Adopted Levels, Gammas

Type	Author	History Citation	Literature Cutoff Date
Full Evaluation	N. Nica	NDS 111,525 (2010)	19-Nov-2009

Q(β^-)=1935.5 *18*; S(n)=8073 *4*; S(p)=7452.5 *18*; Q(α)=−3805 *11* 2012Wa38
Note: Current evaluation has used the following Q record 1934.8 18 *8073* 4 *7451.8* *18* −3807 *11* 2003Au03.
2005Be17: cluster decay $T_{1/2}$ lower limits.

^{97}Nb Levels

Cross Reference (XREF) Flags

A	^{97}Zr β^- decay	D	^{96}Zr(^{3}He,d) IAS
B	^{97}Nb IT decay (58.7 s)	E	^{98}Mo(d,^{3}He)
C	^{96}Zr(^{3}He,d),(d,n)	F	^{98}Mo(pol t,α)

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Theory, calculations, systematics:
  levels: 1986Ta01
  shell closure effects: 1987Ab21
  calculated Gamow-Teller strength distribution: 2005Ju11
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E(level)[†]	J$^\pi$	$T_{1/2}$	XREF	Comments
0.0	9/2$^+$	72.1 min *7*	ABC EF	%β^-=100 μ=6.153 *5* J$^\pi$: from (pol t,α); L=4 in (^{3}He,d), (d,^{3}He). $T_{1/2}$: from 1952Ma24. Others: 74 min *2* (1950Bu54), 75 min *3* (1940Gr04). μ: NMR (1991Be18, also quoted in 1992Be50); other: 7.5 *14* (1976Kr01). Oblate deformation deduced from μ (1991Be18).
743.35 *3*	1/2$^-$	58.7 s *18*	ABC EF	%IT=100 J$^\pi$: from (pol t,α); L=1 in (^{3}He,d), (d,^{3}He). $T_{1/2}$: from 1992KaZM (^{97}Nb IT decay (58.7 s) dataset); others: 52.7 s *18* (1990KaZW); 60 *8* s (1950Bu54).
1147.96[#] *6*	7/2$^+$	≤0.15[‡] ns	A	J$^\pi$: 7/2$^+$,9/2$^+$,11/2$^+$ from M1+E2 γ to 9/2$^+$, g.s.; M1+E2 γ's from 3/2$^+$,5/2$^+$ 1750 and 1852 levels respectively (both based on L=2); the only way to satisfy both conditions is by assigning 7/2$^+$ for 1148 (this level) and 5/2$^+$ for 1750 and 1852.
1160[#] *10*	9/2$^+$		F	J$^\pi$: 9/2$^+$, not 7/2$^+$, from (pol t,α).
1251.01 *7*	3/2$^-$		A C EF	J$^\pi$: from (pol t,α); L=1 in (^{3}He,d), (d,^{3}He).
1276.09 *7*	5/2$^+$		A C	J$^\pi$: L=2 in (^{3}He,d), γ to 9/2$^+$ g.s.
1433.92 *13*	5/2$^-$		A C EF	J$^\pi$: 5/2$^-$ from (pol t,α); L=3 in (d,^{3}He).
1548.36 *11*	(3/2$^+$,5/2$^-$)		A	J$^\pi$: log *ft*=8.68 from 1/2$^+$ parent, strongest γ to 7/2$^+$ 1147.96 level.
1554 *15*	1/2$^-$,3/2$^-$		C	J$^\pi$: L=1 in (^{3}He,d).
1652.82 *21*			A	
1750.43[&] *9*	5/2$^+$	≤0.2[‡] ns	A C e	XREF: C(1754)e(1764). J$^\pi$: L=2 in (^{3}He,d); M1+E2 γ to 7/2$^+$ 1147.96-keV level; $\gamma\gamma(\theta)$ (^{97}Zr β^- decay); see also the argument at level 1149.
1764.42[&] *14*	(3/2$^-$)		A C eF	XREF: C(1776)e(1764)F(1761). J$^\pi$: (3/2$^-$) from (pol t,α); L=(1) in (^{3}He,d).
1851.71 *6*	5/2$^+$	≤0.2[‡] ns	A C	XREF: C(1856). J$^\pi$: L=2 in (^{3}He,d); M1+E2 γ to 7/2$^+$ 1147.96-keV level; $\gamma\gamma(\theta)$ (^{97}Zr β^- decay); see also the argument at level 1149.
1945 *15*	7/2$^+$,9/2$^+$		C	J$^\pi$: L=4 in (^{3}He,d).
1958.4 *6*			A	
2047 *10*	(3/2$^-$)		C F	J$^\pi$: (3/2$^-$) from ^{98}Mo(pol t,α); L(^{3}He,d)=(1).

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Adopted Levels, Gammas (continued)

^{97}Nb Levels (continued)

E(level)[†]	J^π	$T_{1/2}$	XREF	Comments
2092[@] *15*	3/2$^+$,5/2$^+$		C e	XREF: e(2090). J^π: L=2 in (^{3}He,d).
2105.91[@] *6*	(3/2$^+$)	≤0.2[‡] ns	A C e	XREF: C(2114)e(2090). J^π: L=(2) in (^{3}He,d); strong γ to 1/2- 743.35-keV level.
2113[@] *10*	5/2$^-$		C eF	XREF: e(2090). J^π: from (pol t,α).
2247.46 *15*	3/2$^-$		A EF	J^π: L=1 in (d,^{3}He); γ to 5/2$^+$ 1276.09 level.
2357 *15*	(1/2$^+$)		C	J^π: L=(0) in (^{3}He,d).
2388 *10*	(3/2$^-$)		EF	J^π: L=(1) in (d,^{3}He); (3/2) from (pol t,α).
2525 *15*	3/2$^+$,5/2$^+$		C	J^π: L=2 in (^{3}He,d).
2541 *10*	(5/2$^-$)		F	J^π: from (pol t,α).
2550 *20*	1/2$^-$,3/2$^-$		E	J^π: L=1 in (d,^{3}He).
2654 *10*			F	E(level): contains unresolved states.
2676 *15*	3/2$^+$,5/2$^+$		C	J^π: L=2 in (^{3}He,d).
2702 *15*	3/2$^+$,5/2$^+$		C	J^π: L=2 in (^{3}He,d).
2727 *15*	3/2$^+$,5/2$^+$		C	J^π: L=2 in (^{3}He,d).
2748 *15*	(3/2$^+$,5/2$^+$)		C	J^π: L=(2) in (^{3}He,d).
2792 *15*	(1/2$^+$)		C	J^π: L=(0) in (^{3}He,d).
2948 *15*			EF	XREF: F(2961). E(level): level is a multiplet from (d,^{3}He) and (pol t,α). J^π: $\sigma(\theta)$ in (d,^{3}He) shows L=1 + L=3 admixture.
2981 *15*	(1/2$^+$)		C	J^π: L=(0) in (^{3}He,d).
3067 *15*	(3/2$^+$,5/2$^+$)		C	J^π: L=(2) in (^{3}He,d).
3212 *15*	(3/2$^+$,5/2$^+$)		C	J^π: L=(2) in (^{3}He,d).
3326 *15*	(1/2$^-$,3/2$^-$)		C	J^π: L=(1) in (^{3}He,d).
3362 *15*	3/2$^+$,5/2$^+$		C	J^π: L=2 in (^{3}He,d).
3418 *15*	3/2$^+$,5/2$^+$		C	J^π: L=2 in (^{3}He,d).
3486 *15*	(3/2$^+$,5/2$^+$)		C	J^π: L=(2) in (^{3}He,d).
3518 *15*	3/2$^+$,5/2$^+$		C	J^π: L=2 in (^{3}He,d).
3537 *15*	(3/2$^+$,5/2$^+$)		C	J^π: L=2 in (^{3}He,d).
3586 *15*	3/2$^+$,5/2$^+$		C	J^π: L=2 in (^{3}He,d).
3643 *15*	3/2$^+$,5/2$^+$		C	J^π: L=2 in (^{3}He,d).
3759 *15*	(5/2$^-$,7/2$^-$)		C	J^π: L=(3) in (^{3}He,d).
3799 *15*	(3/2$^+$,5/2$^+$)		C	J^π: L=(2) in (^{3}He,d).
3862 *15*	3/2$^+$,5/2$^+$		C	J^π: L=2 in (^{3}He,d).
3945 *15*	3/2$^+$,5/2$^+$		C	J^π: L=2 in (^{3}He,d).
4038 *15*	3/2$^+$,5/2$^+$		C	J^π: L=2 in (^{3}He,d).
4080 *20*			C	
4200 *20*			C	
4350 *20*			C	
4530 *20*			C	
4660 *20*			C	
4780 *20*			C	
4880 *20*			C	
4960 *20*			C	
5220 *20*			C	
5330 *20*			C	
5460 *20*			C	
5630 *20*			C	
14430 *30*	(3/2$^+$)		D	J^π: from (^{3}He,d)IAS, analog of ^{97}Zr 1103 keV *3*/2$^+$ state.
14650 *30*	(7/2$^+$)		D	J^π: from (^{3}He,d)IAS, analog of ^{97}Zr 1264 keV *7*/2$^+$ state.
15640 *30*	(11/2$^-$)		D	J^π: from (^{3}He,d)IAS, analog of ^{97}Zr 2265 keV *11*/2$^-$ state.

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Adopted Levels, Gammas (continued)

^{97}Nb Levels (continued)

† From least squares fit to Eγ in ^{97}Zr β^- decay, where possible. Otherwise, from the reactions indicated in XREF column.

‡ From $\gamma\gamma$(t) in ^{97}Zr β^- decay.

It has been suggested that the 1147.96- and 1160-keV levels are one and the same level. However, the level seen in ^{97}Zr β^- decay cannot have a J>7/2 (nor J<7/2) unless there is something very seriously wrong with the proposed decay scheme. At the same time, $\sigma(\theta)$ and y in ^{98}Mo(pol t,α) duplicate the data for 9/2$^+$ g.s. indicating a 9/2$^+$, not a 7/2$^+$ level.

@ Level at 2090 in (d,^{3}He) data set is a doublet with L=2 + L=3.

& Level at 1764 in (d,^{3}He) data set is a doublet with L=1 + L=2.

$\gamma(^{97}$Nb)

All γ data are from ^{97}Zr β^- decay.

E_i(level)	J^π_i	E_γ	I_γ	E_f	J^π_f	Mult.	δ	α[#]	Comments
743.35	1/2$^-$	743.36 *3*	100	0.0	9/2$^+$	[M4]		0.0210	B(M4)(W.u.)=6.03 *21* α(K)=0.0181 *3*; α(L)=0.00237 *4*; α(M)=0.000423 *6*; α(N+..)=6.47$\times10^{-5}$ *9* α(N)=6.14$\times10^{-5}$ *9*; α(O)=3.32$\times10^{-6}$ *5*
1147.96	7/2$^+$	1147.97 *8*	100	0.0	9/2$^+$	M1+E2	+0.5 *2*	5.47$\times10^{-4}$	B(M1)(W.u.)>6.5$\times10^{-5}$; B(E2)(W.u.)>0.0051 α(K)=0.000481 *8*; α(L)=5.31$\times10^{-5}$ *8*; α(M)=9.34$\times10^{-6}$ *14*; α(N+..)=3.56$\times10^{-6}$ *9* α(N)=1.371$\times10^{-6}$ *20*; α(O)=8.05$\times10^{-8}$ *13*; α(IPF)=2.11$\times10^{-6}$ *8*
1251.01	3/2$^-$	507.64 *8*	100	743.35	1/2$^-$				
1276.09	5/2$^+$	1276.07 *9*	100	0.0	9/2$^+$	[E2]		4.43$\times10^{-4}$	α(K)=0.000372 *6*; α(L)=4.13$\times10^{-5}$ *6*; α(M)=7.26$\times10^{-6}$ *11*; α(N+..)=2.25$\times10^{-5}$ *4* α(N)=1.064$\times10^{-6}$ *15*; α(O)=6.17$\times10^{-8}$ *9*; α(IPF)=2.14$\times10^{-5}$ *3*
1433.92	5/2$^-$	182.9 *5*	17 *4*	1251.01	3/2$^-$				
		690.52 *16*	100 *10*	743.35	1/2$^-$	[E2]		0.00180	α(K)=0.001579 *23*; α(L)=0.000182 *3*; α(M)=3.20$\times10^{-5}$ *5*; α(N+..)=4.91$\times10^{-6}$ *7* α(N)=4.65$\times10^{-6}$ *7*; α(O)=2.59$\times10^{-7}$ *4*
1548.36	(3/2$^+$,5/2$^-$)	272.40 *16*	95 *11*	1276.09	5/2$^+$				
		297.2 *3*	27 *5*	1251.01	3/2$^-$				
		400.42 *16*	100 *6*	1147.96	7/2$^+$				
1652.82		218.9 *2*	100	1433.92	5/2$^-$				
1750.43	5/2$^+$	202.5 *6*	2.1 *6*	1548.36	(3/2$^+$,5/2$^-$)	D,E2[†]			
		473.5 *6*	5.4 *27*	1276.09	5/2$^+$	D,E2[†]			
		602.37 *14*	100 *5*	1147.96	7/2$^+$	M1+E2	+0.11 *6*	0.00228	α(K)=0.00201 *3*; α(L)=0.000225 *4*; α(M)=3.96$\times10^{-5}$ *6*; α(N+..)=6.14$\times10^{-6}$ *9* α(N)=5.80$\times10^{-6}$ *9*; α(O)=3.39$\times10^{-7}$ *5* B(M1)(W.u.)>0.00026
		1750.24 *22*	79 *7*	0.0	9/2$^+$	[E2]		4.13$\times10^{-4}$	α(K)=0.000198 *3*; α(L)=2.18$\times10^{-5}$ *3*; α(M)=3.83$\times10^{-6}$ *6*; α(N+..)=0.000190 *3* α(N)=5.61$\times10^{-7}$ *8*; α(O)=3.29$\times10^{-8}$ *5*; α(IPF)=0.000189 *3* B(E2)(W.u.)>0.0028
1764.42	(3/2$^-$)	111.6 *3*	6.4 *9*	1652.82					
		330.43 *19*	14.1 *15*	1433.92	5/2$^-$				
		513.41 *18*	54 *5*	1251.01	3/2$^-$				

$^{97}_{41}$Nb$_{56}$-4

$\gamma(^{97}Nb)$ (continued)

E_i(level)	J^π_i	E_γ	I_γ	E_f	J^π_f	Mult.	δ	α[#]	Comments
1764.42	(3/2$^-$)	1021.2 *3*	100 *16*	743.35	1/2$^-$				
1851.71	5/2$^+$	305.1 *9*	3 *2*	1548.36	(3/2$^+$,5/2$^-$)	D,E2[†]			
		600.6 *6*	<18	1251.01	3/2$^-$	[E1]		9.01×10^{-4}	α(K)=0.000795 *12*; α(L)=8.79×10^{-5} *13*; α(M)=1.543×10^{-5} *22*; α(N+..)=2.39×10^{-6} *4* α(N)=2.26×10^{-6} *4*; α(O)=1.300×10^{-7} *19* B(E1)(W.u.)>4.7×10^{-7}
		703.76 *5*	100 *5*	1147.96	7/2$^+$	M1+E2	+0.19 *8*	1.60×10^{-3}	α(K)=0.001410 *20*; α(L)=0.0001572 *23*; α(M)=2.77×10^{-5} *4*; α(N+..)=4.30×10^{-6} *7* α(N)=4.06×10^{-6} *6*; α(O)=2.37×10^{-7} *4* B(M1)(W.u.)>0.00021; B(E2)(W.u.)>0.0028
		1851.61 *9*	30 *3*	0.0	9/2$^+$	[E2]		4.37×10^{-4}	α(K)=0.0001783 *25*; α(L)=1.95×10^{-5} *3*; α(M)=3.43×10^{-6} *5*; α(N+..)=0.000236 *4* α(N)=5.04×10^{-7} *7*; α(O)=2.96×10^{-8} *5*; α(IPF)=0.000235 *4* B(E2)(W.u.)>0.0010
1958.4		707.4 *6*	100	1251.01	3/2$^-$				
2105.91	(3/2$^+$)	254.17 *14*	55 *4*	1851.71	5/2$^+$	M1+E2		0.030 *11*	α(K)=0.026 *10*; α(L)=0.0032 *14*; α(M)=0.00057 *24*; α(N+..)=9.E−5 *4* α(N)=8.E−5 *4*; α(O)=4.1×10^{-6} *14* δ: −0.04 *3* or +3.9 *5* from $\gamma\gamma(\theta)$.
		355.40 *9*	100 *4*	1750.43	5/2$^+$	M1+E2		0.011 *3*	α(K)=0.0092 *22*; α(L)=0.0011 *3*; α(M)=0.00019 *6*; α(N+..)=2.9×10^{-5} *8* α(N)=2.8×10^{-5} *8*; α(O)=1.5×10^{-6} *3* δ: −0.04 *3* or +4.0 *5* from $\gamma\gamma(\theta)$.
		558 *1*	1.3 *9*	1548.36	(3/2$^+$,5/2$^-$)				
		829.79 *9*	11.4 *8*	1276.09	5/2$^+$				
		854.89 *8*	17.0 *11*	1251.01	3/2$^-$	(E1)[‡]		4.21×10^{-4}	B(E1)(W.u.)>1.8×10^{-7} α(K)=0.000372 *6*; α(L)=4.08×10^{-5} *6*; α(M)=7.17×10^{-6} *10*; α(N+..)=1.111×10^{-6} *16* α(N)=1.050×10^{-6} *15*; α(O)=6.11×10^{-8} *9*
		1362.68 *9*	49 *5*	743.35	1/2$^-$	[E1]		3.22×10^{-4}	α(K)=0.0001559 *22*; α(L)=1.698×10^{-5} *24*; α(M)=2.98×10^{-6} *5*; α(N+..)=0.0001461 *21* α(N)=4.37×10^{-7} *7*; α(O)=2.57×10^{-8} *4*; α(IPF)=0.0001456 *21* B(E1)(W.u.)>1.3×10^{-7}
2247.46	3/2$^-$	699.2 *3*	36 *7*	1548.36	(3/2$^+$,5/2$^-$)				
		971.34 *15*	100 *6*	1276.09	5/2$^+$	[E1]		3.27×10^{-4}	α(K)=0.000289 *4*; α(L)=3.16×10^{-5} *5*; α(M)=5.56×10^{-6} *8*; α(N+..)=8.62×10^{-7} *12* α(N)=8.14×10^{-7} *12*; α(O)=4.75×10^{-8} *7*

$^{97}_{41}Nb_{56}$-5

$\gamma(^{97}Nb)$ (continued)

† Deduced from RUL.
‡ D,E2 deduced from RUL, level scheme limits mult to E1.
\# 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.

$^{97}_{41}Nb_{56}$-6

Adopted Levels, Gammas

Level Scheme

Intensities: Relative photon branching from each level