^{130}Te(^{40}Ca,5nγ) 1993Ne01

History

Type	Author	Citation	Literature Cutoff Date
Full Evaluation	Balraj Singh and Jun Chen	NDS 194,460 (2024)	31-Oct-2022

1993Ne01: E=195 MeV ^{40}Ca beam was produced from the 88-inch cyclotron at LBNL. Targets were two self-supporting metallic ^{130}Te foils of 0.50 mg/cm^2 each on 0.37 mg/cm^2 Au backings. γ rays were detected with the Berkeley HERA array of 21 Compton-suppressed Ge detectors. Measured Eγ, Iγ, $\gamma\gamma$-coin, and $\gamma\gamma(\theta)$(DCO). Deduced levels, J, π, band structures, γ-ray multipolarities. Systematics of Hf isotopes. Comparisons with theoretical calculations.

Others:

1996We01: E=175, 180, 182.5 MeV. Measured average g factor of pre-yrast states of the (13/2$^+$), $\nu i_{13/2}$ band using transient-field technique at three beam energies and precession angles measured for transitions (381.4γ and probably 215.1γ) from low-lying levels. The measurements for low-lying transitions apparently carry information about the g factors (of unobserved transitions) at medium excitations. Four Ge detectors and 10 NaI(Tl) detectors (as multiplicity filter) used in this experiment at the 14 MV Koffler accelerator of the Weizmann Institute.

2001Do09: ^{118}Sn(^{50}Ti,3n) E=215-231 MeV; ^{104}Ru(^{64}Ni,3n) E=255-282 MeV; ^{94}Zr(^{74}Ge,3n) E=291-321 MeV. Measured γ, relative σ, and γ-ray multiplicity using 8π array of 20 Compton-suppressed Ge detectors and a 71-element BGO array at the 88-Inch Cyclotron of LBNL.

All data are from 1993Ne01, unless otherwise noted.

^{165}Hf Levels

Nomenclature for quasiparticle configurations:
A, B, C, and D: $\nu i_{13/2}$ orbitals.
E and F: N=5, negative-parity neutron orbitals.
A_p, B_p: $\pi h_{11/2}$ orbitals.

E(level)[†]	J$^\pi$[#]	E(level)[†]	J$^\pi$[#]
0.0[d]	(5/2$^-$)	2338.4[e] *9*	(29/2$^-$)
76.4[‡] *7*	(7/2$^-$)	2423.2[d] *9*	(29/2$^-$)
93.9[‡] *7*	(7/2$^-$)	2470.8[c] *9*	31/2$^-$
118.8[a] *12*	13/2$^+$	2485.1[a] *10*	33/2$^+$
218.3[d] *5*	(9/2$^-$)	2728.0[b] *11*	31/2$^+$
334.0[a] *9*	17/2$^+$	2758.2[@] *11*	(31/2$^-$)
530.7[d] *7*	(13/2$^-$)	2839.8[d] *9*	(33/2$^-$)
531.3[b] *12*	15/2$^+$	2870.0[e] *10*	(33/2$^-$)
715.4[a] *9*	21/2$^+$	2959.5[c] *10*	35/2$^-$
937.5[b] *8*	19/2$^+$	3166.7[a] *11*	37/2$^+$
954.4[d] *8*	(17/2$^-$)	3263.3[@] *12*	(35/2$^-$)
1223.9[a] *9*	25/2$^+$	3362.4[d] *10*	(37/2$^-$)
1435.7[d] *8*	(21/2$^-$)	3404.4?[b] *15*	(35/2$^+$)
1467.2[b] *8*	23/2$^+$	3454.8[e] *11*	(37/2$^-$)
1732.0[c] *10*	23/2$^-$	3553.4[&] *12*	(37/2$^+$)
1825.2[a] *9*	29/2$^+$	3559.0[c] *11*	39/2$^-$
1860.6[@] *11*	(23/2$^-$)	3842.5[a] *12*	41/2$^+$
1872.7[e] *8*	(25/2$^-$)	3848.5[@] *14*	(39/2$^-$)
2017.2[d] *9*	(25/2$^-$)	3987.7[d] *11*	(41/2$^-$)
2066.6[c] *9*	27/2$^-$	4110.7[e] *11*	(41/2$^-$)
2074.4[b] *9*	27/2$^+$	4166.5[&] *12*	(41/2$^+$)
2312.9[@] *11*	(27/2$^-$)	4275.6[c] *12*	43/2$^-$

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^{130}Te(^{40}Ca,5nγ) 1993Ne01 (continued)

^{165}Hf Levels (continued)

E(level)[†]	J^{π}[#]	Comments
4513.2[@] *14*	(43/2$^-$)	
4532.1[a] *12*	45/2$^+$	
4716.9[d] *12*	(45/2$^-$)	
4831.5[e] *12*	(45/2$^-$)	
4859.6[&] *13*	(45/2$^+$)	
5086.2[c] *12*	47/2$^-$	
5258.2[@] *15*	(47/2$^-$)	
5271.8[a] *13*	49/2$^+$	
5535.3[d] *12*	(49/2$^-$)	
5603.3[&] *14*	(49/2$^+$)	
5613.8[e] *13*	(49/2$^-$)	
5929.6[c] *13*	51/2$^-$	
6078.7[a] *14*	53/2$^+$	
6086.9[@] *16*	(51/2$^-$)	
6392.3[d] *14*	(53/2$^-$)	
6410.0[&] *17*	(53/2$^+$)	
6483.9[e] *16*	(53/2$^-$)	
6779.2[c] *14*	55/2$^-$	E(level): 6787 in Fig. 2 of 1993Ne01 seems a misprint.
6961.2[a] *14*	57/2$^+$	
7268.9[&] *20*	(57/2$^+$)	
7271.4[d] *15*	(57/2$^-$)	
7419.4?[e] *19*	(57/2$^-$)	
7666.4[c] *18*	59/2$^-$	
7913.0[a] *15*	61/2$^+$	
8183.3?[&] *22*	(61/2$^+$)	
8197.7[d] *18*	(61/2$^-$)	
8603.2[c] *20*	63/2$^-$	
8881.7[a] *19*	65/2$^+$	
9176.4?[&] *25*	(65/2$^+$)	
9177.5?[d] *21*	(65/2$^-$)	E(level): 9187 in Fig. 2 of 1993Ne01 seems a misprint.
9584.1[c] *21*	67/2$^-$	
9927.6?[a] *21*	(69/2$^+$)	

[†] From a least-squares fit to Eγ data.

[‡] Either 76.4, (7/2$^-$) or 93.9, (7/2$^-$) may be a signature partner member of E band.

[#] As proposed by 1993Ne01 based on their γγ(θ) data and band assignments. All assignments are given in parentheses in Adopted Levels levels due to lack of strong arguments.

[@] Band(A): Band based on (23/2$^-$), α=−1/2.

[&] Band(B): Band based on (37/2$^+$), α=+1/2.

[a] Band(C): $\nu i_{13/2}$ band, α=+1/2. Configuration=ABC at 41/2$^+$, tentative $ABCA_pB_p$ at 61/2$^+$. Average g factor of pre-yrast states=0.14 *3* (1996We01). Transient-field technique used for 381.4γ from 21/2$^+$ to 17/2$^+$. The value represents a weighted average of 0.13 *6* at E(^{40}Ca)=175 MeV, 0.17 *5* at E(^{40}Ca)=180 MeV, and 0.12 *5* at E(^{40}Ca)=182.5 MeV.

[b] Band(c): $i_{13/2}$ band, α=−1/2.

[c] Band(D): Configuration=ABF, α=−1/2. Configuration=ABCDF at 55/2$^-$.

[d] Band(E): 5/2[523] or band E, α=+1/2. Configuration=ABE at 29/2$^-$, ABCDE at 53/2$^-$.

[e] Band(F): Band based on (25/2$^-$), α=+1/2.

^{130}Te(^{40}Ca,5nγ) 1993Ne01 (continued)

γ(^{165}Hf)

DCO values are for 80° and 30° geometry with gates on ΔJ=2, quadrupole transitions. Expected DCO values are ≈1.0 for ΔJ=2, stretched quadrupole (most likely E2), and ≈1.5 for ΔJ=1, dipole (likely E1) or dipole+quadrupole (likely M1+E2) transitions.

E_γ †	I_γ ‡	E_i(level)	J_i^π	E_f	J_f^π	Mult. #	Comments
76.2 *10*	<2.0	76.4	(7/2⁻)	0.0	(5/2⁻)		
93.4 *10*	<2.0	93.9	(7/2⁻)	0.0	(5/2⁻)		
124.2 *6*	3.2 *10*	218.3	(9/2⁻)	93.9	(7/2⁻)		DCO=1.03 *12* Mult.: DCO suggests ΔJ=2, quadrupole, but ΔJ^π implies ΔJ=1.
141.8 *6*	4.8 *14*	218.3	(9/2⁻)	76.4	(7/2⁻)		DCO=0.99 *24* Mult.: DCO suggests ΔJ=2, quadrupole, but ΔJ^π implies ΔJ=1.
197.2 *10*	<2.0	531.3	15/2⁺	334.0	17/2⁺	(D)	DCO=1.48 *30*
215.1 *4*	113 *6*	334.0	17/2⁺	118.8	13/2⁺	Q	DCO=1.00 *9*
218.5 *6*	5.4 *8*	218.3	(9/2⁻)	0.0	(5/2⁻)	Q	DCO=1.07 *23*
223.1 *10*	<2.0	937.5	19/2⁺	715.4	21/2⁺	(D)	DCO=1.58 *42*
243.8 *10*	<2.0	1467.2	23/2⁺	1223.9	25/2⁺		
312.4 *4*	31.8 *16*	530.7	(13/2⁻)	218.3	(9/2⁻)	Q	DCO=1.05 *14*
334.6 *10*	2.5 *8*	2066.6	27/2⁻	1732.0	23/2⁻	Q	DCO=1.10 *20*
356.7 *6*	3.4 *10*	2423.2	(29/2⁻)	2066.6	27/2⁻		DCO=1.10 *18* Mult.: DCO suggests ΔJ=2, quadrupole, but ΔJ^π implies ΔJ=1.
368.3 *10*	<2.0	2839.8	(33/2⁻)	2470.8	31/2⁻		
381.4 *4*	126 *6*	715.4	21/2⁺	334.0	17/2⁺	Q	DCO=1.01 *6* Iγ(30°)/Iγ(80°)=1.64 *15*, 1.97 *11*, 1.92 *6* (1996We01).
404.2 *4*	18.5 *28*	2470.8	31/2⁻	2066.6	27/2⁻	Q	DCO=1.00 *9*
405.3 *4*	6.5 *10*	1872.7	(25/2⁻)	1467.2	23/2⁺		I_γ: for 405.3+406.6.
406.1 *6*	5.2 *8*	2423.2	(29/2⁻)	2017.2	(25/2⁻)	Q	DCO=1.00 *17*
406.6 *4*	6.5 *10*	937.5	19/2⁺	531.3	15/2⁺		I_γ: for 405.3+406.6.
412.5 *10*	<2.0	531.3	15/2⁺	118.8	13/2⁺		
416.6 *4*	7.6 *11*	2839.8	(33/2⁻)	2423.2	(29/2⁻)	Q	DCO=0.83 *11*
424.0 *4*	38.6 *19*	954.4	(17/2⁻)	530.7	(13/2⁻)	Q	DCO=1.08 *18*
437.3 *4*	24.3 *12*	1872.7	(25/2⁻)	1435.7	(21/2⁻)	Q	DCO=1.09 *16*
446.1 *10*	2.9 *9*	2758.2	(31/2⁻)	2312.9	(27/2⁻)		
452.5 *6*	4.8 *14*	2312.9	(27/2⁻)	1860.6	(23/2⁻)		
465.7 *4*	28.2 *14*	2338.4	(29/2⁻)	1872.7	(25/2⁻)	Q	DCO=1.02 *13*
481.6 *4*	32.9 *16*	1435.7	(21/2⁻)	954.4	(17/2⁻)	Q	DCO=0.92 *11*
488.7 *4*	23.3 *12*	2959.5	35/2⁻	2470.8	31/2⁻	Q	DCO=1.01 *8*
501.4 *4*	9.1 *14*	2839.8	(33/2⁻)	2338.4	(29/2⁻)	Q	DCO=0.86 *11*
505.1 *6*	5.4 *8*	3263.3	(35/2⁻)	2758.2	(31/2⁻)		
508.5 *4*	100 *5*	1223.9	25/2⁺	715.4	21/2⁺	Q	DCO=1.01 *5*
522.6 *4*	17.7 *26*	3362.4	(37/2⁻)	2839.8	(33/2⁻)	Q	DCO=0.93 *10*
529.2 *6*	4.2 *13*	1467.2	23/2⁺	937.5	19/2⁺	(Q)	DCO=1.14 *28*
531.6 *4*	14.5 *22*	2870.0	(33/2⁻)	2338.4	(29/2⁻)	Q	DCO=0.95 *13*
581.6 *4*	7.9 *12*	2017.2	(25/2⁻)	1435.7	(21/2⁻)	Q	DCO=0.98 *11*
584.8 *4*	13.3 *20*	3454.8	(37/2⁻)	2870.0	(33/2⁻)	(Q)	DCO=0.77 *11*
585.2 *6*	4.2 *13*	3848.5	(39/2⁻)	3263.3	(35/2⁻)		
599.5 *4*	17.9 *27*	3559.0	39/2⁻	2959.5	35/2⁻	Q	DCO=0.91 *11*
601.0 *4*	81 *4*	1825.2	29/2⁺	1223.9	25/2⁺	Q	DCO=0.98 *4*
603.2 *10*	<2.0	937.5	19/2⁺	334.0	17/2⁺		
607.2 *4*	7.1 *11*	2074.4	27/2⁺	1467.2	23/2⁺	Q	DCO=1.06 *13*
613.2 *10*	2.1 *6*	4166.5	(41/2⁺)	3553.4	(37/2⁺)		
625.3 *4*	10.7 *16*	3987.7	(41/2⁻)	3362.4	(37/2⁻)	Q	DCO=0.94 *10*
645.5 *4*	11.2 *17*	2470.8	31/2⁻	1825.2	29/2⁺	D	DCO=1.52 *16*
653.6 *6*	5.0 *8*	2728.0	31/2⁺	2074.4	27/2⁺	Q	DCO=0.89 *14*

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^{130}Te(^{40}Ca,5nγ) 1993Ne01 (continued)

γ(^{165}Hf) (continued)

E_γ[†]	I_γ[‡]	E_i(level)	J_i^π	E_f	J_f^π	Mult.[#]	Comments
655.9 *4*	9.5 *14*	4110.7	(41/2$^-$)	3454.8	(37/2$^-$)	Q	DCO=0.92 *9*
659.9 *4*	55.6 *28*	2485.1	33/2$^+$	1825.2	29/2$^+$	Q	DCO=0.99 *6*
664.7 *4*	6.1 *9*	4513.2	(43/2$^-$)	3848.5	(39/2$^-$)		
675.8 *4*	31.7 *16*	3842.5	41/2$^+$	3166.7	37/2$^+$	Q	DCO=0.92 *7*
676.4[&] *10*	<2.0	3404.4?	(35/2$^+$)	2728.0	31/2$^+$		
681.6 *4*	43.0 *22*	3166.7	37/2$^+$	2485.1	33/2$^+$	Q	DCO=0.98 *5*
689.6 *4*	18.6 *28*	4532.1	45/2$^+$	3842.5	41/2$^+$	Q	DCO=0.92 *8*
693.1 *4*	6.0 *9*	4859.6	(45/2$^+$)	4166.5	(41/2$^+$)		
716.6 *4*	12.8 *20*	4275.6	43/2$^-$	3559.0	39/2$^-$	Q	DCO=1.01 *9*
720.8 *4*	8.9 *13*	4831.5	(45/2$^-$)	4110.7	(41/2$^-$)	Q	DCO=1.16 *21*
729.2 *4*	9.1 *14*	4716.9	(45/2$^-$)	3987.7	(41/2$^-$)	Q	DCO=0.94 *13*
739.7 *4*	14.7 *22*	5271.8	49/2$^+$	4532.1	45/2$^+$	Q	DCO=1.06 *6*
743.7 *6*	4.5 *14*	5603.3	(49/2$^+$)	4859.6	(45/2$^+$)		
745.0 *4*	6.4 *10*	5258.2	(47/2$^-$)	4513.2	(43/2$^-$)		
751.6 *6*	3.4 *10*	1467.2	23/2$^+$	715.4	21/2$^+$		DCO=0.96 *17* Mult.: DCO suggests ΔJ=2, quadrupole, but ΔJ^π implies ΔJ=1.
782.3 *4*	6.1 *9*	5613.8	(49/2$^-$)	4831.5	(45/2$^-$)	Q	DCO=0.97 *15*
806.7 *10*	<2.0	6410.0	(53/2$^+$)	5603.3	(49/2$^+$)		
806.9 *4*	13.7 *21*	6078.7	53/2$^+$	5271.8	49/2$^+$	Q	DCO=0.98 *8*
810.6 *4*	7.8 *12*	5086.2	47/2$^-$	4275.6	43/2$^-$	Q	DCO=1.01 *10*
818.4 *4*	6.1 *9*	5535.3	(49/2$^-$)	4716.9	(45/2$^-$)	(Q)	DCO=0.74 *20*
828.7 *6*	3.7 *11*	6086.9	(51/2$^-$)	5258.2	(47/2$^-$)		
842.7 *4*	17.9 *27*	2066.6	27/2$^-$	1223.9	25/2$^+$	D	DCO=1.81 *21*
843.4 *4*	6.2 *9*	5929.6	51/2$^-$	5086.2	47/2$^-$	Q	DCO=1.06 *20*
849.6 *6*	5.8 *9*	6779.2	55/2$^-$	5929.6	51/2$^-$	Q	DCO=0.91 *13*
857.0 *6*	5.5 *8*	6392.3	(53/2$^-$)	5535.3	(49/2$^-$)	Q	DCO=0.93 *14*
858.9 *10*	<2.0	7268.9	(57/2$^+$)	6410.0	(53/2$^+$)		
870.1 *10*	2.3 *7*	6483.9	(53/2$^-$)	5613.8	(49/2$^-$)		
879.1 *6*	3.2 *10*	7271.4	(57/2$^-$)	6392.3	(53/2$^-$)		
882.5 *4*	6.6 *10*	6961.2	57/2$^+$	6078.7	53/2$^+$	Q	DCO=0.83 *9*
887.2 *10*	2.0 *6*	7666.4	59/2$^-$	6779.2	55/2$^-$	(Q)	DCO=0.87 *25*
914.4[&] *10*	<2.0	8183.3?	(61/2$^+$)	7268.9	(57/2$^+$)		
926.3 *10*	2.9 *9*	8197.7	(61/2$^-$)	7271.4	(57/2$^-$)		
932.7 *6*	3.0 *9*	2758.2	(31/2$^-$)	1825.2	29/2$^+$		
935.5[&] *10*	<2.0	7419.4?	(57/2$^-$)	6483.9	(53/2$^-$)		
936.8 *10*	2.1 *6*	8603.2	63/2$^-$	7666.4	59/2$^-$		
951.8 *6*	4.3 *13*	7913.0	61/2$^+$	6961.2	57/2$^+$	Q	DCO=0.87 *11*
968.7 *10*	2.9 *9*	8881.7	65/2$^+$	7913.0	61/2$^+$		
979.8[&] *10*	<2.0	9177.5?	(65/2$^-$)	8197.7	(61/2$^-$)		
980.9 *6*	3.4 *10*	9584.1	67/2$^-$	8603.2	63/2$^-$		
993.1[&] *10*	<2.0	9176.4?	(65/2$^+$)	8183.3?	(61/2$^+$)		
999.7 *6*	5.3 *8*	4166.5	(41/2$^+$)	3166.7	37/2$^+$		
1016.6[@] *6*	5.3[@] *8*	1732.0	23/2$^-$	715.4	21/2$^+$	(D)	DCO=1.30 *23* I_γ: for 1016.6+1018.5. DCO for 1016.6+1018.5.
1018.5[@] *6*	5.3[@] *8*	4859.6	(45/2$^+$)	3842.5	41/2$^+$	(Q)	DCO=1.30 *23* I_γ: for 1016.6+1018.5. DCO for 1016.6+1018.5.
1045.9[&] *10*	2.0 *6*	9927.6?	(69/2$^+$)	8881.7	65/2$^+$		
1068.4 *6*	4.3 *13*	3553.4	(37/2$^+$)	2485.1	33/2$^+$	(Q)	DCO=0.79 *13*
1089.1 *10*	<2.0	2312.9	(27/2$^-$)	1223.9	25/2$^+$		
1145.8 *10*	<2.0	1860.6	(23/2$^-$)	715.4	21/2$^+$		

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^{130}Te(^{40}Ca,5nγ) 1993Ne01 (continued)

γ(^{165}Hf) (continued)

† 1993Ne01 state that uncertainties are 0.4-1 keV. The evaluators assign Δ(Eγ)=0.4 keV for Iγ>6, 0.6 keV for Iγ=3-6 and 1 keV for Iγ<3.

‡ Uncertainties are 5-30% as stated by 1993Ne01. The evaluators assign as follows: 5% for Iγ>20; 15% for Iγ=5-20; 30% for Iγ<5.

Assigned by the evaluators based on DCO values in 1987Bl06. Mult=Q represents ΔJ=2, quadrupole (most likely E2), while mult=D corresponds to ΔJ=1, dipole (E1, M1 or M1+E2). Exceptions are noted.

@ Multiply placed with undivided intensity.

& Placement of transition in the level scheme is uncertain.

$^{130}Te(^{40}Ca,5n\gamma)$ 1993Ne01

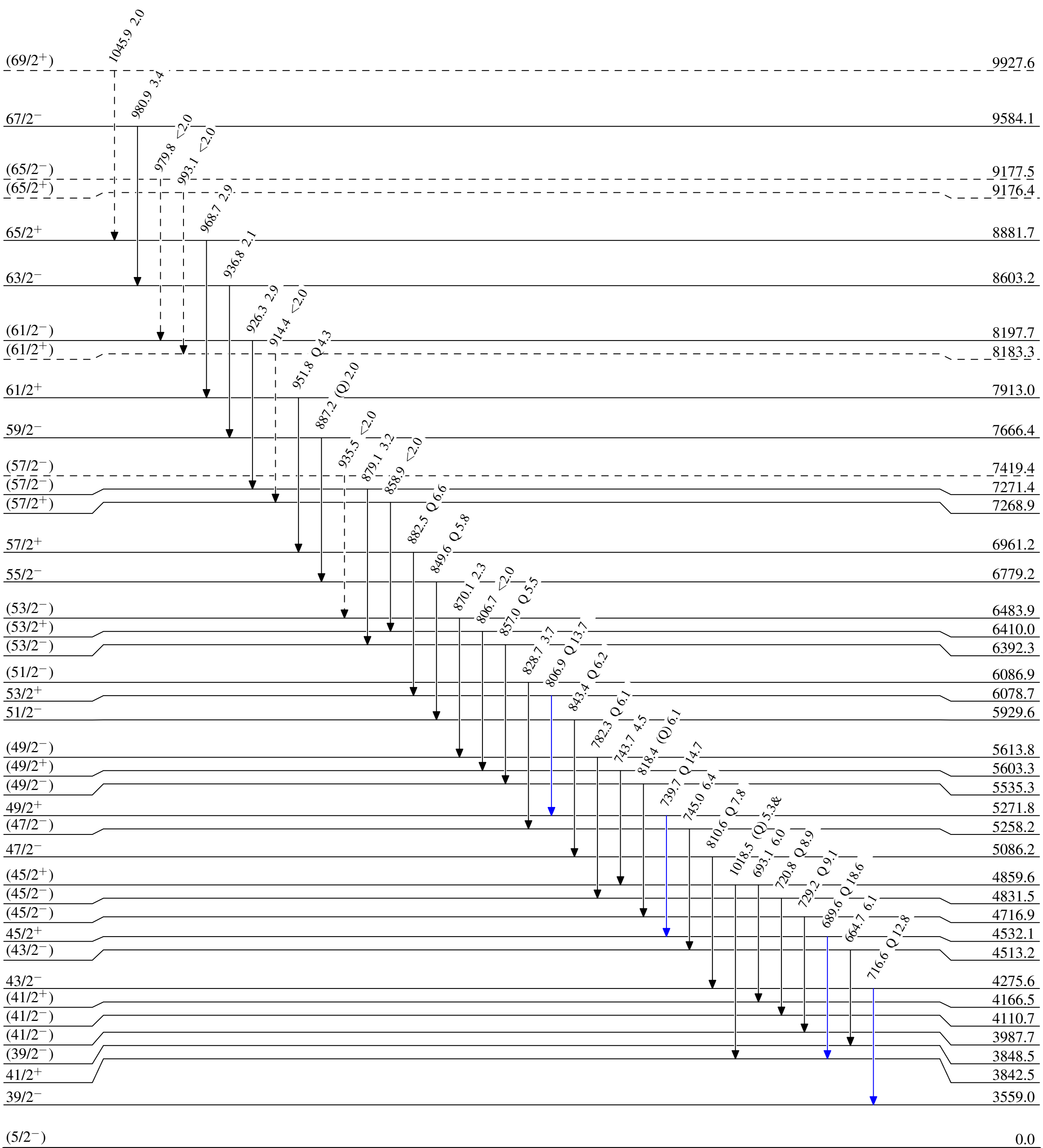
Level Scheme

Intensities: Relative I_γ

& Multiply placed: undivided intensity given

Legend

- $I_\gamma < 2\% \times I_\gamma^{max}$
- $I_\gamma < 10\% \times I_\gamma^{max}$
- $I_\gamma > 10\% \times I_\gamma^{max}$
- γ Decay (Uncertain)



$^{165}_{72}Hf_{93}$

$^{130}Te(^{40}Ca,5n\gamma)$ 1993Ne01

Level Scheme (continued)

Intensities: Relative I_γ

& Multiply placed: undivided intensity given

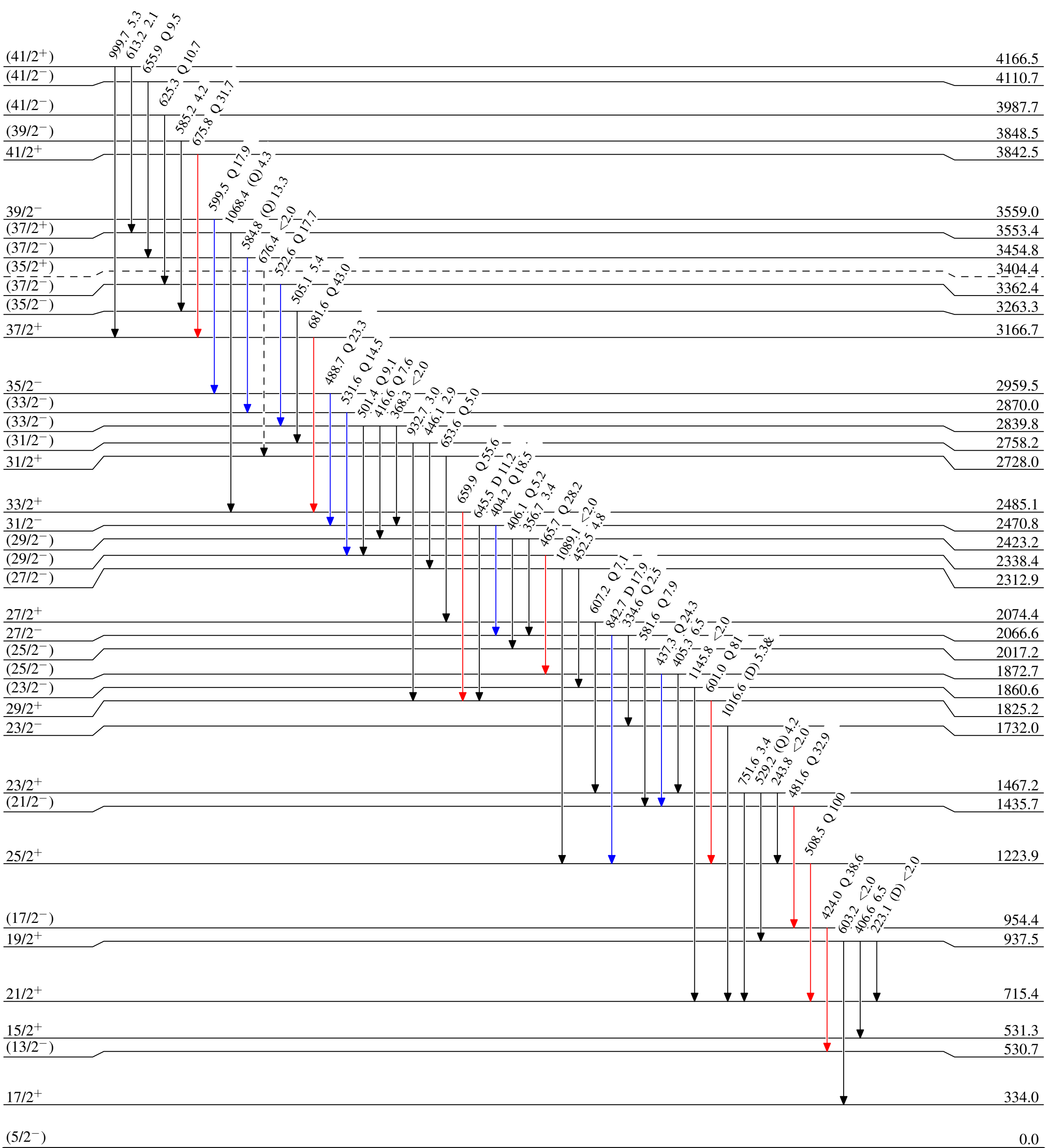
Legend

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

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

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

γ Decay (Uncertain)



$^{165}_{72}Hf_{93}$

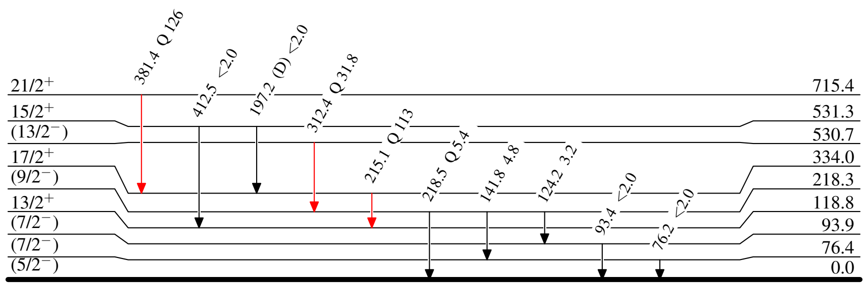
$^{130}Te(^{40}Ca,5n\gamma)$ 1993Ne01

Level Scheme (continued)

Intensities: Relative I_γ
& Multiply placed: undivided intensity given

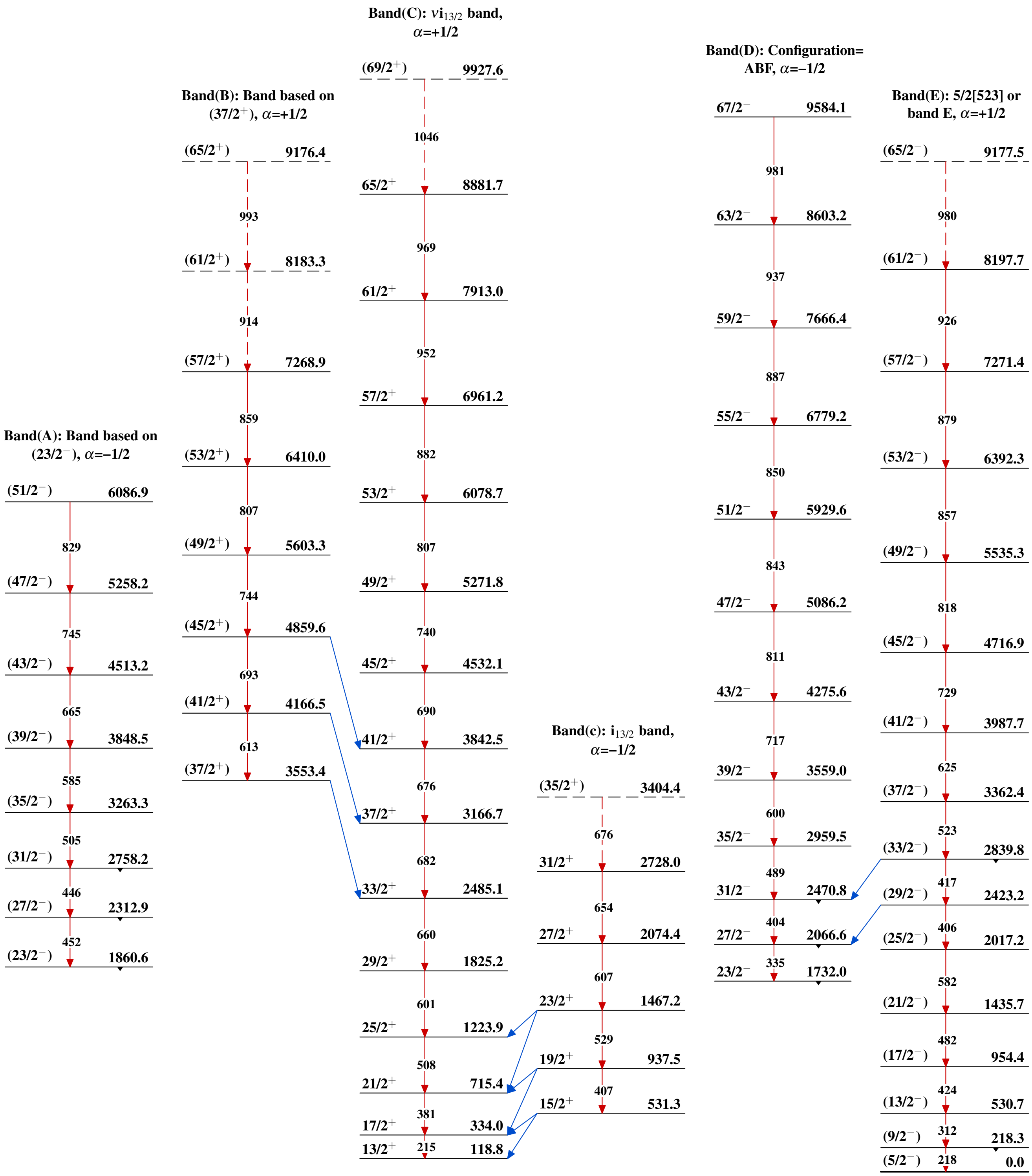
Legend

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



$^{165}_{72}Hf_{93}$

$^{130}Te(^{40}Ca,5n\gamma)$ 1993Ne01



$^{165}_{72}Hf_{93}$

$^{130}Te(^{40}Ca,5n\gamma)$ 1993Ne01 (continued)