Adopted Levels, Gammas

Type	Author	History Citation	Literature Cutoff Date
Full Evaluation	N. Nica	NDS 176, 1 (2021)	1-May-2021

Q(β^-)=−10120 *60*; S(n)=11157 *19*; S(p)=3520 *40*; Q(α)=4901.9 *26* 2021Wa16
S(2n)=19979 *20*, S(2p)=4507 *12*, Q(εp)=2606 *20* (2021Wa16).
Additional information 1.
All the data on the excited states are derived from the heavy-ion-induced reaction study of 2000Di18 and, to a lesser extent, that of 1990Mu14.
According to 2009Ha42 the nucleus ^{160}Hf is populated via ε decay of ^{160}Ta.

^{160}Hf Levels

Cross Reference (XREF) Flags

A ^{164}W α decay
B (HI,xnγ)

E(level)†	J$^\pi$‡	$T_{1/2}$	XREF	Comments
0.0#	0$^+$	13.6 s *2*	AB	%ε+%β^+=99.3 *2*; %α=0.7 *2* %α: from the evaluation of 1998Ak04, based on the relative intensity of gammas in ε+β^+ decay to α particles (1995Hi12). 1973To02 estimate %α=2.3 *6* from parent-daughter α activity ratio. $T_{1/2}$: from 1995Hi12, 193.6γ(t). Others: 13.4 s *4* (1995Hi12) α(t); 13.0 s *15* (1992Ha10), γ(t). g.s. deformation parameters ε_2=0.142, ε_4=−0.013 (2009Pa17).
389.40# *10*	2$^+$		B	J$^\pi$: E2 intraband γ to 0$^+$.
898.26# *15*	4$^+$		B	J$^\pi$: E2 intraband γ to 2$^+$.
1493.35# *18*	6$^+$		B	J$^\pi$: E2 intraband γ to 4$^+$.
2147.48# *20*	8$^+$		B	J$^\pi$: E2 intraband γ to 6$^+$.
2255.32& *22*	7$^{(-)}$		B	J$^\pi$: (E1) interband γ to 6$^+$.
2713.81& *22*	9$^{(-)}$		B	J$^\pi$: (E1) interband γ to 8$^+$.
2747.86 *23*	9$^{(-)}$		B	J$^\pi$: (E1) γ to 8$^+$ and γ from 11$^-$.
2814.68# *22*	10$^+$		B	J$^\pi$: E2 intraband γ to 8$^+$.
2964.33a *24*	10$^{(-)}$		B	J$^\pi$: (M1) interband γ to 9$^{(-)}$.
3026.12& *22*	11$^{(-)}$		B	J$^\pi$: E2 intraband γ to 9$^{(-)}$.
3474.8@ *3*	12$^+$		B	J$^\pi$: E2 interband γ to 10$^+$.
3502.8a *3*	12$^{(-)}$		B	J$^\pi$: (E2) intraband γ to 10$^{(-)}$.
3529.61& *24*	13$^{(-)}$		B	J$^\pi$: E2 intraband γ to 11$^{(-)}$.
4076.3@ *6*	(14$^+$)		B	J$^\pi$: (E2) intraband γ to 12$^+$.
4107.8a *4*	(14$^-$)		B	J$^\pi$: (E2) intraband γ to 12$^{(-)}$.
4120.4& *3*	15$^{(-)}$		B	J$^\pi$: E2 intraband γ to 13$^{(-)}$.
4735.0@ *8*	(16$^+$)		B	J$^\pi$: intraband γ to 14$^{(+)}$.
4747.0& *3*	(17$^-$)		B	J$^\pi$: (E2) intraband γ to 15$^{(-)}$.
4761.7a *5*	(16$^-$)		B	J$^\pi$: intraband γ to (14$^-$).
5351.4a *5*	(18$^-$)		B	J$^\pi$: (E2) intraband γ to (16$^-$).
5415.4@ *8*	(18$^+$)		B	
5505.8& *4*	(19$^-$)		B	J$^\pi$: (E2) intraband γ to (17$^-$).
6087.0a *5*	(20$^-$)		B	J$^\pi$: E2 intraband γ to (18$^-$).
6283.9& *4*	(21$^-$)		B	J$^\pi$: E2 intraband γ to (19$^-$).

Continued on next page (footnotes at end of table)

Adopted Levels, Gammas (continued)

^{160}Hf Levels (continued)

E(level)[†]	J$^{\pi}$[‡]	XREF	Comments
7000.3[&] *5*	(23$^-$)	B	J$^{\pi}$: E2 intraband γ to (21$^-$).
7747.5[&] *5*	(25$^-$)	B	J$^{\pi}$: intraband γ to (23$^-$).

† From a least-squares fit to the listed Eγ values.
‡ Spin-parity assignments reported in the heavy-ion-induced reaction studies and amended by evaluator based on re-evaluated γ multipolarities and the usual considerations of band structure (stretched transitions and increasing spin values with increasing excitation energy), theoretical arguments and systematics.
# Band(A): ground-state band.
@ Band(B): aligned positive-parity band.
& Band(C): negative-parity band, signature=1.
a Band(D): negative-parity band, signature=0.

γ(^{160}Hf)

E$_i$(level)	J$_i^{\pi}$	E$_\gamma$	I$_\gamma$	E$_f$	J$_f^{\pi}$	Mult.[†]	α[‡]	Comments
389.40	2$^+$	389.40 *10*	100	0.0	0$^+$	E2	0.0374	α(K)=0.0277 *4*; α(L)=0.00742 *11*; α(M)=0.001762 *25* α(N)=0.000413 *6*; α(O)=5.76×10^{-5} *8*; α(P)=2.07×10^{-6} *3*
898.26	4$^+$	508.86 *10*	100	389.40	2$^+$	E2	0.0185	α(K)=0.01440 *21*; α(L)=0.00317 *5*; α(M)=0.000742 *11* α(N)=0.0001746 *25*; α(O)=2.50×10^{-5} *4*; α(P)=1.103×10^{-6} *16*
1493.35	6$^+$	595.09 *10*	100	898.26	4$^+$	E2	0.01266	α(K)=0.01004 *14*; α(L)=0.00202 *3*; α(M)=0.000468 *7* α(N)=0.0001103 *16*; α(O)=1.599×10^{-5} *23*; α(P)=7.77×10^{-7} *11*
2147.48	8$^+$	654.13 *10*	100	1493.35	6$^+$	E2	0.01016	α(K)=0.00814 *12*; α(L)=0.001557 *22*; α(M)=0.000360 *5* α(N)=8.48×10^{-5} *12*; α(O)=1.239×10^{-5} *18*; α(P)=6.33×10^{-7} *9*
2255.32	7$^{(-)}$	762.0 *2*	100	1493.35	6$^+$	(E1)	0.00274	α(K)=0.00232 *4*; α(L)=0.000329 *5*; α(M)=7.33×10^{-5} *11* α(N)=1.736×10^{-5} *25*; α(O)=2.64×10^{-6} *4*; α(P)=1.716×10^{-7} *24*
2713.81	9$^{(-)}$	458.47 *13*	39 *8*	2255.32	7$^{(-)}$	(E2)	0.0241	α(K)=0.0185 *3*; α(L)=0.00437 *7*; α(M)=0.001028 *15* α(N)=0.000241 *4*; α(O)=3.42×10^{-5} *5*; α(P)=1.402×10^{-6} *20*
		566.24 *12*	100 *18*	2147.48	8$^+$	(E1)	0.00503	α(K)=0.00424 *6*; α(L)=0.000611 *9*; α(M)=0.0001367 *20* α(N)=3.23×10^{-5} *5*; α(O)=4.89×10^{-6} *7*; α(P)=3.10×10^{-7} *5*
2747.86	9$^{(-)}$	492.7 *3*	18 *4*	2255.32	7$^{(-)}$	[E2]	0.0201	α(K)=0.01554 *22*; α(L)=0.00350 *5*; α(M)=0.000819 *12* α(N)=0.000193 *3*; α(O)=2.75×10^{-5} *4*; α(P)=1.187×10^{-6} *17*
		600.6 *5*	100 *19*	2147.48	8$^+$	(E1)	0.00444	α(K)=0.00375 *6*; α(L)=0.000538 *8*; α(M)=0.0001204 *17* α(N)=2.85×10^{-5} *4*; α(O)=4.31×10^{-6} *6*;

Continued on next page (footnotes at end of table)

Adopted Levels, Gammas (continued)

$\gamma(^{160}Hf)$ (continued)

E_i(level)	J_i^π	E_γ	I_γ	E_f	J_f^π	Mult.[†]	α[‡]	Comments
								α(P)=2.75×10^{-7} *4* I_γ: value includes contribution from the 601.5 γ.
2814.68	10$^+$	667.25 *11*	100	2147.48	8$^+$	E2	0.00971	α(K)=0.00780 *11*; α(L)=0.001476 *21*; α(M)=0.000341 *5* α(N)=8.04×10^{-5} *12*; α(O)=1.176×10^{-5} *17*; α(P)=6.06×10^{-7} *9*
2964.33	10$^{(-)}$	216.57 *13*	79 *21*	2747.86	9$^{(-)}$	(M1)	0.452	α(K)=0.377 *6*; α(L)=0.0582 *9*; α(M)=0.01313 *19* α(N)=0.00312 *5*; α(O)=0.000479 *7*; α(P)=3.19×10^{-5} *5*
		250.42 *13*	100 *25*	2713.81	9$^{(-)}$	(M1)	0.303	α(K)=0.253 *4*; α(L)=0.0389 *6*; α(M)=0.00878 *13* α(N)=0.00209 *3*; α(O)=0.000320 *5*; α(P)=2.13×10^{-5} *3*
3026.12	11$^{(-)}$	211.48 *10*	89 *17*	2814.68	10$^+$	(E1)	0.0511	α(K)=0.0426 *6*; α(L)=0.00660 *10*; α(M)=0.001485 *21* α(N)=0.000349 *5*; α(O)=5.13×10^{-5} *8*; α(P)=2.87×10^{-6} *4*
		278.21 *12*	44 *10*	2747.86	9$^{(-)}$	E2	0.0996	α(K)=0.0673 *10*; α(L)=0.0247 *4*; α(M)=0.00597 *9* α(N)=0.001396 *20*; α(O)=0.000188 *3*; α(P)=4.74×10^{-6} *7*
		312.30 *11*	100 *19*	2713.81	9$^{(-)}$	E2	0.0703	α(K)=0.0493 *7*; α(L)=0.01608 *23*; α(M)=0.00386 *6* α(N)=0.000904 *13*; α(O)=0.0001234 *18*; α(P)=3.55×10^{-6} *5*
3474.8	12$^+$	660.12 *13*	100	2814.68	10$^+$	E2	0.00995	α(K)=0.00798 *12*; α(L)=0.001519 *22*; α(M)=0.000351 *5* α(N)=8.28×10^{-5} *12*; α(O)=1.210×10^{-5} *17*; α(P)=6.20×10^{-7} *9*
3502.8	12$^{(-)}$	538.5 *2*	100	2964.33	10$^{(-)}$	(E2)	0.01609	α(K)=0.01262 *18*; α(L)=0.00268 *4*; α(M)=0.000626 *9* α(N)=0.0001473 *21*; α(O)=2.12×10^{-5} *3*; α(P)=9.70×10^{-7} *14*
3529.61	13$^{(-)}$	503.49 *10*	100	3026.12	11$^{(-)}$	E2	0.0190	α(K)=0.01476 *21*; α(L)=0.00327 *5*; α(M)=0.000767 *11* α(N)=0.000180 *3*; α(O)=2.58×10^{-5} *4*; α(P)=1.130×10^{-6} *16*
4076.3	(14$^+$)	601.5 *5*	100	3474.8	12$^+$	(E2)	0.01234	α(K)=0.00981 *14*; α(L)=0.00196 *3*; α(M)=0.000454 *7* α(N)=0.0001070 *16*; α(O)=1.553×10^{-5} *22*; α(P)=7.59×10^{-7} *11* I_γ: value includes contribution from the 600.6 γ.
4107.8	(14$^-$)	605.0 *2*	100	3502.8	12$^{(-)}$	(E2)	0.01217	α(K)=0.00968 *14*; α(L)=0.00193 *3*; α(M)=0.000447 *7* α(N)=0.0001052 *15*; α(O)=1.528×10^{-5} *22*; α(P)=7.49×10^{-7} *11*
4120.4	15$^{(-)}$	590.76 *12*	100	3529.61	13$^{(-)}$	E2	0.01288	α(K)=0.01021 *15*; α(L)=0.00206 *3*; α(M)=0.000478 *7* α(N)=0.0001126 *16*; α(O)=1.632×10^{-5} *23*; α(P)=7.90×10^{-7} *11*
4735.0	(16$^+$)	658.7 *5*	100	4076.3	(14$^+$)	(E2)		Mult.: assigned (E2) in 20008Di18 but no $\gamma(\theta)$ value.
4747.0	(17$^-$)	626.63 *11*	100	4120.4	15$^{(-)}$	E2	0.01121	α(K)=0.00895 *13*; α(L)=0.001748 *25*; α(M)=0.000405 *6*

Continued on next page (footnotes at end of table)

Adopted Levels, Gammas (continued)

$\gamma(^{160}Hf)$ (continued)

E_i(level)	J_i^π	E_γ	I_γ	E_f	J_f^π	Mult.[†]	α[‡]	Comments
								α(N)=9.54×10^{-5} *14*; α(O)=1.390×10^{-5} *20*; α(P)=6.94×10^{-7} *10*
4761.7	(16$^-$)	653.9 *2*	100	4107.8	(14$^-$)			
5351.4	(18$^-$)	589.7 *2*	100	4761.7	(16$^-$)	(E2)	0.01293	α(K)=0.01025 *15*; α(L)=0.00207 *3*; α(M)=0.000480 *7* α(N)=0.0001132 *16*; α(O)=1.640×10^{-5} *23*; α(P)=7.93×10^{-7} *12*
5415.4	(18$^+$)	680.4 *2*	100	4735.0	(16$^+$)			
5505.8	(19$^-$)	758.8 *2*	100	4747.0	(17$^-$)	(E2)	0.00729	α(K)=0.00592 *9*; α(L)=0.001059 *15*; α(M)=0.000243 *4* α(N)=5.74×10^{-5} *8*; α(O)=8.48×10^{-6} *12*; α(P)=4.62×10^{-7} *7*
6087.0	(20$^-$)	735.58 *15*	100	5351.4	(18$^-$)	E2	0.00781	α(K)=0.00633 *9*; α(L)=0.001146 *16*; α(M)=0.000263 *4* α(N)=6.22×10^{-5} *9*; α(O)=9.16×10^{-6} *13*; α(P)=4.93×10^{-7} *7*
6283.9	(21$^-$)	778.10 *13*	100	5505.8	(19$^-$)	E2	0.00691	α(K)=0.00562 *8*; α(L)=0.000995 *14*; α(M)=0.000228 *4* α(N)=5.39×10^{-5} *8*; α(O)=7.97×10^{-6} *12*; α(P)=4.39×10^{-7} *7*
7000.3	(23$^-$)	716.4 *2*	100	6283.9	(21$^-$)	E2	0.00828	α(K)=0.00669 *10*; α(L)=0.001226 *18*; α(M)=0.000282 *4* α(N)=6.66×10^{-5} *10*; α(O)=9.80×10^{-6} *14*; α(P)=5.21×10^{-7} *8*
7747.5	(25$^-$)	747.2 *2*	100	7000.3	(23$^-$)			

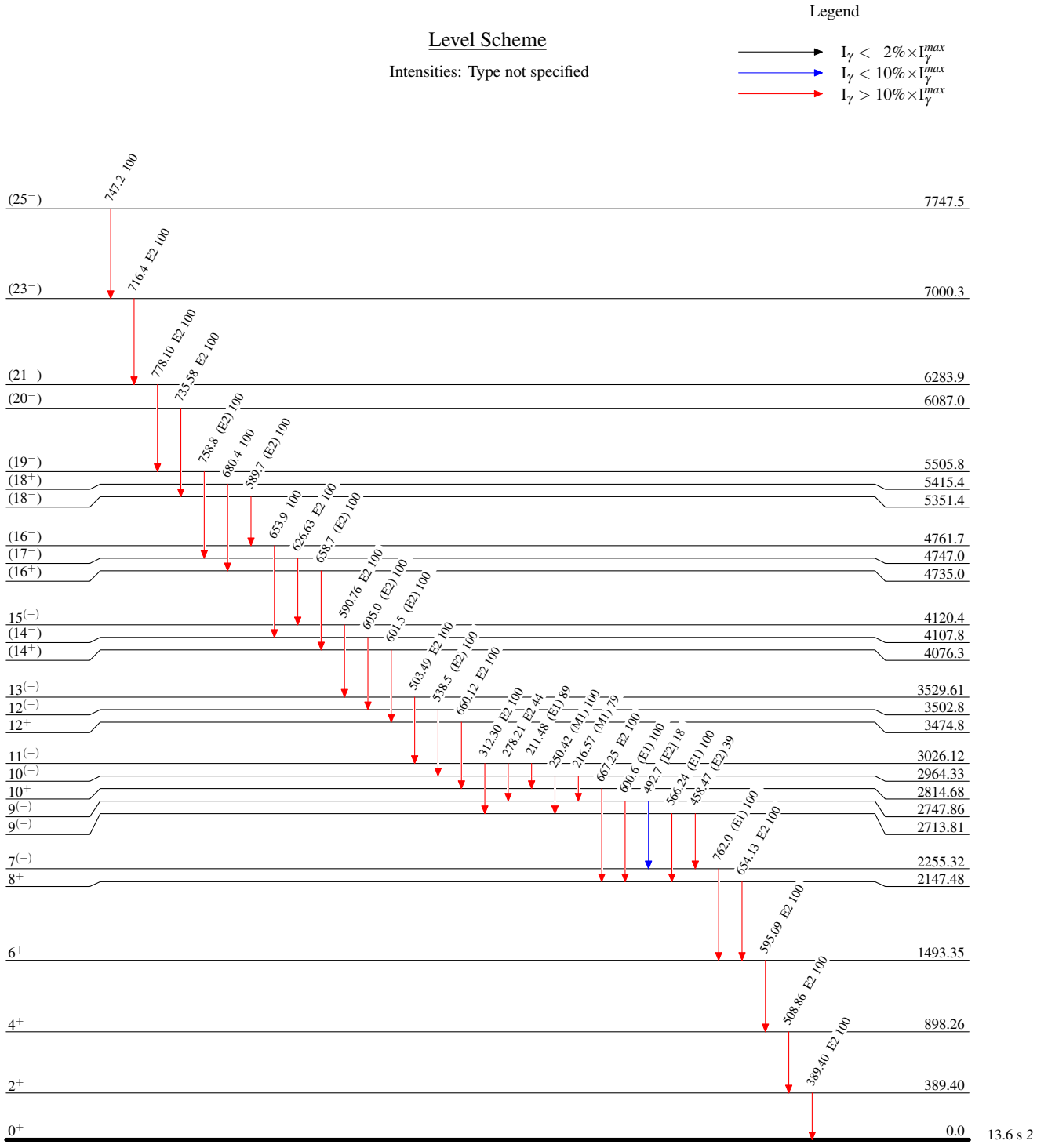
[†] Re-evaluated from (HI,xnγ) dataset that measured dipole or quadrupole transition types based on $\gamma(\theta)$ or DCO but did not measure the electric or magnetic character. The dipole assignments are adopted as tentative while for the quadrupole transitions the assignments of the authors are adopted (all electric − see (HI,xnγ) dataset). All transitions are stretched.

[‡] Additional information 2.

Adopted Levels, Gammas

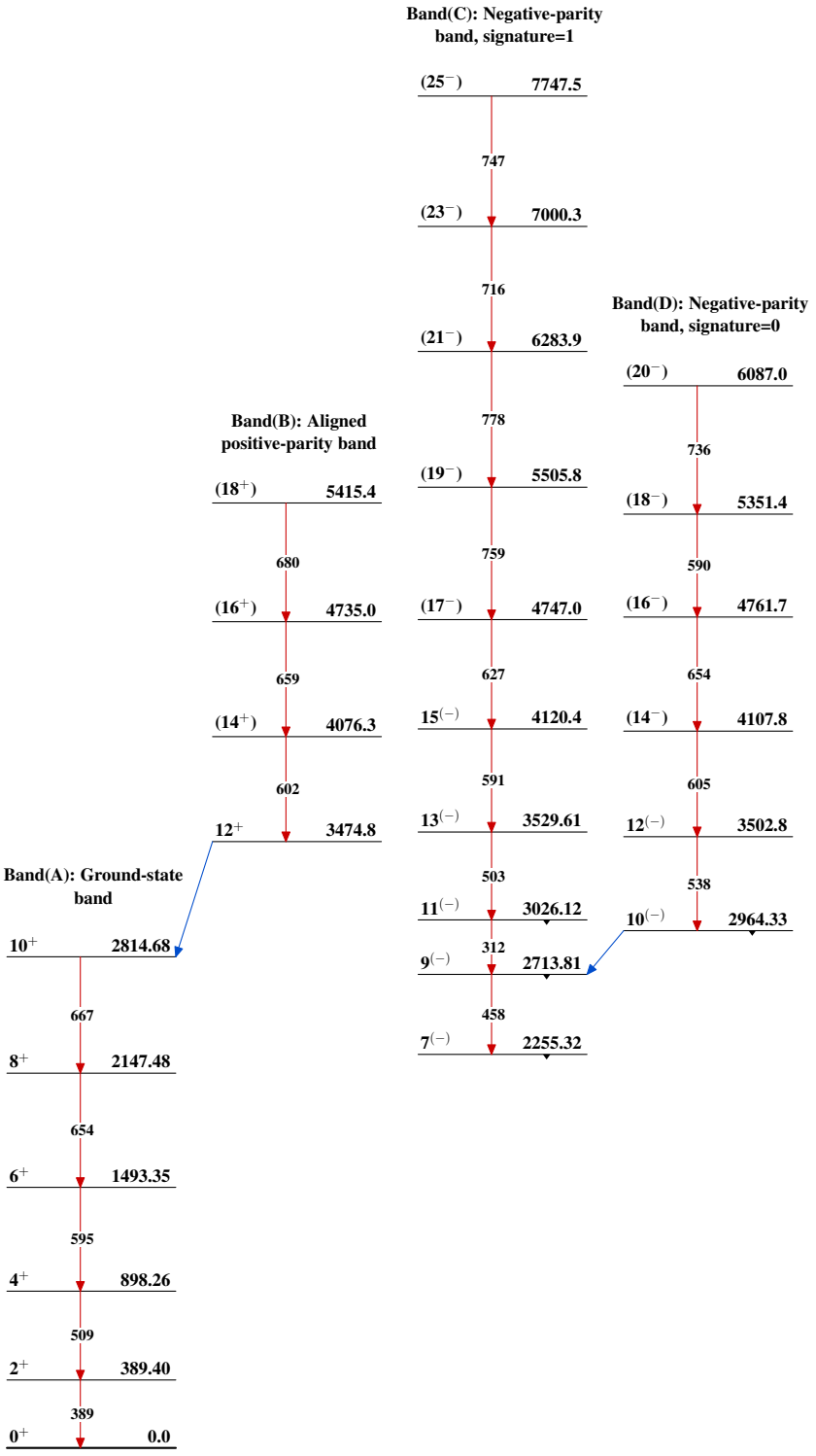
Level Scheme

Intensities: Type not specified



$^{160}_{72}Hf_{88}$

Adopted Levels, Gammas



$^{160}_{72}Hf_{88}$