Adopted Levels, Gammas

Type	Author	History Citation	Literature Cutoff Date
Full Evaluation	D. De Frenne	NDS 110,1745 (2009)	31-Dec-2008

Q(β^-)=4717 *9*; S(n)=6494 *12*; S(p)=13816 *12*; Q(α)=−7593 *10* 2012Wa38
Note: Current evaluation has used the following Q record 4.61E3 3 *6356* 591.412E4 11-752E1 6 2003Au03.
Q(β^-)(g.s.)=4719 keV 15 en Q(β^-)(isomer)=4626 keV 23 (2007Ri01) 2007Ri01 supersedes 2006Ha23.
Other experimental data: Fission yields: 1987GuZX.

^{102}Zr Levels

Band from 2008Li45.

Cross Reference (XREF) Flags

A	^{103}Y β^-n decay	E	^{238}U(α,Fγ)
B	^{102}Y β^- decay (0.36 s)	F	^{248}Cm SF decay
C	^{102}Y β^- decay (0.298 s)	G	^{252}Cf SF decay
D	^{235}U(n,F)		

E(level)[‡]	J$^\pi$[†]	T$_{1/2}$[#]	XREF	Comments
0[@]	0$^+$	2.9 s *2*	ABCDEFG	%β^-=100 <r^2>$^{1/2}$=4.5690 fm *218* (2004An14, evaluation). T$_{1/2}$: from 1976Ah06; half-life was measured by following the growth and decay of the niobium daughter in zirconium samples.
151.78[@] *11*	2$^+$	1.8 ns *4*	BCDEFG	β_2= 0.427 *44*(2001Ra27) μ=+0.44 *10* J$^\pi$: 151.9γ is (E2) as seen in ^{235}U(n,F). T$_{1/2}$: From (2001Ra27). Others: 1.91 ns *25* from ^{252}Cf,^{254}Cf SF decay by recoil-distance Doppler-shift method. 3.0 ns from $\gamma\gamma\gamma$(t) in ^{252}Cf(SF)(2005Fo17)and 2.76 ns *36* from the technique of time-integral perturbed angular correlations using ^{252Cf} SF and ^{248}Cu SF sources (2004Sm04). μ: From g=+0.22 *5* 2004Sm04, 2005Sm08 with the technique of time-integral perturbed angular correlations using ^{252Cf} SF and ^{248}C SF decays.
478.28[@] *16*	4$^+$		BCDEFG	
894.79 *21*	(0$^+$)		C	J$^\pi$: γ decay to 2$^+$ but not to 4$^+$ suggests (0$^+$) for this level. (1$^+$) cannot be excluded but 0$^+$ favored from systematics.
964.78[@] *24*	6$^+$		B DEFG	
1036.3[f] *4*	(2$^+$)		FG	
1159.50 *22*			C	
1211.05 *13*	(2$^+$)		BC	J$^\pi$: based on systematics: from γ decay to 0$^+$ and 2$^+$.
1242.3[f] *3*	(3$^+$)		B EFG	
1386.7[d] *6*	(4$^+$)			
1538.1[f] *5*	(4$^+$)		FG	
1594.9[@] *6*	8$^+$	1.39 ps *21*	EFG	
1652.8[e] *5*	(6$^+$)		G	
1661.8[a] *4*	(5$^-$)		E G	
1793.3 *7*	(3,4)		FG	
1821.1[&] *4*	(4$^-$)		EFG	
1822.5? *8*			B	

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Adopted Levels, Gammas (continued)

^{102}Zr Levels (continued)

E(level)[‡]	J^{π}[†]	$T_{1/2}$[#]	XREF
1829.4[d] 6	(6$^+$)		G
1920.7 6			
1932.6[b]	(8$^+$)		E
1980.8[a] 6	(5$^-$)		B EFG
2092.8[a] 6	(7$^-$)		E G
2175.0[&] 9	(6$^-$)		EFG
2184.0 5	(8$^+$)		G
2351.5[@] 8	10$^+$	0.53 ps 10	EFG
2373.3[d] 4	(8$^+$)		FG
2403.0[&] 8	(7$^-$)		EFG
2465.8[b] 5	(10$^+$)		G
2663.9[a] 5	(9$^-$)		E G
2665.8[&] 8	(8$^-$)		EFG
2825.8[e] 5	(10$^+$)		G
2924.7[c] 6	(7)		FG
2961.4[&] 9	(9$^-$)		EFG
3033.3[d] 5	(10$^+$)		G
3134.2[b]	(12$^+$)		G
3183.6[c] 6	(8)		G
3212.3[@] 9	12$^+$	0.28 ps 4	E G
3293.0[a]	(10$^-$)		E
3371.0[a]	(11$^-$)		E G
3475.8[c] 6	(9)		G
3567.5[e] 6	(12$^+$)		G
3802.0[c] 6	(10)		G
3925.7[b]	(14$^+$)		G
4153.4[@]	14$^+$		E G
4162.2[c] 6	(11)		G
4205.2[a]	(13$^-$)		E G
4828.5[b]	(16$^+$)		E
5160.7[&]	(15$^-$)		E
5169.0[@]	16$^+$		E G
6267.1[@]	18$^+$		E
7451.7[@]	20$^+$		E

† Assignment is based on assumption of observed band structure in ^{252}Cf,^{248}Cm SF decay and ^{238}U(α,Fγ), systematics and γ decay pattern.

‡ Least-squares procedure was used to calculate level energies based on adopted gammas.

$T_{1/2}$ from short-lived isomers from Doppler-profile method (1996Sm04), unless specified otherwise.

@ Band(A): g.s. band.

& Band(B): ν5/2[532]$\otimes\nu$3/2[411].

a Band(C): ν5/2[532]$\otimes$5/2[413].

b Band(D): Band based on (8$^+$).

c Band(E): ΔJ=1 band based on 7. Possible configurations=ν9/2[404]$\otimes\nu$5/2[532] or ν9/2[514]$\otimes\nu$5/2[413] for 7$^-$; ν9/2[404]$\otimes\nu$5/2[413] or ν9/2[514]$\otimes\nu$5/2[532] for 7$^+$.

d Band(F): ν3/2[411]$\otimes\nu$5/2[413].

e Band(G): ν9/2[404]$\otimes\nu$3/2[411]. Alternate configuration=ν9/2[514]$\otimes\nu$3/2[541].

f Band(H): Band based on (2$^+$).

γ(^{102}Zr)

E_i(level)	J^{π}_i	E_{γ}[†]	I_{γ}[†]	E_f	J^{π}_f	Mult.	α[#]	Comments
151.78	2$^+$	151.75 8	100	0	0$^+$	(E2)	0.243 4	B(E2)(W.u.)=105 14
478.28	4$^+$	326.48 21	100	151.78	2$^+$			
894.79	(0$^+$)	743.01 18	100	151.78	2$^+$			
964.78	6$^+$	486.54 19	100	478.28	4$^+$			
1036.3	(2$^+$)	884.5 5		151.78	2$^+$			
		1036.4 5		0	0$^+$			
1159.50		1159.49 22	100	0	0$^+$			
1211.05	(2$^+$)	1059.21 18	73 8	151.78	2$^+$			
		1211.08 16	100 10	0	0$^+$			
1242.3	(3$^+$)	764.0 5		478.28	4$^+$			
		1090.8 4		151.78	2$^+$			
1386.7	(4$^+$)	908.4 5	100 16	478.28	4$^+$			A_2=−0.073 27, A_4=+0.149 40 for 908.0-326.5 $\gamma\gamma$ cascade consistent with 4−>4−>2 cascade with mult=Q for 4 -> 4 transition.

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Adopted Levels, Gammas (continued)

$\gamma(^{102}Zr)$ (continued)

E_i(level)	J^π_i	E_γ†	I_γ†	E_f	J^π_f	Comments
1386.7	(4^+)	1234.5	43 *14*	151.78	2^+	
1538.1	(4^+)	1059.7 *5*	100	478.28	4^+	
1594.9	8^+	630.1 *5*	100	964.78	6^+	
1652.8	(6^+)	687.8	33 *11*	964.78	6^+	
		1174.4 *5*	100 *15*	478.28	4^+	
1661.8	(5^-)	275@ *10*		1386.7	(4^+)	
		697.2 *5*	100	964.78	6^+	
		1183.3 *5*	23	478.28	4^+	
1793.3	(3,4)	551.1	5.4 *19*	1242.3	(3^+)	
		757.0 *5*	100 *16*	1036.3	(2^+)	
1821.1	(4^-)	27.2@ *10*		1793.3	(3,4)	
		282.8 *5*	100	1538.1	(4^+)	
		579.0 *4*	84	1242.3	(3^+)	
		1342.5 *5*	3.6	478.28	4^+	
1822.5?		579.4 *5*	100	1242.3	(3^+)	
1829.4	(6^+)	864.6 *5*	100	964.78	6^+	
1920.7		1442.4 *5*	100	478.28	4^+	
1932.6	(8^+)	968.7‡	100	964.78	6^+	
1980.8	(5^-)	159.7 *4*	100	1821.1	(4^-)	
2092.8	(7^-)	431.0 *5*	100	1661.8	(5^-)	
		498.1 *10*		1594.9	8^+	
		1126.8@		964.78	6^+	E_γ: Only observed in $^{238}U(\alpha,F\gamma)$.
2175.0	(6^-)	193.7@ *5*		1980.8	(5^-)	
2184.0	(8^+)	531.8 *10*	100 *5*	1652.8	(6^+)	
		1219.6 *5*	55 *16*	964.78	6^+	
2351.5	10^+	756.6 *5*	100	1594.9	8^+	
2373.3	(8^+)	544.0	100 *66*	1829.4	(6^+)	
		777.9	47 *75*	1594.9	8^+	
		1408.4	52 *85*	964.78	6^+	
2403.0	(7^-)	228.0 *5*	100 *15*	2175.0	(6^-)	
		422.2 *5*	45 *15*	1980.8	(5^-)	
2465.8	(10^+)	533.5	100 *13*	1932.6	(8^+)	
		870.4	41 *13*	1594.9	8^+	
2663.9	(9^-)	569.4	100	2092.8	(7^-)	
2665.8	(8^-)	262.6 *5*	100 *28*	2403.0	(7^-)	
		490.8 *5*	72 *22*	2175.0	(6^-)	
2825.8	(10^+)	641.3	100 *15*	2184.0	(8^+)	
		1230.4	30 *10*	1594.9	8^+	
2924.7	(7)	1959.9 *5*	100	964.78	6^+	
2961.4	(9^-)	296.4 *5*	90 *30*	2665.8	(8^-)	
		559.0 *5*	100 *30*	2403.0	(7^-)	
3033.3	(10^+)	660.0	100	2373.3	(8^+)	
3134.2	(12^+)	669.3	100	2465.8	(10^+)	
3183.6	(8)	257.2	100	2924.7	(7)	
3212.3	12^+	860.8 *5*	100	2351.5	10^+	
3293.0	(10^-)	331.5‡		2961.4	(9^-)	
		628.4‡		2663.9	(9^-)	
3371.0	(11^-)	706.9	100	2663.9	(9^-)	
3475.8	(9)	292.2	100 *33*	3183.6	(8)	
		549.4	67 *22*	2924.7	(7)	
3567.5	(12^+)	741.7	100	2825.8	(10^+)	
3802.0	(10)	326.2	100 *25*	3475.8	(9)	
		618.4@	25 *8*	3183.6	(8)	

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Adopted Levels, Gammas (continued)

$\gamma(^{102}Zr)$ (continued)

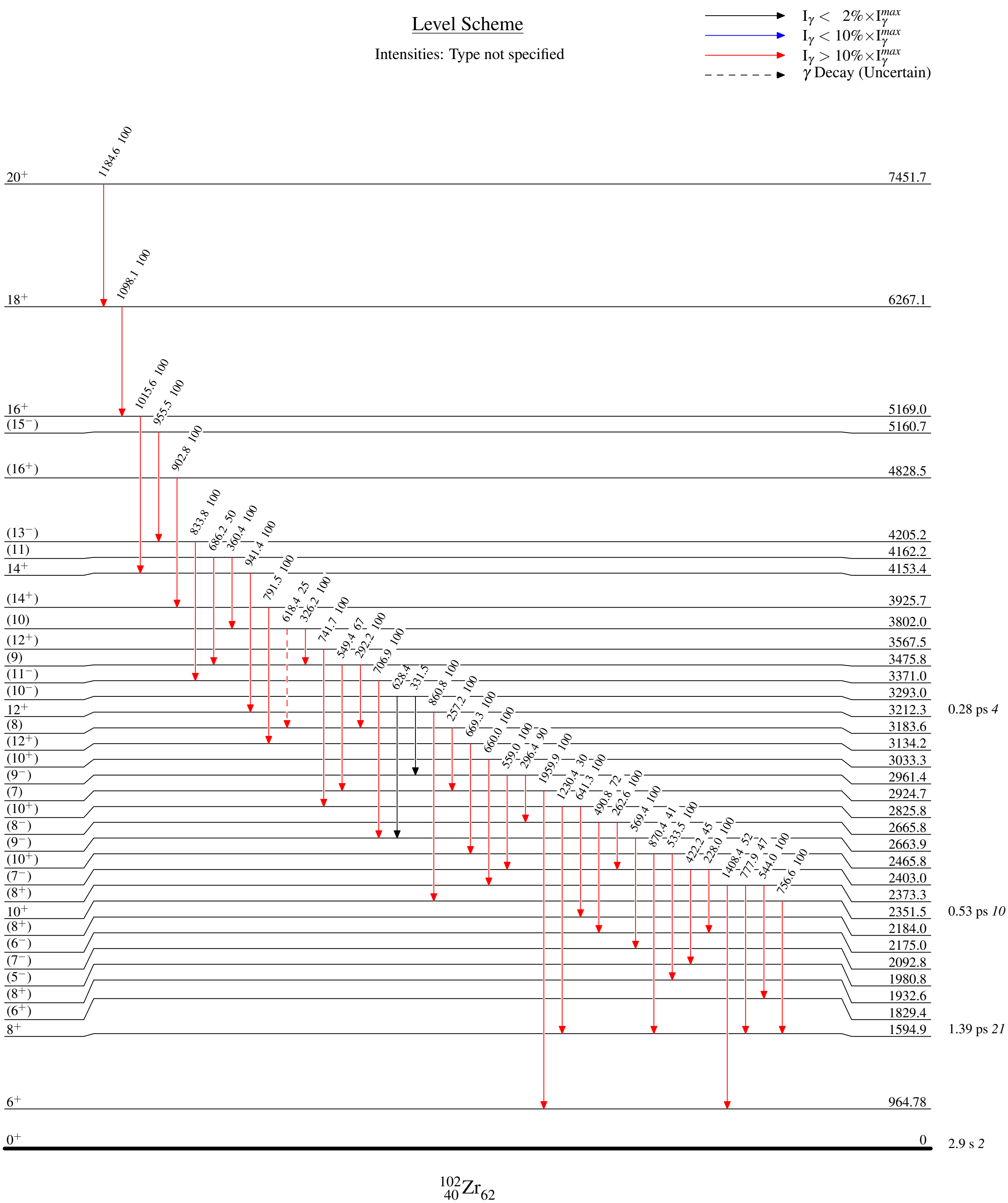
E_i(level)	J^π_i	E_γ†	I_γ†	E_f	J^π_f	E_i(level)	J^π_i	E_γ†	I_γ†	E_f	J^π_f
3925.7	(14^+)	791.5	100	3134.2	(12^+)	4828.5	(16^+)	902.8‡	100	3925.7	(14^+)
4153.4	14^+	941.4	100	3212.3	12^+	5160.7	(15^-)	955.5‡	100	4205.2	(13^-)
4162.2	(11)	360.4	100 *35*	3802.0	(10)	5169.0	16^+	1015.6	100	4153.4	14^+
		686.2	50 *15*	3475.8	(9)	6267.1	18^+	1098.1‡	100	5169.0	16^+
4205.2	(13^-)	833.8	100	3371.0	(11^-)	7451.7	20^+	1184.6‡	100	6267.1	18^+

† Weighted averages of gammas from ^{252}Cf,^{242}Pu SF decay, and ^{102}Y decays if possible. Otherwise from ^{252}Cf,^{242}Pu SF decay.
‡ Only observed in ^{238}U(α,Fγ).
# 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.
@ Placement of transition in the level scheme is uncertain.

Adopted Levels, Gammas

Level Scheme

Intensities: Type not specified



Adopted Levels, Gammas

Level Scheme (continued)

Intensities: Type not specified

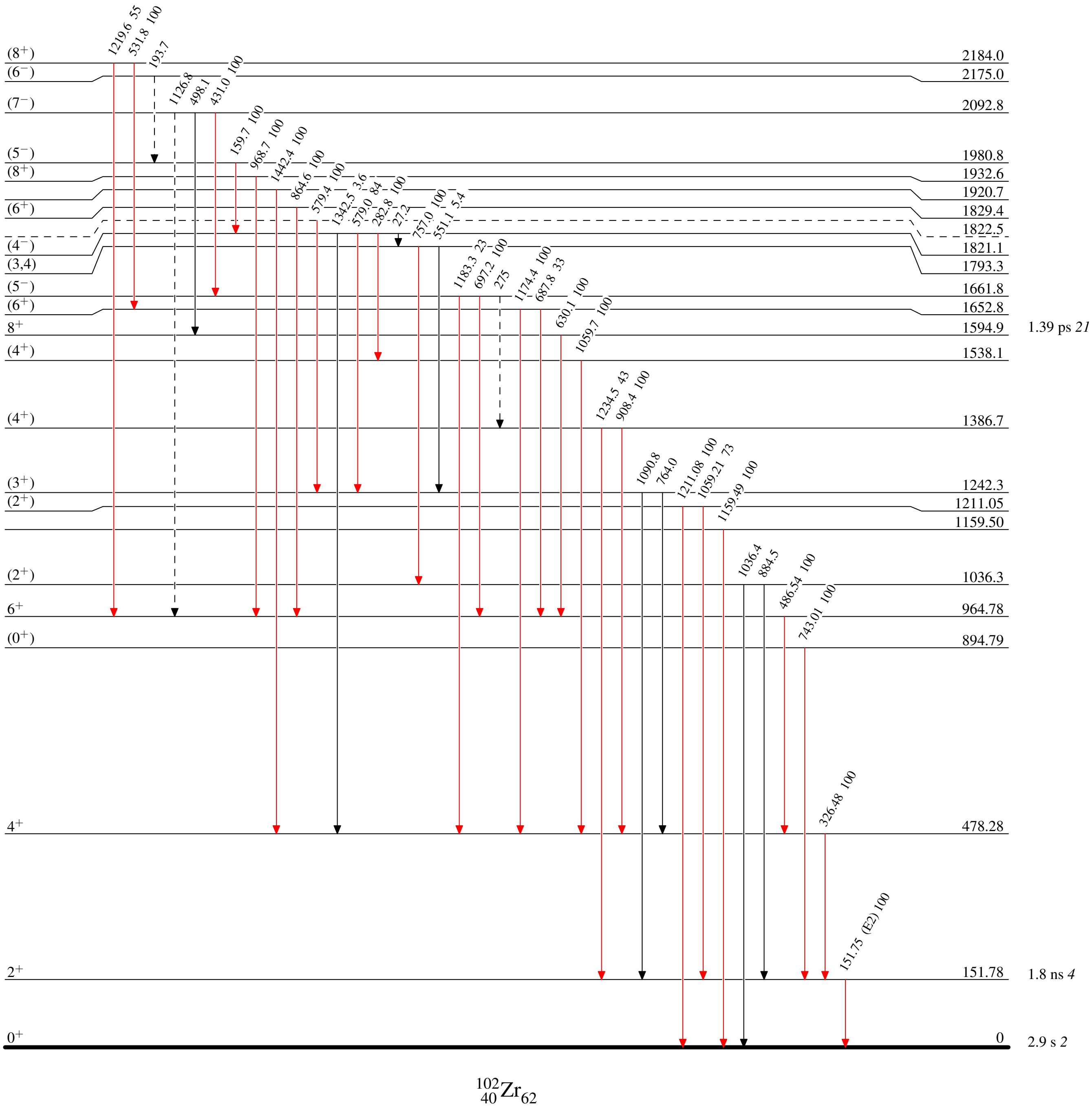
Legend

$I_\gamma < 2\% \times I_\gamma^{max}$

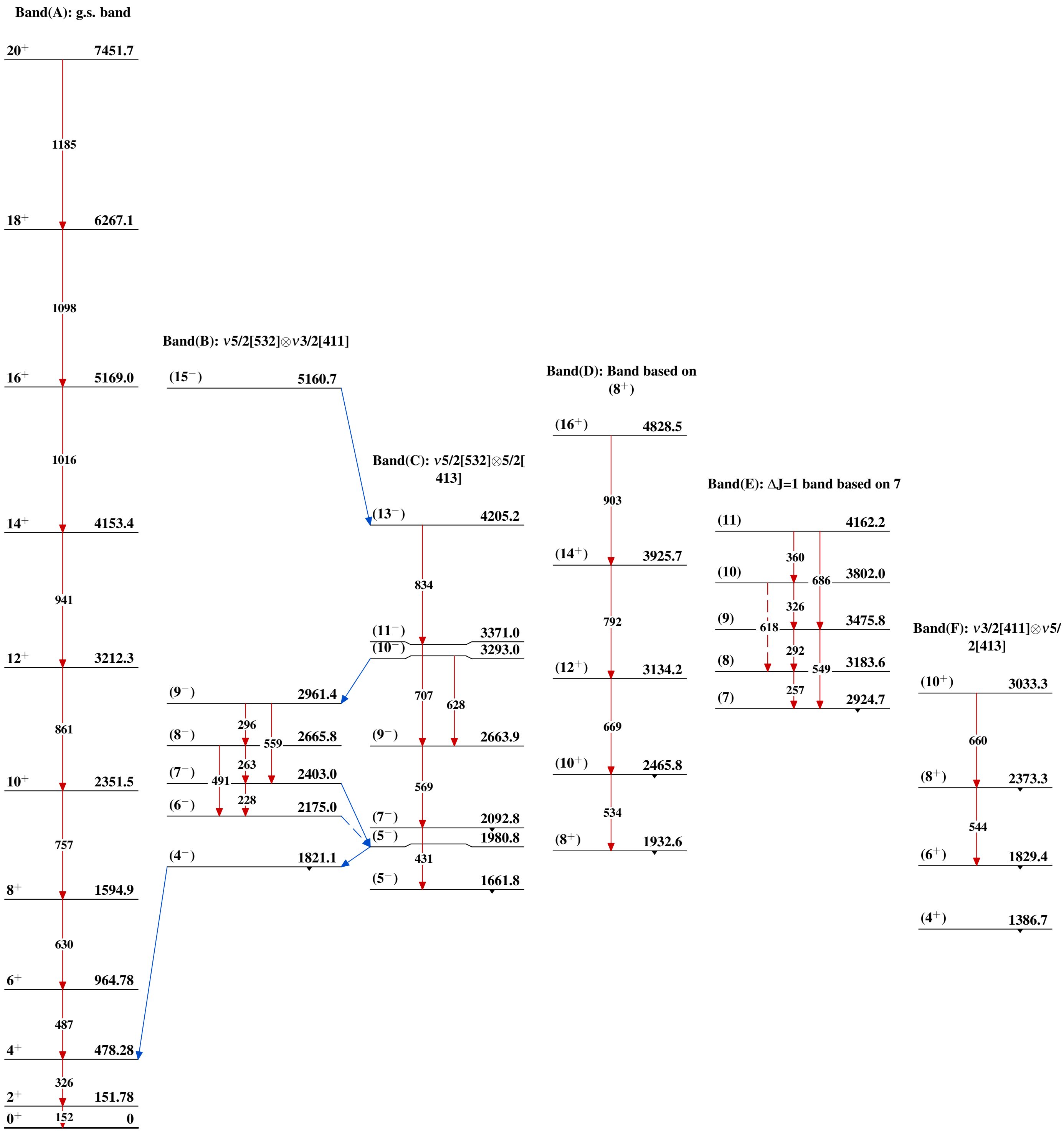
$I_\gamma < 10\% \times I_\gamma^{max}$

$I_\gamma > 10\% \times I_\gamma^{max}$

γ Decay (Uncertain)



Adopted Levels, Gammas



$^{102}_{40}Zr_{62}$

Adopted Levels, Gammas (continued)