Coulomb excitation 1996Wu07,1993Os05

Type	Author	History Citation	Literature Cutoff Date
Full Evaluation	Coral M. Baglin	NDS 113, 1871 (2012)	15-Jun-2012

Others: 1957Ba11, 1958Ba43, 1958Mc02, 1961Mc01, 1961Re02, 1964De07, 1966Go06, 1967Ca08, 1967Gi02, 1969Ro03, 1972La16, 1972Si43, 1976Ba06, 1976Ja18, 1980Ba42, 1983Bo13, 1983Ch35, 1985St05, 1986Bi13, 1987St14, 1992St06, 1997Bb08, 2001Wu03.

The level scheme is from 1996Wu07, 1993Os05.

1996Wu07: enriched targets; E(^{40}Ca)=155 MeV, E(^{58}Ni)=190-235 MeV, E(^{136}Xe)=612-624 MeV, E(^{208}Pb)=952-1053 MeV; Ge, position sensitive avalanche and Si detectors; measured Eγ, γ yields, particle-γ coin, particle-recoil-γ coin (supersedes 1980WuZW, 1984WuZX, 1985WuZY; see also 1996Wu08, 1993Cl04). Deduced E2 matrix elements (static and transitional).

1993Os05: E(^{58}Ni)=240 MeV; 95% ^{192}Os target, 12 Ge detectors; measured Eγ, Iγ, particle-γ coin.

^{192}Os Levels

1996Wu07 determined 36 matrix elements from 225 pieces of data (213 γ yields from 15 independent Coulomb excitation experiments combined with four lifetimes, seven branching ratios and one mixing ratio from the literature), achieving a total χ^2 of 183. These are considered by the evaluator to embody the best information presently available from ^{192}Os Coulomb excitation. Consistency with earlier Coulomb excitation measurements is, in general, good. Averages with those data are used for only the 205γ (12 values) since the conclusions of 1996Wu07 may not be totally independent of those measurements. Data from 1993Os05 are adopted when no data are available from 1996Wu07; however, the 1993Os05 data appear to be somewhat preliminary, several are seriously inconsistent with data from 1996Wu07, and no details of their data analysis were published.

B(E2): data attributed to 1996Wu07 have been calculated by the evaluator from those authors' reported matrix elements, assuming the level spins indicated in this data set. The relative signs of many of those matrix elements have also been determined; please refer to 1996Wu07 for those. See also 1996Wu08, 1996Wu10 for extraction and discussion of intrinsic E2 matrix elements between bands for which $\Delta K=2$. B(E2) values measured in reactions other than Coulomb excitation may also be mentioned here to facilitate intercomparison of all B(E2) data; the reaction data set from which the datum is taken is specified in each of these cases. Otherwise, the data may be assumed to be from Coulomb excitation.

Excitation probabilities: 1969Ca19 (^{16}O), 1970Pr09 (α and ^{16}O), 1971Mi08 (proton, α, ^{16}O), 1988Li22 (α and ^{12}C), 1993Os05 (^{58}Ni), 1996Wu07 (^{58}Ni, ^{136}Xe, ^{208}Pb), 1997Bb08 (^{192}Os; inverse kinematics).

IMPAC, transient field: 1983St01 (^{32}S and ^{58}Ni), 1983St18 (^{32}S and ^{58}Ni).

IMPAC, polarized hosts: 1972Si43 (^{16}O).

Reorientation effects: 1980Ba42 (α, ^{16}O, ^{32}S), 1983Ch35 (^{16}O), 1988Fe04 (^{120}Sn), 1988Li22 (α and ^{12}C).

$\gamma(\theta$,H,t), $\gamma(\theta$,H): 1972Si03 (^{16}O), 1983Bo13 (^{58}Ni), 1983St01 (^{32}S and ^{58}Ni), 1983St18 (^{32}S and ^{58}Ni), 1985St05 (^{32}S and ^{58}Ni).

$\gamma(\theta)$, oriented nuclei: 1984St11 (^{58}Ni).

γ-particle(θ): 1986Bi13 (^{32}S), 1987St14 (^{58}Ni and ^{63}Cu).

E(level)[#]	J$^\pi$[†]	T$_{1/2}$[‡]	Comments
0.0[&]	0$^+$	stable	
205.7[&] *7*	2$^+$	288 ps *4*	B(E2)(g.s. to 206(2$^+$))=2.043 *22*. B(E2)↑: unweighted average of 2.04 *21* (1958Mc02), 1.92 *25* (1967Gi02), 2.21 *22* (1969Ca19), 2.04 *6* (1970Pr09), 1.99 *11* (1971Mi08), 2.09 *21* (1972La16), 2.10 *2* (muonic atom; 1981Ho22), 2.01 *3* (^{192}Os(e,e′); 1984Re10), 1.999 *23* (^{192}Os(e,e′); 1988Bo08), 2.030 *13* (1988Li22), 2.120 *+23−26* (1996Wu07), 1.97 *16* (1997Bb08). the weighted average of these data is 2.047 *13*. Static matrix element, <2$^+$ M(E2) 2+> =−1.21 *+6−17* (1996Wu07). g-factor=0.30 *4* (1967Gi02), 0.39 *3* (1972Si43), 0.383 *9* (1987St14, reevaluation of 0.393 *18* in 1985St05); g/g(^{188}Os 2$^+$)=1.31 *5* (1992St06).
489.1[a] *7*	2$^+$	32.6 ps *+9−10*	B(E2)(g.s. to 489(2$^+$))=0.185 *+7−4* (1996Wu07). B(E2)↑: other B(E2): 0.215 *19* (1969Ca19), 0.196 *12* (1971Mi08), 0.19 *3* ((e,e′), 1984Re10), 0.187 *6* ((e,e′), 1988Bo08). the unweighted average of all data is 0.195 *5*.

Continued on next page (footnotes at end of table)

Coulomb excitation 1996Wu07,1993Os05 (continued)

^{192}Os Levels (continued)

E(level)[#]	J$^{\pi}$[†]	T$_{1/2}$[‡]	Comments
			B(E2)(206(2$^+$) to 489(2$^+$))=0.303 *+17−8* (1996Wu07). Others: 0.36 *3* (1969Ca19), 0.33 *4* (1971Mi08), 0.37 *5* (muonic atom, 1981Ho22). Static matrix element, <2$^+$ M(E2) 2+> =+0.99 *+5−9* (1996Wu07). g-factor=0.32 *3* (1985St05). T$_{1/2}$: weighted average of 34.1 ps *+14−19* from B(E2)(283γ) and 32.1 ps *+8−13* from B(E2)(489γ).
580.2[&] *9*	4$^+$	14.7 ps *4*	B(E2)(206(2$^+$) to 580(4$^+$))=0.895 *24* (1996Wu07). Other values: 0.98 *9* (1969Ca19); 0.97 *12* (1971Mi08). B(E2)(489(2$^+$) to 580(4$^+$))=0.024 *+28−5* (1996Wu07). Static matrix element, <4$^+$ M(E2) 4+> =−0.73 *+26−6* (1996Wu07). g-factor=0.39 *4* (1985St05).
690.3[a] *8*	3$^+$		
909.5[a] *9*	4$^+$	9.8 ps *4*	B(E2)(489(2$^+$) to 910(4$^+$))=0.536 *+16−21* (1996Wu07). Other: 0.31 *6* (1969Ca19). B(E2)(580(4$^+$) to 910(4$^+$))=0.203 *+24−12* (1996Wu07). Other: 0.37 *18* (1969Ca19). B(E2)(206(2$^+$) to 910(4$^+$))=0.0034 *+3−4* (1996Wu07). Static matrix element, <4$^+$ M(E2) 4+> =−0.83 *+9−8* (1996Wu07). T$_{1/2}$: from B(E2)(421γ); 9.7 ps *+12−15* from B(E2)(329γ), 9.0 ps *+13−8* from B(E2)(704γ). g-factor=0.43 *9* (1985St05).
956.4[c] *9*	0$^+$	10.3 ps *+10−11*	B(E2)(489(2$^+$) to 956(0$^+$))=0.040 *+4−3* (1996Wu07). Other: 0.0154 *16* (1993Os05), inconsistent with datum from 1996Wu07. B(E2)(206(2$^+$) to 956(0$^+$))=0.00079 *+22−23*, assuming adopted branching (1996Wu07). T$_{1/2}$: from B(E2)(467γ); 10 ps *3* from B(E2)(751γ).
1069.5[b] *8*	4$^+$	6.5 ps *+11−9*	B(E2)(489(2$^+$) to 1069(4$^+$))=0.124 *+11−18* (1996Wu07). Other: 0.103 *11* (1993Os05). B(E2)(206(2$^+$) to 1069(4$^+$))=0.0026 *+25−12* (1996Wu07). Other: 0.021 *15* (1993Os05); inconsistent with datum from 1996Wu07 and with branching from other reactions. B(E2)(690(3$^+$) to 1069(4$^+$))=0.38 *+5−10*, assuming transition is E2 (1996Wu07). B(E2)(910(4$^+$) to 1069(4$^+$))=0.157 *+22−27*, assuming transition is E2 (1996Wu07). Static matrix element, <4$^+$ M(E2) 4+> =+1.28 *+15−41* (1996Wu07). T$_{1/2}$: from B(E2)(580γ). state contains a significant two-phonon γ vibrational component (based on systematics of E, branching, E2 strengths, static Q), but must also contain a hexadecapole component (based on E4 strength and transfer reaction cross sections) (2001Wu03 and subsequent discussion of that paper).
1088.5[&] *14*	6$^+$	2.47 ps *+8−13*	B(E2)(580(4$^+$) to 1089(6$^+$))=0.95 *+5−3* (1996Wu07). Other: 1.26 *25* (1969Ca19). B(E2)(910(4$^+$) to 1089(6$^+$))=0.017 *+9−10* (1996Wu07). Static matrix element, <6$^+$ M(E2) 6+> =−1.16 *+11−26* (1996Wu07).
1127.4[c] *8*	(2$^+$)		B(E2)(690(3$^+$) to 1128(2$^+$))=0.0101 *10* (1993Os05). B(E2)(489(2$^+$) to 1128(2$^+$))=0.00247 *25* (1993Os05).
1143.4[a] *13*	5$^+$		
1206.2 *12*	0$^+$	35 ps *13*	B(E2)(206(2$^+$) to 1206(0$^+$))=0.00032 *12* (1993Os05).
1341.1 *7*	3$^-$	78 ps *10*	B(E3)=0.37 *4* (1993Os05); inconsistent with B(E3)=0.131 *9* adopted from (e,e′).
1361.9[b] *12*	(5$^+$)		
1465.0[a] *11*	6$^+$	2.73 ps *+36−21*	B(E2)(910(4$^+$) to 1465(6$^+$))=0.49 *+3−6* (1996Wu07). B(E2)(580(4$^+$) to 1465(6$^+$))=0.0005 *+52−5* (1996Wu07); γ not observed. B(E2)(1089(6$^+$) to 1465(6$^+$))=0.171 *+36−14* (1996Wu07). Static matrix element, <6$^+$ M(E2) 6+> =−1.35 *+11−37* (1996Wu07). T$_{1/2}$: from B(E2)(556γ).
1645.0[b] *12*	(6$^+$)		
1708.0[&] *17*	8$^+$	0.81 ps *4*	B(E2)(1089(6$^+$) to 1708(8$^+$))=0.99 *5* (1996Wu07). Static matrix element, <8$^+$ M(E2) 8+> =−1.31 *+18−36* (1996Wu07).
1967.8?[b] *15*	(7$^+$)		1993Os05 report a 323γ deexciting this level, but not the much stronger 606-keV branch which is expected; therefore, the evaluator considers excitation of this level to be uncertain.

Continued on next page (footnotes at end of table)

Coulomb excitation 1996Wu07,1993Os05 (continued)

^{192}Os Levels (continued)

E(level)[#]	J$^{\pi}$[†]	T$_{1/2}$[‡]	Comments
2133.6[@a] *15*	8$^+$	1.34 ps *+16−20*	B(E2)(1465(6$^+$) to 2134(8$^+$))=0.41 *+6−5* (1996Wu07). Static matrix element, <8$^+$ M(E2) 8+> =−0.9 *+5−3* (1996Wu07).
2418.4[&] *20*	10$^+$	0.45 ps *+11−4*	B(E2)(1708(8$^+$) to 2418(10$^+$))=0.85 *+7−20* (1996Wu07).
2894.0[a] *18*	10$^+$		
3103.5 *22*	(12$^+$)	≥2.1 ps	B(E2)(2419(10$^+$) to 3104(12$^+$))≤0.21 (1996Wu07). Member of π=+ band whose states are yrast for J≥12.
3210.5[&] *22*	12$^+$		

[†] From Adopted Levels.
[‡] Deduced by evaluator from B(E2) and adopted γ-ray properties.
[#] From least-squares fit to Eγ, omitting transitions with uncertain placement and allowing 1 keV uncertainty In Eγ.
[@] E=2153.6 in 1993Os05, based on a tentative ΔE=688.3 intraband transition and a definite ΔE=445.2 transition to the 8$^+$ 1708 level. Based on the present scheme, ΔE=426 for the latter transition, and 1996Wu07 do not report it (1996Wu07 report only a 668.6 keV intraband transition). No γ near 426, 445 or 688 keV is evident in the γ spectrum of 1993Os05, but a 669γ could be present. The evaluator adopts the conclusions of 1996Wu07.
[&] Band(A): K$^{\pi}$=0$^+$ g.s. band.
[a] Band(B): K$^{\pi}$=2$^+$ quasi-γ vibration band.
[b] Band(C): K$^{\pi}$=4$^+$ band.
[c] Band(D): possible K=0 band (1993Os05).

γ(^{192}Os)

E$_i$(level)	J$_i^{\pi}$	E$_{\gamma}$[†]	I$_{\gamma}$[‡]	E$_f$	J$_f^{\pi}$	Mult.[#]	δ	α[a]	Comments
205.7	2$^+$	205.8		0.0	0$^+$	E2[&]		0.302	
489.1	2$^+$	283.3	48.6 *27*	205.7	2$^+$	M1+E2	−3.2 *+9−3*	0.126 *14*	I$_{\gamma}$: ΔI$_{\gamma}$ is +27-13. M1 transition matrix element: −0.093 *+36−7* (1996Wu07). δ: from E2 and M1 transition matrix elements (1996Wu07). Others: −3.1 *10* (1971Mi08, from particle-$\gamma(\theta)$); −4.7 *+7−6* (1969Ro03, from beam-$\gamma(\theta)$ and beam-$\gamma\gamma(\theta)$).
		489.1	100 *4*	0.0	0$^+$	E2		0.0241	I$_{\gamma}$: ΔI$_{\gamma}$ is +4-2.
580.2	4$^+$	(91.2)	0.0022	489.1	2$^+$	[E2]		6.36	I$_{\gamma}$: ΔI$_{\gamma}$ is +27-5. E$_{\gamma}$: from adopted level energy difference; γ is not observed and is otherwise unknown, so it is not included in Adopted Gammas.
		374.5	100 *3*	205.7	2$^+$	E2[&]		0.0484	
690.3	3$^+$	484.6		205.7	2$^+$				
909.5	4$^+$	329.3	13.9 *16*	580.2	4$^+$	M1+E2	−1.51 *+13−22*	0.110 *8*	I$_{\gamma}$: ΔI$_{\gamma}$ is +16-8. M1 transition matrix element: −0.245 *+33−17* (1996Wu07). δ: from E2 and M1 transition matrix elements (1996Wu07); presumed to supersede +1.74≤δ≤+3.15 from 1980WuZW.
		420.5	100 *4*	489.1	2$^+$	E2[&]		0.0354	I$_{\gamma}$: ΔI$_{\gamma}$ is +3-4.
		703.8	8.3 *10*	205.7	2$^+$	E2		0.01031	I$_{\gamma}$: ΔI$_{\gamma}$ is +7-10.

Continued on next page (footnotes at end of table)

Coulomb excitation 1996Wu07,1993Os05 (continued)

$\gamma(^{192}Os)$ (continued)

E_i(level)	J_i^π	E_γ[†]	I_γ[‡]	E_f	J_f^π	Mult.[#]	α[a]	Comments
956.4	0^+	467.2	100 *9*	489.1	2^+	[E2]	0.0270	I_γ: from Adopted Gammas.
		750.7[@]	20 *3*	205.7	2^+	[E2]		I_γ: from Adopted Gammas. γ observed by 1993Os05 only.
1069.5	4^+	(160.0)	0.36 *6*	909.5	4^+	[E2]	0.723	E_γ: from adopted level energy difference; γ not observed. I_γ: ΔI_γ is +5-6.
		379.2	51 *13*	690.3	3^+	[E2]	0.0468	I_γ: ΔI_γ is +7-13. Mult.: assumed by 1996Wu07 for analysis of their data. Adopted value is M1+E2 with δ=+3.3 *+15−12*.
		580.5	100 *15*	489.1	2^+	(E2)	0.01593	I_γ: ΔI_γ is +9-15.
		863.7[@]	15 *14*	205.7	2^+	[E2]		I_γ: ΔI_γ is +14-7.
1088.5	6^+	(179.6)	0.010 *6*	909.5	4^+	[E2]	0.480	γ not observed; not included in Adopted Gammas. Eγ from adopted level energy difference.
		508.3	100 *5*	580.2	4^+	E2[&]	0.0219	I_γ: ΔI_γ is +5-3.
1127.4	(2^+)	171.0[@]		956.4	0^+			
		437.1[@]		690.3	3^+	(M1+E2)	0.06 *4*	
		638.4[@]		489.1	2^+	(M1+E2)	0.024 *12*	
		921.7[@]		205.7	2^+	[E2]		
1143.4	5^+	453.1		690.3	3^+	[E2]	0.0292	
		563.2[@b]		580.2	4^+	[M1,E2]	0.033 *16*	
1206.2	0^+	1000.5[@]		205.7	2^+	[E2]		
1341.1	3^-	271.7[@]		1069.5	4^+	(E1+M2)	0.7 *7*	
		650.8[@]		690.3	3^+	[E1]		
		852.1[@]		489.1	2^+	(E1)		
		(1341)		0.0	0^+	(E3)		unobserved but expected; level is directly Coulomb excited.
1361.9	(5^+)	292.5[@]		1069.5	4^+	(M1+E2)	0.19 *9*	
		671.6[@b]		690.3	3^+	[E2]		
1465.0	6^+	376.1[@b]	7.1 *15*	1088.5	6^+	[E2]	0.0478	I_γ: ΔI_γ is +15-6.
		555.5	100 *12*	909.5	4^+	(E2)	0.01767	I_γ: ΔI_γ is +6-12.
		884.8	≤11	580.2	4^+			Iγ=1 *+10−1*.
1645.0	(6^+)	283.2[@]		1361.9	(5^+)			
		575.4		1069.5	4^+	[E2]	0.01626	
		735.6[@b]		909.5	4^+			
1708.0	8^+	619.5		1088.5	6^+	E2[&]	0.01371	
1967.8?	(7^+)	322.8[@b]		1645.0	(6^+)	[M1,E2]	0.14 *7*	
2133.6	8^+	668.6		1465.0	6^+	(E2)[&]	0.01155	
2418.4	10^+	710.4		1708.0	8^+	E2[&]	0.01011	
2894.0	10^+	760.3		2133.6	8^+	(E2)[&]		
3103.5	(12^+)	685		2418.4	10^+	(E2)[&]	0.01094	
3210.5	12^+	792		2418.4	10^+			

[†] From 1996Wu07 (uncertainty unstated), except as noted.
[‡] Relative branching deduced by evaluator using E2 transition matrix elements reported in 1996Wu07.
[#] From Adopted Gammas, except where noted.

Continued on next page (footnotes at end of table)

Coulomb excitation 1996Wu07,1993Os05 (continued)

$\gamma(^{192}Os)$ (continued)

@ From level energy difference in 1993Os05 (uncertainties unstated by authors).
& Intraband transition from state excited in multiple Coulomb excitation; assignments are shown as definite within g.s. band, tentative for others.
a 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.
b Placement of transition in the level scheme is uncertain.

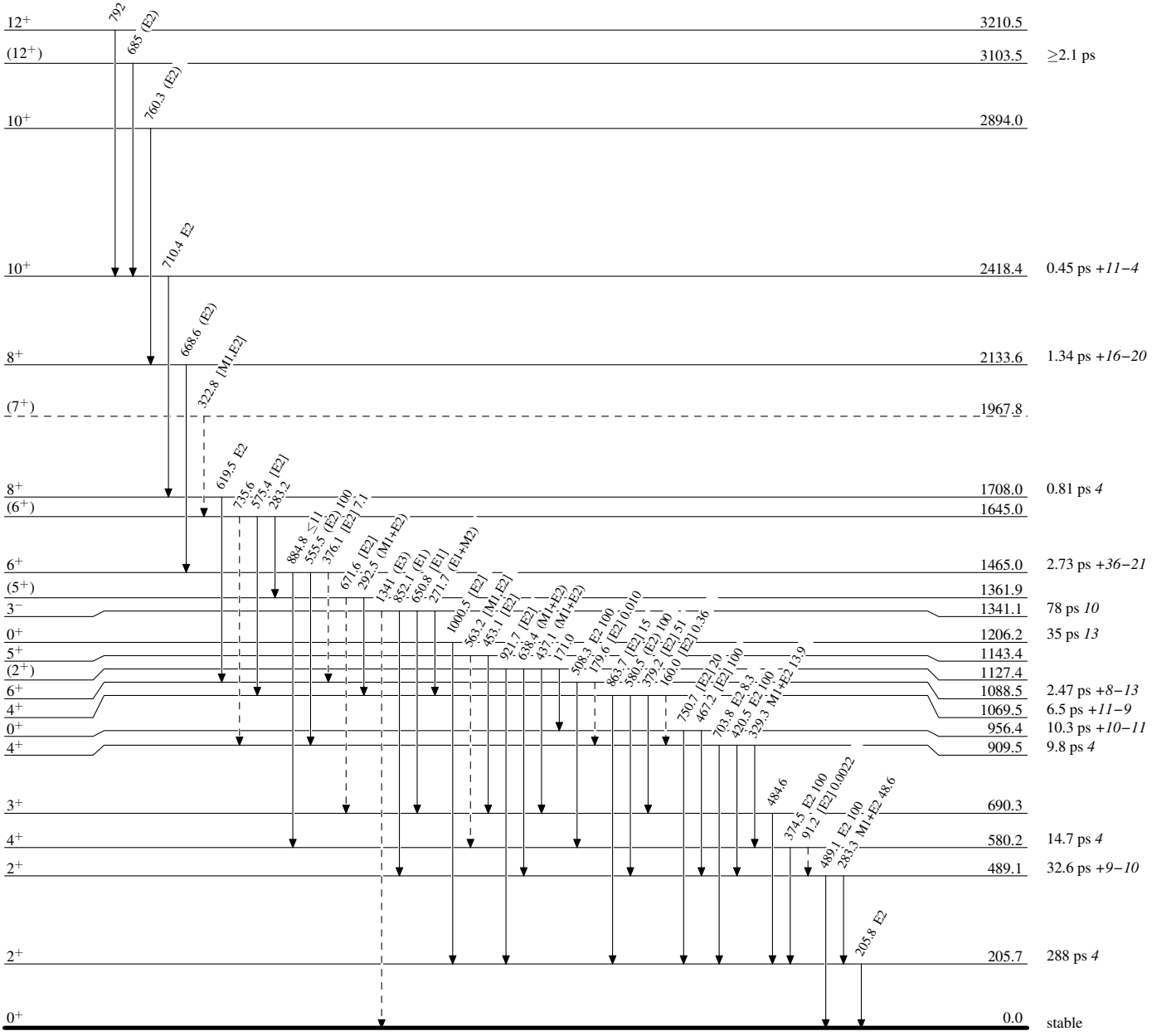
Coulomb excitation 1996Wu07,1993Os05

Legend

Level Scheme

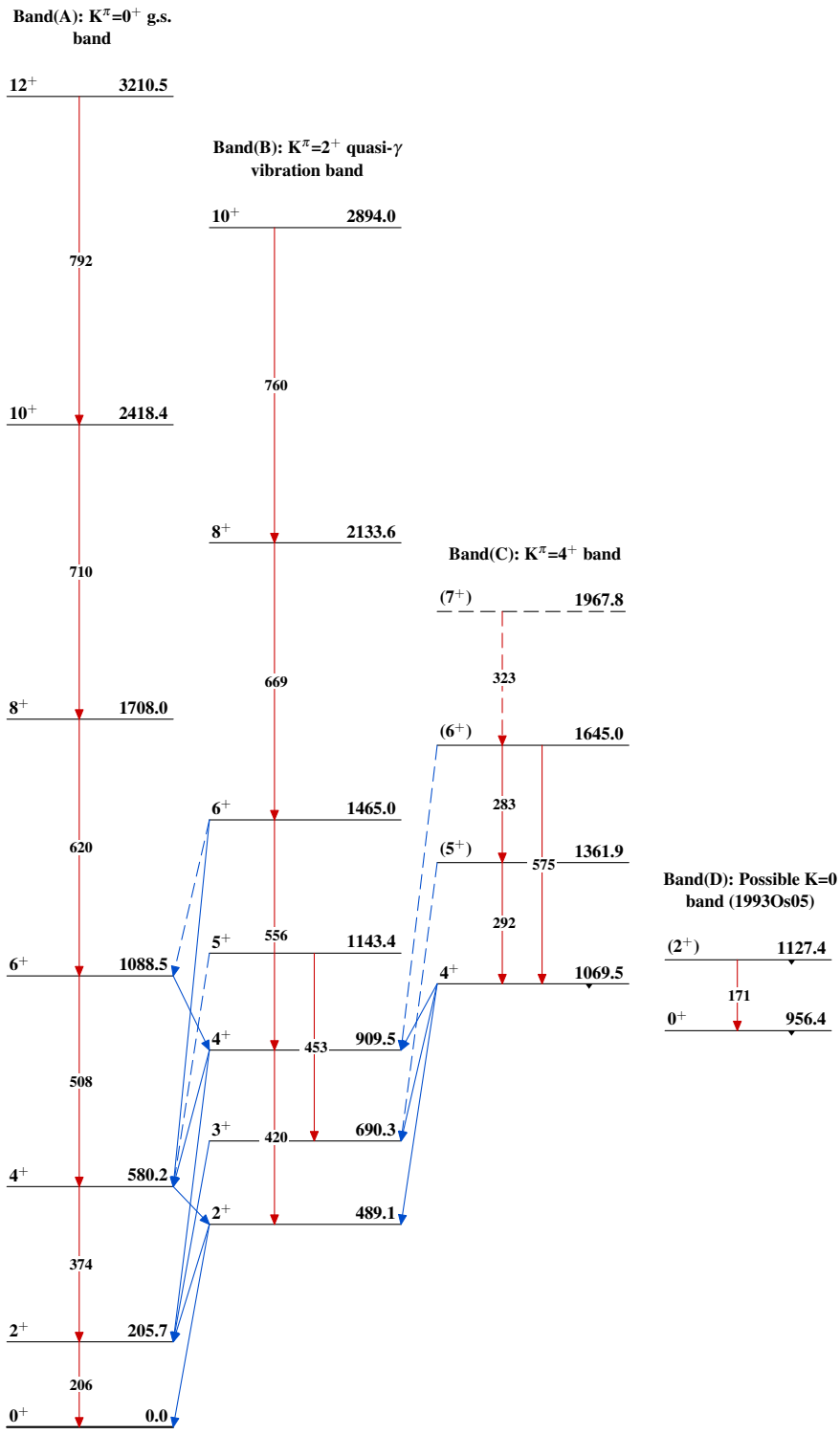
Intensities: Relative photon branching from each level

γ Decay (Uncertain)



$^{192}_{76}Os_{116}$

Coulomb excitation 1996Wu07,1993Os05



$^{192}_{76}Os_{116}$