^{98}Rb β^- decay (115 ms) 2002Lh01,1984Be50

History

Type	Author	Citation	Literature Cutoff Date
Full Evaluation	Jun Chen, Balraj Singh	NDS 164, 1 (2020)	15-Feb-2020

Parent: ^{98}Rb: E=0.0; $J^\pi=0^{(-)}$; $T_{1/2}$=115 ms *6*; Q(β^-)=12054 *16*; %β^- decay=100.0

^{98}Rb-E,J^π,$T_{1/2}$: From ^{98}Rb Adopted Levels.

^{98}Rb-Q(β^-): From 2017Wa10.

The sources of ^{98}Rb studied contained both 114-ms and 96-ms isomers. Combined γ-ray data were given by 2002Lh01, 1984Be50, 1980Sc13 and 1980JuZY.

2002Lh01: source of ^{98}Rb was produced from the fission of ^{238}U by 600-MeV protons at the ISOLDE facility, followed by on-line mass separation. γ rays were detected with a planar and a large coaxial Ge detectors; β particles were detected with a BaF_2 scintillator. Measured Eγ, Iγ, $\gamma\gamma$-coin, $\gamma\gamma$(t), $\beta\gamma$(t). Deduced levels, J, π, $T_{1/2}$, β-decay branching ratios, log*ft*. Comparisons with theoretical calculations.

1984Be50: source of ^{98}Rb was produced by thermal fission of ^{235}U followed by on-line separation by the OSTIS separator at ILL in Grenoble. γ rays were detected with two Ge(Li) detectors. Measured Eγ, Iγ, $\gamma\gamma$-coin, $\gamma\gamma(\theta)$. Deduced levels, J, π, γ-ray mixing ratios. Systematics of neighboring isotones.

1980Sc13, 1980JuZY (also 1982Ka03): ^{98}Rb was produced from thermal ionization and separated by the on-line mass separator OSTIS. γ rays were detected with Ge(Li) detectors and decay and conversion electrons were detected with Si(Li) detectors. Measured Eγ, Iγ, $\gamma\gamma$-coin, $\gamma\gamma$(t), E(ce), I(ce), (ce)γ-coin, β-ce(t). Deduced levels, J, π, $T_{1/2}$, transition strengths. Comparisons with theoretical calculations. Complete details and level scheme are given by 1980JuZY.

2016Pa03: isobaric separated radioactive ion beam of ^{98}Rb was produced in U(p,F),E=500 MeV reaction at TRIUMF-ISAC facility. Measured Eγ, Iγ, I(ce), $\beta\gamma$-, β-ce-, $\gamma\gamma$-, γ(ce)- and ce(ce)-coincidences using 8π array of 20 Compton-suppressed HPGe detectors for γ rays, ten plastic scintillators for β detection, and a set of five Si(Li) detectors (PACES) for conversion electrons. Data collection cycle was: 3 s of background count, 15 s of ^{98}Rb beam implantation on a tape, 15 s of off-beam counting time, and 1 s to roll the implanted tape out of the vacuum chamber to avoid counting of long-lived activities. Deduced absolute intensities of the 71.2- and 144.2-keV transitions, E0 strength of 215-keV transition. Comparison with two-state mixing model for interpretation of ρ^2(E0) value and deduction of mixing of the two low-lying 0^+ and 2^+ states and deformation parameters.

1979Az01: measured β-ce(t). Deduced half-lives of the first 2^+ and 4^+ states.

Others:

$T_{1/2}$ (^{98}Rb isotope): 2015Pr03, 2011Ni01, 2003Be05, 1993Ru01, 1987PfZX, 1986ReZU, 1986Wa17, 1983Re10, 1981En05, 1980Sc13, 1981Re05, 1979Pe17, 1979Ri09, 1979Pe01, 1979En02, 1978Wo09, 1976AmZW, 1976Ru01, 1974Ro15, 1971Tr02, 1970KlZZ, 1967Kl06.

γ, $\gamma\gamma$: 1987Ma58, 1979Bo26, 1979Pe17, 1977Wo07.

$\beta\gamma$ and Q(β^-): 1992Pr03, 1988GrZX (and 1982Pa24), 1987Ma58, 1985IaZZ (also 1984IaZZ), 1984BlZN, 1982Br23, 1979Pe17.

$\gamma\gamma(\theta$,H): 1989Wo05.

$\gamma\gamma$(t): 1987Oh05.

$\beta\gamma\gamma$(t): 1989Ma47 (also 1989Ma38,1990Wo01).

See detailed comments and γ-ray data from the combined activities in ^{98}Rb β^- decay (96 ms).

This decay scheme is from division of the decay scheme for combined source in 2002Lh01 (see Table 3 of 2002Lh01). The decay scheme is considered as incomplete due to a large gap between neutron threshold (S(n)=5913 *5*) and the excitation energy of highest observed level (Pandemonium effect).

^{98}Sr Levels

E(level)†	J^π‡	$T_{1/2}$‡	Comments
0.0	0^+	0.653 s *2*	β_2=0.38 *1* from two-level mixing analysis (2016Pa03).
144.5 *1*	2^+	2.78 ns *8*	$T_{1/2}$: 2.80 ns *8* ($\beta\gamma\gamma$(t),1989Ma47,1989Ma38), 2.74 ns *12* ($\gamma\gamma$(t),1987Oh05), 4 ns *1* (β-ce(t),1980Sc13), 3.6 ns *4* (1979Az01, β-ce(t)). g factor=0.38 *7* ($\gamma\gamma(\theta$,H),1989Wo05). Mixing of the first two 2^+ states is 1.3% (2016Pa03).
215.5 *1*	0^+	22.9 ns *17*	$T_{1/2}$: 21.2 ns *17* ($\gamma\gamma$(t),2002Lh01), 25 ns *2* (β-ce(t),1980Sc13), 23 ns *3* (1979Az01, β-ce(t)). β_2=−0.23 *2* from two-level mixing analysis (2016Pa03).

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^{98}Rb β^- decay (115 ms) 2002Lh01,1984Be50 (continued)

^{98}Sr Levels (continued)

E(level)[†]	J$^\pi$[‡]	T$_{1/2}$[‡]	Comments
			Mixing of the first two 0^+ states is 8.6% (2016Pa03).
871.27 *16*	(2^+)	8.6 ps *14*	
1224.2 *4*	$(0^+,1)$		J$^\pi$: $(0^+,1,2)$ suggested from decay modes and comparison with model calculations (1984Be50, 2002Lh01).
1539.2 *4*	(2^+)		
1600.8 *4*	(2^+)		
1745.1? *5*			
1838.0 *3*	(3^+)	7.5 ns *15*	J$^\pi$: (3^+) from re-analysis by 2002PfZX of $\gamma\gamma(\theta)$ data in 1984Be50 with configuration=ν9/2[404]$\otimes\nu$3/2[411], $K^\pi=3^+$; also proposed by 2002Lh01 based on arguments of hindrances of γ transitions, β feedings and band head of a possible K=3 band. Note that 1984Be50 give J=2 based on their $\gamma\gamma(\theta)$ data and a 1837γ to 0^+ ground state. But the 1837γ was not observed by 2002Lh01. It is also pointed out by 2002Lh01 that J=3 cannot be rejected by $\gamma\gamma(\theta)$ of the 1693-144 cascade in 1984Be50. T$_{1/2}$: 7.1 ns *8* from $\gamma\gamma$(t) (2002Lh01).
1922.2? *5*			
1964.06 *21*	$(1,2^+)$		
2124.17 *23*	$(1^+,2,3,4^+)$		J$^\pi$: 2002Lh01 suggest (2^-) from model calculations with configuration=ν9/2[404]$\otimes\nu$5/2[532].
2237.4? *5*			
2289.0? *4*			
2316.04 *23*	(2^+)		J$^\pi$: $\gamma\gamma(\theta)$ (1984Be50) consistent with J=2 and 2002Lh01 suggest (1,2). Note that (2^+) is inconsistent with the possible strong β^- feeding feeding as also given in 2002Lh01, which could imply that this level could be β^- fed mostly by the decay of (3^+) isomer in ^{98}Rb rather than by the decays of both parent states equally as assumed by 2002Lh01, if the (2^+) assignment can be confirmed.
2804.3 *3*	$(1,2^+)$		
3290.4 *4*	$(1,2^+)$		
3622.6 *5*	$(1,2^+)$		
5913+x			E(level): x<6141 *17* from Q(β^-) (for ^{98}Rb decay)-S(n)(^{98}Sr), where Q(β^-)=12054 *16* and S(n)=5913 *5* from 2017Wa10.

[†] From least-squares fit to γ-ray energies.
[‡] From the Adopted Levels. Values from this dataset are given in comments.

β^- radiations

β feedings and associated log *ft* values are considered as approximate (by evaluators) since several arbitrary assumptions have been made by 2002Lh01 in dividing and separating transitions amongst the two isomers. 2002Lh01 also state that there are unplaced transitions, although, these are not listed in the paper. There could be also a significant amount of unobserved transitions due to Pandemonium effect.

E(decay)	E(level)	Iβ^-[†‡]	Log *ft*	Comments
$(3\times10^{3}$[@] *3*)	5913+x	14.3 *9*		Iβ^-: %β^-n=14.3 *9* for the decay of the ^{98}Rb g.s. and/or isomer.
(8431 *16*)	3622.6	4.1	5.6	av Eβ=3880.6 *77*
(8764 *16*)	3290.4	8	5.4	av Eβ=4040.5 *77*
(9250 *16*)	2804.3	4.7	5.7	av Eβ=4274.2 *77*
(9738 *16*)	2316.04	30	5.0	av Eβ=4508.9 *77*
				E(decay): 10050 *240* from $\beta\gamma$ (1982Pa24). Others: 8600 *110* (1979Pe17), 10203 *60* (1984BlZN), 10026 *150* (1982Br23), 9950 *30* (1985IaZZ,1984IaZZ).

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^{98}Rb β^- decay (115 ms) 2002Lh01,1984Be50 (continued)

β^- radiations (continued)

E(decay)	E(level)	I$\beta^{-\dagger\ddagger}$	Log *ft*	Comments
(9765[#] *16*)	2289.0?	4.2	5.9	av Eβ=4521.9 *77*
(9817[#] *16*)	2237.4?	1.7	6.3	av Eβ=4546.7 *77*
(10090 *16*)	1964.06	11	5.5	av Eβ=4677.9 *77*
(10132[#] *16*)	1922.2?	2.2	6.2	av Eβ=4698.0 *77*
(10309[#] *16*)	1745.1?	2.1	6.3	av Eβ=4783.0 *77*
(10830 *16*)	1224.2	4.7	6.0	av Eβ=5032.7 *77*
(11839 *16*)	215.5	14	5.8	av Eβ=5515.3 *77*

† From I(γ+ce) balance at each level (deduced by evaluators). Values are approximate.
‡ Absolute intensity per 100 decays.
# Existence of this branch is questionable.
@ Estimated for a range of levels.

^{98}Rb β^- decay (115 ms) 2002Lh01,1984Be50 (continued)

$\gamma(^{98}Sr)$

Iγ normalization: From I(γ+ce to g.s.)=85.7, using %β^-n=14.3 *9* in Adopted Levels of ^{98}Rb and assuming no β^- feeding to the g.s. and 2^+ states, with uncertain transitions also included. The normalization is considered as approximate (by evaluators) due to unplaced transitions (although not listed by 2002Lh01), uncertain transitions, and arbitrary assumption for division of γ-ray transitions among two isomers by 2002Lh01, e.g., feeding of 2^+ states is considered as negligible in the low-spin isomer, and also unobserved transitions due to Pandemonium effect.

Note that two γ rays with the same Eγ=167.092 keV *10* are listed in the curved-crystal measurements by 1979Bo26, one assigned to ^{140}Xe decay and the other to ^{98}Rb decay. As there is no γ line observed near 167 keV in the decay of ^{98}Rb, while there is a fairly strong γ ray near this energy in the decay of ^{140}Xe, evaluators believe that there is a print error in 1979Bo26, and that the listed precise gamma energy corresponds to only the decay of ^{140}Xe.

E_γ †	I_γ ‡@	E_i(level)	J_i^π	E_f	J_f^π	Mult.#	α&	$I_{(\gamma+ce)}$ @	Comments
71.0 *1*	0.9 *3*	215.5	0^+	144.5	2^+	E2	3.55		α(K)=2.86; α(L)=0.579; α(M)=0.0979; α(N)=0.01098; α(O)=0.000348 Iγ: from Iγ=2.1 *2* in 2002Lh01 for combined source (96 ms and 115 ms) and Iγ=1.18 *16* (deduced by evaluators) in ^{98}Rb β^- decay (96 ms). See comments for I(71γ) in ^{98}Rb β^- decay (96 ms). Mult.: ce(K)/ce(L)+=5.3 *8* (1980Sc13). K- and L-conversion lines detected in coin with 656γ (2016Pa03).
144.5 *1*	≈20	144.5	2^+	0.0	0^+	E2	0.262		α(K)=0.226; α(L)= 0.0315; α(M)=0.00507; α(N)=0.000627; α(O)=3.01×10^{-5} Iγ: from ΣI(γ+ce to 144 level)≈25, including uncertain transitions. Note that total Iγ=100 for combined source, so Iγ≈80 is allocated to 144γ in ^{98}Rb β^- decay (96 ms). Mult.: ce(K)/ce(L)+=6.0 *4* (1980Sc13). K- and L-conversion lines detected in coin with 656γ (2016Pa03). Iγ(per 100 decays of ^{98}Rb)=34 *3* (1987Ma58). Other: 51 *2* (1982Kr11,1980JuZY).
192.1 *4*	<0.8	2316.04	(2^+)	2124.17	$(1^+,2,3,4^+)$				
215.5		215.5	0^+	0.0	0^+	E0		3.3 *11*	ce(K)/(γ+ce)=0.90 *1*; ce(L)/(γ+ce)=0.10 *1* E_γ: from level energy difference. Mult.: α(K)exp>100, ce(K)/ce(L)=8.7 *6* (K/L(theory)=9.1) (1980Sc13), ce(L)/ce(K)=0.14 *1* (2016Pa03). $I_{(\gamma+ce)}$: from ce(K)(215)/ce(K)(71γ)=1.14 *3* (1980Sc13), K/L(theory)=9.1, α(K)(71γ)=2.86 *5* and α(total)(71γ)=3.55 *6* (from BrIcc), Iγ(71γ)=0.9 *3*. Total intensity=10.0 from 1984Be50 for combined source. K- and L-conversion lines detected in coin with 656γ (2016Pa03). Measured I(215,E0)/[I(γ+ce)(71,E2)]=0.72 *6* (2016Pa03). Deduced ρ^2(E0)=0.053 *5* (2016Pa03). Using an alternative method, 2016Pa03 deduce ρ^2(E0)=0.049 *7*.

$^{98}_{38}Sr_{60}$-4

^{98}Rb β^- decay (115 ms) 2002Lh01,1984Be50 (continued)

$\gamma(^{98}Sr)$ (continued)

E_γ[†]	I_γ[‡@]	E_i(level)	J_i^π	E_f	J_f^π	Mult.[#]	δ[#]	Comments
286.2[a] *2*	<0.1	2124.17	$(1^+,2,3,4^+)$	1838.0	(3^+)			
523.4[a] *3*	<0.1	2124.17	$(1^+,2,3,4^+)$	1600.8	(2^+)			
585.0[a] *3*	<0.1	2124.17	$(1^+,2,3,4^+)$	1539.2	(2^+)			
655.8 *2*	<1.7	871.27	(2^+)	215.5	0^+	[E2]		
726.8 *4*	<0.4	871.27	(2^+)	144.5	2^+	[M1+E2]	0.7 *10*	
871.4 *3*	<0.4	871.27	(2^+)	0.0	0^+	[E2]		
1079.7 *3*	2.2 *3*	1224.2	$(0^+,1)$	144.5	2^+			E_γ: only from decay of ^{98}Rb ground state (2002Lh01). Other: 1080.0 with $I\gamma$=2.2 (1984Be50).
1092.8 *3*	<2.3	1964.06	$(1,2^+)$	871.27	(2^+)			
1253.2[a] *4*	<0.2	2124.17	$(1^+,2,3,4^+)$	871.27	(2^+)			
1600.6[a] *4*	<2.0	1745.1?		144.5	2^+			
1777.7[a] *4*	<2.1	1922.2?		144.5	2^+			
1819.5 *3*	<4.8	1964.06	$(1,2^+)$	144.5	2^+			
1964.1[a] *4*	<3.0	1964.06	$(1,2^+)$	0.0	0^+			
1979.6[a] *3*	<0.3	2124.17	$(1^+,2,3,4^+)$	144.5	2^+			
2092.9[a] *4*	<1.6	2237.4?		144.5	2^+			
2144.5[a] *3*	<3.9	2289.0?		144.5	2^+			
2171.5 *3*	<17.2	2316.04	(2^+)	144.5	2^+	D+Q		δ: +0.5 to +20.0 from $(2172\gamma)(144\gamma)(\theta)$: A_2=−0.27 *16*, A_4=+0.37 *29*. 1984Be50 give δ=+2.6 to +14.6. Additional information 1.
2315.8[a] *4*	<9.6	2316.04	(2^+)	0.0	0^+			
2659.8 *4*	<1.8	2804.3	$(1,2^+)$	144.5	2^+			
2804.2[a] *4*	<2.6	2804.3	$(1,2^+)$	0.0	0^+			
3145.9 *5*	<2.5	3290.4	$(1,2^+)$	144.5	2^+			
3290.2[a] *6*	<5.0	3290.4	$(1,2^+)$	0.0	0^+			
3478.1 *6*	<1.4	3622.6	$(1,2^+)$	144.5	2^+			
3622.4[a] *7*	<2.4	3622.6	$(1,2^+)$	0.0	0^+			

[†] Values are taken from ^{98}Rb β^- decay (96 ms) dataset based on γ-ray data of combined activities mostly from 2002Lh01, unless otherwise noted.

[‡] From combined γ-ray intensity data of 2002Lh01. For transitions that are in both activities (96 ms and 115 ms), intensities have been divided (with upper limits given) by evaluators based on intensity balances. For obtaining branching ratios used in Adopted Gammas, original values of combined sources in 2002Lh01 are used. See ^{98}Rb β^- decay (96 ms) for details and also values for combined sources from other references.

[#] From Adopted Levels. Assignments of multipolarities are supported by ce data (1980Sc13) and $\gamma\gamma(\theta)$ (1984Be50), given in comments. Values of mixing ratios deduced by 1984Be50 are given in comments and found to be inconsistent with quoted A_2 and A_4 coefficients in some cases, for which the adopted δ values given here are from evaluator′s estimate based on A_2 and A_4 values of 1984Be50.

[@] For absolute intensity per 100 decays, multiply by ≈2.52.

[&] 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.

$^{98}_{38}Sr_{60}$-5

^{98}Rb β^- decay (115 ms) 2002Lh01,1984Be50

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)

$^{98}_{37}Rb_{61}$: $0^{(-)}$, 0.0, 115 ms *6*, Q_{β^-}=12054 *16*, $\%\beta^-$=100

Iβ⁻	Log *ft*			
14.3			5913+x	
			5913	
4.1	5.6	(1,2⁺)	3622.6	
8	5.4	(1,2⁺)	3290.4	
4.7	5.7	(1,2⁺)	2804.3	
30	5.0	(2⁺)	2316.04	
4.2	5.9		2289.0	
1.7	6.3		2237.4	
		(1⁺,2,3,4⁺)	2124.17	
11	5.5	(1,2⁺)	1964.06	
2.2	6.2		1922.2	
		(3⁺)	1838.0	7.5 ns *15*
2.1	6.3		1745.1	
		(2⁺)	1600.8	
		(2⁺)	1539.2	
4.7	6.0	(0⁺,1)	1224.2	
		(2⁺)	871.27	8.6 ps *14*
14	5.8	0⁺	215.5	22.9 ns *17*
		2⁺	144.5	2.78 ns *8*
		0⁺	0.0	0.653 s *2*

$^{98}_{38}Sr_{60}$