

Coulomb Excitation of neutron-rich Cd Isotopes

Anna-Lena Hartig

for the IS411/IS477/IS524 collaborations

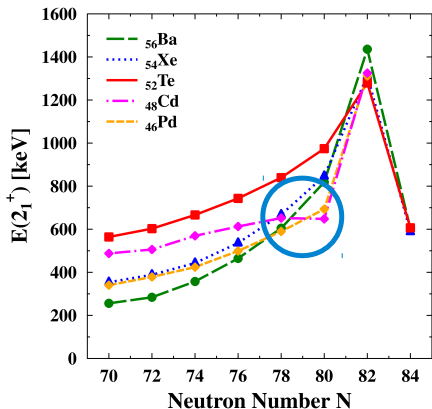


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DARMSTADT

¹²² Xe	¹²³ Xe	¹²⁴ Xe	¹²⁵ Xe	¹²⁶ Xe	¹²⁷ Xe	¹²⁸ Xe	¹²⁹ Xe	¹³⁰ Xe	¹³¹ Xe	¹³² Xe	¹³³ Xe	¹³⁴ Xe	¹³⁵ Xe	¹³⁶ Xe	¹³⁷ Xe	¹³⁸ Xe	¹³⁹ Xe	¹⁴⁰ Xe
¹²¹ I	¹²² I	¹²³ I	¹²⁴ I	¹²⁵ I	¹²⁶ I	¹²⁷ I	¹²⁸ I	¹²⁹ I	¹³⁰ I	¹³¹ I	¹³² I	¹³³ I	¹³⁴ I	¹³⁵ I	¹³⁶ I	¹³⁷ I	¹³⁸ I	¹³⁹ I
¹²⁰ Te	¹²¹ Te	¹²² Te	¹²³ Te	¹²⁴ Te	¹²⁵ Te	¹²⁶ Te	¹²⁷ Te	¹²⁸ Te	¹²⁹ Te	¹³⁰ Te	¹³¹ Te	¹³² Te	¹³³ Te	¹³⁴ Te	¹³⁵ Te	¹³⁶ Te	¹³⁷ Te	¹³⁸ Te
¹¹⁹ Sb	¹²⁰ Sb	¹²¹ Sb	¹²² Sb	¹²³ Sb	¹²⁴ Sb	¹²⁵ Sb	¹²⁶ Sb	¹²⁷ Sb	¹²⁸ Sb	¹²⁹ Sb	¹³⁰ Sb	¹³¹ Sb	¹³² Sb	¹³³ Sb	¹³⁴ Sb	¹³⁵ Sb	¹³⁶ Sb	¹³⁷ Sb
¹¹⁸ Sn	¹¹⁹ Sn	¹²⁰ Sn	¹²¹ Sn	¹²² Sn	¹²³ Sn	¹²⁴ Sn	¹²⁵ Sn	¹²⁶ Sn	¹²⁷ Sn	¹²⁸ Sn	¹²⁹ Sn	¹³⁰ Sn	¹³¹ Sn	¹³² Sn	¹³³ Sn	¹³⁴ Sn	¹³⁵ Sn	¹³⁶ Sn
¹¹⁷ In	¹¹⁸ In	¹¹⁹ In	¹²⁰ In	¹²¹ In	¹²² In	¹²³ In	¹²⁴ In	¹²⁵ In	¹²⁶ In	¹²⁷ In	¹²⁸ In	¹²⁹ In	¹³⁰ In	¹³¹ In	¹³² In	¹³³ In	¹³⁴ In	¹³⁵ In
¹¹⁶ Cd	¹¹⁷ Cd	¹¹⁸ Cd	¹¹⁹ Cd	¹²⁰ Cd	¹²¹ Cd	¹²² Cd	¹²³ Cd	¹²⁴ Cd	¹²⁵ Cd	¹²⁶ Cd	¹²⁷ Cd	¹²⁸ Cd	¹²⁹ Cd	¹³⁰ Cd	¹³¹ Cd	¹³² Cd		
¹¹⁵ Ag	¹¹⁶ Ag	¹¹⁷ Ag	¹¹⁸ Ag	¹¹⁹ Ag	¹²⁰ Ag	¹²¹ Ag	¹²² Ag	¹²³ Ag	¹²⁴ Ag	¹²⁵ Ag	¹²⁶ Ag	¹²⁷ Ag	¹²⁸ Ag	¹²⁹ Ag	¹³⁰ Ag			
¹¹⁴ Pd	¹¹⁵ Pd	¹¹⁶ Pd	¹¹⁷ Pd	¹¹⁸ Pd	¹¹⁹ Pd	¹²⁰ Pd	¹²¹ Pd	¹²² Pd	¹²³ Pd	¹²⁴ Pd								
¹¹³ Rh	¹¹⁴ Rh	¹¹⁵ Rh	¹¹⁶ Rh	¹¹⁷ Rh	¹¹⁸ Rh	¹¹⁹ Rh	¹²⁰ Rh	¹²¹ Rh	¹²² Rh									

Neutron-rich Cd Isotopes

- ▶ $E(2_1^+)$ drops from ^{126}Cd to ^{128}Cd
 - ▶ Not reproduced by SM

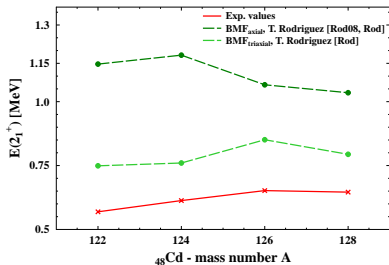


Data from <http://www.nndc.bnl.gov/>
 ^{128}Pd : H. Watanabe, PRL 111, 152501 (2013)

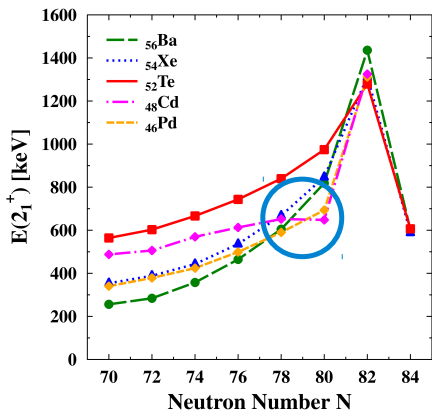
Neutron-rich Cd Isotopes

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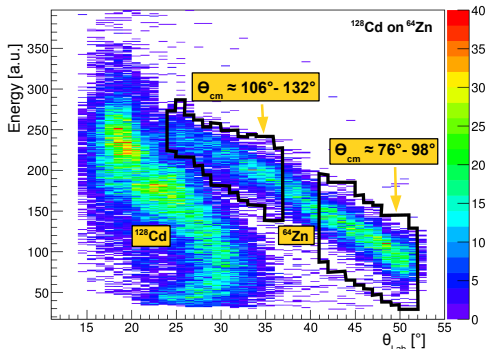
- Not reproduced by SM
- Beyond Mean Field reproduces the trend of $E(2^+)$



T. Rodríguez, then TU Darmstadt



Data from <http://www.nndc.bnl.gov/>
 ^{128}Pd : H. Watanabe, PRL 111, 152501 (2013)

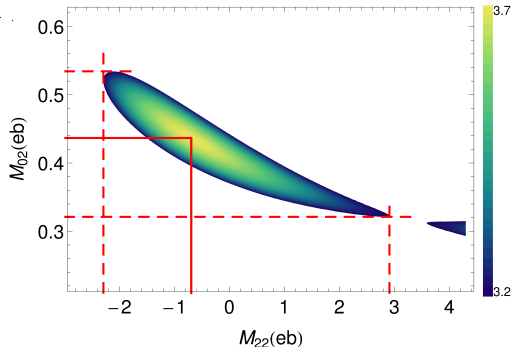


- ▶ Two ranges on kinematic plot
- ▶ Maximum likelihood analysis
- ▶ $M_{02} \longrightarrow B(E2)=0.19 e^2b^2$
- ▶ $M_{22} \longrightarrow Q_s=-0.5 \text{ eb}$

Beam energy	2.82 MeV/u
Particles on target	10^3 pps
^{128}Cd in beam	47(5)%

S. Bönig, PhD thesis, TU Darmstadt, 2014

Analysis of ^{128}Cd

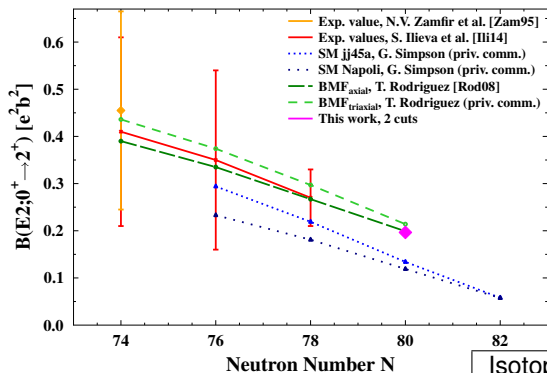


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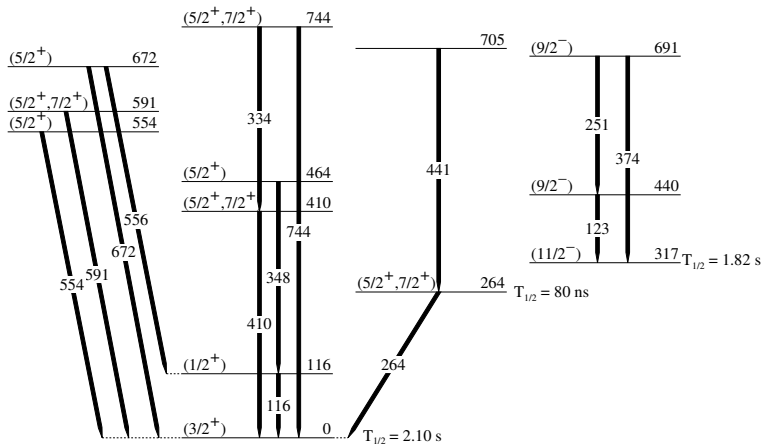
Results for the even-A Cd Isotopes



S. Ilieva, Phys. Rev. C, 89:014313, Jan 2014
 S. Böniß, PhD thesis, TU Darmstadt, 2014

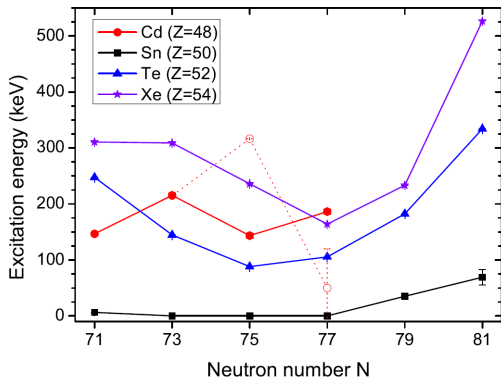
Isotope	B(E2)[e ² b ²]	Q _s [eb]
¹²² Cd	0.41(20)	-0.03 ^{+3.0} _{-1.6}
¹²⁴ Cd	0.35(19)	0.07 ^{+2.9} _{-1.5}
¹²⁶ Cd	0.27(6)	0.27 ^{+1.1} _{-0.7}
¹²⁸ Cd	0.19	-0.5

Adopted Level Scheme for ^{123}Cd (Excerpt)



H. Huck, Phys. Rev. C 40, 1384 (1989)
<http://www.nndc.bnl.gov/ensdf/>

Mass Measurement of the Isomeric State



A. Kankainen, Phys. Rev. C, 87:024307, Feb 2013

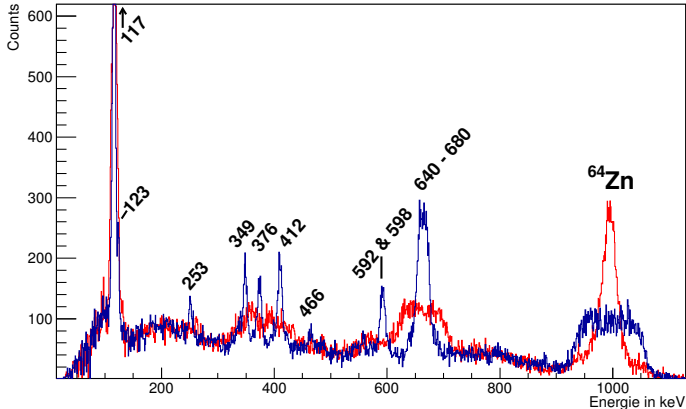
► Mass measurement with JYFLTRAP

- Time-of-Flight Ion Cyclotron Resonance Technique
- New value for the $11/2^-$ -state **144(4) keV**
A. Kankainen, Phys. Rev. C, 87:024307, Feb 2013

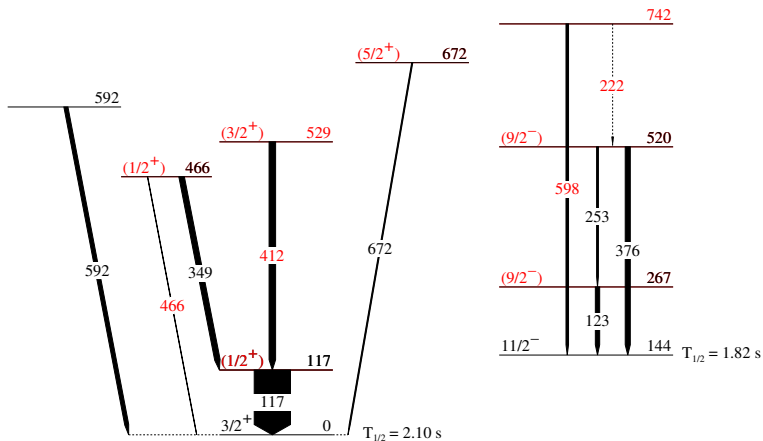
► Conflict with **316.52 keV** H. Huck, Phys. Rev. C 40, 1384 (1989)

γ -Spectrum with Doppler Correction for Projectile and Target

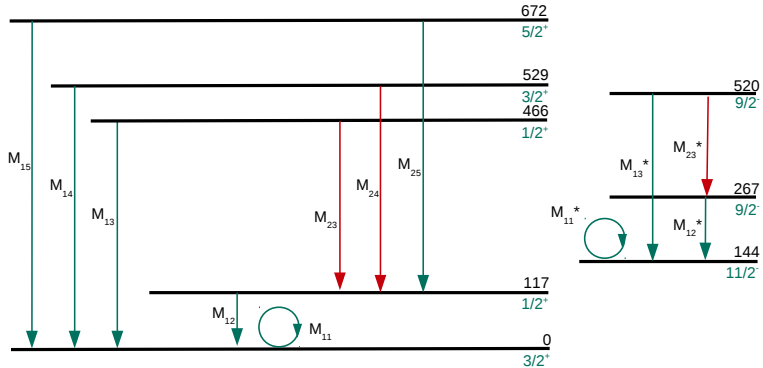
Beam energy 2.85 MeV/u
 ^{123}Cd in beam 29%



Determined Level Scheme for ^{123}Cd

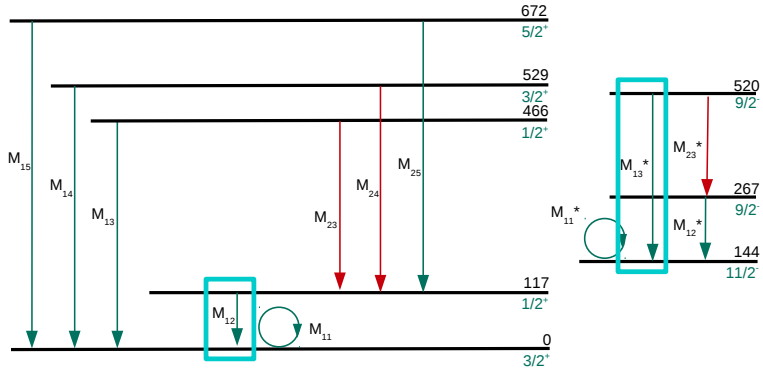


Matrix Elements



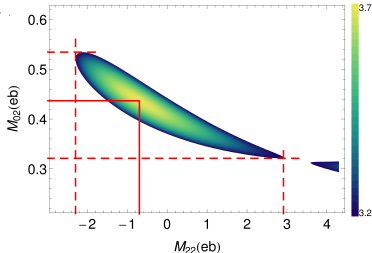
- Quadrupole moments from
D. T. Yordanov, Phys. Rev. Lett., 110:192501, May 2013

Matrix Elements



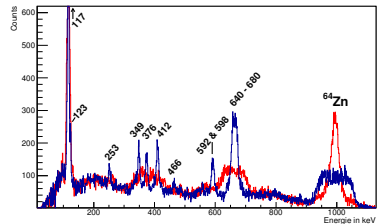
- ▶ 117 keV $\rightarrow M_{3/2 \rightarrow 1/2} = 0.95(4)$ eb
- ▶ 376 keV $\rightarrow M_{11/2 \rightarrow 9/2} = 0.50(4)$ eb

Summary



- ▶ Revision of adopted level scheme
- ▶ Negative and positive parity orbitals contribute to collectivity

- ▶ B(E2) values larger than expected from SM
- ▶ Better agreement with BMF
- ▶ No clear conclusion due to $Q(2^+)$



- ▶ Decay spectroscopy with IDS to determine level scheme
- ▶ Narrow-band laser scans in future experiments



Thank you for your attention!

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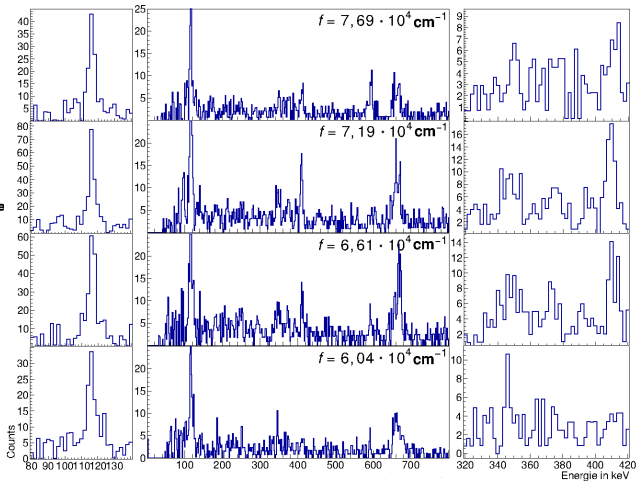
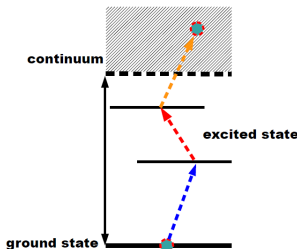


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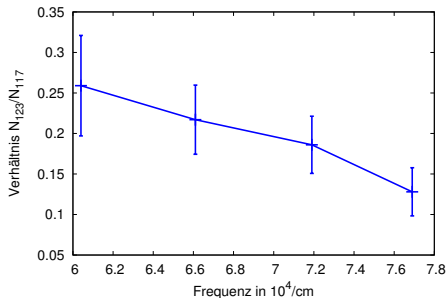


and the IS524-Miniball
Collaboration

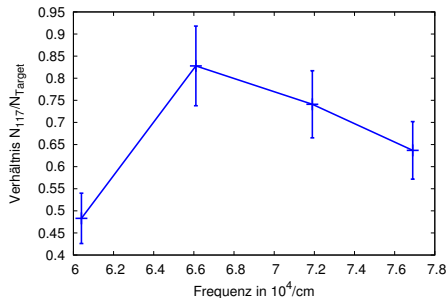
Selective Laser Ionization



Determination of Isomeric Concentration



Ratio of isomeric to ground state

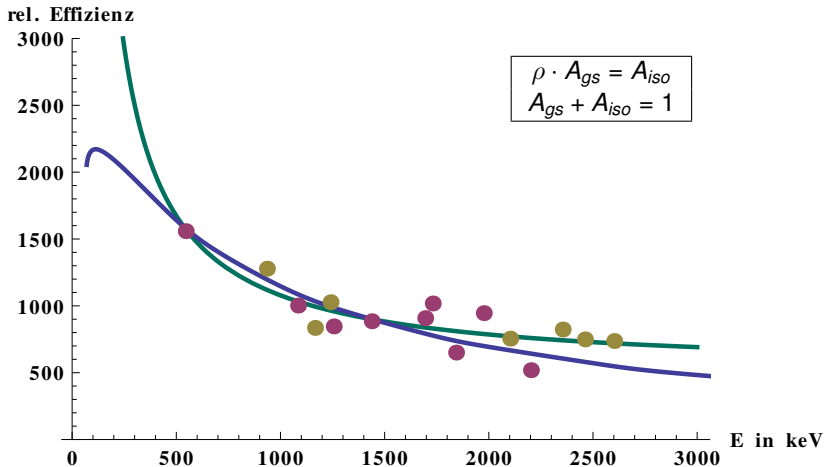


Share of ground state in all events

Calculated Transition Strengths

E_γ in keV	Matrix element	reduced transition probability	
117	0,92 eb	$B(E2, 3/2^+ \rightarrow 1/2^+)$	$0,212(19) e^2b^2$
349	$0,787 \mu_N$	$B(M1, 1/2^+ \rightarrow 1/2^+)$	$0,309(30) \mu_N^2$
466	0,54 eb	$B(E2, 3/2^+ \rightarrow 1/2^+)$	$0,0729(116) e^2b^2$
412	$0,85 \mu_N$	$B(M1, 1/2^+ \rightarrow 3/2^+)$	$0,361(36) \mu_N^2$
529	0,55 eb	$B(E2, 3/2^+ \rightarrow 3/2^+)$	$0,0756(214) e^2b^2$
555	0,271 eb	$B(E2, 1/2^+ \rightarrow 3/2^+)$	$0,0367(81) e^2b^2$
672	0,71 eb	$B(E2, 3/2^+ \rightarrow 5/2^+)$	$0,126(19) e^2b^2$
123	0,182 eb	$B(E2, 11/2^- \rightarrow 9/2^-)$	$0,00279(24) e^2b^2$
253	$0,208 \mu_N$	$B(M1, 9/2^- \rightarrow 9/2^-)$	$0,00433(41) \mu_N^2$
376	0,501 eb	$B(E2, 11/2^- \rightarrow 9/2^-)$	$0,0209(17) e^2b^2$

Determination of Isomeric Concentration



Koinzidenz mit 117 keV

