Adopted Levels, Gammas

History

Type	Author	Citation	Literature Cutoff Date
Full Evaluation	Balraj Singh	ENSDF	25-Mar-2022

$Q(\beta^-)$=1626.5 *6*; S(n)=8246.1 *6*; S(p)=13449 *27*; $Q(\alpha)$=−8232.3 *28* 2021Wa16
S(2n)=14492.4 *6*, S(2p)=24119 *16* (2021Wa16).

1960Dr03: ^{56}Cr produced and identified in bombardment of natural chromium metal electroplated on a gold backing with 2.7-2.9 MeV tritons from Los Alamos accelerator, followed by chemical separation of ^{56}Cr, identified by growth of 2.6-h ^{56}Mn activity. Measured Eγ, Iγ, $\beta\gamma$-coin, $T_{1/2}$ of decay of ^{56}Cr to ^{56}Mn. Since the 1960Dr03 work, no other investigation of half-life of ^{56}Cr or its decay appears to have been made.

Earlier attempts by 1956Jo32, by L.P. Roy and L. Yaffe (Can. Jour. Chem. 35, 156 (1957), and by 1960Eh04 were unsuccessful to identify ^{56}Cr activity.

Mass measurement: 2005Gu27.

Additional information 1.

Other reactions:

1992Wa11: ^{56}Fe(π^-,π^+),E=295 MeV: measured pions, $\sigma(\theta)$; deduced double giant dipole resonance.

1987Gi04: ^{56}Fe(π^-,π^+),E=100-292 MeV: measured σ; deduced nonanalog and double analog transitions.

1982Se09, 1981Pr02, 1978De30: ^{59}Co(π^-,pd),E at rest: measured $\sigma(\theta)$, (particle)(particle)-coin; deduced yields, and missing mass spectra.

Theoretical calculations: 46 primary reference extracted from the NSR database (www.nndc.bnl.gov/nsr/), listed here under document records.

^{56}Cr Levels

Cross Reference (XREF) Flags

A	^{56}V β^- decay (216 ms)	E	^{54}Cr(t,pγ)
B	^{9}Be(^{57}Cr,^{56}Crγ)	F	^{54}Cr(α,^{2}He)
C	^{48}Ca(^{11}B,2npγ)	G	^{238}U(^{48}Ca,Xγ)
D	^{54}Cr(t,p)	H	Coulomb excitation

E(level)†	J$^\pi$	$T_{1/2}$	XREF	Comments
0.0‡	0$^+$	5.94 min *10*	ABCDEFGH	%β^-=100 $T_{1/2}$: from 1960Dr03.
1006.83‡ *10*	2$^+$	3.82 ps *10*	ABCDE GH	J$^\pi$: E2 γ to 0$^+$; L(t,p)=2. $T_{1/2}$: Weighted average of 3.81 ps *10* (2011Se09, recoil-distance method in (^{11}B,2npγ)) and 5.0 ps *+26−13* (2005Bu29, B(E2)(W.u.) in Coulomb excitation). Other: ≥1.4 ps from DSAM in (t,pγ) (1976Ba45).
1675.2 *4*	(0$^+$)		A	J$^\pi$: log *ft*=4.6 from 1$^+$ parent; shell-model prediction (see Fig. 13 in 2006Zh42 for a predicted 0$^+$ state at 1991 keV). However, note that no 0$^+$ state was found in (t,p) work of 1968Ch20 or in (t,pγ) work of 1976Ba45.
1831.65 *14*	2$^+$		ABCDE G	J$^\pi$: L(t,p)=2. Possible bandhead of γ band.
2076.81‡ *14*	4$^+$	2.18 ps *8*	BC G	J$^\pi$: ΔJ=2, E2 γ to 2$^+$; J not 0 from $\gamma(\theta)$ distribution. $T_{1/2}$: from recoil-distance method in (^{11}B,2npγ) (2011Se09).
2278.49 *17*	(3$^+$)		BC G	J$^\pi$: ΔJ=1, dipole γ to 2$^+$; possible member of γ band. J=1 is less likely due to yrast-pattern of level population in (^{48}Ca,Xγ).
2325.9 *5*	2$^+$	≤0.055 ps	A DE	J$^\pi$: L(t,p)=2. $T_{1/2}$: from DSAM in (t,pγ).
2681.8 *10*	(4$^+$)	≥0.7 ps	CdEF	$T_{1/2}$: from DSAM in (^{11}B,2npγ) (1977Na12). J$^\pi$: L(t,p)=4 for 2682 and/or 2688 level.
2687.91 *20*	(4$^+$)		d G	J$^\pi$: L(t,p)=4 for 2682 and/or 2688 level; ΔJ=1, dipole γ to (3$^+$); possible member of γ band.
2822.93 *18*	(4$^+$)		G	J$^\pi$: ΔJ=0, dipole γ to 4$^+$.

Continued on next page (footnotes at end of table)

Adopted Levels, Gammas (continued)

^{56}Cr Levels (continued)

E(level)[†]	J^π	$T_{1/2}$	XREF	Comments
3116.7 *6*			G	J^π: γ to 4^+ suggests J=4,5,6^+.
3164 *6*	$(2^+,3,4^+)$	≤0.21 ps	DE	J^π: γs to 2^+ and (4^+). $T_{1/2}$: from DSAM in (t,pγ).
3251.84[‡] *17*	6^+	≥0.7 ps	BC G	J^π: ΔJ=2, E2 γ to 4^+; band member. $T_{1/2}$: from DSAM in (^{11}B,2npγ) (1977Na12).
3402 *20*			D	
3451 *15*	3^-		D	J^π: L(t,p)=3.
3509 *15*	2^+		D	J^π: L(t,p)=2.
3528.51 *22*	(5^+)		G	J^π: ΔJ=1 dipole γ to (4^+); γ to (3^+).
3648 *15*			D	
3675 *15*			D	
3794 *15*	3^-		D	J^π: L(t,p)=3.
3819 *20*			D	
3841.15 *19*	$6^{(+)}$		C G	J^π: ΔJ=2, quadrupole γ to 4^+; ΔJ=0, D+Q γ to 6^+.
3897 *15*	0^+		D	J^π: L(t,p)=0.
3916 *20*			D	
4014 *15*			D	
4112 *15*			D	
4157.56 *20*	$(5,6,7^+)$		G	J^π: γs to 6^+ and (5^+).
4175 *15*			D	
4247 *20*			D	
4284 *15*			D	
4349 *15*			D	
4445 *15*			D	E(level): energy is close to that of 4448.9, (7^-) level, however, it seems unlikely that L=7 is populated in (t,p) reaction.
4447.79[#] *20*	(7^-)	≥0.7 ps	C FG	J^π: L(α,^{2}He)=(7); ΔJ=1, dipole γ to 6^+. $T_{1/2}$: from DSAM in (^{11}B,2npγ) (1977Na12).
4631 *15*			D	
4678 *15*			D	
4732.53 *22*	$(6^+,7^+)$		G	J^π: γ to $(5,6,7^+)$; γ from (8^+); possible γ to (5^+).
4750.95[‡] *19*	8^+		C G	J^π: ΔJ=2, quadrupole γ to 6^+; band member.
4800 *20*			D	
4848 *20*			D	
4892 *20*			D	
4924 *20*			D	
4989 *15*			D	
5060	(5^-)		F	J^π: L(α,^{2}He)=(5).
5121 *15*	(3^-)		D	J^π: L(t,p)=(3).
5268.4 *3*	(8^+)		G	J^π: γ to $6^{(+)}$; ΔJ=1, dipole γ from (9^-).
5601.44[#] *20*	(9^-)		C G	J^π: ΔJ=2, E2 γ to (7^-); ΔJ=1, dipole γ to 8^+.
5990	(5^-)		F	E(level): unresolved from 6200-keV peak. J^π: L(α,^{2}He)=(5) for 5990+6200.
6200	(5^-)		F	E(level): unresolved from 5990-keV peak. J^π: L(α,^{2}He)=(5) for 5990+6200.
6295.3 *8*	$(8^+,9,10^+)$		G	J^π: γ to 8^+; γ from 10^+.
6518.3[‡] *3*	10^+		G	J^π: ΔJ=2, quadrupole γ to 8^+; band member.
6872.89 *22*			G	J^π: γ to 8^+ suggests J=8,9,10^+.
6879.0 *3*	$(9,10,11^-)$		C G	J^π: γ to (9^-).
7057.16[#] *22*	(11^-)		C G	J^π: ΔJ=2, quadrupole γ to (9^-); band member.
7330	$(6^+,8^+)$		F	J^π: L(α,^{2}He)=(6+8).
7691.9? *3*			G	
8465.5[‡] *17*	12^+		G	J^π: γ to 10^+; band member.
8768.0[#] *3*	(13^-)		C G	J^π: ΔJ=2, quadrupole γ to (11^-); band member.

Continued on next page (footnotes at end of table)

Adopted Levels, Gammas (continued)

^{56}Cr Levels (continued)

E(level)[†]	J^π	XREF	Comments
10849.9[#] *5*	(15^-)	G	J^π: γ to (13^-); band member.
13159.4[#] *11*	(17^-)	G	J^π: γ to (15^-); band member.

† From least-squares fit to Eγ data for levels populated in γ-ray studies. Reduced χ^2 of 2.3 is slightly larger than 2.0 for 95% confidence level. Energies for levels, not populated in γ-ray studies are from ^{54}Cr(t,p).

‡ Band(A): g.s. band.

\# Band(B): Band based on (7^-), 4448.0.

γ(^{56}Cr)

E_i(level)	J_i^π	E_γ[†]	I_γ	E_f	J_f^π	Mult.[@]	δ	Comments
1006.83	2^+	1006.8 *1*	100	0.0	0^+	E2		B(E2)(W.u.)=11.25 *30* B(E2)(W.u.)=8.7 *30* measured from Coulomb excitation cross section (2005Bu29), which gives level $T_{1/2}$=5.0 ps *+26−13*.
1675.2	(0^+)	668.4 *3*	100	1006.83	2^+			E_γ: from ^{56}V β^- decay.
1831.65	2^+	824.8 *1*	100 *6*	1006.83	2^+	M1+E2	−1.8 *10*	I_γ,δ: from (t,pγ). Mult.: from γ(pol) data in (^{11}B,2npγ).
		1830[#] *10*	18[#] *6*	0.0	0^+	Q		Mult.: from $\gamma(\theta)$ in (t,pγ) (1976Ba45).
2076.81	4^+	1070.0 *1*	100	1006.83	2^+	E2		B(E2)(W.u.)=14.6 *6* Mult.: ΔJ=2, quadrupole from $\gamma(\theta)$ and DCO in (^{48}Ca,Xγ); and RUL for E2 and M2 transitions.
2278.49	(3^+)	446.8 *1*	100	1831.65	2^+	D		E_γ: from (^{48}Ca,Xγ) (2006Zh42). Other: 450.1 *7* in (^{11}B,2npγ) (2003Ap01). Values of Eγ in the two studies differ significantly, however, it appears less likely that there are two closely-spaced J=3 levels.
2325.9	2^+	495.5[#]	<6[#]	1831.65	2^+			
		1318.0 *6*	100 *11*	1006.83	2^+	D(+Q)	+0.17 *30*	I_γ,Mult.,δ: from (t,pγ).
		2327.6[#]	<6[#]	0.0	0^+			
2681.8	(4^+)	359[#] *13*	31[#] *9*	2325.9	2^+			
		850.1 *10*	39 *9*	1831.65	2^+			E_γ: from (^{11}B,2npγ) (1977Na12). I_γ: from (t,pγ).
		1680[#] *15*	100[#] *12*	1006.83	2^+			
2687.91	(4^+)	409.4[‡] *1*	100[‡]	2278.49	(3^+)	D		
2822.93	(4^+)	746.1[‡] *1*	100[‡]	2076.81	4^+	D		
3116.7		1039.9[‡] *5*	100[‡]	2076.81	4^+			
3164	(2^+,3,4^+)	479[#] *14*	33[#] *24*	2681.8	(4^+)			
		835[#&] *15*	≤33[#]	2325.9	2^+			
		1330[#&] *10*	≤33[#]	1831.65	2^+			
		2158[#] *6*	100[#] *13*	1006.83	2^+	D+Q,Q		Mult.: from $\gamma(\theta)$ in (t,pγ). δ(Q/D)=+1.0 *11* for J(3166)=2, δ=+2.1 *16* for J(3166)=3. δ(O/Q)=+0.18 *18* for J(3166)=4 in (t,pγ).
3251.84	6^+	1175.1 *1*	100	2076.81	4^+	E2		B(E2)(W.u.)<28

Continued on next page (footnotes at end of table)

Adopted Levels, Gammas (continued)

$\gamma(^{56}Cr)$ (continued)

E_i(level)	J_i^π	E_γ[†]	I_γ	E_f	J_f^π	Mult.[@]	δ	Comments
								Mult.: from $\gamma(\theta)$ and γ(pol) in (^{11}B,2npγ).
3528.51	(5$^+$)	704.0[‡] *10*	100[‡] *7*	2822.93	(4$^+$)	D		
		839.0[‡] *10*	56[‡] *4*	2687.91	(4$^+$)	D		
		1248.4[‡] *10*	44[‡] *5*	2278.49	(3$^+$)			
3841.15	6$^{(+)}$	589.2 *1*	100 *4*	3251.84	6$^+$	D+Q	≈+1.2	E_γ,I_γ,Mult.,δ: from (^{48}Ca,Xγ). Other Eγ=587.6 *6* in (^{11}B,2npγ).
		1763.8[‡] *4*	78[‡] *4*	2076.81	4$^+$	Q		
4157.56	(5,6,7$^+$)	629.0[‡] *1*	4.0[‡] *11*	3528.51	(5$^+$)			
		905.7[‡] *1*	100[‡] *5*	3251.84	6$^+$			
4447.79	(7$^-$)	606.5 *1*	37 *5*	3841.15	6$^{(+)}$			E_γ: from (^{48}Ca,Xγ). Ordering of the 588γ − 609γ cascade in (^{11}B,2npγ) (2003Ap01) reversed in (^{48}Ca,Xγ) (2006Zh42). Eγ=608.8 *6* in (^{11}B,2npγ). I_γ: unweighted average of 32.4 *11* in (^{48}Ca,Xγ) and 41.5 *15* in (^{11}B,2npγ).
		1196.3 *2*	100 *3*	3251.84	6$^+$	D		I_γ: from (^{48}Ca,Xγ).
4732.53	(6$^+$,7$^+$)	574.9[‡] *1*	100[‡] *5*	4157.56	(5,6,7$^+$)			
		1205.5[‡&] *10*	21.2[‡] *27*	3528.51	(5$^+$)			
4750.95	8$^+$	1499.2 *1*	100	3251.84	6$^+$	Q		
5268.4	(8$^+$)	534.9[‡] *4*	62[‡] *5*	4732.53	(6$^+$,7$^+$)			
		1426.9[‡] *6*	100[‡] *11*	3841.15	6$^{(+)}$			
5601.44	(9$^-$)	332.7[‡] *2*	2.80[‡] *24*	5268.4	(8$^+$)	D		
		850.6 *1*	36 *6*	4750.95	8$^+$	D		E_γ: from (^{48}Ca,Xγ). Other: Eγ=848.6 *6* in (^{11}B,2npγ). I_γ: unweighted average of 29.6 *12* in (^{48}Ca,Xγ) and 41.7 *15* in (^{11}B,2npγ).
		1153.6 *1*	100 *3*	4447.79	(7$^-$)	E2		I_γ: from (^{48}Ca,Xγ). Mult.: from $\gamma(\theta)$ and γ(pol) in (^{11}B,2npγ).
6295.3	(8$^+$,9,10$^+$)	1544.3[‡] *10*	100[‡]	4750.95	8$^+$			
6518.3	10$^+$	222.9[‡] *10*	6.0[‡] *12*	6295.3	(8$^+$,9,10$^+$)			
		1767.3[‡] *2*	100[‡] *8*	4750.95	8$^+$	Q		
6872.89		2121.9[‡] *1*	100[‡]	4750.95	8$^+$			
6879.0	(9,10,11$^-$)	1277.5 *2*	100	5601.44	(9$^-$)			E_γ: from (^{48}Ca,Xγ). Other: 1282.8 *10* in (^{11}B,2npγ).
7057.16	(11$^-$)	1455.7 *1*	100	5601.44	(9$^-$)	Q		
7691.9?		812.9[‡&] *1*	100[‡]	6879.0	(9,10,11$^-$)			
8465.5	12$^+$	1947.2 *16*	100	6518.3	10$^+$			
8768.0	(13$^-$)	1710.8 *2*	100	7057.16	(11$^-$)	Q		Mult.: from $\gamma(\theta)$ in (^{11}B,2npγ).
10849.9	(15$^-$)	2081.9[‡] *3*	100[‡]	8768.0	(13$^-$)			
13159.4	(17$^-$)	2309.4[‡] *10*	100[‡]	10849.9	(15$^-$)			

Continued on next page (footnotes at end of table)

Adopted Levels, Gammas (continued)

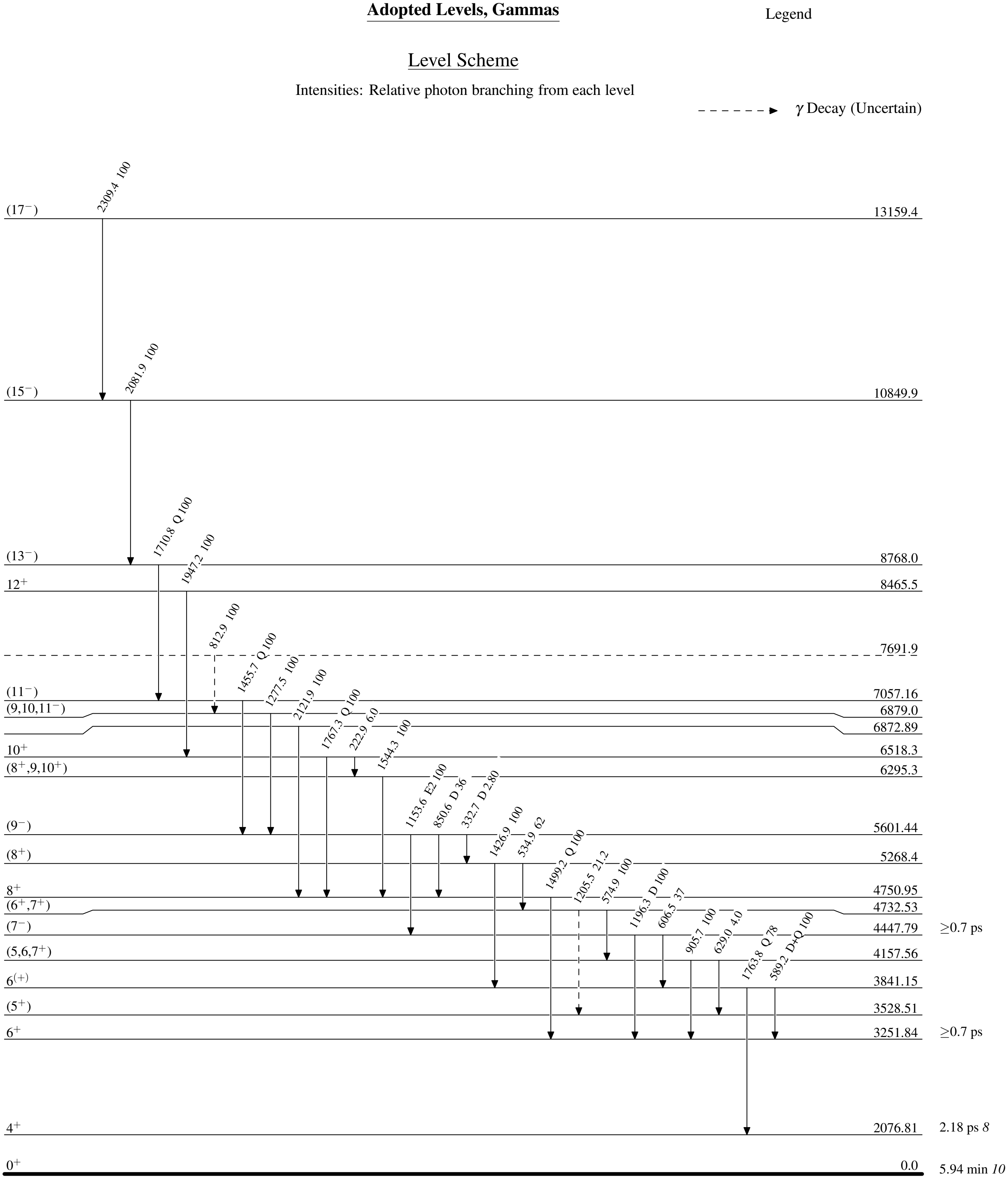
$\gamma(^{56}Cr)$ (continued)

† From weighted averages of available data in β^- decay, $^{48}Ca(^{11}B,2np\gamma)$, (t,p$\gamma$) and $^{238}U(^{48}Ca,X\gamma)$, except as noted.
‡ γ from $^{238}U(^{48}Ca,X\gamma)$ only.
# γ from (t,pγ) only.
@ From $\gamma(\theta)$ and $\gamma\gamma(\theta)$(DCO) in ($^{48}Ca,X\gamma$), unless specified otherwise.
& Placement of transition in the level scheme is uncertain.

Adopted Levels, Gammas

Level Scheme

Intensities: Relative photon branching from each level

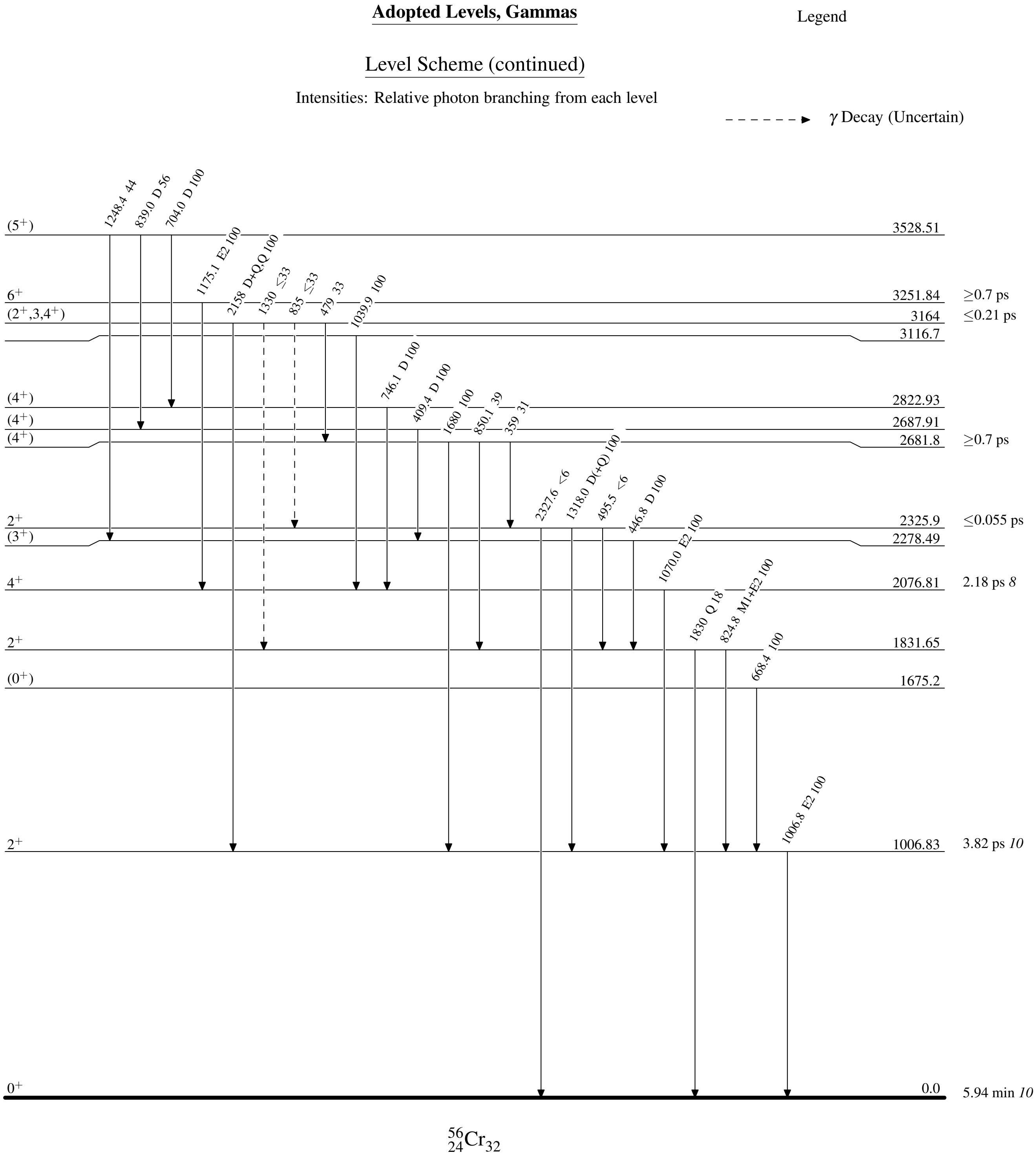


$^{56}_{24}Cr_{32}$

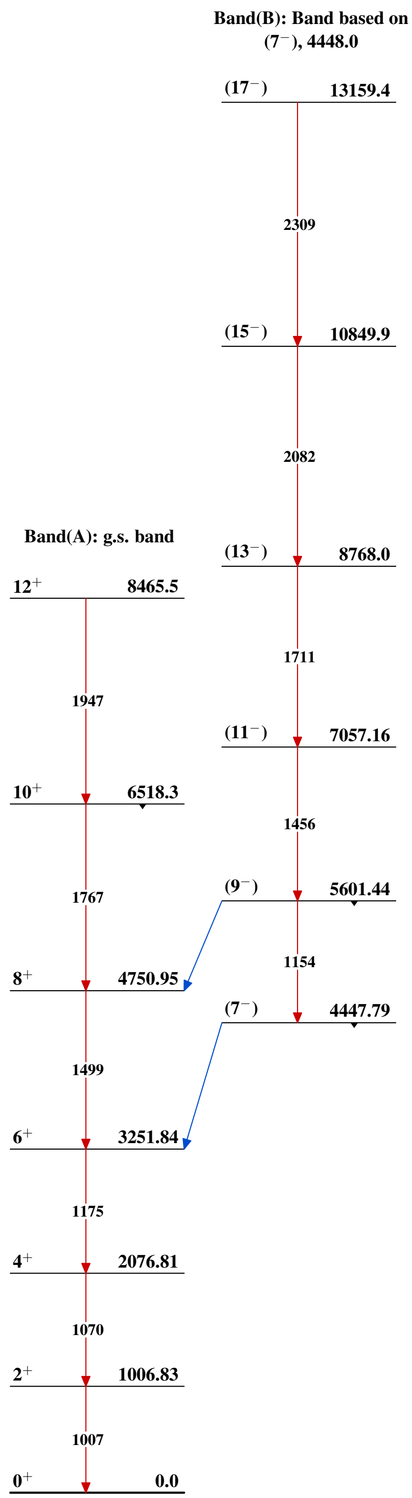
Adopted Levels, Gammas

Level Scheme (continued)

Intensities: Relative photon branching from each level



Adopted Levels, Gammas



$^{56}_{24}Cr_{32}$