^{48}V ε decay 2005TrZZ,1990Me15,1979Gr01

Type	Author	History Citation	Literature Cutoff Date
Full Evaluation	Jun Chen	NDS 179, 1 (2022)	30-Nov-2021

Parent: ^{48}V: E=0.0; $J^\pi=4^+$; $T_{1/2}$=15.974 d *3*; Q(ε)=4014.9 *10*; %ε+%β^+ decay=100.0

^{48}V-J^π,$T_{1/2}$: From Adopted Levels of ^{48}V. Adopted $T_{1/2}$ is taken from weighted average of 15.976 d *3* (1974Ts01) and 15.971 d *4* (1972Em01). Others: 16.15 d *17* (1957Va08); 16.23 d *3* (1975Al23) and 15.94 d *1* (1966Va26) are discrepant and considered as outliers.

^{48}V-Q(ε): From 2021Wa16.

The decay scheme is that of 1976Ja07.

2005TrZZ: ^{48}V activity from ^{nat}Ti(p,n) with the IPEN/CNEN-SP Cyclotron Accelerator. Measured Eγ, Iγ with a HPGe detector.

1990Me15,1976Ja07: ^{48}Sc activity from ^{51}V(n,α) at the Lawrence Livermore Laboratory. Measured Eγ, Iγ with Ge(Li) detectors. Eγ and Iγ values in 1976Ja07 are superseded by those in 1990Me15.

1979Gr01: measured Eγ with a Ge(Li) detector. ^{198}Au standard.

1984Bu34: measured E(ce), I(ce), E(X ray) with a $\pi\sqrt{2}$ spectrometer and Geiger-Mueller counters.

1975Al23: measured Eγ, E(x-rays), Xγ-coin, γ(t) with a Si(Li) and a Ge(Li) detector.

1974HeYW: measured Eγ, Iγ with a Ge(Li) detector.

1974Me15: measured β^+'s; mag spect, Geiger-Mueller counters.

1973Ba02: measured Eγ with NaI(Tl) or Ge(Li) detectors. See also ^{48}Ti(p,p'γ) and Coulomb excitation for data from this work.

1969Ar03: measured Eγ, Iγ with a scintillator.

1967Ko01,1967Ko10: ^{48}V activity from ^{48}Ti(d,2n) at the IKO in Amsterdam. γ rays were detected with NaI and Ge(Li) detectors; β^+ particles and conversion electrons were detected with a magnetic spectrometer and a proportional counter. Measured Eγ, Iγ, E(ce), I(ce), Eβ^+, Iβ^+, $\gamma\gamma\gamma$-coin, $\beta\gamma$-coin.

1957Va08: ^{48}V activity from ^{nat}Ti(d,2n) at the Philips synchro-cyclotron in Amsterdam. γ rays were detected with a NaI(Tl) crystal; positrons and conversion electrons were detected with a magnetic beta-ray spectrometer. Measured Eγ, Iγ, Eβ^+, Iβ^+, E(ce), I(ce), $\beta\gamma$-coin.

Others: 1974Ts01, 1972Em01, 1966Va26, 1957Ha32, 1953Ca43, 1953St30, 1952Ja20, 1946Go01.

β-983γ circular polarization asymmetry parameter=−0.081 *3* (1971Pi05). See 1971Pi05 for a summary of earlier measurements.

^{48}Ti Levels

E(level)	J^π[†]	$T_{1/2}$	Comments
0.0	0^+	stable	
983.535 *4*	2^+		1974Me15 report Eβ^+=3035 *46* with Iβ^+(to 983)/Iβ^+(to 2296)=0.00170 *24*, which however would result in log *ft*(to 983)=10.9 *1*, inconsistent with the expected value of >12.8. The upper limit of I(ε+β^+) from γ+ce intensity balance is negative.
2295.658 *7*	4^+		
2421.068 *20*	2^+		
3223.992 *8*	3^+		
3239.797 *9*	4^+		
3358.80 *4*	3^-		

[†] From Adopted Levels.

ε,β^+ radiations

$\beta\gamma$ coincidence information is from 1967Ko10.

$P_K\omega_K$=0.2005 *30* (1975Al23).

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ε,β⁺ radiations (continued)

E(decay)†	E(level)	Iβ⁺ #@	Iε#@	Log *ft*	I(ε+β⁺)‡@	Comments
(656.1 *10*)	3358.80		0.138‡ *11*	7.78 *4*	0.138 *11*	εK=0.8925; εL=0.09169; εM+=0.01581
(775.1 *10*)	3239.797		7.871‡ *7*	6.174 *1*	7.871 *7*	εK=0.8927; εL=0.09152; εM+=0.01578 Iε: other: 7.9% *6* (1975Al23).
(790.9 *10*)	3223.992		3.252‡ *18*	6.576 *3*	3.252 *18*	εK=0.8927; εL=0.09150; εM+=0.01577 Iε: other: 2.9% *4* (1975Al23).
1072& *50*	2421.068	≤0.001	≤0.002	≥10.4	≤0.003	av Eβ=238.32 *42*; εK=0.5385 *13*; εL=0.05489 *13*; εM+=0.009456 *23* Iβ⁺,Log *ft*: Iβ⁺(to 2421)/Iβ⁺(to 2296)=0.0019 *6* (1974Me15) would result in log *ft*(to 2421)=8.5 *2* which is inconsistent with the expected value of >10.6.
1722 *4*	2295.658	50.4 *3*	39.1 *3*	6.173 *3*	89.5 *3*	av Eβ=291.40 *43*; εK=0.3900 *11*; εL=0.03973 *11*; εM+=0.006845 *19* E(decay): weighted average of 1717 *3* (1967Ko10), 1720 *7* (1974Me15), and 1730 *4* (1957Va08). Iβ⁺: others: 52.0 *10* (1975Al23), 50.1 *10* (triple-γ) and 48.1 *16* (prop. counter) (1967Ko10), 49.8 *17* (1967Ko01), 50.4 *20* (1957Va08), revised by 1967Ko10), 50 *4* (1953Ca43), 61 *3* (1963Ri01), 56.0 *6* (1957Ha32), 60 *4* (1953St30, quoted in 1967Ko10), 58 *4* (1946Go01). ε/β⁺: 0.685 *41* (1975Al23), 0.760 *35* (triple-γ) and 0.83 *6* (prop. counter) (1967Ko10), 0.77 *6* (1967Ko01), 0.43 *3* (1963Ri01), 0.75 *3* (1957Va08), end-point energy of β⁺ spectrum: 698 *4* (1957Va08), 685 *3* (1967Ko10).

† From 1974Me15, except as noted.
‡ From γ+ce intensity balance at each level.
# From I(ε+β⁺) and theoretical ε/β⁺ ratios, unless otherwise noted.
@ Absolute intensity per 100 decays.
& Existence of this branch is questionable.

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γ(^{48}Ti)

Iγ normalization: From ΣI(γ+ce to g.s.)=100.
γγ coincidence information is from 1967Ko01 and 1967Ko10.
α(exp) values quoted from 1967Ko01 are deduced by the authors from measured I(ce)/Iβ$^+$ and Iγ, assuming %Iβ$^+$=48.5.

E_γ	I_γ[†][&]	E_i(level)	J_i^π	E_f	J_f^π	Mult.[‡]	δ[‡]	α[a]	Comments
803.05 *25*	1.36[#] *12*	3223.992	3+	2421.068	2+				E_γ: unweighted average of 803.25 *8* (1990Me15) and 802.85 *3* (2005TrZZ). Other: 801.5 *10* (1973Ba02). I_γ: others: 1.5 *2* (1990Me15).
928.326 *6*	7.83[#] *3*	3223.992	3+	2295.658	4+	(M1(+E2))	−0.02 *2*	1.17×10^{-4} *12*	α=1.17×10^{-4} *12*; α(K)=0.000107 *11*; α(L)=9.5×10^{-6} *10*; α(M)=1.22×10^{-6} *12*; α(N+..)=6.6×10^{-8} *7* α(N)=6.6×10^{-8} *7* E_γ: weighted average of 928.326 *6* (1979Gr01), 928.327 *9* (1990Me15), 928.34 *6* (2005TrZZ), and 928.280 *36* (1974HeYW). Others: 928.0 *5* (1973Ba02), 928.9 *7* (1967Ko01). I_γ: others: 7.7 *5* (1990Me15), 7.62 *9* (1974HeYW); 10 *1* (1975Al23) and 12 *2* (1967Ko01) are discrepant. I(ce)/I(β$^+$)=5.0×10^{-6} *25* (1967Ko01). Mult.: α(exp)=2.0×10^{-4} *10* (1967Ko01).
(938[@])	0.0014[@] *5*	3358.80	3−	2421.068	2+	[E1]		5.98×10^{-5} *9*	α=5.98×10^{-5} *9*; α(K)=5.43×10^{-5} *8*; α(L)=4.84×10^{-6} *7*; α(M)=6.19×10^{-7} *9* α(N)=3.36×10^{-8} *5* E_γ: from Adopted Gammas, not seen in decay studies. I_γ: from I(938γ)/I(2375γ) in Adopted Gammas and I(2375γ) in this dataset.
944.129 *6*	78.72 *7*	3239.797	4+	2295.658	4+	M1+E2	−0.30 *5*	1.06×10^{-4} *2*	α=1.06×10^{-4} *2*; α(K)=9.60×10^{-5} *17*; α(L)=8.58×10^{-6} *15*; α(M)=1.097×10^{-6} *19*; α(N+..)=5.97×10^{-8} *10* α(N)=5.97×10^{-8} *10* E_γ: weighted average of 944.132 *6* (1979Gr01), 944.125 *7* (1990Me15), 944.135 *12* (2005TrZZ), 944.117 *25* (1974HeYW). Others: 943.9 *3* (1973Ba02), 944.3 *5* (1967Ko01). I_γ: others: 77.6 *9* (1990Me15), 79 *3* (1975Al23), 77.5 *50* (1974HeYW), 80 *5* (1967Ko01). Mult.: α(exp)=1.25×10^{-4} *11* (1967Ko01). I(ce)/I(β$^+$)=2.07×10^{-5} *12* (1967Ko01).
983.525 *4*	1000.0 *3*	983.535	2+	0.0	0+	E2			E_γ: weighted average of 983.521 *7* (1979Gr01), 983.526 *5* (1990Me15), 983.526 *5* (2005TrZZ). Others: 983.497 *25* (1974HeYW), 983.20 *15* (1973Ba02), 983.3 *4* (1967Ko01), 986 *3* (1957Va08). I_γ: from 2005TrZZ. Others: 1000 *2* (1990Me15), 1000

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γ(^{48}Ti) (continued)

E_γ	I_γ[†][&]	E_i(level)	J_i^π	E_f	J_f^π	Mult.[‡]	δ[‡]	α[a]	Comments
									(1975Al23, 1967Ko01,1957Va08), 1000 *5* (1974HeYW). Mult.: α(exp)=1.23×10^{-4} *6* (1967Ko01), 1.26×10^{-4} *4* (1957Va08); K/L1=11.2 *1*, L1/M1=7.2 *1* (1984Bu34). I(ce)/Iβ$^+$=2.54×10^{-4} *12* (1967Ko01), 2.28×10^{-4} *7* (1957Va08).
1063.9[@b] *1*	0.05[@] *1*	3358.80	3$^-$	2295.658	4$^+$	[E1]		4.69×10^{-5} *7*	α=4.69×10^{-5} *7*; α(K)=4.26×10^{-5} *6*; α(L)=3.79×10^{-6} *6*; α(M)=4.85×10^{-7} *7* α(N)=2.64×10^{-8} *4* E$_\gamma$,I$_\gamma$: from 1990Me15 only.
1312.105 *6*	982 *3*	2295.658	4$^+$	983.535	2$^+$	E2		9.66×10^{-5} *14*	α=9.66×10^{-5} *14*; α(K)=5.89×10^{-5} *9*; α(L)=5.26×10^{-6} *8*; α(M)=6.73×10^{-7} *10*; α(N+..)=3.18×10^{-5} *5* α(N)=3.65×10^{-8} *6*; α(IPF)=3.17×10^{-5} *5* E$_\gamma$: weighted average of 1312.096 *6* (1979Gr01), 1312.090 *12* (1990Me15), 1312.115 *5* (2005TrZZ), 1312.038 *31* (1974HeYW), 1312.10 *10* (1973Ba02), 1312.0 *5* (1969Ar03), 1311.4 *6* (1967Ko01), 1311.1 *6* (1963Ri01). Other: 1314 *4* (1957Va08). I$_\gamma$: others: 975 *8* (1990Me15), 970 *10* (1975Al23), 999 *50* (1974HeYW), 990 *40* (1967Ko01), 980 *30* (1963Ri01), 980 *30* (1957Va08). Mult.: α(exp)=5.9×10^{-5} *3* (1967Ko01), 6.3×10^{-5} *2* (1957Va08). I(ce)/Iβ$^+$=1.17×10^{-4} *6* (1967Ko01), 1.14×10^{-4} *4* (1957Va08).
1437.521 *21*	1.20 *3*	2421.068	2$^+$	983.535	2$^+$	M1+E2	+0.15 *3*	9.52×10^{-5} *14*	α=9.52×10^{-5} *14*; α(K)=4.23×10^{-5} *6*; α(L)=3.77×10^{-6} *6*; α(M)=4.82×10^{-7} *7*; α(N+..)=4.87×10^{-5} *7* α(N)=2.63×10^{-8} *4*; α(IPF)=4.87×10^{-5} *7* E$_\gamma$: weighted average of 1437.35 *7* (1990Me15), 1437.529 *15* (2005TrZZ), 1437.9 *20* (1969Ar03), and 1438 *2* (1967Ko01). I$_\gamma$: others: 1.2 *2* (1990Me15), 1.1 *4* (1969Ar03), 1.3 *6* (1967Ko01).
2240.396 *10*	23.33[#] *13*	3223.992	3$^+$	983.535	2$^+$	M1+E2	+0.26 *3*	0.000379 *6*	α=0.000379 *6*; α(K)=1.96×10^{-5} *3*; α(L)=1.745×10^{-6} *25*; α(M)=2.23×10^{-7} *4*; α(N+..)=0.000357 *6* α(N)=1.217×10^{-8} *17*; α(IPF)=0.000357 *6* E$_\gamma$: weighted average of 2240.394 *11* (1979Gr01), 2240.398 *10* (1990Me15), 2240.396 *16* (2005TrZZ), and 2240.35 *6* (1974HeYW). Others: 2240.2 *2* (1973Ba02), 2240.1 *5* (1969Ar03), 2240.1 *7* (1967Ko01), 2240.6 *10* (1963Ri01). 1957Va08 placed a Eγ=2253 *15* from a 3240 level and assigned J^π=4$^+$ from their γγ(θ) and ce data, however, 1957Va08 didn′t see the strong 944γ. So the 2253γ from 1957Va08 should correspond to the 2240γ seen in other

$^{48}_{22}Ti_{26}$-4

^{48}V ε decay 2005TrZZ,1990Me15,1979Gr01 (continued)

γ(^{48}Ti) (continued)

E_γ	I_γ[†][&]	E_i(level)	J_i^π	E_f	J_f^π	Mult.[‡]	δ[‡]	α[a]	Comments
									studies, considering large ΔEγ=15 keV. I_γ: others: 24.1 *4* (1990Me15), 18 *5* (1975Al23), 23.9 *15* (1974HeYW), 24 *3* (1969Ar03), 25 *3* (1967Ko01), 29 *2* (1963Ri01), 26 *2* (1957Va08). Mult.: α(exp)=1.51×10^{-5} *17* (1957Va08). δ: +0.21 *5* from γγ(θ) for J(3224)=3 (1957Va08). I(ce)/Iβ$^+$=7.06×10^{-7} *35* (1957Va08). 2240γ-984γ(θ): A_2=+0.104 *8*, A_4=+0.003 *12* (1957Va08).
2375.20 *4*	0.087 *3*	3358.80	3$^-$	983.535	2$^+$	(E1(+M2))	0.00 *3*	0.000902 *13*	α=0.000902 *13*; α(K)=1.174×10^{-5} *17*; α(L)=1.043×10^{-6} *15*; α(M)=1.334×10^{-7} *19* α(N+..)=0.000889 *13* α(N)=7.27×10^{-9} *11*; α(IPF)=0.000889 *13* E_γ: weighted average of 2375.1 *5* (1990Me15) and 2375.20 *4* (2005TrZZ). Other: 2375.6 *25* (1969Ar03). I_γ: other: 0.10 *3* (1969Ar03).
2420.94 *5*	0.067 *3*	2421.068	2$^+$	0.0	0$^+$	E2		0.000539 *8*	α=0.000539 *8*; α(K)=1.82×10^{-5} *3*; α(L)=1.621×10^{-6} *23*; α(M)=2.07×10^{-7} *3*; α(N+..)=0.000519 *8* α(N)=1.130×10^{-8} *16*; α(IPF)=0.000519 *8* E_γ: weighted average of 2421.8 *5* (1990Me15), 2420.93 *4* (2005TrZZ), 2421.7 *25* (1969Ar03). I_γ: others: 0.10 *5* (1990Me15), 0.05 *3* (1969Ar03).

[†] From 2005TrZZ, unless otherwise noted. Values from other decay studies are in good agreement, but less precise and given under comments.
[‡] From Adopted Gammas. Supporting arguments from ce data in this dataset are given under comments where available.
[#] Iγ(803γ):Iγ(928γ):Iγ(2241γ)=4.0 *2*:26.3 *4*:69.7 *5* (1973Ba02).
[@] Not observed by 2005TrZZ. Iγ(938γ)<0.01; Iγ(1063γ)<0.06.
[&] For absolute intensity per 100 decays, multiply by 0.09998 *3*.
[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.

$^{48}_{22}Ti_{26}$-5

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