Adopted Levels, Gammas

History

Type	Author	Citation	Literature Cutoff Date
Full Evaluation	G. Gürdal, E. A. Mccutchan	NDS 136, 1 (2016)	1-Jul-2016

Q(β^-)=−654.6 *16*; S(n)=9218.4 *21*; S(p)=11117.5 *24*; Q(α)=−5983.3 *24* 2012Wa38
S(2n)=15700.5 *21*; S(2p)=20679 *4* (2012Wa38).
α: Additional information 1.

^{70}Zn Levels

Cross Reference (XREF) Flags

A	^{70}Cu β^- decay (44.5 s)	G	^{70}Zn(p,p′γ)	M	^{208}Pb(^{64}Ni,Xγ)
B	^{70}Cu β^- decay (33 s)	H	^{70}Zn(α,α′)	N	^{238}U(^{76}Ge,Xγ)
C	^{70}Cu β^- decay (6.6 s)	I	^{70}Zn(n,n′γ)	O	^{70}Zn(d,d′)
D	^{70}Ga ε decay	J	^{70}Zn(e,e′)	P	^{70}Zn(^{3}He,^{3}He′)
E	^{68}Zn(t,p)	K	Coulomb excitation	Q	^{73}Ge(n,α)
F	^{70}Zn(p,p′),(pol p,p′)	L	^{71}Ga(d,^{3}He)		

E(level)[†]	J$^\pi$	T$_{1/2}$	XREF	Comments
0.0[‡]	0$^+$	≥3.8×10^{18} y	ABCDEFGHIJKLMNOPQ	%2β^-=? T$_{1/2}$: from 2011Be39 for 2ν2β^- decay; also determined T$_{1/2}$≥3.2×10^{19} for 0ν2β^- decay. Others: ≥2.3×10^{17} for 2ν2β^- decay and ≥1.8×10^{19} for 0ν2β^- decay (2010Be41, 2010BeZO, 2009Be27, earlier results by same group as 2011Be39), ≥2.2×10^{17} (2007Bl15, 2006Zu02), ≥1.3×10^{16} for 2ν2β^- decay and ≥0.7×10^{18} for 0ν2β^- decay (2005Da47), ≥1.3×10^{16} (2003Ki08), >4.8×10^{14} y (1952Fr23).
884.92[‡] *8*	2$^+$	3.65 ps *21*	ABC EFGHIJKLMNOPQ	Q=−0.233 *22* (1976Ne06); μ=+0.76 *4* (2009Mu06) β_2=0.20 (1993Mo15) μ: from transient field technique in Coulomb Excitation. Others: +0.76 *8* (2002Ke02), 0.82 *20* (1979BrZP), 0.60 *18* (1977HaZW), all from transient field technique in Coulomb Excitation, and 0.60 *14* (1979Fa06) from IMPAC. T$_{1/2}$: weighted average of 3.67 ps *21* from DSAM and 3.60 ps *35* from RDDS, both in Coulomb Excitation. Others: 3.7 ps *12* from RDDS in ^{238}U(^{76}Ge,Xγ), 2.5 ps *2* from B(E2)=0.205 *19* in (e,e′), 3.3 ps *3* from B(E2)=0.160 *14* in Coulomb Excitation. J$^\pi$: L(t,p)=2. Q: from (e,e′); extracted using anharmonic-vibrator model and is model dependent. β_2: from (pol p,p′). Other: 0.220 from (α,α′).
1070.76 *9*	0$^+$	3.90 ns *20*	C E G I KL	T$_{1/2}$: from (p,p′γ). J$^\pi$: L(t,p)=0.
1554[@] *5*			F H	
1759.16 *10*	2$^+$	1.32 ps *21*	BC EF HIJKL	μ=+0.94 *44* (2009Mu06) XREF: E(1767)F(1764). J$^\pi$: L(p,p′)=2, L(d,^{3}He)=1(+3), strong population in Coulomb excitation. T$_{1/2}$: from DSAM in Coulomb Excitation. Others: 1.4 ps *4* from B(E2)=0.0050 *13* from (e,e′), 0.24 ps *+24−12* from DSAM in (n,n′γ). μ: from transient field technique in Coulomb excitation. Other: +0.84 *38* from reanalysis of transient field data (2010Mo14).
1786.75[‡] *10*	4$^+$	2.9 ps *8*	AB EF I KLMN	μ=+1.48 *56* (2009Mu06)

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Adopted Levels, Gammas (continued)

^{70}Zn Levels (continued)

E(level)[†]	J^π	$T_{1/2}$	XREF	Comments
				J^π: L(t,p)=4. $T_{1/2}$: weighted average of 2.0 ps +9−11 from RDDS in ^{238}U(^{76}Ge,Xγ) and 3.4 ps 8 from RDDS in Coulomb Excitation. Other: 1.32 ps 14 from DSAM in Coulomb Excitation (2009Mu06). μ: from transient field technique in Coulomb excitation. Other: +0.84 52 from reanalysis of transient field data (2010Mo14).
1957.28 12	2^+		C EF HI KL Q	XREF: H(1945). J^π: L(t,p)=2.
2140.64 17	0^+		C EF I L	XREF: F(2150)L(2126). J^π: L(t,p)=0.
2375[@] 5	$(2,1,3)^+$		F H Q	XREF: Q(2300?). J^π: L(p,p′)=2.
2538.31 11	2^+	0.21 ps +28−8	B F I KL	$T_{1/2}$: from DSAM in (n,n′γ). J^π: from L(d,^{3}He)=1+3 and J=2 from $\gamma(\theta)$ in (n,n′γ). 2004Va08 in ^{70}Cu β^- decay (33 s) assign (3^+) to this level, however, this is unlikely given its direct population in Coulomb excitation. L(p,p′)=(0) is discrepant.
2665[@] 5	2^+		EF L	J^π: L(t,p)=2.
2693.40 11	4^+	0.28 ps +35−14	AB EF I K	$T_{1/2}$: from DSAM in (n,n′γ). J^π: L(p,p′)=4.
2805[@] 5			F	
2859.49 11	3^-	0.201 ps 14	B EF HI K	β_3=0.20 (1993Mo15) J^π: L(t,p)=3; analyzing power consistent with 3^- in (pol p,p′). β_3: from (pol p,p′). $T_{1/2}$: from DSAM in Coulomb Excitation.
2895.10[‡] 13	(6^+)		A K MN	J^π: 1108γ to 4^+, band assignment.
2949.67 18	$1^+,2^+,3^+$	0.042 ps +21−14	I KL	XREF: L(?). J^π: M1+E2 2064γ to 2^+. $T_{1/2}$: from DSAM in (n,n′γ).
2954[@] 5			F	E(level): possibly the same as 2949.2-keV level, although L(p,p′)=(1) is discrepant with Adopted J^π.
2978.26 23	4^+		B EF K	J^π: L(t,p)=4.
3022[#] 10			L	E(level): possibly the same as 3037.6-keV level, although L(d,^{3}He)=(1) is discrepant with Adopted J^π.
3038.15 11	5^-	1.04 ps 7	AB EF HI K MN	J^π: L(p,p′)=5, L(t,p)=(5), population in Coulomb Excitation makes $J^\pi=4^-$ or 6^- unlikely. $J^\pi=4^-$ proposed in (n,n′γ) based on population strength and $J^\pi=4^+$ proposed in ^{208}Pb(^{64}Ni,Xγ). $T_{1/2}$: from DSAM in Coulomb Excitation. Configuration=$((\pi\ 2p_{3/2})^2(\nu\ 2p_{1/2})^{-1}(\nu\ 1g_{9/2}))$ (2004Va08).
3222.08 10	1		I	J^π: from $\gamma(\theta)$ in (n,n′γ).
3235 5	$3^+,4^+,5^+$		EF	E(level): from (p,p′). J^π: from L(p,p′)=4.
3246.71 11	$(3^-,4^+)$		B	J^π: strong β feeding from $J^\pi=3^-$ parent, 209γ to 5^-, 708γ to 2^+. E(level): possibily the same as the 3235-keV level.
3328[@] 5	(0^+)		EF	J^π: L(t,p)=(0).
3342.0 3	3^-		A E H	J^π: L(α,α')=3.
3419[@] 5	$(3)^-$		EF	J^π: L(t,p)=(3), L(p,p′)=3.

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Adopted Levels, Gammas (continued)

^{70}Zn Levels (continued)

E(level)†	J^π	XREF	Comments
3464@ *5*	4^+	EF H	J^π: L(t,p)=4.
3476.68 *14*		A M	
3506@ *5*	5^-	EF H L	J^π: L(t,p)=5, L(p,p′)=5; L=1 in (d,^{3}He) is discrepant.
3598.98 *14*		A M	
3634.99 *22*	2^+	C EF L	J^π: L(t,p)=2.
3680@ *5*	0^+	EF H L	J^π: L(t,p)=0; L=1(+3) in (d,^{3}He) is discrepant.
3710.7 *6*	2^+	EF I	J^π: L(t,p)=2.
3750@ *5*	$(0^-,1^-,2^-)$	EF	J^π: L(p,p′)=(1).
3755.4‡ *10*	(8^+)	MN	J^π: 860γ to (6^+), band assignment.
3788.16 *22*		A M	
3813@ *5*		EF	E(level): possible doublet; L(p,p′)=(1)+4.
3844@ *5*	1^-	EF h	J^π: L(t,p)=1.
3848.4 *6*	$(5,6^+)$	A	J^π: direct β^- feeding from J^π=6$^-$ parent, 2062γ to 4$^+$.
3888@ *5*	$(4)^+$	EF h	J^π: L(p,p′)=4.
3904.0 *4*	$(5,6^+)$	A	J^π: direct β^- feeding from J^π=6$^-$ parent, 2117γ to 4$^+$.
3914 *10*		E	
3948@ *5*	1^-	EF	J^π: L(t,p)=1.
3999 *10*	2^+	E H	J^π: L(t,p)=2. E(level): from (t,p).
4001.46 *15*	$(5,6,7^-)$	A	J^π: direct β^- feeding from J^π=6$^-$ parent, 963γ to 5$^-$.
4016 *10*	$3^+,4^+,5^+$	EF	E(level): doublet in (t,p). J^π: L(p,p′)=4.
4061.40 *16*	$(5,6,7^-)$	A	J^π: direct β^- feeding from J^π=6$^-$ parent, 1023γ to 5$^-$.
4066@ *10*	4^+	EF	J^π: L(t,p)=4.
4136@ *10*	$2^+,1^+,3^+$	EF	J^π: L(p,p′)=2.
4146.1 *3*		I	J^π: proposed as 3$^-$ in (n,n′γ) based on population strength.
4172@ *10*	5^-	F H	XREF: H(4200). J^π: L(p,p′)=5, L(α,α')=5.
4264.5 *7*	$(5,6,7^-)$	A	J^π: direct β^- feeding from J^π=6$^-$ parent, 1226γ to 5$^-$.
4291 *10*	2^+	EF	E(level): weighted average of 4297 *10* from (t,p) and 4284 *10* from (p,p′). J^π: L(t,p)=L(p,p′)=2.
4308.99 *18*	$(5,6,7^-)$	A F	J^π: direct β^- feeding from J^π=6$^-$ parent, 1271γ to 5$^-$.
4367 *10*	$3^+,4^+,5^+$	F	J^π: L(p,p′)=4.
4444 *10*	$3^+,4^+,5^+$	F	J^π: L(p,p′)=4.
4464.77 *17*	$(5,6,7^-)$	A	J^π: direct β^- feeding from J^π=6$^-$ parent, 1426.5γ to 5$^-$.
4514.27 *23*	$(5,6,7^-)$	A	J^π: direct β^- feeding from J^π=6$^-$ parent, 1476γ to 5$^-$.
4558.2 *3*	$(5,6^+)$	A	J^π: direct β^- feeding from J^π=6$^-$ parent, 2771γ to 4$^+$.
4588.8 *3*	$(5,6,7^-)$	A	J^π: direct β^- feeding from J^π=6$^-$ parent, 1551γ to 5$^-$.
4710.1 *5*	(5,6,7)	A	J^π: direct β^- feeding from J^π=6$^-$ parent.
4791.7 *10*	(5,6,7)	A	J^π: direct β^- feeding from J^π=6$^-$ parent.
4849.2 *3*	$(5,6^+)$	A	J^π: direct β^- feeding from J^π=6$^-$ parent, 3062γ to 4$^+$.
4935.9‡ *14*	(10^+)	MN	J^π: 1180.5γ to (8^+), band assignment.
5061.3 *5*	(5,6,7)	A	J^π: direct β^- feeding from J^π=6$^-$ parent.
6116.2‡ *17*	(12^+)	MN	J^π: 1180.3γ to (10^+), band assignment.

† From a least-squares fit to Eγ, by evaluators, for levels connected by γ rays. For levels from transfer reactions, corresponding dataset is indicated.
‡ Band(A): yrast band.
# From (d,^{3}He).
@ From (p,p′),(pol p,p′).

Adopted Levels, Gammas (continued)

γ(^{70}Zn)

E_i(level)	J_i^π	E_γ[†]	I_γ[†]	E_f	J_f^π	Mult.[‡]	δ[#]	α	$I_{(\gamma+ce)}$	Comments
884.92	2^+	884.88 *9*	100	0.0	0^+	E2		3.97×10^{-4}		α(K)=0.000356 *5*; α(L)=3.58×10^{-5} *5*; α(M)=5.12×10^{-6} *8*; α(N)=2.04×10^{-7} *3* B(E2)(W.u.)=16.7 *10* Mult.: from Coulomb Excitation from 0^+ ground state.
1070.76	0^+	185.85[@] *3*	100	884.92	2^+	[E2]		0.0634		α(K)=0.0563 *8*; α(L)=0.00613 *9*; α(M)=0.000871 *13*; α(N)=3.07×10^{-5} *5* B(E2)(W.u.)=37.3 *19* E_γ: other: 184.4 *2* in (n,n′γ).
		1067		0.0	0^+	E0			<0.3	$I_{(\gamma+ce)}$: for 100 transitions of 185.9γ as measured in (p,p′γ). Mult.: from internal conversion data in (p,p′γ). E_γ: from (p,p′γ).
1759.16	2^+	874.33[@] *8*	100[@] *9*	884.92	2^+	M1+E2	+0.75 *15*	3.58×10^{-4} *9*		α(K)=0.000321 *9*; α(L)=3.21×10^{-5} *9*; α(M)=4.61×10^{-6} *12*; α(N)=1.85×10^{-7} *5* B(E2)(W.u.)=10 *4*; B(M1)(W.u.)=0.0095 *23* Mult.: D+Q from $\gamma(\theta)$ in (n,n′γ), $\Delta\pi$=no from level scheme.
		1759.6[@] *2*	68[@] *7*	0.0	0^+	[E2]		2.86×10^{-4}		α(K)=7.92×10^{-5} *11*; α(L)=7.86×10^{-6} *11*; α(M)=1.127×10^{-6} *16*; α(N)=4.56×10^{-8} *7* B(E2)(W.u.)=0.60 *12*
1786.75	4^+	901.7 *1*	100	884.92	2^+	[E2]		3.78×10^{-4}		α(K)=0.000339 *5*; α(L)=3.41×10^{-5} *5*; α(M)=4.88×10^{-6} *7*; α(N)=1.95×10^{-7} *3* B(E2)(W.u.)=19 *6*
1957.28	2^+	1072.2[@] *1*	100	884.92	2^+					
2140.64	0^+	1255.6[a] *2*	100	884.92	2^+					
2538.31	2^+	751.5[a] *2*	≈18[a]	1786.75	4^+	[E2]		6.06×10^{-4}		α(K)=0.000543 *8*; α(L)=5.49×10^{-5} *8*; α(M)=7.86×10^{-6} *11*; α(N)=3.11×10^{-7} *5* B(E2)(W.u.)=73 *44*
		779.1[@] *2*	40[@] *4*	1759.16	2^+					I_γ: other: 58 in (n,n′γ).
		1653.9[@] *2*	100[@] *7*	884.92	2^+	M1+E2	−1.5 *3*	2.39×10^{-4} *5*		α(K)=8.78×10^{-5} *14*; α(L)=8.72×10^{-6} *14*; α(M)=1.250×10^{-6} *19*; α(N)=5.06×10^{-8} *8* B(E2)(W.u.)=4.9 *+49−21*; B(M1)(W.u.)=0.0040 *+40−20* Mult.: D+Q from $\gamma(\theta)$ in (n,n′γ), $\Delta\pi$=no from level scheme.
		2537.9[a] *3*	20[a]	0.0	0^+	[E2]		6.18×10^{-4}		α(K)=4.09×10^{-5} *6*; α(L)=4.05×10^{-6} *6*; α(M)=5.81×10^{-7} *9*; α(N)=2.36×10^{-8} *4* B(E2)(W.u.)=0.17 *10*
2693.40	4^+	735.5[a] *2*	11[a]	1957.28	2^+	[E2]		6.43×10^{-4}		α(K)=0.000576 *8*; α(L)=5.82×10^{-5} *9*; α(M)=8.33×10^{-6} *12*; α(N)=3.30×10^{-7} *5* B(E2)(W.u.)=26 *+26−14*
		906.5 *1*	92 *12*	1786.75	4^+					

$\gamma(^{70}Zn)$ (continued)

E_i(level)	J^π_i	E_γ[†]	I_γ[†]	E_f	J^π_f	Mult.[‡]	δ[#]	α	Comments
2693.40	4^+	934.9[a] *3*	30[a]	1759.16	2^+	[E2]		3.46×10^{-4}	α(K)=0.000310 *5*; α(L)=3.12×10^{-5} *5*; α(M)=4.46×10^{-6} *7*; α(N)=1.782×10^{-7} *25* B(E2)(W.u.)=21 *+21−12*
		1809.2[a] *3*	100[a] *16*	884.92	2^+	[E2]		3.04×10^{-4}	α(K)=7.51×10^{-5} *11*; α(L)=7.46×10^{-6} *11*; α(M)=1.069×10^{-6} *15*; α(N)=4.32×10^{-8} *6* B(E2)(W.u.)=2.6 *+26−15*
2859.49	3^-	902		1957.28	2^+				E_γ: observed only in Coulomb Excitation.
		1072.2[&] *1*	100[&] *13*	1786.75	4^+	[E1]		1.12×10^{-4}	α(K)=0.0001001 *14*; α(L)=9.94×10^{-6} *14*; α(M)=1.423×10^{-6} *20*; α(N)=5.74×10^{-8} *8* B(E1)(W.u.)=0.00068 *11*
		1100.5[&] *2*	45[&] *5*	1759.16	2^+	[E1]		1.15×10^{-4}	α(K)=9.54×10^{-5} *14*; α(L)=9.47×10^{-6} *14*; α(M)=1.356×10^{-6} *19*; α(N)=5.47×10^{-8} *8* B(E1)(W.u.)=0.00028 *5*
		1975.0[&] *4*	93[&] *7*	884.92	2^+	[E1]		6.56×10^{-4}	α(K)=3.61×10^{-5} *5*; α(L)=3.57×10^{-6} *5*; α(M)=5.11×10^{-7} *8*; α(N)=2.07×10^{-8} *3* B(E1)(W.u.)=0.000100 *13*
2895.10	(6^+)	1108.4 *1*	100	1786.75	4^+				
2949.67	$1^+,2^+,3^+$	1191.9[a] *3*	72[a]	1759.16	2^+				
		2064.1[a] *2*	100[a]	884.92	2^+	M1+E2	+3.8 *5*	4.04×10^{-4}	α(K)=5.87×10^{-5} *9*; α(L)=5.82×10^{-6} *9*; α(M)=8.34×10^{-7} *12*; α(N)=3.38×10^{-8} *5* B(E2)(W.u.)=11 *+4−6*; B(M1)(W.u.)=0.0022 *+10−13* Mult.: D+Q from $\gamma(\theta)$ in (n,n′γ), E1+M2 excluded by comparison to RUL.
2978.26	4^+	1191.5[&] *2*	100	1786.75	4^+				
3038.15	5^-	1251.7 *1*	100	1786.75	4^+	[E1]		1.68×10^{-4}	α(K)=7.56×10^{-5} *11*; α(L)=7.49×10^{-6} *11*; α(M)=1.073×10^{-6} *15*; α(N)=4.34×10^{-8} *6* B(E1)(W.u.)=0.000195 *14*
3222.08	1	2155.0[ac] *1*	≈33[a]	1070.76	0^+				E_γ: level energy difference gives Eγ=2151.3, transition not included in least-squares fitting.
		3222.0[a] *1*	≈100[a]	0.0	0^+				
3246.71	$(3^-,4^+)$	208.75[&] *7*	55[&] *4*	3038.15	5^-				
		387.10[&] *5*	54[&] *4*	2859.49	3^-				
		553.2[&] *1*	28[&] *4*	2693.40	4^+				
		708.42[&] *7*	100[&] *5*	2538.31	2^+				
		1460.4[&] *2*	20[&] *4*	1786.75	4^+				
3342.0	3^-	1555.2 *3*	100	1786.75	4^+				
3476.68		438.2 *2*	22.2 *10*	3038.15	5^-				
		783.1 *2*	7.8 *10*	2693.40	4^+				
		1690.3 *2*	100.0 *16*	1786.75	4^+				
3598.98		560.82 *8*	100	3038.15	5^-				

$^{70}_{30}Zn_{40}$-5

Adopted Levels, Gammas (continued)

$\gamma(^{70}Zn)$ (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
3634.99	2^+	1875.8[@] *2*	100	1759.16	2^+	4464.77	$(5,6,7^-)$	988.0 *3*	28 *3*	3476.68	
3710.7	2^+	1951.5[a] *6*	100	1759.16	2^+			1426.5 *2*	100 *4*	3038.15	5^-
3755.4	(8^+)	860.3[b]	100	2895.10	(6^+)			1569.8 *2*	32 *3*	2895.10	(6^+)
3788.16		750.0 *2*	63 *4*	3038.15	5^-	4514.27	$(5,6,7^-)$	1476.1 *2*	100	3038.15	5^-
		893.1 *6*	100 *5*	2895.10	(6^+)	4558.2	$(5,6^+)$	1520.1 *3*	67 *5*	3038.15	5^-
3848.4	$(5,6^+)$	2061.6 *6*	100	1786.75	4^+			2771.2 *6*	100 *4*	1786.75	4^+
3904.0	$(5,6^+)$	2117.2 *4*	100	1786.75	4^+	4588.8	$(5,6,7^-)$	1550.6 *3*	100	3038.15	5^-
4001.46	$(5,6,7^-)$	963.3 *1*	100	3038.15	5^-	4710.1	$(5,6,7)$	1815.0 *5*	100	2895.10	(6^+)
4061.40	$(5,6,7^-)$	584.7 *1*	100 *8*	3476.68		4791.7	$(5,6,7)$	1315 *1*	100	3476.68	
		1023.3 *2*	70 *7*	3038.15	5^-	4849.2	$(5,6^+)$	1954.2 *3*	100 *4*	2895.10	(6^+)
4146.1		1107.9[a] *3*	100	3038.15	5^-			3062.1 *6*	85 *4*	1786.75	4^+
4264.5	$(5,6,7^-)$	1226.3 *7*	100	3038.15	5^-	4935.9	(10^+)	1180.5[b]	100	3755.4	(8^+)
4308.99	$(5,6,7^-)$	1270.8 *2*	100 *5*	3038.15	5^-	5061.3	$(5,6,7)$	2166.2 *5*	100	2895.10	(6^+)
		1413.9 *2*	43 *4*	2895.10	(6^+)	6116.2	(12^+)	1180.3[b]	100	4935.9	(10^+)

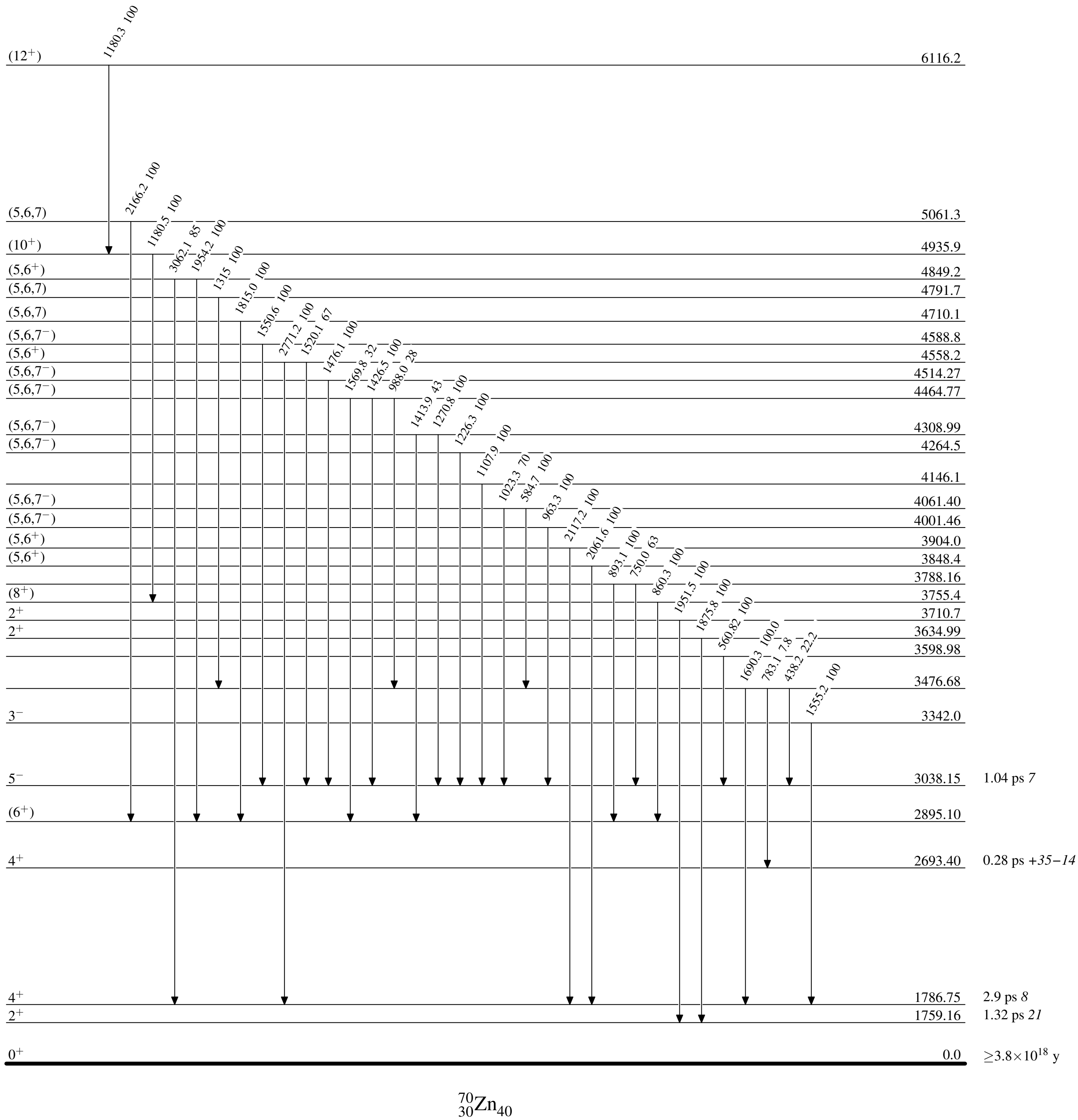
† From ^{70}Cu β^- decay (44.5 s), except where noted.
‡ From $\gamma(\theta)$ in (n,n′γ), except where noted.
# From $\gamma(\theta)$ in (n,n′γ).
@ From ^{70}Cu β^- decay (6.6 s).
& From ^{70}Cu β^- decay (33 s).
a From (n,n′γ).
b From $^{208}Pb(^{64}Ni,X\gamma)$.
c Placement of transition in the level scheme is uncertain.

$^{70}_{30}Zn_{40}$-6

Adopted Levels, Gammas

Level Scheme

Intensities: Relative photon branching from each level

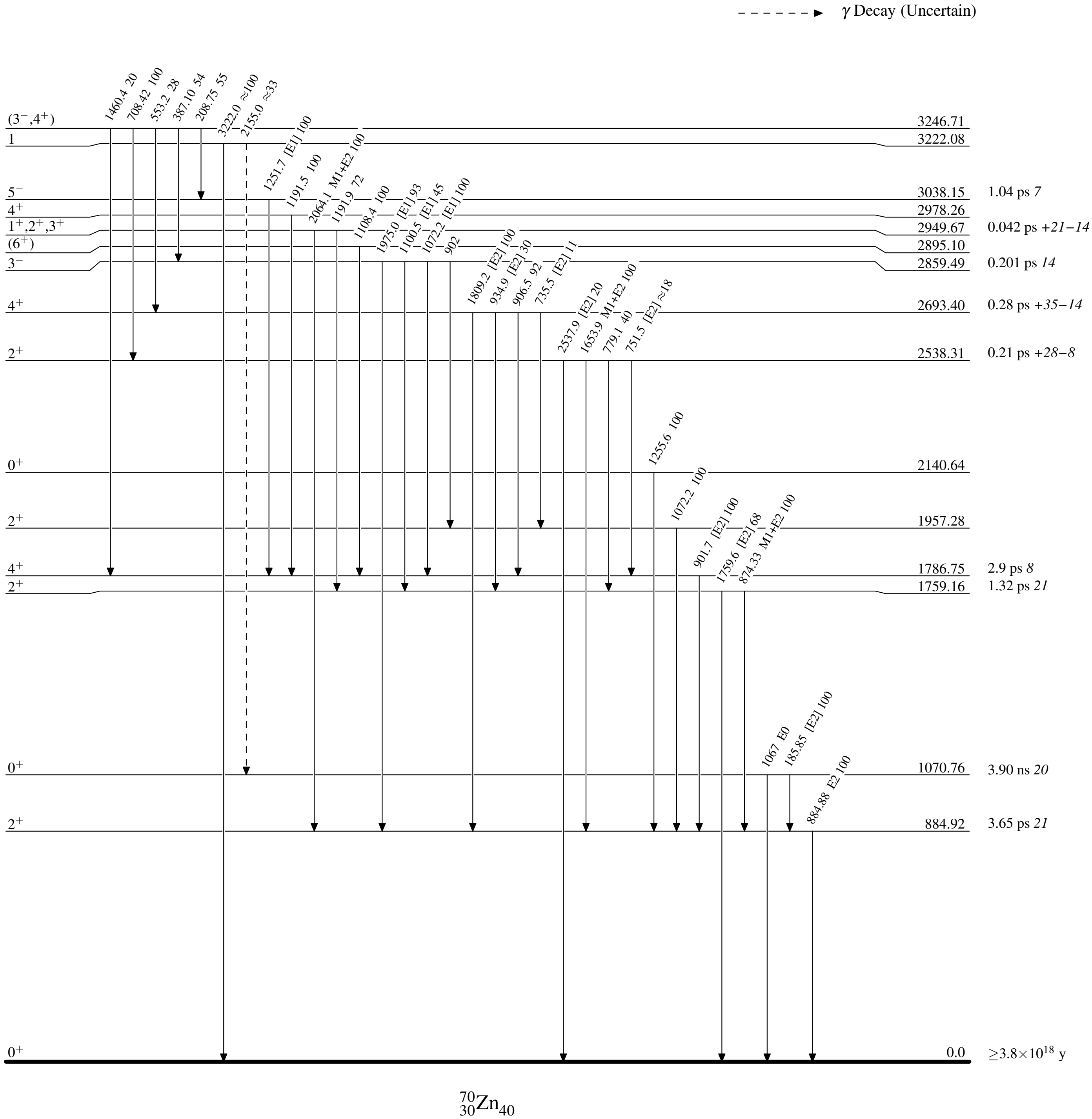


Adopted Levels, Gammas

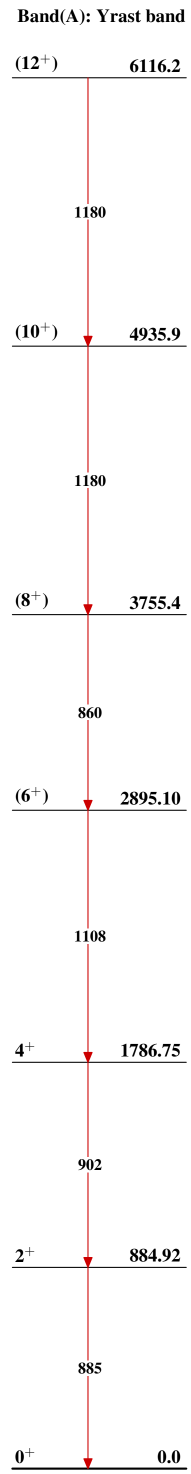
Legend

Level Scheme (continued)

Intensities: Relative photon branching from each level



Adopted Levels, Gammas



$^{70}_{30}Zn_{40}$