Adopted Levels, Gammas

History

Type	Author	Citation	Literature Cutoff Date
Full Evaluation	Balraj Singh and Jun Chen	NDS 172, 1 (2021)	31-Jan-2021

Q(β^-)=6396 *8*; S(n)=5533 *14*; S(p)=9466 *13*; Q(α)=−3886 *10* 2017Wa10
S(2n)=12415 *9*, S(2p)=22081 *11* (2017Wa10).

Mass measurement by Penning-trap method: Mass excess (g.s.)=−79802 *20*; mass excess (2.99-s isomer)= −79488 *10* (2007Ri01,2007Ha32,2006Jo14).

In (t,^{3}He) (1979Aj03), many states are suggested by the observation of 23 groups, several of which are unresolved structures. Measured Q value=−6690 *30* for the energy group labeled as '0', and assigned to the g.s. by 1979Aj03. Based on mass values in 2017Wa10, this Q value agrees better with the first level populated in (t,^{3}He) identified with the 2.99-s, (5^+) isomer, whose energy is measured as 314 *23* (2007Ri01,2007Ha32).

A 0.3−μs isomer is indicated by x(t) measurements (1970Gr38,1972ClZN) of fission fragments from ^{235}U(n,F) (1970Gr38) and ^{252}Cf(SF) (1972ClZN), but the mass assignment is not certain. 1970Gr38 assign this isomer to A=100, whereas 1972ClZN assign it to A=102.

A 3-min activity reported by 1960Or02 and 1971Ca18 from ^{235}U fission and by 1966Gu05 from ^{100}Mo(n,p) reaction most likely corresponds to ^{99}Nb β^- decay ($T_{1/2}$=2.6−min) and not to ^{100}Nb. No such activity has been seen in any of the later studies on the decay of ^{100}Nb.

A 12-min activity assigned to ^{100}Nb by 1961Ta08 from ^{100}Mo(n,p) reaction has not been confirmed in any other ^{100}Nb study. This activity probably corresponds to the decay of ^{101}Mo ($T_{1/2}$=14.6 min) formed by neutron capture in ^{100}Mo.

The following transitions were tentatively assigned to ^{100}Nb from a study of prompt conversion electrons from ^{235}U(n,F) by 1973Kh05: 84.0, 119.1, 126.4, 159.0, 172.0 and 212.0. None of these were assigned to levels in ^{100}Nb.

Additional information 1.

Theory references: consult the NSR database (www.nndc.bnl.gov/nsr/) for six primary references dealing with decay half-lives, β shape factors, and other beta-decay characteristics.

2000Lh01: theoretical calculation of level energies and spin-parities of ^{100}Nb using the Interacting Boson-Fermion-Fermion model.

^{100}Nb Levels

Cross Reference (XREF) Flags

- A ^{100}Zr β^- decay (7.1 s)
- B ^{100}Nb IT decay (12.4 μs)
- C ^{252}Cf SF decay
- D ^{100}Mo(t,^{3}He)

E(level)[†]	J$^\pi$	$T_{1/2}$	XREF	Comments
0.0	1^+	1.4 s *2*	A C	%β^-=100 J$^\pi$: log *ft*=4.6 (allowed β transition) from 0^+ parent. Probable configuration=$\pi g_{9/2}\nu g_{7/2}$. $T_{1/2}$: weighted average of 1.5 s *2* (1976Ah06) and 1.3 s *2* (1972Tr08). Other: ≈1.0 s (1970Ei02). 1969WiZX report 1.7 s *4* from 600.0γ(t), but this 600γ is seen mostly from β decay of the 2.99-s isomer. In 1972Tr08 and 1970Ei02, the half-life was incorrectly assigned to ^{100}Zr decay.
67.4[&] *8*	(2^+)[‡]		C	
159.1[a] *8*	(3^+)[‡]		C	
261.3[&] *10*	(4^+)[‡]		C	
314 *23*	$(5)^+$	2.99 s *11*	B D	%β^-=100 XREF: D(?). Additional information 2. It is assumed by the evaluators that the lowest levels populated in the decay of the 13−μs isomer, and in (t,^{3}He) correspond to this long-lived isomer. E(level): from measured masses of g.s. and isomer (2007Ri01). 2017Au03 give 313

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Adopted Levels, Gammas (continued)

^{100}Nb Levels (continued)

E(level)[†]	Jπ	$T_{1/2}$	XREF	Comments
				keV *8*, apparently deduced from cyclotron frequency ratios for the g.s. and isomeric activities with respect to ^{97}Zr standard cited by 2007Ha32 from measurements in their 2007Ri01 paper. It does not appear that 2007Ha32 made an independent measurement of the frequencies for ^{100}Nb g.s. and the isomer. The 2007Ri01 paper, on the other hand, on page 5 give measured frequencies for the g.s. and the isomer, not the ratios with respect to the ^{97}Zr standard, together with the energy of the isomer with an uncertainty of 23 keV. It is not clear to the evaluators whether frequency ratios listed in the 2007Ha32 carry correct uncertainties. Evaluators sent a query email Dec 5, 2020 to one of the main authors of both the papers for clarification of the assigned uncertainty. There has been no reply as of Jan 10, 2021. Evaluators prefer to assign 23 keV uncertainty as given in the 2017Ri01 paper. Jπ: allowed log *ft* value to 2103, 4^+ state in ^{100}Mo; log *ft* to 1847,6^+ state is direct and possibly allowed (2001Su11). Theoretical structure calculations (2000Lh01) predict 5^+ in a spherical basis with configuration=$\nu s_{1/2}\otimes\pi g_{9/2}$. $T_{1/2}$: from γ(t) in 1987Me06. Others: 3.1 s *3* (1976Ah06), 2.4 s (1967Hu09), 2.4 s *3* (1972He37). 1969WiZX report 3.0 s *7* from γ(t) of a 246.2γ from ^{100}Nb β^- decay, but this γ was not seen in other studies.
348 *23*	$(4^-,5^-,6^-)$	0.41 μs *6*	B	%IT=100 Jπ: (E1) 34.3γ to $(5)^+$; 185γ(M1)−173γ(M1) cascade from 707,(6^-) level. Absence of γ transitions to 261, (4^+) and 159, (3^+) favors 6^-. $T_{1/2}$: weighted average of 0.4 μs *1* (2013RuZX,γγ(t)); 0.46 μs *6* (1986LhZX,γγ(t)); 0.32 μs *8* (1970Gr38, x-ray(t)). See also ^{100}Nb IT decay.
368.2[a] *11*	(5^+)[‡]		C	
400.52 *6*	1^+	90 ps *30*	A	Jπ: log *ft*=4.8 (allowed β transition) from 0^+. Also theoretical prediction (2000Lh01). $T_{1/2}$: from γγ(t) in ^{100}Zr β^- decay (2013RuZX). Other: 0.19 ns *23* (1989Lh01).
471.39 *7*	(1^+)		A	Jπ: log *ft*=5.8 (probable allowed β transition) from 0^+ parent.
492.6 *15*			C	
498.08 *25*	$(0\text{ to }3^+)$[#]		A	Jπ: 498.1γ to 1^+; 0^- from theoretical predictions (2000Lh01).
504.30 *5*	1^+		A	Jπ: log *ft*=4.5 from 0^+; also theoretical prediction (2000Lh01).
521 *23*	$(5^-,6^-,7^-)$	207 ps *14*	B	Jπ: M1 185.4γ from (6^-). Absence of γ transition to 261, (4^+) favors 6^- or 7^-. $T_{1/2}$: γγ(t) in IT decay (2013RuZX). Other: <1 ns (1986LhZX).
542.4[&] *12*	(6^+)[‡]		C	
653.92 *12*	$(0\text{ to }3^+)$[#]		A	Jπ: 253.4γ to 1^+.
703.72 *11*	$(0\text{ to }3^+)$[#]		A	Jπ: 303.2γ to 1^+.
706 *23*	(6^-)		B	Jπ: (E2) 28γ from (8^-); 392.3γ to 5^+.
734 *23*	(8^-)	12.4 μs *3*	B	%IT=100 Jπ: possible $\pi g_{9/2}\otimes\nu h_{11/2}$ configuration from systematics of N=57 and 59 isotones (1999Ge01). But theoretical calculations (2000Lh01) predict 8^+ with $\pi g_{9/2}\otimes\nu g_{7/2}$ configuration. $T_{1/2}$: from 2013RuZX (γ(t) in IT decay, for 173-, 185- and 359-keV γ rays). Others: 13.0 μs *10* (1999Ge01), 12 μs (1980MoZJ).
771.9[a] *13*	(7^+)[‡]		C	
835.7 *18*			C	
1058.8[&] *14*	(8^+)[‡]		C	
1235.3 *18*			C	
1525.9 *21*			C	
0+x			D	E(level): the ground state in Table I of 1979Aj03, with Q_0=−6690 *30* in

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Adopted Levels, Gammas (continued)

^{100}Nb Levels (continued)

E(level)†	XREF	Comments
		(t,^{3}He) seems to corresponds to 314 keV *23*, which is the energy of the 2.99-s, (5$^+$) isomer measured by 2007Ri01 and 2007Ha32 in precise mass measurements of g.s. and isomer of ^{100}Nb, although it is not clear why a high-spin would be preferentially populated in a charge-exchange reaction such as ^{100}Mo(t,^{3}He) instead of the 1$^+$ ground state or other known 1$^+$ states by e.g. Gamow-Teller transition. If x=314, then 314, 348, 521, and 735 populated in 12.4−μs isomer decay match with 0+x, 25+x, 210+x and 410+x levels from (t,^{3}He), respectively, as noted by 1999Ge01.
25+x *10*	D	E(level): this level may correspond to 348.3 level.
131+x *10*	D	
210+x? *15*	D	E(level): this level may correspond to 521.4 level.
348+x *15*	D	
410+x *15*	D	E(level): this level may correspond to 706.7 level.
450+x@ *20*	D	E(level): this level may correspond to 734.7 level.
520+x@ *20*	D	
565+x *10*	D	
595+x?@ *20*	D	
680+x *20*	D	
720+x? *20*	D	
784+x *20*	D	
820+x *20*	D	
865+x@ *20*	D	
893+x *20*	D	
945+x@ *20*	D	
1040+x@ *20*	D	
1075+x@ *20*	D	
1136+x *20*	D	
1180+x *25*	D	
1260+x *30*	D	
1300+x *30*	D	

† From least-squares fit to Eγ data for levels with γ-ray emission. Others are from (t,^{3}He).
‡ Proposed in ^{252}Cf SF decay based on band structure.
# 2$^+$,3$^+$ less likely from log *ft*=6.0-6.8 from 0$^+$, but β feeding is quite weak which could be affected by weak unobserved γ-ray feeding from higher levels.
@ Unresolved structure.
& Band(A): K^π=1$^+$, $\pi g_{9/2}\otimes\nu g_{7/2}$,$\alpha$=0.
a Band(a): K^π=1$^+$ $\pi g_{9/2}\otimes\nu g_{7/2}$,$\alpha$=1.

γ(^{100}Nb)

E$_i$(level)	J$_i^\pi$	E$_\gamma$†	I$_\gamma$†	E$_f$	J$_f^\pi$	Mult.‡	α#	Comments
67.4	(2$^+$)	67.4	100	0.0	1$^+$			
159.1	(3$^+$)	91.6	100	67.4	(2$^+$)			
		159.1	10.8	0.0	1$^+$			
261.3	(4$^+$)	102.1	100	159.1	(3$^+$)			
		194.0	5.3	67.4	(2$^+$)			
348	(4$^-$,5$^-$,6$^-$)	34.3	100	314	(5)$^+$	(E1)	2.55	B(E1)(W.u.)=5.3×10^{-6} *+12−9* Mult.: proposed by 1999Ge01 from ce spectrum and also based on the 28γ(E2)−185γ(M1)−173γ(M1) cascade from 735,(8$^-$) level. But M1 from α(K)exp=4.7 *5* in 1986LhZX.

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Adopted Levels, Gammas (continued)

$\gamma(^{100}Nb)$ (continued)

E_i(level)	J_i^π	E_γ[†]	I_γ[†]	E_f	J_f^π	Mult.[‡]	α[#]	Comments
368.2	(5^+)	106.9	100	261.3	(4^+)			
		209.1	12.9	159.1	(3^+)			
400.52	1^+	400.50 *6*	100	0.0	1^+	[M1]		B(M1)(W.u.)=0.0038 *+19−10*
471.39	(1^+)	471.48 *9*	100	0.0	1^+			
492.6		124.4	100	368.2	(5^+)			
498.08	(0 to 3^+)	498.08 *25*	100	0.0	1^+			
504.30	1^+	33.01 *10*	0.88 *16*	471.39	(1^+)	(M1)	5.46	Mult.: from α(K)exp=3.1 *8* (2007Ri01) in ^{100}Zr β^- decay.
		103.73 *10*	2.6 *4*	400.52	1^+	[M1]	0.204	
		504.29 *5*	100 *13*	0.0	1^+			
521	$(5^-,6^-,7^-)$	173.3 *2*	100	348	$(4^-,5^-,6^-)$	M1	0.0505	B(M1)(W.u.)=0.0195 *13*
542.4	(6^+)	174.1	100	368.2	(5^+)			
		281.2	18.2	261.3	(4^+)			
653.92	(0 to 3^+)	253.4 *1*	100	400.52	1^+			
703.72	(0 to 3^+)	303.2 *1*	55 *8*	400.52	1^+			
		703.7 *4*	100 *19*	0.0	1^+			
706	(6^-)	185.4 *2*	100	521	$(5^-,6^-,7^-)$	M1	0.0422	
		358.6 *2*	88	348	$(4^-,5^-,6^-)$			
		392.3 *2*	60	314	$(5)^+$			
734	(8^-)	28	100	706	(6^-)	(E2)	110	B(E2)(W.u.)=0.87 *16*
771.9	(7^+)	229.7	100	542.4	(6^+)			
		403.6	26	368.2	(5^+)			
835.7		343.1	100	492.6				
1058.8	(8^+)	286.9	100	771.9	(7^+)			
		516.4	27	542.4	(6^+)			
1235.3		742.6	100	492.6				
1525.9		290.6	100	1235.3				

[†] From β^- decay, IT decay or ^{252}Cf SF decay, where a level is populated. All the excited states are populated uniquely in each of the datasets.

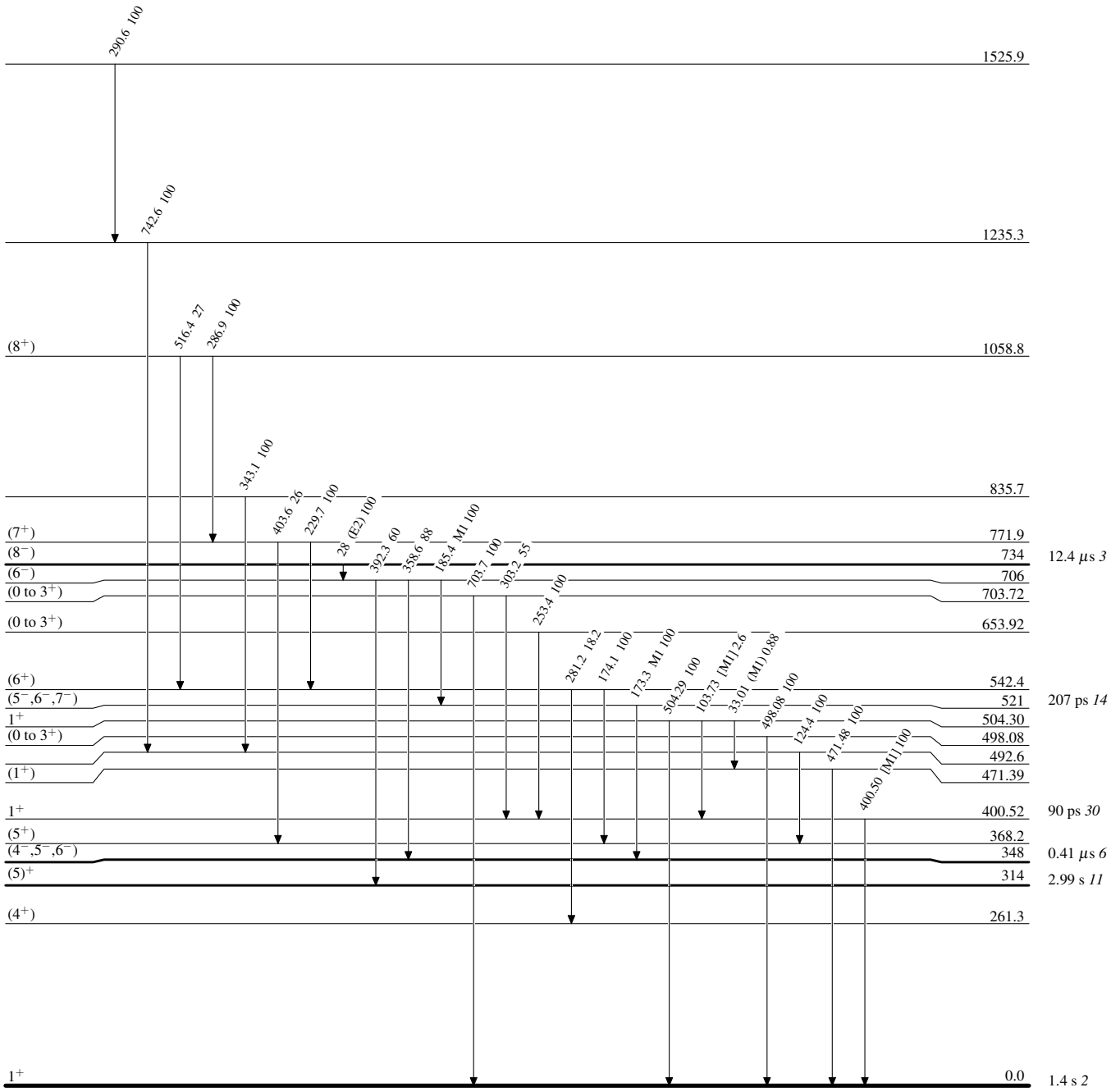
[‡] From ce data in ^{100}Nb IT decay, unless otherwise noted.

[#] 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.

Adopted Levels, Gammas

Level Scheme

Intensities: Relative photon branching from each level

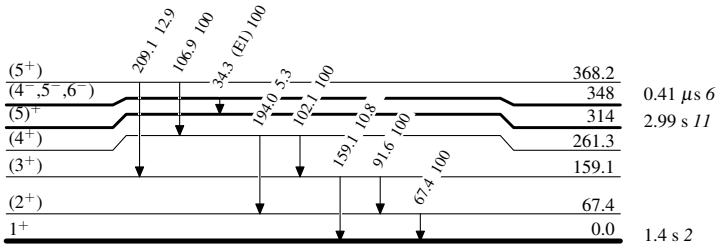


$^{100}_{41}Nb_{59}$

Adopted Levels, Gammas

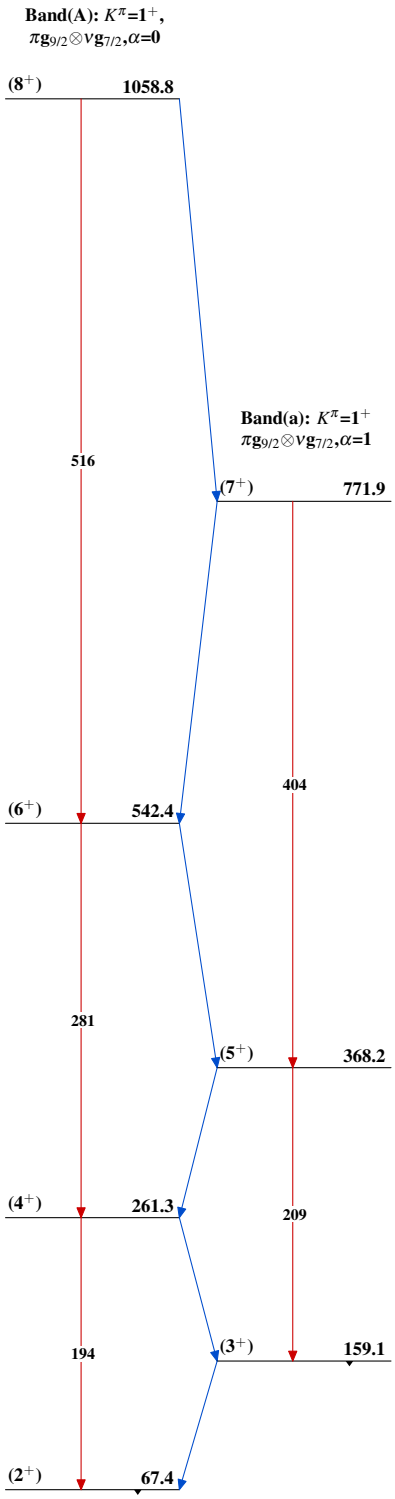
Level Scheme (continued)

Intensities: Relative photon branching from each level



$^{100}_{41}Nb_{59}$

Adopted Levels, Gammas



$^{100}_{41}Nb_{59}$