^{33}Cl $\varepsilon+\beta^+$ decay (2.5059 s) 1980Wi13

History

Type	Author	Citation	Literature Cutoff Date
Full Evaluation	Jun Chen and Balraj Singh	NDS 199,1 (2025)	30-Sep-2024

Parent: ^{33}Cl: E=0.0; J$^\pi$=3/2$^+$; T$_{1/2}$=2.5059 s *23*; Q(ε)=5582.5 *4*; %ε+%β^+ decay=100

^{33}Cl-J$^\pi$,T$_{1/2}$: From the Adopted Levels of ^{33}Cl.

^{33}Cl-Q(ε): From 2021Wa16.

1980Wi13: ^{33}Cl was produced by ^{32}S(d,n)^{33}Cl reaction with 11.0 MeV deuterons from the ONR-CIT tandem accelerator on a natural sulphur target. γ rays were detected with a Ge(Li) detector. Measured Eγ, Iγ. Deduced levels, ε-decay branching ratios, log *ft*. Comparisons with available data.

1987Bo21: ^{33}Cl was produced from the β^+-decay of ^{33}Ar at ISOLDE facility of CERN. γ rays were detected with a Ge(Li) detector. Measured Eγ, Iγ.

2014Ko17: ^{33}Cl was produced from the β^+-decay of ^{33}Ar at ISOLDE facility, CERN. The γ rays were detected with cluster detectors. Measured Eγ, Iγ for 841.3γ, 1966.9γ and 2867γ.

1970Ba65: ^{33}Cl source was produced with 2.8 MeV deuteron beam on sulfur powder of either natural or enriched ^{32}S. γ rays were detected with two coaxial Ge(Li) detectors. Measured Eγ, Iγ, γ(t). Deduced levels, parent T$_{1/2}$, ε-decay branching ratios, log *ft*.

Half-life measurements: 1958Mu05, 1960Ja12, 1970Sc16, 1972Es02, 1973Ta04, 1977Az01, 2015Gr14. Others: 1940Ho01, 1941Wh02, 1948Sc20, 1951Bo56, 1954Ty33, 1960Wa04, 1962Va27, 1970Ba65.

Additional information 1.

β measurements: 1941Wh02, 1951Bo56, 1960Wa04, 1962Va27.

^{33}S Levels

E(level)†	J$^\pi$‡	T$_{1/2}$‡	E(level)†	J$^\pi$‡	T$_{1/2}$‡
0.0	3/2$^+$	stable	3935.1 *8*	3/2$^+$	24 fs *7*
840.9 *4*	1/2$^+$	1.17 ps *7*	4053.2 *8*	1/2$^+$	12 fs *8*
1966.3 *4*	5/2$^+$	94 fs *14*	4144.3 *10*	5/2$^+$	24 fs *7*
2312.6 *7*	3/2$^+$	117 fs *17*	4375.4 *8*	1/2$^+$	24 fs *10*
2866.9 *5*	5/2$^+$	12 fs *4*	4424.7 *8*	1/2$^+$,3/2	19 fs *10*
3832.0 *8*	5/2$^+$	30 fs *8*	4746.2 *8*	1/2$^+$,3/2$^+$,5/2$^+$	<7 fs

† From a least-squares fit to γ-ray energies, assuming ΔEγ=1 keV for Eγ values without uncertainties.

‡ From the Adopted Levels.

ε,β^+ radiations

E(decay)	E(level)	Iβ^+ #	Iε#	Log *ft*	I($\varepsilon+\beta^+$)†#	Comments
(836.3 *14*)	4746.2		4.1×10^{-5} *12*	5.4 +*2*−*1*		εK=0.9059 *5*; εL=0.08215 *38*; εM=0.01192 *16*
(1157.8 *14*)	4424.7	<6.7×10^{-7}	<5.6×10^{-5}	>5.5	<5.7×10^{-5}	av Eβ=56.29 *36*; εK=0.8953 *7*; εL=0.08108 *37*; εM=0.01176 *16*
(1207.1 *14*)	4375.4	<1.6×10^{-6}	<4.2×10^{-5}	>5.7	<4.4×10^{-5}	av Eβ=75.73 *36*; εK=0.8722 *11*; εL=0.07897 *37*; εM=0.01146 *15*
(1438.2 *15*)	4144.3	<1.1×10^{-5}	<1.5×10^{-5}	>6.3	<2.6×10^{-5}	av Eβ=168.19 *45*; εK=0.5265 *49*; εL=0.04764 *49*; εM=0.00691 *11*
(1529.3 *14*)	4053.2	2.8×10^{-5} *14*	1.9×10^{-5} *6*	6.57 *31*	4.7×10^{-5} *15*	av Eβ=205.50 *37*; εK=0.3743 *42*; εL=0.03387 *41*; εM=0.00491 *9*
(1647.4 *14*)	3935.1	<5.2×10^{-5}	<1.8×10^{-5}	>6.3	<7×10^{-5}	av Eβ=254.61 *38*; εK=0.2342 *31*; εL=0.02119 *29*; εM=0.00307 *6*
(1750.5 *14*)	3832.0	<7.6×10^{-5}	<1.6×10^{-5}	>6.4	<9.2×10^{-5}	av Eβ=298.10 *38*; εK=0.1577 *22*; εL=0.01427 *21*; εM=0.00207 *4*
(2715.6 *12*)	2866.9	0.43 *6*	0.0064 *9*	4.19 +*8*−*5*	0.44‡ *6*	av Eβ=725.91 *27*; εK=0.01314 *18*;

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^{33}Cl ε+β^+ decay (2.5059 s) 1980Wi13 (continued)

ϵ,β^+ radiations (continued)

E(decay)	E(level)	Iβ^+ [#]	Iε [#]	Log *ft*	I($\varepsilon+\beta^+$) [†#]	Comments
						εL=0.001188 *17*; εM=1.723×10^{-4} *33* I($\varepsilon+\beta^+$): other: 0.56 *6* (1970Ba65).
(3269.9 *13*)	2312.6	0.0351 *48*	2.19×10^{-4} *30*	5.82 *+7−5*	0.0353 *48*	av Eβ=982.31 *37*; εK=0.00562 *8*; εL=5.08×10^{-4} *7*; εM=7.37×10^{-5} *14* I($\varepsilon+\beta^+$): other: <0.05 (1970Ba65).
(3616.2 *12*)	1966.3	0.46 *6*	0.00186 *24*	4.98 *6*	0.46[‡] *6*	av Eβ=1144.86 *28*; εK=0.00367 *5*; εL=3.312×10^{-4} *47*; εM=4.80×10^{-5} *9* I($\varepsilon+\beta^+$): other: 0.56 *6* (1970Ba65).
(4741.6 *12*)	840.9	0.48 *6*	6.7×10^{-4} *8*	5.66 *6*	0.48 *6*	av Eβ=1681.09 *29*; εK=0.001262 *17*; εL=1.140×10^{-4} *16*; εM=1.654×10^{-5} *31* I($\varepsilon+\beta^+$): other: 0.54 *10* (1970Ba65).
(5582.5 *15*)	0.0	98.50 *19*	0.0755 *10*	3.753 *+2−1*	98.58 *19*	av Eβ=2086.86 *19*; εK=6.94×10^{-4} *9*; εL=6.27×10^{-5} *9*; εM=9.09×10^{-6} *17* I($\varepsilon+\beta^+$): as given in 1980Wi13, deduced from 100-Iβ(excited states) by assuming unobserved feedings to higher levels negligible. Other: 98.3 *2* deduced the same way in 1970Ba65, but fewer γ rays are observed in that work than 1980Wi13.

[†] Deduced from measured γ-ray intensities, compared with measured intensity of 511-keV radiation produced by the annihilation for excited states (1970Ba65,1980Wi13), unless otherwise noted. Quoted values are from 1980Wi13.
[‡] Reported in 1980Wi13 as weighted average of value measured (but not listed) by 1980Wi13 and value from 1970Ba65.
[#] Absolute intensity per 100 decays.

γ(^{33}S)

Iγ normalization: Weighted average of 0.00435 *60*, 0.00436 *57* and 0.00436 *58* from Iγ intensity balance and measured %Iβ in 1980Wi13 at 841, 1966, and 2867 levels, respectively.
1987Bo21 report %Iγ=0.55 *6*, 0.42 *4* and 0.55 *5* for 841γ, 1966γ and 2867γ, respectively, as per 100 ^{33}Ar decays, but from comparisons with values in 1980Wi13 and 1970Ba65, these values are more likely per 100 ^{33}Cl decays.

E$_\gamma$ [†]	I$_\gamma$ [†#]	E$_i$(level)	J$^\pi_i$	E$_f$	J$^\pi_f$	Mult. [‡]	δ [‡]	Comments
840.7 *9*	118.6 *36*	840.9	1/2$^+$	0.0	3/2$^+$	M1+E2	0.19 *3*	%Iγ=0.517 *70* E$_\gamma$: weighted average of 841.3 *10* (2014Ko17), 840.4 *9* (1987Bo21), and 840.5 *10* (1970Ba65). I$_\gamma$: others: 96 *12* (1970Ba65), 100 *11* (1987Bo21). %Iγ=0.55 *6* in 1987Bo21 gives a relative Iγ=100 *11*.
1125	1.38 *34*	1966.3	5/2$^+$	840.9	1/2$^+$	E2		%Iγ=0.0060 *17*
1472	5.79 *33*	2312.6	3/2$^+$	840.9	1/2$^+$	M1+E2	−0.32 *4*	%Iγ=0.0252 *36*
1519	<0.52	3832.0	5/2$^+$	2312.6	3/2$^+$	M1+E2	−0.29 *9*	%Iγ<0.0023
1966.4 *5*	104.2 *16*	1966.3	5/2$^+$	0.0	3/2$^+$	M1+E2	−0.58 *4*	%Iγ=0.454 *60* E$_\gamma$: weighted average of 1966.9 *12* (2014Ko17), 1967.3 *9* (1987Bo21), and 1966.1 *5* (1970Ba65). I$_\gamma$: others: 100 *7* (1970Ba65), 76 *7* (1987Bo21). %Iγ=0.42 *4* in 1987Bo21 gives a relative Iγ=76 *7*.
2026	1.54 *19*	2866.9	5/2$^+$	840.9	1/2$^+$	[E2]		%Iγ=0.0067 *12*

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^{33}Cl $\varepsilon+\beta^+$ decay (2.5059 s) 1980Wi13 (continued)

$\gamma(^{33}S)$ (continued)

E_γ †	I_γ †#	E_i(level)	J^π_i	E_f	J^π_f	Mult.‡	δ‡	Comments
2312	2.31 *14*	2312.6	3/2$^+$	0.0	3/2$^+$	M1+E2	−28 +*16*−*80*	%Iγ=0.0101 *15*
2409	<0.36	4375.4	1/2$^+$	1966.3	5/2$^+$			%Iγ<0.0016
2866.8 *5*	100.0 *18*	2866.9	5/2$^+$	0.0	3/2$^+$	M1+E2	+0.116 *9*	%Iγ=0.436 *58* E_γ: weighted average of 2867 *3* (2014Ko17), 2867.7 *9* (1987Bo21), and 2866.5 *5* (1970Ba65). I_γ: others: 100 *7* (1970Ba65), 100 *9* (1987Bo21). %Iγ=0.55 *5* in 1987Bo21 gives a relative Iγ=100 *9*.
3094	<0.3	3935.1	3/2$^+$	840.9	1/2$^+$	(M1+E2)	>−1.7	%Iγ<0.0013
3212	<0.13	4053.2	1/2$^+$	840.9	1/2$^+$			%Iγ<5.7×10^{-4}
3584	<0.09	4424.7	1/2$^+$,3/2	840.9	1/2$^+$	D+Q		%Iγ<3.9×10^{-4}
3832	<0.12	3832.0	5/2$^+$	0.0	3/2$^+$	M1+E2	+0.37 *2*	%Iγ<5.2×10^{-4}
3905	<0.068	4746.2	1/2$^+$,3/2$^+$,5/2$^+$	840.9	1/2$^+$			%Iγ<3.0×10^{-4}
3935	<0.095	3935.1	3/2$^+$	0.0	3/2$^+$	M1+E2	−0.23 *7*	%Iγ<4.1×10^{-4}
4053	0.11 *3*	4053.2	1/2$^+$	0.0	3/2$^+$			%Iγ=0.00048 *15*
4144	<0.058	4144.3	5/2$^+$	0.0	3/2$^+$	(M1+E2)		%Iγ<2.5×10^{-4}
4375	<0.099	4375.4	1/2$^+$	0.0	3/2$^+$			%Iγ<4.3×10^{-4}
4424	<0.067	4424.7	1/2$^+$,3/2	0.0	3/2$^+$			%Iγ<2.9×10^{-4}
4746	0.085 *23*	4746.2	1/2$^+$,3/2$^+$,5/2$^+$	0.0	3/2$^+$			%Iγ=0.00037 *11*

† From 1980Wi13, unless otherwise noted. Values of intensities are relative to Iγ(2866.8γ)=100.
‡ From the Adopted Gammas.
# For absolute intensity per 100 decays, multiply by 0.00436 *57*.

^{33}Cl ε decay (2.5059 s) 1980Wi13

Decay Scheme

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