^{73}Zn β^- decay (24.5 s) 2017Ve05,1983Ru06

History

Type	Author	Citation	Literature Cutoff Date
Full Evaluation	Balraj Singh and Jun Chen	NDS 158, 1 (2019)	16-May-2019

Parent: ^{73}Zn: E=0.0; J$^\pi$=1/2$^-$; $T_{1/2}$=24.5 s *2*; Q(β^-)=4105.9 *25*; %β^- decay=100.0

^{73}Zn-J$^\pi$,$T_{1/2}$: From Adopted Levels of ^{73}Zn, where half-life is from measurement by 2017Ve05.

^{73}Zn-Q(β^-): From 2017Wa10.

2017Ve05: ^{73}Zn ions were produced by the collision of 1.4 GeV protons on the neutron converter of a UC_x target at the ISOLDE-CERN facility. Fragments were separated and selected by a magnetic high-resolution mass separator (HRS). γ rays were detected with two HPGe detectors for γ-ray identification and with two $LaBr_3$(Ce) crystals for fast-timing; β particles were detected with an ultrafast plastic scintillator. Measured Eγ, Iγ, Eβ, $\gamma\gamma$-coin, $\beta\gamma$-coin, $\beta\gamma\gamma$-coin, γ(t), $\beta\gamma$(t), $\beta\gamma\gamma$(t). Deduced levels, $T_{1/2}$, β- decay branching ratios, log *ft*, γ transition strengths. Comparisons with theoretical calculations.

1983Ru06: ^{73}Zn source was produced by bombarding a 23 mg/cm^2 ^{nat}W target with a 9 MeV/nucleon ^{76}Ge beam from the UNILAC accelerator at GSI. γ rays were detected with two Ge detectors and β particles were detected with a plastic scintillator. Measured Eγ, Iγ, Eβ, $\gamma\gamma$-coin, $\beta\gamma$-coin, $\beta\gamma$(t). Deduced levels, J, π, β-decay branching ratios, log *ft*. Comparisons with available data.

Others:

2010Di14: re-analyzed data from the measurement by 2009Va01 for ^{73}Zn decay, which is not reported in 2009Va01.

1972Er05: measured Eγ, Iγ, Eβ, $\beta\gamma$-coin, β(t). Deduced parent $T_{1/2}$.

The total average radiation energy of 4113 keV *98* calculated using the RADLIST code agrees well the expected value of Q(β^-)=4105.9 keV *25* (2017Wa10) indicating the completeness of the decay scheme.

^{73}Ga Levels

E(level)[†]	J$^\pi$[@]	$T_{1/2}$[&]	Comments
0.0[#]	1/2$^-$		
<0.3[#]	3/2$^-$		E(level): from 2017Ve05.
198.65 *20*	5/2$^-$		
217.69 *10*	3/2$^-$	47 ps *6*	
495.93 *18*	5/2$^-$,7/2$^-$	22 ps *6*	
911.03 *18*	3/2$^-$	≤28 ps	
1113.6 *3*	1/2$^-$		
1393.07[‡] *21*	(5/2$^-$)		
1692.85 *20*	(1/2$^-$,3/2$^-$)		
1721.54[‡] *22*	(1/2$^-$,3/2$^-$)		
1924.61 *20*	1/2$^-$,3/2$^-$		
1980.01[‡] *21*	(1/2$^-$,3/2$^-$)		
2109.07 *20*	3/2$^-$		
2246.2[‡] *3*	(1/2$^-$,3/2$^-$)		
2466.5[‡] *3*	(3/2$^+$)		
2770.38[‡] *24*	(1/2$^-$,3/2$^-$)		
2814.6[‡] *4*			
2986.8 *3*	(1/2,3/2)$^-$		
3099.1[‡] *4*	(1/2$^-$,3/2$^-$)		

[†] From a least-squares fit to γ-ray energies for levels populated in γ-ray studies. Several ground-transitions could decay to either the g.s. or the level at <0.3 keV. In the fitting procedure final level energy is assumed as 0.15 keV *15* to cover the range up to 0.3 keV.

[‡] Levels proposed by 2017Ve05.

[#] Existence of a level near the g.s. is deduced from the observed Doppler-broadening of 199.2γ from the 199.2, 5/2$^-$ level in Coulomb excitation (2010Di14), which restricts the lifetime of the 5/2$^-$ level considerably smaller than 3.5 ns (maximum

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^{73}Zn β^- decay (24.5 s) 2017Ve05,1983Ru06 (continued)

^{73}Ga Levels (continued)

time-of-flight between target and detector) consistent with the lifetime=3.3 ps from Weisskopf estimate for a pure 199-keV M1 transition but not with 13 ns *2* from measured B(E2)(W.u.)=11 *2* for the assumption of a pure E2 to $1/2^-$ g.s. Energy of the closely-spaced level near the g.s. is estimated as <0.3 keV from 2017Ve05 in ^{73}Zn β^- decay based on a search for energy differences between γ cascades deexciting the same level but proceeding through distinct paths, and also based on a search for doublets in γ-ray spectra. The energy of this level is also estimated by 2010Di14 as 0.4 keV *4* (or <0.8 keV) using the approach based on energy differences between γ cascades.

@ From Adopted Levels. Assignments adopted only from this dataset are also noted separately.

& From $\beta\gamma\gamma$(t) in 2017Ve05 using the Advanced Time-Delayed method with an ultrafast plastic scintillator and $LaBr_3$(Ce) detector.

β^- radiations

E(decay)	E(level)	$I\beta^-$ †‡	Log *ft*	Comments
(1007 *3*)	3099.1	0.033 *14*	6.0 *2*	av Eβ=364.1 *11*
(1119 *3*)	2986.8	0.18 *5*	5.4 *1*	av Eβ=412.3 *11*
(1291 *3*)	2814.6	0.020 *11*	6.6 *3*	av Eβ=487.5 *12*
(1336 *3*)	2770.38	0.19 *5*	5.7 *1*	av Eβ=507.1 *12*
(1639 *3*)	2466.5	0.046 *16*	6.7 *2*	av Eβ=643.6 *12*
(1860 *3*)	2246.2	0.10 *3*	6.6 *1*	av Eβ=744.5 *12*
(1997 *3*)	2109.07	2.6 *7*	5.3 *1*	av Eβ=807.8 *12*
(2126 *3*)	1980.01	0.58 *14*	6.0 *1*	av Eβ=867.9 *12*
(2181 *3*)	1924.61	0.77 *19*	6.0 *1*	av Eβ=893.7 *12*
(2384 *3*)	1721.54	0.27 *7*	6.6 *1*	av Eβ=988.9 *12*
(2413 *3*)	1692.85	0.77 *19*	6.2 *1*	av Eβ=1002.5 *12*
(2713 *3*)	1393.07	0.013 *15*	8.1 *5*	av Eβ=1144.2 *12*
(2992 *3*)	1113.6	0.32 *8*	6.9 *1*	av Eβ=1277.1 *12*
(3195 *3*)	911.03	1.8 *5*	6.3 *1*	av Eβ=1374.0 *12*
(3610 *3*)	495.93	0.05 *14*	8.1 *13*	av Eβ=1573.2 *12*
(3888 *3*)	217.69	5.6 *14*	6.2 *1*	av Eβ=1707.2 *12*
(3907 *3*)	198.65	0.10 *4*	7.9 *2*	av Eβ=1716.3 *12*
(4105.9 *25*)	0.0	86.6 *30*	5.10 *2*	av Eβ=1812.1 *12* E(decay): end-point energy of the detected β^- radiation is 4700 *200* (1972Er05), not from a normal Kurie plot, see 1984Be10. 1984Be10 quote Eβ≈4500 from data of 1972Er05 if a Kurie plot is used. $I\beta^-$: deduced by 2017Ve05 for the doublet of 0.0, $1/2^-$ and 0.15 keV, $3/2^-$. Other: 89 deduced by 1983Ru06 from comparison of single β-rays and β-coincident γ-rays assuming a 100% branch of the 450-keV transition following ^{73}Cu decay.

† From γ-ray intensity imbalance at each level except for Iβ(g.s. doublet)=86.6 *30* which is deduced by 2017Ve05 based on known absolute intensities of the most intense transitions (325.7γ, 739.4γ, and 767.8γ) in ^{73}Ge from the adopted dataset of ^{73}Ga β decay in ENSDF (2004 update; remain unchanged in current update), with the observed ^{73}Zn activity corrected for saturation using known $T_{1/2}$ of ^{73}Ga for each implantation pulse.

‡ Absolute intensity per 100 decays.

$\gamma(^{73}Ga)$

Iγ normalization: From ΣI(γ to g.s. doublet)=100−Iβ(g.s. doublet)=13.4 *30* assuming negligible contributions from conversion electrons, with Iβ(g.s. doublet)=86.6 *30*, deduced by 2017Ve05 based on known absolute intensities of the most intense transitions (325.7γ, 739.4γ, and 767.8γ) in ^{73}Ge from the adopted dataset of ^{73}Ga β decay in ENSDF (2004 update; remain unchanged in current update), with the observed ^{73}Zn activity corrected for saturation using known $T_{1/2}$ of ^{73}Ga for each implantation pulse.

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^{73}Zn β^- decay (24.5 s) 2017Ve05,1983Ru06 (continued)

γ(^{73}Ga) (continued)

E_γ[†]	I_γ[†#]	E_i(level)	J^π_i	E_f	J^π_f	Comments
198.4[‡] 2	2.8 2	198.65	5/2⁻	<0.3	3/2⁻	
217.8[‡] 2	100 3	217.69	3/2⁻	0.0	1/2⁻	E_γ: weighted average of 217.4 2 (2017Ve05), 217.9 2 (2010Di14) and 218.1 2 (1983Ru06). I_γ: from 1983Ru06. Other: 100 5 from 2017Ve05.
278.1 3	1.8 2	495.93	5/2⁻,7/2⁻	217.69	3/2⁻	E_γ: weighted average of 277.9 3 (2017Ve05) and 278.4 4 (1983Ru06). I_γ: weighted average of 2.1 3 (2017Ve05) and 1.6 2 (1983Ru06).
297.3 2	0.2 1	495.93	5/2⁻,7/2⁻	198.65	5/2⁻	
415.2 2	2.0 3	911.03	3/2⁻	495.93	5/2⁻,7/2⁻	E_γ: weighted average of 415.2 2 (2017Ve05) and 415.2 4 (1983Ru06). I_γ: unweighted average of 2.3 1 (2017Ve05) and 1.7 2 (1983Ru06).
482.2 2	0.1 1	1393.07	(5/2⁻)	911.03	3/2⁻	
495.7[‡] 2	26.4 19	495.93	5/2⁻,7/2⁻	<0.3	3/2⁻	E_γ: weighted average of 495.6 1 (2017Ve05), 496.2 2 (2010Di14) and 495.6 3 (1983Ru06). I_γ: weighted average of 28.4 14 (2017Ve05) and 24.7 13 (1983Ru06).
579.3 3	0.1 1	1692.85	(1/2⁻,3/2⁻)	1113.6	1/2⁻	
586.6[@] 5	0.1 1	1980.01	(1/2⁻,3/2⁻)	1393.07	(5/2⁻)	
608.4[@] 5	0.1 1	1721.54	(1/2⁻,3/2⁻)	1113.6	1/2⁻	
693.4 1	7.0 7	911.03	3/2⁻	217.69	3/2⁻	E_γ: weighted average of 693.4 1 (2017Ve05), 693.3 3 (2010Di14) and 693.1 3 (1983Ru06). I_γ: unweighted average of 7.7 4 (2017Ve05) and 6.3 4 (1983Ru06).
716.1 2	0.8 1	2109.07	3/2⁻	1393.07	(5/2⁻)	
781.7 2	1.0 1	1692.85	(1/2⁻,3/2⁻)	911.03	3/2⁻	
810.5 4	0.3 1	1721.54	(1/2⁻,3/2⁻)	911.03	3/2⁻	
910.8[‡] 3	31.8 13	911.03	3/2⁻	<0.3	3/2⁻	E_γ: unweighted average of 910.6 1 (2017Ve05), 911.4 2 (2010Di14) and 910.5 4 (1983Ru06). I_γ: weighted average of 31.6 16 (2017Ve05) and 31.9 13 (1983Ru06).
1013.4 4	0.3 1	1924.61	1/2⁻,3/2⁻	911.03	3/2⁻	
1069.7 3	0.2 1	1980.01	(1/2⁻,3/2⁻)	911.03	3/2⁻	
1113.5[‡] 3	5.1 4	1113.6	1/2⁻	0.0	1/2⁻	E_γ: weighted average of 1113.6 2 (2017Ve05) and 1113.0 4 (1983Ru06); unplaced in 1983Ru06. I_γ: weighted average of 5.3 4 (2017Ve05) and 4.9 5 (1983Ru06).
1194.2 4	0.2 1	1393.07	(5/2⁻)	198.65	5/2⁻	
1196.9 3	5.4 8	1692.85	(1/2⁻,3/2⁻)	495.93	5/2⁻,7/2⁻	
1197.7 4	12.8 9	2109.07	3/2⁻	911.03	3/2⁻	E_γ: weighted average of 1198.1 4 (2017Ve05) and 1197.3 4 (1983Ru06). I_γ: weighted average of 11.9 23 (2017Ve05) and 12.9 9 (1983Ru06).
1392.9[‡] 3	0.9 1	1393.07	(5/2⁻)	<0.3	3/2⁻	
1428.6 2	2.2 7	1924.61	1/2⁻,3/2⁻	495.93	5/2⁻,7/2⁻	E_γ: weighted average of 1428.7 2 (2017Ve05) and 1428.3 5 (1983Ru06). I_γ: unweighted average of 2.9 2 (2017Ve05) and 1.5 4 (1983Ru06).
1475.1 3	2.6 2	1692.85	(1/2⁻,3/2⁻)	217.69	3/2⁻	E_γ: weighted average of 1475.2 2 (2017Ve05) and 1474.3 5 (1983Ru06). I_γ: weighted average of 2.6 2 (2017Ve05) and 2.2 5 (1983Ru06).
1483.9 3	1.8 2	1980.01	(1/2⁻,3/2⁻)	495.93	5/2⁻,7/2⁻	

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$^{73}Zn\ \beta^-$ decay (24.5 s) 2017Ve05,1983Ru06 (continued)

$\gamma(^{73}Ga)$ (continued)

E_γ [†]	I_γ [†#]	E_i(level)	J_i^π	E_f	J_f^π	Comments
1493.5[@] 6	0.1 1	1692.85	(1/2⁻,3/2⁻)	198.65	5/2⁻	
1504.0 3	0.6 1	1721.54	(1/2⁻,3/2⁻)	217.69	3/2⁻	
1593.7 5	0.2 1	2986.8	(1/2,3/2)⁻	1393.07	(5/2⁻)	
1613.1 2	15.7 9	2109.07	3/2⁻	495.93	5/2⁻,7/2⁻	E_γ: weighted average of 1613.1 2 (2017Ve05) and 1612.9 4 (1983Ru06). I_γ: weighted average of 16.3 13 (2017Ve05) and 15.4 9 (1983Ru06).
1692.8[‡] 2	2.7 4	1692.85	(1/2⁻,3/2⁻)	0.0	1/2⁻	E_γ: weighted average of 1692.8 2 (2017Ve05) and 1692.5 6 (1983Ru06). I_γ: weighted average of 2.6 2 (2017Ve05) and 3.6 5 (1983Ru06).
1707.0 4	0.3 1	1924.61	1/2⁻,3/2⁻	217.69	3/2⁻	
1721.3[‡] 2	3.2 3	1721.54	(1/2⁻,3/2⁻)	<0.3	3/2⁻	
1726.0 4	0.1 1	1924.61	1/2⁻,3/2⁻	198.65	5/2⁻	
1761.6 5	0.6 2	1980.01	(1/2⁻,3/2⁻)	217.69	3/2⁻	
1859.5 3	0.3 1	2770.38	(1/2⁻,3/2⁻)	911.03	3/2⁻	
1873.0 5	0.3 1	2986.8	(1/2,3/2)⁻	1113.6	1/2⁻	
1891.3 5	0.8 1	2109.07	3/2⁻	217.69	3/2⁻	
1924.5[‡] 2	8.7 7	1924.61	1/2⁻,3/2⁻	0.0	1/2⁻	E_γ: weighted average of 1924.5 2 (2017Ve05) and 1924.7 8 (1983Ru06). I_γ: weighted average of 8.1 7 (2017Ve05) and 9.3 7 (1983Ru06).
1970.5 7	0.2 1	2466.5	(3/2⁺)	495.93	5/2⁻,7/2⁻	
1979.7[‡] 2	6.2 5	1980.01	(1/2⁻,3/2⁻)	<0.3	3/2⁻	E_γ: weighted average of 1979.7 2 (2017Ve05) and 1979.9 8 (1983Ru06). I_γ: weighted average of 6.2 5 (2017Ve05) and 6.2 6 (1983Ru06).
2028.3 5	0.4 1	2246.2	(1/2⁻,3/2⁻)	217.69	3/2⁻	
2108.9[‡] 2	10.8 13	2109.07	3/2⁻	0.0	1/2⁻	E_γ: weighted average of 2108.9 2 (2017Ve05) and 2109 1 (1983Ru06). I_γ: unweighted average of 9.5 8 (2017Ve05) and 12.1 9 (1983Ru06).
2246.1[‡] 3	1.1 2	2246.2	(1/2⁻,3/2⁻)	0.0	1/2⁻	
2248.6 5	0.3 1	2466.5	(3/2⁺)	217.69	3/2⁻	
2274.3 3	1.1 1	2770.38	(1/2⁻,3/2⁻)	495.93	5/2⁻,7/2⁻	
[x]2343.6 3	2.4 2					I_γ: other: 2.3 4 (1983Ru06).
2466.4[‡] 3	0.2 1	2466.5	(3/2⁺)	0.0	1/2⁻	
2571.2 7	0.1 1	2770.38	(1/2⁻,3/2⁻)	198.65	5/2⁻	
2616.1 5	0.1 1	2814.6		198.65	5/2⁻	
2769.3[@] 5	0.2 1	2986.8	(1/2,3/2)⁻	217.69	3/2⁻	
2770.2[‡] 3	1.4 3	2770.38	(1/2⁻,3/2⁻)	0.0	1/2⁻	E_γ: this transition from 2017Ve05 could correspond to the transition of 2772 3 with Iγ=1.7 3 placed from a 2990 level in 1983Ru06.
2787.9 4	0.4 1	2986.8	(1/2,3/2)⁻	198.65	5/2⁻	
2814.2[‡] 5	0.2 1	2814.6		<0.3	3/2⁻	
2881.7 5	0.1 1	3099.1	(1/2⁻,3/2⁻)	217.69	3/2⁻	
2900.2 5	0.2 1	3099.1	(1/2⁻,3/2⁻)	198.65	5/2⁻	
2986.7[‡] 3	1.9 2	2986.8	(1/2,3/2)⁻	0.0	1/2⁻	E_γ: weighted average of 2986.7 3 (2017Ve05) and 2989 3 (1983Ru06). I_γ: other: 2.1 3 for the 2989 transition in 1983Ru06. Note that 2017Ve05 also observe a transition of 2900.2 placed from 3099 level.
3098.8[‡] 6	0.2 1	3099.1	(1/2⁻,3/2⁻)	<0.3	3/2⁻	

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^{73}Zn β^- decay (24.5 s) 2017Ve05,1983Ru06 (continued)

γ(^{73}Ga) (continued)

† From 2017Ve05, unless otherwise noted.

‡ Final level could be the g.s. and/or closely-spaced level at <0.3 keV according to data in 2017Ve05. In the least-squares fitting procedure, the final level is assumed to be at 0.15 keV *15* to cover the range up to 0.3 keV.

For absolute intensity per 100 decays, multiply by 0.066 *15*.

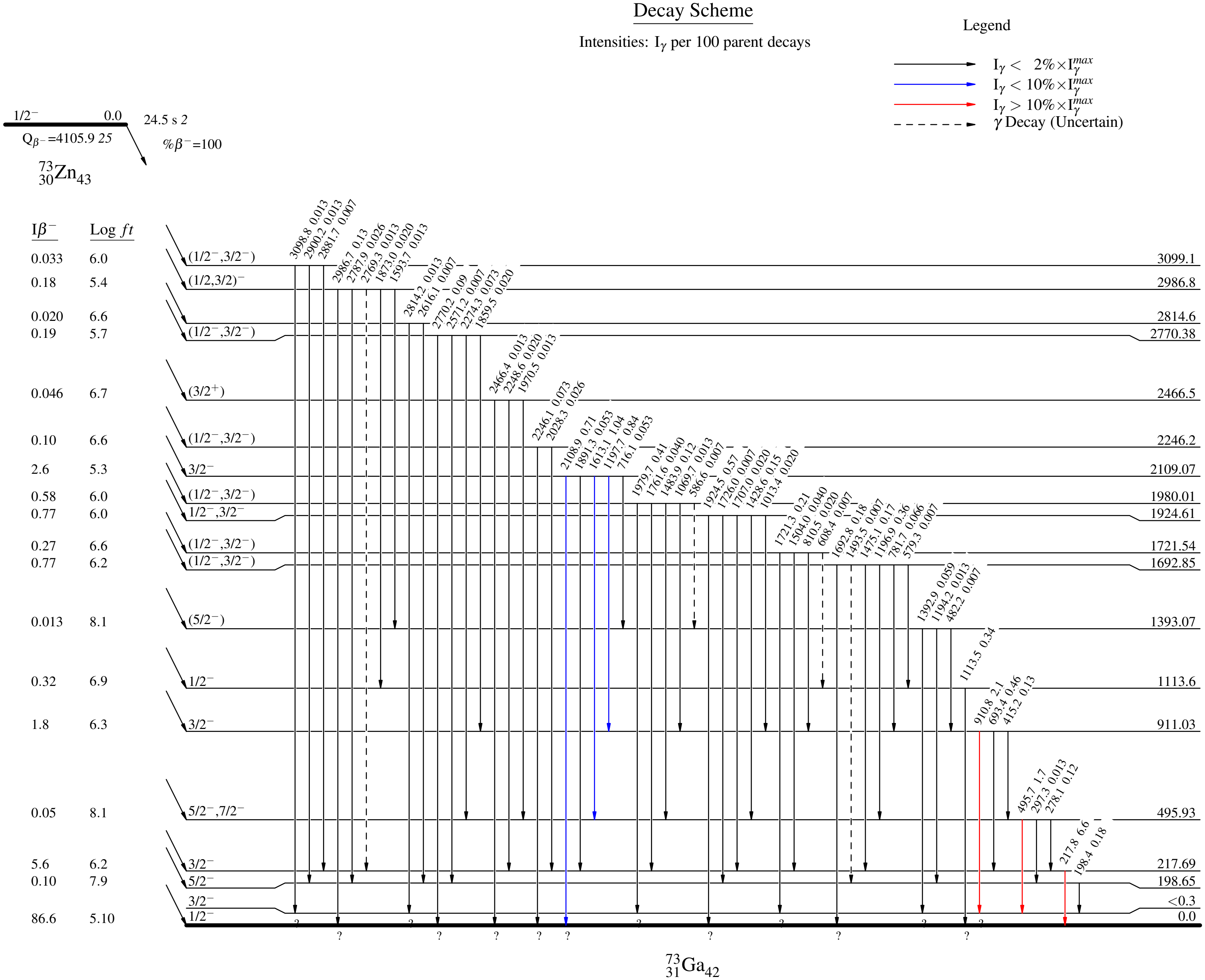
@ Placement of transition in the level scheme is uncertain.

^{x} γ ray not placed in level scheme.

^{73}Zn β^- decay (24.5 s)   2017Ve05,1983Ru06

Decay Scheme

Intensities: I_γ per 100 parent decays



From ENSDF

$^{73}_{31}Ga_{42}$-6