Adopted Levels, Gammas

History

Type	Author	Citation	Literature Cutoff Date
Full Evaluation	Coral M. Baglin	NDS 114, 1293 (2013)	1-Sep-2013

Q(β^-)=1544.3 *18*; S(n)=7928.3 *25*; S(p)=7692 *3*; Q(α)=−4179 *3* 2012Wa38

Hyperfine anomaly between ^{91g}Y and ^{91m}Y In Fe: see 2004Ni13 (NMR on oriented nuclei with β and γ detection); −4.2% 8 anomaly.

Theory (partial list):

Level structure: 1975Gl07, 1966Ve02, 1965Au04 (shell-model calculations).

Unique-forbidden β decay matrix elements: 1985Kh03, 1985To18, 1972Ej01.

Magnetic moment: 1988Sa42, 1986Le15 (quasi-particle phonon model).

Other reaction:

^{92}Zr(γ,p) (2007Tr10); 18, 21.5, 23.5 MeV bremsstrahlung end-point energies; measured γ spectra; observed known 555γ from ^{91}Y and and 1205γ from ^{91}Zr; deduced isomeric ratio for ^{91m,g}Y.

^{91}Y Levels

Cross Reference (XREF) Flags

A	^{91}Y IT decay (49.71 min)	E	^{94}Zr(p,α)
B	^{91}Sr β^- decay	F	^{12}C(^{82}Se,p2nγ)
C	^{89}Y(t,p)	G	^{173}Yb(^{24}Mg,Xγ),^{176}Yb(^{23}Na,Xγ)
D	^{92}Zr(d,^{3}He),(t,α)		

E(level)[†]	J$^\pi$[‡]	$T_{1/2}$	XREF	Comments
0	1/2$^-$	58.51 d *6*	ABCDE G	%β^-=100 μ=0.1641 *8* J$^\pi$: J=1/2 from atomic beam (1962Pe21); L(t,p)=0 on 1/2$^-$ target. $T_{1/2}$: from 1971Ba28. Other measurements: 58.8 d *2* (1963Ho15), 59.1 d *2* (1961Wy01), 58.3 d *8* (1956He77), 57.5 d *5* (1955Ka12), and 58.5 d *10* (1954Bu38). μ: From atomic beam magnetic resonance (1989Ra17 and 2011StZZ, from 1962Pe21); relative to ^{89}Y.
555.58[#] *5*	9/2$^+$[@]	49.71 min *4*	AB DEFG	%IT≈100; %β^-<1.5 (1953Am08) μ=5.96 *4* (1991Be18) J$^\pi$: L(t,α)=4; M4 transition to 1/2$^-$. $T_{1/2}$: from 1969Kn01. Other measurement: 50.30 min *25* (1953Am08). μ: From NMR on oriented nuclei (2011StZZ from 1991Be18), assuming the hyperfine field for Y in Fe is −30.67 T 18. Other μ: 6.01 *+31−15* (1991Be18) and 5.96 *6* (1992Be50) arising from different assumed values for the latter field. Additionally, μ(^{87}Y, 381)/μ=1.016 *1* (1992Be50).
653.02 *7*	3/2$^-$		BCDE	J$^\pi$: L(t,α)=1; L(t,p)=2 on 1/2$^-$ target.
925.74 *7*	5/2$^-$		BCDE	J$^\pi$: L(t,α)=3; L(t,p)=2 on 1/2$^-$ target.
1186.88 *6*	(7/2)$^-$		BC E	J$^\pi$: L(t,p)=4 on 1/2$^-$ target; 534γ to 3/2$^-$ 653. Supported by J$^\pi$(p,α)=(7/2$^-$).
1305.39 *6*	(5/2)$^+$		B E	J$^\pi$: M1,E2 750γ to 9/2$^+$ 556; 652γ to 3/2$^-$ 653; J$^\pi$(p,α)=(5/2$^+$). 1305γ feeds 1/2$^-$ g.s., but it is a very weak branch.
1473.69 *7*	3/2$^-$		BCDE	J$^\pi$: L(t,α)=1; L(t,p)=2 for 1/2$^-$ target.
1485.09[#] *21*	(13/2$^+$)[@]		FG	J$^\pi$: stretched Q 930γ to 9/2$^+$ 556.
1545.90 *6*	(5/2)$^-$		B DE	XREF: D(1552). J$^\pi$: L(t,α)=3; 1546γ to 1/2$^-$; 359γ to (7/2)$^-$; J$^\pi$(p,α)=(5/2$^-$).
1547 *10*	7/2$^-$,9/2$^-$		C	J$^\pi$: L(t,p)=4 on 1/2$^-$ target. Probably differs from 1552 level seen in (t,α). Otherwise, L(t,α)=3 and L(t,p)=4 on 1/2$^-$ target would determine J$^\pi$=7/2$^-$; such a state would exhaust 50% of the $f_{7/2}$ proton hole strength, in contradiction to shell-model systematics (1975Pr04).

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Adopted Levels, Gammas (continued)

^{91}Y Levels (continued)

E(level)[†]	J^{π}[‡]	XREF	Comments
1579.93 *7*	5/2$^+$,7/2$^+$	B E	J^{π}: log *ft*=6.4, log $f^{1u}t$=7.1 from 5/2$^+$; 1024γ to 9/2$^+$ is M1 or E2.
1980.41 *7*	(5/2)$^-$	BCDE	XREF: D(1974). J^{π}: 3/2$^-$, 5/2$^-$ from L(t,p)=2 on 1/2$^-$ target; (5/2$^-$) from (p,α). L(t,α)=(3), inconsistent with L(d,^{3}He)=(1).
2066.62 *7*	(5/2)$^+$	BCD	J^{π}: L(t,p)=3 on 1/2$^-$ target. 1413γ to 3/2$^-$ 653 level.
2129.09 *12*	3/2,5/2,7/2	B d	XREF: d(2159). J^{π}: log *ft*=8.1, log $f^{1u}t$=8.3 from 5/2$^+$.
2157.1[#] *3*	(17/2$^+$)[@]	FG	J^{π}: stretched Q 672γ to (13/2$^+$) 1485.
2158 *15*	3/2$^-$,5/2$^-$	Cd	XREF: d(2159). J^{π}: L(t,p)=2 on 1/2$^-$ target.
2206.76 *9*	5/2$^-$	BCDE	J^{π}: L(t,α)=3. L(t,p)=2 on 1/2$^-$ target. However, 1651γ to 9/2$^+$; transfer reactions and decay may populate two different levels at this energy.
2279.34 *10*	(5/2$^+$,7/2$^-$)	B	J^{π}: log *ft*=7.1, log $f^{1u}t$=7.1 from 5/2$^+$; 1724γ to 9/2$^+$; 1627γ to 3/2$^-$.
2412.15 *12*	(3/2$^-$)	B E	J^{π}: log *ft*=7.7, log $f^{1u}t$=7.5 from 5/2$^+$; J^{π}(p,α)=(3/2$^-$).
2471 *13*	3/2$^-$	CD	J^{π}: L(t,α)=1; L(t,p)=2 on 1/2$^-$ target.
2530	(5/2$^-$)	E	J^{π}: J^{π}(p,α)=(5/2$^-$).
2568 *11*	1/2$^-$	CD	J^{π}: L(t,p)=0 on 1/2$^-$ target. Supported by L(t,α)=1.
2572.13? *12*	(5/2$^+$,7/2,9/2$^-$)	B	J^{π}: 2016γ to 9/2$^+$; 1646γ to 5/2$^-$ 926.
2631		C	Possibly an unresolved doublet.
2689	(7/2$^-$,9/2$^-$)	C	J^{π}: L(t,p)=(4) on 1/2$^-$ target.
2761.9 *6*	(15/2,17/2)	G	J^{π}: 1277γ to (13/2$^+$) 1485 In (^{24}Mg,Xγ).
2780	(9/2$^+$)	E	J^{π}: J^{π}(p,α)=(9/2$^+$).
2822 *15*		C	
2960	(3/2$^-$)	C E	XREF: E(2970). J^{π}: (3/2$^-$) from (p,α), assuming this level is identical to the 2970 keV level in (p,α).
2980	(1/2$^-$)	C	J^{π}: L(t,p)=(0) on 1/2$^-$ target.
3045	1/2$^-$	C	J^{π}: L(t,p)=0 on 1/2$^-$ target.
3100	(9/2$^-$)	E	J^{π}: J^{π}(p,α)=(9/2$^-$).
3162.9 *6*	(15/2,17/2)	G	J^{π}: 1678γ to (13/2$^+$) 1485 In (^{24}Mg,Xγ); 570γ from (19/2,27/2) 3733.
3196	(7/2$^-$,9/2,11/2$^+$)	C	Possibly an unresolved doublet. J^{π}: L(t,p)=(4,5) on 1/2$^-$ target.
3227	(9/2$^+$,11/2$^+$)	C	J^{π}: L(t,p)=(5) on 1/2$^-$ target.
3284	7/2$^-$,9/2$^-$	C	J^{π}: L(t,p)=4 on 1/2$^-$ target.
3320	11/2$^-$,13/2$^-$	C	J^{π}: L(t,p)=6 on 1/2$^-$ target.
3353	7/2$^-$,9/2$^-$	C	J^{π}: L(t,p)=4 on 1/2$^-$ target.
3414	7/2$^-$,9/2$^-$	C	J^{π}: L(t,p)=4 on 1/2$^-$ target.
3445	7/2$^-$,9/2$^-$	C	J^{π}: L(t,p)=4 on 1/2$^-$ target.
3502	5/2$^+$,7/2,9/2$^-$	C	J^{π}: L(t,p)=3,4 on 1/2$^-$ target.
3527.7[#] *4*	(21/2$^+$)[@]	FG	J^{π}: stretched Q 1371γ to (17/2$^+$) 2157.
3544	11/2$^-$,13/2$^-$	C	J^{π}: L(t,p)=6 on 1/2$^-$ target.
3568.1 *6*	(19/2,21/2)	G	J^{π}: 1411γ to (17/2$^+$) 2157 In (^{24}Mg,Xγ).
3611	(3/2$^-$,5/2$^-$)	C	J^{π}: L(t,p)=(2) on 1/2$^-$ target.
3684	(3/2$^-$,5/2,7/2$^+$)	C	J^{π}: L(t,p)=(2,3) on 1/2$^-$ target.
3733.2 *4*	(19/2,21/2)	FG	J^{π}: 1576γ to (17/2$^+$) 2157 In (^{24}Mg,Xγ).
3751	5/2$^+$,7/2,9/2$^-$	C	J^{π}: L(t,p)=3,4 on 1/2$^-$ target.
3793	9/2$^+$,11/2$^+$	C	J^{π}: L(t,p)=5 on 1/2$^-$ target.
3839	9/2$^+$,11/2$^+$	C	J^{π}: L(t,p)=5 on 1/2$^-$ target.
3870	3/2$^-$,5/2$^-$	C	J^{π}: L(t,p)=2 on 1/2$^-$ target.
3938	(9/2$^+$,11/2$^+$)	C	J^{π}: L(t,p)=(5) on 1/2$^-$ target.
3966	(3/2$^-$,5/2$^-$)	C	J^{π}: L(t,p)=(2) on 1/2$^-$ target.
4064.5 *8*		G	
4096	(3/2$^-$,5/2$^-$)	C	J^{π}: L(t,p)=(2) on 1/2$^-$ target.
4147.0 *4*	(23/2,25/2$^+$)	FG	J^{π}: (23/2) proposed In (^{24}Mg,Xγ), (25/2$^+$) In (^{82}Se,p2nγ. 619γ to (21/2$^+$) 3528 and 579γ to (19/2,21/2) 3568; 334γ-619γ cascade from (25/2$^+$) 4481 through this level to (21/2$^+$) 3528 level cannot be stretched Q – Q (see comment on J(4481)) but, for either, ADO and DCO In (^{82}Se,p2nγ) favor ΔJ=0,2.

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Adopted Levels, Gammas (continued)

^{91}Y Levels (continued)

E(level)†	Jπ‡	XREF	Comments
4190.5 *8*		G	
4225	(1/2⁻)	C	Possibly an unresolved doublet. Jπ: L(t,p)=(0).
4451	(3/2⁻,5/2⁻)	C	Jπ: L(t,p)=(2) on 1/2⁻ target.
4481.2 *5*	(25/2⁺)	FG	Jπ: 954γ to (21/2⁺) 3528 In (^{82}Se,p2nγ). ΔJ=(0,2) 334γ to 4147. (25/2⁺) is supported In (^{24}Mg,Xγ), where 954-keV crossover γ eliminates the possibility that each of the 334γ and the 619γ In that cascade to (21/2⁺) 3528 is ΔJ=2.
4611.4 *8*		G	
4808.5 *6*		FG	Jπ: possible ΔJ=0,2 327γ to (25/2⁺) 4481 In (^{24}Mg,Xγ), so J≤(29/2).
5574.8 *7*		G	Jπ: 1094γ to (25/2⁺) 4481 In (^{24}Mg,Xγ), so J≤(29/2).
5778.1 *10*		G	Jπ: 1297γ to (25/2⁺) 4481 In (^{24}Mg,Xγ) so J≤(29/2).
6503.1 *9*		G	
6896.1 *11*		G	

† Level energies with ΔE<5 keV are from least-squares fit to adopted Eγ; the others are from (t,p), (t,α) and/or (p,α). If no uncertainty is given, this is because the authors did not state one.

‡ Target spins are 1/2⁻ for (t,p) and 0⁺ for (p,α). Jπ assignments from (p,α) are based on DWBA three-nucleon transfer calculations.

\# Band(A): ΔJ=2 sequence based on 9/2⁺ isomer.

@ ΔJ=2 sequence based on 9/2⁺ isomer.

Adopted Levels, Gammas (continued)

γ(^{91}Y)

E$_i$(level)	J$^{\pi}_i$	E$_{\gamma}$†	I$_{\gamma}$‡	E$_f$	J$^{\pi}_f$	Mult.†	δ†	α&	Comments
555.58	9/2$^+$	555.57 5	100	0	1/2$^-$	M4		0.0531	B(M4)(W.u.)=1.6 8 calculated hindrance: 9 3 (2012Se10).
653.02	3/2$^-$	652.9 2	100	0	1/2$^-$				
925.74	5/2$^-$	272.6 6	6.8 10	653.02	3/2$^-$	[M1,E2]		0.021 8	
		925.8 2	100.0 9	0	1/2$^-$	(E2)			Mult.: M1,E2 from α(K)exp in β^- decay; ΔJ=2 from level scheme.
1186.88	(7/2)$^-$	261.2 2	80.7 12	925.74	5/2$^-$				
		533.9 1	13.9 6	653.02	3/2$^-$				
		631.3 1	100.0 18	555.58	9/2$^+$				
1305.39	(5/2)$^+$	118.5 2	0.311 14	1186.88	(7/2)$^-$	[E1]		0.0653	
		379.9 1	0.622 14	925.74	5/2$^-$				
		652.3 3	12.6 7	653.02	3/2$^-$				
		749.8 1	100.0 7	555.58	9/2$^+$	(E2)			Mult.: M1,E2 from α(K)exp in β^- decay; not M1 from level scheme.
		1305.3 1	0.071 14	0	1/2$^-$				
1473.69	3/2$^-$	820.8 2	96.0 20	653.02	3/2$^-$				
		1473.8 1	100.0 20	0	1/2$^-$				
1485.09	(13/2$^+$)	929.5# 2	100#	555.58	9/2$^+$	Q#			
1545.90	(5/2)$^-$	359.1 1	2.83 19	1186.88	(7/2)$^-$				
		620.1 1	100.0 19	925.74	5/2$^-$	M1(+E2)	≤2.1		δ: +0.05 7 or −1.81 +23−27 from γγ(θ) in β^- decay.
		892.9 1	3.96 19	653.02	3/2$^-$				
		1545.9 1	3.77 19	0	1/2$^-$				
1579.93	5/2$^+$,7/2$^+$	274.7 2	3.09 8	1305.39	(5/2)$^+$	(M1)		0.01245	
		393.0 1	0.15 1	1186.88	(7/2)$^-$				
		653 2	1.1 4	925.74	5/2$^-$				
		1024.3 1	100	555.58	9/2$^+$	M1,E2			
1980.41	(5/2)$^-$	506.7 1	19.4 15	1473.69	3/2$^-$				
		793.6 1	28.4 15	1186.88	(7/2)$^-$				
		1054.6 1	100.0 15	925.74	5/2$^-$				
		1327.4 1	17.9 15	653.02	3/2$^-$				
2066.62	(5/2)$^+$	486.5 2	8.2 3	1579.93	5/2$^+$,7/2$^+$				
		520.8 3	3.4 3	1545.90	(5/2)$^-$				
		593.1 1	9.6 3	1473.69	3/2$^-$				
		761.4 1	58.7 10	1305.39	(5/2)$^+$				
		879.7 1	19.1 3	1186.88	(7/2)$^-$				
		1140.8 1	13.0 3	925.74	5/2$^-$				
		1413.4 1	100.0 14	653.02	3/2$^-$				
2129.09	3/2,5/2,7/2	823.7 1	100	1305.39	(5/2)$^+$				
2157.1	(17/2$^+$)	672.0# 2	100#	1485.09	(13/2$^+$)	Q#			
2206.76	5/2$^-$	626.8 1	4.7 4	1579.93	5/2$^+$,7/2$^+$				
		660.9 1	10.8 4	1545.90	(5/2)$^-$				
		901.3 2	10.0 4	1305.39	(5/2)$^+$				

From ENSDF

$^{91}_{39}$Y$_{52}$-4

Adopted Levels, Gammas (continued)

$\gamma(^{91}Y)$ (continued)

E_i(level)	J_i^π	E_γ[†]	I_γ[‡]	E_f	J_f^π	Mult.[†]	Comments
2206.76	5/2⁻	1280.9 5	100.0 11	925.74	5/2⁻		
		1553.6 3	1.8 4	653.02	3/2⁻		
		1651.4 5	31.2 4	555.58	9/2⁺		
2279.34	(5/2⁺,7/2⁻)	973.9 1	25.0 21	1305.39	(5/2)⁺		
		1353.5 2	14.6 21	925.74	5/2⁻		
		1626.8 3	8.3 21	653.02	3/2⁻		
		1724.0 5	100.0 21	555.58	9/2⁺		
2412.15	(3/2⁻)	1486.4 1	100 25	925.74	5/2⁻		
		2412.3[a] 2	33 8	0	1/2⁻		
2572.13?	(5/2⁺,7/2,9/2⁻)	992.2[a] 1	100 8	1579.93	5/2⁺,7/2⁺		
		1646[a] 1	6.9 8	925.74	5/2⁻		
		2016[a] 1	9.2 23	555.58	9/2⁺		
2761.9	(15/2,17/2)	1276.8[@] 7	100[@]	1485.09	(13/2⁺)		
3162.9	(15/2,17/2)	1677.7[@] 7	100[@]	1485.09	(13/2⁺)		
3527.7	(21/2⁺)	1370.6[#] 3	100[#]	2157.1	(17/2⁺)	Q[#]	
3568.1	(19/2,21/2)	806.2[@] 7	100[@] 14	2761.9	(15/2,17/2)		
		1410.8[@] 7	98[@] 12	2157.1	(17/2⁺)		
3733.2	(19/2,21/2)	570.3[@] 7	88[@] 11	3162.9	(15/2,17/2)		
		1576.3[@] 4	100[@] 14	2157.1	(17/2⁺)		
4064.5		1907.3[@] 9	100[@]	2157.1	(17/2⁺)		
4147.0	(23/2,25/2⁺)	413.8 2	44 4	3733.2	(19/2,21/2)		E_γ: from $^{12}C(^{82}Se,p2n\gamma)$. I_γ: from $^{173}Yb(^{24}Mg,X\gamma)$; <54 from $(^{82}Se,p2n\gamma)$.
		578.6[@] 7	30[@] 4	3568.1	(19/2,21/2)		
		619.2 3	100 7	3527.7	(21/2⁺)		E_γ,I_γ: from $^{12}C(^{82}Se,p2n\gamma)$. Mult.: ADO and DCO In $(^{82}Se,p2n\gamma)$ favor ΔJ=0,2.
4190.5		2033.3[@] 9	100[@]	2157.1	(17/2⁺)		
4481.2	(25/2⁺)	334.2[@] 4	100[@] 10	4147.0	(23/2,25/2⁺)		other Eγ: 334.7 2 from $^{12}C(^{82}Se,p2n\gamma)$. Mult.: ADO and DCO In $(^{82}Se,p2n\gamma)$ favor ΔJ=0,2.
		953.5[@] 9	10.9[@] 20	3527.7	(21/2⁺)		
4611.4		420.8[@] 9	40[@] 12	4190.5			
		546.8[@] 9	100[@] 16	4064.5			
4808.5		327.4[#] 2	100[#]	4481.2	(25/2⁺)		Mult.: possibly ΔJ=0,2 γ from $^{12}C(^{82}Se,p2n\gamma)$.
5574.8		766.4[@] 7	100[@] 14	4808.5			
		963.2[@] 9	65[@] 10	4611.4			
		1093.7[@] 9	61[@] 10	4481.2	(25/2⁺)		
5778.1		1296.7[@] 9	100[@]	4481.2	(25/2⁺)		
6503.1		928.5[@] 7	100[@]	5574.8			

From ENSDF

$^{91}_{39}Y_{52}$-5

Adopted Levels, Gammas (continued)

γ(^{91}Y) (continued)

E_i(level)	E_γ †	I_γ ‡	E_f
6896.1	393.2@ *9*	100@ *16*	6503.1
	1117.8@ *9*	53@ *13*	5778.1

† From ^{91}Sr β^- decay, except as noted.
‡ γ branching ratios for each level; from β^- decay, except as noted.
# From ^{12}C(^{82}Se,p2nγ).
@ From ^{173}Yb(^{24}Mg,Xγ).
& 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.
a Placement of transition in the level scheme is uncertain.

From ENSDF

$^{91}_{39}Y_{52}$-6

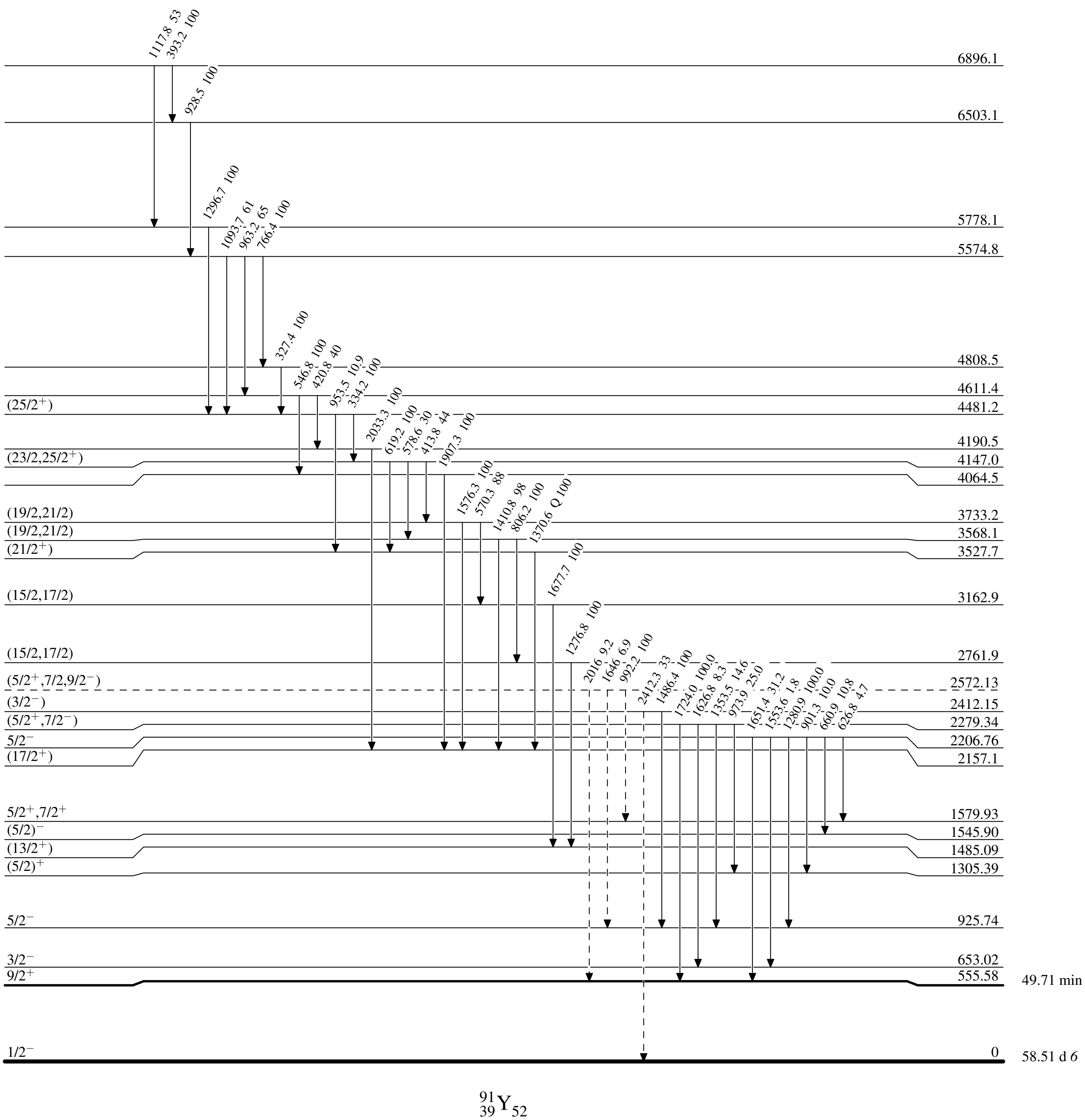
Adopted Levels, Gammas

Legend

Level Scheme

Intensities: Relative photon branching from each level

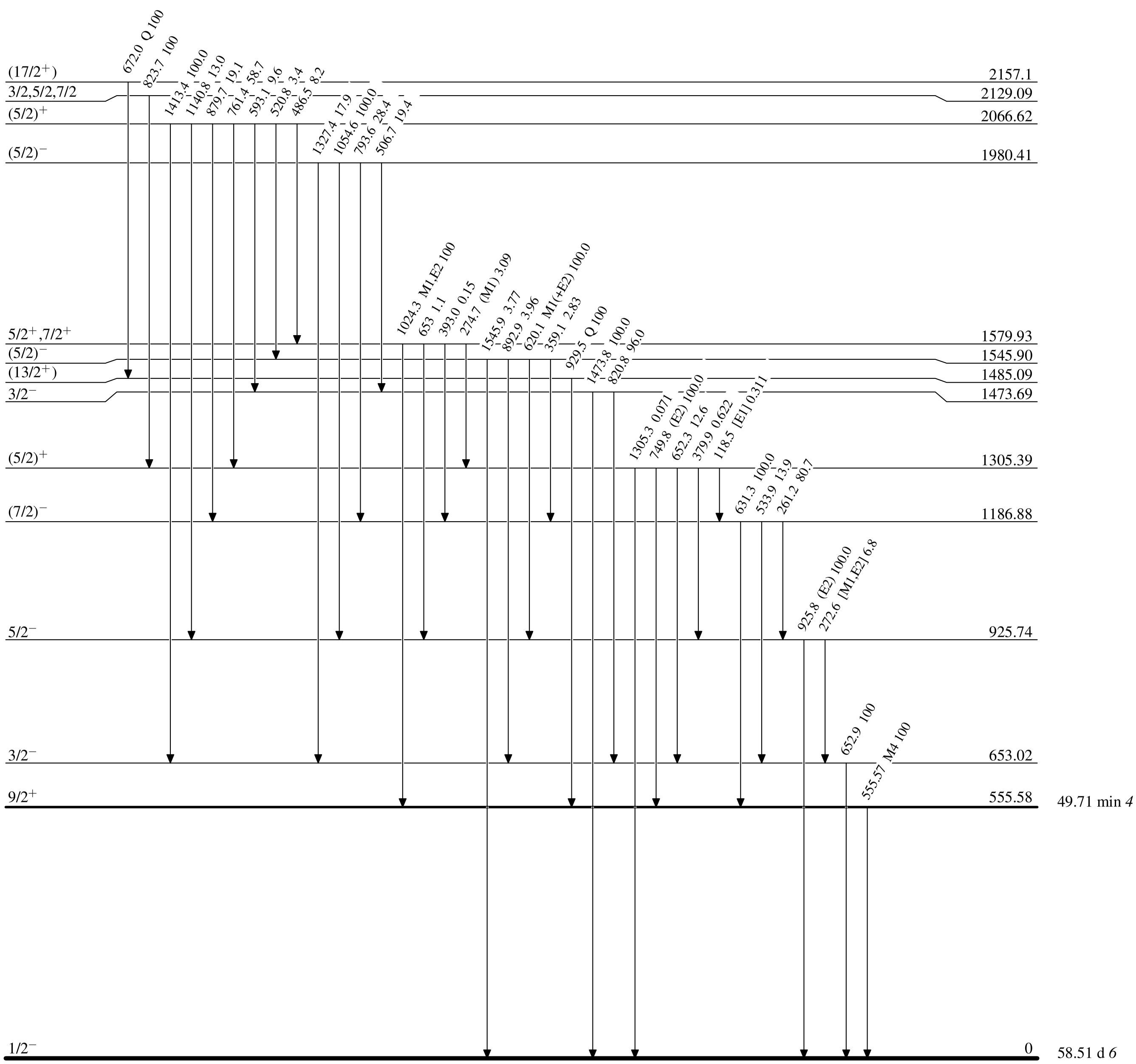
γ Decay (Uncertain)



Adopted Levels, Gammas

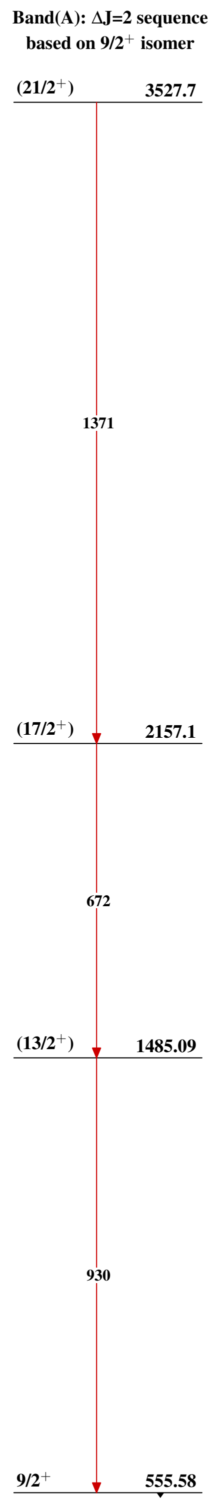
Level Scheme (continued)

Intensities: Relative photon branching from each level



$^{91}_{39}Y_{52}$

Adopted Levels, Gammas



$^{91}_{39}Y_{52}$