(HI,xnγ) 1982Dr03,1988Bu19,1967Bu02

History

Type	Author	Citation	Literature Cutoff Date
Full Evaluation	E. Achterberg, O. A. Capurro, G. V. Marti	NDS 110, 1473 (2009)	31-May-2008

1988Bu19: ^{154}Sm(^{29}Si,5nγ), E=150, 155 MeV. Measured Eγ, Iγ, $\gamma\gamma$ coin, $\gamma\gamma(\theta)$. Deduced γ-ray multipolarities. Detector: HERA spectrometer array of 20 Compton-suppressed germanium detectors.

1982Dr03: ^{166}Er(^{16}O,4nγ), 96% enriched target, E=89.3 MeV. Measured Eγ, Iγ, $\gamma\gamma$ coin, $\gamma\gamma(\theta)$, E(ce), Ice. Detectors: Ge(Li), anti-Compton Ge(Li). Magnetic filter and Si(Li) detector for electron measurements.

Additional information 1.

1967Bu02,1967Bu18: ^{169}Tm(^{14}N,5nγ), E=93 MeV; ^{165}Ho(^{19}F,6n), E=120 MeV. Measured Eγ, Iγ, E(ce), Ice. Detectors: Ge(Li), magnetic spectrometer.

Others: 1981Dr06, 1980Dr10, 1973Ne08.

^{178}Os Levels

Level scheme is mainly from 1982Dr03, plus identification of an additional band structure in 1988Bu19, except where noted.
Except when indicated otherwise, energies, intensities, angular distribution coefficients, and band arrangement are from 1982Dr03.

E(level)	J$^\pi$	Comments
0.0[†]	0$^+$	
132.00[†] *20*	2$^+$	
398.4[†] *3*	4$^+$	
761.1[†] *4*	6$^+$	
1023.0? *5*	(4$^+$)	Tentative level, deexciting via a 624-keV γ to the 398-keV level.
1193.4[†] *4*	8$^+$	
1468.9[&] *5*	4$^-$	
1538.1[@] *5*	5$^-$	
1681.4[†] *5*	10$^+$	
1706.6[&] *5*	6$^-$	B(E1,946)/B(E2,238)=1.0×10^{-7} *2* b^{-1} (1982Dr03).
1780.5[@] *4*	7$^-$	B(E1,587)/B(E2,242)=7.5×10^{-7} *11* b^{-1}, B(E1,1020)/B(E2,242)=0.35×10^{-7} *5* b^{-1} (1982Dr03).
2018.1[&] *5*	8$^-$	
2096.4[a] *6*	(7)	
2097.7[@] *5*	9$^-$	B(E1,416)/B(E2,317)≈3.8×10^{-7} b^{-1}, B(E1,904)/B(E2,317)=1.3×10^{-7} *2* b^{-1} (1982Dr03).
2219.2[†] *5*	12$^+$	
2384.1[&] *6*	10$^-$	
2464.2[a] *6*	(9)	
2488.3[@] *5*	11$^-$	B(E1,807)/B(E2,391)=1.4×10^{-7} *3* b^{-1} (1982Dr03).
2804.1[†] *5*	14$^+$	
2817.0[&] *6*	12$^-$	
2905.5[a] *7*	(11)	
2950.3[@] *5*	13$^-$	
3314.5[&] *7*	14$^-$	
3402.3[a] *7*	(13)	
3428.7[†] *6*	16$^+$	
3473.5[@] *6*	15$^-$	
3506.1[#] *6*	16$^+$	
3872.9[&] *8*	16$^-$	
3948.8[a] *8*	(15)	

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(HI,xnγ) 1982Dr03,1988Bu19,1967Bu02 (continued)

^{178}Os Levels (continued)

E(level)	J$^{\pi}$	Comments
4019.5[†] 7	18$^+$	
4039.7[@] 7	17$^-$	
4140.0[#] 7	18$^+$	
4482.6[&] 9	18$^-$	
4544.6[a] 9	(17)	
4640.2[@] 8	19$^-$	
4662.4[†] 8	20$^+$	
4862.0[#] 8	20$^+$	
5129.6[&] 10	20$^-$	
5188.0[a] 10	(19)	
5290.5[@] 9	(21$^-$)	
5381.6[†] 9	(22$^+$)	
5584.0[#] 9	22$^+$	
5877.0[a] 11	(21)	
6153.9[†] 10	(24$^+$)	
6327.0?[#]	(24$^+$)	
6957.4[‡] 10	(26$^+$)	
6986.9? 11	(26$^+$)	Level not confirmed by 1988Bu19.
7787.4[‡] 10	(28$^+$)	
8651.2[‡] 11	(30$^+$)	
9551.7[‡] 12	(32$^+$)	
10488.5[‡] 12	(34$^+$)	
11461.3[‡] 13	(36$^+$)	
12470.3[‡] 15	(38$^+$)	
13517.3[‡] 18	(40$^+$)	
0.0+x[b]	(4$^+$)	Additional information 2. This is the lowest identified level for a proposed β band in 1982Dr03. These authors propose, on the basis of unassigned strong lines in the electron spectra at 689 and 692 keV, that these might represent E0 transitions linking to the g.s. band levels. They thus suggest for the energy of this level x≈1167 keV, assuming a 689 keV transition connecting from the second level of this new band to the 6$^+$ state in the g.s. band.
282.7+x[b] 4	(6$^+$)	
646.2+x[b] 5	(8$^+$)	
1081.6+x[b] 6	(10$^+$)	
1585.2+x[b] 7	(12$^+$)	
2153.4+x[b] 9	(14$^+$)	
2775.1+x[b] 9	(16$^+$)	

[†] Band(A): K^{π}=0$^+$ g.s. (yrast) rotational band.
[‡] Band(B): Rotational band (1988Bu19) Band established on the basis of coincidences of the intraband transitions with transitions in the g.s. rotational band. See 1988Bu19 for discussions regarding possible interpretations for the structure of this band.
[#] Band(C): "Yrare" sideband of the g.s. rotational band Established in 1980Dr10.
[@] Band(D): Negative parity rotational band (Band I, 1982Dr03).
[&] Band(E): Negative parity rotational band (Band II, 1982Dr03).
[a] Band(F): Rotational band (Band III, 1982Dr03).

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(HI,xnγ) 1982Dr03,1988Bu19,1967Bu02 (continued)

^{178}Os Levels (continued)

[b] Band(G): Tentative β band (1982Dr03) The energies of the other levels assigned to this band are relative to the bandhead at ≈ 1167 keV (1982Dr03). The suggested E0 nature of possible linking transitions (see Comment for 0.0+x level in the level table) also fixes the J^π sequence of this band, assuming a stretched E2 cascade.

γ(^{178}Os)

γ ray energies from 1982Dr03, except where noted. The energy uncertainties have been assigned by the evaluators based on the remark by the authors indicating a range of 0.2-0.4 keV, depending on energy and intensity of the peak.

The angular correlation parameter R from 1988Bu19 is determined from gated coincidences, with detectors at 30° and 100°. It is defined by R=I(γ1(30°),γ2(100°))/I(γ2(30°),γ1(100°)), where γ1 is a known quadrupole line, and γ2 is an unknown line. If the unknown γ is a stretched quadrupole, then R=1, while a stretched dipole would yield R=2.

E_γ	I_γ	E_i(level)	J^π_i	E_f	J^π_f	Mult.	α[&]	Comments
132.0 *2*	47.1 *14*	132.00	2+	0.0	0+	E2	1.468	Mult.: A_2=0.18 *4*, A_4=−0.05 *6*.
237.6 *3*	4.5[†] *7*	1706.6	6−	1468.9	4−			
242.4 *3*	4.0[†] *5*	1780.5	7−	1538.1	5−			
266.4 *2*	100	398.4	4+	132.00	2+	E2	0.1311	Mult.: A_2=0.222 *7*, A_4=−0.09 *1*. α_L(exp)≈0.029, theory: α_L(E2)=0.0386.
282.7 *4*	≈2	282.7+x	(6+)	0.0+x	(4+)			Additional information 3.
311.5 *2*	10.7 *6*	2018.1	8−	1706.6	6−			
317.1 *2*	11.7 *6*	2097.7	9−	1780.5	7−	(E2)	0.0776	Mult.: A_2=0.31 *2*, A_4=−0.11 *2*.
[x]328.0 *4*	1.7 *3*							
362.7 *2*	101 *2*	761.1	6+	398.4	4+	E2	0.0529	Mult.: Values for the (362.7γ+363.5γ) combination: A_2=0.242 *7*, A_4=−0.08 *1*; α_K(exp)=0.040 *7*, α_L(exp)=0.019 *5*, theory: α_K(E2)=0.0365, α_L(E2)=0.0123.
363.5 *3*	≈7	646.2+x	(8+)	282.7+x	(6+)	E2	0.0525	Mult.: See Comment for the 362.7-keV γ ray for justification of the suggested multipolarity.
366.0 *2*	10.9 *12*	2384.1	10−	2018.1	8−	E2	0.0516	Mult.: A_2=0.32 *3*, A_4=−0.10 *3*.
367.8[@] *4*	≈5[†]	2464.2	(9)	2096.4	(7)	E2	0.0509	Mult.: A_2=0.29 *4*, A_4=−0.09 *5*.
389.8 *4*	2.2 *6*	2096.4	(7)	1706.6	6−			
390.6 *2*	15.3 *7*	2488.3	11−	2097.7	9−	E2	0.0431	Mult.: A_2=0.29 *2*, A_4=−0.13 *2*.
416.4[@] *4*	1.3[†] *5*	2097.7	9−	1681.4	10+	(E1)	0.01144	Mult.: A_2=−0.12 *9*.
432.3 *2*	77.7 *12*	1193.4	8+	761.1	6+	E2	0.0329	Unresolved doublet in singles spectra: the other component has 432.9 keV. Mult.: Values for the (432.3γ+432.9γ) combination: A_2=0.28 *1*, A_4=−0.11 *1*; α_K(exp)=0.037 *7*, α_L(exp)=0.007 *3*, theory: α_K(E2)=0.024, α_L(E2)=0.00682.
432.9 *3*	9.8 *12*	2817.0	12−	2384.1	10−	E2	0.0328	Unresolved doublet in singles spectra: the other component has 432.3 keV. See Comment for 432.3 keV γ deexciting the 1193 keV level for angular distribution and α data.
435.4 *3*	6.6 *6*	1081.6+x	(10+)	646.2+x	(8+)	E2	0.0323	Mult.: A_2=0.43 *10*, A_4=−0.09 *11*.
441.3 *3*	6.0 *9*	2905.5	(11)	2464.2	(9)			
446.2 *4*	3.8[†] *7*	2464.2	(9)	2018.1	8−			
462.0 *2*	10.9[†] *8*	2950.3	13−	2488.3	11−	E2	0.0278	Mult.: A_2=0.27 *2*, A_4=−0.11 *2*.
488.1 *2*	58.4 *10*	1681.4	10+	1193.4	8+	E2	0.0242	Mult.: A_2=0.264 *8*, A_4=−0.11 *1*; α_K(exp)=0.020 *3*, α_L(exp)=0.005 *2*, theory: α_K(E2)=0.0181, α_L(E2)=0.00466.
496.8 *3*	6.0 *10*	3402.3	(13)	2905.5	(11)			
497.5 *2*	9.0 *9*	3314.5	14−	2817.0	12−	E2	0.0231	Mult.: A_2=0.22 *3*, A_4=−0.12 *3*.
503.6 *4*	5.0 *5*	1585.2+x	(12+)	1081.6+x	(10+)	E2	0.0224	Mult.: A_2=0.35 *4*, A_4=−0.13 *5*.

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(HI,xnγ) 1982Dr03,1988Bu19,1967Bu02 (continued)

γ(^{178}Os) (continued)

Eγ	Iγ	Ei(level)	J_i^π	Ef	J_f^π	Mult.	α[&]	Comments
513.4 *4*	3.2[†] *6*	4019.5	18+	3506.1	16+			
523.2 *3*	9.3 *5*	3473.5	15−	2950.3	13−	E2	0.0204	Mult.: A_2=0.29 *3*, A_4=−0.11 *3*.
537.8 *2*	41.2 *7*	2219.2	12+	1681.4	10+	E2	0.0191	Mult.: A_2=0.273 *9*, A_4=−0.112 *11*; α_K(exp)=0.0135 *15*, α_L(exp)=0.0024 *12*, theory: α_K(E2)=0.0145, α_L(E2)=0.00348.
546.5 *4*	4.1 *4*	3948.8	(15)	3402.3	(13)	E2	0.0184	Mult.: A_2=0.21 *6*, A_4=−0.08 *7*.
558.4 *4*	7.1 *5*	3872.9	16−	3314.5	14−	E2	0.01745	Mult.: A_2=0.30 *5*, A_4=−0.14 *6*.
566.2 *3*	8.0 *6*	4039.7	17−	3473.5	15−	E2	0.01689	Mult.: A_2=0.22 *3*, A_4=−0.08 *3*.
568.2 *4*	4.2 *6*	2153.4+x	(14+)	1585.2+x	(12+)	E2	0.01675	Mult.: A_2=0.35 *6*, A_4=−0.24 *8*.
584.9 *2*	27.6 *10*	2804.1	14+	2219.2	12+	E2	0.01565	Mult.: A_2=0.30 *2*, A_4=−0.14 *3*. Experimental α values for the (584.9γ+587.0γ) combination: α_K(exp)=0.0120 *2*, α_L(exp)=0.0023 *12*, theory: α_K(E2)=0.0121, α_L(E2)=0.00273.
587.0 *3*	9.3 *7*	1780.5	7−	1193.4	8+	E1	0.00547	Mult.: A_2=−0.32 *4*, A_4=+0.00 *4*. See also comment for the 584.9 keV γ regarding α values.
590.8 *4*	5.5 *4*	4019.5	18+	3428.7	16+	(E2)	0.01529	Mult.: A_2=0.22 *6*, A_4=−0.12 *7*. α_{tot}(exp)<0.015 (1982Dr03), theory: α_{tot}(E2)=0.0153.
595.8 *4*	2.7 *6*	4544.6	(17)	3948.8	(15)			
600.5 *4*	6.1 *9*	4640.2	19−	4039.7	17−	E2	0.01472	Mult.: A_2=0.24 *4*, A_4=−0.08 *5*.
609.7 *4*	6.2 *6*	4482.6	18−	3872.9	16−	E2	0.01422	Mult.: A_2=0.25 *5*, A_4=−0.11 *6*.
621.7 *4*	≈2	2775.1+x	(16+)	2153.4+x	(14+)			
624.6[a] *3*	3.8[a] *6*	1023.0?	(4+)	398.4	4+	(M1,E2)	0.025 *12*	This is a member of an unresolved doublet. The other component is placed in the level scheme deexciting the 3429 keV level. Mult.: Values for this unresolved doublet: A_2=0.18 *2*, A_4=−0.10 *3*; α_K(exp)=0.017 *2*, theory: α_K(M1)=0.031, α_K(E2)=0.0105.
624.6[a] *3*	15.0[a] *6*	3428.7	16+	2804.1	14+	(M1,E2)	0.025 *12*	This is a member of an unresolved doublet. The other component is placed in the level scheme deexciting a tentative 1023-keV level. Mult.: Values for this unresolved doublet: A_2=0.18 *2*, A_4=−0.10 *3*; α_K(exp)=0.017 *2*, theory: α_K(M1)=0.031, α_K(E2)=0.0105.
633.9 *4*	1.1[†] *3*	4140.0	18+	3506.1	16+			
642.9 *4*	4.5 *3*	4662.4	20+	4019.5	18+	E2	0.01260	Mult.: A_2=0.19 *5*, A_4=−0.12 *6*.
643.4 *4*	≈2[†]	5188.0	(19)	4544.6	(17)			
647.0 *4*	1.4 *3*	5129.6	20−	4482.6	18−	(E2)	0.01243	Mult.: A_2=0.21 *13*.
650.3 *4*	2.2 *5*	5290.5	(21−)	4640.2	19−			
689.0 *4*	≈1	5877.0	(21)	5188.0	(19)			Mult.: α_{tot}(exp)>0.09 (1982Dr03), theory: α_{tot}(M1)=0.0289, α_{tot}(E2)=0.0108. Based on the very high experimental α value, 1982Dr03 suggest that this transition has a strong E0 component. This disagrees with the tentative spin assignments in their level scheme. Note also that α_{tot}(M3,theory)=0.176.
701.9 *4*	3.5 *3*	3506.1	16+	2804.1	14+	E2	0.01037	Mult.: A_2=0.33 *7*, A_4=−0.15 *8*.
711.2 *4*	3.1 *3*	4140.0	18+	3428.7	16+	E2	0.01008	Mult.: A_2=0.39 *7*, A_4=−0.10 *8*.
719.2 *4*	2.5 *5*	5381.6	(22+)	4662.4	20+	E2	0.00984	1988Bu19 report Eγ=719.4 *2* keV, Iγ=6.3. Mult.: Angular correlation parameter R=1.0 *1* (1988Bu19).

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(HI,xnγ) 1982Dr03,1988Bu19,1967Bu02 (continued)

γ(^{178}Os) (continued)

Eγ	Iγ	Ei(level)	J^π_i	Ef	J^π_f	Mult.	α[&]	Comments
722.0[a] 4	≈2.6[a]	4862.0	20+	4140.0	18+			
722.0[a] 4	≈2.1[a]	5584.0	22+	4862.0	20+			
x731.0 4	≈1.0							
731.0 4	1.8 4	2950.3	13−	2219.2	12+			
743.0[b] 4	1.3 4	6327.0?	(24+)	5584.0	22+			
772.3 4	1.9[†] 6	6153.9	(24+)	5381.6	(22+)	E2	0.00844	1988Bu19 report Eγ=772.5 2 keV, Iγ=4.0. Mult.: Angular correlation parameter R=0.9 1 (1988Bu19).
777.0 3	7.5 12	1538.1	5−	761.1	6+	E1	0.00313	Mult.: A_2=−0.17 8, A_4=+0.08 9.
803.5[#] 2	3.3[‡]	6957.4	(26+)	6153.9	(24+)	E2	0.00776	Mult.: Angular correlation parameter R=1.1 1 (1988Bu19).
807.0 4	1.6 3	2488.3	11−	1681.4	10+	E1	0.00291	Mult.: A_2=−0.27 10.
x814.0 4	≤3.0							
830.0[#] 3	2.5[‡]	7787.4	(28+)	6957.4	(26+)	E2	0.00725	Mult.: Angular correlation parameter R=1.0 1 (1988Bu19).
833.0[b] 4	1.0 3	6986.9?	(26+)	6153.9	(24+)			Transition not seen by 1988Bu19.
x843.0 4	2.5[†] 6							
x850.6 4	3.0 6							
863.8[#] 3	1.8[‡]	8651.2	(30+)	7787.4	(28+)	E2	0.00668	Mult.: Angular correlation parameter R=1.1 1 (1988Bu19).
900.5[#] 4	1.3[‡]	9551.7	(32+)	8651.2	(30+)	E2	0.00613	Mult.: Angular correlation parameter R=1.1 1 (1988Bu19).
904.4 4	4.6 7	2097.7	9−	1193.4	8+	E1	0.00234	Mult.: A_2=−0.23 4, A_4=−0.03 4. Angular correlation parameter R=1.6 1 (1988Bu19).
x910.7 4	2.1 3					E1	0.00231	Mult.: A_2=−0.23 8, A_4=+0.01 9.
936.8[#] 4	1.0[‡]	10488.5	(34+)	9551.7	(32+)	E2	0.00566	Mult.: Angular correlation parameter R=0.8 2 (1988Bu19).
945.6 4	6.4 5	1706.6	6−	761.1	6+	(E1)	0.00216	Mult.: A_2=+0.31 2, A_4=−0.01 3. α_{tot}(exp)=0.002 3. The angular distribution coefficients suggest a possible ΔJ=0 dipole transition. The theoretical conversion coefficients are α_{tot}(E1)=0.0022, α_{tot}(M1)=0.0129, thus E1 seems the most likely value, but either value is possible in view of the experimental uncertainty in the conversion coefficient,
x968.9 4	≤3.0							
972.8[#] 5	0.7[‡]	11461.3	(36+)	10488.5	(34+)	E2	0.00525	Mult.: Angular correlation parameter R=0.9 2 (1988Bu19).
1009.0[#] 6	0.6[‡]	12470.3	(38+)	11461.3	(36+)			
1019.5 4	2.3 2	1780.5	7−	761.1	6+	(E1)	0.00188	Mult.: A_2=−0.10 8.
1047.0[#] 10	0.5[‡]	13517.3	(40+)	12470.3	(38+)			
x1059.0 4	1.7 3					E2	0.00443	Mult.: A_2=+0.37 10.
1070.4 4	2.7 4	1468.9	4−	398.4	4+	(D,Q)		Mult.: A_2=+0.25 5, A_4=−0.02 5.
x1092.0 5	≈1							
x1113.0 5	≈1							
1139.9[b] 4	0.6 3	1538.1	5−	398.4	4+			
x1202.0 5	≈1							

† Peak contaminated in singles spectra, intensity from coincidence spectra.
‡ Intensities from 1988Bu19.

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(HI,xnγ) 1982Dr03,1988Bu19,1967Bu02 (continued)

γ(^{178}Os) (continued)

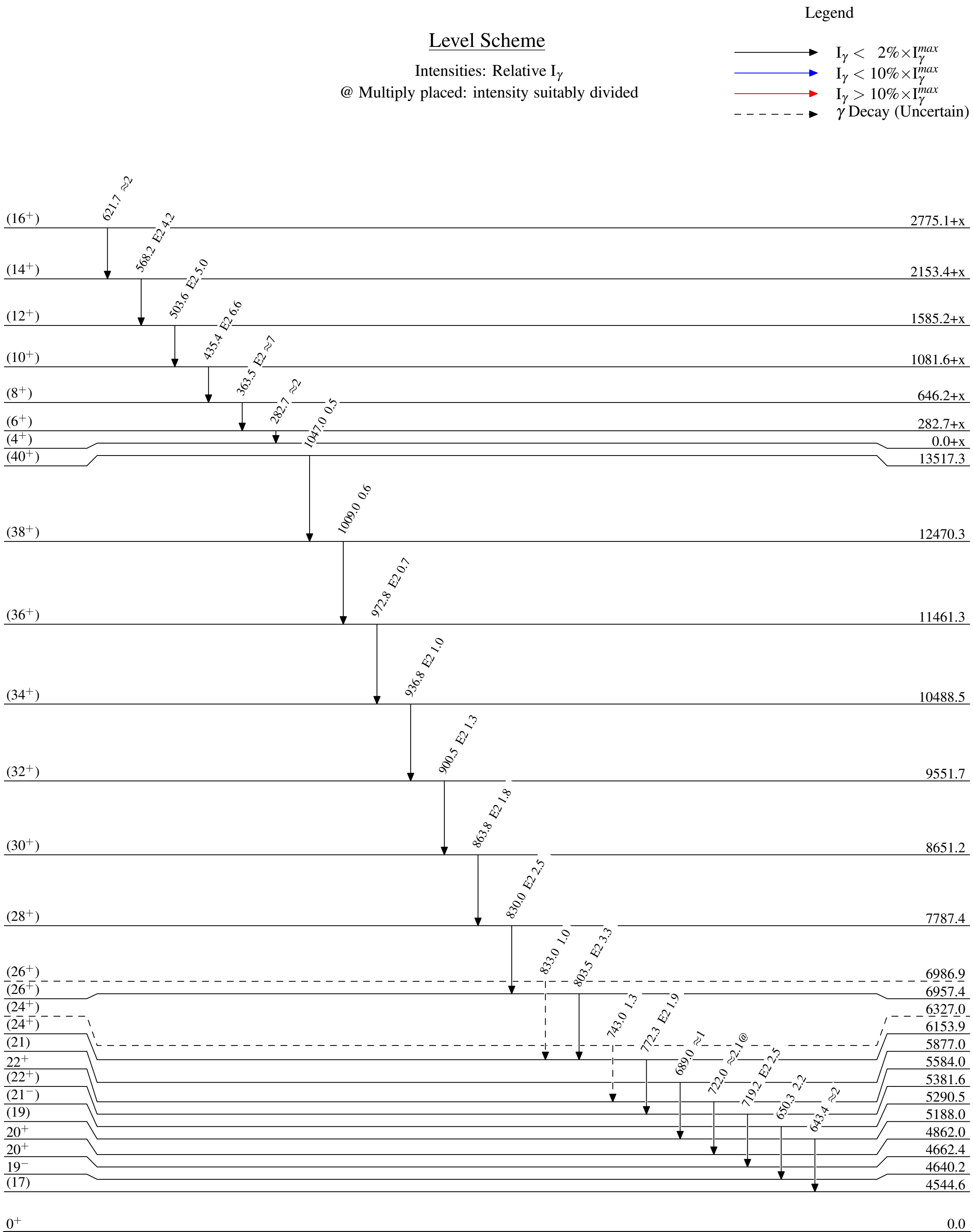
[#] γ rays reported only in 1988Bu19.
[@] There may be an additional uncertainty associated with the angular distribution coefficients for this γ ray, since the peak is contaminated in singles spectra and its intensity has been estimated from coincidence measurements.
[&] Total theoretical internal conversion 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] Multiply placed with intensity suitably divided.
[b] Placement of transition in the level scheme is uncertain.
[x] γ ray not placed in level scheme.

(HI,xnγ) 1982Dr03,1988Bu19,1967Bu02

Level Scheme

Intensities: Relative I_γ

@ Multiply placed: intensity suitably divided



$^{178}_{76}Os_{102}$

(HI,xnγ) 1982Dr03,1988Bu19,1967Bu02

Level Scheme (continued)

Intensities: Relative I_γ

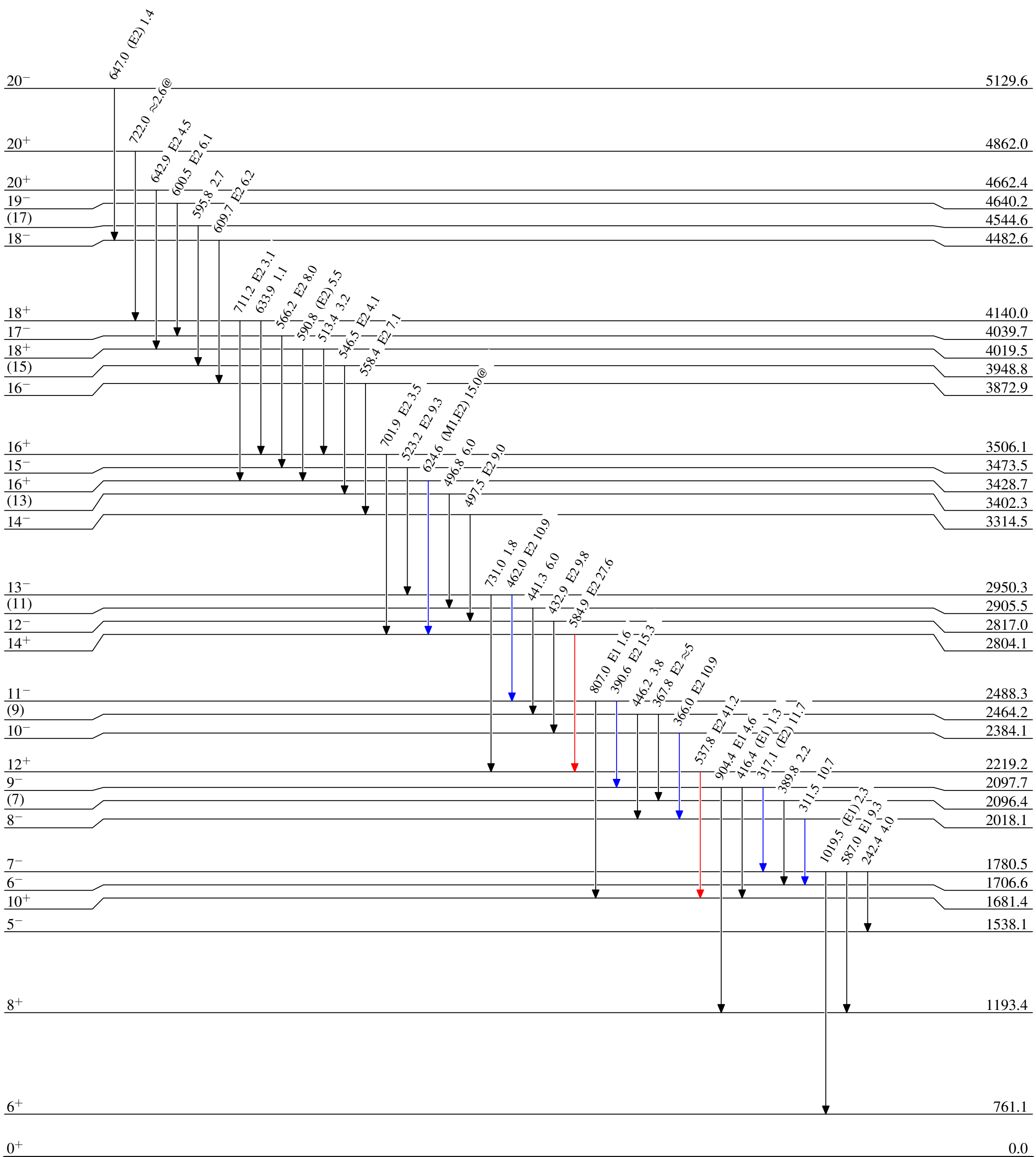
@ Multiply placed: intensity suitably divided

Legend

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

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

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



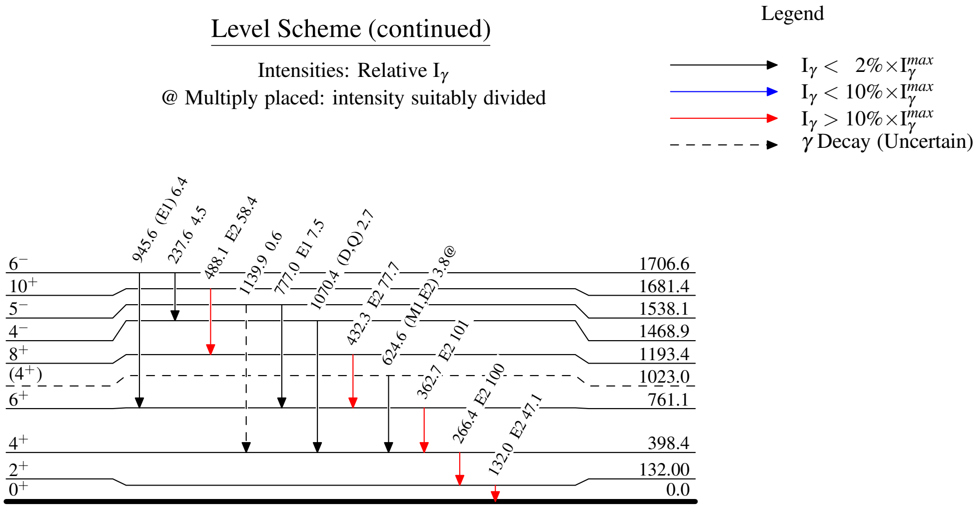
$^{178}_{76}Os_{102}$

(HI,xnγ) 1982Dr03,1988Bu19,1967Bu02

Level Scheme (continued)

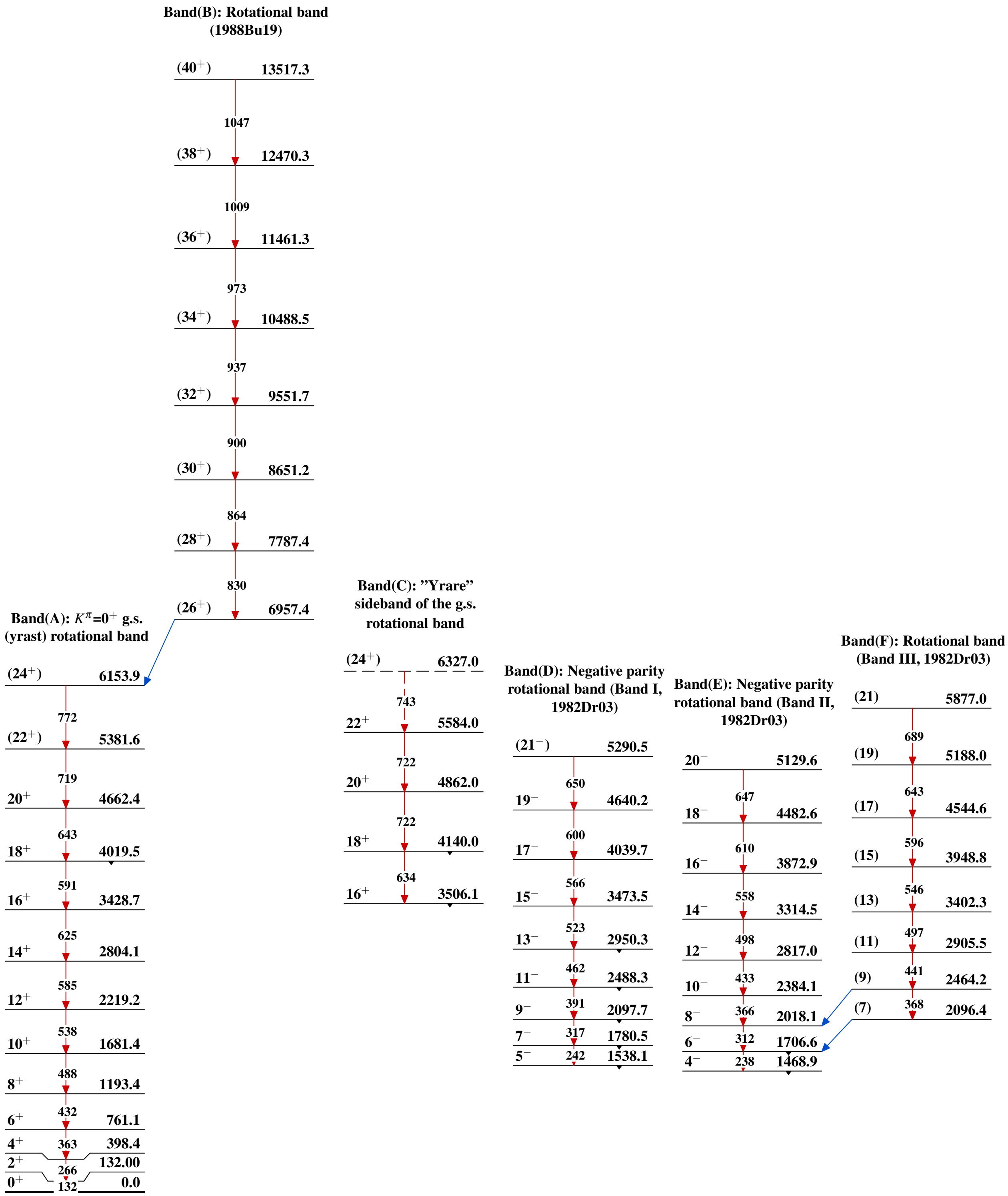
Intensities: Relative I_γ

@ Multiply placed: intensity suitably divided



$^{178}_{76}Os_{102}$

(HI,xnγ) 1982Dr03,1988Bu19,1967Bu02



$^{178}_{76}Os_{102}$

(HI,xnγ) 1982Dr03,1988Bu19,1967Bu02 (continued)