^{77}Cu β^- decay (469.8 ms) 2009Il01,2009Pa35

History			
Type	Author	Citation	Literature Cutoff Date
Full Evaluation	Balraj Singh	ENSDF	30-Sep-2020

Parent: ^{77}Cu: E=0.0; $J^\pi=5/2^-$; $T_{1/2}$=469.8 ms *20*; Q(β^-)=9926.4 *23*; %β^- decay=100.0

^{77}Cu-Q(β^-): From measured mass excess for ^{77}Cu from 2017We16 and mass excess for ^{77}Zn from 2017Wa10. Other: 10170 *150* (syst, 2017Wa10).

^{77}Cu-J^π,$T_{1/2}$: From ^{77}Cu Adopted Levels.

^{77}Cu-%β^- decay: %β^-n=30.3 *20* (2009Il01), weighted average of two measurements giving 31.6 *12* and 28.0 *16*. Other: 30.0 *27* (2009Wi03, from the same group as 2009Il01).

2009Il01, 2009Wi03: ^{77}Cu isotope produced in the reaction ^{238}U(p,F) with a 50 MeV beam provided by the HRIBF facility at ORNL, RIB facility. The radioactive beams were extracted and mass separated. Detected decay products with a Micro-channel plate detector, an ionization chamber and a moving tape collector. In one experiment, the Cu ions were accelerated to 225 MeV and measured β-delayed neutron emission probabilities. In a second experiment, the low-energy ions (200 keV) were sent to Low-energy Radioactive Ion Beam Spectroscopy Station (LeRIBSS). Measured Eγ, Iγ, β, $\gamma\gamma$, $\beta\gamma$ coin, absolute branching ratios in ^{77}Cu β decay and 772.4-keV ($1/2^-$) isomer in ^{77}Zn, half-life of ^{77}Cu g.s. using two plastic β-detectors and γ-rays with four clover Ge detectors. 2009Gr06 is from the same group as 2009Wi03.

2009Pa35: ^{77}Cu produced in the fission of uranium (target=uranium carbide) by spallation neutrons which were produced by 1 GeV protons hitting a tantalum target. The ^{77}Cu nuclei were selected by Resonant Ionization Laser Ion Source (RILIS) and General Purpose mass separator (GPS) at the CERN-ISOLDE facility. The separated ^{77}Cu nuclei at a typical energy of 60 keV were implanted on a tape surrounded by three E-ΔE plastic detectors for β-particle detection and two HPGe detectors. Measured γ, β, $\beta\gamma$ coin, $\beta\beta$ coin, $\gamma\gamma$ coin and delayed-neutron events. The neutrons were detected with the Mainz neutron long counter. Major contribution to γ-ray and β spectra are from ^{77}Ga decay as indicated by a comparison of 'laser-on' and 'laser-off' spectra. In both the spectra, lines from ^{77}Ga are quite prominent. The decay scheme of ^{77}Ga is poorly known. By subtraction procedures, 2009Pa35 obtained a spectrum which mainly contained lines from ^{77}Cu activity. In the presence of the impurities, singles β spectrum could not be obtained, thus no information could be obtained for β feeding to the ground state and the 772-keV isomeric state.

All data are from 2009Il01, unless otherwise stated. The level schemes are proposed by 2009Il01 and 2009Pa35, more complete in the former work, thus adopted here.

Total decay energy of 7231 keV *320* deduced (by RADLIST code) from proposed decay scheme is much lower than the expected value of 10490 keV *500*, indicating that decay scheme is incomplete.

^{77}Zn Levels

E(level)‡	J^π†	$T_{1/2}$†	Comments
0.0	$7/2^+$	2.08 s *5*	Configuration=$\nu g_{9/2}^{-3}$.
114.721 *10*	$(9/2^+)$		
772.440 *15*	$1/2^-$	1.05 s *10*	%β^-=66 *7*; %IT=34 *7* (2009Il01) Total feeding of this isomer is 31.4% *33*, out of which 10.8% *3* proceeds via IT decay and 20.6% *33* via β- decay (2009Il01). Probable $\nu p_{1/2}$ orbital.
801.89 *11*	$(11/2^+)$		J^π: $(11/2^+)$ proposed in 2009Pa35 based on systematics.
1130.5 *3*			
1235.1 *5*			
1277.690 *15*	$(5/2^-,3/2^+)$		J^π: $(3/2^+)$ in 2009Il01 and $(5/2^-)$ proposed in 2009Pa35 based on systematics.
1284.62 *15*			
1363.786 *25*	$(1/2^+,3/2^-)$		J^π: $(1/2^+)$ in 2009Il01 and $(3/2^-)$ proposed in 2009Pa35.
1409.078 *20*			
1427.3 *3*			
1637.48 *21*			
1875.66 *11*			
2082.81 *4*			
2152.6 *23*			
2235.378 *24*	$(5/2^+)$		

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^{77}Cu β^- decay (469.8 ms) 2009Il01,2009Pa35 (continued)

^{77}Zn Levels (continued)

E(level)[‡]	Comments
2380.4 *3*	
2527.2? *5*	
2545.84 *12*	
2574.2? *4*	
2654.14 *9*	
2872.67 *5*	
2891.8? *3*	
3001.12 *10*	
3083.18 *9*	
3095.1? *5*	
3139.30 *15*	
3204.56 *5*	
3386.92 *13*	
3426.98 *13*	
3709.9 *15*	
3744.00 *9*	
3823.88 *16*	
4334.35 *20*	
4531.9 *4*	
4557.5+x	E(level): level introduced by compiler to account for population of neutron-unbound levels, as suggested by %β^-n values measured by 2010Ho10 and 2014XuZZ. 2009Pa35 estimate log *ft*=4.1 for level decaying by neutrons to first 2^+ level in ^{76}Zn and 4.4 for level decaying to first 4^+ level in ^{76}Zn, but the feeding pattern of ^{76}Zn levels could be more complex x<5368.9 *34* from Q(β^-)-S(n)(^{77}Zn), where Q(β^-)=9926.4 *23* and S(n)=4557.5 *25* (2017Wa10 and mass measurement by 2017We16).
4605.27 *21*	

† From Adopted Levels, based on systematics, decay pattern and β feedings.
‡ From least-square fit to Eγ data. Due to poor fit in the level scheme, 2118.8γ from 2235 level was not included in the fitting procedure.

β^- radiations

E(decay)	E(level)	Iβ^-[†‡]	Log *ft*[†]	Comments
(5321.1 *23*)	4605.27	1.54 *16*	5.63 *5*	av Eβ=2403.1 *12*
(3×10^3[@] *3*)	4557.5+x	30.1 *20*		Iβ^-: from %β^-n=30.1 *20* for ^{77}Cu decay (see ^{77}Cu Adopted Levels).
(5394.5 *23*)	4531.9	0.44 *7*	6.2 *1*	av Eβ=2438.7 *12*
(5592.1 *23*)	4334.35	1.17 *13*	5.84 *5*	av Eβ=2534.7 *12*
(6102.5 *23*)	3823.88	2.19 *17*	5.74 *4*	av Eβ=2783.0 *12*
(6182.4 *23*)	3744.00	3.0 *4*	5.6 *1*	av Eβ=2821.8 *12*
(6217 *3*)	3709.9	0.90 *12*	6.2 *1*	av Eβ=2838.4 *14*
(6499.4 *23*)	3426.98	1.55 *18*	6.02 *5*	av Eβ=2976.1 *12*
(6539.5 *23*)	3386.92	1.89 *16*	5.95 *4*	av Eβ=2995.6 *12*
(6721.8 *23*)	3204.56	5.1 *3*	5.57 *3*	av Eβ=3084.3 *12*
(6787.1 *23*)	3139.30	2.19 *24*	5.96 *5*	av Eβ=3116.1 *12*
(6831.3[#] *24*)	3095.1?	0.23 *8*	7.0 *2*	av Eβ=3137.6 *12*
(6843.2 *23*)	3083.18	2.26 *19*	5.96 *4*	av Eβ=3143.4 *12*
(6925.3 *23*)	3001.12	1.35 *18*	6.2 *1*	av Eβ=3183.3 *12*
(7034.6[#] *23*)	2891.8?	0.35 *8*	6.8 *1*	av Eβ=3236.5 *12*
(7053.7 *23*)	2872.67	4.3 *3*	5.74 *3*	av Eβ=3245.8 *12*
(7272.3 *23*)	2654.14	1.69 *15*	6.21 *4*	av Eβ=3352.2 *12*
(7352.2[#] *23*)	2574.2?	0.36 *8*	6.9 *1*	av Eβ=3391.1 *12*

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^{77}Cu β^- decay (469.8 ms) 2009Il01,2009Pa35 (continued)

β^- radiations (continued)

E(decay)	E(level)	Iβ^-[†‡]	Log *ft*[†]	Comments
(7380.6 *23*)	2545.84	1.05 *12*	6.44 *5*	av Eβ=3404.9 *12*
(7399.2 *24*)	2527.2?	0.65 *11*	6.7 *1*	av Eβ=3414.0 *12*
(7546.0 *23*)	2380.4	0.66 *12*	6.7 *1*	av Eβ=3485.4 *12*
(7691.0 *23*)	2235.378	7.2 *4*	5.69 *3*	av Eβ=3556.0 *12* Log *ft*: value of 5.69 *3* is lower than >5.9 expected for a first-forbidden β transition.
(7774 *3*)	2152.6	0.57 *9*	6.8 *1*	av Eβ=3596.3 *16*
(7843.6 *23*)	2082.81	0.6 *3*	6.8 *2*	av Eβ=3630.3 *12*
(8050.7 *23*)	1875.66	1.04 *22*	6.6 *1*	av Eβ=3731.1 *12*
(8288.9 *23*)	1637.48	0.45 *8*	7.0 *1*	av Eβ=3846.9 *12*
(8499.1 *23*)	1427.3	0.9 *2*	6.8 *1*	av Eβ=3949.2 *12*
(8517.3 *23*)	1409.078	3.9 *4*	6.16 *5*	av Eβ=3958.0 *12*
(8562.6 *23*)	1363.786	1.0 *3*	6.8 *1*	av Eβ=3980.1 *12*
(8641.8 *23*)	1284.62	2.4 *2*	6.40 *4*	av Eβ=4018.6 *12*
(8648.7 *23*)	1277.690	1.9 *5*	6.5 *1*	av Eβ=4021.9 *12*
(8691.3 *24*)	1235.1	0.18 *7*	7.5 *2*	av Eβ=4042.6 *12*
(8795.9 *23*)	1130.5	0.35 *8*	7.3 *1*	av Eβ=4093.5 *12*
(9124.5[#] *23*)	801.89	0.82 *12*	>7.0	av Eβ=4253.2 *12* Iβ^-: 0.82 *12* from in-out intensity balance is inconsistent with expected zero feeding for a 5/2$^-$ to (11/2$^+$) β transition, thus the β feeding to this level is considered by the evaluator as questionable if J^π=(11/2$^+$) for the 802 level. Log *ft*: considered by evaluator as a lower limit.
(9154.0[#] *23*)	772.440			Apparent β feeding of 6% *3* from in-out intensity balance is within 2σ of expected zero feeding for a ΔJ=2, $\Delta\pi$=no β transition.
(9811.7 *23*)	114.721	1.9 *4*	9.1[1u] *1*	av Eβ=4593.3 *12*
(9926.4 *23*)	0.0	8 *3*	6.2 *2*	av Eβ=4642.8 *12* Iβ^-: from total (absolute) intensity of prompt γ rays, IT transition and 114γ (assumed as M1+E2, $\delta\approx$0.1)=41.1% *11* and absolute intensity out of the g.s. as 49.1% *26*. If 114γ is assumed E2 (an unlikely scenario), the β feeding to the g.s.=5% *3*. The value is from 2009Il01, none given in 2009Pa35.

[†] The β feedings are from γ-ray intensity balance at each level, unless otherwise stated. All β feedings are considered as upper limits and associated log *ft* values as lower limits since some γ rays may be below the detection limit of this experiment.
[‡] Absolute intensity per 100 decays.
[#] Existence of this branch is questionable.
[@] Estimated for a range of levels.

^{77}Cu β^- decay (469.8 ms) 2009Il01,2009Pa35 (continued)

$\gamma(^{77}Zn)$

Iγ normalization: From 2009Il01. Other: 0.198 obtained from intensity data per 100 decays of the parent measured by comparing γ-ray intensities to the number of implanted ^{77}Cu ions, as given in 2009Wi03. Normalization factor of ≈0.37 implied from β feedings and relative γ-ray intensities in level-scheme figure of 2009Pa35 seems in serious disagreement.

Values of relative γ-ray intensities from β-delayed neutron decay to ^{76}Zn from 2009Il01 are: 100.2 *9* for 598.56 *5* γ to first 2^+ level and 2.89 *11* for 697.72 *8* γ to first 4^+ level in ^{76}Zn. Corresponding value in 2009Pa35 is 89 *3* for 598.3 *3* γ.

E_γ †	I_γ †@	E_i(level)	J_i^π	E_f	J_f^π	Mult.	δ	α&	$I_{(\gamma+ce)}$ @	Comments
114.72 *1*	40.5 *11*	114.721	$(9/2^+)$	0.0	$7/2^+$	[M1+E2]	0.10 *3*	0.046 *2*	42.4 *11*	α(K)=0.041 *2*; α(L)=0.0043 *3*; α(M)=0.00062 *4*; α(N)=2.38×10^{-5} *12* Eγ=114.7 *3*, Iγ=33 *4* (2009Pa35). Absolute Iγ=6.0 (2009Wi03) in agreement with 7.7 from 2009Il01. $I_{(\gamma+ce)}$: from 2009Il01. I_γ: deduced (by evaluators) from listed I(γ+ce) and α. δ: assumed in 2009Il01 with an uncertainty of 0.03, from similar $9/2^+$ to $7/2^+$ transitions amongst low-lying levels in ^{73}Ge and ^{75}Ge.
131.35 *22*	1.37 *24*	1409.078		1277.690	$(5/2^-,3/2^+)$					
352.86 *15*	2.3 *4*	1637.48		1284.62						
466.88 *25*	2.9 *8*	1875.66		1409.078						
505.25 *1*	100.0 *7*	1277.690	$(5/2^-,3/2^+)$	772.440	$1/2^-$					Eγ=505.7 *9*, Iγ=100 *5* (2009Pa35). Absolute Iγ=19.8 (2009Wi03) in agreement with 19.1 from 2009Il01.
591.33 *2*	31.6 *7*	1363.786	$(1/2^+,3/2^-)$	772.440	$1/2^-$					Eγ=591.1 *2*, Iγ=34 *4* (2009Pa35).
637.29 *5*	7.2 *6*	2872.67		2235.378	$(5/2^+)$					Eγ=638.0 *10*, Iγ=7 *2* (2009Pa35).
687.17 *11*	4.2 *6*	801.89	$(11/2^+)$	114.721	$(9/2^+)$					Eγ=685.5 *5*, Iγ=4 *1* (2009Pa35).
772.43 *2*		772.440	$1/2^-$	0.0	$7/2^+$	[E3]				Measured Iγ=56.7 *11* (2009Il01), 64 *9* (2009Pa35). Absolute Iγ=10.8 (2009Il01), 11.1 (2009Wi03). No intensity is given in the data field for Iγ as it varies with time due to the long half-life of 1.05 s for the isomer as compared to the half-life 469.8 ms for the parent activity of ^{77}Cu. Eγ=772.0 *2* (2009Pa35).
805.11 *3*	18.9 *6*	2082.81		1277.690	$(5/2^-,3/2^+)$					Eγ=804.5 *10*, Iγ=16 *2* (2009Pa35).
826.33 *18*	1.7 *3*	2235.378	$(5/2^+)$	1409.078						
871.45 *9*	6.3 *6*	2235.378	$(5/2^+)$	1363.786	$(1/2^+,3/2^-)$					Eγ=871.9 *10*, Iγ=10 *2* (2009Pa35).
903.8 *14*	3.3 *6*	3139.30		2235.378	$(5/2^+)$					
957.69 *2*	36.2 *8*	2235.378	$(5/2^+)$	1277.690	$(5/2^-,3/2^+)$					Eγ=957.3 *3*, Iγ=40 *3* (2009Pa35).
997.29 *15*	2.9 *4*	2872.67		1875.66						

^{77}Cu β^- decay (469.8 ms) 2009Il01,2009Pa35 (continued)

$\gamma(^{77}Zn)$ (continued)

E_γ [†]	I_γ [†@]	E_i(level)	J_i^π	E_f	J_f^π	Comments
1000.33 *14*	3.4 *5*	3083.18		2082.81		
1015.8 *3*	1.8 *4*	1130.5		114.721	$(9/2^+)$	
1056.6 *3*	2.0 *4*	3139.30		2082.81		
1120.4 *5*	0.9 *4*	1235.1		114.721	$(9/2^+)$	
1169.81 *16*	3.9 *5*	1284.62		114.721	$(9/2^+)$	Eγ=1169.8 *10*, Iγ=6 *1* (2009Pa35).
1268.14 *12*	5.4 *6*	2545.84		1277.690	$(5/2^-,3/2^+)$	
1277.68 *2*	37.3 *8*	1277.690	$(5/2^-,3/2^+)$	0.0	$7/2^+$	Eγ=1277.7 *2*, Iγ=46 *4* (2009Pa35). Absolute Iγ=7.2 (2009Wi03) in agreement with 7.1 from 2009Il01.
1284.8 *5*	12.1 *7*	1284.62		0.0	$7/2^+$	
1290.34 *8*	8.7 *7*	2654.14		1363.786	$(1/2^+,3/2^-)$	Eγ=1290.8 *8*, Iγ=17 *3* (2009Pa35).
1409.07 *2*	34.4 *10*	1409.078		0.0	$7/2^+$	Eγ=1409.3 *3*, Iγ=37 *3* (2009Pa35).
1427.7 *6*	9.9 *6*	1427.3		0.0	$7/2^+$	
1463.69 *14*	3.8 *5*	2872.67		1409.078		Eγ=1463.7 *10*, Iγ=6 *2* (2009Pa35).
1528.0[#a] *3*	1.8 *4*	2891.8?		1363.786	$(1/2^+,3/2^-)$	
1594.8 *1*	7.0 *7*	2872.67		1277.690	$(5/2^-,3/2^+)$	Eγ=1595.3 *10*, Iγ=8 *2* (2009Pa35).
1661.16 *9*	10.4 *15*	3744.00		2082.81		Eγ=1662.1 *10*, Iγ=7 *2* (2009Pa35).
1723.41 *9*	6.9 *9*	3001.12		1277.690	$(5/2^-,3/2^+)$	
1730.18 *18*	3.7 *6*	3139.30		1409.078		
[x]1795.0[‡] *6*	1.0 *4*					
1805.5 *1*	7.2 *6*	3083.18		1277.690	$(5/2^-,3/2^+)$	Eγ=1805.0 *10*, Iγ=8 *2* (2009Pa35).
1817.4[#a] *5*	1.2 *4*	3095.1?		1277.690	$(5/2^-,3/2^+)$	
1840.15 *21*	4.6 *7*	3204.56		1363.786	$(1/2^+,3/2^-)$	Eγ=1840.6 *10*, Iγ=5 *2* (2009Pa35).
1875.86 *17*	5.3 *7*	1875.66		0.0	$7/2^+$	
1926.87 *4*	21.5 *7*	3204.56		1277.690	$(5/2^-,3/2^+)$	Eγ=1926.0 *5*, Iγ=33 *2* (2009Pa35).
2017.8[#] *4*	1.5 *4*	3426.98		1409.078		
2023.04 *14*	5.1 *5*	3386.92		1363.786	$(1/2^+,3/2^-)$	Eγ=2023.0 *10*, Iγ=13 *2* (2009Pa35).
2037.9 *23*	2.9 *5*	2152.6		114.721	$(9/2^+)$	
[x]2063.0[‡] *6*	1.8 *7*					
[x]2085.7[‡] *4*	1.6 *4*					
2109.4[#] *3*	3.3 *5*	3386.92		1277.690	$(5/2^-,3/2^+)$	Eγ=2108.4 *10*, Iγ=6 *2* (2009Pa35).
2118.8 *4*	2.0 *5*	2235.378	$(5/2^+)$	114.721	$(9/2^+)$	E_γ: poor fit, not included in the least-squares fitting procedure. Level-energy difference=2120.6.
2141.7 *5*	1.2 *4*	3426.98		1284.62		
2149.32 *14*	5.3 *6*	3426.98		1277.690	$(5/2^-,3/2^+)$	
2234.3 *4*	1.3 *4*	2235.378	$(5/2^+)$	0.0	$7/2^+$	
2265.6 *3*	3.4 *6*	2380.4		114.721	$(9/2^+)$	
[x]2310.5[‡] *6*	1.1 *4*					
2335.1 *3*	1.9 *6*	3744.00		1409.078		Eγ=2335.0 *10*, Iγ=7 *3* (2009Pa35).
2396.6[#] *3*	3.6 *5*	3823.88		1427.3		
2432.2 *15*	4.6 *6*	3709.9		1277.690	$(5/2^-,3/2^+)$	
2459.4[#a] *4*	1.9 *4*	2574.2?		114.721	$(9/2^+)$	

^{77}Cu β^- decay (469.8 ms) 2009Il01,2009Pa35 (continued)

$\gamma(^{77}Zn)$ (continued)

E_γ [†]	I_γ [†@]	E_i(level)	J_i^π	E_f	J_f^π	Comments
2466.6 *7*	1.2 *4*	3744.00		1277.690	(5/2$^-$,3/2$^+$)	Eγ=2463.6 *10*, Iγ=6 *2* (2009Pa35), placed from 3826 level in 2009Pa35 on the basis of coin with 591γ. The evaluators assume that same γ is seen in both 2009Il01 and 2009Pa35. 2463.6-591.1 γγ coin result of 2009Pa35 seems in disagreement with that from 2009Il01.
2527.2 *5*	3.3 *6*	2527.2?		0.0	7/2$^+$	
2546.12 *16*	7.6 *6*	3823.88		1277.690	(5/2$^-$,3/2$^+$)	Eγ=2549.0 *10*, Iγ=13 *2* (2009Pa35).
2757.9 *5*	1.3 *4*	2872.67		114.721	(9/2$^+$)	
2967.6 *7*	1.0 *4*	3083.18		114.721	(9/2$^+$)	
[x]2989.3[‡] *5*	1.6 *4*					
[x]3133.2[‡] *5*	1.6 *4*					
3139.1[#] *6*	2.2 *6*	3139.30		0.0	7/2$^+$	
3178.0[#] *6*	1.9 *4*	4605.27		1427.3		
3387.2[#] *6*	1.3 *3*	3386.92		0.0	7/2$^+$	
3743.6 *4*	2.2 *5*	3744.00		0.0	7/2$^+$	
3826.7[a] *10*	3 *1*	3823.88		0.0	7/2$^+$	E_γ,I_γ: γ from 2009Pa35 only, treated as uncertain by the evaluators since not reported in 2009Il01.
4220.5 *16*	0.5 *3*	4334.35		114.721	(9/2$^+$)	
4334.2 *2*	5.5 *6*	4334.35		0.0	7/2$^+$	
4417.0 *4*	2.3 *3*	4531.9		114.721	(9/2$^+$)	
4490.37 *23*	4.6 *6*	4605.27		114.721	(9/2$^+$)	
4605.3 *6*	1.4 *3*	4605.27		0.0	7/2$^+$	

[†] From 2009Il01. Values from 2009Pa35 are in general agreement but less precise.
[‡] Assigned to ^{77}Cu decay based on half-life. It could not be placed in the level scheme due to lack of γγ coin data.
[#] Transition without strong coincidence evidence and/or other linking transitions.
[@] For absolute intensity per 100 decays, multiply by 0.191 *6*.
[&] Total theoretical internal conversion coefficients, calculated using the BrIcc code (2008Ki07) with Frozen orbital approximation based on γ-ray energies, assigned multipolarities, and mixing ratios, unless otherwise specified.
[a] Placement of transition in the level scheme is uncertain.
[x] γ ray not placed in level scheme.

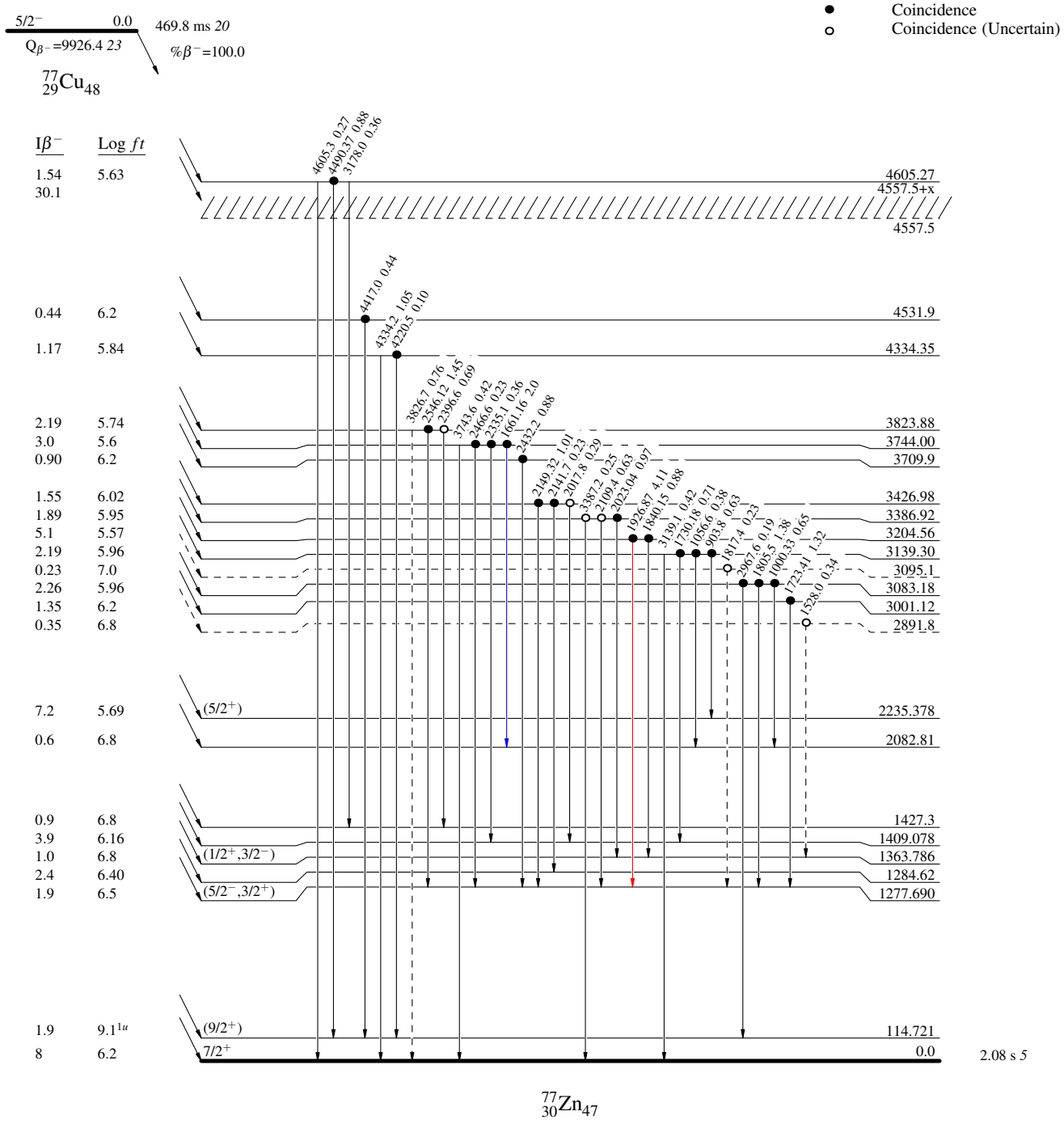
$^{77}_{30}Zn_{47}$-6

^{77}Cu β^- decay (469.8 ms) 2009Il01,2009Pa35

Decay Scheme

Intensities: $I_{(\gamma+ce)}$ per 100 parent decays

Legend
- $I_\gamma < 2\% \times I_\gamma^{max}$
- $I_\gamma < 10\% \times I_\gamma^{max}$
- $I_\gamma > 10\% \times I_\gamma^{max}$
- γ Decay (Uncertain)
- Coincidence
- Coincidence (Uncertain)



^{77}Cu β^- decay (469.8 ms) 2009Il01,2009Pa35

Decay Scheme (continued)

Intensities: $I_{(\gamma+ce)}$ per 100 parent decays

Legend
- $I_\gamma < 2\% \times I_\gamma^{max}$
- $I_\gamma < 10\% \times I_\gamma^{max}$
- $I_\gamma > 10\% \times I_\gamma^{max}$
- γ Decay (Uncertain)
- Coincidence

5/2$^-$ 0.0 469.8 ms *20*
Q_{β^-}=9926.4 *23* $\%\beta^-$=100.0
$^{77}_{29}Cu_{48}$

Iβ⁻	Log *ft*		
4.3	5.74	2757.9 0.25, 1594.8 1.34, 1463.69 0.73, 997.29 0.55, 637.29 1.38	2872.67
1.69	6.21	1290.34 1.66, 2459.4 0.36, 1268.14 1.03, 2527.2 0.63	2654.14
0.36	6.9		2574.2
1.05	6.44		2545.84
0.65	6.7		2527.2
0.66	6.7	2265.6 0.65	2380.4
7.2	5.69	2234.3 0.25, 2118.8 0.38, 957.69 6.9, 871.45 1.20, 826.33 0.32	2235.378
0.57	6.8	2037.9 0.55	2152.6
0.6	6.8	805.11 3.61	2082.81
1.04	6.6	1875.86 1.01, 466.88 0.55	1875.66
0.45	7.0	352.86 0.44	1637.48
0.9	6.8	1427.7 1.89	1427.3
3.9	6.16	1409.07 6.6	1409.078
1.0	6.8	131.35 0.26	1363.786
2.4	6.40	591.33 6.04	1284.62
1.9	6.5	1284.8 2.31, 1169.81 0.74, 1277.68 7.1, 505.25 19.1, 1120.4 0.17	1277.690
0.18	7.5	1015.8 0.34	1235.1
0.35	7.3		1130.5
0.82	>7.0	687.17 0.80, 772.43 [E3]	801.89 (11/2$^+$)
			772.440 1/2$^-$ 1.05 s *10*
1.9	9.1[1u]	114.72 [M1+E2] 8.1	114.721 (9/2$^+$)
8	6.2		0.0 7/2$^+$ 2.08 s *5*

$^{77}_{30}Zn_{47}$