^{40}Ca(^{28}Si,4pγ) E=122 MeV 2004Ka18

History

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

2004Ka18: E=122 MeV. Measured Eγ, Iγ, $\gamma\gamma$, $\gamma(\theta)$, $\gamma\gamma(\theta)$(DCO) using the Gammasphere array of 101 HPGe detectors and Microball array of 95 CsI(Tl) scintillators for particle detection.

^{64}Zn Levels

E(level)†	Jπ‡	E(level)†	Jπ‡	E(level)†	Jπ‡	E(level)†	Jπ‡
0.0&	0^+	5623.9 *8*	$8^{(-)}$	9364.3 *9*	$11^{(-)}$	15418.3[c] *20*	(19)
991.1& *5*	2^+	5699.1 *7*	$8^{(-)}$	9440.5[a] *8*	$11^{(-)}$	15939.5 *23*	
1799.4 *5*	2^+	5936.7 *9*	$8^{(+)}$	9667.1 *14*	(14)	15945.3[b] *11*	$20^{(-)}$
2305.9& *6*	4^+	5951.7 *7*	$9^{(-)}$	9804.0 *9*	$11^{(-)}$	16681.5[d] *21*	(20)
2736.2 *6*	4^+	6032.0 *7*	$8^{(+)}$	9948.7[b] *8*	$12^{(-)}$	17078.9 *24*	
2997.9 *7*	3^-	6124.5# *7*	$8^{(+)}$#	10460.5[a] *8*	$13^{(-)}$	17087.5[a] *11*	$21^{(-)}$
3077.1 *6*	$4^{(+)}$	6377.5 *10*	$9^{(-)}$	11023.6[b] *8*	$14^{(-)}$	17847.9[c] *21*	(21)
3306.0 *7*	$4^{(+)}$	6998.2 *8*	$11^{(-)}$	11459.2[c] *17*	(15)	18483.7[b] *12*	$22^{(-)}$
3924.2 *6*	5^-	7062.0 *8*	$10^{(-)}$	11626.6[a] *9*	$15^{(-)}$	19359.5[d] *23*	(22)
3993.8& *7*	6^+	7118.5 *8*	$10^{(+)}$	12336.0[b] *9*	$16^{(-)}$	19775.6[a] *13*	$23^{(-)}$
4076.8 *7*	$6^{(+)}$@	7212.5 *9*	$11^{(-)}$	12462.4[d] *19*	(16)	20652.0[c] *24*	(23)
4156.1 *7*	$5^{(-)}$	7556.5 *11*	$10^{(-)}$	13082.4[a] *9*	$17^{(-)}$	21298.2[b] *14*	$24^{(-)}$
4237.7 *7*	6^+	8181.5 *12*	$10^{(-)}$	13319.0[c] *19*	(17)	22892.7[a] *17*	$25^{(-)}$
4635.6 *7*	7^-	8303.0 *9*	$12^{(-)}$	13948.4[b] *10*	$18^{(-)}$	24869.3[b] *17*	$26^{(-)}$
4669.1 *7*	$6^{(-)}$	8322.3 *11*	(11)	14386.0[d] *20*	(18)		
4980.5 *7*	$7^{(-)}$	8426.4 *10*	$11^{(-)}$	14857.3 *22*			
5151.6 *7*	$7^{(-)}$	8581.1 *9*	(12)	14862.7[a] *10*	$19^{(-)}$		

† From a least-squares fit to Eγ data, assuming ΔEγ=1 keV when not stated.

‡ From 2004Ka18 based on $\gamma\gamma(\theta)$ data and band assignments. The assignments are the same in the Adopted Levels, except that many are placed in parentheses when strong arguments are lacking. Other exceptions are noted.

Based on several other in-beam γ-ray studies, namely (α,nγ),(^{11}B,2npγ), two levels are listed in the Adopted Levels near this energy: an (8^+) deexciting by 502, 1488, 1886 and 2130 γ rays; and a (9^-) deexciting by 1144γ.

@ $(5)^+$ in the Adopted Levels from $\gamma(\theta$,lin pol) data in (α,nγ),(^{11}B,2npγ).

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

a Band(B): Collective band based on $11^{(-)}$, α=1. Configuration=$\pi[(f_{7/2}^{-1})(p_{3/2}f_{5/2}^2(g_{9/2}^1]\otimes\nu[(p_{3/2}f_{5/2})^4(g_{9/2}^2)]$; also [11,02] in the notation used by 2004Ka18, implying one proton hole in $f_{7/2}$ and one proton in $g_{9/2}$ orbitals, no neutron hole in $f_{7/2}$ orbital and 2 neutrons in $g_{9/2}$ orbital.

b Band(b): Collective band based on $11^{(-)}$, α=0. See configuration listed above for its signature partner.

c Band(C): Band based on (15), α=1.

d Band(c): Band based on (16), α=0.

$\gamma(^{64}Zn)$

R_{aa}=Angular Anisotropy=I$\gamma(35°)$/I$\gamma(80°)$.
R_{ac}=Angular correlation ratio=$I_{\gamma\gamma}(35°)/I_{\gamma\gamma}(80°)$.

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^{40}Ca(^{28}Si,4pγ) E=122 MeV 2004Ka18 (continued)

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

E_γ	I_γ	E_i(level)	J_i^π	E_f	J_f^π	Mult.‡	Comments
155†		8581.1	(12)	8426.4	11$^{(-)}$		
259†		8581.1	(12)	8322.3	(11)		
328†		5951.7	9$^{(-)}$	5623.9	8$^{(-)}$		
341†		3077.1	4$^{(+)}$	2736.2	4$^+$		
398.2 *3*	9.5 *2*	4635.6	7$^-$	4237.7	6$^+$	D@	R_{ac}=0.61 *5*, R_{aa}=0.69 *6*.
429.8 *3*	1.2 *1*	2736.2	4$^+$	2305.9	4$^+$	D	R_{aa}=1.2 *4*, ΔJ=0 transition.
502†		6124.5	8$^{(+)}$	5623.9	8$^{(-)}$		
508.1 *5*		9948.7	12$^{(-)}$	9440.5	11$^{(-)}$		
512†		4669.1	6$^{(-)}$	4156.1	5$^{(-)}$		
512.0 *5*		10460.5	13$^{(-)}$	9948.7	12$^{(-)}$		
515†		5151.6	7$^{(-)}$	4635.6	7$^-$		
547.4 *3*	2.0 *1*	5699.1	8$^{(-)}$	5151.6	7$^{(-)}$	D@	R_{aa}=0.87 *15*.
561†		15418.3	(19)	14857.3			
563.3 *3*	65.5 *3*	11023.6	14$^{(-)}$	10460.5	13$^{(-)}$	D@	R_{ac}=0.78 *2*, R_{aa}=0.76 *2*.
584.8 *5*	3.8 *2*	9948.7	12$^{(-)}$	9364.3	11$^{(-)}$	D@	R_{aa}=0.80 *8*.
592.5 *3*	9.4 *2*	4669.1	6$^{(-)}$	4076.8	6$^{(+)}$	D+Q	R_{ac}=0.58 *8*, R_{aa}=0.68 *8*; ΔJ=0 transition.
603.0 *3*	102.7 *4*	11626.6	15$^{(-)}$	11023.6	14$^{(-)}$	D@	R_{ac}=0.79 *2*, R_{aa}=0.81 *2*.
617.9 *5*	1.7 *1*	3924.2	5$^-$	3306.0	4$^{(+)}$		
641.4 *5*	47.0 *3*	4635.6	7$^-$	3993.8	6$^+$	D@	R_{ac}=0.73 *2*, R_{aa}=0.80 *3*.
656.7 *5*	3.0 *1*	10460.5	13$^{(-)}$	9804.0	11$^{(-)}$	Q#	R_{aa}=1.28 *24*.
709.5 *3*		12336.0	16$^{(-)}$	11626.6	15$^{(-)}$		
742†		16681.5	(20)	15939.5			
744†		4669.1	6$^{(-)}$	3924.2	5$^-$		
744†		4980.5	7$^{(-)}$	4237.7	6$^+$		
746.4 *3*	87.2 *4*	13082.4	17$^{(-)}$	12336.0	16$^{(-)}$	D@	R_{ac}=0.86 *2*, R_{aa}=0.81 *3*.
769†		17847.9	(21)	17078.9			
771.2 *5*	2.9 *1*	3077.1	4$^{(+)}$	2305.9	4$^+$	D	R_{aa}=0.80 *18*, ΔJ=0 transition.
808.4 *5*	12.4 *3*	1799.4	2$^+$	991.1	2$^+$	D+Q	R_{aa}=0.71 *6*, ΔJ=0 transition.
824.6 *5*	3.7 *2*	4980.5	7$^{(-)}$	4156.1	5$^{(-)}$	Q#	R_{aa}=1.66 *13*.
848†		3924.2	5$^-$	3077.1	4$^{(+)}$		
851†		4156.1	5$^{(-)}$	3306.0	4$^{(+)}$		
856†		13319.0	(17)	12462.4	(16)		
865.8 *5*	25.8 *3*	13948.4	18$^{(-)}$	13082.4	17$^{(-)}$	D@	R_{ac}=0.78 *3*, R_{aa}=0.86 *8*.
914.5 *5*	29.6 *3*	14862.7	19$^{(-)}$	13948.4	18$^{(-)}$	D@	R_{ac}=0.80 *5*, R_{aa}=0.83 *5*.
926.2 *5*	4.9 *2*	3924.2	5$^-$	2997.9	3$^-$	Q#	R_{aa}=1.43 *11*.
936.7 *5*	15.6 *3*	2736.2	4$^+$	1799.4	2$^+$	Q#	R_{ac}=1.25 *7*, R_{aa}=1.17 *9*.
955.0 *5*	6.1 *2*	5623.9	8$^{(-)}$	4669.1	6$^{(-)}$	Q#	R_{ac}=1.04 *15*, R_{aa}=1.34 *17*.
971.1 *5*	5.3 *2*	5951.7	9$^{(-)}$	4980.5	7$^{(-)}$	Q#	R_{aa}=1.6 *4*.
989†		5623.9	8$^{(-)}$	4635.6	7$^-$		
991.0 *5*	100.0 *19*	991.1	2$^+$	0.0	0$^+$	Q#	R_{ac}=1.19 *3*, R_{aa}=1.17 *2*.
995†		7118.5	10$^{(+)}$	6124.5	8$^{(+)}$		
999.9& *6*	4.8& *4*	3306.0	4$^{(+)}$	2305.9	4$^+$		
999.9& *6*	4.8& *4*	4076.8	6$^{(+)}$	3077.1	4$^{(+)}$		R_{aa}=0.92 *3* for doublet. From (α,nγ),(^{11}B,2npγ) (1980Si02), this placement of 999.9γ is suspect.
1003†		12462.4	(16)	11459.2	(15)		
1020.0 *5*	6.0 *2*	10460.5	13$^{(-)}$	9440.5	11$^{(-)}$		

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^{40}Ca(^{28}Si,4pγ) E=122 MeV 2004Ka18 (continued)

γ(^{64}Zn) (continued)

E_γ	I_γ	E_i(level)	J_i^π	E_f	J_f^π	Mult.[‡]	Comments
1029.9 *5*	3.3 *2*	5699.1	$8^{(-)}$	4669.1	$6^{(-)}$	Q[#]	R_{aa}=1.31 *10*.
1032[†]		15418.3	(19)	14386.0	(18)		
1046.2 *5*	19.2 *3*	6998.2	$11^{(-)}$	5951.7	$9^{(-)}$	Q[#]	R_{ac}=1.34 *15*, R_{aa}=1.44 *18*.
1056.4 *5*	17.6 *3*	4980.5	$7^{(-)}$	3924.2	5^-	Q[#]	R_{ac}=1.27 *17*, R_{aa}=1.70 *15*.
1064.1 *5*	4.3 *2*	5699.1	$8^{(-)}$	4635.6	7^-		
1067[†]		14386.0	(18)	13319.0	(17)		
1074.7 *5*	15.9 *4*	11023.6	$14^{(-)}$	9948.7	$12^{(-)}$		
1078[†]		4156.1	$5^{(-)}$	3077.1	$4^{(+)}$		
1082.1 *5*	13.7 *3*	15945.3	$20^{(-)}$	14862.7	$19^{(-)}$		
1086[†]		9667.1	(14)	8581.1	(12)		
1087[†]		7118.5	$10^{(+)}$	6032.0	$8^{(+)}$		
1142.0 *5*	4.1 *8*	17087.5	$21^{(-)}$	15945.3	$20^{(-)}$		
1144.4 *4*	15 *4*	6124.5	$8^{(+)}$	4980.5	$7^{(-)}$	(D)[@]	E_γ: in the Adopted dataset, this γ ray is placed from a different level near 6124 keV with J^π=(9^-). R_{ac}=0.90 *24*, R_{aa}=1.01 *7*.
1166		7118.5	$10^{(+)}$	5951.7	$9^{(-)}$		E_γ: contaminated.
1166	52.4 *4*	11626.6	$15^{(-)}$	10460.5	$13^{(-)}$	Q[#]	R_{ac}=1.27 *11*, R_{aa}=1.25 *6*. E_γ: contaminated.
1167[†]		17847.9	(21)	16681.5	(20)		
1182[†]		7118.5	$10^{(+)}$	5936.7	$8^{(+)}$		
1187[†]		3924.2	5^-	2736.2	4^+		
1200[†]		2997.9	3^-	1799.4	2^+		
1204[†]		8322.3	(11)	7118.5	$10^{(+)}$		
1227.2 *6*	1.3 *1*	5151.6	$7^{(-)}$	3924.2	5^-	Q[#]	R_{aa}=1.39 *9*.
1260.3 *7*	15.6 *2*	7212.5	$11^{(-)}$	5951.7	$9^{(-)}$	Q[#]	R_{ac}=1.21 *12*, R_{aa}=1.15 *11*.
1263[†]		16681.5	(20)	15418.3	(19)		
1292[†]		19775.6	$23^{(-)}$	18483.7	$22^{(-)}$		
1304.9 *5*	5.8 *2*	8303.0	$12^{(-)}$	6998.2	$11^{(-)}$		
1309[†]		8426.4	$11^{(-)}$	7118.5	$10^{(+)}$		
1312.5 *9*		12336.0	$16^{(-)}$	11023.6	$14^{(-)}$		
1315[&]	113.4[&] *5*	2305.9	4^+	991.1	2^+	Q[#]	I_γ: from thickness of arrow in figure 1 of 2004Ka18, the evaluators estimate that about 60% intensity is from 2306 level and about 40% from 5951 level. R_{ac}=1.12 *4*, R_{aa}=1.39 *3* for doublet.
1315[&]	113.4[&] *5*	5951.7	$9^{(-)}$	4635.6	7^-		
1340.0 *7*	12.4 *2*	4076.8	$6^{(+)}$	2736.2	4^+	Q[#]	R_{ac}=1.26 *15*, R_{aa}=1.26 *11*.
1363.0 *4*	6.9 *2*	7062.0	$10^{(-)}$	5699.1	$8^{(-)}$	Q[#]	R_{ac}=1.5 *3*, R_{aa}=1.3 *3*.
1395.6 *9*	4.2 *2*	18483.7	$22^{(-)}$	17087.5	$21^{(-)}$		
1397.0 *5*	4.3 *2*	6032.0	$8^{(+)}$	4635.6	7^-		
1455.2 *5*		13082.4	$17^{(-)}$	11626.6	$15^{(-)}$		
1462[†]		8581.1	(12)	7118.5	$10^{(+)}$		
1488[†]		6124.5	$8^{(+)}$	4635.6	7^-		
1500.3 *5*	9.2 *2*	4237.7	6^+	2736.2	4^+	Q[#]	R_{ac}=1.74 *20*, R_{aa}=1.64 *24*.
1523[†]		21298.2	$24^{(-)}$	19775.6	$23^{(-)}$		
1583[†]		8581.1	(12)	6998.2	$11^{(-)}$		
1605[†]		7556.5	$10^{(-)}$	5951.7	$9^{(-)}$		
1613.3 *6*	57.4 *11*	13948.4	$18^{(-)}$	12336.0	$16^{(-)}$	Q[#]	R_{aa}=1.09 *8*.

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^{40}Ca(^{28}Si,4pγ) E=122 MeV 2004Ka18 (continued)

γ(^{64}Zn) (continued)

E_γ	I_γ	E_i(level)	J_i^π	E_f	J_f^π	Mult.‡	Comments
1618.6 *5*	20.4 *5*	3924.2	5^-	2305.9	4^+		
1622.5 *8*	0.8 *5*	9804.0	$11^{(-)}$	8181.5	$10^{(-)}$		
1686.9 *5*	45.5 *4*	3993.8	6^+	2305.9	4^+	Q#	R_{ac}=1.27 *17*, R_{aa}=1.36 *5*.
1699†		5936.7	$8^{(+)}$	4237.7	6^+		
1741†		6377.5	$9^{(-)}$	4635.6	7^-		
1773.2 *10*	2.8 *5*	4076.8	$6^{(+)}$	2305.9	4^+		From (α,nγ),(^{11}B,2npγ) (1980Si02), existence or placement of 1773.2γ is suspect.
1779.6 *6*	30.5 *3*	14862.7	$19^{(-)}$	13082.4	$17^{(-)}$	Q#	R_{ac}=1.31 *6*, R_{aa}=1.24 *9*.
1792†a		11459.2	(15)	9667.1	(14)		
1793†		6032.0	$8^{(+)}$	4237.7	6^+		
1799.6 *7*	5.5 *2*	1799.4	2^+	0.0	0^+	Q#	R_{aa}=1.6 *3*.
1808†		9364.3	$11^{(-)}$	7556.5	$10^{(-)}$		
1850.4 *10*	2.3 *4*	4156.1	$5^{(-)}$	2305.9	4^+		
1860†		13319.0	(17)	11459.2	(15)		
1886†		6124.5	$8^{(+)}$	4237.7	6^+		
1924†		14386.0	(18)	12462.4	(16)		
1935.3 *7*	4.1 *3*	4237.7	6^+	2305.9	4^+	Q#	E_γ: poor fit. Level-energy difference=1931.8. R_{ac}=1.6 *3*, R_{aa}=1.46 *10*.
1943†		5936.7	$8^{(+)}$	3993.8	6^+		
1997.4 *6*	29.9 *4*	15945.3	$20^{(-)}$	13948.4	$18^{(-)}$	Q#	R_{ac}=1.44 *9*, R_{aa}=1.16 *8*.
2005.0 *10*	2.4 *3*	2997.9	3^-	991.1	2^+		
2037.8 *7*	5.8 *3*	6032.0	$8^{(+)}$	3993.8	6^+	Q#	R_{ac}=1.66 *22*, R_{aa}=1.37 *18*.
2048†		8426.4	$11^{(-)}$	6377.5	$9^{(-)}$		
2086.2 *7*	5.6 *2*	3077.1	$4^{(+)}$	991.1	2^+	(Q)#	R_{aa}=1.1 *4*.
2099†		15418.3	(19)	13319.0	(17)		
2129.7 *7*	2.6 *2*	6124.5	$8^{(+)}$	3993.8	6^+	Q#	R_{aa}=1.49 *9*.
2158.3 *9*	4.3 *2*	10460.5	$13^{(-)}$	8303.0	$12^{(-)}$		
2225.1 *10*	22.0 *4*	17087.5	$21^{(-)}$	14862.7	$19^{(-)}$	Q#	R_{ac}=1.27 *11*, R_{aa}=1.35 *12*.
2229.8		8181.5	$10^{(-)}$	5951.7	$9^{(-)}$		E_γ: from level-energy difference. Eγ=2219 given in figure 1 of 2004Ka18 does not fit; γ not listed in authors' table I.
2296†		16681.5	(20)	14386.0	(18)		
2321.9 *9*	3.6 *2*	9440.5	$11^{(-)}$	7118.5	$10^{(+)}$		
2429†		17847.9	(21)	15418.3	(19)		
2538.6 *10*	14.8 *3*	18483.7	$22^{(-)}$	15945.3	$20^{(-)}$	Q#	R_{ac}=1.26 *15*, R_{aa}=1.23 *16*.
2678†		19359.5	(22)	16681.5	(20)		
2688.5 *10*	11.2 *6*	19775.6	$23^{(-)}$	17087.5	$21^{(-)}$	Q#	R_{ac}=1.5 *3*, R_{aa}=1.15 *6*.
2720 *1*	1.1 *1*	11023.6	$14^{(-)}$	8303.0	$12^{(-)}$		
2743†		9804.0	$11^{(-)}$	7062.0	$10^{(-)}$		
2804†		20652.0	(23)	17847.9	(21)		
2814 *1*	4.5 *2*	21298.2	$24^{(-)}$	18483.7	$22^{(-)}$		
2886 *1*	1.1 *1*	9948.7	$12^{(-)}$	7062.0	$10^{(-)}$	Q#	R_{aa}=1.5 *3*.
2950 *1*	4.4 *2*	9948.7	$12^{(-)}$	6998.2	$11^{(-)}$	D@	R_{ac}=0.87 *8*, R_{aa}=0.91 *8*.
3117 *1*	1.1 *1*	22892.7	$25^{(-)}$	19775.6	$23^{(-)}$		
3247 *1*	2.9 *1*	10460.5	$13^{(-)}$	7212.5	$11^{(-)}$	Q#	R_{aa}=1.24 *10*.
3414†		9364.3	$11^{(-)}$	5951.7	$9^{(-)}$		
3461 *1*	5.5 *2*	10460.5	$13^{(-)}$	6998.2	$11^{(-)}$	Q#	R_{ac}=1.4 *3*, R_{aa}=1.7 *5*.
3571 *1*		24869.3	$26^{(-)}$	21298.2	$24^{(-)}$		

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^{40}Ca(^{28}Si,4pγ) E=122 MeV 2004Ka18 (continued)

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

† From Fig. 1 of 2004Ka18; not listed in authors′ Table I.
‡ The assignments are not explicitly stated by 2004Ka18, but are implied from R(DCO) and R(angular anisotropy) from the following expected ratios: R_{ac} or $R_{aa}\approx0.8$ for ΔJ=1, dipole; $R_{ac}\approx1.3$, $R_{aa}\approx1.4$ for ΔJ=2, quadrupole.
# R_{aa} and/or R_{ac} consistent with ΔJ=2, qudrupole.
@ R_{aa} and/or R_{ac} consistent with ΔJ=1, dipole or dipole+quadrupole.
& Multiply placed with undivided intensity.
a Placement of transition in the level scheme is uncertain.

^{40}Ca(^{28}Si,4pγ) E=122 MeV 2004Ka18

Level Scheme

Intensities: Relative I_γ

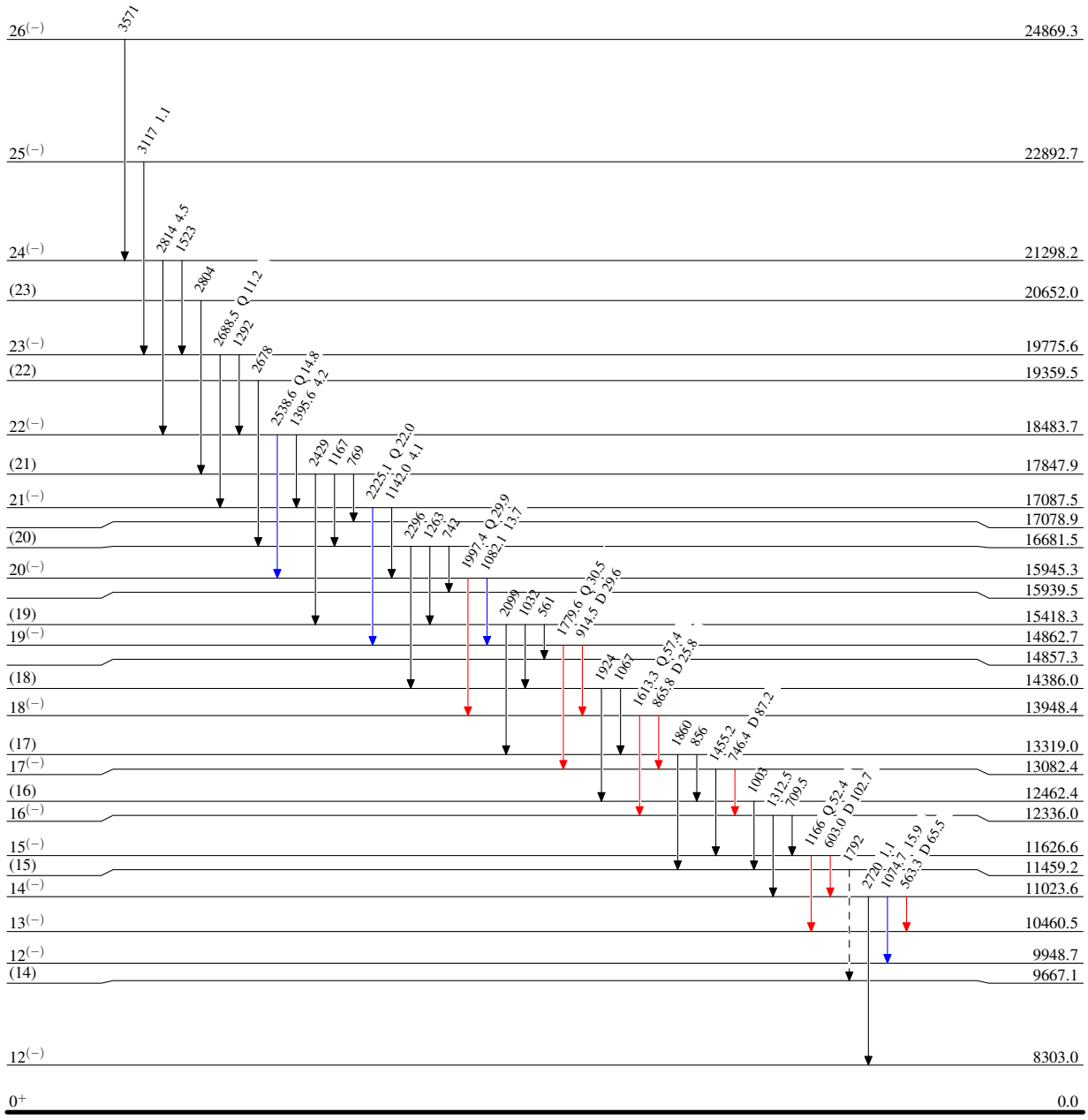
Legend

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

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

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

γ Decay (Uncertain)



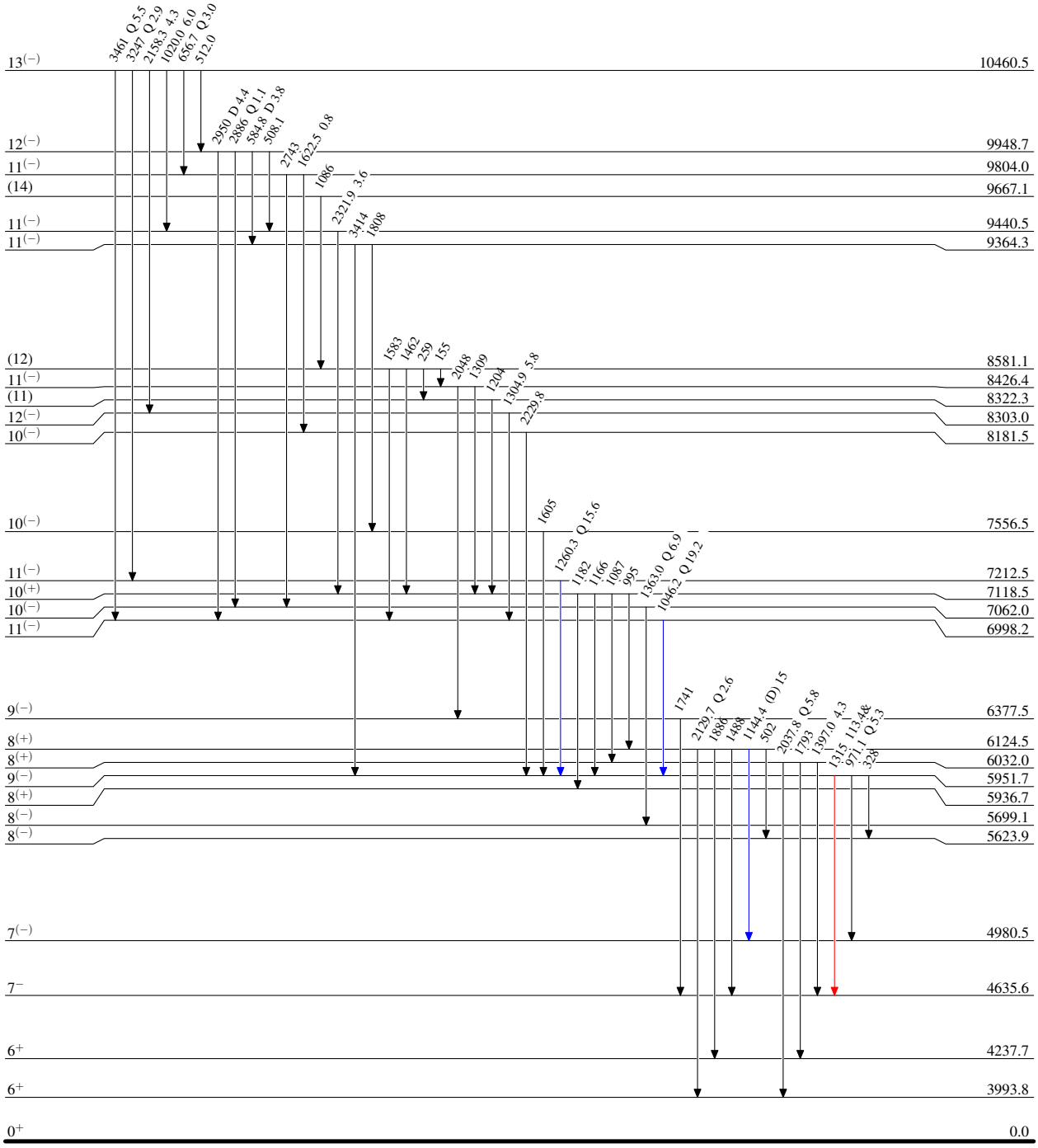
$^{64}_{30}Zn_{34}$

^{40}Ca(^{28}Si,4pγ) E=122 MeV 2004Ka18

Level Scheme (continued)

Intensities: Relative I_γ
& Multiply placed: undivided intensity given

Legend
$I_\gamma < 2\% \times I_\gamma^{max}$
$I_\gamma < 10\% \times I_\gamma^{max}$
$I_\gamma > 10\% \times I_\gamma^{max}$



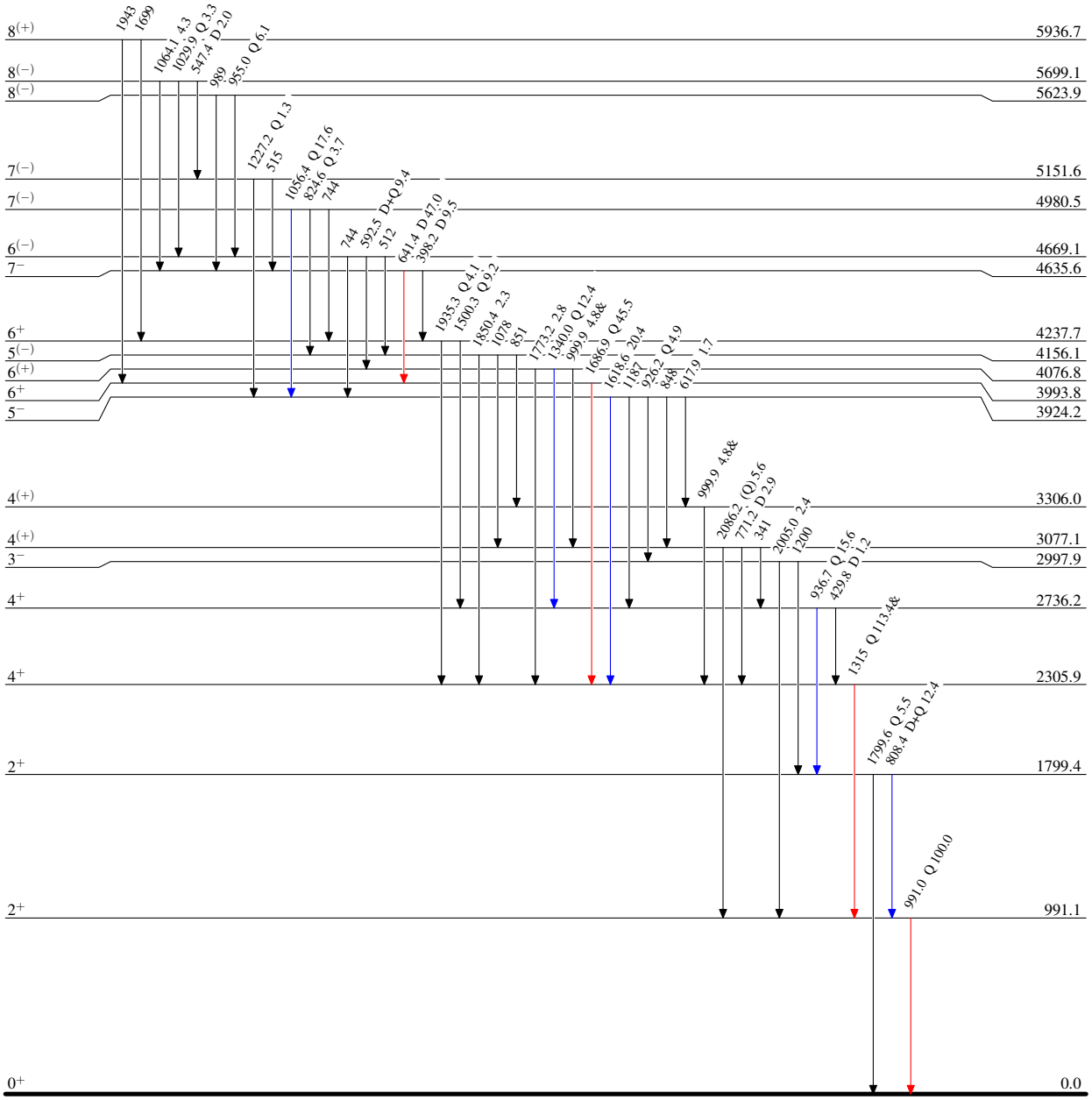
$^{64}_{30}Zn_{34}$

^{40}Ca(^{28}Si,4pγ) E=122 MeV 2004Ka18

Level Scheme (continued)

Intensities: Relative I_γ
& Multiply placed: undivided intensity given

Legend
$I_\gamma < 2\% \times I_\gamma^{max}$
$I_\gamma < 10\% \times I_\gamma^{max}$
$I_\gamma > 10\% \times I_\gamma^{max}$



$^{64}_{30}Zn_{34}$

^{40}Ca(^{28}Si,4pγ) E=122 MeV 2004Ka18