^{98}Pd ε decay (17.7 min) 1990RyZX,1972Ga21,1972Ba37

History

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

Parent: ^{98}Pd: E=0; $J^\pi=0^+$; $T_{1/2}$=17.7 min *4*; Q(ε)=1854 *13*; %ε+%$β^+$ decay=100.0

^{98}Pd-$T_{1/2}$: From ^{98}Pd Adopted Levels.

^{98}Pd-Q(ε): From 2017Wa10.

1990RyZX: ^{98}Pd source was produced via ^{63}Cu(^{40}Ar,X) fusion evaporation with E=4.7 MeV/nucleon ^{40}Ar beam produced at GSI on 3.1 mg/cm^2 target. Reaction products were separated by the GSI online mass separator. γ rays were detected with Xγ LEGE and γX detectors. Measured Eγ, E(X ray), Iγ, γγ-coin, γX-coin. Deduced levels, J, π, decay branching ratios, log*ft*, Gamow-Teller strengths. Comparisons with theoretical calculations.

1972Ga21: ^{98}Pd source was produced via (α,xn) reactions by irradiating 100 mg/cm^2 isotopic metallic ruthenium targets with E=25 MeV alpha beam from the U-120 cyclotron at the Institute of Nuclear Physics in Krakow. γ rays were detected with a Ge detector (FWHM=5 keV at 662 keV) and conversion electrons were detected with a toroidal spectrometer. Measured Eγ, Iγ, E(ce), I(ce). Deduced levels, J, π, decay branchings, conversion coefficients, γ-ray multipolarities. Comparisons with theoretical calculations.

1972Ba37: ^{98}Pd sources were produced via ^{96}Ru(α,2n) and ^{89}Y(^{14}N,5n) reactions with beams provided from the heavy-ion accelerator at Yale University. γ rays were detected with Si(Li) and Ge(Li) detectors. Measured Eγ, Iγ, γγ-coin. Deduced levels, J, π, decay branching ratios, log*ft*.

1978Ki17: ^{98}Pd source was produced via ^{96}Ru(α,2n) at the Institute for Nuclear Physics of the Academy of Sciences of Kazach SSR. γ rays were detected with a Ge(Li) detector. Deduced level, J, π, decay branching ratios, log *ft*, conversion coefficients, γ-ray multipolarities. Note that 1978Ki17 use Ice(K) data from 1972Ga21 together with their Iγ data to deduce conversion coefficients.

Others: 1969An32, 1956Ka25, 1955At34, 1953At27.

Theory and analysis of $β^+$, ε data (log *ft* values, Q values etc.): 1991Ku22, 1990KlZZ, 1989SoZU.

The level scheme is from 1990RyZX, which is more complete than those in 1972Ga21, 1972Ba37 and 1978Ki17. The ordering of the 68γ-107γ cascade has not been firmly established. 1978Ki17 and 1972Ba37 propose the reverse cascade thus, defining a level at 68. The present sequence has been adopted on the basis of (p,nγ) reaction where only a 104γ (probably same as 107γ) is reported and (d,3nγ) reaction where 107γ appears to be more intense than the 68γ. Levels at 386 (1969An32) and 661 (1969An32,1972Ga21) have been discarded since 386γ is from ^{99}Pd ε decay and 661γ is assigned to 837 level.

^{98}Rh Levels

E(level)†	J^π‡
0.0	$(2)^+$
106.87 *16*	$(3)^+$
112.06 *17*	1^+
174.64 *15*	(2^+)
837.0 *3*	1^+
1007.5 *3*	1^+
1111.9 *4*	1^+
1262.3 *3*	1^+

† From least-squares fit to γ-ray energies, assuming ΔEγ=0.5 keV if not given.

‡ From Adopted Levels.

ε,$β^+$ radiations

E(decay)	E(level)	Iε‡	Log *ft*	I(ε+$β^+$)†‡	Comments
(592 *13*)	1262.3	2.4 *3*	4.42 *6*	2.4 *3*	εK=0.8604 *2*; εL=0.11262 *16*; εM+=0.02698 *5* I(ε+$β^+$)=2.4 *2* in 1990RyZX.
(742 *13*)	1111.9	0.96 *15*	5.03 *7*	0.96 *15*	εK=0.8621 *2*; εL=0.1113 *1*; εM+=0.02660 *3* I(ε+$β^+$)=0.96 *5* in 1990RyZX.

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ε,β+ radiations (continued)

E(decay)	E(level)	Iβ+ ‡	Iε‡	Log *ft*	I(ε+β+)†‡	Comments
(847 *13*)	1007.5		5.9 *5*	4.35 *4*	5.9 *5*	εK=0.8630 *1*; εL=0.11062 *8*; εM+=0.02642 *2* I(ε+β+)=6.0 *3* in 1990RyZX.
(1017 *13*)	837.0		23.5 *15*	3.92 *3*	23.5 *15*	εK=0.8639; εL=0.10985 *5*; εM+=0.02621 *2* I(ε+β+)=24 *1* in 1990RyZX.
(1679# *13*)	174.64	<0.12	<2.4	>5.4	<2.5	av Eβ=294.2 *57*; εK=0.823 *3*; εL=0.1031 *4*; εM+=0.02454 *10*
(1742 *13*)	112.06	4.4 *4*	62 *5*	3.97 *4*	66 *5*	av Eβ=321.4 *57*; εK=0.808 *4*; εL=0.1011 *5*; εM+=0.02407 *11* I(ε+β+)=66 *4* in 1990RyZX.
(1747# *13*)	106.87	<0.11	<1.5	>5.6	<1.6	av Eβ=323.6 *57*; εK=0.807 *4*; εL=0.1009 *5*; εM+=0.02402 *11*

† From I(γ+ce) imbalance at each level.
‡ Absolute intensity per 100 decays.
# Existence of this branch is questionable.

γ(^{98}Rh)

Iγ normalization: ΣI(γ+ce to g.s.)=100, assuming no ε+β+ decay to ground state. Measurement of absolute intensity of 112γ relative to 652γ (taken as 90% *10*) from ^{98}Rh ε decay gives Iγ normalization=0.47 *8* (1969An32), which implies unrealistic direct ε+β+ feeding of 19% *3* to (2)+ g.s. from 0+ parent.

The following γ rays tentatively assigned to ^{98}Pd decay (1969An32) have been discarded since these were not confirmed in any of the later studies: 603, 717, 954, 1021, 1255, 1333, 1902, 1923, 1998, 2016. A 386 γ assigned to this decay (1969An32) belongs to ^{99}Pd decay (1972Ba37).

E_γ†	I_γ‡&	E_i(level)	J_i^π	E_f	J_f^π	Mult.#	α[a]	Comments
62.5[b] *5*		174.64	(2+)	112.06	1+			E_γ: from 1972Ga21 only. Not seen in 1990RyZX, 1978Ki17 and 1972Ba37. Mult.: 1972Ga21 give α(K)exp=1.00, suggesting M1. I_γ: 1972Ga21 give 0.18 *7* and Ice(K)/Ice(K)(112γ)=0.004. Other: <0.5 (1978Ki17, not seen).
67.7 *2*	14.7 *7*	174.64	(2+)	106.87	(3)+	(M1)@	1.040 *17*	%Iγ=8.5 *5* α(K)=0.904 *15*; α(L)=0.1111 *19*; α(M)=0.0207 *4* α(N)=0.00342 *6*; α(O)=0.000169 *3* E_γ: weighted average of 67.7 *2* (1972Ba37), 67.5 *5* (1978Ki17), and 67.8 *2* (1972Ga21). Other: 67.7 (1990RyZX). I_γ: others: 19 *2* (1978Ki17), 14 *4* (1972Ga21), 18.1 (1972Ba37). Mult.: α(K)exp=0.58 *6*. 1972Ga21 give 0.88 *27* with Ice(K)/Ice(K)(112γ)=0.396 *16*.
106.8 *2*	23.7 *12*	106.87	(3)+	0.0	(2)+	M1	0.285	%Iγ=13.7 *8* α(K)=0.248 *4*; α(L)=0.0303 *5*; α(M)=0.00564 *9* α(N)=0.000934 *14*; α(O)=4.65×10^{-5} *7* E_γ: weighted average of 106.8 *2* (1972Ba37), 106.5 *5* (1978Ki17), and 106.9 *2* (1972Ga21). Other: 106.75 (1990RyZX).

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^{98}Pd ε decay (17.7 min) 1990RyZX,1972Ga21,1972Ba37 (continued)

γ(^{98}Rh) (continued)

E_γ [†]	I_γ [‡&]	E_i(level)	J_i^π	E_f	J_f^π	Mult.[#]	α[a]	Comments
								I_γ: others: 25 *2* (1978Ki17), 33 *6* (1972Ga21), 25.5 (1972Ba37). Mult.: α(K)exp=0.30 *5*. 1972Ga21 give 0.26 *7* with Ice(K)/Ice(K)(112γ)=0.336 *25*.
112.2 *2*	100 *5*	112.06	1^+	0.0	$(2)^+$	M1	0.249	%Iγ=57.9 *10* α(K)=0.216 *4*; α(L)=0.0264 *4*; α(M)=0.00491 *8* α(N)=0.000813 *12*; α(O)=4.05×10^{-5} *6* E_γ: weighted average of 112.5 *2* (1972Ba37), 112.0 *5* (1978Ki17), 112.0 *2*, and 112 *1* (1969An32). Other: 112.0 (1990RyZX). I_γ: others: 100 (1972Ba37,1978Ki17,1972Ga21, 1969An32). Mult.: α(K)exp=0.225 *50* (1972Ga21).
174.5 *2*	12.4 *6*	174.64	(2^+)	0.0	$(2)^+$	(M1)[@]	0.0743	%Iγ=7.2 *5* α(K)=0.0648 *10*; α(L)=0.00779 *12*; α(M)=0.001450 *21* α(N)=0.000240 *4*; α(O)=1.209×10^{-5} *18* E_γ: weighted average of 174.5 *2* (1972Ba37), 174.5 *5* (1978Ki17), and 174.6 *2* (1972Ga21). Other: 174.4 (1990RyZX). I_γ: others: 18 *2* (1978Ki17), 6.5 (1972Ga21), 21.2 (1972Ba37). Mult.: α(K)exp=0.057 *11*. 1972Ga21 give 0.075 *24* with Ice(K)/Ice(K)(112γ)=0.033 *5*.
661.9 *3*	33.5 *17*	837.0	1^+	174.64	(2^+)	(M1,E2)	0.00261	%Iγ=19.4 *11* E_γ: weighted average of 663.0 *4* (1972Ba37), 661.5 *15* (1978Ki17), 661.7 *2* (1972Ga21) and 661 *1* (1969An32). Other: 662.2 (1990RyZX). I_γ: others: 50 *5* (1978Ki17), 30 *2* (1972Ga21), 52.8 (1972Ba37), 43 *7* (1969An32). Mult.: α(K)exp=0.0036 *8*. 1972Ga21 give 0.0027 *7* with Ice(K)/Ice(K)(112γ)=0.0056 *12*.
725.6 *4*	6.7 *7*	837.0	1^+	112.06	1^+			%Iγ=3.9 *5* E_γ: weighted average of 725.7 *4* (1972Ba37) and 725.0 *10* (1978Ki17). Other: 724.7 (1990RyZX). I_γ: others: 7.7 *9* (1978Ki17), 10.2 (1972Ba37).
832.8	5.4 *6*	1007.5	1^+	174.64	(2^+)			%Iγ=3.1 *4*
837.6 *7*	0.45 *9*	837.0	1^+	0.0	$(2)^+$			%Iγ=0.26 *6* E_γ: weighted average of 837.9 *4* (1972Ba37) and 836.0 *10* (1978Ki17). other: 836.8 (1990RyZX). I_γ: others: 3 *1* (1978Ki17), 30.3 (1972Ba37). Note severe disagreement in 1972Ba37.
895.4	2.6 *3*	1007.5	1^+	112.06	1^+			%Iγ=1.50 *18*
999.9	0.66 *13*	1111.9	1^+	112.06	1^+			%Iγ=0.38 *8*
1007.5	2.2 *2*	1007.5	1^+	0.0	$(2)^+$			%Iγ=1.27 *13*
1087.7	2.4 *3*	1262.3	1^+	174.64	(2^+)			%Iγ=1.39 *18*
1111.9	1.00 *20*	1111.9	1^+	0.0	$(2)^+$			%Iγ=0.58 *12*
1150.1	1.2 *3*	1262.3	1^+	112.06	1^+			%Iγ=0.69 *18*
1262.5	0.50 *10*	1262.3	1^+	0.0	$(2)^+$			%Iγ=0.29 *6*

[†] Values without uncertainties are from 1990RyZX.

[‡] Deduced by evaluators from I(γ+ce) values in 1990RyZX and calculated conversion coefficients (using BrIcc) for assigned mult;

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γ(^{98}Rh) (continued)

normalized to Iγ(112γ)=100 *5*. Although no uncertainties are given for I(γ+ce) values in 1990RyZX, based on uncertainties of decay branching ratios values deduced by 1990RyZX from I(γ+ce), it is reasonable for the evaluators to make the following assignments of uncertainties for Iγ from 1990RyZX: 20% for Iγ<2, 10% for Iγ≤10 and 5% for Iγ≥10. Values from other references are noted under comments and disagree for some of the transitions.

[#] From ce data in 1972Ga21, as adopted in Adopted Levels. Note that α(K)exp values reported in 1972Ga21 were normalized to α(K)exp=0.0842 *14* for the M1+E2 212γ in ^{121}Te IT decay in 1968Ma52, but another precise but discrepant α(K)exp=0.0768 *17* (1971Ed03) has also been reported. For better accuracy, the evaluators have re-deduced α(K)exp values (given in comments) using relative Ice(K) values from 1972Ga21 and relative Iγ values adopted in this dataset, normalized to theoretical α(K)=0.2164 (from BrIcc) for 112.2γ assumed as M1. Experimental K/L values in Fig.3 of 1972Ga21 (not tabulated) are consistent with mult=M1 or E1.

[@] E1 is not excluded if γ intensity from 1978Ki17 is used.

[&] For absolute intensity per 100 decays, multiply by 0.579 *22*.

[a] 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.

[b] Placement of transition in the level scheme is uncertain.

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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

Decay Scheme

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