Coulomb excitation **1996Wu07,2001Wu03,1985St05**

History

Type	Author	Citation	Literature Cutoff Date
Full Evaluation	F. G. Kondev, S. Juutinen, D. J. Hartley	NDS 150, 1 (2018)	1-Feb-2018

1996Wu07 (also 1984WuZX): (^{40}Ca,^{40}Ca′) E=155.0 MeV; (^{58}Ni,^{58}Ni′) E=190.0, 209.7 MeV; (^{208}Pb,^{208}Pb′) E=1007.0 MeV. Measured Eγ, Iγ, γγ. Deduced 36 (mainly E2) matrix elements from 242 experimental γ-ray yields obtained from 16 independent Coulomb excitation measurements. The analysis utilized five lifetimes, nine branching ratios and one E2/M1 mixing ratio from literature.

2001Wu03: (^{58}Ni,^{58}Ni′) E=275 MeV. Measured lifetimes by recoil-distance method (RDM) using SPEEDY array consisting of 7 segmented clover detectors and one 70% efficient Ge detector in coin with an array of solar cells for backscattered particles.

1997Bb08: ^{12}C(^{188}Os,^{188}Os′) E=270 MeV. Deduced $T_{1/2}$.

1985St05 (also 1992St06,1987St14,1984St11): (^{58}Ni,^{58}Ni′) E=220 MeV; (^{32}S,^{32}S′) E=95 MeV; (^{63}Cu,^{63}Cu′) E=230 MeV. Measured relative population to different states, g-factors by γ(θ,H) using IMPAC technique.

1998St15, 1996St22, 1994St23: (^{16}O,^{16}O′) E=36 MeV; (^{32}S,^{32}S′) E=80 MeV; (^{58}Ni,^{58}Ni′) E=150 MeV. Measured γ(θ,H,t), IMPAC technique, deduced hyperfine fields.

g-factor measurements: 1996St22, 1994St23, 1992St06, 1985St05 (also 1984St11), 1982Le02, 1972Si03 (also 1972Si43,1972SiYG), 1971SiYO, 1970Be36, 1967Gi02, 1966Go06, 1964Sp02, 1963Go05.

Q measurements: 1980Ba42 (also 1978BaYK), 1975Ro24, 1972La16 (also 1971LaZO,1970Pr09), 1964Sp09. Reorientation technique in Coul. ex.

Others:

1982Le02: (^{32}S,^{32}S′) E=80 MeV. g-factor measurement using transient field technique.

1980Ba42, 1972La16 (also 1978BaYK,1971LaZO): (^{32}S,^{32}S′) E=62 MeV; (^{16}O,^{16}O′) E=48 MeV; (α,α′) E=14.5 MeV. Measured Q.

1975Ro24: (^{16}O,^{16}O′) E=40 MeV. Measured γγ(θ,H), deduced quadrupole moment ratio.

1972Si43 (also 1972Si03,1972SiYG): (^{16}O,^{16}O′) E=36 MeV. Measured γ(θ,H), deduced g-factor.

1971Mi08 (also 1968MiZZ): (^{16}O,^{16}O′) E=42, 45.1, 45.5 MeV; (α,α′) E=15 MeV; (p,p′) E=4.56-5.08 MeV. Measured γ, particle γ coin.

1970Pr09: (^{16}O,^{16}O′) E=42, 47, 52, 53 MeV; (α,α′) E=10, 11, 12 MeV. Deduced Q.

1970Be36: (^{16}O,^{16}O′). Measured γ(θ,H), deduced g-factor.

1969Ca19 (also 1971SiYO,1967Ca08): (^{16}O,^{16}O′) E=40 MeV; (^{32}S,^{32}S′) E=90 MeV. Measured ^{16}O γ(θ), γ(θ,H,t), deduced g-factor.

1967Gi02, 1966Go06: (^{16}O,^{16}O′) E=35.4 MeV. Measured γ(θ,H), deduced g-factor.

1966As03: (^{16}O,^{16}O′) E≈36 MeV. Measured $T_{1/2}$(level) by recoil method.

1964Sp09, 1964Sp02: relative quadrupole measurement and g-factor.

1964De07: (^{16}O,^{16}O′) E=18-44 MeV.

1963Go05: (p,p′γ). Measured γ(θ,H), deduced g-factor.

1961Mc01 (also 1961Mc18,1958Mc02): (p,p′γ) E=4.5, 5.0 MeV.

1961Re02: (α,α′γ) and (p,p′γ) E=4.8, 3.5 MeV. Measured ce.

1958Ba43, 1957Ba11: (p,p′γ) E=4.5 MeV.

Relative population in (^{58}Ni,^{58}Ni′) at 220 MeV (1985St05)

Level	Relative Population
155	100
478	90
633	29
940	31
966	14
1086	1
1279	2
1425	4
1515	4

^{188}Os Levels

E(level)[†]	J$^{\pi}$[‡]	$T_{1/2}$[#]	Comments
0[a]	0$^+$		
155.0[a] *3*	2$^+$	0.704 ns *7*	g=+0.267 *26* (1985St05) Q=−1.15 *25* (1980Ba42) B(E2)↑=2.512 *32* (1996Wu07) $T_{1/2}$: From Adopted Levels. Directly measured values in Coulomb excitation: 0.645 ns *97* (RDM,2001Wu03), 0.714 ns *35* (1997Bb08), 0.707 ns *35* (RDM,1966As03), and 0.728 ns *69* (RDM,1963Go05). Other: 0.695 ns *10* from B(E2) in 1996Wu07. B(E2)↑: Others: 2.52 *13* (1976Ba06), 2.69 *27* (1972La16), 2.78 *15* (1971Mi08), 2.90 *8* (1970Pr09), 2.7 *4* (1967Ca08), 3.7 *5* (1961Re02), 3.17 *33* (1961Mc18), 2.80 *31* (1961Mc01,1958Mc02) and 3.5 *10* (1957Ba11). g: From $\gamma(\theta$,H) in Coulomb excitation. Others: 0.259 *25* (1984St11), 0.29 *3* (1972Si03,1972Si43,1972SiYG), 0.256 *26* (1971SiYO), 0.300 *15* (1982Le02), 0.285 *12* (1970Be36), 0.284 *21* (1967Gi02), 0.270 *18* (1966Go06), 0.23 *3* (1964Sp02), 0.20 *2* (1963Go05). 1992St06 quote a weighted average value of +0.298 *11*, which includes values obtained from studies other than Coulomb excitation. Q: earlier values from the same group: −1.32 *23* (1972La16), −1.31 *34* (1970Pr09). Others: 1975Ro24 and 1964Sp09 give ratios of Q′s for first 2$^+$ levels in ^{188}Os, ^{190}Os, ^{192}Os.
478.0[a] *6*	4$^+$	17.7 ps *10*	B(E2)↑=1.40 *+3−2* (1996Wu07) g=+0.36 *4* (1985St05) $T_{1/2}$: Other: 19.3 ps *+3−4* from B(E2)(from 155, 2$^+$). B(E2)↑: Others: 1.47 *15* (1971Mi08), 1.41 *11* (1969Ca19), 1.36 *20* (1967Ca08). g: From $\gamma(\theta$,H) (1985St05). Other: g(478)/g(155)=1.32 *17* (1984St11).
633.0[b] *4*	2$^+$	9.4 ps *10*	B(E2)↑=0.233 *+2−9* (1996Wu07) g=+0.39 *4* (1985St05) Q=+1.00 *25* (1980Ba42) B(E2)↑: from g.s. Others: 0.247 *15* (1971Mi08) 0.250 *22* (1969Ca19), 0.211 *30* (1967Ca08), 0.20 *6* (1961Mc01). B(E2)(from 155,2$^+$)=0.150 *4* (1996Wu07). Others: 0.156 *11* (1971Mi08), 0.146 *13* (1969Ca19), 0.164 *24* (1967Ca08). B(E2)(from 478,4$^+$)=0.016 *+4−5* (1996Wu07). B(E2)(633,2$^+$ to 155,2$^+$)/B(E2)(633,2$^+$ to g.s.)=3.5 *2* (1980Ba42). g: From $\gamma(\theta$,H) in Coulomb excitation. Other: g(633)/g(155)=1.45 *18* (1984St11). $T_{1/2}$: Other: 6.46 ps *+26−9* from B(E2)(from 0, 0$^+$).
789.9[b] *6*	3$^+$		
940.3[a] *7*	6$^+$	2.95 ps *17*	B(E2)↑=1.217 *21* (1996Wu07) g=+0.41 *6* (1985St05) B(E2)↑: from 633,4$^+$. Other: 1.68 *26* (1969Ca19). $T_{1/2}$: Other: 3.09 ps *5* from B(E2)(from 633, 4$^+$). g: From $\gamma(\theta$,H) in Coulomb excitation. Additional information 1.
965.2[b] *5*	4$^+$	6.0 ps *5*	g=+0.40 *12* (1985St05) B(E2)↑=0.0160 *9* (1996Wu07) B(E2)↑: from 155,2$^+$. Other: 0.020 *4* (1969Ca19). B(E2)(from 478,4$^+$)=0.135 *7* (1996Wu07). Other: 0.159 *32* (1969Ca19). B(E2)(from 633,2$^+$)=0.63 *+5−4* (1996Wu07). Other: 1.05 *35* (1969Ca19). B(E2)(from 940,6$^+$)=0.025 *+6−11* (1996Wu07). g: From $\gamma(\theta$,H) in Coulomb excitation. $T_{1/2}$: Other: 5.7 ps *6* from B(E2)(from 155, 2$^+$). Additional information 2.
1086.1 *7*	0$^+$	11.5[@] ps *6*	B(E2)↑=0.00122 *6* (1996Wu07) B(E2)↑: from 155, 2$^+$. Other: 0.0061 *15* (1969Ca19). B(E2)(from 633,2$^+$)=0.0055 *+4−3* (1996Wu07). Additional information 3.
1278.7 *6*	4$^+$	3.9 ps *8*	B(E2)↑=0.138 *+13−10* (1996Wu07) B(E2)↑: from 633, 2$^+$. B(E2)(from 155,2$^+$)=0.0030 *11* (1996Wu07).

Continued on next page (footnotes at end of table)

Coulomb excitation 1996Wu07,2001Wu03,1985St05 (continued)

^{188}Os Levels (continued)

E(level)[†]	Jπ[‡]	$T_{1/2}$[#]	Comments
			B(E2)(from 965,4$^+$)=0.299 *26* (1996Wu07), assuming pure E2. $T_{1/2}$: Other: 3.3 ps *+3−4* from B(E2)(from 633, 2$^+$). Additional information 4. Static E2 matrix element (1279 to 1279)=+2.68 *+22−19* (1996Wu07).
1424.1[b] *6*	(6$^+$)	4.0[@] ps *4*	B(E2)↑=0.67 *6* (1996Wu07) B(E2)↑: from 965, 4$^+$. B(E2)(from 940,6$^+$)=0.164 *+21−40* (1996Wu07). B(E2)(from 478,4$^+$)=0.00179 *+24−12* (1996Wu07). $T_{1/2}$: from B(E2)(from 965,4$^+$). Additional information 5. Static E2 matrix element (1424 to 1424)=−1.33 *+23−56* (1996Wu07).
1514.8[a] *8*	8$^+$	0.96 ps *6*	B(E2)↑=1.21 *7* (1996Wu07) B(E2)↑: from 940, 6$^+$. $T_{1/2}$: Other: 0.96 ps *6* from B(E2)(940, 6$^+$). Additional information 6. Static E2 matrix element (1515 to 1515)=−1.38 *+44−26* (1996Wu07).
1979.1[b] *12*	8$^+$	2.8[@] ps *+15−5*	B(E2)↑=0.50 *+9−27* (1996Wu07) B(E2)↑: from 1424,6$^+$. Additional information 7. Static E2 matrix element (1979 to 1979)=−2.4,−0.8 (1996Wu07).
2169.9[a] *10*	10$^+$	0.39[@] ps *+3−5*	B(E2)↑=1.47 *+20−12* (1996Wu07) B(E2)↑: from 1515, 8$^+$. Additional information 8. Static E2 matrix element (2170 to 2170)=−1.73,−0.8 (1996Wu07).
2868.9[&a] *14*	12$^+$	0.60[@] ps *10*	B(E2)↑=0.67 *11* (1996Wu07) B(E2)↑: from 2170, 10$^+$. Additional information 9.
2929.9[&] *14*	12$^+$	2.4[@] ps *+42−6*	B(E2)↑=0.11 *+4−7* (1996Wu07) B(E2)↑: from 2170, 10$^+$. Additional information 10.

[†] From least-squares fit to Eγ.
[‡] From Adopted Levels.
[#] From 2001Wu03 using the recoil-distance method, unless otherwise stated.
[@] From B(E2)′s in 1996Wu07 and the corresponding branching ratios.
[&] Level not confirmed in (HI,xγ) and excluded from Adopted Levels.
[a] Band(A): g.s. band.
[b] Band(B): γ band.

Coulomb excitation 1996Wu07,2001Wu03,1985St05 **(continued)**

$\gamma(^{188}Os)$

E_γ †	I_γ †	E_i(level)	J_i^π	E_f	J_f^π	Mult.†	δ†	α#	Comments
(25.32 *8*)	2.7×10^{-5} *9*	965.2	4$^+$	940.3	6$^+$	[E2]		3.06×10^3	α(L)=2.31×10^3 *4*; α(M)=583 *9* α(N)=139.0 *20*; α(O)=20.3 *3*; α(P)=0.01613 *23* Iγ(24.9)/Iγ(487)=2.7×10^{-7} *9* from B(E2)′s of 1996Wu07.
155.044 *4*	100	155.0	2$^+$	0	0$^+$	E2		0.810	α(K)=0.324 *5*; α(L)=0.367 *6*; α(M)=0.0931 *13* α(N)=0.0224 *4*; α(O)=0.00334 *5*; α(P)=2.95×10^{-5} *5*
157.0@		789.9	3$^+$	633.0	2$^+$				
175.0 *3*	18.5 *11*	965.2	4$^+$	789.9	3$^+$	[M1,E2]		1.146 *17*	α(K)=0.948 *14*; α(L)=0.1530 *23*; α(M)=0.0351 *6* α(N)=0.00857 *13*; α(O)=0.001480 *22*; α(P)=0.0001102 *17*
312.00 *2*	3.49 *13*	789.9	3$^+$	478.0	4$^+$	E2(+M1)		0.233	α(K)=0.193 *3*; α(L)=0.0307 *5*; α(M)=0.00704 *10* α(N)=0.001720 *24*; α(O)=0.000297 *5*; α(P)=2.22×10^{-5} *4*
312.0 *10*	11 *4*	1278.7	4$^+$	965.2	4$^+$	(E2+M1)		0.233	α(K)=0.193 *4*; α(L)=0.0307 *5*; α(M)=0.00704 *12* α(N)=0.00172 *3*; α(O)=0.000297 *5*; α(P)=2.22×10^{-5} *4*
322.92 *2*	100	478.0	4$^+$	155.0	2$^+$	E2		0.0736	α(K)=0.0490 *7*; α(L)=0.0187 *3*; α(M)=0.00461 *7* α(N)=0.001112 *16*; α(O)=0.0001736 *25*; α(P)=4.97×10^{-6} *7*
332.62 *5*	34 *3*	965.2	4$^+$	633.0	2$^+$	E2		0.0675	α(K)=0.0455 *7*; α(L)=0.01680 *24*; α(M)=0.00413 *6* α(N)=0.000997 *14*; α(O)=0.0001561 *22*; α(P)=4.63×10^{-6} *7* Iγ(332)/Iγ(487)=0.37 *4* from B(E2)′s of 1996Wu07.
453.34 *4*	13.83 *14*	1086.1	0$^+$	633.0	2$^+$	(E2)		0.0291	α(K)=0.0215 *3*; α(L)=0.00587 *9*; α(M)=0.001418 *20* α(N)=0.000343 *5*; α(O)=5.50×10^{-5} *8*; α(P)=2.26×10^{-6} *4*
459.4 *5*	100 *4*	1424.1	(6$^+$)	965.2	4$^+$	[E2]		0.0282	α(K)=0.0208 *3*; α(L)=0.00563 *9*; α(M)=0.001358 *20* α(N)=0.000329 *5*; α(O)=5.28×10^{-5} *8*; α(P)=2.19×10^{-6} *4*
462.38 *7*	100	940.3	6$^+$	478.0	4$^+$	E2		0.0277	α(K)=0.0205 *3*; α(L)=0.00551 *8*; α(M)=0.001330 *19* α(N)=0.000322 *5*; α(O)=5.17×10^{-5} *8*; α(P)=2.16×10^{-6} *3*
478.00 *2*	80.2 *18*	633.0	2$^+$	155.0	2$^+$	E2+M1	−12 *3*	0.031 *4*	α(K)=0.0193 *4*; α(L)=0.00500 *8*; α(M)=0.001203 *18* α(N)=0.000291 *5*; α(O)=4.70×10^{-5} *7*; α(P)=2.04×10^{-6} *4* I_γ: Iγ(478)/Iγ(633)=0.80 *2* from B(E2)′s of 1996Wu07 and 0.72 4 in 1969Ca19. δ: from adopted gammas. Others: −15.9 *+14−25* from M1 and E2 matrix elements given by 1996Wu07; >30 (1969Ca19), >17 (1971Mi08) from γ(θ) in γ(θ,H) in Coulomb excitation. α: 0.031 *4*, deduced from α(K)exp=0.023 *3* (1959Ki44) and T/K=1.34 *3* from BrICC.
484.7 *5*	32.2 *9*	1424.1	(6$^+$)	940.3	6$^+$	[M1+E2]		0.0719 *11*	α(K)=0.0598 *9*; α(L)=0.00941 *14*; α(M)=0.00215 *3* α(N)=0.000525 *8*; α(O)=9.09×10^{-5} *13*; α(P)=6.83×10^{-6} *10* Iγ(484)/Iγ(459)=0.45 *12* from B(E2)′s of 1996Wu07.
487.70 *6*	100 *10*	965.2	4$^+$	478.0	4$^+$	M1+E2	+3.2 *+13−3*	0.0284 *20*	α(K)=0.0217 *18*; α(L)=0.00508 *21*; α(M)=0.00121 *5* α(N)=0.000294 *11*; α(O)=4.79×10^{-5} *21*;

$^{188}_{76}Os_{112}$-5

Coulomb excitation 1996Wu07,2001Wu03,1985St05 **(continued)**

$\gamma(^{188}Os)$ (continued)

E_γ [†]	I_γ [†]	E_i(level)	J_i^π	E_f	J_f^π	Mult.[†]	δ[†]	α[#]	$I_{(\gamma+ce)}$	Comments
										α(P)=2.35×10^{-6} *21* δ: from M1 and E2 matrix elements given by 1996Wu07. B(M1)(from 965,4$^+$ to 478,4$^+$)=0.0022 *+4−11* (1996Wu07). Additional information 11.
489.0 *4*	44.5 *12*	1278.7	4$^+$	789.9	3$^+$	(E2+M1)		0.0703		α(K)=0.0584 *9*; α(L)=0.00919 *13*; α(M)=0.00210 *3* α(N)=0.000513 *8*; α(O)=8.88×10^{-5} *13*; α(P)=6.67×10^{-6} *10*
555.0 *5*	100	1979.1	8$^+$	1424.1	(6$^+$)	[E2]		0.01770		α(K)=0.01356 *19*; α(L)=0.00317 *5*; α(M)=0.000757 *11* α(N)=0.000183 *3*; α(O)=2.99×10^{-5} *5*; α(P)=1.446×10^{-6} *21* E_γ,I_γ: From 1996Wu07. Uncertainty in Eγ estimated by evaluators.
574.4 *3*	100	1514.8	8$^+$	940.3	6$^+$	E2		0.01632		α(K)=0.01257 *18*; α(L)=0.00287 *4*; α(M)=0.000684 *10* α(N)=0.0001657 *24*; α(O)=2.71×10^{-5} *4*; α(P)=1.343×10^{-6} *19*
633.03 *3*	100.0 *8*	633.0	2$^+$	0	0$^+$	E2		0.01305		α(K)=0.01020 *15*; α(L)=0.00219 *3*; α(M)=0.000518 *8* α(N)=0.0001258 *18*; α(O)=2.07×10^{-5} *3*; α(P)=1.092×10^{-6} *16*
634.97 *4*	100.0 *13*	789.9	3$^+$	155.0	2$^+$	E2+M1	−7 *3*	0.0134 *9*		α(K)=0.0105 *8*; α(L)=0.00222 *10*; α(M)=0.000525 *23* α(N)=0.000127 *6*; α(O)=2.10×10^{-5} *10*; α(P)=1.13×10^{-6} *9*
645.9 *2*	100.0 *24*	1278.7	4$^+$	633.0	2$^+$	[E2]		0.01247		α(K)=0.00977 *14*; α(L)=0.00207 *3*; α(M)=0.000490 *7* α(N)=0.0001189 *17*; α(O)=1.96×10^{-5} *3*; α(P)=1.047×10^{-6} *15*
655.1	100	2169.9	10$^+$	1514.8	8$^+$	[E2]		0.01209		α(K)=0.00948 *14*; α(L)=0.00200 *3*; α(M)=0.000472 *7* α(N)=0.0001144 *16*; α(O)=1.89×10^{-5} *3*; α(P)=1.016×10^{-6} *15*
699[‡]	100	2868.9	12$^+$	2169.9	10$^+$	[E2]		0.01047		α(K)=0.00828 *12*; α(L)=0.001680 *24*; α(M)=0.000396 *6* α(N)=9.60×10^{-5} *14*; α(O)=1.591×10^{-5} *23*; α(P)=8.88×10^{-7} *13*
760[‡]	100	2929.9	12$^+$	2169.9	10$^+$	[E2]		0.00874		α(K)=0.00697 *10*; α(L)=0.001356 *19*; α(M)=0.000318 *5* α(N)=7.72×10^{-5} *11*; α(O)=1.285×10^{-5} *18*; α(P)=7.48×10^{-7} *11*
810.60 *8*	81 *8*	965.2	4$^+$	155.0	2$^+$	E2		0.00762		α(K)=0.00612 *9*; α(L)=0.001155 *17*; α(M)=0.000270 *4* α(N)=6.56×10^{-5} *10*; α(O)=1.096×10^{-5} *16*; α(P)=6.57×10^{-7} *10* Iγ(810)/Iγ(487)=0.77 *6* from B(E2)′s of 1996Wu07 and 0.90 23 in 1969Ca19.
931.34 *3*	100.0 *7*	1086.1	0$^+$	155.0	2$^+$	E2		0.00573		α(K)=0.00465 *7*; α(L)=0.000829 *12*; α(M)=0.000193 *3* α(N)=4.68×10^{-5} *7*; α(O)=7.88×10^{-6} *11*; α(P)=4.99×10^{-7} *7*
947.1 *5*	10.4 *9*	1424.1	(6$^+$)	478.0	4$^+$	[E2]		0.00554		α(K)=0.00450 *7*; α(L)=0.000798 *12*; α(M)=0.000185 *3* α(N)=4.50×10^{-5} *7*; α(O)=7.58×10^{-6} *11*; α(P)=4.83×10^{-7} *7* Iγ(946)/Iγ(459)=0.098 *19* from B(E2)′s of 1996Wu07.
1086.5		1086.1	0$^+$	0	0$^+$	E0			0.0082 *4*	
1124.0	35 *13*	1278.7	4$^+$	155.0	2$^+$	[E2]		0.00395		α(K)=0.00324 *5*; α(L)=0.000543 *8*; α(M)=0.0001253 *18* α(N)=3.05×10^{-5} *5*; α(O)=5.18×10^{-6} *8*; α(P)=3.47×10^{-7} *5*; α(IPF)=4.89×10^{-7} *7* I_γ: Deduced by the evaluators from the B(E2) value of 1996Wu07 by assuming Mult=E2 for the ΔJ=0 or 1 transitions.

$^{188}_{76}Os_{112}$-6

Coulomb excitation **1996Wu07,2001Wu03,1985St05** **(continued)**

$\gamma(^{188}Os)$ (continued)

† From adopted gammas, unless otherwise stated.
‡ Seen in (^{208}Pb,$^{208}Pb'$) only (1996Wu07).
# Additional information 12.
@ Placement of transition in the level scheme is uncertain.

$^{188}_{76}Os_{112}$-7

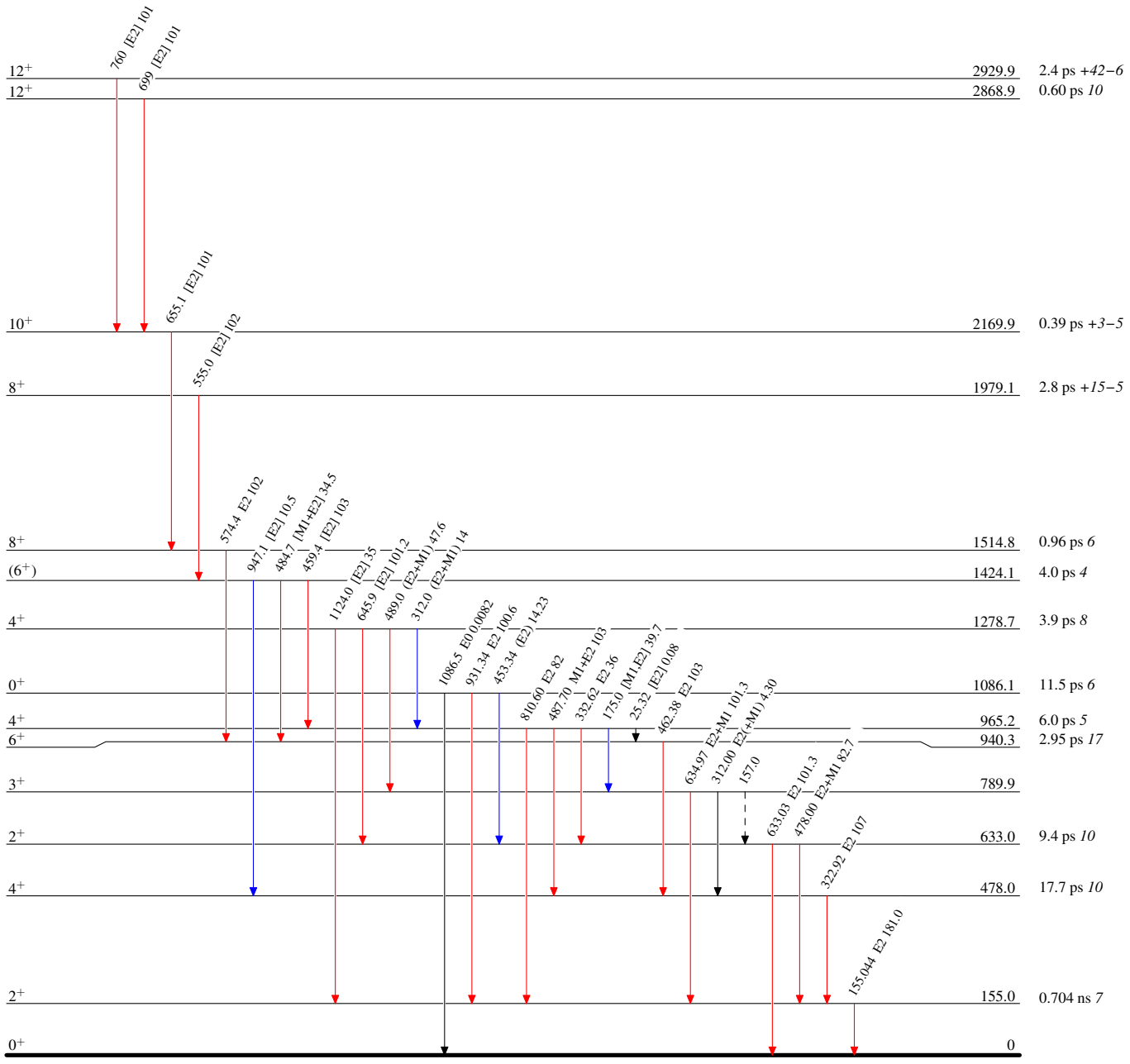
Coulomb excitation 1996Wu07,2001Wu03,1985St05

Level Scheme

Intensities: Relative $I_{(\gamma+ce)}$

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)



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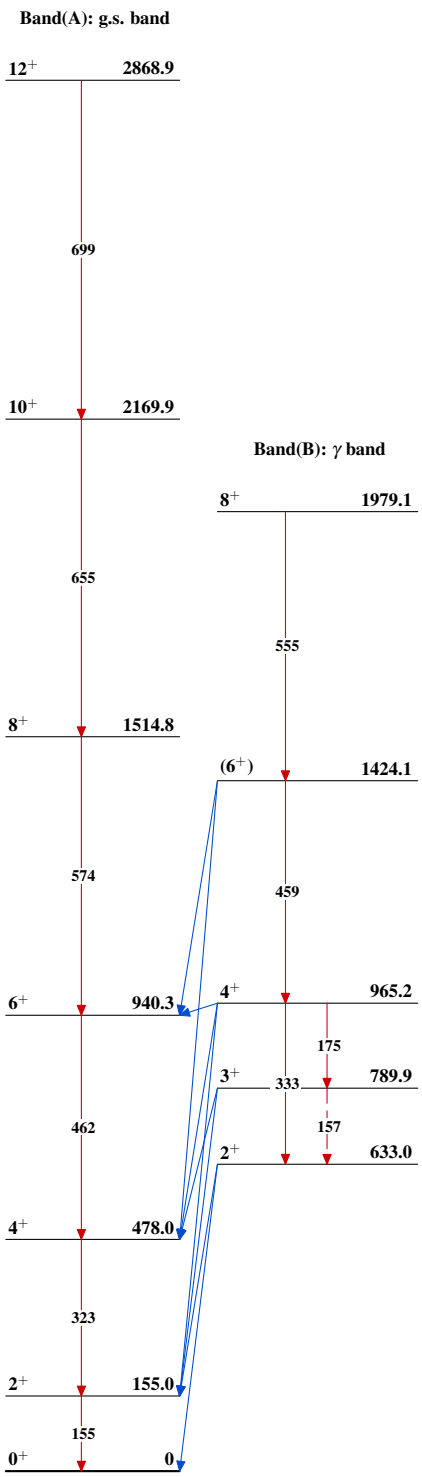
Coulomb excitation 1996Wu07,2001Wu03,1985St05



$^{188}_{76}Os_{112}$