitations across Z = 28 in Co isotopes.
- Odd-mass nuclei as probes.

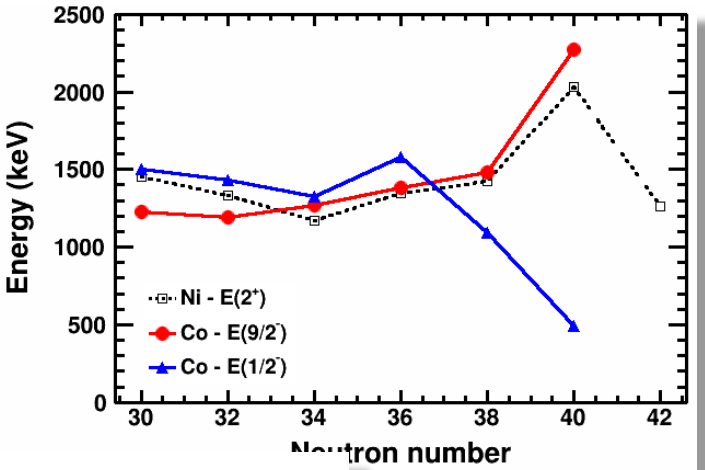


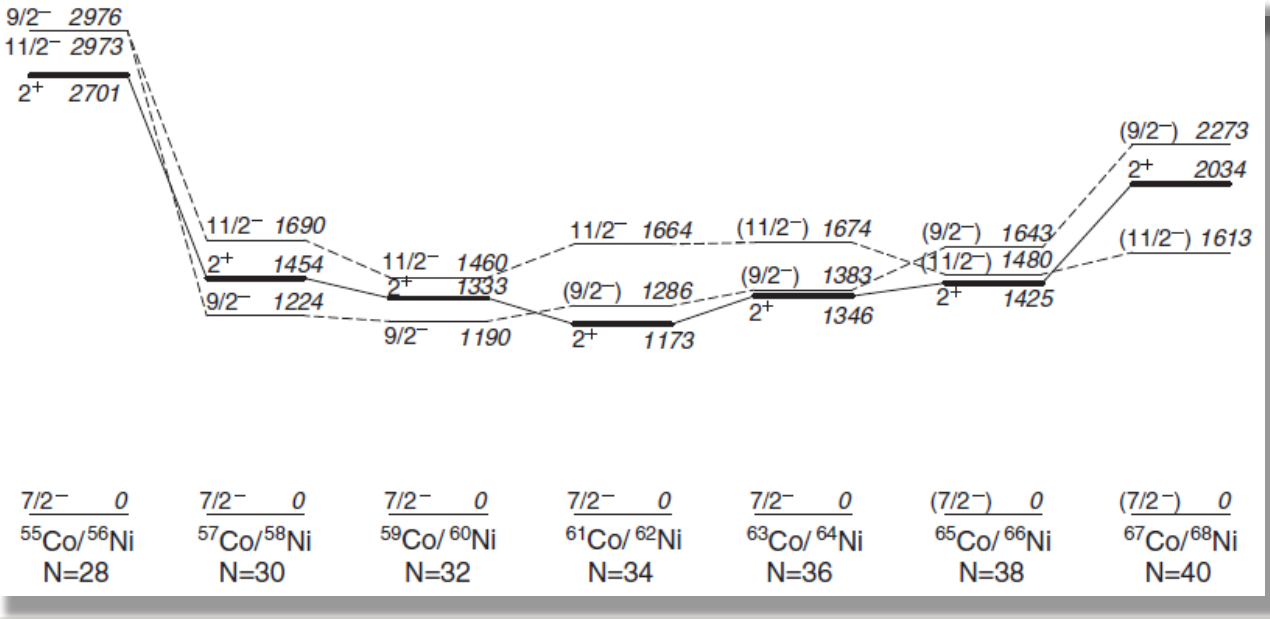


D. Pauwels *et al.*, PRC **78**, 041307 (2008).
D. Pauwels *et al.*, PRC **79** 044309 (2009).
F. Recchia *et al.*, PRC **85**, 064305 (2012).

Co isotopes: high-spin energy systematics

- Ground state $7/2^-$ spin and parity. Assigned as a hole in proton $f_{7/2}$.
- $9/2^-$ and $11/2^-$ excitation attributed to coupling with 2^+ in adjacent Ni isotopes.

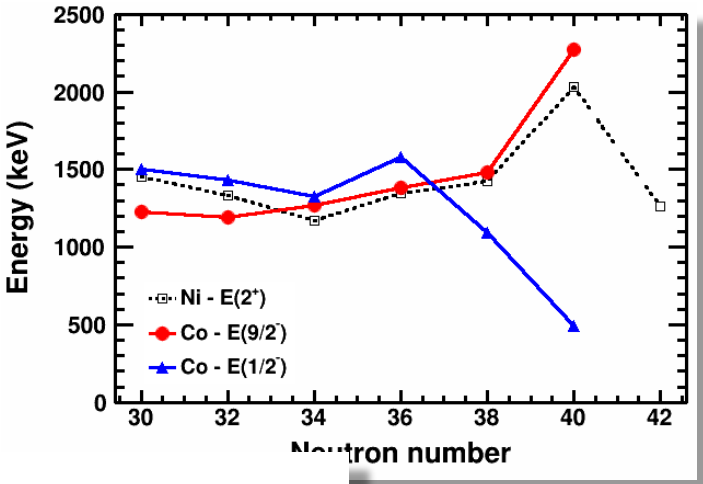


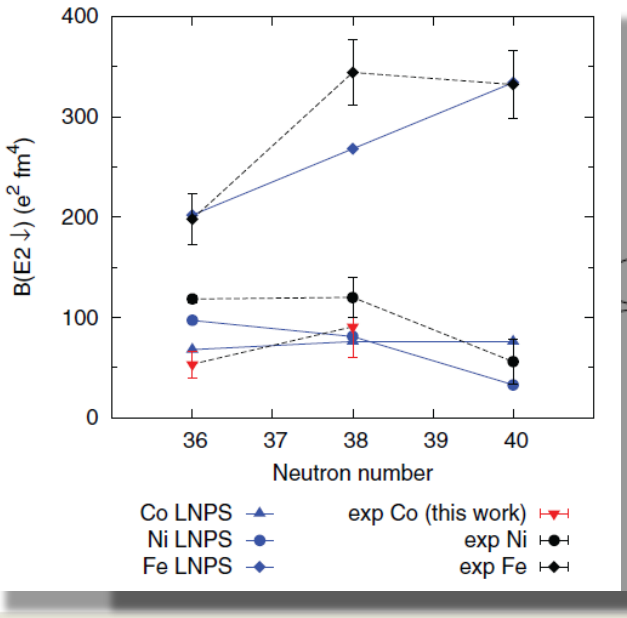


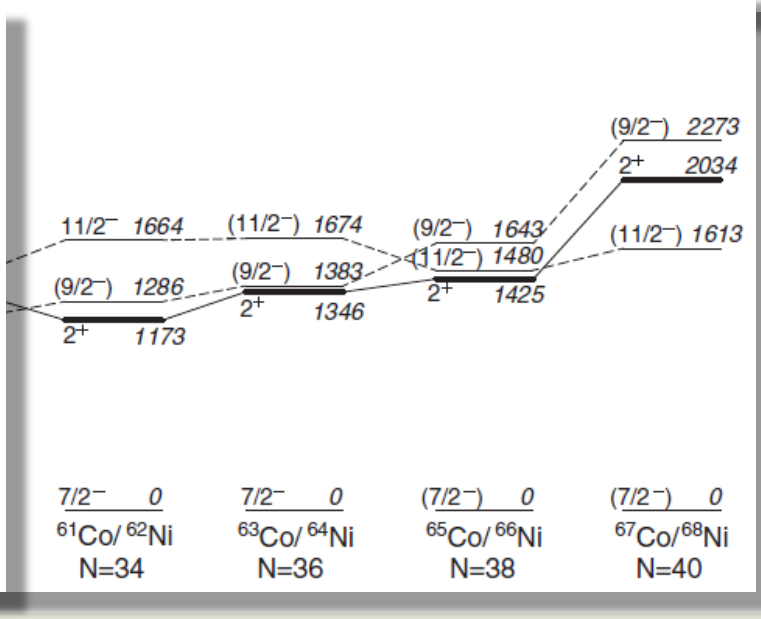
F. Recchia *et al.*, PRC **85**, 064305 (2012).

Co isotopes: high-spin B(E2)

- Ground state $7/2^-$ spin and parity. Assigned as a hole in proton $f_{7/2}$.
- $9/2^-$ and $11/2^-$ excitation attributed to coupling with 2^+ in adjacent Ni isotopes.



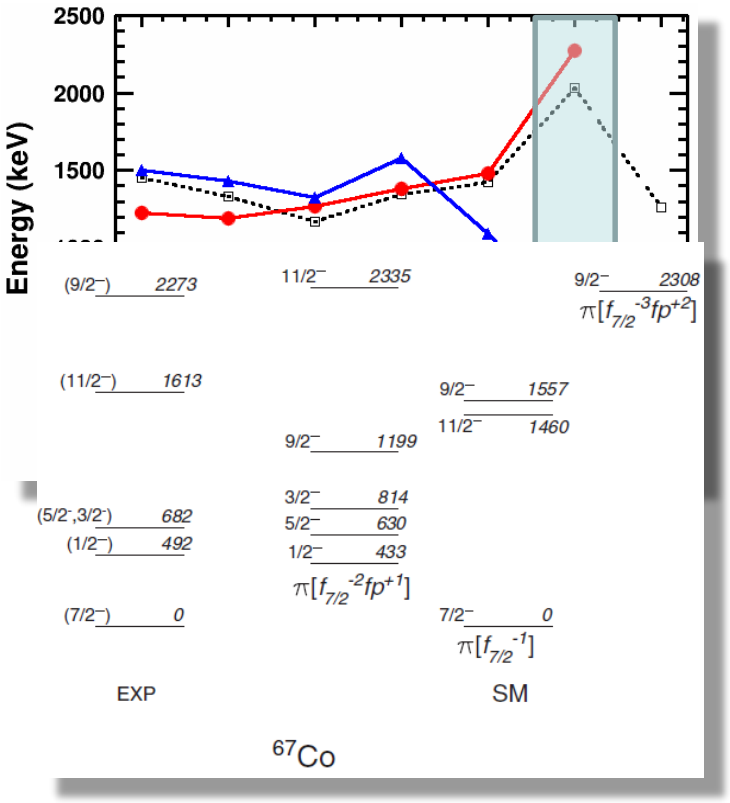


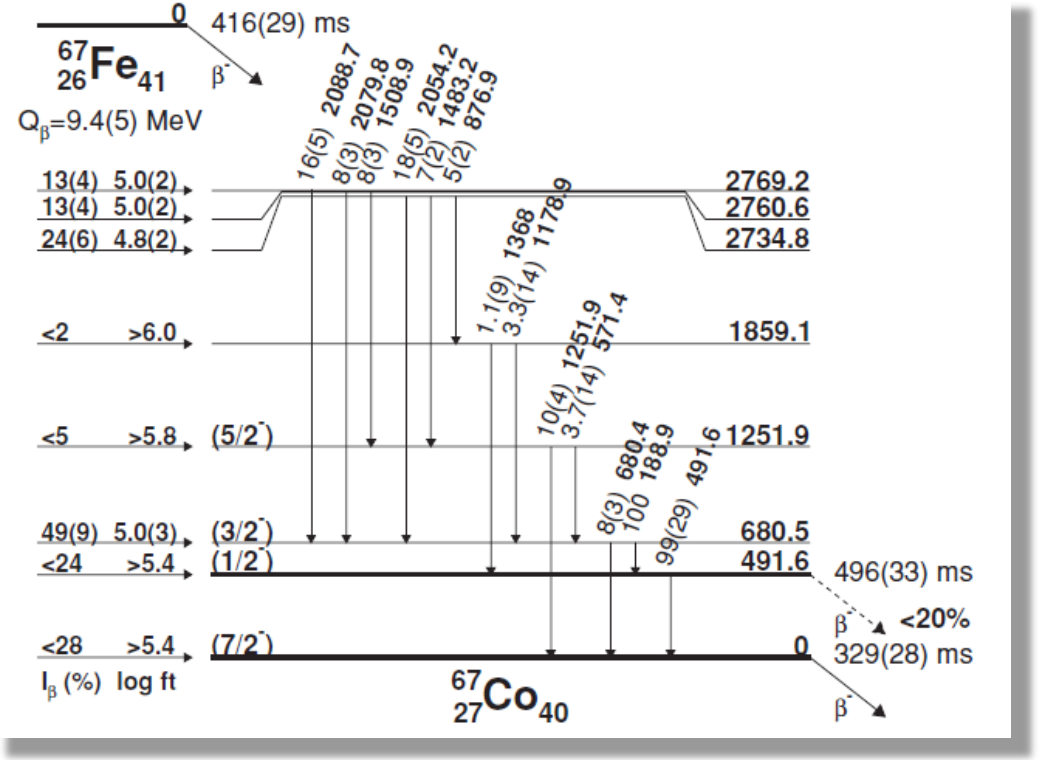


F. Recchia *et al.*, PRC **85**, 064305 (2012).
V. Modamio *et al.*, PRC **88**, 044326 (2013)
A. Dijon *et al.*, PRC **83**, 064321 (2011)

^{67}Co: low-spin ½-

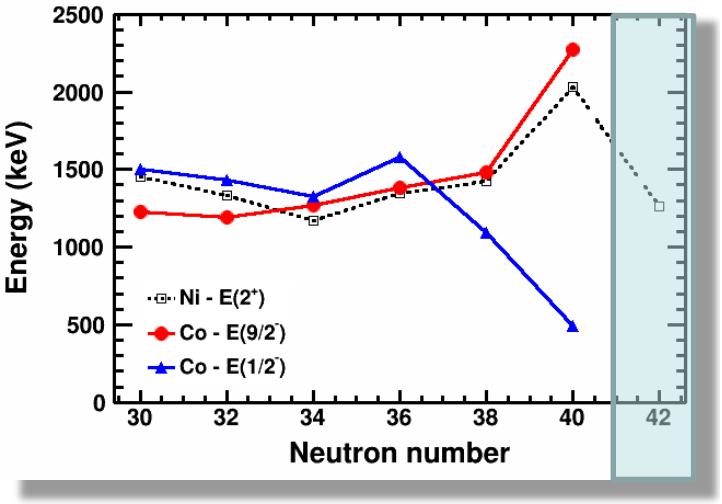
- Excited 1/2- state follows systematics of $9/2^-$ up to N = 38

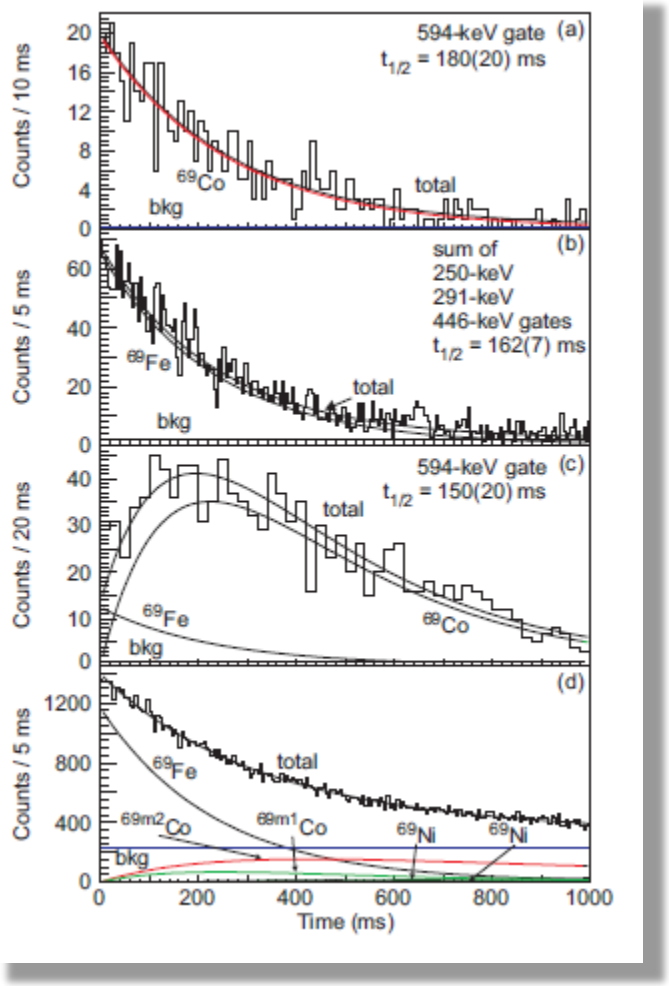


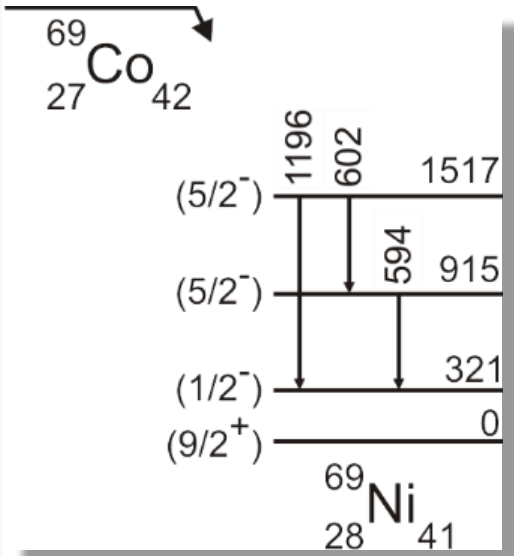


D. Pauwels *et al.*, PRC **78**, 041307 (2008).
D. Pauwels *et al.*, PRC **79** 044309 (2009).
F. Recchia *et al.*, PRC **85**, 064305 (2012).

^{69}Co – Multiple beta-decaying states present

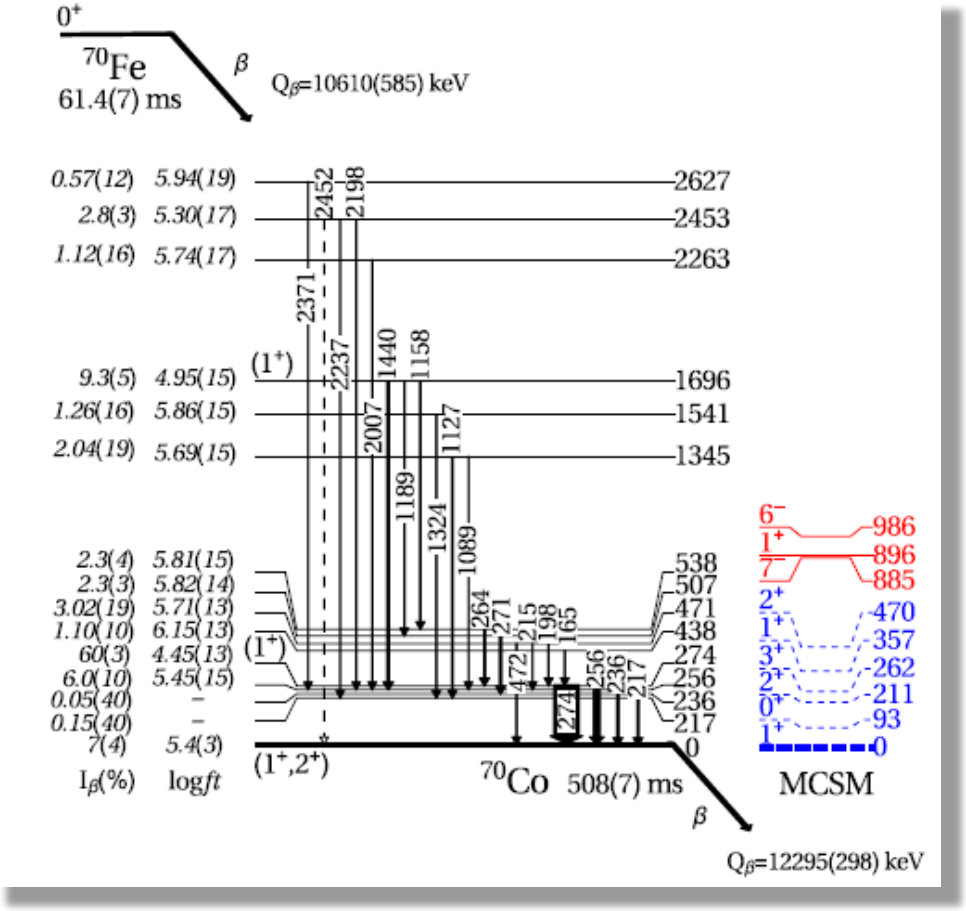






SNL *et al.*, PRC **92**, 024319 (2015)

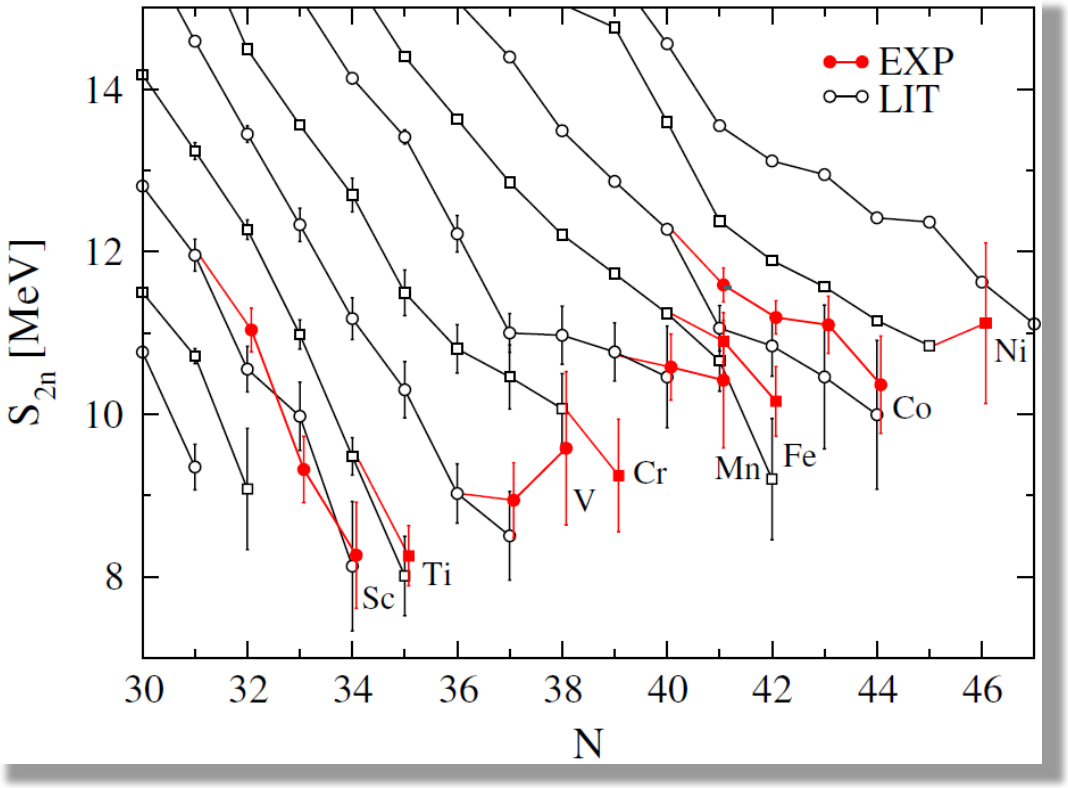
^{70}Co – an example of what is next



A.I. Morales *et al.*, PLB **765**, 328 (2017).

Mass surface

- Mass surface for Z = 21 – 29 around N = 40.
- Errors are still large.
- Need to take proper account of isomeric states in region.
- Multiple beta-decaying isomers
  - ^{67,68,69,70}Co



A. Estrade *et al*., PRL **107**, 172503 (2011)

Summary

- Need to search for remaining states in nuclei with neutron numbers beyond N = 40.
- Need to push beyond energy systematics in lighter-Z nuclei.
- Mass measurements / laser spectroscopy are needed in Co isotopes.
- Branching ratio and lifetime measurements are important.
  - Branches are small
- What is necessary to connect regions?