^{63}Zn $\varepsilon+\beta^+$ decay 1974Kl02,1971GiZP,1969Bo15

History

Type	Author	Citation	Literature Cutoff Date
Full Evaluation	Jun Chen	NDS 196,17 (2024)	30-Sep-2023

Parent: ^{63}Zn: E=0.0; $J^\pi=3/2^-$; $T_{1/2}$=38.49 min *5*; $Q(\varepsilon+\beta^+)$=3366.4 *15*; $\%\varepsilon+\beta^+$ decay=100

^{63}Zn-J^π,$T_{1/2}$: From Adopted Levels of ^{63}Zn.

^{63}Zn-$Q(\varepsilon+\beta^+)$: From 2021Wa16.

1974Kl02: ^{63}Zn source was produced by ^{63}Cu(d,2n) with 14 MeV deuteron beam from the synchro-cyclotron of Instituut voor Kernphysisch Onderzoek, Amsterdam. γ rays were detected with a Compton-suppression Ge(Li)-NaI(Tl) system. Measured Eγ, Iγ, $\gamma\gamma$-coin. Deduced levels, J, π, decay branching ratios, log *ft*. Comparisons with available data.

1971GiZP (also 1971GiZS,1971GiZX same thesis): ^{63}Zn source was produced via ^{63}Cu(p,n) with 12 MeV proton from the Michigan State University Sector-Focused Cyclotron. γ rays were detected with Ge(Li) detectors. Measured Eγ, Iγ, $\gamma\gamma$-coin, γ(t). Deduced levels, J, π, parent $T_{1/2}$, decay branching ratios, log *ft*. Comparisons with available data. See also 1974FiZF and 1973FiZT from the same lab for a measurement of end-point energy using a pilot-B plastic scintillator and the same source.

1969Bo15: ^{63}Zn source was produced via (d,2n) with 15 MeV deuteron from the Gottingen synchrocyclotron. γ rays were detected with a Ge(Li)-NaI(Tl) spectrometer. Measured Eγ, Iγ. Deduced levels, J, π, decay branching ratios, log *ft*. Comparisons with available data.

1970Ki06: ^{63}Zn source was produced via (n,2n) with neutrons from the neutron generator at the Department of Physics of University of Helsinki. Target was natural Zn. γ rays were detected with a Ge(Li) detector. Measured Eγ, Iγ. Deduced levels, J, π, decay branching ratios, log *ft*. Comparisons with available data.

1967De08: ^{63}Zn source was produced via (γ,n) on ^{64}Zn with a bremsstrahlung from the 30 MeV electron LINAC at the University of Ghent. γ rays were detected with a Ge(Li) detector. Measured Eγ, Iγ. Deduced levels, J, π, decay branching ratios, log *ft*. Comparisons with available data.

Others:

2015BoZY: measured Eγ, γ(t). Deduced parent $T_{1/2}$.

1982Gr10: measured Eγ, γ(t). Deduced parent $T_{1/2}$.

1970Sa33: measured Eγ, Iγ. Deduced levels.

1966Ho14: measured Eγ, Iγ.

1961Cu02: measured Eγ, Iγ, E(ce), I(ce). Deduced levels, conversion coefficients.

1959Ri38: measured Eγ, Iγ. Deduced levels.

The total energy released in this decay is 3367 keV *29* calculated using RADLIST, which is in good agreement with Q-value=3366.4 *15* indicating the completeness of this decay scheme.

^{63}Cu Levels

E(level)†	J^π‡	E(level)†	J^π‡	E(level)†	J^π‡
0.0	$3/2^-$	2062.19 *13*	$(3/2)^-$	2716.77 *10*	$3/2^-,5/2^-$
669.68 *4*	$1/2^-$	2081.43 *25*	$5/2^-$	2780.50 *21*	$(3/2^-)$
962.100 *33*	$5/2^-$	2092.67 *14*	$7/2^-$	2806.54 *32*	$3/2^-$
1327.07 *9*	$7/2^-$	2336.59 *11*	$5/2^-$	2857.82 *31*	$(1/2^-,3/2^-)$
1412.05 *4*	$5/2^-$	2497.2 *4*	(3/2)	2889.5 *4*	$(1/2^-,3/2,5/2^-)$
1547.05 *5*	$3/2^-$	2512.3 *5*	$(3/2)^+$	3044.5 *7*	$(5/2)^-$
1861.14 *22*	$7/2^-$	2535.82 *7*	$5/2^-$	3100.8 *7*	$1/2^-,3/2^-$
2011.33 *27*	$3/2^-$	2696.65 *12*	$1/2^-,3/2^-,5/2^-$		

† From a least-squares fit to γ-ray energies.

‡ From Adopted Levels.

^{63}Zn $\varepsilon+\beta^+$ decay 1974Kl02,1971GiZP,1969Bo15 (continued)

ε,β^+ radiations

av Eβ: Additional information 1.

E(decay)	E(level)	Iβ^+ ‡	Iε‡	Log *ft*	I($\varepsilon+\beta^+$)†‡	Comments
(265.6 *19*)	3100.8		6.8×10^{-4} *17*	6.9 *1*	6.8×10^{-4} *17*	εK=0.87582 *31*; εL=0.10632 *22*; εM+=0.01785 *7*
(321.9 *19*)	3044.5		0.0050 *9*	6.2 *1*	0.0050 *9*	εK=0.87698 *29*; εL=0.10535 *21*; εM+=0.01768 *7*
(476.9 *19*)	2889.5		0.112 *17*	5.2 *1*	0.112 *17*	εK=0.87873 *27*; εL=0.10388 *19*; εM+=0.01739 *7*
(508.6 *18*)	2857.82		0.0073 *14*	6.5 *1*	0.0073 *14*	εK=0.87895 *27*; εL=0.10369 *19*; εM+=0.01736 *7*
(559.9 *18*)	2806.54		0.0049 *11*	6.7 *1*	0.0049 *11*	εK=0.87926 *27*; εL=0.10343 *19*; εM+=0.01731 *7*
(585.9 *18*)	2780.50		0.0308 *25*	5.95 *+5−4*	0.0308 *25*	εK=0.87939 *27*; εL=0.10332 *19*; εM+=0.01729 *7*
(649.6 *18*)	2716.77		0.091 *9*	5.57 *+6−5*	0.091 *9*	εK=0.87968 *27*; εL=0.10308 *19*; εM+=0.01724 *7*
(669.8 *18*)	2696.65		0.147 *19*	5.39 *+7−6*	0.147 *19*	εK=0.87976 *26*; εL=0.10302 *18*; εM+=0.01723 *6*
(830.6 *18*)	2535.82		0.271 *19*	5.32 *4*	0.271 *19*	εK=0.88024 *26*; εL=0.10261 *18*; εM+=0.01715 *6*
(854.1 *19*)	2512.3		0.0109 *18*	6.7 *1*	0.0109 *18*	εK=0.88030 *26*; εL=0.10256 *18*; εM+=0.01715 *6*
(869.2 *19*)	2497.2		0.0264 *26*	6.37 *5*	0.0264 *26*	εK=0.88033 *26*; εL=0.10253 *18*; εM+=0.01714 *6*
(1029.8 *18*)	2336.59		0.133 *9*	5.82 *3*	0.133 *9*	εK=0.88063 *26*; εL=0.10228 *18*; εM+=0.01708 *6*
(1285.0 *18*)	2081.43	3.3×10^{-4} *8*	0.027 *6*	6.7 *1*	0.027 *6*	av Eβ=115.1 *6*; εK=0.8700 *5*; εL=0.10075 *18*; εM+=0.01683 *6*
(1304.2 *18*)	2062.19	0.0028 *4*	0.167 *24*	5.9 *1*	0.170 *24*	av Eβ=123.1 *6*; εK=0.8667 *6*; εL=0.10034 *19*; εM+=0.01676 *6*
(1355.1 *18*)	2011.33	<4.21×10^{-4}	<0.01358	>7.0	<0.014	av Eβ=144.2 *6*; εK=0.8545 *9*; εL=0.09889 *20*; εM+=0.01651 *6*
(1505.3 *18*)	1861.14	1.3×10^{-4} *11*	0.007 *6*	8.4 *+9−3*	0.007 *6*	av Eβ=228.5 *7*; εK=0.8637 *6*; εL=0.10114 *19*; εM+=0.01690 *6*
(1819.4 *18*)	1547.05	0.038 *7*	0.055 *15*	6.7 *1*	0.093 *16*	av Eβ=340.5 *6*; εK=0.520 *5*; εL=0.0600 *6*; εM+=0.01001 *10*
(1954.4 *18*)	1412.05	0.50 *4*	0.424 *24*	5.88 *3*	0.92 *5*	av Eβ=399.0 *7*; εK=0.406 *5*; εL=0.0468 *6*; εM+=0.00781 *10*
(2039.3 *18*)	1327.07	0.0039 *28*	0.01 *1*	8.7 *+6−2*	0.014 *10*	av Eβ=463.9 *7*; εK=0.635 *4*; εL=0.0739 *5*; εM+=0.01235 *9*
(2404.3 *18*)	962.100	4.97 *30*	1.19 *6*	5.62 *3*	6.16 *31*	av Eβ=598.0 *7*; εK=0.1701 *29*; εL=0.01959 *33*; εM+=0.00327 *5*
(2696.7 *18*)	669.68	7.1 *5*	0.93 *6*	5.82 *3*	8.0 *5*	av Eβ=730.0 *7*; εK=0.1021 *18*; εL=0.01175 *21*; εM+=0.001961 *34*
(3366.4 *21*)	0.0	80.2 *6*	3.74 *7*	5.413 *5*	83.9 *6*	av Eβ=1038.2 *7*; εK=0.0393 *7*; εL=0.00452 *8*; εM+=7.55×10^{-4} *13* I($\varepsilon+\beta^+$): from 100−ΣI(β^+ to excited level).

† From γ+ce intensity balance at each level for excited levels.
‡ Absolute intensity per 100 decays.

γ(^{63}Cu)

Iγ normalization: From I(670γ)/I(β^+)=0.0833 *35* (from the original value of 0.0914 *36* and a 3.4% correction for annihilation mentioned by the authors) in 1969Bo15 and the ratio of I(β^+)/I(ε+β^+)=0.9343 *12* deduced by the evaluator based on net γ+ce feeding to each level and theoretical ε/β^+ ratios calculated by BetaShape.

Eγ and Iγ data are also available in 1970Ki06, 1967De08, 1966Ho14, 1961Cu02, 1959Ri38, but less precise and less complete than those in 1974Kl02, 1971GiZN and 1969Bo15.

E$_\gamma$[‡]	I$_\gamma$[‡&]	E$_i$(level)	J$^\pi_i$	E$_f$	J$^\pi_f$	Mult.[@]	δ[@]	α[†]	Comments
244.3 *5*	0.065 *10*	2780.50	(3/2$^-$)	2535.82	5/2$^-$	[M1]		0.00534 *8*	α(K)=0.00479 *7*; α(L)=0.000483 *7*; α(M)=6.80×10^{-5} *10* α(N)=2.054×10^{-6} *31* %Iγ=0.0054 *9*
365.2 *4*	0.15 *3*	1327.07	7/2$^-$	962.100	5/2$^-$	M1+E2	−0.060 *5*	2.04×10^{-3} *3*	α(K)=0.001830 *26*; α(L)=0.0001832 *26*; α(M)=2.58×10^{-5} *4* α(N)=7.83×10^{-7} *11* %Iγ=0.0124 *25* E$_\gamma$: from 1974Kl02. Other: 364.5 *20* (1969Bo15). I$_\gamma$: weighted average of 0.22 *11* (1969Bo15) and 0.14 *3* (1974Kl02).
443.13 *20*	0.20 *5*	2535.82	5/2$^-$	2092.67	7/2$^-$	[M1]		1.30×10^{-3} *2*	α(K)=0.001163 *16*; α(L)=0.0001160 *16*; α(M)=1.631×10^{-5} *23* α(N)=4.97×10^{-7} *7* %Iγ=0.017 *4*
449.93 *5*	2.80 *20*	1412.05	5/2$^-$	962.100	5/2$^-$	M1+E2	+0.115 *10*	1.27×10^{-3} *2*	α(K)=0.001138 *16*; α(L)=0.0001135 *16*; α(M)=1.596×10^{-5} *23* α(N)=4.86×10^{-7} *7* %Iγ=0.231 *19* E$_\gamma$: weighted average of 450.0 *2* (1971GiZS) and 449.93 *5* (1974Kl02). Other: 450.0 *5* (1969Bo15). I$_\gamma$: weighted average of 2.95 *55* (1969Bo15), 2.7 *2* (1971GiZS), and 2.88 *20* (1974Kl02).
475.8 *9*	0.07 *4*	2336.59	5/2$^-$	1861.14	7/2$^-$	[M1]		1.10×10^{-3} *2*	α(K)=0.000988 *14*; α(L)=9.85×10^{-5} *14*; α(M)=1.385×10^{-5} *20* α(N)=4.22×10^{-7} *6* %Iγ=0.0058 *33*
515.0 *10*	0.26 *10*	2062.19	(3/2)$^-$	1547.05	3/2$^-$	(M1+E2)		0.0013 *4*	α(K)=0.00116 *33*; α(L)=1.16×10^{-4} *34*; α(M)=1.6×10^{-5} *5* α(N)=4.9×10^{-7} *13* %Iγ=0.022 *8*
533.8 *6*	0.06 *2*	2081.43	5/2$^-$	1547.05	3/2$^-$	M1+E2	+0.23 *+13−11*	0.00088 *4*	α(K)=0.00079 *4*; α(L)=7.9×10^{-5} *4*; α(M)=1.11×10^{-5} *5*

$^{63}_{29}$Cu$_{34}$-3

$\gamma(^{63}$Cu) (continued)

E_γ‡	I_γ‡&	E_i(level)	J^π_i	E_f	J^π_f	Mult.@	δ@	α†	Comments
									α(N)=3.37×10^{-7} *16* %Iγ=0.0050 *17*
584.85 *15*	0.36 *7*	1547.05	3/2$^-$	962.100	5/2$^-$	(M1(+E2))	+0.10 *+14−15*	0.000695 *17*	α(K)=0.000624 *15*; α(L)=6.20×10^{-5} *15*; α(M)=8.71×10^{-6} *22* α(N)=2.66×10^{-7} *6* %Iγ=0.030 *6* E_γ: weighted average of 585.2 *5* (1971GiZS) and 584.82 *15* (1974Kl02). I_γ: weighted average of 0.22 *10* (1971GiZS) and 0.40 *5* (1974Kl02).
624.3 *3*	0.17 *4*	2716.77	3/2$^-$,5/2$^-$	2092.67	7/2$^-$				%Iγ=0.0140 *34* E_γ: from 1974Kl02. Other: 624.1 *6* (1971GiZS). I_γ: from 1974Kl02. Other: 0.18 *5* (1971GiZS).
669.64 *5*	100.0 *40*	669.68	1/2$^-$	0.0	3/2$^-$	M1+E2	0.106 *5*	0.000519 *7*	α(K)=0.000466 *7*; α(L)=4.62×10^{-5} *6*; α(M)=6.50×10^{-6} *9* α(N)=1.988×10^{-7} *28* %Iγ=8.3 *5* E_γ: weighted average of 669.6 *2* (1969Bo15), 669.71 *10* (1971GiZS), and 669.62 *5* (1974Kl02). Mult.: M1 from ce data in 1961Cu02. α_T(exp)=5.2×10^{-4} *3* (1961Cu02).
675.0 *6*	0.18 *4*	2535.82	5/2$^-$	1861.14	7/2$^-$	[M1,E2]		0.00062 *12*	α(K)=0.00056 *11*; α(L)=5.6×10^{-5} *11*; α(M)=7.9×10^{-6} *15* α(N)=2.4×10^{-7} *4* %Iγ=0.0149 *34*
685.5 *6*	0.25 *20*	2696.65	1/2$^-$,3/2$^-$,5/2$^-$	2011.33	3/2$^-$	[M1,E2]		0.00060 *11*	α(K)=0.00054 *10*; α(L)=5.4×10^{-5} *10*; α(M)=7.5×10^{-6} *14* α(N)=2.3×10^{-7} *4* %Iγ=0.021 *17* E_γ: weighted average of 684.7 *17* (1969Bo15) and 685.6 *6* (1974Kl02). I_γ: unweighted average of 0.45 *17* (1969Bo15) and 0.05 *2* (1974Kl02).
742.27 *10*	0.82 *10*	1412.05	5/2$^-$	669.68	1/2$^-$	E2		0.000571 *8*	α(K)=0.000512 *7*; α(L)=5.11×10^{-5} *7*; α(M)=7.18×10^{-6} *10* α(N)=2.161×10^{-7} *30* %Iγ=0.068 *9* E_γ: weighted average of 742.5 *5* (1969Bo15), 742.5 *5* (1971GiZS), and 742.25 *10*

$^{63}_{29}$Cu$_{34}$-4

γ(^{63}Cu) (continued)

E_γ[‡]	I_γ[‡&]	E_i(level)	J^π_i	E_f	J^π_f	Mult.[@]	δ[@]	α[†]	Comments
									(1974Kl02). I_γ: from 1974Kl02. Others: 0.86 *13* (1969Bo15) and 0.76 *13* (1971GiZS).
754.6 *7*	0.09 *5*	2081.43	5/2⁻	1327.07	7/2⁻	(M1(+E2))	0.4 *+5−4*	0.00042 *5*	α(K)=0.00038 *4*; α(L)=3.7×10^{-5} *4*; α(M)=5.3×10^{-6} *6* α(N)=1.61×10^{-7} *17* %Iγ=0.007 *4* E_γ: weighted average of 754.4 *7* (1971GiZS) and 754.8 *8* (1974Kl02). I_γ: weighted average of 0.33 *15* (1971GiZS) and 0.08 *3* (1974Kl02).
765.7 *5*	0.08 *3*	2092.67	7/2⁻	1327.07	7/2⁻	(M1(+E2))	−0.2 *5*	0.00039 *4*	α(K)=0.000352 *35*; α(L)=3.5×10^{-5} *4*; α(M)=4.9×10^{-6} *5* α(N)=1.50×10^{-7} *14* %Iγ=0.0066 *25*
877.2 *8*	0.04 *2*	1547.05	3/2⁻	669.68	1/2⁻	(M1(+E2))	−0.6 *+7−16*	0.00031 *4*	α(K)=0.00028 *4*; α(L)=2.8×10^{-5} *4*; α(M)=3.9×10^{-6} *6* α(N)=1.19×10^{-7} *16* %Iγ=0.0033 *17*
899.1 *4*	0.15 *3*	1861.14	7/2⁻	962.100	5/2⁻	M1+E2	+0.040 *7*	0.000278 *4*	α(K)=0.0002494 *35*; α(L)=2.462×10^{-5} *35*; α(M)=3.46×10^{-6} *5* α(N)=1.063×10^{-7} *15* %Iγ=0.0124 *25* E_γ: weighted average of 899.2 *6* (1971GiZS) and 899.0 *4* (1974Kl02). I_γ: from 1974Kl02. Other: 0.16 *6* (1971GiZS).
924.3 *5*	0.129 *24*	2336.59	5/2⁻	1412.05	5/2⁻	[M1,E2]		0.000293 *31*	α(K)=0.000263 *28*; α(L)=2.60×10^{-5} *28*; α(M)=3.7×10^{-6} *4* α(N)=1.12×10^{-7} *11* %Iγ=0.0106 *20* E_γ: from 1974Kl02. Others: 923.5 *10* (1969Bo15) and 924.6 *6* (1971GiZS). I_γ: weighted average of 0.252 *88* (1969Bo15), 0.13 *6* (1971GiZS), and 0.120 *24* (1974Kl02).
962.07 *4*	79.1 *22*	962.100	5/2⁻	0.0	3/2⁻	M1+E2	−0.479 *21*	0.000252 *4*	α(K)=0.0002260 *33*; α(L)=2.232×10^{-5} *33*; α(M)=3.14×10^{-6} *5* α(N)=9.61×10^{-8} *14* %Iγ=6.53 *32* E_γ: weighted average of 961.9 *2* (1969Bo15), 962.14 *10* (1971GiZS), and 962.06 *4* (1974Kl02). I_γ: weighted average of 78.8 *22* (1969Bo15), 79.8 *32* (1971GiZS), and 79 *4* (1974Kl02). α_T(exp)=2.3×10^{-4} *3* (1961Cu02).
989.6 *7*	0.047 *13*	2535.82	5/2⁻	1547.05	3/2⁻	[M1,E2]		0.000251 *23*	α(K)=0.000225 *21*; α(L)=2.23×10^{-5} *21*; α(M)=3.13×10^{-6} *29*

$^{63}_{29}Cu_{34}$-5

$\gamma(^{63}Cu)$ (continued)

E_γ ‡	I_γ ‡&	E_i(level)	J^π_i	E_f	J^π_f	Mult. @	δ @	α †	Comments
									α(N)=9.6×10^{-8} *8* %Iγ=0.0039 *11*
1048.8 *5*	0.054 *14*	2011.33	3/2$^-$	962.100	5/2$^-$	M1+E2	+0.23 *+15−9*	0.000205 *4*	α(K)=0.0001840 *35*; α(L)=1.814×10^{-5} *35*; α(M)=2.55×10^{-6} *5* α(N)=7.83×10^{-8} *15* %Iγ=0.0045 *12*
^{x}1087# *2*	0.32# *11*								%Iγ=0.026 *9*
1123.73 *7*	1.35 *14*	2535.82	5/2$^-$	1412.05	5/2$^-$	[M1,E2]		0.000192 *14*	α(K)=0.000171 *12*; α(L)=1.69×10^{-5} *12*; α(M)=2.37×10^{-6} *17* α(N)=7.3×10^{-8} *5*; α(IPF)=1.41×10^{-6} *25* %Iγ=0.111 *13* E_γ: weighted average of 1123.7 *3* (1969Bo15), 1123.8 *2* (1971GiZS), and 1123.72 *7* (1974Kl02). I_γ: from 1974Kl02. Others: 1.53 *33* (1969Bo15) and 1.3 *2* (1971GiZS).
1130.67 *25*	0.15 *3*	2092.67	7/2$^-$	962.100	5/2$^-$	M1+E2	−1.06 *+23−22*		%Iγ=0.0124 *25* E_γ: from 1974Kl02. Other: 1130.6 *5* (1971GiZS). I_γ: weighted average of 0.13 *4* (1971GiZS) and 0.16 *3* (1974Kl02).
1149.52 *16*	0.237 *30*	2696.65	1/2$^-$,3/2$^-$,5/2$^-$	1547.05	3/2$^-$	[M1,E2]		0.000184 *13*	α(K)=0.000163 *11*; α(L)=1.61×10^{-5} *11*; α(M)=2.26×10^{-6} *16* α(N)=6.9×10^{-8} *4*; α(IPF)=2.7×10^{-6} *5* %Iγ=0.0196 *26* E_γ: weighted average of 1149.6 *3* (1971GiZS) and 1149.50 *16* (1974Kl02). Other: 1150 *2* (1969Bo15). I_γ: weighted average of 0.295 *55* (1969Bo15), 0.21 *5* (1971GiZS), and 0.23 *3* (1974Kl02).
1169.6 *3*	0.15 *5*	2716.77	3/2$^-$,5/2$^-$	1547.05	3/2$^-$				%Iγ=0.012 *4* E_γ: from 1974Kl02. Other: 1168 *3* (1969Bo15). I_γ: unweighted average of 0.197 *44* (1969Bo15) and 0.094 *20* (1974Kl02).
^{x}1189# *3*	0.22# *11*								%Iγ=0.018 *9*
1208.8 *3*	0.154 *30*	2535.82	5/2$^-$	1327.07	7/2$^-$	[M1,E2]		0.000172 *11*	α(K)=0.000146 *9*; α(L)=1.44×10^{-5} *9*; α(M)=2.03×10^{-6} *13* α(N)=6.2×10^{-8} *4*; α(IPF)=8.7×10^{-6} *15* %Iγ=0.0127 *25* E_γ: from 1974Kl02. Others: 1208 *2* (1969Bo15) and 1208.6 *8* (1971GiZS).

$^{63}_{29}Cu_{34}$-6

γ(^{63}Cu) (continued)

E_γ [‡]	I_γ [‡&]	E_i(level)	J^π_i	E_f	J^π_f	Mult. [@]	δ [@]	α [†]	Comments
									I_γ: weighted average of 0.153 *44* (1969Bo15), 0.17 *6* (1971GiZS), and 0.15 *3* (1974Kl02).
1233.7 *5*	0.03 *1*	2780.50	(3/2$^-$)	1547.05	3/2$^-$				%Iγ=0.0025 *8*
1326.99 *11*	0.85 *5*	1327.07	7/2$^-$	0.0	3/2$^-$	E2		0.0001757 *25*	α(K)=0.0001267 *18*; α(L)=1.250×10^{-5} *18*; α(M)=1.758×10^{-6} *25* α(N)=5.37×10^{-8} *8*; α(IPF)=3.47×10^{-5} *5* %Iγ=0.070 *5* E_γ: weighted average of 1326.4 *3* (1969Bo15), 1327.0 *4* (1971GiZS), and 1327.03 *8* (1974Kl02). I_γ: weighted average of 0.99 *12* (1969Bo15), 0.84 *6* (1971GiZS), and 0.84 *5* (1974Kl02).
1341.7 *6*	0.03 *1*	2011.33	3/2$^-$	669.68	1/2$^-$	(M1(+E2))	−0.6 *+7−16*	0.000160 *13*	α(K)=0.000116 *6*; α(L)=1.14×10^{-5} *7*; α(M)=1.60×10^{-6} *9* α(N)=4.91×10^{-8} *27*; α(IPF)=3.1×10^{-5} *6* %Iγ=0.0025 *8*
1374.44 *13*	0.423 *30*	2336.59	5/2$^-$	962.100	5/2$^-$	(M1(+E2))		0.000166 *12*	α(K)=0.000113 *5*; α(L)=1.11×10^{-5} *5*; α(M)=1.56×10^{-6} *8* α(N)=4.78×10^{-8} *22*; α(IPF)=4.1×10^{-5} *6* %Iγ=0.0349 *29* E_γ: weighted average of 1374.3 *3* (1969Bo15), 1374.4 *3* (1971GiZS), and 1374.47 *13* (1974Kl02). I_γ: weighted average of 0.481 *88* (1969Bo15), 0.41 *6* (1971GiZS), and 0.42 *3* (1974Kl02).
1389.66 *8*	0.49 *7*	2716.77	3/2$^-$,5/2$^-$	1327.07	7/2$^-$				%Iγ=0.040 *6* E_γ: from 1974Kl02. Other: 1389.5 *6* (1971GiZS). I_γ: weighted average of 0.44 *9* (1971GiZS) and 0.52 *7* (1974Kl02).
1392.51 *14*	1.39 *18*	2062.19	(3/2)$^-$	669.68	1/2$^-$	(M1+E2)		0.000167 *12*	α(K)=0.000110 *5*; α(L)=1.08×10^{-5} *5*; α(M)=1.52×10^{-6} *7* α(N)=4.66×10^{-8} *21*; α(IPF)=4.5×10^{-5} *7* %Iγ=0.115 *16* E_γ: weighted average of 1391.5 *4* (1969Bo15), 1392.3 *5* (1971GiZS), and 1392.55 *8* (1974Kl02). I_γ: unweighted average of 1.75 *11* (1969Bo15), 1.24 *12* (1971GiZS), and 1.18 *18* (1974Kl02).
1412.07 *5*	9.01 *33*	1412.05	5/2$^-$	0.0	3/2$^-$	M1+E2	+0.66 *+5−7*	0.0001641 *25*	α(K)=0.0001050 *15*; α(L)=1.032×10^{-5} *15*; α(M)=1.452×10^{-6} *21* α(N)=4.46×10^{-8} *6*; α(IPF)=4.73×10^{-5} *9* %Iγ=0.74 *4*

γ(^{63}Cu) (continued)

E_γ[‡]	I_γ[‡&]	E_i(level)	J^π_i	E_f	J^π_f	Mult.[@]	δ[@]	α[†]	Comments
									E_γ: weighted average of 1411.9 *2* (1969Bo15), 1412.07 *20* (1971GiZS), and 1412.08 *5* (1974Kl02). I_γ: weighted average of 8.75 *33* (1969Bo15), 9.3 *4* (1971GiZS), and 9.1 *4* (1974Kl02).
1445.8 *4*	0.03 *1*	2857.82	(1/2$^-$,3/2$^-$)	1412.05	5/2$^-$	[M1,E2]		0.000173 *13*	α(K)=0.000102 *4*; α(L)=1.00×10^{-5} *4*; α(M)=1.41×10^{-6} *6* α(N)=4.33×10^{-8} *18*; α(IPF)=5.9×10^{-5} *8* %Iγ=0.0025 *8*
1479.1 *5*	0.02 *1*	2806.54	3/2$^-$	1327.07	7/2$^-$	[E2]		0.000178 *14*	α(K)=9.7×10^{-5} *4*; α(L)=9.6×10^{-6} *4*; α(M)=1.35×10^{-6} *6* α(N)=4.14×10^{-8} *16*; α(IPF)=7.0×10^{-5} *9* %Iγ=0.0017 *8*
1547.03 *6*	1.51 *6*	1547.05	3/2$^-$	0.0	3/2$^-$	M1+E2	+0.20 *7*	0.0001812 *29*	α(K)=8.70×10^{-5} *12*; α(L)=8.54×10^{-6} *12*; α(M)=1.201×10^{-6} *17* α(N)=3.70×10^{-8} *5*; α(IPF)=8.44×10^{-5} *16* %Iγ=0.125 *7* E_γ: weighted average of 1546.9 *2* (1969Bo15) and 1547.04 *6* (1974Kl02). Other: 1546.8 *6* (1971GiZS). I_γ: weighted average of 1.42 *22* (1969Bo15), 1.6 *1* (1971GiZS), and 1.49 *6* (1974Kl02).
1573.67 *20*	0.190 *20*	2535.82	5/2$^-$	962.100	5/2$^-$	[M1,E2]		0.000199 *16*	α(K)=8.64×10^{-5} *31*; α(L)=8.49×10^{-6} *32*; α(M)=1.19×10^{-6} *4* α(N)=3.67×10^{-8} *13*; α(IPF)=0.000103 *13* %Iγ=0.0157 *18* E_γ: weighted average of 1573.4 *5* (1971GiZS) and 1573.71 *20* (1974Kl02). Other: 1574.0 *20* (1969Bo15). I_γ: weighted average of 0.142 *44* (1969Bo15), 0.19 *7* (1971GiZS), and 0.20 *2* (1974Kl02).
1667.2 *6*	0.017 *7*	2336.59	5/2$^-$	669.68	1/2$^-$	[E2]		0.0002452 *34*	α(K)=7.97×10^{-5} *11*; α(L)=7.84×10^{-6} *11*; α(M)=1.102×10^{-6} *15* α(N)=3.38×10^{-8} *5*; α(IPF)=0.0001565 *22* %Iγ=0.0014 *6*
^{x}1696.6 *10*	0.024 *12*								%Iγ=0.0020 *10*
1754.9 *5*	0.053 *12*	2716.77	3/2$^-$,5/2$^-$	962.100	5/2$^-$				%Iγ=0.0044 *10*
^{x}1816.9[#] *10*	0.0306[#] *33*								%Iγ=0.00253 *29*
1826.2 *8*	0.057 *17*	2497.2	(3/2)	669.68	1/2$^-$				%Iγ=0.0047 *14* E_γ: unweighted average of 1825.4 *6* (1971GiZS) and 1827.0 *5* (1974Kl02).

$^{63}_{29}$Cu$_{34}$-8

γ(^{63}Cu) (continued)

E_γ ‡	I_γ ‡&	E_i(level)	J_i^π	E_f	J_f^π	Mult. @	α †	Comments
								I_γ: weighted average of 0.11 *4* (1971GiZS) and 0.051 *13* (1974Kl02).
1861.2 *3*	0.183 *27*	1861.14	7/2$^-$	0.0	3/2$^-$	E2	0.000317 *4*	α(K)=6.46×10^{-5} *9*; α(L)=6.34×10^{-6} *9*; α(M)=8.92×10^{-7} *12* α(N)=2.74×10^{-8} *4*; α(IPF)=0.0002448 *34* %Iγ=0.0151 *23* E_γ: weighted average of 1860.9 *6* (1971GiZS) and 1861.3 *3* (1974Kl02). I_γ: weighted average of 0.24 *5* (1971GiZS) and 0.170 *24* (1974Kl02).
1865.7 *3*	0.29 *5*	2535.82	5/2$^-$	669.68	1/2$^-$	[E2]	0.000319 *4*	α(K)=6.43×10^{-5} *9*; α(L)=6.31×10^{-6} *9*; α(M)=8.87×10^{-7} *12* α(N)=2.73×10^{-8} *4*; α(IPF)=0.0002470 *35* %Iγ=0.024 *4* E_γ: weighted average of 1865.3 *3* (1969Bo15), 1865.7 *6* (1971GiZS), and 1866.1 *3* (1974Kl02). I_γ: unweighted average of 0.383 *33* (1969Bo15), 0.26 *5* (1971GiZS), and 0.24 *3* (1974Kl02).
1927.0 *7*	0.069 *11*	2889.5	(1/2$^-$,3/2,5/2$^-$)	962.100	5/2$^-$			%Iγ=0.0057 *10* E_γ: weighted average of 1926.4 *20* (1969Bo15), 1926.8 *8* (1971GiZS), and 1927.2 *7* (1974Kl02). I_γ: weighted average of 0.066 *11* (1969Bo15), 0.082 *25* (1971GiZS), and 0.070 *14* (1974Kl02).
2011.8 *5*	0.13 *2*	2011.33	3/2$^-$	0.0	3/2$^-$	(M1(+E2))	0.000350 *29*	α(K)=5.47×10^{-5} *14*; α(L)=5.37×10^{-6} *14*; α(M)=7.55×10^{-7} *20* α(N)=2.32×10^{-8} *6*; α(IPF)=0.000290 *28* %Iγ=0.0107 *17* E_γ: weighted average of 2012.0 *5* (1969Bo15), 2012.0 *5* (1971GiZS), and 2011.4 *5* (1974Kl02). I_γ: from 1974Kl02. Others: 0.120 *22* (1969Bo15) and 0.14 *3* (1971GiZS).
2026.9 *3*	0.74 *5*	2696.65	1/2$^-$,3/2$^-$,5/2$^-$	669.68	1/2$^-$	[M1,E2]	0.000357 *30*	α(K)=5.40×10^{-5} *14*; α(L)=5.30×10^{-6} *14*; α(M)=7.45×10^{-7} *19* α(N)=2.29×10^{-8} *6*; α(IPF)=0.000297 *28* %Iγ=0.061 *5* E_γ: from 1971GiZS. Others: 2027.2 *5* (1969Bo15) and 2026.8 *3* (1974Kl02). I_γ: weighted average of 0.66 *11* (1969Bo15), 0.78 *5* (1971GiZS), and 0.68 *7* (1974Kl02).
2047.0 *8*	0.064 *11*	2716.77	3/2$^-$,5/2$^-$	669.68	1/2$^-$			%Iγ=0.0053 *9* E_γ: weighted average of 2048.6 *15* (1969Bo15), 2047.2 *8* (1971GiZS), and 2046.4 *8* (1974Kl02). I_γ: weighted average of 0.077 *11* (1969Bo15), 0.04 *14* (1971GiZS), and 0.045 *13* (1974Kl02).

$^{63}_{29}$Cu$_{34}$-9

$\gamma(^{63}$Cu) (continued)

E_γ ‡	I_γ ‡&	E_i(level)	J_i^π	E_f	J_f^π	Mult. @	δ @	α †	Comments
2062.1 *3*	0.41 *4*	2062.19	(3/2)$^-$	0.0	3/2$^-$	(M1+E2)	−0.26 *+16−18*	0.000371 *31*	α(K)=5.24×10^{-5} *13*; α(L)=5.13×10^{-6} *13*; α(M)=7.22×10^{-7} *18* α(N)=2.22×10^{-8} *5*; α(IPF)=0.000313 *29* %Iγ=0.034 *4* E_γ: from 1974Kl02. Others: 2062.0 *8* (1969Bo15) and 2062.3 *5* (1971GiZS). I_γ: weighted average of 0.350 *77* (1969Bo15), 0.41 *6* (1971GiZS), and 0.42 *4* (1974Kl02).
2081.5 *3*	0.18 *2*	2081.43	5/2$^-$	0.0	3/2$^-$	(M1(+E2))		0.000379 *31*	α(K)=5.15×10^{-5} *13*; α(L)=5.05×10^{-6} *13*; α(M)=7.10×10^{-7} *18* α(N)=2.19×10^{-8} *5*; α(IPF)=0.000322 *30* %Iγ=0.0149 *18* E_γ: weighted average of 2082.0 *5* (1969Bo15), 2081.4 *7* (1971GiZS), and 2081.4 *3* (1974Kl02). I_γ: from 1974Kl02. Others: 0.164 *44* (1969Bo15) and 0.21 *5* (1971GiZS).
2092.6 *5*	0.034 *10*	2092.67	7/2$^-$	0.0	3/2$^-$	E2		0.000415 *6*	α(K)=5.21×10^{-5} *7*; α(L)=5.11×10^{-6} *7*; α(M)=7.18×10^{-7} *10* α(N)=2.208×10^{-8} *31*; α(IPF)=0.000357 *5* %Iγ=0.0028 *8* E_γ: from 1974Kl02. Other: 2092.5 *8* (1971GiZS). I_γ: weighted average of 0.057 *25* (1971GiZS) and 0.03 *1* (1974Kl02).
^{x}2103.3 *12*	0.046 *22*								%Iγ=0.0038 *18* E_γ: from 1971GiZS. Other: 2103.2 *30* (1969Bo15). I_γ: weighted average of 0.033 *22* (1969Bo15) and 0.069 *30* (1971GiZS).
2110.7 *5*	0.079 *15*	2780.50	(3/2$^-$)	669.68	1/2$^-$				%Iγ=0.0065 *13* E_γ: weighted average of 2110.6 *6* (1971GiZS) and 2110.8 *5* (1974Kl02). I_γ: weighted average of 0.087 *22* (1971GiZS) and 0.075 *15* (1974Kl02).
^{x}2181.8 *7*	0.016 *10*								%Iγ=0.0013 *8*
2188.0 *7*	0.02 *1*	2857.82	(1/2$^-$,3/2$^-$)	669.68	1/2$^-$	[M1,E2]		0.000423 *34*	α(K)=4.72×10^{-5} *11*; α(L)=4.62×10^{-6} *11*; α(M)=6.50×10^{-7} *16* α(N)=2.00×10^{-8} *5*; α(IPF)=0.000371 *33* %Iγ=0.0017 *8*
2219.9 *7*	0.036 *10*	2889.5	(1/2$^-$,3/2,5/2$^-$)	669.68	1/2$^-$				%Iγ=0.0030 *8*
2336.6 *2*	0.97 *6*	2336.59	5/2$^-$	0.0	3/2$^-$	(M1(+E2))		0.00049 *4*	α(K)=4.21×10^{-5} *9*; α(L)=4.12×10^{-6} *9*; α(M)=5.79×10^{-7} *13*

γ(^{63}Cu) (continued)

E_γ [‡]	I_γ [‡&]	E_i(level)	J^π_i	E_f	J^π_f	Mult. [@]	α [†]	Comments
								α(N)=1.79×10^{-8} *4*; α(IPF)=0.00044 *4* %Iγ=0.080 *6* E_γ: weighted average of 2336.5 *2* (1969Bo15), 2336.8 *3* (1971GiZS), and 2336.5 *3* (1974Kl02). I_γ: weighted average of 1.039 *66* (1969Bo15), 0.99 *8* (1971GiZS), and 0.91 *6* (1974Kl02).
2497.5 *4*	0.252 *22*	2497.2	(3/2)	0.0	3/2$^-$			%Iγ=0.0208 *20* E_γ: weighted average of 2497.7 *4* (1969Bo15), 2497.5 *6* (1971GiZS), and 2497.4 *4* (1974Kl02). I_γ: from 1969Bo15. Others: 0.25 *3* (1971GiZS) and 0.26 *3* (1974Kl02).
2512.2 *5*	0.128 *20*	2512.3	(3/2)$^+$	0.0	3/2$^-$	[E1]	0.000993 *14*	α(K)=2.328×10^{-5} *33*; α(L)=2.272×10^{-6} *32*; α(M)=3.19×10^{-7} *4* α(N)=9.84×10^{-9} *14*; α(IPF)=0.000968 *14* %Iγ=0.0106 *17* E_γ: weighted average of 2512.0 *5* (1969Bo15), 2512.5 *5* (1971GiZS), and 2512.0 *5* (1974Kl02). I_γ: weighted average of 0.142 *22* (1969Bo15), 0.12 *3* (1971GiZS), and 0.12 *2* (1974Kl02).
2536.0 *2*	0.82 *5*	2535.82	5/2$^-$	0.0	3/2$^-$	(M1(+E2))	0.00057 *4*	α(K)=3.66×10^{-5} *8*; α(L)=3.58×10^{-6} *8*; α(M)=5.04×10^{-7} *11* α(N)=1.553×10^{-8} *33*; α(IPF)=0.00053 *4* %Iγ=0.068 *5* E_γ: weighted average of 2535.9 *2* (1969Bo15), 2536.2 *4* (1971GiZS), and 2536.0 *3* (1974Kl02). I_γ: weighted average of 0.842 *44* (1969Bo15), 0.80 *5* (1971GiZS), and 0.81 *8* (1974Kl02).
2696.7 *2*	0.49 *5*	2696.65	1/2$^-$,3/2$^-$,5/2$^-$	0.0	3/2$^-$	[M1,E2]	0.00064 *4*	α(K)=3.30×10^{-5} *7*; α(L)=3.23×10^{-6} *7*; α(M)=4.54×10^{-7} *10* α(N)=1.401×10^{-8} *29*; α(IPF)=0.00060 *4* %Iγ=0.040 *5* E_γ: from 1969Bo15. Others: 2697.0 *4* (1971GiZS) and 2696.6 *3* (1974Kl02). I_γ: from 1974Kl02. Others: 0.470 *88* (1969Bo15) and 0.5 *4* (1971GiZS).
2717.0 *4*	0.143 *12*	2716.77	3/2$^-$,5/2$^-$	0.0	3/2$^-$			%Iγ=0.0118 *11* E_γ: weighted average of 2717.0 *5* (1969Bo15), 2717.2 *5* (1971GiZS), and 2716.9 *4* (1974Kl02). I_γ: weighted average of 0.131 *22* (1969Bo15), 0.140 *12* (1971GiZS), and 0.16 *2* (1974Kl02).
2780.5 *3*	0.187 *15*	2780.50	(3/2$^-$)	0.0	3/2$^-$			%Iγ=0.0154 *14* E_γ: weighted average of 2780.6 *3* (1971GiZS) and 2780.3 *4* (1974Kl02). Other: 2780.1 *20* (1969Bo15). I_γ: weighted average of 0.197 *22* (1969Bo15), 0.180 *15* (1971GiZS), and 0.19 *2* (1974Kl02).
2806.7 *4*	0.037 *7*	2806.54	3/2$^-$	0.0	3/2$^-$	[M1,E2]	0.00069 *5*	α(K)=3.09×10^{-5} *6*; α(L)=3.02×10^{-6} *6*; α(M)=4.25×10^{-7} *9*

γ(^{63}Cu) (continued)

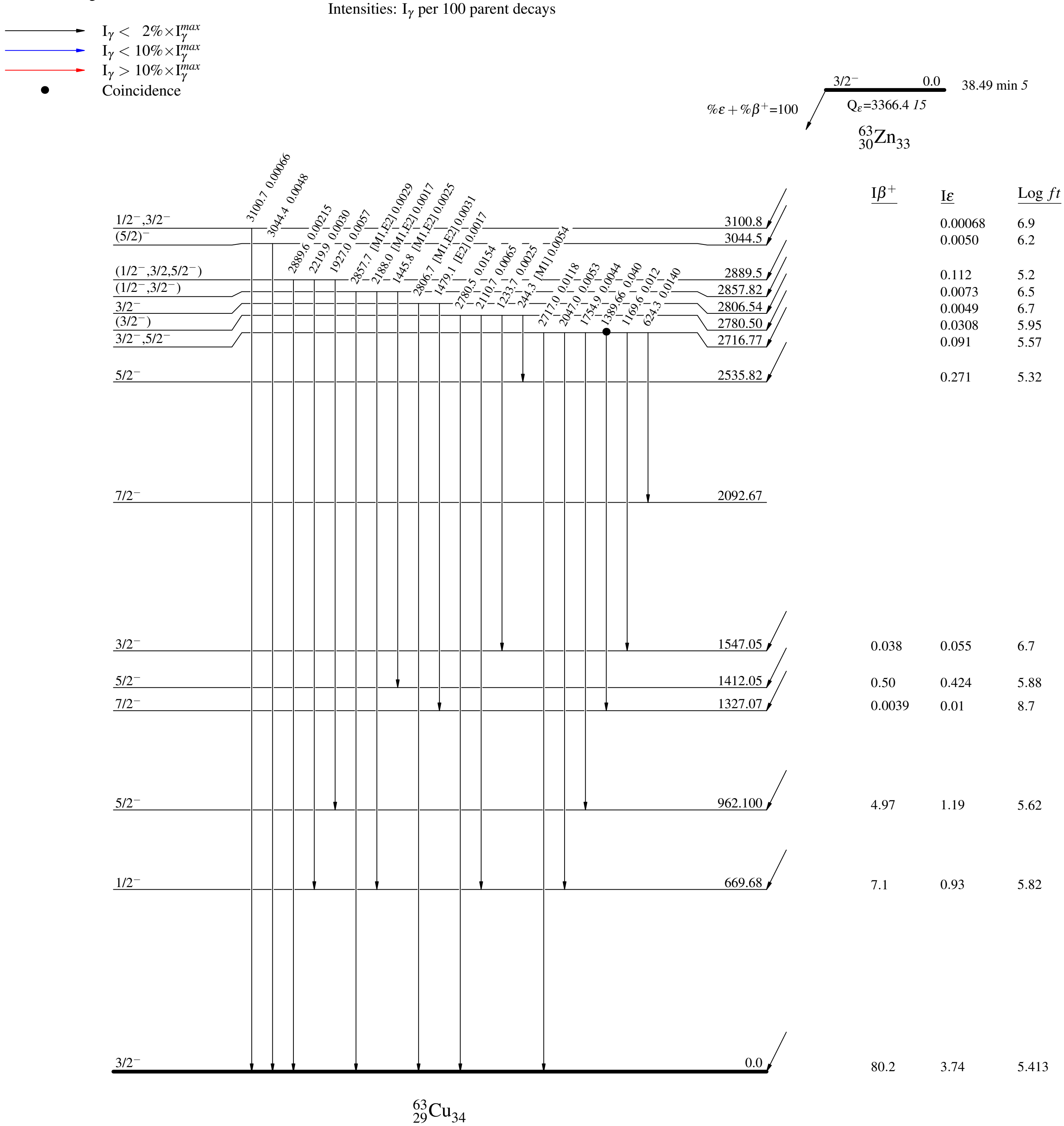
E_γ ‡	I_γ ‡&	E_i(level)	J^π_i	E_f	J^π_f	Mult. @	α †	Comments
								α(N)=1.311×10^{-8} *27*; α(IPF)=0.00065 *4* %Iγ=0.0031 *6* E_γ: weighted average of 2806.5 *4* (1969Bo15), 2807.1 *6* (1971GiZS), and 2806.6 *6* (1974Kl02). I_γ: weighted average of 0.0295 *66* (1969Bo15), 0.039 *7* (1971GiZS), and 0.05 *1* (1974Kl02).
2857.7 *7*	0.035 *6*	2857.82	(1/2$^-$,3/2$^-$)	0.0	3/2$^-$	[M1,E2]	0.00071 *5*	α(K)=3.00×10^{-5} *6*; α(L)=2.93×10^{-6} *6*; α(M)=4.13×10^{-7} *9* α(N)=1.273×10^{-8} *26*; α(IPF)=0.00067 *5* %Iγ=0.0029 *5* E_γ: weighted average of 2857.4 *10* (1969Bo15), 2857.8 *7* (1971GiZS), and 2857.6 *8* (1974Kl02). I_γ: weighted average of 0.0361 *77* (1969Bo15), 0.032 *6* (1971GiZS), and 0.04 *1* (1974Kl02).
^{x}2882.1# *20*	0.0109# *33*							%Iγ=9.0×10^{-4} *28*
2889.6 *5*	0.026 *3*	2889.5	(1/2$^-$,3/2,5/2$^-$)	0.0	3/2$^-$			%Iγ=0.00215 *26* E_γ: weighted average of 2891.1 *15* (1969Bo15), 2889.5 *5* (1971GiZS), and 2889.4 *8* (1974Kl02). I_γ: from 1971GiZS. Others: 0.0263 *55* (1969Bo15) and 0.03 *1* (1974Kl02).
3044.4 *7*	0.058 *10*	3044.5	(5/2)$^-$	0.0	3/2$^-$			%Iγ=0.0048 *9* E_γ: weighted average of 3044.9 *10* (1969Bo15), 3044.0 *7* (1971GiZS), and 3044.6 *8* (1974Kl02). I_γ: weighted average of 0.055 *11* (1969Bo15), 0.058 *10* (1971GiZS), and 0.06 *1* (1974Kl02).
^{x}3090.8# *20*	0.0044# *22*							%Iγ=3.6×10^{-4} *18*
3100.7 *7*	0.0080 *20*	3100.8	1/2$^-$,3/2$^-$	0.0	3/2$^-$			%Iγ=6.6×10^{-4} *17* E_γ: weighted average of 3100.9 *7* (1969Bo15), 3100.3 *10* (1971GiZS), and 3100.7 *8* (1974Kl02). I_γ: weighted average of 0.0088 *22* (1969Bo15), 0.009 *4* (1971GiZS), and 0.007 *2* (1974Kl02).

† Additional information 2.
‡ From 1974Kl02, unless otherwise noted. Intensities as quoted from 1969Bo15 are the original values renormalized to Iγ(699.6γ)=100.
# From 1969Bo15.
@ From Adopted Gammas.
& For absolute intensity per 100 decays, multiply by 0.0825 *33*.
^{x} γ ray not placed in level scheme.

^{63}Zn $\varepsilon+\beta^+$ decay 1974Kl02,1971GiZP,1969Bo15

Decay Scheme

Intensities: I_γ per 100 parent decays

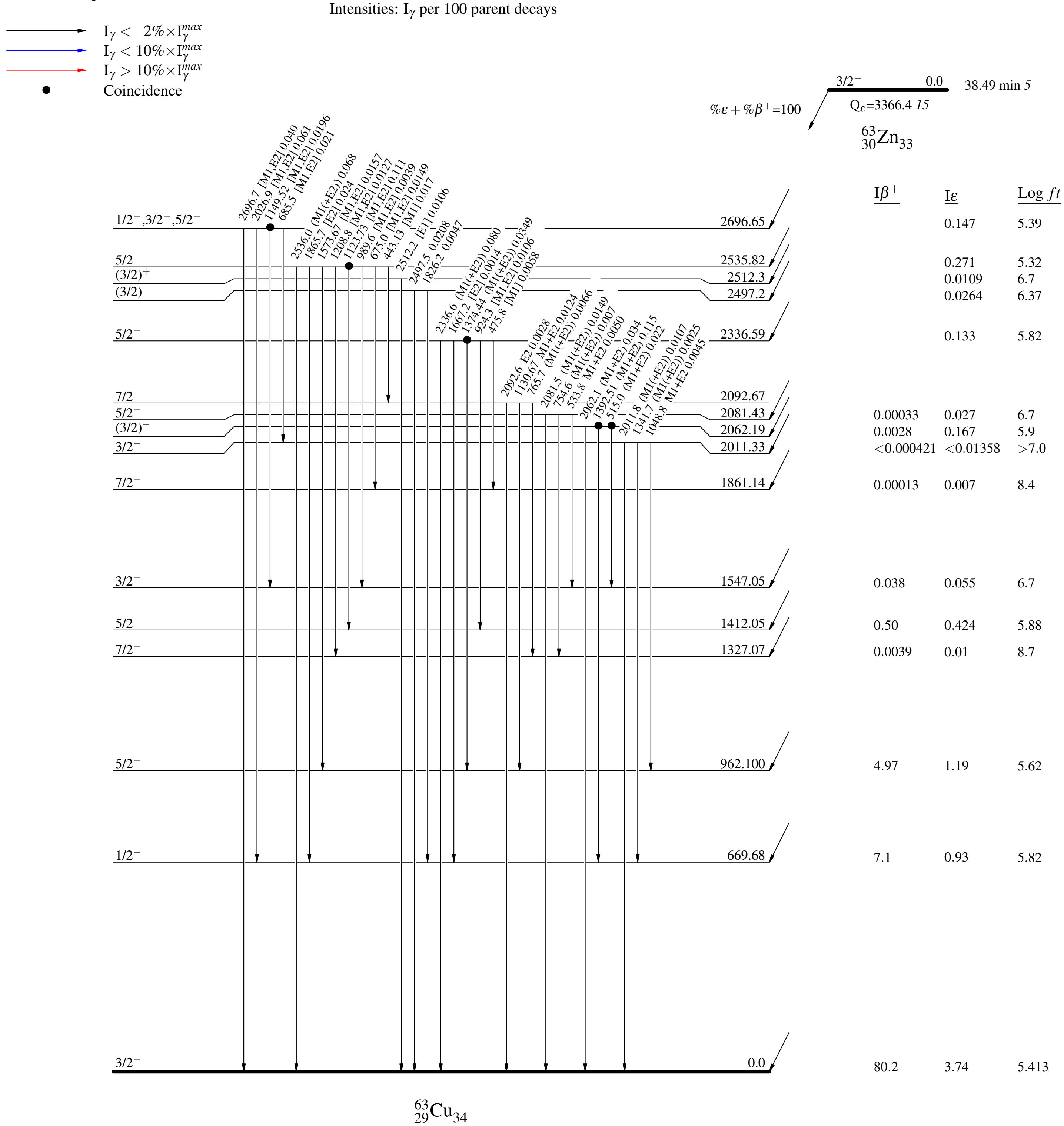


^{63}Zn ε+β^+ decay 1974Kl02,1971GiZP,1969Bo15

Decay Scheme (continued)

Intensities: I_γ per 100 parent decays

Legend



^{63}Zn $\varepsilon+\beta^+$ decay 1974Kl02,1971GiZP,1969Bo15