

⁶⁵Ga ε decay 1972Du03

Type	Author	History	Literature Cutoff Date
Full Evaluation	E. Browne, J. K. Tuli	Citation NDS 111, 2425 (2010)	1-Aug-2009

Parent: ⁶⁵Ga: E=0; J^π=3/2⁻; T_{1/2}=15.2 min 2; Q(ε)=3254.9 9; %ε+%β⁺ decay=100.0

1972Du03: ⁶⁴Zn(d,n), E(d)=5 MeV; enriched ⁶⁴Zn target and mass-separated source; measured E_γ, I_γ and γγ coincidences; Ge(Li), Si(Li) and NaI.

1975Ch27: ⁶⁴Zn(p,γ), E(p)=3 MeV, natural Zn target; measured E_γ, I_γ and γγ coincidences; Ge(Li) and NaI.

1972Nu02: ⁶⁴Zn(p,γ)⁶⁵Ga, E(p)=3.5 MeV; natural Zn target; measured E_γ, I_γ and γγ± coincidences; Ge(Li), NaI detectors.

1957Da07,1957Ma11: ⁶⁴Zn(d,n), E(d)≈7 MeV; chemical separation; measured E_γ, I_γ, γγ and β⁺γ coincidences, Eβ⁺, Iβ⁺, Ice and T_{1/2} of ⁶⁵Ga parent; magnetic spectrometer, scintillators.

1975Ro25: ⁶⁴Zn(d,n)⁶⁵Ga, E(d)=5 MeV; measured delayed β⁺γ, ceβ⁺ and γγ± coincidences; deduced ⁶⁵Zn level lifetimes; E/ΔE telescope, Ge(Li), scintillators.

1972Ba42: ⁶⁴Zn(p,γ)⁶⁵Ga, E(p)=3.8 MeV; enriched ⁶⁴Zn target; measured E_γ, and I_γ; Ge(Li).

1969Ba37: ⁶³Cu(α,2n)⁶⁵Ga, Eα=25 MeV, evaporation separation; measured Ice(K), Ice(L) and α(K)/(α(L)+α(M)); β spectrometer.

1968Li05: measured E_γ, I_γ, γγ coincidences and Ice(K).

1960Au03: measured E_γ, I_γ, prompt and delayed γγ and β⁺γ coincidences.

1971Sh36: measured E_γ, I_γ and delayed γγ coincidences.

Others: 1953Cr15, 1970Ho13, 1971Dz03.

Note: unplaced γ's account for only 0.30% 3 of the total γ intensity.

Measured β⁺ end-point energies from 1957Da07 are given below:

E(level)	E(β ⁺)
0.0	2237 15
115.1	2113 20
866.9	1390 40
1343.9	820 80

⁶⁵Zn Levels

E(level) [†]	J ^π [‡]	T _{1/2}	Comments
0	5/2 ⁻		
53.928 10	(1/2) ⁻	1.62 μs 6	T _{1/2} : weighted mean of delayed β ⁺ γ coincidence measurements 1.65 μs 5 (1960Au03) and 1.52 μs 9 (1975Ro25).
115.126 14	3/2 ⁻	0.44 ns 2	T _{1/2} : From conversion electron β ⁺ coincidences (1975Ro25). Others: 0.46 ns 7 (1968Li05), and 0.49 ns 9 (1971Sh36) from delayed γγ coincidences.
206.95 10	3/2 ⁻	<0.2 ns	T _{1/2} : from measurement of γ-γ [±] coincidences (1975Ro25).
768.84 12	5/2 ⁻		
864.7 4	7/2 ⁻		J ^π : log ft=7.32 10 is in disagreement with adopted J ^π =7/2 ⁻ indicating the presence of unobserved transitions. See ⁶⁵ Zn adopted gammas.
866.93 12	1/2 ⁻	<0.2 ns	T _{1/2} : from measurement of γ-γ [±] coincidences (1975Ro25).
909.70 10	3/2 ⁻		
1047.43 13	5/2 ⁻		
1343.94 12	5/2 ⁻		
1469.80 9	3/2 ⁻		
1576.8 4	3/2 ⁻		Level proposed by 1972Nu02 and confirmed by reaction data.
1587.8 8	7/2 ⁻		Level proposed by 1972Ba42, 1975Ch27 and confirmed by reaction data.
2081.52 20	(1/2,3/2,5/2 ⁺)		Level proposed by 1972Ba42, 1972Nu02, 1975Ch27 and confirmed by reaction data.
2419.18 21	1/2 ⁻		
2549.5? 5	5/2 ⁻ ,7/2 ⁻		Level proposed by 1972Nu02 and 1975Ch27.

Continued on next page (footnotes at end of table)

^{65}Ga ε decay 1972Du03 (continued) ^{65}Zn Levels (continued)† From a least-squares fit to E_{γ} data.

‡ From Adopted Levels.

 ε, β^+ radiations

<u>E(decay)</u>	<u>E(level)</u>	<u>$I\beta^+$ †‡</u>	<u>$I\varepsilon$ ‡‡</u>	<u>Log ft</u>	<u>$I(\varepsilon + \beta^+)$ #</u>	<u>Comments</u>
(835.7 9)	2419.18		0.19 4	5.12 10	0.19 4	$\varepsilon K=0.8834$; $\varepsilon L=0.09896$; $\varepsilon M+=0.01764$
(1667.1 12)	1587.8	0.0011 7	0.0039 24	7.4 3	0.005 3	av $E\beta=277.0$ 7; $\varepsilon K=0.6845$ 12; $\varepsilon L=0.07590$ 14; $\varepsilon M+=0.013513$ 24
(1678.1 10)	1576.8	0.0035 17	0.011 6	6.95 21	0.015 7	av $E\beta=281.7$ 6; $\varepsilon K=0.6753$ 11; $\varepsilon L=0.07488$ 12; $\varepsilon M+=0.013330$ 22
(1785.1 9)	1469.80	0.48 11	0.92 20	5.10 10	1.4 3	av $E\beta=327.6$ 6; $\varepsilon K=0.5820$ 11; $\varepsilon L=0.06450$ 12; $\varepsilon M+=0.011481$ 21
(1911.0 9)	1343.94	0.51 11	0.59 12	5.36 9	1.10 22	av $E\beta=382.2$ 6; $\varepsilon K=0.4735$ 10; $\varepsilon L=0.05244$ 11; $\varepsilon M+=0.009333$ 20 E(decay): for a level at ≈ 1.38 MeV (1957Da07,1957Ma11).
(2207.5 9)	1047.43	1.9 5	0.84 19	5.33 10	2.7 6	$I\beta^+$: $I\beta^+/I\beta^+$ (total)=10% 4 (1957Da07). av $E\beta=512.8$ 6; $\varepsilon K=0.2739$ 7; $\varepsilon L=0.03030$ 7; $\varepsilon M+=0.005392$ 13
(2345.2 9)	909.70	0.71 15	0.23 5	5.95 9	0.94 19	av $E\beta=574.3$ 6; $\varepsilon K=0.2121$ 5; $\varepsilon L=0.02345$ 6; $\varepsilon M+=0.004172$ 10
(2388.0 9)	866.93	6.5 14	1.9 4	5.05 9	8.4 17	av $E\beta=593.5$ 6; $\varepsilon K=0.1962$ 5; $\varepsilon L=0.02169$ 5; $\varepsilon M+=0.003859$ 9 E(decay): for a level at ≈ 0.85 MeV (1957Da07, 1957Ma11).
(2390.2 10)	864.7	0.035 8	0.0099 22	7.32 10	0.045 10	$I\beta^+$: $I\beta^+/I\beta^+$ (total)=19% 6 (1957Da07). av $E\beta=594.5$ 6; $\varepsilon K=0.1954$ 5; $\varepsilon L=0.02160$ 5; $\varepsilon M+=0.003844$ 9 Log ft : 7.32 10 is in disagreement with adopted $J^{\pi}=7/2^-$ indicating the presence of unobserved transitions. See ^{65}Zn adopted gammas.
(2486.1 9)	768.84	1.8 4	0.41 10	5.74 10	2.2 5	av $E\beta=637.8$ 6; $\varepsilon K=0.1647$ 4; $\varepsilon L=0.01820$ 4; $\varepsilon M+=0.003239$ 7
(3047.9 9)	206.95	10.2 22	0.85 18	5.60 9	11.1 23	av $E\beta=895.0$ 6; $\varepsilon K=0.06792$ 12; $\varepsilon L=0.007497$ 13
(3139.8 9)	115.126	58 14	4.2 11	4.94 11	62 15	av $E\beta=937.6$ 6; $\varepsilon K=0.05986$ 10; $\varepsilon L=0.006606$ 11
(3201.0 9)	53.928	10 6	0.7 4	5.74 24	11 6	$I\beta^+$: $I\beta^+/I\beta^+$ (total)=56% 3 (1957Da07). av $E\beta=966.0$ 6; $\varepsilon K=0.05517$ 9; $\varepsilon L=0.006088$ 10

† From $I(\gamma+ce)$ imbalances at each level.‡ From $I(\gamma+ce)$ imbalances and theoretical ε/β^+ ratios.

Absolute intensity per 100 decays.

⁶⁵Ga ε decay **1972Du03** (continued)

γ(⁶⁵Zn)

I_γ normalization: From I_γ(γ[±])/I_γ(751.8)=21.9 21 (1972Du03), I(γ+ce) imbalances at each level and theoretical ε/β⁺ ratios. In agreement with Iβ⁺(total)/I_γ(115)=1.7 from 1968Li05.

E _γ [†]	I _γ ^{@a}	E _i (level)	J _i ^π	E _f	J _f ^π	Mult.#	δ [#]	α ^b	Comments
53.93 [‡] 1	9.0 9	53.928	(1/2) ⁻	0	5/2 ⁻	E2		6.86	α(K)=5.69; α(L)=0.88 α(K)/(α(L)+α(M))=5.6 6 (1969Ba37). α(K)/(α(L)+α(M))≈3.8 and I _{ce} /Iβ ⁺ (total)=0.1 (1957Da07).
61.20 [‡] 1	21.1 20	115.126	3/2 ⁻	53.928	(1/2) ⁻	M1(+E2)	<0.4	0.5 3	α(K)=0.44 24; α(L)=0.06 4 α(K)/(α(L)+α(M))=6.0 15 (1969Ba37). E _γ : uncertainty not given (1972Du03). γ not reported in any other work.
92 ^c	≤0.74	206.95	3/2 ⁻	115.126	3/2 ⁻				
115.09 [‡] 4	100 15	115.126	3/2 ⁻	0	5/2 ⁻	M1+E2	-0.29 3	0.070 6	α(K)=0.061 5; α(L)=0.0067 6 α(K)/(α(L)+α(M))=7.1 10 (1969Ba37).
153.0 [‡] 2	16.4 16	206.95	3/2 ⁻	53.928	(1/2) ⁻	M1+E2	+0.19 5	0.024 2	α(K)=0.0212 20; α(L)=0.00221 22 α(K)/(α(L)+α(M))=7.1 10 (1969Ba37).
206.9 [‡] 2	4.7 5	206.95	3/2 ⁻	0	5/2 ⁻	M1+E2	+0.87 20	0.024 5	α(K)=0.021 4; α(L)=0.0022 4
422.2 3	0.103 25	1469.80	3/2 ⁻	1047.43	5/2 ⁻				
^x 479.5 6	0.04 3								
560.1 2	0.15 ^{&} 2	1469.80	3/2 ⁻	909.70	3/2 ⁻				
574.8 5	0.05 5	1343.94	5/2 ⁻	768.84	5/2 ⁻				
602.7 3	0.123 ^{&} 3	1469.80	3/2 ⁻	866.93	1/2 ⁻				
653.7 2	1.39 14	768.84	5/2 ⁻	115.126	3/2 ⁻	M1+E2	-0.14 12		
659.9 3	0.234 ^{&} 24	866.93	1/2 ⁻	206.95	3/2 ⁻				
702.7 2	0.148 ^{&} 15	909.70	3/2 ⁻	206.95	3/2 ⁻				
714.8 2	0.30 3	768.84	5/2 ⁻	53.928	(1/2) ⁻	[E2]			
751.8 2	15.0 9	866.93	1/2 ⁻	115.126	3/2 ⁻				
768.9 2	2.35 20	768.84	5/2 ⁻	0	5/2 ⁻	M1+E2	+0.51 +10-28		
794.6 2	0.49 5	909.70	3/2 ⁻	115.126	3/2 ⁻	M1+E2	+0.40 12		
813.0 2	0.21 2	866.93	1/2 ⁻	53.928	(1/2) ⁻	[M1]			I _γ : from 1972Nu02.
855.8 2	0.32 3	909.70	3/2 ⁻	53.928	(1/2) ⁻	(M1+E2)	-0.96 20		
864.7 4	0.084 ^{&} 9	864.7	7/2 ⁻	0	5/2 ⁻	M1+E2	-2.27 3		
866.8 4	0.24 ^{&} 3	866.93	1/2 ⁻	0	5/2 ⁻	[E2]			
909.7 2	0.94 9	909.70	3/2 ⁻	0	5/2 ⁻	M1+E2	+0.25 4		
932.2 2	3.32 25	1047.43	5/2 ⁻	115.126	3/2 ⁻	M1+E2	-0.42 5		
993.7 4	0.074 ^{&} 8	1047.43	5/2 ⁻	53.928	(1/2) ⁻				E _γ : from 1972Nu02. E _γ =993.4 5 from 1972Du03.
1047.4 2	1.66 12	1047.43	5/2 ⁻	0	5/2 ⁻	(M1+E2)			δ: -0.40 7 or +6 +7-2.
1137.0 2	0.269 23	1343.94	5/2 ⁻	206.95	3/2 ⁻	(M1+E2)			δ: +0.16 20 or ≤-3.2.
^x 1214.7 ^c 8	≤0.02								

⁶⁵Ga ε decay **1972Du03** (continued)

<u>γ(⁶⁵Zn) (continued)</u>								
<u>E_γ †</u>	<u>I_γ @a</u>	<u>E_i(level)</u>	<u>J_i^π</u>	<u>E_f</u>	<u>J_f^π</u>	<u>Mult.#</u>	<u>δ[#]</u>	<u>Comments</u>
1228.8 2	1.32 9	1343.94	5/2 ⁻	115.126	3/2 ⁻	M1+E2	-0.33 3	
^x 1247.8 8	0.009 2							
1262.9 2	0.141 14	1469.80	3/2 ⁻	206.95	3/2 ⁻			I _γ : 0.32 3 from 1975Ch27 and 0.17 1 from 1972Nu02.
1290.6 6	0.022 7	1343.94	5/2 ⁻	53.928	(1/2) ⁻			I _γ : 0.011 8 from 1972Nu02 and 0.09 2 from 1972Ba42.
1343.9 2	0.37 3	1343.94	5/2 ⁻	0	5/2 ⁻	(M1+E2)		I _γ : from 1972Nu02.
1354.7 2	1.46 16	1469.80	3/2 ⁻	115.126	3/2 ⁻	M1+E2	+0.21 3	
^x 1368 ^c	≤0.013							E _γ : uncertainty not given in 1972Du03.
^x 1408.9 ^c 4	0.059 6							E _γ , I _γ : from 1975Ch27. Reported in 1975Ch27, 1972Ba42 and placed from a proposed 1524 level. γ not reported by 1972Du03, 1972Nu02.
1415.9 2	0.42 5	1469.80	3/2 ⁻	53.928	(1/2) ⁻	(M1+E2)	+0.24 5	
1469.8 2	0.123& 13	1469.80	3/2 ⁻	0	5/2 ⁻			
^x 1502.5 8	0.018 5							
1524.0 8	0.009 7	1576.8	3/2 ⁻	53.928	(1/2) ⁻	(M1+E2)	-2.5 3	E _γ : placed by 1972Nu02. An alternative placement from a proposed 1524 level has been suggested by 1972Ba42. I _γ : from 1972Du03. I _γ =0.007 7 (1972Nu02), 0.10 2 (suggesting possible contamination, 1972Ba42).
1576.5 4	0.018 9	1576.8	3/2 ⁻	0	5/2 ⁻			
1587.8 8	0.009 5	1587.8	7/2 ⁻	0	5/2 ⁻	M1+E2	+0.31 2	I _γ : 0.066 7 from 1975Ch27 and 0.06 2 from 1972Ba42.
1685.4 ^c 4	0.034 9	2549.5?	5/2 ⁻ ,7/2 ⁻	864.7	7/2 ⁻			
^x 1740.1 2	0.025 12							
^x 1826.8 2	0.067 7							
1874.6 ^c 2	0.137 16	2081.52	(1/2,3/2,5/2 ⁺)	206.95	3/2 ⁻			
^x 1887.8 2	0.016 5							
1966.4 ^c 4	0.119 14	2081.52	(1/2,3/2,5/2 ⁺)	115.126	3/2 ⁻			
^x 2009.7 6	0.011 7							
^x 2081.4 8	0.013 7							
^x 2087.5 8	0.011 7							
^x 2102.1 2	0.025 5							I _γ : 0.211 21 from 1975Ch27.
^x 2163.7 8	0.027 7							
2212.1 3	0.247 20	2419.18	1/2 ⁻	206.95	3/2 ⁻			
^x 2251.8 2	0.009 9							
^x 2289.8 4	0.013& 2							I _γ : 0.029 7 from 1972Du03 and 0.015 3 from 1972Nu02.
2304.3 13	0.018 9	2419.18	1/2 ⁻	115.126	3/2 ⁻			
^x 2343.1 6	0.022 5							
2365.2 3	0.072 9	2419.18	1/2 ⁻	53.928	(1/2) ⁻			
^x 2404.3 4	0.045 7							
2419.7 8	0.006 5	2419.18	1/2 ⁻	0	5/2 ⁻			
2432.9 ^c 8	0.011 5	2549.5?	5/2 ⁻ ,7/2 ⁻	115.126	3/2 ⁻			
^x 2458.4 6	0.016 5							
^x 2468.6 ^c 8	≤0.004							
^x 2526.0 11	0.006 6							

⁶⁵Ga ε decay **1972Du03** (continued)

γ(⁶⁵Zn) (continued)

<u>E_γ[†]</u>	<u>I_γ^{@a}</u>	<u>E_i(level)</u>	<u>J_i^π</u>	<u>E_f</u>	<u>J_f^π</u>	<u>Comments</u>
2549.6 ^c 4	0.056 9	2549.5?	5/2 ⁻ , 7/2 ⁻	0	5/2 ⁻	
^x 2570.8 3	0.008 3					
^x 2583.9 3	0.0036 23					
^x 2627.6 8	0.0043 23					
^x 2635.7 3	0.0090 23					
^x 2648.7 13	0.0029 23					
^x 2679.4 8	0.0090 23					
^x 2685.6 13	0.0036 18					
^x 2722.0 8	0.0025 11					
^x 2792.4 3	0.0090 23					
^x 2801.6 3	0.0043 11					
^x 2835.5 3	0.025 5					
^x 2853.2 4	0.0025 7					
^x 2891.2 17	0.0018 7					
^x 2901.4 18	0.0018 7					
^x 2908.1 18	0.0011 7					
^x 2941.1 ^c 18	≤0.0011					
^x 2963.3 19	0.0011 7					
^x 2996.0 13	0.0036 11					
^x 3004.3 13	0.0036 11					
^x 3014.8 13	0.0011 7					
^x 3025.7 ^c 20	≤0.0023					
^x 3056.0 13	0.0029 11					
^x 3114.3 ^c 13	≤0.0012					

I_γ: 0.057 6 from [1975Ch27](#) and 0.013 3 from [1972Nu02](#).

[†] From [1972Du03](#), except as noted. γ placements are from [1972Du03](#), [1975Ch27](#) and [1972Nu02](#).

[‡] From adopted gammas.

From adopted gammas.

@ Relative intensity from [1972Du03](#), except as noted. Data from [1975Ch27](#), [1972Nu02](#) are mostly in good agreement with [1972Du03](#).

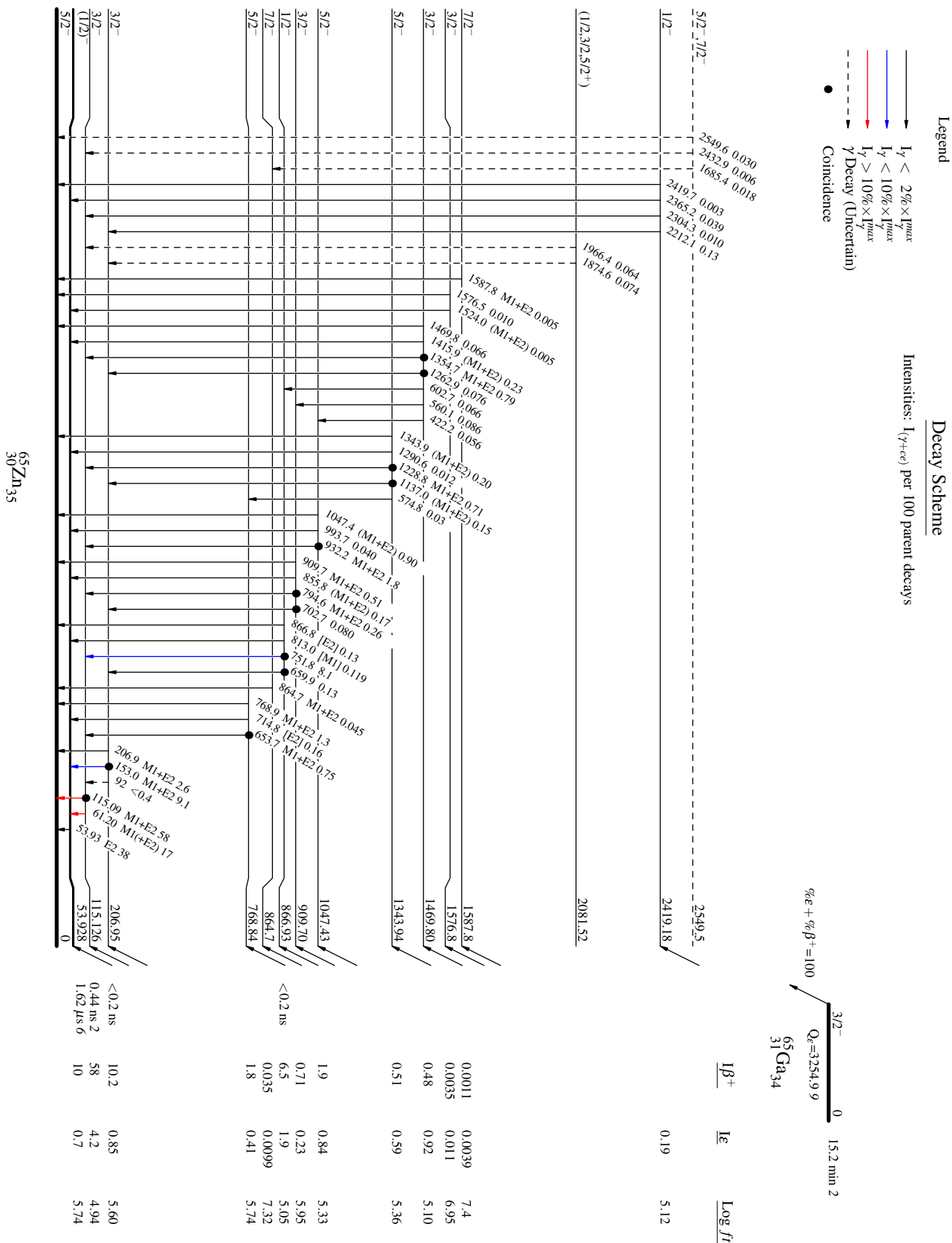
& From [1975Ch27](#).

^a For absolute intensity per 100 decays, multiply by 0.54 10.

^b 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.

^c Placement of transition in the level scheme is uncertain.

^x γ ray not placed in level scheme.



⁶⁵Zn₃₅