^{59}Co(^{7}Li,pnγ) 2018Sa02

History

Type	Author	Citation	Literature Cutoff Date
Full Evaluation	Balraj Singh and Jun Chen	NDS 178, 41 (2021).	12-Nov-2021

2018Sa02: E(^{7}Li)=22-24 MeV beam from the Pelletron-LINAC facility at TIFR-Mumbai. Target was 5.2 mg/cm^2 ^{59}Co evaporated on 4 mg/cm^2 thick Ta foil. Measured Eγ, Iγ, $\gamma\gamma$-coin, $\gamma\gamma(\theta)$(ADO), $\gamma\gamma$(linear polarization) using an array of 11 Compton-suppressed Clover Ge detectors. Comparisons with shell-model calculations, and deduced configurations.

^{64}Cu Levels

E(level)†	J$^\pi$‡	E(level)†	J$^\pi$‡	E(level)†	J$^\pi$‡	E(level)†	J$^\pi$‡
0.0	1$^+$	1460.6 *5*	4$^-$	2647.0 *8*	(5)	3798.5 *6*	9$^-$
158.9 *3*	2$^+$	1592.7 *5*	6$^-$	2689.8 *7*	6$^-$	3986.2 *8*	9$^-$
277.8 *3*	2$^+$	1615.5 *8*	5$^-$	2715.5 *7*	7$^-$	4159.7 *10*	
342.2 *4*	1$^+$	1704.8 *6*	4$^+$	2810.8 *7*	6$^-$	4162.8 *9*	
361.7 *3*	3$^+$	1735.9 *6*	4$^+$	2913.7 *11*	5$^-$	4165.6 *7*	9$^-$
574.0 *4*	4$^+$	1769.7 *6*	5$^+$	2924.4 *6*	6$^-$	4268.1 *8*	
607.8 *4*	2$^+$	1905.8 *8*	4$^+$	2948.2 *8*	5$^-$	4358.5 *8*	
662.4 *4*	1$^+$	1924.5 *8*		2964.2 *8*	5$^-$	4550.5 *10*	
737.0 *5*	2$^+$	1978.6 *8*	5$^+$	3049.8 *8*	7$^-$	4554.4 *12*	
745.5 *4*	3$^+$	2018.3 *7*	4$^+$	3124.5 *6*	7$^-$	4566.9 *8*	10$^-$
774.1 *6*	(1)	2071.8 *6*	5$^-$	3175.6 *8*		4689.9 *12*	
820.2 *6*	(4)	2090.6 *5*	4$^-$	3189.6 *6*	8$^-$	4896.9 *10*	10$^-$
876.4 *4*	(0)$^+$	2251.1 *8*	5$^+$	3267.1 *8*		5084.0 *10*	(9)
895.1 *3*	(3)$^+$	2321.5 *7*	5$^-$	3277.2 *9*		5094.2 *10*	(9)
926.0 *5*	1$^+$	2376.3 *6*	7$^-$	3350.2 *10*	6$^-$	5685.0 *10*	(11)
1096.1 *6*	2$^+$	2385.8 *6*	6$^-$	3375.0 *7*	6$^-$	5911.1 *12*	
1239.5 *5*	3$^+$	2414.7 *8*		3487.1 *7*	8$^-$	5916.0 *12*	(10)
1242.0 *7*		2435.4 *8*		3603.7 *6*	7$^-$	6068.7 *12*	(10)
1290.0 *6*	2$^+$	2496.9 *7*	5$^+$	3680.1 *11*			
1353.3 *5*	4$^+$	2516.9 *7*	5$^-$	3685.2 *11*	7$^-$		
1435.4 *6*	4$^+$	2582.8 *11*	5$^-$	3732.2 *9*			

† From a least-squares fit to γ-ray energies.

‡ As proposed in 2018Sa02, based on $\gamma\gamma(\theta)$(ADO), $\gamma\gamma$(lin pol) and comparison with shell-model calculations. Evaluators note that strong arguments for J^π assignments are generally missing in this work, thus assignments are either different in the Adopted Levels or treated as tentative.

γ(^{64}Cu)

ADO=Angular Distribution of γ rays from Oriented nuclei, defined by 2018Sa02 as: Iγ_1(140°)(gated on γ_2 at all angles) / Iγ_1(115°)(gated on γ_2 at all angles).

Expected values of ADO ratio R$_{ADO}$ are 1.24 *2* for pure quadrupole transitions, 0.81 *1* for pure dipole with gates on pure dipole transitions of 159 and 278 keV (2018Sa02). A value between 0.81 and 1.24 indicates mixed multipolarity with δ(Q/D)>0, and a value <0.81 would indicate δ(Q/D)<0.

Positive value of polarization (POL) indicates an electric nature and negative for magnetic, and a near-zero value represents a mixed (most likely M1+E2) transition (2018Sa02).

E$_\gamma$†	I$_\gamma$	E$_i$(level)	J$^\pi_i$	E$_f$	J$^\pi_f$
84.0 *5*	0.64 *8*	361.7	3$^+$	277.8	2$^+$
118.8 *5*		277.8	2$^+$	158.9	2$^+$
137.5 *5*		745.5	3$^+$	607.8	2$^+$

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$^{59}Co(^{7}Li,pn\gamma)$ 2018Sa02 (continued)

$\gamma(^{64}Cu)$ (continued)

E_γ [†]	I_γ	E_i(level)	J^π_i	E_f	J^π_f	Mult. [#]	Comments
158.8 *5*		158.9	2+	0.0	1+		
200.1 *5*		3124.5	7−	2924.4	6−		
202.7 *5*	103.9 *5*	361.7	3+	158.9	2+		
212.1 *5*	100.0	574.0	4+	361.7	3+		
228.7 *5*		3603.7	7−	3375.0	6−	D+Q	R_{ADO}=0.96 *7*.
249.8 *5*	2.74 *5*	2321.5	5−	2071.8	5−	(M1+E2)	R_{ADO}=0.83 *3*, POL=−0.22 *25*.
265.5 *5*		607.8	2+	342.2	1+		
277.9 *5*		277.8	2+	0.0	1+	(M1+E2)	R_{ADO}=1.00 *47*, POL=−0.13 *16*.
311.3 *5*		3798.5	9−	3487.1	8−	D	R_{ADO}=0.80 *11*.
313.4 *5*	1.99 *10*	2689.8	6−	2376.3	7−	D	R_{ADO}=0.85 *6*.
313.5 *5*	1.12 *79*	3124.5	7−	2810.8	6−	D+Q	R_{ADO}=0.93 *6*.
313.6 *5*	0.97 *69*	2018.3	4+	1704.8	4+	D	R_{ADO}=0.87 *4*.
314.0 *5*	8.3 *15*	2385.8	6−	2071.8	5−	D+Q	R_{ADO}=0.95 *10*.
320.6 *5*	1.89 *15*	895.1	(3)+	574.0	4+	(D+Q) [@]	R_{ADO}=1.00 *11*.
342.2 *5*		342.2	1+	0.0	1+		
361.7 *5*		361.7	3+	0.0	1+		
384.0 *5*	0.19 *4*	745.5	3+	361.7	3+	D	R_{ADO}=0.87 *8*.
384.6 *5*	1.95 *23*	662.4	1+	277.8	2+	D(+Q)	R_{ADO}=0.85 *13*.
402.0 *5*	0.86 *14*	3350.2	6−	2948.2	5−	D+Q	R_{ADO}=0.99 *10*.
412.4 *5*	0.99 *60*	774.1	(1)	361.7	3+	Q	R_{ADO}=1.52 *13*.
415.1 *5*	3.36 *55*	574.0	4+	158.9	2+		
426.3 *5*	0.86 *27*	2516.9	5−	2090.6	4−	D+Q	R_{ADO}=0.83 *12*.
434.6 *5*	1.43 *39*	3124.5	7−	2689.8	6−	(M1+E2)	R_{ADO}=0.99 *7*, POL=−0.17 *27*.
458.5 *5*		820.2	(4)	361.7	3+	D	R_{ADO}=0.86 *7*.
459.0 *5*	2.16 *37*	737.0	2+	277.8	2+	D	R_{ADO}=0.76 *10*.
467.7 *5*	2.21 *30*	745.5	3+	277.8	2+	(M1+E2)	R_{ADO}=0.89 *3*, POL=−0.04 *15*.
478.6 *5*	0.80 *15*	2496.9	5+	2018.3	4+	D+Q	R_{ADO}=0.67 *7*. I_γ: uncertainty of 15.2 in Table I of 2018Sa02 seems a misprint, evaluators consider it as 1.52.
478.6 *5*	2.92 *43*	3603.7	7−	3124.5	7−		
479.2 *5*	13.8 *15*	2071.8	5−	1592.7	6−	(M1+E2)	R_{ADO}=0.87 *3*, POL=−0.15 *22*.
533.3 *5*	1.23 *13*	895.1	(3)+	361.7	3+	D+Q	R_{ADO}=0.97 *13*.
534.2 *5*		876.4	(0)+	342.2	1+	D [@]	R_{ADO}=0.67 *10*.
538.6 *5*	2.65 *52*	2924.4	6−	2385.8	6−	M1+E2	R_{ADO}=0.87 *3*, POL=−0.31 *26*.
560.0 *5*	1.93 *56*	4358.5		3798.5	9−		
561.7 *5*		3277.2		2715.5	7−		
561.8 *5*	0.62 *19*	4165.6	9−	3603.7	7−		
562.4 *5*	1.59 *28*	2948.2	5−	2385.8	6−	D+Q	R_{ADO}=0.91 *4*.
565.3 *5*	1.31 *43*	1460.6	4−	895.1	(3)+		
575.2 *5*	1.45 *4*	2647.0	(5)	2071.8	5−	D+Q	R_{ADO}=0.69 *6*.
578.4 *5*		737.0	2+	158.9	2+		
578.4 *5*	0.36 *7*	2964.2	5−	2385.8	6−	D+Q	R_{ADO}=0.66 *5*.
580.5 *5*		4566.9	10−	3986.2	9−		
607.7 *5*		607.8	2+	0.0	1+		
608.8 *5*	9.50 *15*	3798.5	9−	3189.6	8−	M1+E2	R_{ADO}=0.98 *2*, POL=−0.24 *18*.
617.3 *5*	1.56 *9*	895.1	(3)+	277.8	2+	D [@]	R_{ADO}=0.68 *4*.
629.7 *5*	2.22 *20*	2090.6	4−	1460.6	4−	D+Q	R_{ADO}=0.98 *6*.
662.5 *5*		662.4	1+	0.0	1+		
664.0 *5*	1.39 *25*	3049.8	7−	2385.8	6−	M1+E2	R_{ADO}=0.93 *3*, POL=−0.54 *34*.
664.4 *5*	0.61 *20*	4268.1		3603.7	7−		
679.2 *5*	1.40 *37*	3603.7	7−	2924.4	6−	D+Q	R_{ADO}=0.89 *4*.
738.5 *5*	1.15 *10*	3124.5	7−	2385.8	6−	D+Q	R_{ADO}=0.93 *7*.
771.5 *5*	1.43 *16*	3487.1	8−	2715.5	7−	D+Q	R_{ADO}=0.92 *6*.
783.7 *5*	18.2 *11*	2376.3	7−	1592.7	6−	M1+E2	R_{ADO}=0.71 *1*, POL=−0.38 *24*.
789.8 *5*	1.00 *18*	3175.6		2385.8	6−		

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$^{59}Co(^{7}Li,pn\gamma)$ 2018Sa02 (continued)

$\gamma(^{64}Cu)$ (continued)

E_γ [†]	I_γ	E_i(level)	J^π_i	E_f	J^π_f	Mult. [#]	Comments
813.4 *5*	4.33 *26*	3189.6	8^-	2376.3	7^-	(M1+E2)	R_{ADO}=0.90 *3*, POL=−0.27 *38*.
861.3 *5*	0.84 *31*	1435.4	4^+	574.0	4^+	D+Q	R_{ADO}=1.14 *11*.
876.4 *5*		876.4	$(0)^+$	0.0	1^+		
877.5 *5*		1239.5	3^+	361.7	3^+		
878.1 *5*		3375.0	6^-	2496.9	5^+	D+Q	R_{ADO}=0.98 *6*.
881.3 *5*	0.39 *7*	3267.1		2385.8	6^-		
895.2 *5*		895.1	$(3)^+$	0.0	1^+		
926.0 *5*		926.0	1^+	0.0	1^+		
937.2 *5*	0.60 *44*	1096.1	2^+	158.9	2^+	D+Q	R_{ADO}=0.89 *13*.
947.7 *5*		1290.0	2^+	342.2	1^+	D	R_{ADO}=0.81 *24*.
959.3 *5*	1.61 *6*	1704.8	4^+	745.5	3^+	(M1+E2)	R_{ADO}=0.77 *2*, POL=−0.29 *29*.
962.0 *5*		1239.5	3^+	277.8	2^+		
991.5 *5*	4.60 *12*	1353.3	4^+	361.7	3^+	(M1+E2)	R_{ADO}=1.12 *5*, POL=−0.5 *22*.
1018.9 *7*	71.06 *42*	1592.7	6^-	574.0	4^+		
1040.7 *7*	1.70 *14*	2810.8	6^-	1769.7	5^+	D	R_{ADO}=0.80 *8*.
1041.4 *7*	1.93 *9*	1615.5	5^-	574.0	4^+	D+Q	R_{ADO}=0.93 *5*.
1075.7 *7*		1353.3	4^+	277.8	2^+		
1098.4 *7*	3.01 *78*	4896.9	10^-	3798.5	9^-	(M1+E2)	R_{ADO}=1.02 *4*, POL=−0.33 *43*.
1098.9 *7*	1.59 *83*	1460.6	4^-	361.7	3^+	D+Q	R_{ADO}=0.89 *8*.
1122.6 *7*	8.09 *12*	2715.5	7^-	1592.7	6^-	D+Q	R_{ADO}=1.02 *7*.
1161.6 *7*	4.27 *28*	1735.9	4^+	574.0	4^+	(M1+E2)	R_{ADO}=0.68 *2*, POL=−0.02 *57*.
1195.5 *7*	2.19 *9*	1769.7	5^+	574.0	4^+		
1195.6 *7*	1.07 *14*	2090.6	4^-	895.1	$(3)^+$		
1218.4 *7*	1.22 *26*	3603.7	7^-	2385.8	6^-	(M1+E2)	R_{ADO}=0.95 *4*, POL=−0.29 *73*.
1231.2 [‡&] *7*	0.74 *7*	1592.7	6^-	361.7	3^+	[E3]	
1242.0 *7*		1242.0		0.0	1^+		
1282.4 *7*	1.44 *21*	3603.7	7^-	2321.5	5^-	(E2+M3)	R_{ADO}=1.13 *5*, POL=+0.9 *14*.
1314.7 [‡&] *7*	2.24 *64*	1592.7	6^-	277.8	2^+	[M4]	R_{ADO}=0.78 *4*.
1331.7 *7*	3.62 *50*	1905.8	4^+	574.0	4^+	D+Q	R_{ADO}=0.97 *4*.
1350.4 *7*	0.69 *14*	1924.5		574.0	4^+		
1355.9 *7*	0.75 *16*	3732.2		2376.3	7^-		
1360.9 *7*	0.72 *16*	4550.5		3189.6	8^-		
1374.4 *7*	0.62 *17*	1735.9	4^+	361.7	3^+		
1377.7 *7*	2.58 *23*	4566.9	10^-	3189.6	8^-	(E2)	R_{ADO}=1.16 *7*, POL=+1.1 *18*.
1407.8 *7*	2.10 *9*	1769.7	5^+	361.7	3^+	Q	R_{ADO}=1.13 *12*.
1422.4 *7*	1.15 *7*	3798.5	9^-	2376.3	7^-	Q	R_{ADO}=1.18 *9*.
1469.9 *7*	0.28 *6*	4159.7		2689.8	6^-		
1517.0 *7*	0.84 *7*	2090.6	4^-	574.0	4^+	D+Q	R_{ADO}=0.76 *7*.
1531.9 *7*	1.32 *3*	3603.7	7^-	2071.8	5^-		Mult.: E2+M3 in 2018Sa02. R_{ADO}=0.57 *3*, POL=+0.8 *20*. Note that R_{ADO} is inconsistent with Mult=E2+M3 in 2018Sa02.
1596.6 *7*	11.74 *16*	3189.6	8^-	1592.7	6^-	(E2+M3)	R_{ADO}=1.10 *1*, POL=2.3 *43*.
1609.5 *7*	4.90 *13*	3986.2	9^-	2376.3	7^-	(E2)	R_{ADO}=1.25 *2*, POL=+0.9 *19*.
1616.8 *7*	4.32 *13*	1978.6	5^+	361.7	3^+	Q	R_{ADO}=1.22 *4*.
1677.0 *7*	2.50 *12*	2251.1	5^+	574.0	4^+	(M1+E2)	R_{ADO}=1.04 *3*, POL=−0.3 *29*.
1786.5 *7*	0.26 *13*	4162.8		2376.3	7^-		
1789.5 *7*	1.80 *19*	4165.6	9^-	2376.3	7^-	Q	R_{ADO}=1.26 *4*.
1840.6 *7*	0.44 *5*	2414.7		574.0	4^+		
1861.3 *7*	1.02 *6*	2435.4		574.0	4^+		
1886.4 *7*	0.32 *10*	5685.0	(11)	3798.5	9^-	Q	R_{ADO}=1.33 *10*.
1894.4 *7*	2.20 *53*	5084.0	(9)	3189.6	8^-	D+Q	R_{ADO}=1.03 *8*.
1904.6 *7*	0.60 *6*	5094.2	(9)	3189.6	8^-	D+Q	R_{ADO}=0.94 *22*.
2008.7 *10*	0.22 *7*	2582.8	5^-	574.0	4^+	D+Q	R_{ADO}=0.98 *5*.
2087.4 *10*	0.30 *4*	3680.1		1592.7	6^-		
2092.5 *10*	0.40 *5*	3685.2	7^-	1592.7	6^-	D+Q	R_{ADO}=0.90 *8*.

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^{59}Co(^{7}Li,pnγ) 2018Sa02 (continued)

γ(^{64}Cu) (continued)

E_γ†	I_γ	E_i(level)	J^π_i	E_f	J^π_f	Mult.#	Comments
2112.5 *10*		5911.1		3798.5	9^-		
2117.4 *10*	0.38 *5*	5916.0	(10)	3798.5	9^-	D+Q	R_{ADO}=1.07 *13*.
2178.0 *10*		4554.4		2376.3	7^-		
2206.4 *10*	0.65 *6*	3798.5	9^-	1592.7	6^-	[M3]	
2270.1 *10*	0.38 *5*	6068.7	(10)	3798.5	9^-	D+Q	R_{ADO}=0.71 *3*.
2313.5 *10*		4689.9		2376.3	7^-		
2339.6 *10*		2913.7	5^-	574.0	4^+	D	R_{ADO}=0.82 *4*.

† Uncertainty is stated by 2018Sa02 as 0.5 keV for Eγ<1 MeV, 0.7 keV for Eγ=1-2 MeV and 1 keV for Eγ>2 MeV.

‡ Placement from the 1592.7, 6^- level to 2^+ or 3^+ levels requires high Mult, which is considered questionable by evaluators. It is very likely that the transition corresponds to the transition with a close energy from 1594, (1^+,2) level as seen in (d,pγ) and adopted in Adopted Levels.

Deduced by 2018Sa02 based on $\gamma\gamma$(ADO) and $\gamma\gamma$(lin pol). In most cases, experimental polarization asymmetries overlap zero value, making the magnetic or electric character uncertain. Evaluators treat such assignments as tentative, even though authors′ assignments are firm.

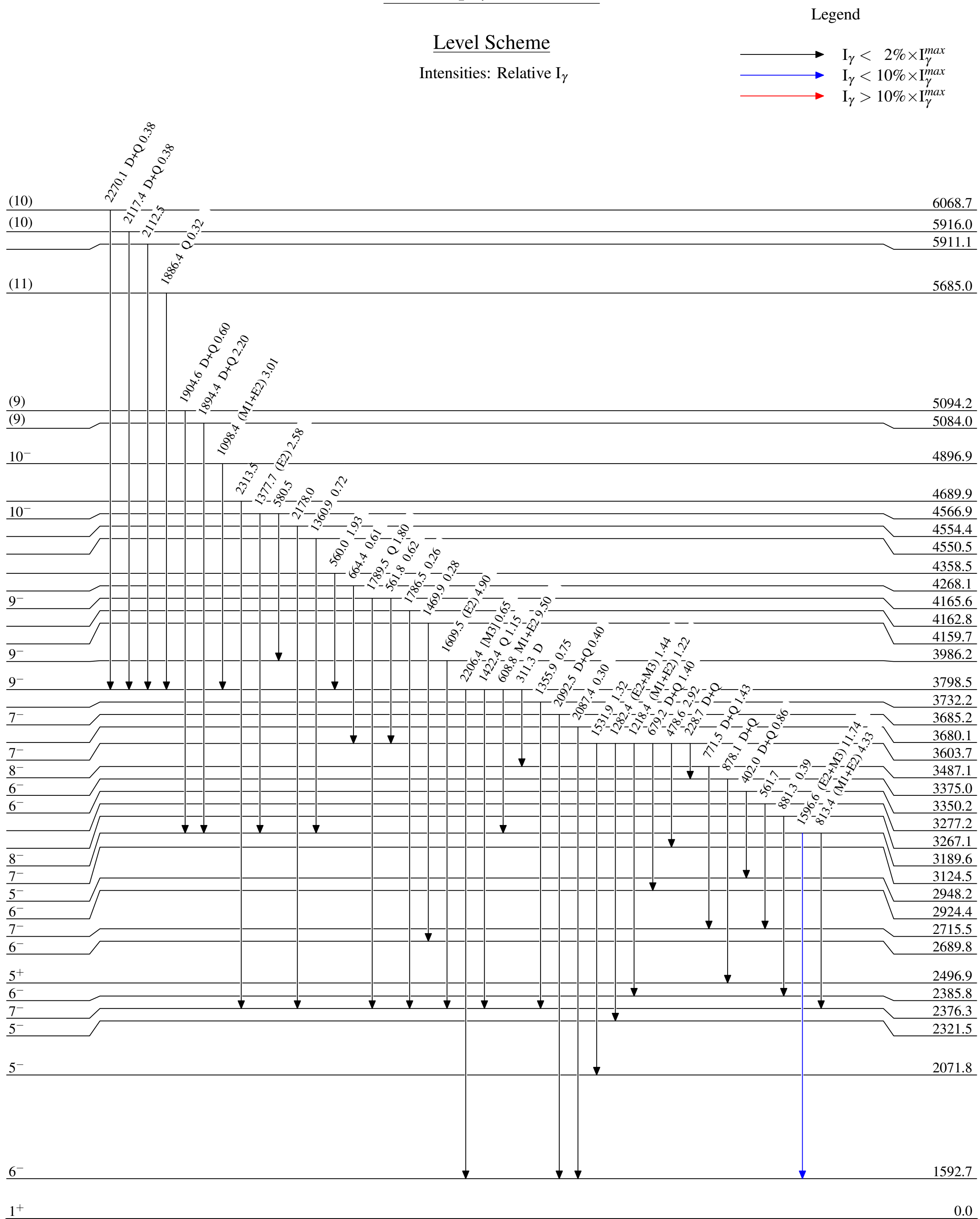
@ Deduced by evaluators based on R_{ADO} ratio as compared to assignments with similar R_{ADO}; not given in 2018Sa02.

& Placement of transition in the level scheme is uncertain.

$^{59}Co(^7Li,pn\gamma)$ 2018Sa02

Level Scheme

Intensities: Relative I_γ

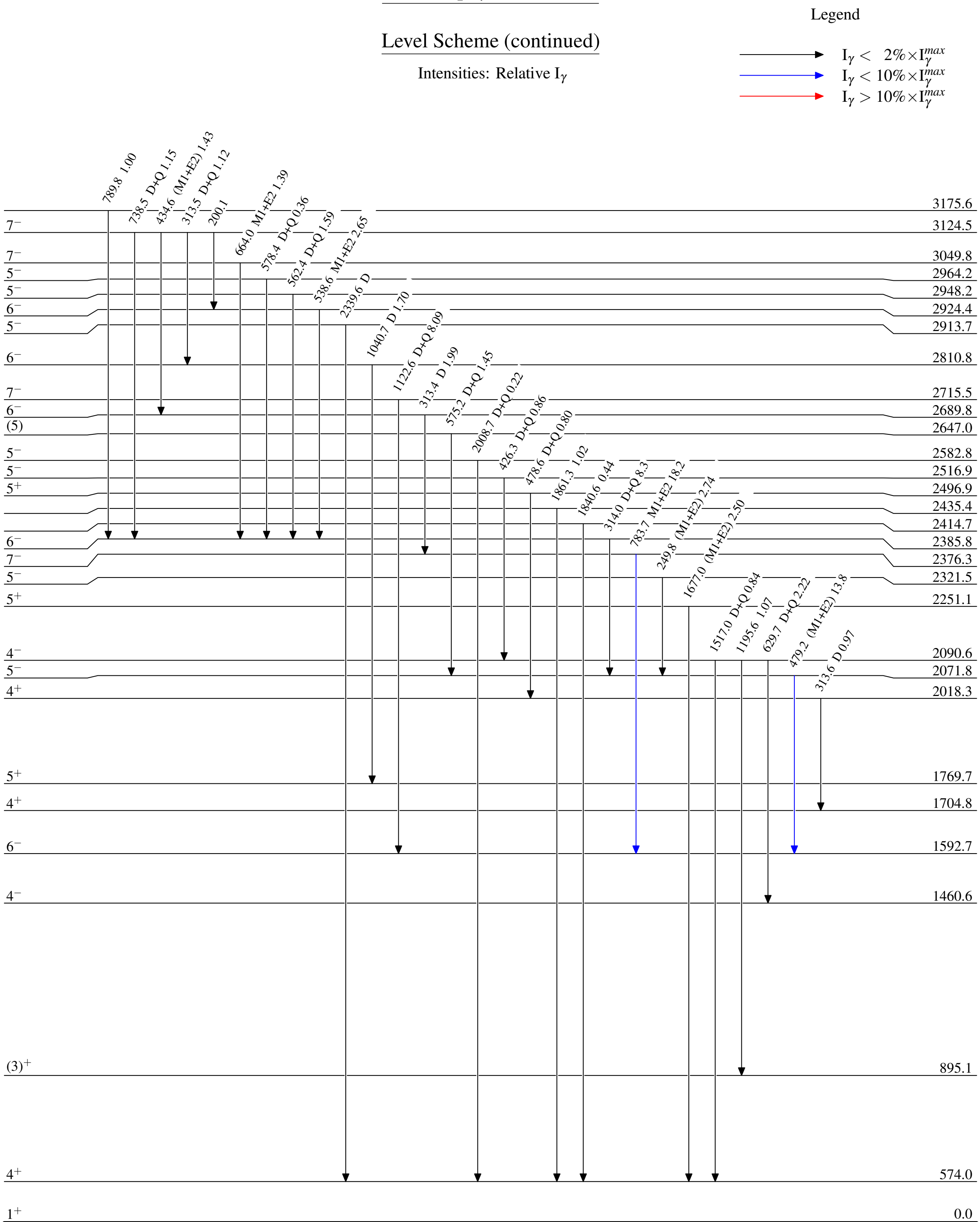


$^{64}_{29}Cu_{35}$

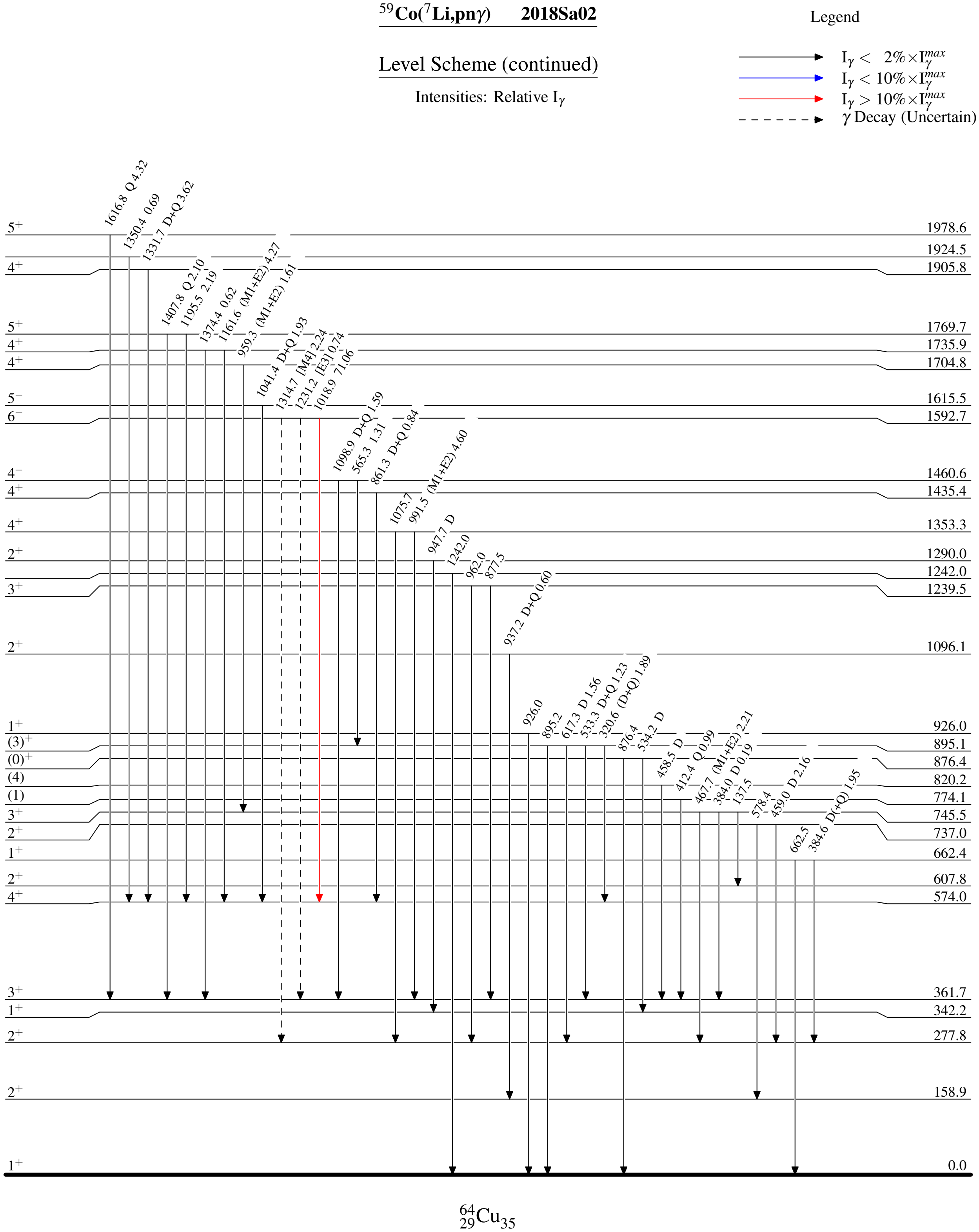
^{59}Co(^{7}Li,pnγ) 2018Sa02

Level Scheme (continued)

Intensities: Relative I_γ



$^{64}_{29}Cu_{35}$



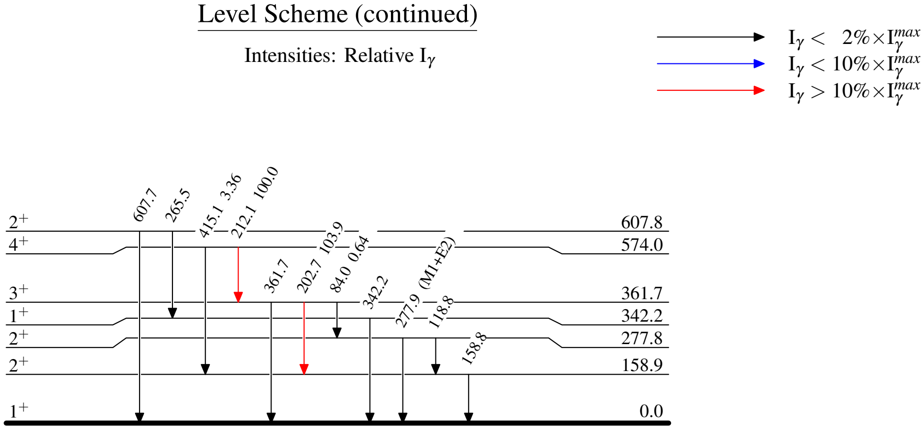
^{59}Co(^{7}Li,pnγ) 2018Sa02
Level Scheme (continued)
Intensities: Relative Iγ
Legend
Iγ < 2%×Iγ^max
Iγ < 10%×Iγ^max
Iγ > 10%×Iγ^max
γ Decay (Uncertain)
5+ 1978.6
1924.5
4+ 1905.8
5+ 1769.7
4+ 1735.9
4+ 1704.8
5− 1615.5
6− 1592.7
4− 1460.6
4+ 1435.4
4+ 1353.3
2+ 1290.0
1242.0
3+ 1239.5
2+ 1096.1
1+ 926.0
(3)+ 895.1
(0)+ 876.4
(4) 820.2
(1) 774.1
3+ 745.5
2+ 737.0
1+ 662.4
2+ 607.8
4+ 574.0
3+ 361.7
1+ 342.2
2+ 277.8
2+ 158.9
1+ 0.0
1616.8 Q 4.32
1350.4 0.69
1331.7 D+Q 3.62
1407.8 Q 2.10
1195.5 2.19
1374.4 0.62
1161.6 (M1+E2) 4.27
959.3 (M1+E2) 1.61
1041.4 D+Q 1.93
1314.7 [M4] 2.24
1231.2 [E3] 0.74
1018.9 71.06
1098.9 D+Q 1.59
565.3 1.31
861.3 D+Q 0.84
1075.7
991.5 (M1+E2) 4.60
947.7 D
1242.0
962.0
877.5
937.2 D+Q 0.60
926.0
895.2
617.3 D 1.56
533.3 D+Q 1.23
320.6 (D+Q) 1.89
876.4
534.2 D
458.5 D
412.4 Q 0.99
467.7 (M1+E2) 2.21
384.0 D 0.19
137.5
578.4
459.0 D 2.16
662.5
384.6 D(+Q) 1.95
$^{64}_{29}Cu_{35}$

$^{59}Co(^{7}Li,pn\gamma)$ 2018Sa02

Level Scheme (continued)

Intensities: Relative I_γ

Legend



$^{64}_{29}Cu_{35}$