Nuclear Data Sheets for $A = 180^*$

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Abstract: Spectroscopic data for all nuclei with mass number $A=180$ have been evaluated, and the corresponding level schemes from radioactive decay and reaction studies are presented.

Cutoff Date: All data received by February 2015 have been evaluated. The main source used for bibliographic information is the nsr database (2014Pr09).

General Policies and Organization of Material: see <http://www.nndc.bnl.gov/nds/NDSPolicies.pdf>.

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General Comments: The statistical analysis of γ -ray data and deduced level schemes is carried out through computer codes available at Brookhaven Lab's website: www.nndc.bnl.gov. The direct feeding(s) to excited states in β^- and ϵ decays have generally been computed by the evaluator from $I(\gamma+ce)$ intensity balances at each level; the associated $\log ft$ values are calculated using LOGFT code. Theoretical conversion coefficients are from BrIcc code: v2.3a (30-Jun-2013) (2008Ki07) with "Frozen Orbitals" approximation, and with implicit uncertainty of 1.4%.

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NUCLEAR DATA SHEETS

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Skeleton Scheme for A=180

Ground-State and Isomeric-Level Properties				
Nuclide	Level	J π	T _{1/2}	Decay Modes
¹⁸⁰ Tm	0.0		>300 ns	% β^- =100
¹⁸⁰ Yb	0.0	0+	2.4 min 5	% β^- =100
¹⁸⁰ Lu	0.0	5+	5.7 min 1	% β^- =100
¹⁸⁰ Hf	0.0	0+	stable	
	1141.552	8-	5.53 h 2	%IT=99.69 8; % β^- =0.31 8
¹⁸⁰ Ta	0.0	1+	8.154 h 6	% β^- =15 3; % ϵ =85 3
	77.2	9-	>7.1×10 ¹⁵ y	
¹⁸⁰ W	0.0	0+	1.8×10 ¹⁸ y 2	% α =100
¹⁸⁰ Re	0.0	(1)-	2.46 min 3	% ϵ +% β^+ =100
¹⁸⁰ Os	0.0	0+	21.5 min 4	% ϵ +% β^+ =100
¹⁸⁰ Ir	0.0	(5+)	1.5 min 1	% ϵ +% β^+ =100
¹⁸⁰ Pt	0.0	0+	56 s 3	% ϵ +% β^+ =99.7; % α =0.3
¹⁸⁰ Au	0.0		8.4 s 6	% α ≥1.8; % ϵ +% β^+ ≤98.2
¹⁸⁰ Hg	0.0	0+	2.59 s 1	% ϵ +% β^+ =52 2; % α =48 2
¹⁸⁰ Tl	0.0	(5-)	1.09 s 1	% ϵ +% β^+ =94 4; %eSF=3.2×10 ⁻³ 2; % α =6 4
¹⁸⁰ Pb	0.0	0+	4.1 ms 3	% α =100
¹⁸¹ Hg	0.0	1/2-	3.6 s 1	% ϵ p=1.3×10 ⁻² 3; ...
¹⁸⁴ Pt	0.0	0+	17.3 min 2	% α =1.7×10 ⁻³ 7; ...
¹⁸⁴ Au	68.46	2+	47.6 s 14	% α ≤0.0160; ...
¹⁸⁴ Hg	0.0	0+	30.87 s 26	% α =1.26 20; ...
¹⁸⁴ Tl	0.0	(2-)	10.1 s 5	% α =2.1 7; ...
¹⁸⁴ Pb	0.0	0+	490 ms 25	% α =80 15; ...
¹⁸⁴ Bi	0.0+x		13 ms 2	% α =100
	0.0+y		6.6 ms 15	% α =100

Skeleton Scheme for A=180 (continued)

Adopted Levels

$Q(\beta^-)=6530$ CA; $S(n)=4440$ CA; $S(p)=9140$ CA; $Q(\alpha)=-1560$ CA 1997Mo25.

$S(2n)=10300$ (calculated, 1997Mo25); $S(2p)=20690$ (calculated, 1997Mo25).

2012Ku26: ^{180}Tm nuclide produced in the reaction $^9\text{Be}(^{238}\text{U},X)$, with $E(^{238}\text{U})=1$ GeV/nucleon provided by the SIS-18 synchrotron at GSI facility. Reaction products were separated by the FRS operated in an overall achromatic ion-optical mode and identified on an event-by-event basis using time-of-flight, energy loss and magnetic rigidity measurements. Data collected on four FRS magnetic rigidity settings centered on ^{172}Dy , ^{194}Os , ^{198}Os , and ^{202}Os . Production cross section for ^{180}Tm determined to be 4.5 nb 9.

 ^{180}Tm Levels

E(level)	$T_{1/2}$	Comments
0.0	>300 ns	$\% \beta^- = 100$. E(level): assuming the observed events correspond to the ground state. $T_{1/2}$: lower limit based on time-of-flight through experimental setup (2012Ku26). Actual half-life is expected to be much longer based on calculated value of 14.5 s (1997Mo25). $\% \beta^-$: β decay is the only decay mode expected.

Adopted Levels

$Q(\beta^-)=2080$ SY; $S(n)=6130$ SY; $S(p)=10290$ SY; $Q(\alpha)=-390$ SY 2012Wa38.

$\Delta Q(\beta^-)=310$; $\Delta S(n)=360$; $\Delta S(p)=590$; $\Delta Q(\alpha)=500$ (2012Wa38).

$S(2n)=11050$ syst 300; $Q(\beta^-n)=-3610$ syst 300 (2012Wa38).

1987Ru04: ^{180}Yb produced by bombarding targets of natural tungsten and tantalum with ^{186}W ($E=15$ MeV/nucleon) followed by mass separation with the GSI on-line mass separator. ^{180}Yb identified by detection of Lu K x-ray and 173γ in coincidence with β 's.

 ^{180}Yb Levels

E(level)	J^π	$T_{1/2}$	Comments
0.0	0+	2.4 min 5	$\% \beta^- = 100$. $T_{1/2}$: from $\gamma(t)$ of Lu K x-ray and 173γ (1987Ru04).

Adopted Levels, Gammas

$Q(\beta^-)=3100$ 70; $S(n)=5690$ 70; $S(p)=7430$ SY; $Q(\alpha)=270$ 120 2012Wa38.

$\Delta S(p)=210$ (2012Wa38).

$S(2n)=12480$ 70; $S(2p)=17140$ syst 410; $Q(\beta^-n)=-4280$ 70 (2012Wa38).

Other reactions:

$^{181}\text{Ta}(\pi^-,p)$, $^{181}\text{Ta}(\pi^+,p)$: 1976De39, 1977Ab09, 1977Ja10, 1977Ja15, 1980Do07, 1980Mc03, 1981Mc09, 1982Br32, 1984Fr08, 2000De57.

Muons on ^{181}Ta : 1978Li11, 1980Li16.

No evidence for a ^{180}Lu isomer was observed with $T_{1/2}$ between 10 s and 5 min (1986Le19), $T_{1/2}>100$ s (1986Ke19),

$T_{1/2}<1$ min (1987Ru040).

For theoretical predictions of isomer energies in ^{180}Lu see: 1990SoZZ, 1989Ry04, 1986Ke19, 1986Le19.

 ^{180}Lu Levels

Cross Reference (XREF) Flags

A ^{180}Yb β^- Decay

B $^{180}\text{Hf}(^{238}\text{U},X\gamma)$

E(level) [†]	J π	XREF	$T_{1/2}$	Comments
0.0 §	5+	AB	5.7 min 1	% β^- =100. $T_{1/2}$: weighted average of 4.5 min 10 (1960At01), 5.3 min 3 (1971Gu02), 5.8 min 2 (1971Sw01), and 5.7 min 1 (1973KaYQ). Other: 2.5 min 5 (1961Ta08). Configuration= $\pi 9/2[514]v1/2[510]$. J π : log ft =5.2 and 5.9 to J π =(4)+ and J π =(5)+ levels, respectively, in ^{180}Hf . See comment on 13.9-keV level.
13.9 3	3-	A		J π : calculation of quasiparticle states predicts close-lying states of 3- and 5+. The 375.2-172.9 keV γ cascade from the 562.0 keV (J π =1+) state are the strongest γ 's following ^{180}Yb β^- -decay, indicating the 13.9-keV level is the 3- state. Therefore J π =5+ for the ground state. Configuration $\pi 7/2[404]v1/2[510]$. J π : (M1+E2) 103 γ to 5+, 339 γ from 3+.
102.83 17	(4+)	A		
141.0 § 3	(6+) [‡]	B		
186.8 3	(2,3+,1-)	A		J π : 173 γ to 3-, 375 γ from 1+.
306.0 § 3	(7+) [‡]	B		
442.27 17	3+	A		J π : (E2) 120 γ from 1+, 442 γ to 5+.
453.2 3	2+	A		J π : M1(+E2) 109 γ from 1+, 439 γ to 3-.
496.0 § 3	(8+) [‡]	B		
562.0 3	1+	A		J π : log ft =5.4 in ^{180}Yb β^- decay (J π =0+).
624.0 5	(9-)	B	≥ 1 ms	E(level): K π =9- isomer. Possible configuration= $\pi 9/2[514]v9/2[624]$. J π : E1 128 γ to (8+). $T_{1/2}$: from $^{180}\text{Hf}(^{238}\text{U},X\gamma)$.
947.8 4	1+	A		J π : log ft =5.3 in ^{180}Yb β^- decay (J π =0+).
981.6 4	1+	A		J π : log ft =4.9 in ^{180}Yb β^- decay (J π =0+).

[†] From least-squares fit to E γ 's by evaluator; $\Delta E=0.3$ keV is assumed when not explicitly given.

[‡] From assumed band structure (2001Wh02).

§ (A): K π =5+ band. Possible configuration= $\pi 9/2[514]v1/2[510]$.

 $\gamma(^{180}\text{Lu})$

E(level)	E γ [†]	I γ [†]	Mult. [‡]	α	Comments
13.9	(14)	100	[M2]	71100	
102.83	102.8	100	(M1+E2)	3.21 20	
141.0	141.2 §	100			
186.8	172.9 2	100			Mult.: E1 is favored from intensity balance in ^{180}Yb β^- decay.
306.0	165.3 §				
	306.3 §				
442.27	339.4 2	100 13			
	442.3	13 4	[E2]	0.0255	
453.2	266.4 2	100 27			
	439.3	47 20			
496.0	189.6 §				
	355.2 §				
562.0	108.8 3	11 3	M1(+E2)	2.66 24	

Continued on next page (footnotes at end of table)

Adopted Levels, Gammas (continued) $\gamma(^{180}\text{Lu})$ (continued)

E(level)	$E\gamma^{\dagger}$	$I\gamma^{\dagger}$	Mult. ‡	α	Comments
562.0	119.7	23 3	(E2)	1.698	
	375.2 2	100 14			
624.0	128.0§	100§	E1	0.183	Mult.: from $\alpha(\text{exp})=0.3$ <i>I</i> in $^{180}\text{Hf}(^{238}\text{U}, X\gamma)$.
947.8	385.8 3	100			
981.6	419.6 3	100			

 † From ^{180}Yb β^- decay, except as noted. ‡ From ce measurements in ^{180}Yb β^- decay, except where noted.§ From $^{180}\text{Hf}(^{238}\text{U}, X\gamma)$. **^{180}Yb β^- Decay 1995Me03, 1987Ru04**Parent ^{180}Yb : $E=0.0$; $J\pi=0+$; $T_{1/2}=2.4$ min 5; $Q(\text{g.s.})=2080$ syst; $\% \beta^-$ decay=100.1995Me03: ^{180}Yb activity from ^{197}Au or ^{136}Xe at 11 MeV/nucleon on targets of natural W or Re. Channel selection using online mass separator, fast tape transport system, and the FEBIAD-B2-C ion source to suppress contamination from ^{180}Lu . Measured $E\gamma$, $I\gamma$, $\gamma\gamma$, $\beta\gamma$, and $I(\text{ce})$ using setups of two Ge detectors and a $4\pi\beta$ counter or a low-energy Ge detector and a mini-orange electron spectrometer.1987Ru04: ^{180}Yb activity from ^{186}W at 15 MeV/nucleon on targets of natural W or Ta. Channel selection with GSI online mass separator and fast transport tape system. Measured $E\gamma$, $I\gamma$, $\gamma\gamma$, and $\beta\gamma$ using a plastic $4\pi\beta$ detector and γ and γ/X Ge detectors.

The level scheme is that of 1995Me03. The level scheme proposed by 1987Ru04 is in general agreement, except for the omission of the 13.9-keV level, which results in all the level energies in 1987Ru04 quoted as 13.9-keV lower than those in 1995Me03. Configuration assignments are from 1995Me03.

Total energy release is calculated as 2180 keV 130 by the RADLST code, in general agreement with the Q value of 2080 keV 210, syst. However, due to large uncertainties on $I\gamma$'s, unknown multiplicities, and a difference of 1 MeV between the highest observed level and the decay Q value, the level scheme should be considered incomplete. ^{180}Lu Levels

E(level) †	$J\pi^{\ddagger}$	$T_{1/2}^{\ddagger}$	Comments
0.0	5+	5.7 min 1	Configuration (v1/2 $^-$ [510])(π 9/2 $^-$ [514]).
13.9 3	3-		Configuration (v1/2 $^-$ [510])(π 7/2 $^+$ [404]).
102.83 17	(4+)		
186.8 3	(2, 3+, 1-)		
442.27 17	3+		Configuration (v3/2 $^-$ [512])(π 9/2 $^-$ [514]).
453.2 3	2+		Configuration (v11/2 $^+$ [615])(π 7/2 $^+$ [404]).
562.0 3	1+		Configuration (v9/2 $^+$ [624])(π 7/2 $^+$ [404]).
947.8 4	1+§		
981.6 4	1+§		

 † From a least-squares fit to $E\gamma$'s by the evaluator. $\Delta E\gamma=0.3$ keV is taken when no uncertainty is given. ‡ From the Adopted Levels.§ Calculated two-quasiparticle spectrum predicts two closely lying 1+ states around 1 MeV in excitation energy with configurations (v1/2 $^-$ [510])(π 1/2 $^-$ [514]) and (v7/2 $^-$ [514])(π 9/2 $^-$ [514]). β^- radiations

$E\beta^-$	E(level)	$I\beta^{-\dagger\ddagger\text{§}}$	$\text{Log } ft^{\ddagger}$	Comments
(1098)	981.6	33	≈ 4.9	$I\beta^-$: other: ≈ 37 in 1995Me03.
(1132)	947.8	26	≈ 5.3	
(1518)	562.0	32	≈ 5.4	
(1893#)	186.8	9	≈ 6.3	

 † From intensity balance at each level and assuming E1 multipolarity for the 172.9 γ . ‡ Large uncertainties on $I\gamma$'s and unknown multiplicities make a precise determination of $I\beta^-$ difficult. Both $I\beta^-$ and $\text{Log } ft$ should be considered approximate.

§ Absolute intensity per 100 decays.

Existence of this branch is questionable.

^{180}Yb β^- Decay 1995Me03,1987Ru04 (continued) $\gamma(^{180}\text{Lu})$ I γ normalization: From $\Sigma I(\gamma+ce)=100$ for 103 γ , 173 γ , 439 γ , and 442 γ and assuming E1 multipolarity for the 173 γ .

E $\gamma^\dagger$	E(level)	I $\gamma^\ddagger$ @	Mult.#	α	Comments
(14)	13.9		[M2]	71100	
102.8§	102.83	9 2	(M1+E2)	3.21 20	
108.8 3	562.0	8 2	M1(+E2)	2.66 24	I γ : other: 12 4 (1987Ru04).
119.7§	562.0	16 2	(E2)	1.698	
172.9 2	186.8	100 5	(E1)	0.0834	Mult.: E1 assumed for intensity balance calculations.
266.4 2	453.2	15 4			I γ : other: 24 5 (1987Ru04).
339.4 2	442.27	47 6			I γ : other: 44 6 (1987Ru04).
375.2 2	562.0	71 10			I γ : other: 87 15 (1987Ru04).
385.8 3	947.8	41 10			I γ : corrected for contribution from ^{180}Ir .
					I γ : other: 25 8 (1987Ru04).
419.6 3	981.6	52 8			I γ : other: 56 7 (1987Ru04).
439.3§	453.2	7 3			
442.3§	442.27	6 2	[E2]	0.0255	
547.9& 4	562.0	31 8			E γ , I γ : from 1987Ru04 only. Not observed by 1995Me03 who propose line as originating from summing effects.
					E γ : not included in Adopted Gammas.

 † From 1987Ru04, except where noted. E γ 's were measured in coincidence with β^- . ‡ From 1995Me03. Values from 1987Ru04 are included in the comments.

§ From 1995Me03.

Determined from conversion electron data (1995Me03); no specific details are given by authors.

@ For absolute intensity per 100 decays, multiply by 0.63 4.

& Placement of transition in the level scheme is uncertain.

Decay Scheme

$^{180}\text{Hf}(^{238}\text{U}, X\gamma)$ 2001Wh02 $E(^{238}\text{U})=1.6 \text{ GeV}$, beam chopped at 8.25/16.5 μs and 2/4 ms on/off cycles. Measured E γ , I γ , $\gamma\gamma$, γ -x-ray and γ -t coincidences using Gammasphere consisting of 98 HPGe and 3 x-ray detectors, all with Compton-suppression. ^{180}Lu Levels

E(level) †	J $\pi^\ddagger$	T $_{1/2}$	Comments
0.0§	5+		
141.0§	(6+)		
306.0§	(7+)		
496.0§	(8+)		

Continued on next page (footnotes at end of table)

$^{180}\text{Hf}(^{238}\text{U}, \text{X}\gamma)$ 2001Wh02 (continued) ^{180}Lu Levels (continued)

$E(\text{level})^\dagger$	$J\pi^\ddagger$	$T_{1/2}$	Comments
624.0	(9-)	≥ 1 ms	E(level): $K\pi=9-$ isomer. Possible configuration= $\pi 9/2[514]\nu 9/2[624]$. $T_{1/2}$: from comparison of relative intensity of isomer in 16.5 μs and 4 ms beam-off cycles.

† From least-squares fit to $E\gamma$ by evaluator.

‡ As proposed by 2001Wh02 based on assumed multipolarities and band structure.

§ (A): $K\pi=5+$ band. Possible configuration= $\nu 1/2[510] \pi 9/2[514]$.

 $\gamma(^{180}\text{Lu})$

$E\gamma$	$E(\text{level})$	Mult. †	Comments
128.0	624.0	E1	$\alpha(\text{exp})=0.3$ l , from transition intensity balance. Mult.: from $\alpha(\text{exp})$.
141.2	141.0	(M1)	
165.3	306.0	(M1)	
189.6	496.0	(M1)	
306.3	306.0	(E2)	
355.2	496.0	(E2)	

† From expected band structure as proposed by 2001Wh02, except where noted. The 100–200 keV transitions are assumed to be M1 and the 300–400 keV cross-over transitions are assumed to be E2.

Adopted Levels, Gammas

Q(β⁻)=-846 3; S(n)=7387.76 15; S(p)=8010 5; Q(α)=1283.0 18 2012Wa38.

S(2n)=13486.75 17; S(2p)=14666 10 (2012Wa38).

Other reactions:

¹⁷⁴Yb(¹⁸O,¹²C): 2001Sa29.

¹⁸⁰Hf(γ,γ'): Mossbauer: 1966Ge08, 1968Sn02, 1970Ch27, 1972BoYJ, 1971Ko29, 1973Ka31, 1973PeZE, 1973Zi02, 1980Da12.

¹⁸⁰Hf(e,e'): 1988Ma47.

¹⁸⁰Hf(p,p'γ): 1966Ha48, 2011Ta22.

¹⁸⁰Hf(pol p,p): 1998Do16.

¹⁸⁰Hf(p,γ), IAR: 1968Ca17.

¹⁸⁰Hf(¹⁶O,¹⁶O'γ): 1973Kl08.

¹⁸¹Ta(γ,p): 1973DaYV, 1974AlYH, 1974Da08, 1987Da29, 2000Gr12, 2012Is03, 2012KaZV.

¹⁸¹Ta(e,e'p): 1972ShYD, 1972ShYE, 1972SuZT, 1973SuZW, 1976Su01, 1976Su02, 1989Ge04, 1992Ga02, 1992Pa03.

¹⁸¹Ta(μ⁻,γ): 1971KeZQ.

¹⁸¹Hf(pol n,np): 1991WhZZ, 1992WhZY.

¹⁸¹Ta(n,d): 2000Be62, 2002BeZR, 2007Sh15, 2008SeZT, 2009Lu09.

¹⁸¹Ta(d,³He): 1996Fa06, 2009He15.

¹⁸¹Ta(¹²C,¹³N), ¹⁸¹Ta(¹⁴N,¹⁵O): 1967Vo01.

¹⁸³W(n,α): 1975Qa01, 2006Av01.

¹⁸⁰Hf Levels

Cross Reference (XREF) Flags

A ¹⁸⁰Lu β⁻ Decay

B ¹⁸⁰Ta ε Decay

C ¹⁸⁰Hf IT Decay (5.53 h)

D ¹⁷⁸Hf(t,p)

E ¹⁷⁹Hf(n,γ) E=res: Av

F ¹⁷⁹Hf(n,γ) E=thermal

G ¹⁷⁹Hf(d,p)

H ¹⁸⁰Hf(γ,γ')

I ¹⁸⁰Hf(n,n'γ)

J Coulomb Excitation

K ¹⁸⁰Hf(pol p,p')

L ¹⁸⁰Hf(¹³⁶Xe,¹³⁶Xe'γ)

M ¹⁸⁰Hf(²³⁸U,²³⁸U'γ)

E(level) [†]	Jπ	XREF	T _{1/2} [‡]	Comments
0.0 [#]	0+	ABCDEFGHIJKLM	stable	
93.3240 [#] 20	2+	ABCDEFGHIJKLM	1.519 ns 10	Q=-2.00 2; μ=+0.61 3; B(E2) [†] =4.73 3. Jπ: E2 93.3γ to 0+. T _{1/2} : weighted average of 1.524 ns 10 from ¹⁸⁰ Hf IT decay (5.53 h) and 1.50 ns 2 from Coulomb excitation. μ: integral perturbed angular correlation (1996Al20). Others: μ=+0.53 3, Coulomb excitation integral perturbed angular distributions (1968Be04); μ=+0.51 8, Mossbauer effect (1972JhZZ); μ=+0.77 7, integral perturbed angular correlations (1961Bo25). Δ<r ² > ^{178,180} =0.072 fm ² 4 (1992An17). Other: 1992Be07. B(E2) [†] : from 1977Ro08. Q: hyperfine structure of muonic x-rays (1984Ta10). Other: 1970Ch27.
308.576 [#] 3	4+	A CDEFG IJKLM	71 ps 10	μ=+1.44 16; B(E2) [†] =2.1. Jπ: E2 215.3γ to 2+, γγ(θ) in ¹⁸⁰ Hf IT decay (5.53 h). μ: Integral perturbed angular correlations (1996Al20). Other: μ=+2.0 4, Integral perturbed angular correlations (recalculated for consistency with adopted half-life) (1961Bo25,2011StZZ). Isotope shifts (1987Au07,1991Au02). T _{1/2} : from centroid shift in ¹⁸⁰ Hf IT decay (5.53 h). Other: 86 ps from Coulomb excitation. B(E2) [†] : from 1964Al25.
640.849 [#] 11	6+	CDEFG IJKLM	10.0 ps 7	μ=+2.0 4. Jπ: E2 332.3γ to 4+, γγ(θ) in ¹⁸⁰ Hf IT decay (5.53 h). T _{1/2} : from DSAM and yield measurements in Coulomb excitation. μ: Integral perturbed angular correlation (1996Al20).
1084.006 [#] 15	8+	C FG IJKLM	2.18 ps 11	Jπ: E2 443γ to 6+, γγ(θ) in ¹⁸⁰ Hf IT decay (5.53 h). T _{1/2} : from DSAM and yield measurements in Coulomb excitation.

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Adopted Levels, Gammas (continued) ^{180}Hf Levels (continued)

E(level) [†]	J π	XREF	T _{1/2} [‡]	Comments
1101.9 ^c 5	0+	D F I		XREF: D(?)F(1107). J π : E2 1009 γ to 2+, $\gamma(\theta)$ in $^{180}\text{Hf}(n,n'\gamma)$. E(level): a 0+ level at 1107 keV was observed in $^{179}\text{Hf}(n,\gamma)$, E=thermal. Subsequent $^{180}\text{Hf}(n,n'\gamma)$ studies found no evidence for an 1107-keV level, instead identified a 0+ level at 1102 keV. The evaluator assumes these correspond to the same level and adopts the level energy from $^{179}\text{Hf}(n,\gamma)$, E=thermal.
1141.552 ^a 15	8-	C FG LM	5.53 h 2	%IT=99.69 8; % β^- =0.31 8; Q=+4.6 3; μ =+8.7 10. J π : E1 57.5 γ to 8+, $\gamma\gamma(\theta)$ in ^{180}Hf IT decay (5.53 h). T _{1/2} : from ^{180}Hf IT decay (5.53 h). % β^- =0.023 3 to 177 (J π =8+) level in ^{180}Ta (1985Ke02). % β^- =0.29 5 (additional systematic uncertainty=0.06) to 77.1 (J π =9-) level in ^{180}Ta (1992Ke04). See 1992Ke04 for discussions on the relevance of this decay branch to the nucleosynthesis of ^{180}Ta (>1.2 $\times 10^{15}$ y) in stellar matter. μ : Mossbauer (1971Ko29). Others: 9.0 9, low temperature nuclear orientation (1976Kr11), 8.3 18, NMR on oriented nuclei (2014Mu03). Q: low temperature nuclear orientation (1973Ka31). Configuration= $\pi 7/2[404] \otimes \pi 9/2[514]$.
1164.11 5		F		
1183.36 ^c 13	2+	A I kL		J π : M1(+E2) 1090 γ to 2+, 1183 γ to 0+, 875 γ to 4+.
1192.60 6	(6+)	EF		J π : 3+,6+ based on population intensity in $^{179}\text{Hf}(n,\gamma)$, E=res:Av; 552 γ to 6+ favors J π =6+ assignment.
1199.72 ^e 5	2+	A DEFG IJkL	0.51 ps 5	B(E2) $\uparrow$ =0.113 7. J π : L(t,p)=2. T _{1/2} : deduced from measured B(E2) in Coulomb excitation and adopted γ -ray branching ratios.
1260.70 5	(2+)	EF		J π : 952 γ to 4+, 1261 γ to 0+.
1291.15 ^e 5	3+	A EF I L		J π : M1+E2 982 γ to 4+, M1+E2 1198 γ to 2+, band assignment. J π =4+,5+ from population intensity in $^{179}\text{Hf}(n,\gamma)$, E=res:Av is inconsistent.
1300.37 6	(2+)	EF I K		XREF: K(1289). J π : population by 6088 γ (E2) in $^{179}\text{Hf}(n,\gamma)$ E=res:Av and population in (pol p,p') suggests J π =(2+). Tentatively (E1) multipolarity decomposed for 1300 γ triplet from $\gamma(\theta)$ in $^{180}\text{Hf}(n,n'\gamma)$ suggests J π =(1-).
1315.7 ^d 5	0+	D I		J π : L(t,p)=0.
1354.1? 3	(1-, 2-, 3-)	I		J π : (E1) 1261 γ to 2+.
1369.65 ^c 8	(4+)	EF I KL		J π : 728 γ to 6+, 1276 γ to 2+.
1374.36 [@] 4	(4-)	A EFG I LM	0.57 μ s 2	J π : from $^{179}\text{Hf}(d,p)$ and $\gamma(\theta)$ in $^{180}\text{Hf}(n,n'\gamma)$; configuration=9/2[624] - 1/2[510]. However, J π =3- in $^{179}\text{Hf}(n,\gamma)$, E=thermal.
1381.58 5	(3+, 2+, 4+)	EF		T _{1/2} : from $^{179}\text{Hf}(n,\gamma)$, E=thermal.
1384.6 ^a 4	9-	LM		J π : 1073 γ to 4+, 1289 γ to 2+.
1409.26 ^e 7	(4+)	A EFg I L		J π : (E2) 1316 γ to 2+, 768 γ to 6+.
1409.36 ^d 19	(2+)	D g I		J π : L(t,p)=(2), 1101 γ to 4+, 1409 γ to 0+.
1420.6 10		F		
1429.82 5	(3-)	EF I		J π : 3-,6- from weak population by primary E1 5957 γ in $^{179}\text{Hf}(n,\gamma)$, E=res:Av, 1337 γ to 2+.
1444 6	(5-)	K		J π : from (pol p,p').
1472.40 6	(6+)	EF		J π : 388 γ to 8+, 1164 γ to 4+.
1482.67 [@] 4	(5-)	DEFG I LM		J π : from $^{179}\text{Hf}(d,p)$, M1+E2 108 γ to 4-, and band assignment.
1484.48 6		EF I		
1508 2		G I		
1525 4		G		
1539.29 5	(3-)	EF I		J π : 3-,6- from weak population by primary E1 in $^{179}\text{Hf}(n,\gamma)$, E=res:Av, 1447 γ to 2+.
1557.33 ^e 22	(5+)	EF I L		J π : 266 γ to 3+, 916 γ to 6+, 1249 γ to 4+, band assignment.
1559.29 4	(4+)	F K		J π : D 77 γ to (5-), 259 γ to (2+,1-).
1597.53 11	(4+, 5+)	EF I		J π : 306 γ to 3+, 956 γ to 6+.

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Adopted Levels, Gammas (continued) ^{180}Hf Levels (continued)

E(level) [†]	J π	XREF	T _{1/2} [‡]	Comments
1607.67 5	(4)+	A D F I		J π : L(t,p)=(4), 408 γ E2 to 2+.
1609.38 4	(3-)	A EFg I		J π : M1+E2 235 γ to (4-), 410 γ to 2+.
1613.09@ 4	(6-)	EFg I LM		J π : 130 γ to (5-), 238 γ to (4-), band assignment.
1631.0# 3	10+	J LM	0.79 ps 4	J π : E2 547 γ to 8+.
1633.43 17	(2+, 3, 4+)	I		T _{1/2} : from DSAM and yield measurements in Coulomb excitation.
1637.33 14	(2+)	EF I		J π : 434 γ to 2+, 224 γ to (4+).
1650 4	(3-)	G K		J π : 1328 γ to 4+, 1637 γ to 0+.
1652.7 ^a 4	(10-)	LM		J π : from (pol p,p').
1657.98 ^c 10	(6+)	F L		E(level): from (d,p).
1686.9 8		G I		J π : 511 γ to 8-, 268 γ to 9-, band assignment.
				J π : 288 γ to (4+), (D+Q) 1017 γ to 6+, band assignment.
				XREF: G(1689).
				J π : 1593 γ to 2+ observed in (n,n' γ) is inconsistent with spin assignment of J π =(6-) in (d,p). Possibly two distinct levels.
1700.84& 4	(6+)	EF I LM	<5 ns	J π : 1391 γ to 4+, 1061 γ to 6+, band assignment.
				T _{1/2} : from comparison of γ -ray intensities across the bandhead for varying widths of coincidence time window in $^{180}\text{Hf}(^{136}\text{Xe}, ^{136}\text{Xe}'\gamma)$.
1709.1 5	(5-)	DEF K		XREF: D(1716).
				J π : from (pol p,p').
1724.47 ^e 25	(6+)	I L		J π : (E2) 1417 γ to 4+, (M1) 1083 γ to 6+, band assignment.
1724.88 9	(2+, 3+, 4+)	EF I		J π : M1+E2 434 γ to 3+.
1738.8 10		F		
1742.67 15	(5)+	A I k		J π : (M1) 135 γ to (4)+.
1743.38 7	(2+)	F I k		J π : 452 γ to 3+, 313.5 γ to (3-), 1743 γ to 0+.
1756		D		
1765.1@ 3	(7-)	LM		J π : 282 γ to (5-), 152 γ to (6-), band assignment.
1787.7 10	(6-)	FG		J π : from (d,p).
1813.91 8	(3-)	EF K		XREF: K(1804).
				J π : from (pol p,p').
1818.60 4	(5-)	EF		J π : M1 205.5 γ to (6-), 1510 γ to 4+.
1820.97 17	(3-)	d g I		J π : 447 γ to (4-), 621 γ to 2+.
1828.4 10		F		
1839 6	3-	K		J π : from (pol p,p').
1862.4 10		G I		
1889 3		G		
1892.7& 4	(7+)	LM		J π : 192 γ to (6+), band assignment.
1901.9 ^f 8		L		
1904.0& 7		L		
1904.2 6	(1, 2+)	d I		J π : 1811 γ to 2+, 1904 γ to 0+.
1909.72 9	(4+, 3)	dEFG		J π : 302 γ to (4)+, 710 γ to 2+, 536 γ to (4-). J π =(7-) for 1908 5 level is inconsistent with decay pattern and could correspond to a different level.
1926.4 8	3-	G I K		J π : from (pol p,p').
1928.7 ^e 4	(7+)	L		J π : D 1288 γ to 6+, 845 γ to 8+, 371 γ to (5+), band assignment.
1931.9 10		F		
1937.2 10		D F		
1938.2@ 4	(8-)	LM		
1945.23 13	(2+)	F		J π : 1637 γ to 4+, 1947 γ to 0+.
1945.7 ^a 5	(11-)	LM		J π : 561 γ to 9-, 293 γ to (10-), band assignment.
1948.6 8		I		
1971 3		G		
2022.6 10		FG		E(level): 1714 γ to 4+ is inconsistent with J π =(1-) in (d,p); possibly two distinct levels.
2034.43 7		EF		
2046.9 ^c 4	(8+)	L		J π : 388 γ to (6+), 963 γ to 8+, band assignment.
2059.0 10		F		
2075.3 8		G I k		J π =4+ for 2067 level in (pol p,p').
2078.34 12		F k		J π =4+ for 2067 level in (pol p,p').
2110.9& 4	(8+)	LM		J π : 410 γ to (6+), 218 γ to (7+), band assignment.
2120.1? 10	1, 2&	D H K	0.46 ps 22	XREF: D(2115)K(2125).
2133.6 ^e 4	(8+)	L		J π : stretched (E2) 1493 γ to 6+, (M1) 1050 γ to 8+.

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Adopted Levels, Gammas (continued) ^{180}Hf Levels (continued)

E(level) [†]	J π	XREF	T _{1/2} [‡]	Comments
2134.2@ 4	(9-)			J π : 409 γ to (7-), 196 γ to (8-), band assignment.
2147.1 10		FG		XREF: G(2143).
2151.48 6		EF		
2174.0 3	3-	FG K		J π : from (pol p,p').
2183.1 3		A		
2196.91 22		A		
2201.0 10		F K		XREF: K(2205).
2215.9 10		FG		
2242.6 10		FG		XREF: G(2238).
2246.1 10		F		
2252.9 10		F k		J π : 4+ from (pol p,p') for level at 2257 6.
2261.8 7		F k		J π : 4+ from (pol p,p') for level at 2257 6.
2262.3 ^a 5	(12-)			J π : 610 γ to (10-), 317 γ to (11-).
2271 3		G		
2273.0 ^f 8		L		
2274.3 [#] 4	12+	J L	0.37 ps 3	J π : E2 642 γ to 10+ and band structure observed in Coulomb excitation. T _{1/2} [‡] : from DSAM and yield measurements in Coulomb excitation.
2276.4 10		F		
2293.0 10		F K		
2300.9 ^g 7				L
2303		D		
2316.71 10	(4-, 5-)	EF		J π : 703 γ to (6-), 707 γ to (3-), 2008 γ to 4+.
2320.8 7		F		
2334.98 21		F		
2341.4 10		F		
2348		D		
2350.4@ 5	(10-)			J π : 412 γ to (8-), 216 γ to (9-), band assignment.
2351.8 ^{&} 5	(9+)			J π : 459 γ to (7+), 241 γ to (8+), band assignment.
2369.0 10		F		
2377.7 10	1 $\frac{1}{2}^+$	H	0.29 ps 7	
2389.0 6	(1, 2+)	I		J π : 2296 γ to 2+, 2389 γ to 0+.
2391 6	4+	K		J π : from (pol p,p').
2398.9 ^e 5	(9+)	L		J π : (M1) 1315 γ to 8+, 767 γ to 10+, 470 γ to (7+), band assignment.
2413.5 10		F		
2425.2 12	(10+)		M <2 ns	K π =(10+). Configuration= $\nu 9/2[624] \otimes \nu 11/2[615]$. T _{1/2} [‡] : from $\gamma(t)$ in $^{180}\text{Hf}(^{238}\text{U}, ^{238}\text{U}'\gamma)$.
2447 6	5-			J π : from (pol p,p').
2465.7 10		F		
2472.4 7		F		
2477.11 10	(4, 5)	F		J π : 864 γ to (6-), 938 γ to (3-), 1186 γ to 3+, 1835 γ to 6+.
2482 6	3-	K		J π : from (pol p,p').
2485.5 ^b 5	12+	M	0.94 μ s 11	K π =12+. Configuration= $\pi^2 8- \otimes \nu 9/2[624] \otimes \nu 1/2[510]$. J π : 539.5 γ to (11-), 832 γ to (10-), 1101 γ to 9-.
				T _{1/2} [‡] : from $\gamma(t)$ in $^{180}\text{Hf}(^{238}\text{U}, ^{238}\text{U}'\gamma)$. Other: 9.6 μ s from 2000Wh04.
2493.5 7	1 $\frac{1}{2}^+$	H	62 fs 13	
2504.8 10		F		
2532.8 ^c 4	(10+)			J π : 485 γ to (8+); band assignment.
2533 20	3-	K		J π : from (pol p,p').
2537.4 10	(14+)	M	>10 μ s	T _{1/2} [‡] : >>10 μ s from $^{180}\text{Hf}(^{238}\text{U}, ^{238}\text{U}'\gamma)$. K π =(14+). Configuration= $\pi^2 8- \otimes \nu 9/2[624] \otimes \nu 3/2[512]$. J π : 52 γ to 12+.
2549.4 10		F		
2561.2 7		F		
2582.5 7	1 $\frac{1}{2}^+$	H	10 fs 3	
2588.0@ 7	(11-)			J π : 454 γ to (9-); band assignment.
2591 20	4+	K		J π : from (pol p,p').
2603.1 ^a 6	(13-)	L		J π : 341 γ to (12-), 657.5 γ to (11-); band assignment.
2613.9 ^e 4	(10+)	L		J π : (E2) 1530 γ to 8+; band assignment.
2614.8 ^{&} 6	(10+)	LM		J π : 504 γ to (8+); band assignment.
2617.2 7	1 $\frac{1}{2}^+$	H	9.5 fs 8	

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Adopted Levels, Gammas (continued) ^{180}Hf Levels (continued)

E(level) [†]	$J\pi$	XREF	$T_{1/2}$ [‡]	Comments
2623.6 ^b 8	(13+)		M	$J\pi$: 138 γ to 12+; band assignment.
2680.04 14	4+, 5-	F		$J\pi$: 980 γ to (6+), 1141 γ to (3-).
2682.4 7		F		
2706.2 10		F		
2712.5 7	1 $\S$	H	12.4 fs 24	
2730.7 ^f 4			L	
2741.5 5		F		
2771.9 10		F		
2784.0 10		F		
2796.0 ^g 7			L	
2797.1 6		F		
2806.0 10		F		
2807.0 ^b 6	(14+)		M	$J\pi$: 183 γ to (13+), 321.5 γ to 12+; band assignment.
2812.4 10	1 $\S$	H	0.16 ps 3	
2839.2 5		F		
2848.4 [@] 7	(12-)		LM	$J\pi$: 498 γ to (10-); band assignment.
2850.3 6		F		
2858.7 7		F		
2873.4 10		F		
2879.8 10	1, 2 $\S$	H	0.25 ps 7	
2892.3 7	1 $\S$	H	20.0 fs 21	
2896.9 ^{&} 6	(11+)		LM	$J\pi$: 545 γ to (9+); band assignment.
2913.6 10		F		
2948.0 7	1 $\S$	H	13.0 fs 9	
2960.7 ^e 6	(11+)		L	$J\pi$: 562 γ to (9+), 1330 γ to 10+; band assignment.
2965.4 ^a 6	(14-)		L	$J\pi$: 703 γ to (12-); band assignment.
2993.1 10	1 $\S$	H	47 fs 5	
3000.1 10		F		
3005.4 [#] 5	14+		L	$J\pi$: (E2) 731 γ to 12+; band assignment.
3011.3 7	1 $\S$	H	30 fs 6	
3022.6 6		F		
3049.7 6		F		
3058.6 10		F		
3068.8 7	1 $\S$	H	14.1 fs 13	
3081.5 10	1 $\S$	H	0.17 ps 5	
3083.6 10		F		
3086.0 10	1 $\S$	H	0.14 ps 3	
3089.8 7		F		
3100.8 10		F		
3100.8 ^b 9	(15+)		M	$J\pi$: 294 γ to (14+); band assignment.
3110.6 ^c 5	(12+)		L	$J\pi$: 578 γ to (10+); band assignment.
3123.4 [@] 8	(13-)		LM	$J\pi$: 535 γ to (11-); band assignment.
3124.1 10		F		
3125.6 7	1 $\S$	H	29 fs 3	
3129.2 ^e 5	(12+)		L	$J\pi$: (E2) 1498 γ to 10+; band assignment.
3131.7 7		F		
3150.7 7	1 $\S$	H	10 fs 4	
3153.1 10		F		
3163.2 10		F		
3174.4 10		F		
3184.0 7		F		
3191.4 ^{&} 7	(12+)		LM	$J\pi$: 577 γ to (10+); band assignment.
3200.4 10		F		
3215.3 10		F		
3253.1 10		F		
3254.3 7	1 $\S$	H	32 fs 8	
3257.7 10		F		
3300.4 ^f 5			L	
3303.7 10		F		
3317.0 5		F		
3330.1 10	1 $\S$	H	95 fs 20	
3330.3 7		F		
3338.7 10		F		

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Adopted Levels, Gammas (continued) ^{180}Hf Levels (continued)

E(level) [†]	J π	XREF	T _{1/2} [‡]	Comments
3350.2 ^a 7	(15-)	L		J π : 747 γ to (13-); band assignment.
3384.0 ^g 9		L		
3417.2 5		F		
3428.7 10		F		
3432.1 [@] 9	(14-)	L		J π : 584 γ to (12-); band assignment.
3442.9 10		F		
3446.9 ^b 9	(16+)	M		J π : 639 γ to (14+); band assignment.
3468.6 10		F		
3483.4 10		F		
3489.2 10		F		
3499.9 10		F		
3506.8 10	1, 2 $\S$	H	77 fs 16	
3515.7 10		F		
3526.7 10		F		
3528.9 13		M		
3559.6 7	1 $\S$	H	12.8 fs 23	
3569.5 7	1 $\S$	H	30 fs 6	
3584.2 7	1 $\S$	H	7.3 fs 19	
3592.5 7	1 $\S$	H	16 fs 4	
3596.5 10		F		
3597.5 10	(18-)	M	90 μ s 10	K π =(18-). Configuration= $\pi^2 8-\otimes v 9/2[624]\otimes v 11/2[615]$. J π : M2 151 γ to (16+). T _{1/2} : from $\gamma(t)$ in $^{180}\text{Hf}(^{238}\text{U}, ^{238}\text{U}, \gamma)$. J π : 646 γ to (11+); band assignment.
3606.5 ^e 7	(13+)	L		
3615.1 7	1 $\S$	H	13.0 fs 13	
3625.4 10		F		
3627.1 10	1 $\S$	H	51 fs 12	
3640.7 10		F		
3653.8 10		F		
3672.2 7		F		
3678.1 ^e 6	(14+)	L		J π : 549 γ to (12+); band assignment.
3681.2 10		F		
3734.0 [@] 10	(15-)	L		J π : 611 γ to (13-); band assignment.
3751.3 7		F		
3755.4 ^a 7	(16-)	L		J π : 790 γ to (14-); band assignment.
3766.6 7	1 $\S$	H	10.0 fs 14	
3774.3 7	1 $\S$	H	4.7 fs 19	
3781.5 ^c 6	(14+)	L		J π : 671 γ to (12+); band assignment.
3786.2 7	1 $\S$	H	8.6 fs 18	
3804.1 7	1 $\S$	H	16 fs 3	
3813.5 [#] 7	16+	L		J π : (E2) 808 γ to 14+; band assignment.
3818.0 10	1 $\S$	H	40 fs 8	
3829.6 10	1 $\S$	H	25 fs 5	
3836.5 7	1 $\S$	H	14.7 fs 24	
3848.3 6		F		
3851.7 7	1 $\S$	H	7.0 fs 14	
3855.6 10		F		
3862.2 10	1, 2 $\S$	H	69 fs 22	
3869.2 7		F		
3880.3 10		F		
3889.4 10	1 $\S$	H	12.6 fs 16	
3908.5 10		F		
3926.5 7		F		
3928.0 10	1 $\S$	H	22 fs 4	
3948.1 10	1 $\S$	H	25 fs 6	
3957.6 7		F		
3967.8 10	1 $\S$	H	18 fs 4	
3971.3 ^f 6		L		
3975.3 7		F		
3978.4 7	1 $\S$	H	1.8 fs 9	
3987.6 10		F		
3992.3 10		F		
4003.1 7		F		

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Adopted Levels, Gammas (continued) ^{180}Hf Levels (continued)

E(level) [†]	J π	XREF	Comments
4091.3@ 10	(16-)	L	J π : 659 γ to (14-); band assignment.
4137.7 10		F	
4180.1 ^a 8	(17-)	L	J π : 830 γ to (15-); band assignment.
4270.2 ^e 7	(16+)	L	J π : 592 γ to (14+); band assignment.
4323.5 ^e 12	(15+)	L	J π : 717 γ to (13+); band assignment.
4331.9 10		F	
4356.0 10		F	
4413.1@ 11	(17-)	L	J π : 679 γ to (15-); band assignment.
4423.1 7		F	
4682.0 [#] 9	18+	L	J π : 868.5 γ to 16+; band assignment.
4808.5 7		F	
4852.8 7		F	
4916.3 5		F	
4924.2 ^e 12	(18+)	L	J π : 654 γ to (16+).
4965.4 6		F	
5048.3 7		F	
5057.6 6		F	
5554.0 [#] 13	20+	L	J π : 872 γ to 18+; band assignment.
5629.2 ^e 16	(20+)	L	J π : 705 γ to (18+); band assignment.
5666.0 13	(20+)	L	J π : 984 γ to 18+.

[†] From least-squares fit to E γ , by evaluator.[‡] From $^{180}\text{Hf}(\gamma, \gamma')$, except where noted.[§] From $\gamma(0)$ in $^{180}\text{Hf}(\gamma, \gamma')$.[#] (A): K π =0+ g.s. rotational band.

@ (B): 2 quasiparticle band on 1374 keV (4-).

& (C): 2 quasiparticle band on 1703 keV (6+).

^a (D): 2 quasiparticle 8- band.^b (E): 4 quasiparticle 12+ band.^c (F): K π =0+ rotational band.^d (G): K π =0+ rotational band.^e (H): K π =2+ γ vibrational band.^f (I): Low-K γ vibrational band. Suggested as even spin and positive parity by 2008Ta28.^g (J): Low-K γ vibrational band. Suggested as odd spin by 2008Ta28. $\gamma(^{180}\text{Hf})$

E(level)	E γ [†]	I γ [†]	Mult. [‡]	δ [‡]	α	Comments
93.3240	93.324 2	100	E2		4.63	B(E2)(W.u.)=154.8 21. Mult.: from ce data in ^{180}Hf IT decay (5.53 h) and $^{179}\text{Hf}(\text{n}, \gamma)$, E=thermal.
308.576	215.252 2	100	E2		0.225	B(E2)(W.u.)=230 40. Mult.: from ce data in ^{180}Hf IT decay (5.53 h) and $^{179}\text{Hf}(\text{n}, \gamma)$, E=thermal.
640.849	332.271 10	100	E2		0.0586	B(E2)(W.u.)=219 16. Mult.: from ce data in ^{180}Hf IT decay (5.53 h) and $^{179}\text{Hf}(\text{n}, \gamma)$, E=thermal.
1084.006	443.162 15	100	E2		0.0264	B(E2)(W.u.)=245 13. E γ : from ^{180}Hf IT decay (5.53 h). Mult.: from ce data in ^{180}Hf IT decay (5.53 h) and $^{179}\text{Hf}(\text{n}, \gamma)$, E=thermal.
1101.9	1008.6 [#] 5	100	E2		0.00402 6	
1141.552	57.538 17	100.0 20	E1		0.296	B(E1)(W.u.)=3.46 $\times 10^{-17}$ 10. α : experimental value from ^{180}Hf IT decay (5.53 h) (1986BeZE). E γ , I γ : from ^{180}Hf IT decay (5.53 h). Mult.: K forbidden E1 transition. Multipolarity from ce data in ^{180}Hf IT decay (5.53 h).

Continued on next page (footnotes at end of table)

Adopted Levels, Gammas (continued) $\gamma(^{180}\text{Hf})$ (continued)

E(level)	$E\gamma^{\dagger}$	$I\gamma^{\dagger}$	Mult. ‡	$\delta^{\ddagger}$	α	Comments
1141.552	500.697 15	29.6 8	M2+E3	-5.3 2	0.0610	B(E3)(W.u.)= 7.11×10^{-10} 23; B(M2)(W.u.)= 9.8×10^{-15} 8. E γ , I γ : from ^{180}Hf IT decay (5.53 h). Mult.: from ce data in ^{180}Hf IT decay (5.53 h). δ : from $\gamma\gamma(\theta)$ in ^{180}Hf IT decay (5.53 h).
1164.11	1070.7 5	100				
1183.36	875.3 $\S$ 3	19 $\S$ 4				
	1089.9 $\S$ 2	100 $\S$ 7	M1 (+E2)	-0.3 4	0.0065 9	
	1183.2 $\#$ 8	3.3 $\#$ 8				
1192.60	551.75 d 6	<240 d				
	884.7 7	100 70				
1199.72	890.9 4	3.0 3	[E2]		0.00518 8	B(E2)(W.u.)=0.50 8. I γ : from ^{180}Lu β^- decay. Other: <10 for multiply placed 891 γ in $^{179}\text{Hf}(n,\gamma)$, E=thermal.
	1106.00 15	94 4	M1+E2	9.6 +22-58	0.00338 18	B(E2)(W.u.)=5.2 6; B(M1)(W.u.)=0.00016 8. I γ : weighted average of 98 4 in ^{180}Lu β^- decay and 90 4 in $^{179}\text{Hf}(n,\gamma)$, E=thermal. Mult., δ : from Coulomb excitation (1974Va09). δ : Others: -0.45 25 or <-10 (1983Gr30) and 2.2 13 (1991Gr19); both from $\gamma(\theta)$ in $^{180}\text{Hf}(n,n'\gamma)$.
	1199.7 $\S$ 2	100 $\S$ 7	(E2)		0.00285 4	B(E2)(W.u.)=3.7 5.
1260.70	96.589 10	0.45 13				
	952.2 d 7	<1.3 d				
	1167.0 e 10	<3.7				
	1260.8 3	100 13				
1291.15	982.1 3	19.9 12	M1+E2	-5.0 +20-15	0.0044 3	
	1197.8 3	100 7	M1+E2		0.0041 13	δ : <-10 or 0.18 5 (1991Gr19) and >3 (1983Gr30); both from $\gamma(\theta)$ in $^{180}\text{Hf}(n,n'\gamma)$.
1300.37	1300.5 4	100				
1315.7	1222.4 $\#$ 5	100	E2		0.00275 4	
1354.1?	1260.8 $\#$ de 3	100 d	(E1)			
1369.65	186.6 @ 5					
	728.1 3	4 $\#$ 2				
	1061.0 3	100 $\#$ 20				
	1276.5 4	6 $\#$ 2				
1374.36	113.66 2	0.21 4	[M2]		22.8	B(M2)(W.u.)=0.17 4.
	1065.77 5	100 1	E1 (+M2)	-0.12 30	0.0017 22	B(E1)(W.u.)= 2.85×10^{-10} 11.
	1281.7 2	4.42 21	[M2]		0.01080	B(M2)(W.u.)= 1.99×10^{-5} 12. I γ =24 12 from ^{180}Lu β^- decay disagrees with value from (n, γ).
1381.58	81.21 2	100 7				
	1072.6 5	93 67				
	1288.7 d 5	<215 d				
1384.6	242.9 @ 5	100 @				
1409.26	209.51 7	1.6 12				
	768.1 6	4.9 16				
	1100.60 15	100 5	M1+E2		0.0050 16	
	1316.4 3	70.0 21	(E2)		0.00240 4	
1409.36	1100.7 $\#$ 5	100 $\#$ 50	(E2)		0.00337 5	
	1316.1 $\#$ 8	29 $\#$ 15	(E2)		0.00240 4	
	1409.3 $\#$	12 $\#$ 3				
1420.6	1112 b	100				
1429.82	55.449 e 3	47 11				
	1121.7 5	100 17				
	1336.8 10	61 25				

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Adopted Levels, Gammas (continued) $\gamma(^{180}\text{Hf})$ (continued)

E(level)	$E\gamma^{\dagger}$	$I\gamma^{\dagger}$	Mult. ‡	$\delta^{\ddagger}$	α	Comments
1472.40	181.26 ^e 4	24 12				E γ : questionable placement as level scheme would require M3 or E4 multipolarity for the transition.
	388.45 14	100 16				
	830.8 4	72 20				
	1163.9 10	52 28				
1482.67	108.308 2	100 4	M1+E2 $\&$	0.80 $\&$ 12	2.95 6	
	1389.0 7	8 3				
1484.48	223.76 6	100 70				
	1391.1 ^d 10	<130 ^d				
1508	1416.6 ^{#ef} 4	100				
1539.29	109.476 3	100 10				E γ : questionable placement as level scheme would require E3 or M4 multipolarity for the transition.
	900.5 ^{be}					
	1231.9 5	55 10				
	1446.9 10	<21				
1557.33	266.1 [#] 7	7 3				I γ : other: 13.3 12 in $^{180}\text{Hf}(^{136}\text{Xe}, ^{136}\text{Xe}'\gamma)$.
	915.8 4	21 3				
	1249.1 3	100 3				
1559.29	76.624 3	100 10	D $\&$			
	177.71 3	35 6				
	258.90 ^{de} 3	<21 ^d				
1597.53	125.26 3	22 13				
	306.40 10	47 6				
	956.3 5	50 25				
	1288.7 ^d	100 ^d 25				
1607.67	177.86 3	12 3				
	198.3 $\S$ 2	2.57 $\S$ 13	[E2]		0.296	
	233.33 8	14 3				
	316.50 $\S$ 3	30.0 $\S$ 9	E2 $\&$		0.0675	
	407.94 2	100.0 19	E2 $\&$		0.0329	
	424.4 $\S$ 2	2.8 $\S$ 4	E2		0.0296	
	1299.3 $\S$ 2	31.3 $\S$ 13	(E2)		0.00246 4	
	1514.4 $\S$ 2	20.0 $\S$ 20	[E2]		0.00190 3	
1609.38	235.024 6	100.0 25	M1+E2 $\&$	0.4 $\&$ 3	0.33 4	δ : others: -0.4 1 or >25 (1983Gr30) and +0.09 3 or -15 +10-5 (1991Gr19) both from $\gamma(0)$ in $^{180}\text{Hf}(n,n'\gamma)$.
	409.61 8	4.0 7				
	1300.3 [#]	50 [#] 7	(E1)			
	1516.5 4	4.7 13				
1613.09	53.800 1	41 4				E γ : an unplaced M1 130.26 γ observed in $^{179}\text{Hf}(n,\gamma)$, E=thermal could correspond to this placement.
	129.7 [@] 5	58 [@] 3				
	238.1 5	100 8				
	243.40 10	13 6				
1631.0	547.3 [@] 5	100 [@]	E2		0.01547	I γ : other: 100 3 in $^{180}\text{Hf}(^{136}\text{Xe}, ^{136}\text{Xe}'\gamma)$. B(E2)(W.u.)=238 12. Mult.: stretched Q from R(DCO) in $^{180}\text{Hf}(^{136}\text{Xe}, ^{136}\text{Xe}'\gamma)$.
1633.43	224.1 [#] 8	45 20				
	342.3 [#] 3	100 25				
	433.7 ^{#d} 2	<225 ^d	M1+E2	+0.4 3	0.064 8	
1637.33	255.34 ^e 3	22 3				
	346.25 14	100 24				
	1328.4 10	62 14				
	1543.8 5	27 14				
	1636.8 ^d 5	<38 ^d				
1652.7	268.1 [@] 5	100.0 16				
	511.2 [@] 5	10.5 16				
1657.98	288.4 [@] 5					

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Adopted Levels, Gammas (continued) $\gamma(^{180}\text{Hf})$ (continued)

E(level)	$E\gamma^{\dagger}$	$I\gamma^{\dagger}$	Mult. ‡	α	Comments
1657.98	1017.1 1		(D+Q)		Mult.: stretched Q or unstretched D+Q from R(DCO) in $^{180}\text{Hf}(^{136}\text{Xe}, ^{136}\text{Xe}'\gamma)$. (D+Q) from assumed band assignment.
	1350@ 1				
1686.9	1593.6# 8	100			
1700.84	141.55 1				Mult., δ : M1+E2 with $\delta=1.2+16-6$ from ce data in $^{180}\text{Hf}(n,n'\gamma)$ is inconsistent with $\Delta J=2$ from level scheme.
	1061.0d 3	78@d 5			
	1391.1d 10	100@d 13			
1709.1	1400.5 5	100			
1724.47	314.8@ 5	38@ 4			
	1082.8# 5	97.1@ 21	(M1)	0.00684 10	Mult.: D from R(DCO) in $^{180}\text{Hf}(^{136}\text{Xe}, ^{136}\text{Xe}'\gamma)$, $\Delta\pi=\text{no}$ from level scheme.
	1416.6# 4	100.0@ 14	(E2)	0.00211 3	Mult.: stretched Q from R(DCO) in $^{180}\text{Hf}(^{136}\text{Xe}, ^{136}\text{Xe}'\gamma)$.
1724.88	355.2 1	20 6			
	433.71 12	67 6	M1+E2	0.049 21	
	1416.7 3	100 12			
	1631.4 7	24 10			
1738.8	256.1b	100			
1742.67	135.0\$ 2	90\$ 13	(M1)&	1.700	Mult.: from unplaced 135.09 γ seen in $^{179}\text{Hf}(n,\gamma)$, E=thermal.
	333.0\$ 5	60\$ 7			
	451.6\$ 2	45.8\$ 21			
	1434.1\$e 2	100\$ 10			
1743.38	258.90d 3	48d 5			
	313.50 10	62 5			
	452.53 16	76 14			
	1650.2 7	67 33			
	1743.2 2	100 29			
1765.1	152.2@ 5	28@ 4			
	282.3@ 5	100@ 4			
1787.7	303.2b	100			
1813.91	207.0b				
	254.61 9	100 5			
	274.6 1	84 11			
	331.1b				
	1721.0 7	37 32			
1818.60	205.51 1	100 4	M1&	0.523	
	1510.5 7	8 4			
1820.97	208.5#e 3	75 30			E γ : questionable placement as level scheme would require M3 or E4 multipolarity for the transition.
	446.8# 3	100 25			
	451e	<10			
	529.0# 3	75 20			
	621.3# 5	90 25			
1828.4	1519.8b	100			
1862.4	1553.8 10	100			
1892.7	192.0@ 5	100@			
1901.9	1261@ 1	100@			
1904.0	1263 1	100			
1904.2	1810.9# 8	100 43			
	1904.1# 8	57 29			
1909.72	302.06 8	100 30			
	536.2b				
	709.8 4	70 35			
1926.4	1926.4# 8	100			
1928.7	371.2@ 5	51@ 3			
	844.9@ 5	7.0@ 10			
	1288@ 1	100@ 5	M1	0.00449 7	Mult.: D from R(DCO) in $^{180}\text{Hf}(^{136}\text{Xe}, ^{136}\text{Xe}'\gamma)$, $\Delta\pi=\text{no}$ from level scheme.
1931.9	322.5b	100			
1937.2	329.5b	100			

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Adopted Levels, Gammas (continued) $\gamma(^{180}\text{Hf})$ (continued)

E(level)	$E\gamma^{\dagger}$	$I\gamma^{\dagger}$	Mult. ‡	α	Comments
1938.2	173.0@ 5	26@ 4			
	325.3@ 5	100@ 7			
1945.23	385.84 14	43 9			
	654.9 6	30 5			
	745.4 4	32 14			
	1636.8 ^d 5	<32 ^d			
	1853.0 ^e 7	18 16			
	1946.5 7	100 11			
1945.7	293.0@ 5	100.0@ 17			
	560.9@ 5	14@ 3			
1948.6	1948.6 [#] 8	100			
2022.6	1714.0 ^b	100			
2034.43	551.75 ^d 6	100 ^d 17			
	743.4 2	<100			
	1941.0 7	42 25			
2046.9	388.1@ 5	100@ 9			
	962.9@ 5	53@ 6			
2059.0	576.3 ^b				
2075.3	1982.0 [#] 8	100			
2078.34	465.25 ^b 11	100 9			
	703.3 ^b ^e 5	31 15			
	1767.6 ^b 2	100 25			E γ : poor energy fit, excluded from least-squares fitting. E from level energy difference is 1769.8.
	1986.7 ^b				
2110.9	218.3@ 5	100@ 4			
	409.9@ 5	17@ 4			
2120.1?	2120.1	100	(D+Q) ^a		
2133.6	409.0@ 5	76@ 4			
	1050@ 1	65.9@ 15	(M1)	0.00738 11	Mult.: D from R(DCO) in $^{180}\text{Hf}(^{136}\text{Xe}, ^{136}\text{Xe}'\gamma)$, $\Delta\pi=\text{no}$ from level scheme.
	1493@ 1	100.0@ 15	(E2)	0.00194 3	Mult.: stretched Q from R(DCO) in $^{180}\text{Hf}(^{136}\text{Xe}, ^{136}\text{Xe}'\gamma)$, E2 from assumed band structure.
2134.2	196.2@ 5	16@ 4			
	369.1@ 5	100@ 16			
2147.1	1838.5 ^b	100			
2151.48	538.39 4	100 6			
	890.9 ^d 4	<43 ^d			
	952.2 ^d 7	<8 ^d			
	2058.3 17	15 9			
2174.0	799.9 ^b 3	100 21			
	1864.8 ^b 5	26 16			
2183.1	1874.5 ^{\S} 3	100 ^{\S}			
2196.91	997.1 ^{\S} 3	15 ^{\S} 5			
	1888.4 ^{\S} 3	100 ^{\S} 17			
2201.0	826.6 ^b	100			
2215.9	1575.0 ^b	100			
2242.6	868.2 ^b	100			
2246.1	1937.5 ^b	100			
2252.9	643.5 ^b	100			
2261.8	1620.5 ^b				
	1953.6 ^b				
2262.3	316.9@ 5	100@ 4			
	610.0@ 5	37@ 4			
2273.0	371.1@ 5	11@ 3			
	1189@ 1	100@ 6			
2274.3	643.4@ 5	100@	(E2)	0.01055	B(E2)(W.u.)=227 19. Mult.: stretched Q from R(DCO) in $^{180}\text{Hf}(^{136}\text{Xe}, ^{136}\text{Xe}'\gamma)$, E2 from assumed band structure.
2276.4	667.0 ^b	100			
2293.0	1984.4 ^b	100			
2300.9	396.8@ 5				
	1217@ 1				
2316.71	282.28 8	100 14			

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Adopted Levels, Gammas (continued) $\gamma(^{180}\text{Hf})$ (continued)

E(level)	$E\gamma^{\dagger}$	$I\gamma^{\dagger}$	Mult. ‡	α	Comments
2316.71	703.3 5	26 14			
	707.3 5	21 12			
	2008.3 17	36 14			
2320.8	946.6 ^b				
	2012.1 ^b				
2334.98	725.6 ^b 2	100			
2341.4	2032.8 ^b	100			
2350.4	216.2 [@] 5				
	412.2 [@] 5				
2351.8	241.0 [@] 5	100 [@] 5			
	459.0 [@] 5	42 [@] 5			
2369.0	759.6 ^b	100			
2377.7	2377.7 ^a	100 ^a	D ^a		
2389.0	2295.2 [#] 8	100 67			
	2389.4 [#] 8	100 67			
2398.9	470.4 [@] 5	48 [@] 5			
	767 [@] 1	@			
	1315 ^f 1	100 5	(M1)	0.00428 6	Mult.: D from R(DCO) in $^{180}\text{Hf}(^{136}\text{Xe}, ^{136}\text{Xe}'\gamma)$, $\Delta\pi=\text{no}$ from level scheme.
2413.5	2104.9 ^b	100			
2425.2	481 ^c 3	$\approx 10^c$	[E1]	0.00715 14	B(E1)(W.u.) $>7.2\times 10^{-8}$.
	771.7 ^c 22	$\approx 100^c$	[E1]	0.00268 4	B(E1)(W.u.) $>1.8\times 10^{-7}$.
	1040.8 ^c 15	$\approx 20^c$	[E1]		B(E1)(W.u.) $>1.4\times 10^{-8}$.
2465.7	856.3 ^b	100			
2472.4	865.2 ^b				
	2163.4 ^b				
2477.11	160.40 3	48 12			
	864.2 3	56 16			
	917.4 5	100 32			
	937.8 5	64 32			
	1185.8 6	48 24			
	1835.8 10	28 24			
2485.5	223.3 ^c 2	2.8 ^c 3	[E1]	0.0445	B(E1)(W.u.) $=4.0\times 10^{-10}$ 7.
	539.5 ^c 3	100 ^c 5	[E1]	0.00557 8	B(E1)(W.u.) $=1.01\times 10^{-9}$ 14.
	832.4 ^c 15	1.3 ^c 5	[M2]	0.0342	B(M2)(W.u.) $=2.4\times 10^{-5}$ 10.
	1101.1 ^c 7	37 ^c 3	[E3]	0.00723 11	B(E3)(W.u.) $=0.089$ 14.
2493.5	2400.3 ^a	100 ^a			
	2493.3 ^a	35 ^a 17	D ^a		
2504.8	2196.2 ^b	100			
2532.8	485.2 [@] 5	100 [@] 21			
	902.4 [@] 5	71 [@] 7			
2537.4	52	100	[E2]	58.3	B(E2)(W.u.) <0.046 .
2549.4	1175.0 ^b	100			
2561.2	1079.4 ^b				
	1185.9 ^b				
2582.5	2489.3 ^a	61 ^a 27			
	2582.3 ^a	100 ^a	D ^a		
2588.0	453.8 [@] 5	100 [@]			
2603.1	340.6 [@] 5	100 [@] 7			
	657.5 [@] 5	43 [@] 7			
2613.9	480.3 [@] 5	100 [@] 8			
	983.0 [@] 5	34 [@] 6			
	1530 [@] 1	89 [@] 8	(E2)	0.00187 3	Mult.: stretched Q from R(DCO) in $^{180}\text{Hf}(^{136}\text{Xe}, ^{136}\text{Xe}'\gamma)$, assumed E2.
2614.8	263.0 [@] 5	100 [@] 9			
	504.0 [@] 5	64 [@] 9			
2617.2	2523.9 ^a	100 ^a			
	2617.2 ^a	49 ^a 7	D ^a		
2623.6	138	100			
2680.04	363.32 10	76 14			
	979.7 7	<104			
	1140.8 8	100 29			
	1488.0 10	29 24			

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Adopted Levels, Gammas (continued) $\gamma(^{180}\text{Hf})$ (continued)

E(level)	$E\gamma^{\dagger}$	$I\gamma^{\dagger}$	Mult. ‡	α	Comments
2682.4	1073.3 ^b				
	1199.4 ^b				
2706.2	2397.6 ^b	100			
2712.5	2619.3 ^a	56 ^a 11			
	2712.3 ^a	100 ^a	D ^a		
2730.7	456.7 [@] 5	47 [@] 3			
	596.7 [@] 5	19 [@] 3			
	1098 [@] 1	100 [@] 7	(D+Q)		Mult.: from R(DCO) in $^{180}\text{Hf}(^{136}\text{Xe}, ^{136}\text{Xe}'\gamma)$.
2741.5	1131.0 ^b				E γ : poor energy fit, excluded from least-squares fitting.
	1262.0 ^b				E from level energy difference is 1258.8.
	1367.7 ^b				
	2430.1 ^b				
2771.9	1397.5 ^b	100			
2784.0	1301.3 ^b	100			
2796.0	495.1 [@] 5				
	1165 [@] 1				
2797.1	1316.9 ^b				E γ : poor energy fit, excluded from least-squares fitting.
	1419.4 ^b				E from level energy difference is 1422.7.
	2489.4 ^b				
2806.0	1431.6 ^b	100			
2807.0	183.4 ^c 6	57 ^c 11			
	270.0 ^c 20	41 ^c 23			
	321.5 ^c 3	100 ^c 16			
2812.4	2812.4	100			
2839.2	1231.6 ^b				
	1356.4 ^b				
	1469.6 ^b 7				
2848.4	498.0 [@] 5	100 [@]			
2850.3	1239.7 ^b				
	1365.4 ^b				
	2543.2 ^b				
2858.7	1249.3 ^b				
	2550.2 ^b				
2873.4	2564.8 ^b	100			
2879.8	2879.8 ^a	100 ^a	(D+Q) ^a		
2892.3	2799.1 ^a	100 ^a			
	2892.1 ^a	47 ^a 11	D ^a		
2896.9	282.0 [@] 5	80 [@] 20			
	545.0 [@] 5	100 [@] 20			
2913.6	2272.7 ^b	100			
2948.0	2854.8 ^a	100 ^a			
	2947.8 ^a	40 ^a 5	D ^a		
2960.7	561.7 [@] 5	48 [@] 5			
	1330 [@] 1	100 [@] 10			
2965.4	362.3 [@] 5	100 [@] 17			
	703.0 [@] 5	83 [@] 17			
2993.1	2993.1 ^a	100 ^a	D ^a		
3000.1	2691.5 ^b	100			
3005.4	730.9 [@] 5	100 [@]	(E2)	0.00792 12	Mult.: stretched Q from R(DCO) in $^{180}\text{Hf}(^{136}\text{Xe}, ^{136}\text{Xe}')$, E2 from assumed band structure.
3011.3	2918.1 ^a	100 ^a			
	3011.1 ^a	80 ^a 26	D ^a		
3022.6	1540.5 ^b				
	2711.5 ^b				
	2931.1 ^b				
3049.7	1437.4 ^b				
	2406.9 ^b				
	2742.1 ^b				
3058.6	2750.0 ^b	100			
3068.8	2975.6 ^a	100 ^a			
	3068.6 ^a	77 ^a 12	D ^a		

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Adopted Levels, Gammas (continued) $\gamma(^{180}\text{Hf})$ (continued)

E(level)	$E\gamma^{\dagger}$	$I\gamma^{\dagger}$	Mult. $\ddagger$	α	Comments
3081.5	3081.5 ^a	100 ^a	D ^a		
3083.6	2442.7 ^b	100			
3086.0	3086.0 ^a	100 ^a	D ^a		
3089.8	1715.4 ^b				
	2781.2 ^b				
3100.8	2792.2 ^b	100			
3100.8	293.9 ^c 8	100 ^c			
3110.6	577.8 [@] 5	60 [@] 30			
	836.3 [@] 5	100 [@] 14			
3123.4	535.4 [@] 5	100 [@]			
3124.1	2815.5 ^b	100			
3125.6	3032.4 ^a	100 ^a			
	3125.4 ^a	33 ^a 9	D ^a		
3129.2	515.4 [@] 5	61 [@] 7			
	1498 [@] 1	100 [@] 7	(E2)	0.00193 3	Mult.: stretched Q from R(DCO) in $^{180}\text{Hf}(^{136}\text{Xe}, ^{136}\text{Xe}'\gamma)$, assumed E2.
3131.7	1521.7 ^b				
	2823.8 ^b				
3150.7	3057.5 ^a	33 ^a 12			
	3150.5 ^a	100 ^a	D ^a		
3153.1	1670.4 ^b	100			
3163.2	2854.6 ^b	100			
3174.4	3081.0 ^b	100			
3184.0	1809.9 ^b				
	2542.9 ^b				
3191.4	294.5 [@] 5	@			
	576.7 [@] 5	@			
3200.4	2891.8 ^b	100			
3215.3	2906.7 ^b	100			
3253.1	3159.7 ^b	100			
3254.3	3161.1 ^a	100 ^a			
	3254.1 ^a	91 ^a 35	D ^a		
3257.7	2616.8 ^b	100			
3300.4	569.8 [@] 5	100 [@] 11			
	686.8 [@] 5	50 [@] 11			
	1026 [@] 1	@			
	1669 [@] 1	@			
3303.7	1694.3 ^b	100			
3317.0	1836.6 ^b				
	1947.1 ^b				
	2672.9 ^b				E γ : poor energy fit, excluded from least-squares fitting. E from level energy difference is 2676.4.
	3009.6 ^b				
3330.1	3330.1 ^a	100 ^a	D ^a		
3330.3	1956.6 ^b				
	3021.0 ^b				
3338.7	1729.3 ^b	100			
3350.2	384.8 [@] 5	100 [@] 30			
	747.2 [@] 5	$\approx$ 100 [@]			
3384.0	588.0 [@] 5				
	1110 ^{@e} 1				
3417.2	1804.2 ^b				
	1936.3 ^b				
	2775.9 ^b				
	3107.2 ^b				
3428.7	1946.0 ^b	100			
3432.1	583.7 [@] 5				
3442.9	3134.3 ^b	100			
3446.9	346.1 ^c 1	100 ^c 40			
	639.4 ^c 15	80 ^c 30			
3468.6	2827.7 ^b	100			
3483.4	2109.0 ^b	100			
3489.2	3180.6 ^b	100			

Continued on next page (footnotes at end of table)

Adopted Levels, Gammas (continued) $\gamma(^{180}\text{Hf})$ (continued)

E(level)	$E\gamma^{\dagger}$	$I\gamma^{\dagger}$	Mult. ‡	α	Comments
3499.9	3191.3 ^b	100			
3506.8	3506.8 ^a	100 ^a	(D+Q) ^a		
3515.7	3207.1 ^b	100			
3526.7	3218.1 ^b	100			
3528.9	427.9 ^c 16				
	722.0 ^c 15				
3559.6	3466.4 ^a	100 ^a			
	3559.4 ^a	95 ^a 29	D ^a		
3569.5	3476.3 ^a	100 ^a			
	3569.3 ^a	39 ^a 19	D ^a		
3584.2	3491.0 ^a	66 ^a 18			
	3584.0 ^a	100 ^a	D ^a		
3592.5	3499.3 ^a	100 ^a			
	3592.3 ^a	101 ^a 44	D ^a		
3596.5	2222.1 ^b	100			
3597.5	150.6 ^c 5	100 ^c	(M2)	8.13 15	B(M2)(W.u.)=0.0153 18. Mult.: M2 or E3 from $\alpha(\text{exp})$ in $^{180}\text{Hf}(^{238}\text{U}, ^{238}\text{U}'\gamma)$; M2 assuming lowest multipole dominates.
3606.5	645.8 [@] 5	83 [@] 17			
	1332 [@] 1	100 [@] 17			
3615.1	3521.9 ^a	100 ^a			
	3614.9 ^a	16 ^a 6	D ^a		
3625.4	3316.8 ^b	100			
3627.1	3627.1 ^a	100 ^a	D ^a		
3640.7	3332.1 ^b	100			
3653.8	3560.4 ^b	100			
3672.2	3363.4 ^b				
	3579.0 ^b				
3678.1	548.9 [@] 5				
	673 [@]				
	1404 [@] 1				
3681.2	3372.6 ^b	100			
3734.0	610.6 [@] 5	100 [@]			
3751.3	3442.4 ^b				
	3658.3 ^b				
3755.4	405.4 [@] 5				
	790.0 [@] 5				
3766.6	3673.4 ^a	100 ^a			
	3766.4 ^a	43 ^a 13	D ^a		
3774.3	3681.1 ^a	35 ^a 14			
	3774.1 ^a	100 ^a	D ^a		
3781.5	670.8 [@] 5				
	776.1 [@] 5				
3786.2	3693.0 ^a	100 ^a			
	3786.0 ^a	99 ^a 35	D ^a		
3804.1	3710.9 ^a	100 ^a			
	3803.9 ^a	41 ^a 16	D ^a		
3813.5	807.9 [@] 5	100 [@]	(E2)	0.00637 9	Mult.: stretched Q from R(DCO) in $^{180}\text{Hf}(^{136}\text{Xe}, ^{136}\text{Xe}'\gamma)$, E2 from assumed band structure.
3818.0	3818.0 ^a	a	D ^a		
3829.6	3829.6 ^a	a	D ^a		
3836.5	3743.3 ^a	100 ^a			
	3836.3 ^a	27 ^a 8	D ^a		
3848.3	3208.6 ^b				
	3539.7 ^b				
	3753.6 ^b				
3851.7	3758.5 ^a	100 ^a			
	3851.5 ^a	85 ^a 30	D ^a		
3855.6	2246.2 ^b	100			
3862.2	3862.2 ^a	100 ^a	(D+Q) ^a		
3869.2	2388.0 ^b				
	3226.9 ^b				
3880.3	3239.4 ^b	100			

Continued on next page (footnotes at end of table)

Adopted Levels, Gammas (continued) $\gamma(^{180}\text{Hf})$ (continued)

E(level)	$E\gamma^\dagger$	$I\gamma^\dagger$	Mult. ‡	Comments
3889.4	3889.4 ^a	100 ^a	D ^a	
3908.5	3267.6 ^b	100		
3926.5	2317.7 ^b			
	3617.2 ^b			
3928.0	3928.0 ^a	100 ^a	D ^a	
3948.1	3948.1 ^a	100 ^a	D ^a	
3957.6	3648.6 ^b			
	3864.6 ^b			
3967.8	3967.8 ^a	100 ^a	D ^a	
3971.3	671.0@ 5			
	965.7 5			
3975.3	2489.5 ^b			
	3667.9 ^b			
3978.4	3885.2 ^a	28 ^a 14		
	3978.2 ^a	100 ^a	D ^a	
3987.6	2504.9 ^b	100		
3992.3	2382.9 ^b	100		
4003.1	2627.9 ^b			
	3695.4 ^b			
4091.3	659.2@ 5	100		
4137.7	2763.3 ^b	100		
4180.1	424.8@ 5			
	829.8@ 5			
4270.2	456@			
	592.3@ 5			
	1265@			
4323.5	717@	100@		
4331.9	2722.5 ^b	100		
4356.0	2746.6 ^b	100		
4413.1	679.1@ 5	100@		
4423.1	2813.9 ^b			
	4329.6 ^b			
4682.0	868.5@ 5	100@		
4808.5	3201.2 ^b			
	4499.5 ^b			
4852.8	3245.2 ^b			
	4759.3 ^b			
4916.3	3437.3 ^b			E γ : poor energy fit, excluded from least-squares fitting. E from level energy difference is 3433.6.
	3541.9 ^b			
	4272.8 ^b			
	4606.5 ^b			
4924.2	654@	100@		
4965.4	3479.3 ^b			
	3590.4 ^b			
	4659.0 ^b			
5048.3	3566.6 ^b			
	4953.8 ^b			
5057.6	3576.0 ^b			
	4748.5 ^b 6			
5554.0	872@	100@		
5629.2	705@	100@		
5666.0	984@	100@		

 † From $^{179}\text{Hf}(n,\gamma)$ E=thermal, except where noted. ‡ From $^{180}\text{Hf}(n,n'\gamma)$, unless otherwise specified. § From ^{180}Lu β^- decay.# From $^{180}\text{Hf}(n,n'\gamma)$.@ From $^{180}\text{Hf}(^{136}\text{Xe}, ^{136}\text{Xe}'\gamma)$.& From ce data in $^{179}\text{Hf}(n,\gamma)$ E=thermal (1986RoZM).a From $^{180}\text{Hf}(\gamma,\gamma')$.b From $\gamma\gamma$ coin with fixed energy sum in $^{179}\text{Hf}(n,\gamma)$ E=thermal (1990Bo52).c From $^{180}\text{Hf}(^{238}\text{U}, ^{238}\text{U}'\gamma)$.

Footnotes continued on next page

Adopted Levels, Gammas (continued) $\gamma(^{180}\text{Hf})$ (continued)

^d Multiply placed; undivided intensity given.

^e Placement of transition in the level scheme is uncertain.

^f Multiply placed.

 ^{180}Lu β^- Decay 1986KeZW,1973KaYQ,1971Gu02

Parent ^{180}Lu : $E=0.0$; $J\pi=5+$; $T_{1/2}=5.7$ min 1; $Q(g.s.)=3100$ 70; $\%\beta^-$ decay=100.

1986KeZW: ^{180}Lu activity from $^{180}\text{Hf}(n,p)$, $E(n)=\text{fast}$. Measured $E\gamma$, $I\gamma$ using Ge(Li) detector (FWHM=1.5 keV at 500 keV).

1973KaYQ: ^{180}Lu activity from $^{180}\text{Hf}(n,p)$, $E(n)=14$ MeV. Measured $E\gamma$, $I\gamma$, $E\beta$, $I\beta$, $\gamma(t)$, $\gamma\gamma$, and $\beta\gamma$ coincidences with Ge(Li) detectors and scintillation spectrometers.

1971Gu02: ^{180}Lu activity from $^{180}\text{Hf}(n,p)$, $E(n)=14.8$ MeV. Measured $E\gamma$, $I\gamma$, $E\beta$, $I\beta$, $\gamma(t)$, $\gamma\gamma$, and $\beta\gamma$ coincidences with a Ge(Li) and NaI(Tl) detector and a plastic scintillator.

Other: 1971Sw01.

No β^- population (0.005% 18) from ^{180}Lu to $^{180m}\text{Hf}(5.5\text{ h})$ (1986Ke19). Other value: 0.46% 15 (1984Es02). The discrepancy with the value given by 1986Ke19 could be explained by assuming the existence of a ^{180}Lu isomer. However, 1986Le19 found no evidence of a ^{180}Lu isomer in the 10–300 s half-life range. % branching given by 1984Es02 may be affected by an imprecise correction of the contribution from ^{180}Hf (5.5 h) directly produced in the reaction. Its uncertainty may have also been underestimated by using a linear approximation with partial derivatives for the propagation of large uncertainties.

 ^{180}Hf Levels

See 1992So09 and 1990SoZZ for configuration assignments of ^{180}Hf levels populated in the β^- decay of ^{180}Lu , based on β^- transition rates, on calculated two-quasiparticle excitation energies, and on level de-excitation patterns.

$E(\text{level})^\dagger$	$J\pi^\ddagger$	$T_{1/2}^\ddagger$	$E(\text{level})^\dagger$	$J\pi^\ddagger$	$T_{1/2}^\ddagger$	$E(\text{level})^\dagger$	$J\pi^\ddagger$
0.0 §	0+	stable	1291.46# 6	3+		1742.87 12	(5)+
93.306 § 15	2+	1.519 ns 10	1374.9 3	(4-)	0.57 μ s 2	2183.1 3	
308.541 § 21	4+	71 ps 10	1409.56# 12	(4+)		2197.04 22	
1183.47 13	2+		1607.97 5	(4)+			
1200.04# 5	2+	0.51 ps 5	1609.8 4	(3-)			

[†] From a least-squares fit to $E\gamma$, by evaluator.

[‡] From the Adopted Levels.

§ $K\pi=0+$ ground state rotational band.

$K\pi=2+$ γ -vibrational band.

 β^- radiations

$E\beta^-$	$E(\text{level})$	$I\beta^{-\ddagger}$	$\text{Log } ft$	Comments
(1360 70)	1742.87	9 1	5.95 10	
(1490 70)	1609.8	1.5 2	6.88 10	
(1490 70)	1607.97	78 2	5.17 8	$I\beta^-$: 90% to 1607.7, 1609.7, and 1742.7 levels (1971Gu02).
				$E\beta^-$: 1540 100 (1971Gu02).
(1730 70)	1374.9	0.7 4	7.5 3	$I\beta^-$: 8% (1971Gu02).
				$E\beta^-$: 2000 200 (1971Gu02).
(1810 [‡] 70)	1291.46	2 1	7.07 23	
(1900 [‡] 70)	1200.04	3 2	7.0 3	
(2790 70)	308.541	5 2	7.42 18	$E\beta^-$: 2740 200 (1971Gu02).
				$I\beta^-$: 2% (1971Gu02).

[†] Absolute intensity per 100 decays.

[‡] Existence of this branch is questionable.

 $\gamma(^{180}\text{Hf})$

$I\gamma$ normalization: From decay scheme assuming no β^- feeding to g.s. and 93.3 level and setting $\Sigma(I(\gamma+ce))$ to g.s. (except 93.3 γ) and 93.3 level)=100%.

Continued on next page (footnotes at end of table)

^{180}Hf IT Decay (5.53 h) $^{1961}\text{Ed01}, ^{1970}\text{Re08}, ^{1971}\text{Gu02}$ Parent ^{180}Hf : E=1141.729 21; $J\pi=8^-$; $T_{1/2}=5.53$ h 2; %IT decay=99.7 1. **^{180}Hf Levels**

E(level) [†]	$J\pi^{\ddagger}$	$T_{1/2}$	Comments
0.0 §	0+	stable	
93.325 § 12	2+	1.524 ns 10	$g=+0.305$ 14 (1996Al20). $T_{1/2}$: weighted average of 1.40 ns 10 (1955Su64), 1.48 ns 5 (1960De18), 1.53 ns 6 (1961Bo25), 1.50 ns 4 (1962Fo05), 1.53 ns 5 (1963Li04), and 1.528 ns 10; all from $\gamma\gamma(t)$ or γ -x-ray(t).
308.751 § 14	4+	71 ps 10	$g=+0.36$ 4 (1996Al20). $J\pi$: $A_2=0.093$ 7 and $A_4=0.014$ 9 from $\gamma\gamma(0)$ for the 215 γ -93 γ cascade are consistent with $J=4$ if 215 γ and 93 γ are E2 (1961Bo25,1975Gr18). Other: 1962Ko15. $T_{1/2}$: weighted average of 60 ps 17 (1958Su54) and 75 ps 10 (1963Li04), both from centroid shift measurements.
641.026 § 18	6+		$g=+0.34$ 7 (1996Al20). $J\pi$: $A_2=0.09$ 1 and $A_4=0.006$ 10 from $\gamma\gamma(0)$ from the 332 γ -215 γ cascade are consistent with $J=6$ if 332 γ and 215 γ are E2 (1961Bo25,1975Gr18).
1084.183 § 21	8+		$J\pi$: $A_2=0.091$ 5 and $A_4=0.010$ 7 from $\gamma\gamma(0)$ for the 443 γ -332 γ cascade are consistent with $J=8$ if 443 γ and 332 γ are E2 (1962Ko15,1975Gr18).
1141.729 # 21	8-	5.53 h 2	$\% \beta^-=0.3$ 1; %IT=99.7 1 (1992Ke04). $T_{1/2}$: weighted average of 5.5 h 1 (1951Bu50), 5.5 h 1 (1963Ra14), 5.519 h 4 (1980Ho17), 5.40 h 5 (2003Al36), and 5.540 h 3 (2006Vo12). A 0.4% uncertainty was added in quadrature to latter three values to incorporate systematic errors. Other: 2001Al23, reported variation in $T_{1/2}$ with temperature which was not confirmed in 2003Al36 by same authors. $J\pi$: $A_2=0.154$ 15, $A_2=0.162$ 15, $A_2=0.165$ 15, $A_2=0.14$ 4 for the 57 γ -443 γ , 57 γ -332 γ , 57 γ -215 γ , and 57 γ -93 γ cascades, respectively, are consistent with $J=8$ if $\delta(57\gamma)<0.1$ (1960De22,1975Gr18). Parity mixing with 1084-keV ($J\pi=8+$) level was reported by 1966Bl12, 1966Bo12, 1972JeZZ, 1973Sc25, 1972Ku23, 1972Li11, 1972Kr06, 1975Ch16, 2007St20. Configuration= $\pi 7/2[404] \otimes \pi 9/2[514]$.

[†] From a least-squares fit to E_γ by evaluator.[‡] From the Adopted Levels.§ $K\pi=0+$ g.s.-rotational band.# $K\pi=8-$ bandhead. **$\gamma(^{180}\text{Hf})$** I_γ normalization: From decay scheme using $\% \beta^-=0.3$ 1 (1992Ke04), and $I(\gamma+ce)(332.3\gamma)=99.7\%$ 1.

$E_\gamma^{\dagger}$	E(level)	$I_\gamma^{\ddagger\#}$	Mult.§	δ	α	Comments
57.538 17	1141.729	51.0 10	E1		0.652 25	E_γ : weighted average of 57.54 1 (1961Ed01), 57.549 5 (1970Re08), 57.442 15 (1971Gu02), and 57.44 5 (1972GeZG). I_γ : weighted average of 51.3 12 (1961Ed01), 51.3 20 (1970Re08), and 47.5 34 (1971Gu02). $\alpha=0.75$ 3 from intensity balance at 1084 level. α : experimental value (1986BeZE). Mult.: K-forbidden E1 transition. Multipolarity from $ce(L1)/ce(L2)$ exp=4.02 18, $ce(L1)/ce(L3)$ exp=4.49 9, $ce(L2)/ce(L3)$ exp=1.16 3, $ce(M1)/ce(M2)$ exp=3.79 15, $ce(M2)/ce(M3)$ exp=1.28 6, $ce(N1)/ce(N2)$ exp=4.1 5, $ce(N1)/ce(N3)$ exp=6.7 13, $ce(N2)/ce(N3)$ exp=1.6 4, weighted averages from 1967Gi11, 1967Sc19, 1970Gv01, 1972Dr02, and 1981Fr05. Penetration parameters are $\lambda(1)=7.0$ 7 and $\lambda(2)=0$, from $ce(L1)/ce(L3)$ exp: 4.49 20, $ce(L2)/ce(L3)$ exp: 1.16 5, and $\alpha(L3)$ exp=0.061 4 (1981Fr05). $\delta(M2/E1)=-0.009$ +65-85, $\delta(E3/E1)=0.013$ 20 (1972Kr06), $\gamma(0,H,t)$. Other: 1961Ed01.

Continued on next page (footnotes at end of table)

^{180}Hf IT Decay (5.53 h) $^{1961}\text{Ed01}, ^{1970}\text{Re08}, ^{1971}\text{Gu02}$ (continued) $\gamma(^{180}\text{Hf})$ (continued)

$E\gamma^\dagger$	E(level)	$I\gamma^\ddagger$	Mult.§	δ	α	Comments
93.324 15	93.325	17.5 5	E2		4.63	<p>$E\gamma$: weighted average of 93.33 2 (1961Ed01), 93.332 6 (1970Re08), 93.263 15 (1971Gu02), and 93.328 15 (1972GeZG).</p> <p>$I\gamma$: weighted average of 17.6 4 (1961Ed01), 18.0 5 (1970Re08), 19.5 17 (1971Gu02), and 15.5 8 (1972GeZG).</p> <p>$\alpha(\text{exp})=4.77$ 6 (1986BeZE), 4.91 23 (1967Ne07), 5.14 24 (1961Ed01). ce(K)/ce(L1)+ce(L2)/ce(L3)/ce(M)+ce(N)+ce(O) exp: 205 12/343 17/239 13/169 12 s (1961Ed01). Others: 1967Sc19, 1968Gv01, 1968El02, 1970Gv01, 1972Dr02.</p>
215.426 13	308.751	86.7 20	E2		0.225	<p>$E\gamma$: weighted average of 215.25 13 (1961Ed01), 215.251 13 (1970Re08), 215.241 15 (1971Gu02), and 215.243 15 (1972GeZG).</p> <p>$I\gamma$: weighted average of 88.2 25 (1961Ed01), 86.5 20 (1970Re08), 85.9 25 (1971Gu02), and 86.2 25 (1972GeZG).</p> <p>$\alpha(\text{K})\text{exp}=0.123$ 9 (1961Ed01); ce(L1)/ce(L3) exp: 0.73 5, ce(L2)/ce(L3) exp: 1.52 10 (1968Gv01).</p>
332.274 15	641.026	100.0 25	E2		0.0586	<p>$E\gamma$: weighted average of 332.5 3 (1961Ed01), 332.307 36 (1970Re08), 332.272 15 (1971Gu02), and 332.269 18 (1972GeZG).</p> <p>$I\gamma$: weighted average of 100 4 (1961Ed01), 100.0 25 (1970Re08), 100 4 (1971Gu02), and 100.0 25 (1972GeZG).</p> <p>$\alpha(\text{K})\text{exp}=0.038$ 3 (1961Ed01). ce(L1)/ce(L3) exp: 1.8 1, ce(L2)/ce(L3) exp: 1.6 1 (1968Gv01, 1975Gr18).</p>
443.162 15	1084.183	86.8 25	E2		0.0264	<p>$E\gamma$: weighted average of 443.8 6 (1961Ed01), 443.181 55 (1970Re08), 443.168 15 (1971Gu02), and 443.149 20 (1972GeZG).</p> <p>$I\gamma$: weighted average of 86.6 46 (1961Ed01), 90.4 30 (1970Re08), 84.8 25 (1971Gu02), and 86.4 25 (1972GeZG).</p> <p>$\alpha(\text{K})\text{exp}=0.0189$ 17 (1961Ed01). ce(L1)/ce(L3) exp: 3.0, ce(L2)/ce(L3) exp: 1.9 s (1968Gv01, 1975Gr18).</p>
500.697 15	1141.729	15.1 4	M2+E3	-5.3 2	0.0610	<p>$E\gamma$: weighted average of 500.714 66 (1970Re08), 500.702 15 (1971Gu02), and 500.680 25 (1972GeZG).</p> <p>$I\gamma$: weighted average of 13.6 12 (1970Re08), 15.7 14 (1971Gu02), 15.1 8 (1972GeZG), and 15.2 4 (1971Ja21). Value from 1971Ja21 is deduced by the evaluator using their measured ratio $I\gamma(443\gamma)/I\gamma(501\gamma)=5.70$ 15 and $I\gamma(443\gamma)=86.8$ 25.</p> <p>$\alpha(\text{K})\text{exp}=0.0383$ 12, $\alpha(\text{L})\text{exp}=0.0168$ 11 (1967Gi11). ce(L1)/ce(L3) exp: 3.0 3, ce(L2)/ce(L3) exp: 3.0 3 (1968Gv01). Others: 1961Ed01, 1967Sc19, 1990Mi25.</p> <p>δ: -5.3 4 from $\gamma\gamma(0)$ in 1961Bo25 and -5.3 3 from γ anisotropy in 1971Kr18. Also 1962Ko15. Penetration parameter $\lambda=-40$ 8 from ce(K)/ce(L1)/ce(L2)/ce(L3) exp: 0.043 3/0.0072 5/0.0072 5/0.0023 2 consistent with $\delta=5.4$ (1977Se10). Penetration parameter $\lambda=-44$ 6 from $\alpha(\text{K})\text{exp}=0.0463$ 12, ce(K)/ce(L) exp: 2.65 10, ce(L1)/ce(L2) exp: 1.00 4, ce(L1)/ce(L3) exp: 3.0 2, and $\delta=-5.5$ 2 (1990Mi25, 1990MiZP).</p>

† Weighted average of data from 1961Ed01, 1970Re08, 1971Gu02, and 1972GeZG. Individual values are included in the comments.

‡ Weighted average of data from 1961Ed01, 1970Re08, 1971Ja21, 1971Gu02, and 1972GeZG. Individual values are included in the comments.

§ From ce measurements as provided in the comments.

For absolute intensity per 100 decays, multiply by 0.941 9.

^{180}Hf IT Decay (5.53 h) 1961Ed01,1970Re08,1971Gu02 (continued)

Decay Scheme

Intensities: I(γ +ce) per 100
parent decays
%IT=99.7 1

 ^{180}Ta ϵ Decay 1980Ry01,1962Ga07,1974HeYW

Parent ^{180}Ta : E=0.0; $J\pi=1+$; $T_{1/2}=8.154$ h 6; Q(g.s.)=845.6 26; % ϵ decay=86 3.
1962Ga07: ^{180}Ta activity from $^{180}\text{Hf}(d,2n)$, E(d)=11 MeV. Measured $E\gamma$, $I\gamma$, Ice, $\beta\gamma$ coin using a 6-gap orange spectrometer and NaI detector.
1980Ry01: ^{180}Ta activity from 14 MeV neutrons on natural Ta foils. Measured $E\gamma$, $I\gamma$, Ice, $4\pi\beta$ and γ -x-ray coincidences using Ge(Li) and intrinsic Ge detectors and a $4\pi\beta$ counter.
1974HeYW: Measured $E\gamma$, $I\gamma$ using Ge(Li) detector.

 ^{180}Hf Levels

E(level) [†]	$J\pi^{\dagger}$	$T_{1/2}^{\dagger}$
0.0	0+	stable
93.3240 20	2+	1.519 ns 10

[†] From the Adopted Levels.

 β^+, ϵ Data

E ϵ	E(level)	I $\epsilon^{\dagger}$	Log ft	I($\epsilon+\beta^+$) [†]
(752 3)	93.3240	25 1	5.978 24	25 1
(846 3)	0.0	61 2	5.700 21	61 2

[†] For intensity per 100 decays, multiply by 1.00 4.

 $\gamma(^{180}\text{Hf})$

$I\gamma$ normalization: See ^{180}Ta β^- decay for decay scheme normalization.

$E\gamma^{\dagger}$	E(level)	$I\gamma^{\ddagger}$	Mult. [†]	α	Comments
93.324 2	93.3240	100	E2	4.63	$E\gamma$: 93.4 2 is measured by 1974HeYW.

[†] From the Adopted Gammas.

[‡] For absolute intensity per 100 decays, multiply by 0.0451 16.

^{180}Ta ϵ Decay 1980Ry01,1962Ga07,1974HeYW (continued) **$^{178}\text{Hf}(\text{t},\text{p})$ 1983Bu03**

E(p)=15 MeV. Target enriched to 94.7% ^{178}Hf . Measured $\sigma(\theta)$ for $\theta=7.5^\circ$ to 67.5° in steps of 7.5° using Enge split-pole magnetic spectrograph and photographic emulsions (FWHM =15 keV); DWBA analysis.

 ^{180}Hf Levels

E(level)	$L^\dagger$	E(level)	$L^\dagger$	E(level)
0.0	0	1316	0	1824
93		1409 ‡	(2)	1906
308		1482		1939
638		1608	(4)	2115
1102?		≈ 1716		2303
1199	2	1756		2348

† Definite L values are from a comparison with DWBA calculations. Tentative L values are given from a comparison of the shape of angular distribution to that measured from levels with well-established spin values.

‡ Angular distribution suggests that this level is not the same as the $J\pi=4+$, 1409.2-keV level observed in (n, γ).

 $^{179}\text{Hf}(\text{n},\gamma)$ E=thermal 1974Bu22,1990Bo52,1986RoZM

1974Bu22: 83.6% enriched ^{179}Hf target. Measured E_γ , I_γ using bent crystal spectrometer for $E_\gamma=40$ –1300 keV, Ge(Li) anti-Compton spectrometer for $E_\gamma=400$ –2100 keV, and Ge(Li) pair spectrometer for $E_\gamma=4.7$ –7.3 MeV. S(n)=7387.7 keV 3.

1990Bo52: Target: ^{179}Hf . Measured E_γ , total I_γ for γ -ray cascades. Measured $\gamma\gamma$ coin for γ -rays with fixed energy sum feeding the 93 (2+), 309 (4+), 641 (6+), and 1374 (3-) levels using two Ge(Li) detectors.

1986RoZM: Measured conversion coefficients; deduced multiplicities.

Others: 1966Na03, 1967Pr08, 1975Ma19, 1984Pr03, 1985GrZR, 1990BoZN, 2008Ng01, 2009No12, 2011Bu08.

 ^{180}Hf Levels

E(level) †	$J\pi^\ddagger$	$T_{1/2}$	Comments
0.0 $^\&$	0+		
93.3240 $^\&$ 20	2+		
308.576 $^\&$ 3	4+		
640.850 $^\&$ 11	6+		
1083.93 $^\&$ 4	8+		
1107.24 5	0+		E(level), $J\pi$: original assignment by 1974Bu22 has been reassigned to 1102 level in the Adopted Levels.
1141.48 5	8-		
1164.08 ^a 5	0+		
1192.63 6	6+		
1199.68 5	2+		
1260.67 ^a 4	2+		

Continued on next page (footnotes at end of table)

$^{179}\text{Hf}(\text{n},\gamma)$ E=thermal 1974Bu22,1990Bo52,1986RoZM (continued) **^{180}Hf Levels (continued)**

E(level) [†]	$J\pi^{\ddagger}$	$T_{1/2}$	Comments
1290.99 6	4+		
1300.35 5	2+		$J\pi$: adopted (E1) 1300 γ to 0+ suggests $J\pi=(1-)$ while population by (E2) 6088 γ suggests $\pi=(+)$.
1369.57 8	4+		
1374.33 4	3-	0.57 μs 2	$T_{1/2}$: from 1990GrZS.
1381.55 5	3+		
1409.24 6	4+		
1420.5@ 7			
1429.77 4	3-		
1472.23 7	6+, (7+)		$J\pi$: γ -rays to 4+ states favor the $J\pi=6+$ assignment.
1482.63 4	3-		
1484.43 ^a 6	4+		
1532.9@ ^b 5			
1539.25 4	3-		
1557.28 23			
1559.26 4	4+		
1597.48 7	6+, (3+)		$J\pi$: tentatively placed 956 γ to 6+ favors the $J\pi=6+$ assignment.
1607.62 4	3+, (4+)		
1609.35 4	3-		
1613.05 4	4-, (5-)		
1637.16 14	2+		
1657.96@ 10			
1666.2@ ^b 7			
1680.4@ ^b 10			
1700.81 4	5+		
1709.5 3	4-, (5-)		
1724.77 9	2+, 3+		
1727.4@ ^b 7			
1738.4@ 7			
1743.33 6	2+		
1786.5@ 7			
1813.90 8	3-		
1818.56 4	(3-, 6-)		
1828.0@ 7			
1861.61@ ^b 9			
1909.68 9	4+, 5+		
1932.2@ 7			
1936.9@ 7			
1945.22 13	2+		
1959.46@ ^b 8			
2018.2@ ^b			
2022.2@ 7			
2034.37 7	4+, 5+		
2058.4@ 7			
2077.82@ 10			
2146.7@ 7			
2151.46 6	3-, (4-)		
2153.3@ ^b 7			
2174.0@ 3			
2187.56 ^b 20			
2200.6@ 7			
2215.5@ 7			
2242.2@ 7			
2245.7@ 7			
2252.4@ 7			
2261.5@ 6			
2275.6@ 4			
2292.6@ 7			
2316.64 9	(4-), 5-		
2320.9@ 4			
2334.90@ 20			
2341.0@ 7			
2368.7@ 7			

Continued on next page (footnotes at end of table)

$^{179}\text{Hf}(\text{n},\gamma)$ E=thermal 1974Bu22,1990Bo52,1986RoZM (continued) **^{180}Hf Levels (continued)**

E(level) [†]	$J\pi^{\ddagger}$	E(level) [†]	$J\pi^{\ddagger}$	E(level) [†]	$J\pi^{\ddagger}$
2413.1@ 7		3123.8@ 7		3653.5@ 7	
2465.3@ 7		3131.5@ 6		3672.0@ 6	
2472.5@ 6		3152.8@ 7		3683.5@ 7	
2477.04 10	5-	3163.1@ 7		3751.1@ 6	
2504.3@ 7		3174.2@ 7		3848.2@ 5	
2549.0@ 7		3183.8@ 6		3855.3@ 7	
2560.7@ 5		3200.2@ 7		3869.2@ 6	
2679.97 13	4, 5-	3215.2@ 7		3880.1@ 7	
2682.1@ 6		3252.9@ 7		3908.2@ 7	
2706.0@ 7		3258.1@ 7		3926.2@ 6	
2741.3@ 5		3303.4@ 7		3957.3@ 6	
2771.6@ 7		3316.9@ 5		3974.8@ 6	
2783.7@ 7		3330.2 6		3987.3@ 7	
2797.1@ 5		3338.4@ 7		3992.1@ 7	
2805.7@ 7		3416.9 5		4002.9@ 6	
2839.9@ 5		3428.4@ 7		4137.4@ 7	
2849.8@ 5		3442.6@ 7		4331.7@ 7	
2858.5@ 6		3468.4@ 7		4355.7@ 7	
2873.0@ 7		3483.0@ 7		4422.9@ 6	
2913.3@ 7		3488.9@ 7		4808.6@ 6	
2999.7@ 7		3499.5@ 7		4852.9@ 6	
3022.2@ 5		3515.4@ 7		4916.1@ 5	
3049.3@ 5		3526.4@ 7		4964.9@ 5	
3058.0@ 7		3596.2@ 7		5048.0@ 6	
3083.2@ 7		3605.9@ 6		5057.6@ 6	
3089.7@ 5		3625.0@ 7		7387.60 § 8	4+, 5+ #
3100.5@ 7		3640.3@ 7			

[†] From a least-squares fit to secondary γ -rays of 1974Bu22 by evaluator.

[‡] As proposed by 1974Bu22 based on decay properties, feeding from primary transitions and data from $^{179}\text{Hf}(\text{n},\gamma)$, E=res:Av.

§ Capture state.

Most of the contribution to the capture state is from $J\pi=5+$ thermal-neutron resonances (1990Bo50,1990Bo52).

@ From $\gamma\gamma$ coin, observed by 1990Bo52 only.

& $K\pi=0+$ g.s. rotational band.

^a $K\pi=0+$ rotational band.

^b Level energy is not definite because order of γ -ray cascade is unknown (1990Bo52). Level is not included in Adopted Levels.

 $\gamma(^{180}\text{Hf})$

γ -ray energies, unless otherwise specified, are from 1974Bu22, as follows: 1. From combined bent crystal and Ge(Li) anti-Compton measurements for energies below 1300 keV. 2. From Ge(Li) anti-Compton spectrometer for energies between 1300 and 2300 keV. 3. From Ge(Li) pair spectrometer for energies greater than 4500 keV (primary γ -rays). Evaluator has increased values from bent crystal measurements by 17 ppm to make them consistent with 59.31922 keV 7 (1980De40) for the K-L3 tungsten x-ray standard.

$E\gamma^{\dagger}$	E(level)	$I\gamma^{\ddagger}$	Mult.§	$\delta^{\S}$	Comments
*45.755 7		0.30 6	M1		
53.799 1	1613.05	0.32 3			ce(L1):ce(L2):ce(L3) exp= ≤ 30 : ≤ 30 : ≤ 25 (1967Pr08).
55.448 3	1429.77	0.17 4			ce(L1):ce(L2):ce(L3) exp= ≤ 25 :35:25 (1967Pr08).
57.554 17	1141.48				I γ : I γ =82 % 2, relative intensity de-exciting the 5.5-h ^{180}Hf isomer measured following reactor shut down (1974Bu22).
*65.24 4		0.15 10			
76.623 3	1559.26	0.48 5	D		$\alpha(\text{L2})\text{exp}<0.2$ (1986RoZM).
81.21 2	1381.55	0.15 1			
92.44 1	1199.68	0.014 8			
*92.50 1		0.015 8			
*92.56 1		0.016 8			
*92.797 8		0.060 8			
93.324 2	93.3240	9.85 10	E2		$\alpha(\text{K})\text{exp}=1.05$ 5, $\alpha(\text{L1}+\text{L2})\text{exp}=1.26$ 7, $\alpha(\text{L3})\text{exp}=1.20$ 7, $\alpha(\text{M})\text{exp}=0.62$ 6, $\alpha(\text{N}+\text{O})\text{exp}=0.184$ 16 (1986RoZM). ce(L):ce(M):ce(N) exp= <2300 : <730 : <100 (1967Pr08).

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$^{179}\text{Hf}(\text{n},\gamma)$ E=thermal 1974Bu22,1990Bo52,1986RoZM (continued) $\gamma(^{180}\text{Hf})$ (continued)

$E\gamma^{\dagger}$	E(level)	$I\gamma^{\ddagger}$	Mult. §	$\delta^{\S}$	Comments
96.589 10	1260.67	0.017 5			
x104.604 10		0.008 5			
x104.692 10		0.008 5			
x105.433 10		0.039 5			
108.308 2	1482.63	1.90 8	M1+E2	0.80 12	$\alpha(\text{L1})\text{exp}=0.33\ 4$, $\alpha(\text{M})\text{exp}=0.21\ 2$ (1986RoZM). ce(K):ce(L1):ce(L2):ce(L3):ce(M) exp= $\leq 30:20:20:\leq 20:20$ (1967Pr08). ce(K):ce(L1):ce(L2) exp= $\leq 25:\leq 20:\leq 20$ (1967Pr08).
109.474 3	1539.25	0.62 6			
113.66 2	1374.33	0.05 1			
x113.71 1		0.13 9			
x115.91 2		0.14 2			
x123.930 3		0.54 5	M1+E2	0.9 3	
125.26 3	1597.48	0.07 4			
x130.260 3		0.65 6	M1		
x135.09 1		0.48 5	M1+E2	0.71 22	
x138.05 3		0.08 4			
141.55 1	1700.81	0.17 4	M1+E2	1.2 +16-6	$\alpha(\text{K})\text{exp}=0.77\ 25$ (1986RoZM).
x152.05 3		0.135 11			
x155.06 6		0.050 8			
x155.60 6		0.030 5			
x158.33 6		0.03 2			
160.40 3	2477.04	0.12 3			
x161.67 8		0.04 3			
x163.07 4		0.05 4			
x163.41 2		0.11 4			
x167.10 1		0.30 4	M1		
x168.80 5		0.06 1			
177.71 3	1559.26	0.17 3			$\alpha(\text{K})\text{exp}(178\gamma\text{ doublet})=0.67\ 20$ (1986RoZM).
177.86 3	1607.62	0.19 4			$\alpha(\text{K})\text{exp}(178\gamma\text{ doublet})=0.67\ 20$ (1986RoZM).
181.26 4	1472.23	0.06 3			
x185.25 4		0.06 3			
x186.04 2		0.19 4	M1		
x188.14 2		0.17 3	M1		
x192.83 2		0.24 4	M1		
198.35 ¹ 7	1607.62	0.04 ¹ 3			
	1680.4	0.04 ¹ 3			
x203.27 [@] 8		0.07 [@] 3			
205.51 1	1818.56	1.35 5	M1		$\alpha(\text{L})\text{exp}=0.068\ 9$ (1986RoZM). $\alpha(\text{L1}+\text{L2})\text{exp}=0.48\ 4$ must be a misprint in 1986RoZM and could correspond to $\alpha(\text{K})\text{exp}$. ce(K)/ce(L12) exp=5.4 (1967Pr08).
207.0 ⁱ	1813.90				
x207.98 2		0.59 4	M1		
209.51 7	1409.24	0.04 3			
215.252 2	308.576	34.5 2	E2		$\alpha(\text{K})\text{exp}=0.113\ 9$, $\alpha(\text{L1}+\text{L2})\text{exp}=0.0481\ 9$, $\alpha(\text{L3})\text{exp}=0.0246\ 9$, $\alpha(\text{M})\text{exp}=0.0171\ 12$, $\alpha(\text{N}+\text{O})\text{exp}=0.0039\ 4$ (1986RoZM). ce(K):ce(L2):ce(L3):ce(M):ce(N)exp=<650:170:60:60:15 (1967Pr08).
x219.7 1		0.040 8			
223.76 6	1484.43	0.06 4			
233.33 8	1607.62	0.22 5			
235.020 6	1609.35	4.46 11	M1+E2	0.4 3	$\alpha(\text{K})\text{exp}=0.271\ 24$, $\alpha(\text{L})\text{exp}=0.039\ 4$, $\alpha(\text{M})\text{exp}=0.0092\ 4$ (1986RoZM). ce(K):ce(L2):ce(M) exp=100:20:7 (1967Pr08). $\alpha(\text{K})\text{exp}\leq 0.06$ (1986RoZM). Mult.: E1 from $\alpha(\text{K})\text{exp}$. Decay scheme requires E2.
238.56 5	1613.05	0.79 6	(E2)		
243.40 10	1613.05	0.10 5			
245.0 ^h	1727.4				
254.61 9	1813.90	0.19 1			
255.34 ^m 3	1637.16	0.08 1			
256.1 ^h	1738.4				
x258.21 6		0.045 10			
258.90 ¹ 3	1559.26	0.10 ¹ 1			
	1743.33	0.10 ¹ 1			

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$^{179}\text{Hf}(\text{n},\gamma)$ E=thermal 1974Bu22,1990Bo52,1986RoZM (continued) $\gamma(^{180}\text{Hf})$ (continued)

$E\gamma^{\dagger}$	E(level)	$I\gamma^{\ddagger}$	Mult. [§]	Comments
$^{x}260.08\ 3$		0.080 12		
$^{x}261.18\ 3$		0.13 1		
$^{x}265.27\ 6$		0.060 13		
$^{x}266.07\ 2$		0.190 13		
274.6 1	1813.90	0.16 2		
282.28 8	2316.64	0.42 6		
$^{x}284.60\ 10$		0.23 7		
$^{x}291.01\ 8$		0.32 7		
302.06 8	1909.68	0.23 7		
303.2h	1786.5			
306.40 10	1597.48	0.15 2		
$^{x}310.4\ 1$		0.060 9		
313.50 10	1743.33	0.13 1		$I\gamma$: includes undetermined contribution from ^{178}Hf .
316.61 6	1607.62	0.64 8	E2	$\alpha(\text{K})\text{exp}=0.042\ 11$, $\alpha(\text{L})\text{exp}=0.014\ 5$ (1986RoZM).
$^{x}319.25$		0.06		
322.5 ¹	1932.2			
329.5 ⁱ	1936.9			
331.1h	1813.90			
332.271 10	640.850	9.25 20	E2	$\alpha(\text{K})\text{exp}=0.042\ 3$, $\alpha(\text{L})\text{exp}=0.0131\ 14$, $\alpha(\text{M})\text{exp}=0.0051\ 6$ (1986RoZM). ce(K)/ce(L2) exp=3.0 (1967Pr08).
$^{x}344.1\ 1$		0.060 9		
346.25 14	1637.16	0.37 9		
355.2 1	1724.77	0.10 3		
$^{x}358.2\ 1$		0.030 15		
363.32 10	2679.97	0.16 3		
$^{x}365.58\ 3$		0.28 3		
$^{x}367.36\ 7$		0.17 3		
385.84 14	1945.22	0.19 4		
388.45 14	1472.23	0.25 4		$I\gamma$: includes possible contribution from ^{178}Hf .
$^{x}389.95\ 7$		0.39 3		
$^{x}391.06^{\text{a}}\ 13$		0.13 ^a 3		
$^{x}392.4\ 4$		0.14 3		
407.94 2	1607.62	1.57 3	E2	$\alpha(\text{K})\text{exp}=0.032\ 5$ (1986RoZM). $I\gamma$: may include weak ^{178}Hf line. $E\gamma$: 1990Bo52 place a 408.5 γ from a level at 2017.8 keV.
409.61 8	1609.35	0.18 3		
$^{x}410.5\ 1$		0.060 24		
$^{x}420.96\ 10$		0.33 3	M1	
433.71 12	1724.77	0.34 3		
$^{x}440.87\ 20$		0.20 3		
443.09 4	1083.93	1.69 3	E2	$\alpha(\text{K})\text{exp}=0.0183\ 24$ (1986RoZM).
$^{x}446.87\ 5$		0.56 3		
$^{x}451.64\ 8$		0.35 2		
452.53 16	1743.33	0.16 3		
465.25 11	2077.82	0.35 3		$E\gamma$: placement from 1990Bo52. Unplaced in 1974Bu22.
476.86 7	1959.46	0.57 4		$E\gamma$: placement from 1990Bo52. Unplaced in 1974Bu22.
487.29 8	1861.61	0.55 4		$E\gamma$: placement from 1990Bo52. Unplaced in 1974Bu22.
500.64 18	1141.48			$I\gamma$: $I\gamma=18\%$ 2, relative intensity de-exciting the 5.5-h ^{180}Hf isomer, measured following reactor shut down (1974Bu22).
$^{x}527.08\ 3$		0.73 4		
$^{x}530.10\ 8$		0.24 5		
$^{x}534.52\ 4$		0.60 4		
535.2h	2018.2			
536.2g	1909.68			
538.39 4	2151.46	0.65 4		
551.75 ¹ 6	1192.63	0.24 ¹ 4		
	2034.37	0.24 ¹ 4		
576.3h	2058.4			
$^{x}577.56\ 8$		0.14 4		
583.4 5	1959.46	0.13 8		$E\gamma$: placement from 1990Bo52. Unplaced in 1974Bu22.
$^{x}585.0\ 5$		0.15 9		
$^{x}586.9\ 6$		0.14 8		
$^{x}588.6\ 5$		0.13 8		

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$^{179}\text{Hf}(\text{n},\gamma)$ E=thermal 1974Bu22,1990Bo52,1986RoZM (continued) $\gamma(^{180}\text{Hf})$ (continued)

$E\gamma^{\dagger}$	E(level)	$I\gamma^{\ddagger}$	Mult. [§]	Comments
$^{x}595.6^{\text{k}}_5$		0.07 6		
$^{x}621.3_4$		0.41 6		
643.5 ⁱ	2252.4			
644.3 6	2018.2	0.280 17		$I\gamma$: possible contribution from ^{178}Hf . $E\gamma$: placement from 1990Bo52. Unplaced in 1974Bu22.
654.9 6	1945.22	0.13 2		$I\gamma$: includes contribution from ^{179}Hf .
$^{x}659.1_5$		0.26 13		
$^{x}664.1_6$		0.18 9		
667.9 4	2275.6	0.17 7		$E\gamma$: placement from 1990Bo52. Unplaced in 1974Bu22.
$^{x}680.1@_5$		0.09@ 5		
$^{x}681.8@_5$		0.10@ 5		
$^{x}683.7@_4$		0.12@ 6		
$^{x}686.9@_3$		0.14@ 6		
$^{x}690.1@_6$		0.12@ 7		
$^{x}691.4_5$		0.13 5		
703.3@ ⁵	2316.64	0.11@ 6		$E\gamma$: 1990Bo52 place a 704.0 γ from a level at 2078.3 keV.
706.4 ^h	2187.56			
707.3@ ⁵	2316.64	0.09@ 5		
709.8 4	1909.68	0.16 8		
$^{x}714.6@_3$		0.10@ 6		
$^{x}716.1@_3$		0.16@ 6		
725.6 2	2334.90	0.42 6		$E\gamma$: placement from 1990Bo52. Unplaced in 1974Bu22.
728.1 ^k 3	1369.57	0.23 8		
$^{x}729.9^{\text{k}}_3$		0.28 8		
$^{x}741.9_4$		0.14 7		
743.4 ^k 2	2034.37	0.24 5		
745.4 4	1945.22	0.14 6		$I\gamma$: $I\gamma \leq 0.05$ from ^{178}Hf .
$^{x}758.1_4$		0.20 8		
759.6 ⁱ	2368.7			
$^{x}761.1_3$		0.09 5		
$^{x}763.3^{\text{k}}_5$		0.11 4		
$^{x}764.8^{\text{k}}_5$		0.13 5		
768.1 6	1409.24	0.12 4		$I\gamma$: $I\gamma = 0.06$ from ^{178}Hf .
777.3 ^g	2153.3			
$^{x}784.5_5$		0.08 5		
$^{x}786.1^{\text{k}}_5$		0.10 5		
$^{x}787.6^{\text{k}}_5$		0.14 5		
$^{x}792.1_5$		0.11 6		
$^{x}794.0^{\text{k}}_5$		0.10 5		
799.9 3	2174.0	0.38 8		$E\gamma$: placement from 1990Bo52. Unplaced in 1974Bu22.
$^{x}803.6^{\text{k}}_7$		0.09 5		
$^{x}809.9_3$		0.20 4		
$^{x}811.8^{\text{k}}_7$		0.07 5		
$^{x}819.7_6$		0.10 5		
826.6 ^g	2200.6			
830.8 4	1472.23	0.18 5		
$^{x}844.8_7$		0.07 6		
$^{x}846.2_6$		0.15 5		
$^{x}847.3_7$		0.06 5		
$^{x}853.8_5$		0.09 5		
$^{x}856.2_5$		0.09 5		
856.3 ⁱ	2465.3			
$^{x}857.5_5$		0.11 7		
864.2 3	2477.04	0.14 4		
865.2 ⁱ	2472.5			
868.2 ^g	2242.2			
$^{x}880.8_7$		0.12 6		
884.7 ^k 7	1192.63	0.10 7		
$^{x}888.5_7$		0.08 7		
890.9 ^l 4	1199.68	0.28 ^l 4		
	2151.46	0.28 ^l 4		
892.4 5	1532.9	0.20 8		$E\gamma$: placement from 1990Bo52. Unplaced in 1974Bu22.
900.5 ^{fm}	1539.25			

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$^{179}\text{Hf}(\text{n},\gamma)$ E=thermal 1974Bu22,1990Bo52,1986RoZM (continued) $\gamma(^{180}\text{Hf})$ (continued)

$E\gamma^{\dagger}$	E(level)	$I\gamma^{\ddagger}$	Mult. §	Comments
$^{x}913.8^{\text{k}}_5$		0.09 7		
915.8 4	1557.28	0.49 7		$E\gamma$: peak exhibits triplet structure. $E\gamma$: unplaced by 1974Bu22. Placement by evaluator on basis of (n,n' γ) data.
917.4 5	2477.04	0.25 8		
$^{x}921.0^{\text{k}}_5$		0.14 4		
$^{x}928.4_5$		0.13 7		
$^{x}930.8_5$		0.13 7		
$^{x}935.4_5$		0.14 10		
937.8 5	2477.04	0.16 8		
946.6 $^{\text{k}}_6$	2320.9	0.15 9		$E\gamma$: placement from 1990Bo52. Unplaced in 1974Bu22.
952.2 $^{\text{l}}_7$	1260.67	0.05 $^{\text{l}}$		
	2151.46	0.05 $^{\text{l}}$		
956.3 $^{\text{k}}_5$	1597.48	0.16 8		
$^{x}965.8_5$		0.14 7		
$^{x}968.8_4$		0.40 8		
$^{x}973.0_5$		0.18 5		
$^{x}977.9_7$		0.12 5		
979.7 7	2679.97	0.11 11		
982.1 3	1290.99	0.85 5		
$^{x}1003.0_4$		0.54 5		
$^{x}1011.7_4$		0.13 4		
1014.3 6	1107.24	0.10 8		
1017.1 1	1657.96	1.00 6		$E\gamma$: placement from 1990Bo52. Unplaced in 1974Bu22.
$^{x}1019.3^{\text{k}}_5$		0.11 8		
$^{x}1022.9_5$		0.16 6		
1025.7 $^{\text{f}}$	1666.2			
$^{x}1030.5^{\text{k}}_{10}$		0.07 7		
$^{x}1034.9_5$		0.10 7		
$^{x}1041.7_5$		0.13 5		
$^{x}1054.6_4$		0.28 7		
1061.0 $^{\text{l}}_3$	1369.57	2.65 $^{\text{l}}_{13}$		
	1700.81	2.65 $^{\text{l}}_{13}$		
1065.77 5	1374.33	23.75& 24		
1070.7 5	1164.08	0.36 15		
1072.6 5	1381.55	0.14 10		
1073.3 $^{\text{l}}$	2682.1			
$^{x}1077.4_2$		0.30 15		
1079.4 $^{\text{h}}$	2560.7			
$^{x}1083.2_4$		0.44 18		
$^{x}1085.6_5$		0.08 6		
$^{x}1097.6_7$		0.14 8		
1100.60 15	1409.24	2.43 12		
1106.00 15	1199.68	2.48 12		
$^{x}1110.5_6$		0.13 5		
1112 $^{\text{e}}$	1420.5			$E\gamma$ =1099.6 in 1990Bo52 (Table I) is probably a typo.
$^{x}1117.0_6$		0.12 4		
1121.7 5	1429.77	0.36 6		
$^{x}1123.0^{\text{k}}_{10}$		0.05 4		
$^{x}1127.6^{\text{k}}_8$		0.08 6		
1131.0 $^{\text{i}}$	2741.3			
$^{x}1138.4_{10}$		0.12 5		
1140.8 8	2679.97	0.21 6		
$^{x}1151.7_5$		0.28 4		
1163.9 10	1472.23	0.13 7		$I\gamma$: possible contribution from chlorine contamination.
1167.0 $^{\text{m}}_{10}$	1260.67	<0.14		
1175.0 $^{\text{g}}$	2549.0			
$^{x}1181.8_{10}$		0.10 7		
1185.8 6	2477.04	0.12 6		
1185.9 $^{\text{g}}$	2560.7			
1197.8 3	1290.99	4.27 30		
1199.4 $^{\text{h}}$	2682.1			
1199.7 4	1199.68	2.77 28		
$^{x}1206.9_3$		1.60 24		

Continued on next page (footnotes at end of table)

$^{179}\text{Hf}(\text{n},\gamma)$ E=thermal 1974Bu22,1990Bo52,1986RoZM (continued) $\gamma(^{180}\text{Hf})$ (continued)

$E\gamma^{\dagger}$	E(level)	$I\gamma^{\ddagger}$	Mult. [§]	Comments
$^{x}1211.9\ 6$		0.15 6		
$^{x}1226.5\ 5$		0.20 6		
1231.6 ⁱ	2839.9			
1231.9 5	1539.25	0.34 6		
1239.7 ⁱ	2849.8			
1249.1 3	1557.28	2.32 7		$E\gamma$: unplaced by 1974Bu22. Placement by evaluator on basis of (n,n' γ) data.
1249.3 ⁱ	2858.5			
1260.8 3	1260.67	3.8 5		
1262.0 ^h	2741.3			
1276.5 ^k 4	1369.57	0.27 5		
1281.7 2	1374.33	1.05& 5		
$^{x}1286.9^{\text{k}}\ 10$		0.09 6		
1288.7 ^l 5	1381.55	0.32 ^l 8		
	1597.48	0.32 ^l 8		
1299.0 6	1607.62	0.50 3		
1300.5 4	1300.35	1.85 11		
1301.3 ^h	2783.7			
$^{x}1302.0\ 5$		1.10 7		
1316.4 3	1409.24	1.70 5		
1316.9 ^h	2797.1			$E\gamma$: 1315.1 from level energy difference.
1328.4 10	1637.16	0.23 5		
1336.8 10	1429.77	0.22 9		
$^{x}1338.3\ 10$		0.12 11		
$^{x}1350.7\ 5$		0.11 2		
$^{x}1352.2^{\text{@}}\ 8$		0.04 [@] 4		
1356.4 ^h	2839.9			
$^{x}1359.4^{\text{k}}\ 10$		0.07 5		
1365.4 ^h	2849.8			
1367.1 10	2741.3	0.09 6		$E\gamma$: placement from 1990Bo52. Unplaced in 1974Bu22.
$^{x}1386.5\ 10$		0.09 7		
1389.0 7	1482.63	0.15 6		
1391.1 ^l 10	1484.43	0.08 ^l 7		
	1700.81	0.08 ^l 7		
$^{x}1394.5\ 3$		0.72 5		
1397.5 ^g	2771.6			
1400.5 5	1709.5	0.16 6		$I\gamma$: 25% may be due to ^{178}Hf .
1416.7 3	1724.77	0.51 6		
1419.4 ^g	2797.1			$E\gamma$: 1423.4 from level energy difference.
1431.6 ^g	2805.7			
1437.4 ⁱ	3049.3			
$^{x}1440.5\ 10$		0.07 6		
1446.9 10	1539.25	0.07 6		$I\gamma$: $I\gamma=0.035$ may be due to ^{178}Hf .
$^{x}1449.5\ 7$		0.10 6		
$^{x}1456.4\ 10$		0.08 5		
1469.6 7	2839.9	0.09 5		$E\gamma$: placement from 1990Bo52. Unplaced in 1974Bu22.
1488.0 10	2679.97	0.06 5		
$^{x}1490.7\ 10$		0.04 4		
$^{x}1493.9\ 10$		0.06 5		
$^{x}1499.9\ 10$		0.08 6		
$^{x}1503.3\ 6$		0.08 6		
1510.5 7	1818.56	0.11 6		
1515.4 ^m 4	1607.62	0.27 4		
1516.5 4	1609.35	0.21 6		
1519.8 ^e	1828.0			
1521.7 ⁱ	3131.5			
1540.5 ^h	3022.2			
1543.8 5	1637.16	0.10 5		
$^{x}1550.2\ 7$		0.08 6		
$^{x}1552.2\ 7$		0.07 6		
1553.8 10	1861.61	0.06 5		$E\gamma$: placement from 1990Bo52. Unplaced in 1974Bu22.
$^{x}1570.3\ 10$		0.05 4		
$^{x}1572.0\ 10$		0.07 6		
1575.0 ^f	2215.5			

Continued on next page (footnotes at end of table)

$^{179}\text{Hf}(\text{n},\gamma)$ E=thermal 1974Bu22,1990Bo52,1986RoZM (continued) $\gamma(^{180}\text{Hf})$ (continued)

$E\gamma^{\dagger}$	E(level)	$I\gamma^{\ddagger}$	Mult. §	Comments
$^{x}1577.0\ 4$		0.15 6		
$^{x}1578.7\ 7$		0.08 6		
$^{x}1580.8\ 10$		0.06 5		
$^{x}1603.0\ 4$		0.09 5		
$^{x}1614.7\ 4$		0.11 5		
1620.5^{f}	2261.5			
$^{x}1623.9\ 4$		0.10 5		
$1631.4\ 7$	1724.77	0.12 5		
$^{x}1633.8\ 7$		0.13 5		
$1636.8^{\text{l}}\ 5$	1637.16	0.14 ^l 6		
	1945.22	0.14 ^l 6		
$^{x}1642.2\ 5$		0.19 8		
$1650.2\ 7$	1743.33	0.14 7		
$^{x}1657.7\ 5$		0.07 6		
1670.4^{h}	3152.8			
$^{x}1672.8\ 7$		0.09 7		
$^{x}1675.6\ 4$		0.22 9		
1694.3^{i}	3303.4			
1714.0^{e}	2022.2			
$1715.6\ 7$	3089.7	0.14 7		$E\gamma$: placement from 1990Bo52. Unplaced in 1974Bu22.
$1721.0\ 7$	1813.90	0.07 6		
$^{x}1727.8\ 2$		0.17 7		
1729.3^{i}	3338.4			
$1743.2\ 2$	1743.33	0.21 6		$I\gamma$: $I\gamma=0.07$ is due to ^{178}Hf .
$^{x}1746.3\ 3$		0.23 7		
$^{x}1759.9\ 4$		0.15 8		
$1767.6\ 2$	2077.82	0.35 9		$E\gamma$: placement from 1990Bo52. Unplaced in 1974Bu22.
$^{x}1769.8\ 5$		0.12 7		
$^{x}1771.8\ 3$		0.23 9		
$^{x}1800.8^{\text{@}}\ 10$		0.06 [@] 5		
1804.2^{i}	3416.9			
1809.9^{g}	3183.8			
$^{x}1813.8^{\text{@}}\ 10$		0.06 [@] 5		
$^{x}1833.9\ 7$		0.11 4		
$1835.8\ 10$	2477.04	0.07 6		
1836.6	3316.9			
1838.5^{e}	2146.7			
$^{x}1841.5\ 3$		0.28 7		
1846.4^{e}	2153.3			
$1853.0^{\text{@}}\ 7$	1945.22	0.08 [@] 7		
$1864.8\ 5$	2174.0	0.10 6		$E\gamma$: placement from 1990Bo52. Unplaced in 1974Bu22.
$1879.0\ 2$	2187.56	0.23 7		
$^{x}1881.3^{\text{@}}\ 8$		0.06 [@] 6		
$^{x}1890.0^{\text{k}}\ 7$		0.10 6		
$^{x}1892.5\ 5$		0.17 7		
$^{x}1895.5\ 7$		0.10 6		
$^{x}1898.2\ 10$		0.09 6		
$^{x}1909.0\ 7$		0.15 6		
$^{x}1911.4\ 7$		0.13 6		
$^{x}1920.9\ 10$		0.06 5		
$^{x}1923.8\ 10$		0.07 6		
1936.3^{h}	3416.9			$E\gamma$: 1933.5 from level energy difference.
1937.5^{e}	2245.7			
$^{x}1938.5\ 5$		0.16 6		
$1941.0\ 7$	2034.37	0.10 6		
$^{x}1942.9\ 7$		0.10 6		
1946.0^{h}	3428.4			
$1946.5\ 7$	1945.22	0.44 5		
1947.1^{g}	3316.9			
1953.6^{e}	2261.5			
$^{x}1954.8\ 7$		0.13 8		
1956.6^{g}	3330.2			
$^{x}1977.7\ 16$		0.14 6		

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$^{179}\text{Hf}(\text{n},\gamma)$ E=thermal 1974Bu22,1990Bo52,1986RoZM (continued) $\gamma(^{180}\text{Hf})$ (continued)

$E_{\gamma}^{\dagger}$	E(level)	$I_{\gamma}^{\ddagger}$	Mult. [§]	Comments
1984.4 ^e	2292.6			
1986.7 ^d	2077.82			
1988.4 ⁱ	3605.9			
2008.3 17	2316.64	0.15 6		
2012.1 ^e	2320.9			
2032.8 ^e	2341.0			
^x 2051.7 17		0.10 6		
2058.3 17	2151.46	0.10 6		
^x 2085.1 17		0.09 7		
^x 2089.1 10		0.10 8		
2104.9 ^e	2413.1			
^x 2106.4 17		0.14 6		
2109.0 ^g	3483.0			
^x 2118.7 19		0.15 6		
^x 2160.0 19		0.14 6		
2163.4 ^e	2472.5			
^x 2183.5 19		0.89 7		
2196.2 ^e	2504.3			
^x 2199.2 18		0.17 5		
2222.1 ^g	3596.2			
^x 2238.5 18		0.08 6		
2246.2 ⁱ	3855.3			
2272.7 ^f	2913.3			
2317.7 ⁱ	3926.2			
2330.5 ^j	7387.60			
2340.2 ^j	7387.60			
2382.9 ⁱ	3992.1			
2388.0 ^h	3869.2			
2397.6 ^e	2706.0			
2406.9 ^f	3049.3			
2424.1 ^j	7387.60			
2430.1 ^e	2741.3			
2442.7 ^f	3083.2			
2472.2 ^j	7387.60			
2489.4 ^e	2797.1			
2489.5 ^h	3974.8			
2504.9 ^h	3987.3			
2534.5 ^j	7387.60			
2542.9 ^f	3183.8			
2543.2 ^e	2849.8			
2550.2 ^e	2858.5			
2564.8 ^e	2873.0			
2578.8 ^j	7387.60			
2616.8 ^f	3258.1			
2627.9 ^g	4002.9			
2672.9 ^f	3316.9			E_{γ} : 2676.4 from level energy difference.
2691.5 ^e	2999.7			
2711.5 ^e	3022.2			
2722.5 ⁱ	4331.7			
2742.1 ^e	3049.3			
2746.6 ⁱ	4355.7			
2750.0 ^e	3058.0			
2763.3 ⁱ	4137.4			
2775.9 ^f	3416.9			
2781.2 ^e	3089.7			
2792.2 ^e	3100.5			
2813.9 ⁱ	4422.9			
2815.5 ^e	3123.8			
2823.8 ^e	3131.5			
2827.7 ^f	3468.4			
2854.6 ^e	3163.1			
2891.8 ^e	3200.2			
2906.7 ^e	3215.2			

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$^{179}\text{Hf}(\text{n},\gamma)$ E=thermal 1974Bu22,1990Bo52,1986RoZM (continued) $\gamma(^{180}\text{Hf})$ (continued)

$E\gamma^{\dagger}$	E(level)	$I\gamma^{\ddagger}$	Mult. §	$E\gamma^{\dagger}$	E(level)	$I\gamma^{\ddagger}$	Mult. §
2931.1 ^d	3022.2			3872.5 ^j	7387.60		
2965.1 ^j	7387.60			3888.4 ^j	7387.60		
3009.6 ^e	3316.9			3899.0 ^j	7387.60		
3021.0 ^e	3330.2			3904.8 ^j	7387.60		
3032.1 ^j	7387.60			3919.3 ^j	7387.60		
3056.0 ^j	7387.60			3945.3 ^j	7387.60		
3081.0 ^d	3174.2			3959.4 ^j	7387.60		
3107.2 ^e	3416.9			3972.0 ^j	7387.60		
3134.3 ^e	3442.6			4049.5 ^j	7387.60		
3159.7 ^d	3252.9			4057.5 ^j	7387.60		
3180.6 ^e	3488.9			4070.8 ^j	7387.60		
3191.3 ^e	3499.5			4084.4 ^j	7387.60		
3201.2 ⁱ	4808.6			4129.0 ^j	7387.60		
3207.1 ^e	3515.4			4134.8 ^j	7387.60		
3208.6 ^f	3848.2			4172.4 ^j	7387.60		
3218.1 ^e	3526.4			4187.6 ^j	7387.60		
3226.9 ^f	3869.2			4204.2 ^j	7387.60		
3239.4 ^f	3880.1			4213.4 ^j	7387.60		
3245.2 ⁱ	4852.9			4224.6 ^j	7387.60		
3250.4 ^j	7387.60			4235.0 ^j	7387.60		
3267.6 ^f	3908.2			4256.5 ^j	7387.60		
3300.1 ^e	3605.9			4264.0 ^j	7387.60		
3316.8 ^e	3625.0			4272.8 ^f	4916.1		
3332.1 ^e	3640.3			4287.4 ^j	7387.60		
3363.4 ^e	3672.0			4298.5 ^j	7387.60		
3372.6 ^e	3683.5			4304.8 ^j	7387.60		
3385.1 ^j	7387.60			4329.6 ^d	4422.9		
3395.7 ^j	7387.60			4330.1 ^j	7387.60		
3400.5 ^j	7387.60			4339.1 ^j	7387.60		
3413.6 ^j	7387.60			4366.5 ^j	7387.60		
3430.7 ^j	7387.60			4388.3 ^j	7387.60		
3437.3 ^h	4916.1			4474.6 ^j	7387.60		
3442.4 ^e	3751.1			4499.5 ^e	4808.6		
3461.7 ^j	7387.60			4514.9 ^j	7387.60		
3479.3 ^h	4964.9			4529.5 ^j	7387.60		
3479.7 ^j	7387.60			4539.0 ^j	7387.60		
3507.7 ^j	7387.60			4547.9 ^j	7387.60		
3518.5 ^j	7387.60			4582.1 ^j	7387.60		
3532.6 ^j	7387.60			4590.4 ^j	7387.60		
3539.7 ^e	3848.2			4604.1 ^j	7387.60		
	7387.60			4606.5 ^e	4916.1		
3541.9 ^g	4916.1			4616.2 ^j	7387.60		
3560.4 ^d	3653.5			4646.1 ^j	7387.60		
3566.6 ^h	5048.0			4659.0 ^e	4964.9		
3576.0 ^h	5057.6			4681.7 ^j	7387.60		
3579.0 ^d	3672.0			4705.8 ^j	7387.60		
3590.4 ^g	4964.9			4707.8 ⁵	7387.60	1120 [#]	
3617.2 ^e	3926.2			$\times 4738.3$ 5		280 [#]	
3636.8 ^j	7387.60			4748.5 ^e	5057.6		
3648.6 ^e	3957.3			4759.3 ^d	4852.9		
3658.3 ^d	3751.1			4827.2 ⁶	7387.60	350 [#]	
3667.9 ^e	3974.8			4838.8 ^j	7387.60		
3695.4 ^e	4002.9			$\times 4852.7$ 5		450 [#]	
3701.7 ^j	7387.60			4883.8 ^j	7387.60		
3716.0 ^j	7387.60			4910.6 ⁵	7387.60	990 [#]	
3734.4 ^j	7387.60			4914.8 ^j	7387.60		
3747.6 ^j	7387.60			4922.6 ^j	7387.60		
3753.6 ^d	3848.2			4953.8 ^d	5048.0		
3762.9 ^j	7387.60			4974.8 ^j	7387.60		
3780.0 ^j	7387.60			5019.1 ^j	7387.60		
3791.6 ^j	7387.60			5046.9 ^j	7387.60		
3861.5 ^j	7387.60			5053.8 ^j	7387.60		
3864.6 ^d	3957.3			5066.6 ⁵	7387.60	150 [#]	

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$^{179}\text{Hf}(\text{n},\gamma)$ E=thermal 1974Bu22,1990Bo52,1986RoZM (continued) $\gamma(^{180}\text{Hf})$ (continued)

$E\gamma^{\dagger}$	E(level)	$I\gamma^{\ddagger}$	Mult. §	$E\gamma^{\dagger}$	E(level)	$I\gamma^{\ddagger}$	Mult. §
5071.1 4	7387.60	580 [#]		5660.4 j	7387.60		
^x 5074.5@ 6		150#@		5663.0 7	7387.60	25 [#]	(E2) ^b
5095.3 j	7387.60			5677.8 3	7387.60	310 [#]	
5111.8 j	7387.60			5686.8 j	7387.60		
5126.6 j	7387.60			5707.1 j	7387.60		
5135.6 j	7387.60			5721.6 j	7387.60		
5142.2 j	7387.60			5729.1 j	7387.60		
5145.6 j	7387.60			5751.3 7	7387.60	22 [#]	(E2) ^b
5172.4 j	7387.60			5774.5 4	7387.60	390 [#]	
5187.2 j	7387.60			5778.1 4	7387.60	1050 ^{#c}	
5202.2 j	7387.60			5830.4 6	7387.60	30 [#]	
5214.2 j	7387.60			5847.4 2	7387.60	1000 [#]	
5234.4 4	7387.60	550 [#]		5856.0 j	7387.60		
5241.2 j	7387.60			5904.6 3	7387.60	80 [#]	
5311.0 j	7387.60			5956.9 3	7387.60	290 [#]	
5329.7 j	7387.60			5967.0 j	7387.60		
5353.3 4	7387.60	140 [#]		5975.9 j	7387.60		
5365.6 j	7387.60			5978.8 4	7387.60	95 [#]	
5370.3 j	7387.60			6013.0 4	7387.60	110 [#]	
5428.8 j	7387.60			6018.8 4	7387.60	140 [#]	
5450.9 j	7387.60			6087.9 ^b	7387.60	21 ^{#b} 6	(E2) ^b
5454.9 j	7387.60			6096.6 4	7387.60	64 [#]	
5477.9 3	7387.60	440 [#]		6192.1 6	7387.60	13 [#]	
5527.8 j	7387.60			6747.0 7	7387.60	24 [#]	
5559.9 j	7387.60			7079.3 3	7387.60	194 [#]	
5572.4 4	7387.60	1490 ^{#a}		7295.4 ^b	7387.60	3.4 ^{#b} 14	(E2) ^b
5602.1 j	7387.60						
5649.4 j	7387.60						

[†] Energies are from 1974Bu22. Evaluator increased values from bent crystal measurements by 17 ppm to make them consistent with 59.31922 keV 7 (1980De40) for the K-L3 tungsten x-ray standard.

[‡] Intensities of secondary γ -rays from 1974Bu22 are per 100 neutron captures. Uncertainties do not include the uncertainty in the neutron-capture cross section or in the ^{179}Hf isotopic abundance (83.6% 2). Intensities of primary γ -rays are relative to 1000 for 5847.4 γ (1974Bu22).

[§] From ce data of 1986RoZM.

[#] Intensities of primary γ -rays are relative to 1000 for 5847.4 γ (1974Bu22).

@ Uncertain isotopic assignment (1974Bu22).

& $I\gamma(1066\gamma)/I\gamma(1282\gamma)=23$ disagrees with ≈ 6 from ^{180}Lu β^- decay. Careful examination of different diffraction settings suggests the 1066 γ is a singlet or very closely spaced doublet. See 1974Bu22 for further discussion.

^a Doublet with ^{178}Hf line.

^b From 1984Pr03. Intensities are normalized to $I\gamma(5663\gamma)=25$ from 1974Bu22.

^c Doublet.

^d From $\gamma\gamma$ coin with energy sum=7294.8 keV; final level energy=93.4 (1990Bo52).

^e From $\gamma\gamma$ coin with energy sum=7079.5 keV; final level energy=308.7 (1990Bo52).

^f From $\gamma\gamma$ coin with energy sum=6747.2 keV; final level energy=641.0 (1990Bo52).

^g From $\gamma\gamma$ coin with energy sum=6013.8 keV; final level energy=1374.5 (1990Bo52).

^h From $\gamma\gamma$ coin with energy sum=5905 keV; final level energy=1482.6 (1990Bo52).

ⁱ From $\gamma\gamma$ coin with energy sum=5779 keV; final level energy=1609.3 (1990Bo52).

^j From 1990Bo52.

^k Assignment to ^{180}Hf is probable.

^l Multiply placed; undivided intensity given.

^m Placement of transition in the level scheme is uncertain.

^x γ ray not placed in level scheme.

¹⁷⁹Hf(n,γ) E=res: Av ¹⁹⁷⁴Bu22

$J\pi(^{179}\text{Hf})=9/2+$.

En=50-10000 eV. Measured E_γ , I_γ using Ge(Li) detector located inside a split-ring NaI detector. Double escape peaks enhanced using triple coincidence between Ge(Li) detector and two opposite quarters of the NaI detector. Deduced multiplicities of primary transitions from relative γ -ray intensities.

Spins of levels populated by primary γ -rays are 1,2,3,4,5,6,7, based on the assumption that primary γ -rays are M1,E1, or E2 and that neutrons are captured in $J\pi=4+,5+$ (s-wave) and $J\pi=3-,4-,5-,6-$ (p-wave) resonance states. Level spins and parities are based on γ -ray multiplicities determined from a comparison of relative γ -ray intensities. Dipole γ -rays to J=4,5 final states are about twice as strong as those to J=3,6 final states because there are twice as many ways to populate a J=4 or 5 state as there are to populate a J=3 or 6 state. Final states with J=2 or 7 may be populated only by quadrupole γ -rays from s-wave resonance states, or by dipole γ -rays from p-wave resonance states, both with much lower intensity for similar reasons as those mentioned above. See 1970Bo29 for a detailed description of this method.

Others: 1972Si20 (En=25 keV), 1988Mu26 (En=2 keV), 2005Me01 (En=0.1-100 eV), 2005TrZY (En=0.005-200 eV), 2006Wi11 (En=3-225 keV).

¹⁸⁰Hf Levels

E(level) [†]	$J\pi^\ddagger$	E(level) [†]	$J\pi^\ddagger$	E(level) [†]	$J\pi^\ddagger$
0.0	0+	1380.9 7	3+, 6+	1637.3 7	2+, 3+, 6+, 7+
93.1 5	2+	1409.4 6	4+, 5+	1701.0 6	4+, 5+
308.6 4	4+	1430.5 5	3-, 6-	1709.6 5	4-, (5-)
640.9 5	3+, 6+	1472.5 5	2+, 3+, 6+, 7+	1724.8 11	2+, 3+
1192.4 6	3+, 6+	1482.6 5	3-, 6-	1813.7 8	3-
1198.9 6	2+, 7+	1484.9 9	4+, 5+	1818.3 6	3-, 6-
1260.5 9	2+, 7+	1539.7 5	3-, 6-	1910.6 18	4+, 5+
1290.9 6	4+, 5+	1557.6 5	4+, 5+	2034.9 14	4+, 5+
1300.6 8	2+, 7+	1596.1 9	2+, 3+, 6+, 7+	2152.0 9	3-, (4-)
1369.3 5	4+, 5+	1608.9 6	3-, 4-, 5-, 6-	2314.6 9	(4-), 5-
1374.1 5	3-, 6-	1612.3 6	3-, 4-, 5-, 6-	7388.15 § 40	

[†] Level energies as determined by 1974Bu22 using the capture state energy (7388.15 keV) and the primary γ -ray energy (including recoil energy). To incorporate effects due to p-wave capture, the energy difference has been corrected for energy shifts between multipoles by decreasing the capture state energy by 0.79 keV for E1 transitions and increasing it by 0.69 keV for E2(+E1) transitions.

[‡] From multipolarity of primary γ -ray transition and comparison of relative γ -ray intensities. See description of method in general comments.

§ Capture state. Level energy is determined from the energies of the 7079.4 γ (including recoil energy) and the 308.58-keV level.

$\gamma(^{180}\text{Hf})$

E_γ	E(level)	$I_\gamma^\dagger$	Mult. [‡]	E_γ	E(level)	$I_\gamma^\dagger$	Mult. [‡]
5072.8 8	7388.15	113 11	E1	5904.6 2	7388.15	181 7	E1
5235.3 8	7388.15	143 14	E1	5916.1 3	7388.15	6.8 27	E2, (M1)
5353.2 13	7388.15	36 7	M1	5956.7 2	7388.15	126 5	E1
5477.5 17	7388.15	34 7	M1	5978.6 4	7388.15	31.6 47	M1
5569.0 5	7388.15	127 13	E1	6007.1 6	7388.15	19.7 39	M1
5573.7 7	7388.15	138 14	E1	6013.1 2	7388.15	190 6	E1
5664 § 1	7388.15	6.2 31	(E2)	6018.9 3	7388.15	36.5 55	M1
5677.7 2	7388.15	194 19	E1	6088.1 7	7388.15	7.6 30	E2
5687.0 5	7388.15	18.6 56	M1	6097.2 5	7388.15	30.2 45	M1
5751.4 6	7388.15	10.0 35	M1, (E2)	6128.2 8	7388.15	7.2 36	E2
5775.0 # 4	7388.15	229 # 80	E1	6189.8 5	7388.15	6.1 24	E2
5778.4 # 4	7388.15	229 # 80	E1	6196.3 5	7388.15	7.7 31	E2
5791.9 8	7388.15	12.3 43	M1	6747.1 3	7388.15	41.3 62	M1
5830.4 2	7388.15	33.9 51	M1	7079.4 2	7388.15	100 5	M1
5847.5 2	7388.15	135 7	E1	7295.6 4	7388.15	15.5 47	E2
5903.1 8	7388.15	31.4 63	M1				

[†] Intensities are given relative to 100 for the 7079.4 γ .

[‡] From a comparison of relative intensities; an E_γ^6 energy dependence is removed from I_γ to approximately equalize all transition intensities of a particular multipolarity.

§ Placement of transition in the level scheme is uncertain.

Multiply placed; undivided intensity given.

$^{179}\text{Hf}(\text{d},\text{p})$ 1972Za04 $J\pi(^{179}\text{Hf})=9/2+$.E(d)=12 MeV. Measured $\sigma(\theta)$ at $\theta=25^\circ$, 35° , 45° , 55° , and 65° using Browne-Buechner broad-range magnetic spectrograph and nuclear track emulsion plates; DWBA analysis. **^{180}Hf Levels**

E(level) [†]	$J\pi^{\ddagger}$	E(level) [†]	$J\pi^{\ddagger}$	E(level) [†]	$J\pi^{\ddagger}$
0.0 [§]	0+	1508 2		1926 ^b 4	(4-)
95 [§]	2+	1525 4		1971 3	
301 [§]	4+	1609 ^{&} 1	5-	2023 ^c 2	(1-)
640 [§]	6+	1650 4		2074 ^c 2	(2-)
1090 [§] 1	8+	1689 ^a 2	6-	2143 4	
1146 [#] 1	8-	1787 ^{&} 2	6-	2170 4	
1197 3		1824 ^b 2	(3-)	2213 3	
1371 [@]	4-	1861 3		2238 3	
1408 2		1889 3		2271 ^d 3	8-
1480 [@] 1	5-	1908 ^a 5	(7-) ^e		

[†] Uncertainties are given as the standard deviation of the excitation energy at different angles.[‡] Spin, band, and quasiparticle configuration assignments are based on comparison between experimental and theoretical relative level intensity populations and on rotational structure. Discrepancies with assignments given in adopted levels are indicated.[§] $K\pi=0+$ g.s. rotational band member.[#] $K\pi=8-$ band member. Probable configuration= $\pi 7/2[404]+\pi 9/2[514]$.[@] $K\pi=4-$ band member. Probable configuration= $9/2[624]-1/2[510]$.[&] $K\pi=5-$ band member. Probable configuration= $9/2[624]+1/2[510]$.^a $K\pi=6-$ band member. Probable configuration= $9/2[624]+3/2[512]$.^b $K\pi=3-$ band member. Probable configuration= $9/2[624]-3/2[512]$.^c $K\pi=1-$ band member. Probable configuration= $9/2[624]-7/2[503]$.^d $K\pi=8-$ band member. Probable configuration= $9/2[624]+7/2[503]$.^e $J\pi=(4+)$ in the Adopted Levels. **$^{180}\text{Hf}(\gamma,\gamma')$ 1997Pi08** $E\gamma = 4.3\text{-MeV}$ endpoint bremsstrahlung radiation on target enriched to 94.3% ^{180}Hf . Measured $E\gamma$, $I\gamma$, $\gamma(\theta)$ at $\theta=90^\circ$, 127° , and 150° using three HPGe detectors; deduced branching ratios, $I_{s,0}$ and Γ_0 . See also 1997PiZY.

Others: 1996KaZP, 1997Be58, 1997Be76, 1997Og05, 1997LaZZ, 1999To05, 1999Ab39, 1999Ab40, 2001De51.

 ^{180}Hf Levels

E(level) [†]	$J\pi^{\ddagger}$	$T_{1/2}^{\S}$	$R_{\text{exp}}^{\#}$	E(level) [†]	$J\pi^{\ddagger}$	$T_{1/2}^{\S}$	$R_{\text{exp}}^{\#}$
0.0	0+ [@]			3506.8 10	1, 2	77 fs 16	
93.3 [@] 3	2+ [@]			3559.4 8	1	12.8 fs 23	1.03 24
2120.1? 10	1, 2	0.46 ps 22		3569.3 8	1	30 fs 6	0.42 18
2377.7 10	1	0.29 ps 7		3584.0 8	1	7.3 fs 19	1.6 4
2493.3 8	1	62 fs 13	0.39 17	3592.3 8	1	16 fs 4	1.1 4
2582.3 8	1	10 fs 3	1.84 25	3614.9 8	1	13.0 fs 13	0.17 6
2617.2 8	1	9.5 fs 8	0.55 6	3627.1 10	1	51 fs 12	
2712.3 8	1	12.4 fs 24	2.0 4	3766.4 8	1	10.0 fs 14	0.46 12
2812.4 10	1	0.16 ps 3		3774.1 8	1	4.7 fs 19	3.1 10
2879.8 10	1, 2	0.25 ps 7		3786.0 8	1	8.6 fs 18	1.1 3
2892.1 8	1	20.0 fs 21	0.52 10	3803.9 8	1	16 fs 3	0.44 15
2947.8 8	1	13.0 fs 9	0.44 5	3818.0 10	1	40 fs 8	
2993.1 10	1	47 fs 5		3829.6 10	1	25 fs 5	
3011.1 8	1	30 fs 6	0.88 22	3836.3 8	1	14.7 fs 24	0.29 7
3068.6 8	1	14.1 fs 13	0.84 10	3851.5 8	1	7.0 fs 14	0.9 3
3081.5 10	1	0.17 ps 5		3862.2 10	1, 2	69 fs 22	
3086.0 10	1	0.14 ps 3		3889.4 10	1	12.6 fs 16	
3125.4 8	1	29 fs 3	0.36 9	3928.0 10	1	22 fs 4	
3150.5 8	1	10 fs 4	3.3 10	3948.1 10	1	25 fs 6	
3254.1 8	1	32 fs 8	0.99 26	3967.8 10	1	18 fs 4	
3330.1 10	1	95 fs 20		3978.2 8	1	1.8 fs 9	3.9 16

Footnotes continued on next page

$^{180}\text{Hf}(\gamma, \gamma')$ 1997Pi08 (continued) **^{180}Hf Levels (continued)**

[†] As given in 1997Pi08.

[‡] From multipolarity of ground state transition determined through angular correlation analysis, except where noted.

[§] Deduced by evaluator from $\Gamma_{\gamma 0}$ and $\Gamma_{\gamma 1}$ calculated from R_{exp} , assuming that only the transition to the first $J\pi=2+$ state significantly contributes to the level de-excitation.

[#] $R_{\text{exp}}=(\Gamma_1/E\gamma_1^3)/(\Gamma_0/E\gamma_0^3)$.

[@] From the Adopted Levels.

 $\gamma(^{180}\text{Hf})$

E(level)	$E\gamma^{\dagger}$	$I\gamma^{\ddagger}$	Mult. [§]	E(level)	$E\gamma^{\dagger}$	$I\gamma^{\ddagger}$	Mult. [§]
93.3	93			3559.4	3466.1	100	
2120.1?	2120.1	100	(D+Q)		3559.4	95 29	D
2377.7	2377.7	100	D	3569.3	3476.0	100	
2493.3	2400.0	100			3569.3	39 19	D
	2493.3	35 17	D	3584.0	3490.7	66 18	
2582.3	2489.0	61 27			3584.0	100	D
	2582.3	100	D	3592.3	3499.0	100	
2617.2	2523.9	100			3592.3	101 44	D
	2617.2	49 7	D	3614.9	3521.6	100	
2712.3	2619.0	56 11			3614.9	16 6	D
	2712.3	100	D	3627.1	3627.1	100	D
2812.4	2812.4	100		3766.4	3673.1	100	
2879.8	2879.8	100	(D+Q)		3766.4	43 13	D
2892.1	2798.8	100		3774.1	3680.8	35 14	
	2892.1	47 11	D		3774.1	100	D
2947.8	2854.5	100		3786.0	3692.7	100	
	2947.8	40 5	D		3786.0	99 35	D
2993.1	2993.1	100	D	3803.9	3710.6	100	
3011.1	2917.8	100			3803.9	41 16	D
	3011.1	80 26	D	3818.0	3818.0	100	D
3068.6	2975.3	100		3829.6	3829.6	100	D
	3068.6	77 12	D	3836.3	3743.0	100	
3081.5	3081.5	100	D		3836.3	27 8	D
3086.0	3086.0	100	D	3851.5	3758.2	100	
3125.4	3032.1	100			3851.5	85 30	D
	3125.4	33 9	D	3862.2	3862.2	100	(D+Q)
3150.5	3057.2	33 12		3889.4	3889.4	100	D
	3150.5	100	D	3928.0	3928.0	100	D
3254.1	3160.8	100		3948.1	3948.1	100	D
	3254.1	91 35	D	3967.8	3967.8	100	D
3330.1	3330.1	100	D	3978.2	3884.9	28 14	
3506.8	3506.8	100	(D+Q)		3978.2	100	D

[†] Only level energies are reported in 1997Pi08. For ground state transitions, $E\gamma$ is taken as the reported level energy. For transitions to the 93.3-keV level, $E\gamma$'s are from level energy differences.

[‡] Deduced by evaluator from R_{exp} .

[§] From angular correlation ratio $W(90^\circ)/W(127^\circ)$.

 $^{180}\text{Hf}(n, n'\gamma)$ 1983Gr30, 1991Gr19, 1979Bo43

1991Gr19, 1983Gr30, 1979Bo43: $E(n)=\text{fast}$. Measured $E\gamma$, $I\gamma$, $\gamma(0)$ at 90° , 110° , 125° , 135° , and 140° using a Ge(Li) detector. All three papers are by similar authors, thus, the evaluator considers the results of 1991Gr19 to supercede those given in 1983Gr30 and 1979Bo43.

Others: 1969Hi03, 1978Si13, 1981Ko32, 1991GrZX, 1991GrZX, 2004Sh37, 2011Se12.

$^{180}\text{Hf}(n,n'\gamma)$ 1983Gr30,1991Gr19,1979Bo43 (continued) ^{180}Hf Levels

The levels at 1107.2, 1164.2, 1192.6, and 1381.6 keV proposed in (n, γ), E=thermal were not observed by 1983Gr30.

They place limits on the depopulating transition intensities of 1107-keV level: 1014 γ , $I\gamma<7$; 1164-keV level:

1071 γ , $I\gamma<3$; 1193-keV level: 552 γ , $I\gamma<1$, 885 γ , $I\gamma<1.5$; 1382-keV level: 1073 γ , $I\gamma<3$.

E(level) [†]	$J\pi^{\ddagger}$	Comments
0.0	0+	
93.41 10	2+	
308.67 18	4+	
640.92 25	6+	
1084.0 4	8+	
1102.0 5	0+	$J\pi$: from isotropic $\gamma(\theta)$ for 1009 γ .
1183.1 4	2+	
1199.83 24	2+	
1291.77 25	3+	
1300.3 4	(1-)	$J\pi$: from 1991Gr19 based on $\gamma(\theta)$ decomposed for the 1299 γ , 1300 γ , 1301 γ triplet. $J\pi=2+$ from 1983Gr30 based on $\gamma(\theta)$ for single 1301 γ .
1315.8 5	0+	$J\pi$: from isotropic $\gamma(\theta)$ for 1222 γ .
1354.1 5	(2-)	$J\pi$: $\gamma(\theta)$ would also allow $J\pi=2+$. See comment on 1260.7 γ .
1369.5 4	4+	
1373.7 3	(3-)	$J\pi$: from $\gamma(\theta)$ in 1983Gr30. $J\pi=4-$ from $\gamma(\theta)$ in 1991Gr19 is inconsistent with 1281.5 γ to 2+.
1409.4 4	4+	
1409.4 4	2+	
1430.7 6	3-	
1482.4 10	3-	
1484.4 10	4+	
1510.0? 5		
1540.1 6	(3-, 4+)	
1557.5 4	5+	
1597.7? 10	4+	
1608.13 25	4+	
1608.9 3	3-	$J\pi$: from $\gamma(\theta)$ in 1983Gr30. $J\pi=5-$ from $\gamma(\theta)$ in 1991Gr19 is inconsistent with 410 γ to 2+.
1611.8 4	4-	
1633.7 3	(3+)	$J\pi$: $\gamma(\theta)$ gives $J\geq 2$; no observed γ -rays to the ground state band suggests $J=3$.
1637.2 8	2+	
1687.0 8		
1700.3? 7	6+	
1724.7 4	2+	
1725.4 4	6+	
1742.8? 10	5+	
1743.0? 10	2+	
1820.0 3	3-	
1861.8 9	(5+)	$J\pi$: from rotational band assignment for levels built on the $J\pi=(3+)$ 1633-keV level.
1904.2 6		
1926.4 8		
1948.6 8		
2075.4 8		
2082.7? 10		
2389.0 6		

[†] From a least-squares fit to $E\gamma$ by evaluator.

[‡] From $\gamma(\theta)$, γ -ray decay pattern and assumed rotational structure as proposed in 1991Gr19 and 1983Gr30. Specific arguments, when given by the authors, are included in the comments.

 $\gamma(^{180}\text{Hf})$

$E\gamma^{\dagger}$	E(level)	$I\gamma^{\dagger}$	Mult. [‡]	$\delta^{\ddagger}$	Comments
93.4 1	93.41	2.0×10^3 5			
^x 204.5 3		22 10			
208.5 3	1820.0	15 6			
215.3 2	308.67	1400 150	E2		
224.1 8	1633.7	9 4			
235.0 2	1608.9	59 8	M1+E2	δ : -0.4 1 or >25 (1983Gr30); +0.09 3 or -15 +10-5 (1991Gr19).	

Continued on next page (footnotes at end of table)

$^{180}\text{Hf}(\text{n},\text{n}'\gamma)$ 1983Gr30,1991Gr19,1979Bo43 (continued)					
$\gamma(^{180}\text{Hf})$ (continued)					
$E\gamma^{\dagger}$	E(level)	$I\gamma^{\dagger}$	Mult. ‡	$\delta^{\ddagger}$	Comments
238.7 4	1611.8	6 2			
^x 243.2 7		3 2			
266.1 7	1557.5	1.7 8			
^x 292.5 4		7 4			
^x 304.0 4		25 5			
316.6 3	1608.13	25 5			
332.0 2	640.92	140 15	E2		
342.3 3	1633.7	20 5			
^x 344.9 3		27 5			
346 1	1637.2	10 5			
^x 352.7 4		6 2			
^x 357.5 7		6 2			
^x 366.4 4		4 2			
408.0 2	1608.13	54 8	E2		
410.2 5	1608.9	5 2			
^x 421.1 3		15 5			
433.7 [@] 2	1633.7	45 [@] 10	M1+E2	+0.4 3	
	1725.4	45 [@] 10	M1+E2		
443.1 3	1084.0	13 5			E γ : 433.1 3 in Table 1 of 1983Gr30 is likely a typo.
446.8 3	1820.0	20 5			
451 ^{@a}	1742.8?	<2 [@]			
	1820.0	<2 [@]			
^x 458.0 8		3 1			
^x 465.1 4		5 2			
^x 477.0 5		12 5			
^x 482.0 5		6 2			
^x 487.4 3		20 5			
^x 498.9 3		16 5			
^x 500.7		<5			
527.0 3	1820.0	15 4			
^x 534.5 4		15 6			
^x 555.4 4		5 2			
617 ^a	1700.3?	<3			
621.3 5	1820.0	18 5			
^x 634.0 5		4 2			
^x 643.9 5		4 2			
^x 656.7 5		3 1			
^x 725.3 5		4 1			
728.1 7	1369.5	2 1			
^x 739.9 5		6 2			
^x 743.6 5		2 1			
^x 763.1 5		4 2			
768.3 8	1409.4	2 1			
^x 778.3 5		3 1			
^x 786.1 8		2.5 15			
874.3 5	1183.1	20 5			
890.5 5	1199.83	2.5 15			
916.3 5	1557.5	6 2			
^x 918.2 6		2.5 15			
^x 969.1 5		7 3			
^x 972.8 8		3 1			
982.2 5	1291.77	33 5	M1+E2	-5.0 +20-15	
1008.6 5	1102.0	65 6	E2		
1060.9 5	1369.5	50 10			
1065.9 5	1373.7	250 20	E1 (+M2)	-0.12 30	
1082.8 5	1724.7	3 2			
1089.7 5	1183.1	120 10	M1 (+E2)	-0.3 4	
1100.7 ^{&} 5	1409.4	42 ^{&&} 21	M1+E2		δ : <-0.4 or >2 (1983Gr30).
	1409.4	68 ^{&&} 34	(E2)		
1106.2 5	1199.83	150 15	M1+E2		δ : -2.2 13 (1991Gr19); -0.45 25 or <-10 (1983Gr30).
1122.0 7	1430.7	6 2			
^x 1164		<1.5			
^x 1167		<1.5			

Continued on next page (footnotes at end of table)

$^{180}\text{Hf}(\text{n},\text{n}'\gamma)$ 1983Gr30,1991Gr19,1979Bo43 (continued) $\gamma(^{180}\text{Hf})$ (continued)

$E\gamma^{\dagger}$	E(level)	$I\gamma^{\dagger}$	Mult. ‡	Comments
1183.2 8	1183.1	4 1		
1197.7 8	1291.77	165 15	M1+E2	δ : <-10 or 0.18 5 (1991Gr19); >3 (1983Gr30).
1200.3 7	1199.83	110 15	(E2)	
^x 1206.7 5		53 20	(E1)	
1222.4 5	1315.8	40 5	E2	
1231.7 7	1540.1	4 1		
1249.0 6	1557.5	25 5		
1260.7# 5	1354.1	100	(E1)	$E\gamma$: placement from 1991Gr19. 1983Gr30 place the γ as a single depopulating transition from a 2+ level at 1260.7 keV. 1991Gr19 argue that such a decay pattern would be unusual for a low-lying state in a deformed nucleus.
1276.8 8	1369.5	3 1		
1281.5 8	1373.7	9 3		
1289 ^a 1	1597.7?	3.0 15		
1300.3@ 4	1300.3	160@ 20	(E1)	
	1608.13	160@ 20	(E2)	
	1608.9	160& 20	(E1)	
^x 1315 1		10 5		
1316.1& 8	1409.4	35\$& 16	(E2)	
	1409.4	20\$& 10		
1328 1	1637.2	2 1		
1337.3 8	1430.7	3 2		
1389	1482.4	<2		
1391@ ^a	1484.4	<2@		
	1700.3?	<2@		
^x 1393.5 7		4 1		
1409.3 7	1409.4	8 2		$E\gamma$: unplaced in 1983Gr30.
1416.6@ 4	1510.0?	3@ 1		
	1724.7	3@ 1		
^x 1434.5 8		8 2		
1446	1540.1	<2		
1514.4@ 8	1608.13	4@ 2		
	1608.9	4@ 2		
1553.1 8	1861.8	4 2		
^x 1575.4 8		3 1		
1593.6 8	1687.0	3 1		
^x 1601.0 8		2 1		
1631 1	1725.4	<2		
^x 1662.5 8		9 3		
1743 ^a	1743.0?	<2		
^x 1767.8 8		14 6		
1774 ^a	2082.7?	<2		
1810.9 8	1904.2	7 3		
^x 1834.3 8		6 2		
^x 1840		<3		
^x 1861.4 5		5 2		
^x 1885.9 8		10 3		
^x 1895		<2		
1904.1 8	1904.2	4 2		
1926.4 8	1926.4	7 3		
1948.6 8	1948.6	8 3		
^x 1961.2 8		10 4		
1982.0 8	2075.4	5 2		
^x 1990.9 8		5 2		
^x 1996.7 8		3 2		
^x 2006.5 8		5 2		
^x 2024.0 8		5 2		
^x 2035.1 8		5 2		
^x 2051.1 8		4 2		
^x 2093.4 8		4 2		
^x 2109.0 8		4 2		
^x 2168.4 8		3 2		
^x 2278.9 8		3 2		

Continued on next page (footnotes at end of table)

$^{180}\text{Hf}(\text{n}, \text{n}'\gamma)$ 1983Gr30, 1991Gr19, 1979Bo43 (continued) $\gamma(^{180}\text{Hf})$ (continued)

$E\gamma^\dagger$	E(level)	$I\gamma^\dagger$
2295.2 8	2389.0	3 2
^x 2323.4 8		3 2
2389.4 8	2389.0	3 2

[†] From 1983Gr30, except where noted.

[‡] From $\gamma(0)$ in 1983Gr30 and 1991Gr19. Quadrupole transitions are assumed to be E2, and transitions with mixed multiplicities, M1+E2.

[§] From 1991Gr19.

[#] Possible doublet.

[@] Multiply placed; undivided intensity given.

[&] Multiply placed; intensity suitably divided.

^a Placement of transition in the level scheme is uncertain.

^x γ ray not placed in level scheme.

 $^{180}\text{Hf}(\text{pol p}, \text{p}') 1992\text{Pe02}, 1986\text{Og02}$

1992Pe02: E(pol p)=98.4 MeV on a 93.9% ^{180}Hf isotopically enriched target. Measured $\sigma(\theta)$ and asymmetries using QDDM magnetic spectrometer (FWHM=50 keV); deduced deformation parameters from coupled-channels calculation.

1986Og02: E(pol p)=65 MeV on a 93.65% ^{180}Hf isotopically enriched target. Measured $\sigma(\theta)$ and asymmetries from $\theta=11^\circ$ to $\theta=75^\circ$ in 1° steps at the forward angles and in 2° steps at the backward angles using RAIDEN high resolution spectrograph and a counter array consisting of a position sensitive proportional chamber, a pair of single-wire proportional chambers, and a plastic scintillator (FWHM=25 keV); deduced deformation parameters β_2 , β_4 , and β_6 from coupled-channel calculations.

 ^{180}Hf Levels

E(level) [†]	$J\pi^\#$	Comments
0.0 [‡]	0+	
93 [‡]	2+	$\beta_2=0.260$ (1992Pe02); $\beta_2=0.2507$ (1986Og02). E(level): from 1986Og02. Other: 91 (1992Pe02).
309 [‡]	4+	$\beta_4=-0.050$ (1992Pe02); $\beta_4=-0.0562$ (1986Og02). E(level): from 1986Og02. Other: 312 (1992Pe02).
641 [‡]	6+	$\beta_6=0.004$ (1992Pe02); $\beta_6=-0.0110$ (1986Og02). E(level): from 1986Og02. Other: 652 (1992Pe02).
1086 ^{‡§} 6	8+	
1190 [§] 6	2+	$\beta_2=0.047$ (1992Pe02).
1289 [§] 6	2+	$\beta_2=0.019$ (1992Pe02).
1372 [§] 6	3-	$\beta_3=0.026$ (1992Pe02).
1444 6	5-	$\beta_5=0.017$ (1992Pe02).
1566 [§] 6	4+	$\beta_4=0.022$ (1992Pe02).
1651 6	3-	$\beta_3=0.038$ (1992Pe02).
1715 6	5-	$\beta_5=0.014$ (1992Pe02).
1740 6	3-	$\beta_3=0.019$ (1992Pe02).
1804 [§] 6	3-	$\beta_3=0.026$ (1992Pe02).
1839 6	3-	$\beta_3=0.040$ (1992Pe02).
1920 6	3-	$\beta_3=0.019$ (1992Pe02).
2067 6	4+	$\beta_4=0.020$ (1992Pe02).
2125 6		
2169 [§] 6	3-	$\beta_3=0.018$ (1992Pe02).
2205 6		
2257 6	4+	$\beta_4=0.018$ (1992Pe02).
2295 6		
2391 6	4+	$\beta_4=0.015$ (1992Pe02).
2447 [§] 6	5-	$\beta_5=0.027$ (1992Pe02).
2482 6	3-	$\beta_3=0.029$ (1992Pe02).
2533 20	3-	$\beta_3=0.018$ (1992Pe02).
2591 20	4+	$\beta_4=0.022$ (1992Pe02).

[†] From 1992Pe02, except where noted.

Footnotes continued on next page

$^{180}\text{Hf}(\text{pol p,p'})$ 1992Pe02,1986Og02 (continued) **^{180}Hf Levels (continued)**‡ $K\pi=0+$ g.s. rotational band.

§ Peak used for internal energy calibration (1992Pe02).

Based on comparison of experimental cross sections and asymmetries with results from coupled-channel calculations (1992Pe02).

 $^{180}\text{Hf}(^{136}\text{Xe}, ^{136}\text{Xe}'\gamma)$ 2007Ng03,2008Ta28

2007Ng03: $^{180}\text{Hf}(^{136}\text{Xe}, ^{136}\text{Xe}'\gamma)$, $E(^{136}\text{Xe})=750$ MeV. Measured $E\gamma$, $I\gamma$, $\gamma\gamma$, $\gamma\gamma(\theta)(\text{DCO})$, $\gamma(\text{particle})$ coincidences using the Gammasphere array consisting of 100 Compton-suppressed HPGe detectors for γ -rays and CHICO position-sensitive parallel-plate avalanche counter for beam and target like fragments. Coincidence requirement was at least two γ -rays in γ -ray detectors and two correlated particles in CHICO detector.

2008Ta28: $^{232}\text{Th}(^{180}\text{Hf}, ^{180}\text{Hf}'\gamma)$, $E(^{180}\text{Hf})=1300$ MeV. Measured $E\gamma$, $I\gamma$, $\gamma\gamma$, $\gamma(\text{particle})$ coincidences using the Gammasphere array consisting of 100 Compton-suppressed HPGe detectors for γ -rays and the CHICO position sensitive parallel plate avalanche counter for beam and target-like fragments. Report results similar to 2007Ng03, with extension of bands to higher spins and identification of new interband transitions.

 ^{180}Hf Levels

$E(\text{level})^\dagger$	$J\pi^\ddagger$	$T_{1/2}$	$E(\text{level})^\dagger$	$J\pi^\ddagger$	$E(\text{level})^\dagger$	$J\pi^\ddagger$
0.0 §	0+		1936.3 g 13	8-	3121.6 h 15	13-
92.8 § 5	2+		1945.3 f 10	11-	3128.3 # 9	12+
307.9 § 7	4+		2046.5 & 8	8+	3192.6 c 12	12+
640.1 § 8	6+		2112.0 c 11	8+	3299.4 a 9	(12+)
1083.3 § 8	8+		2132.4 h 14	9-	3350.0 f 11	15-
1141.3 e 8	8-		2132.6 # 8	8+	3383.2 b 11	
1183.3 & 11	2+		2262.3 e 10	12-	3430.3 g 16	14-
1199.0 # 9	2+		2272.5 a 9	(8+)	3605.7 @ 10	13+
1290.9 @ 8	3+		2273.6 § 9	12+	3677.3 # 9	14+
1369.9 & 10	4+		2300.1 b 10		3732.2 h 16	15-
1372.9 g 12	4-		2348.6 g 14	10-	3755.3 e 11	16-
1384.3 f 9	9-		2353.0 d 11	9+	3780.7 & 9	14+
1408.2 # 8	4+		2398.2 @ 9	9+	3812.7 § 10	16+
1481.1 h 13	5-		2532.2 & 9	10+	3970.4 a 9	(14+)
1556.7 @ 8	5+		2586.2 h 15	11-	4089.5 g 16	16-
1611.0 g 13	6-		2602.9 f 10	13-	4180.0 f 11	17-
1630.2 § 8	10+		2612.9 # 8	10+	4269.4 # 10	16+
1652.4 e 9	10-		2616.0 c 11	10+	4322.7 @ i 14	15+
1658.3 & 9	6+		2729.3 a 9	(10+)	4411.3 h 17	17-
1702.0 c 10	6+	<5 ns j	2795.2 b 10		4681.2 § 11	18+
1723.2 # 8	6+		2846.6 g 15	12-	4923.4 # i 14	18+
1763.3 h 13	7-		2898.0 d 12	11+	5553.2 § i 15	20+
1893.9 d 11	7+		2959.9 @ 9	11+	5628.4 # i 17	20+
1901.3 a 10	(6+)		2965.2 e 10	14-	5665.2 i 15	20+
1903.3 b 10			3004.6 § 9	14+		
1928.0 @ 8	7+		3109.9 & 9	12+		

† From a least-squares fit to $E\gamma$'s by evaluator. $\Delta E=1$ keV assumed when no uncertainty given.

‡ As proposed by 2007Ng03 based on DCO ratios for selected transitions, decay properties and band assignments.

§ (A): $K\pi=0+$, gs.# (B): $K\pi=2+$, γ -vibrational band, $\alpha=0$.@ (C): $K\pi=2+$, γ -vibrational band, $\alpha=1$.& (D): $K\pi=0+$ band.a (E): Low-K γ -vibrational band, likely even spin and positive ; parity.b (F): Low-K γ -vibrational band, likely odd spin.c (G): $K\pi=6+$ two-quasi particle band, $\pi 7/2[404] \otimes \pi 5/2[402]$, $\alpha=0$.d (H): $K\pi=6+$ two-quasi particle band, $\pi 7/2[404] \otimes \pi 5/2[402]$, $\alpha=1$.e (I): $K\pi=8-$ two-quasi particle band, $\pi 7/2[404] \otimes \pi 9/2[514]$, $\alpha=0$.f (J): $K\pi=8-$ two-quasi particle band, $\pi 7/2[404] \otimes \pi 9/2[514]$, $\alpha=1$.g (K): $K\pi=4-$ two-quasi particle band, $\nu 9/2[624] \otimes \nu 1/2[510]$, $\alpha=0$.h (L): $K\pi=4-$ two-quasi particle band, $\nu 9/2[624] \otimes \nu 1/2[510]$, $\alpha=1$.

i Observed only by 2008Ta28.

j From comparison of γ -ray intensities across the bandhead for varying width of coincidence time window.

$^{180}\text{Hf}(^{136}\text{Xe}, ^{136}\text{Xe}'\gamma)$ 2007Ng03,2008Ta28 (continued) $\gamma(^{180}\text{Hf})$

DCO ratio= $(I_\gamma(30^\circ \text{ or } 150^\circ, 90^\circ))/(I_\gamma(90^\circ, 30^\circ \text{ or } 150^\circ))$, where $I_\gamma(\theta_1, \theta_2)$ is the intensity of the γ transition observed at angle θ_1 in coincidence with a $\Delta J=2$, stretched quadrupole γ at θ_2 . The DCO ratio is expected to be 1.0 for $\Delta J=2$, stretched quadrupole and 0.5 for $\Delta J=1$, dipole.

$E\gamma^\dagger$	E(level)	$I\gamma^\S$	Mult.#	Comments
57.8 5	1141.3			
92.8 5	92.8	23.1 8		
108.2 5	1481.1	0.67 4		
129.7 5	1611.0	0.207 9		
152.2 5	1763.3	0.13 2		
173.0 5	1936.3	0.07 1		
186.6 5	1369.9			
192.0 5	1893.9			
196.2 5	2132.4	0.04 1		
209 1	1408.2			
215.3 5	307.9	107 4		
216.2 5	2348.6			
218.3 5	2112.0	0.23 1		
238.1 5	1611.0	0.36 1		
241.0 5	2353.0	0.19 1		
242.9 5	1384.3	1.44 4		
263.0 5	2616.0	0.11 1		
266.1 5	1556.7			
268.1 5	1652.4	1.24 2		
282.0 5	2898.0	0.04 1		
282.3 5	1763.3	0.46 2		
288.4 5	1658.3			
293.0 5	1945.3	0.59 1		
294.5 5	3192.6			
314.8 5	1723.2	0.53 5		
316.9 5	2262.3	0.27 1		
325.3 5	1936.3	0.27 2		
332.2 5	640.1	100 3	E2	Mult.: R(DCO)=1.12 2.
340.6 5	2602.9	0.14 1		
362.3 5	2965.2	0.06 1		
369.1 5	2132.4	0.25 4		
371.1 5	2272.5	0.08 2		
371.2 5	1928.0	0.51 3		
384.8 5	3350.0	0.03 1		
388.1 5	2046.5	0.32 3		
396.8 5	2300.1	0.36 3		
405.4 5	3755.3	0.02 1		
409.0 5	2132.6	1.02 6		
409.9 5	2112.0	0.04 1		
412.2 5	2348.6	0.20 1		
424.8 5	4180.0			
443.4 5	1083.3	51.9 15	E2	Mult.: R(DCO)=1.16 2.
453.8 5	2586.2	0.15 1		
456 $\ddagger$	4269.4			
456.7 5	2729.3	0.27 2		
459.0 5	2353.0	0.08 1		
470.4 5	2398.2	0.21 2		
480.3 5	2612.9	0.53 4		
485.2 5	2532.2	0.14 3		
495.1 5	2795.2	0.09 2		
498.0 5	2846.6	0.09 1		
501.4 5	1141.3			
504.0 5	2616.0	0.07 1		
511.2 5	1652.4	0.13 2		
515.4 5	3128.3	0.17 2		
535.4 5	3121.6	0.07 2		
545.0 5	2898.0	0.05 1		
547.3 5	1630.2	24.5 6	E2	Mult.: R(DCO)=1.12 2.
548.9 5	3677.3	0.13 2		
560.9 5	1945.3	0.08 2		

Continued on next page (footnotes at end of table)

$^{180}\text{Hf}(^{136}\text{Xe}, ^{136}\text{Xe}'\gamma)$ 2007Ng03, 2008Ta28 (continued) $\gamma(^{180}\text{Hf})$ (continued)

$E\gamma^{\dagger}$	E(level)	$I\gamma^{\S}$	Mult.#	Comments
561.7 5	2959.9	0.10 1		
569.8 5	3299.4	0.18 2		
576.7 5	3192.6			
577.8 5	3109.9	0.04 2		
583.7 5	3430.3			
588.0 5	3383.2			
592.3 5	4269.4	0.05 2		
596.7 5	2729.3	0.11 2		
610.0 5	2262.3	0.10 1		
610.6 5	3732.2			
643.4 5	2273.6	10.1 4	(E2)	Mult.: R(DCO)=1.06 2.
645.8 5	3605.7	0.05 1		
654 $\ddagger$	4923.4			
657.5 5	2602.9	0.06 1		
659.2 5	4089.5			
670.8 5	3780.7	0.04 2		
671.0 5	3970.4			
673 $\ddagger$	3677.3			
679.1 5	4411.3			
686.8 5	3299.4	0.09 2		
703.0 5	2965.2	0.05 1		
705 $\ddagger$	5628.4			
717 $\ddagger$	4322.7			
730.9 5	3004.6	3.25 3	(E2)	Mult.: R(DCO)=1.03 2.
747.2 5	3350.0	0.03 3		
767 1	2398.2			E γ : from Fig. 2 of 2007Ng03, not listed in authors' Table I.
776.1 5	3780.7			
790.0 5	3755.3			
807.9 5	3812.7	0.78 2	(E2)	Mult.: R(DCO)=0.98 3.
829.8 5	4180.0			
836.3 5	3109.9	0.07 1		
844.9 5	1928.0	0.07 1		
868.5 5	4681.2	0.13 1		
872 $\ddagger$	5553.2			
902.4 5	2532.2	0.10 1		
916.1 5	1556.7	0.22 2		
962.9 5	2046.5	0.17 2		
965.7 5	3970.4			
983.0 5	2612.9	0.18 3		
983.4 5	1290.9	0.57 3		
984 $\ddagger$	5665.2			
1018 1	1658.3	0.31 2	(D+Q)	Mult.: R(DCO)=1.05 6. Mult.: stretched Q or unstretched D+Q from R(DCO). (D+Q) from level scheme.
1026 1	3299.4			
1050 1	2132.6	0.89 2	D	Mult.: R(DCO)=0.69 3.
1062 1	1702.0	0.31 2		
1065 1	1372.9			
1083 1	1723.2	1.36 3	D	Mult.: R(DCO)=0.72 3.
1098 1	2729.3	0.58 4	(D+Q)	Mult.: R(DCO)=0.91 5.
1100 1	1408.2	2.3 2		
1106 1	1199.0	1.13 3		
1110& 1	3383.2			
1165 1	2795.2			
1189 1	2272.5	0.70 4		
1198 1	1290.9	3.1 2		
1217 1	2300.1			
1249 1	1556.7	1.65 8		
1261 1	1901.3	0.16 2		
1263 1	1903.3	0.36 3		
1265 $\ddagger$	4269.4			
1288 1	1928.0	1.00 5	D	Mult.: R(DCO)=0.62 3.
1315@ 1	1408.2	1.35@ 5		
	2398.2	0.44@ 2	D	Mult.: R(DCO)=0.62 4.

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$^{180}\text{Hf}(^{136}\text{Xe}, ^{136}\text{Xe}'\gamma)$ 2007Ng03, 2008Ta28 (continued) $\gamma(^{180}\text{Hf})$ (continued)

$E\gamma^\dagger$	E(level)	$I_\gamma^\S$	Mult. #	Comments
1330 1	2959.9	0.21 2		
1332 1	3605.7	0.06 1		
1350 1	1658.3	0.07 1		
1394 1	1702.0	0.40 5		
1404 1	3677.3			
1415 1	1723.2	1.40 2	(E2)	Mult.: R(DCO)=1.07 3.
1493 1	2132.6	1.35 2	(E2)	Mult.: R(DCO)=1.07 3.
1498 1	3128.3	0.28 2	(E2)	Mult.: R(DCO)=1.02 5.
1530 1	2612.9	0.47 4	(E2)	Mult.: R(DCO)=1.01 4.
1669 1	3299.4			

† From 2007Ng03, except where noted. Uncertainty is stated by 2007Ng03 as ≈ 0.5 keV. The evaluator assigns 1 keV for $E\gamma$'s above 1000, quoted to nearest keV.

‡ Observed only by 2008Ta28.

§ From 2007Ng03, normalized to $I_\gamma(332\gamma)=100$.

From R(DCO) measurements in 2007Ng03. Stretched quadrupole transitions are assumed as E2.

@ Multiply placed; intensity suitably divided.

& Placement of transition in the level scheme is uncertain.

 $^{180}\text{Hf}(^{238}\text{U}, ^{238}\text{U}'\gamma)$ 2001Ch10, 1999Da09

2001Ch10, 2014TaZY: $E(^{238}\text{U})=1.6$ GeV, pulsed beam. Measured $E\gamma$, I_γ , $\gamma\gamma$, and $\gamma\gamma\Delta t$, using Gammasphere array consisting of 98 HPGe detectors and 3 LEPS detectors.

1999Da09, 1999Ch48: $E(^{238}\text{U})=1.6$ GeV, pulsed beam. Measured $E\gamma$, I_γ , $\gamma\gamma$, $T_{1/2}(1/2)$ for delayed γ -rays using an array of 12 Compton-suppressed HPGe detectors for $(^{238}\text{U}, ^{238}\text{U}'\gamma)$. Includes results of $^{180}\text{Hf}(^{208}\text{Pb}, ^{208}\text{Pb}'\gamma)$ $E=1.3$ GeV using Gammasphere array. See also 2001Ch89.

 ^{180}Hf Levels

$E(\text{level})^\dagger$	$J\pi^\ddagger$	$T_{1/2}^\S$	Comments
0.0&	0+		
93.40& 10	2+		
309.00& 15	4+		
641.50& 18	6+		
1084.83& 20	8+		
1142.17 ^a 20	8-		$K\pi=8-$. Configuration= $\pi 7/2[404]\otimes\pi 9/2[514]$.
1374.9 [#] 17	(4-)		
1385.6 ^a 3	9-		
1482.9 [#] 19	(5-)		
1612.9 [#] 19	(6-)		
1654.3 ^a 3	10-		
1703.3 [@] 8	(6+)		
1764.9 [#] 20	(7-)		
1895.3 [@] 11	(7+)		
1937.9 [#] 20	(8-)		
1947.2 ^a 5	11-		
2113.3 [@] 11	(8+)		
2133.9 [#] 21	(9-)		
2263.9 ^a 5	12-		
2349.9 [#] 22	(10-)		
2354.3 [@] 12	(9+)		
2426.5 12	(10+)	<2 ns ^c	$K\pi=(10+)$. Configuration= $\nu 9/2[624]\otimes\nu 11/2[615]$.
2487.0 ^b 5	12+	0.94 μs^c 11	$K\pi=12+$. Configuration= $\pi^2 8-\otimes\nu 9/2[624]\otimes\nu 1/2[510]$.
2538.9 10	(14+)	>10 μs	$K\pi=(14+)$. Configuration= $\pi^2 8-\otimes\nu 9/2[624]\otimes\nu 3/2[512]$.
2587.9 [#] 23	(11-)		
2617.3 [@] 13	(10+)		
2625.0 ^b 7	(13+)		
2808.5 ^b 6	(14+)		
2847.9 [#] 24	(12-)		

Continued on next page (footnotes at end of table)

$^{180}\text{Hf}(^{238}\text{U}, ^{238}\text{U}'\gamma)$ 2001Ch10,1999Da09 (continued) ^{180}Hf Levels (continued)

$E(\text{level})^\dagger$	$J\pi^\ddagger$	$T_{1/2}^\S$	Comments
2900.3@ 14	(11+)		
3102.3 ^b 9	(15+)		
3122.9# 25	(13-)		
3194.3@ 15	(12+)		
3448.4 ^b 9	(16+)		
3530.4 13			
3599.0 10	(18-)	90 μs 10	$K\pi=(18-)$. Configuration= $\pi^2 8-\otimes v 9/2[624]\otimes v 11/2[615]$.

[†] From a least-squares fit to $E\gamma$, by evaluator. $\Delta E=1$ keV is assumed for transitions where no uncertainty is given.

[‡] $J\pi$ for levels below 1.1 MeV are from the Adopted Levels. Others are as proposed by 1999Da09 and 2001Ch10 based on assumed band structure.

[§] From 2001Ch10, 1999Da09 using time spectra for the γ -rays triggered with the beam-sweeper, except where noted.

(A): 2 quasiparticle band based on 1374 keV (4-).

@ (B): 2 quasiparticle band based on 1703 keV (6+).

& (C): g.s. band.

^a (D): 2 quasiparticle 8- band.

^b (E): 4 quasiparticle 12+ band.

^c From 2014TaZY.

 $\gamma(^{180}\text{Hf})$

$E\gamma$	$E(\text{level})$	$I\gamma$	Mult.	Comments
52	2538.9	65 3		
57.2 1	1142.17	22.5 1		
93.4 1	93.40	100		
108	1482.9			
130	1612.9			
137.9 5	2625.0	2.1 10		
150.6 5	3599.0	0.9 5	(M2)	$\alpha(\text{exp})=9$ 6 from intensity balance (1999Da09). Mult.: M2 or E3 from $\alpha(\text{exp})$. M2 proposed by 1999Da09 assuming lowest multipole dominates.
152	1764.9			
173	1937.9			
183.4 6	2808.5	2.5 5		
192	1895.3			
196	2133.9			
215.6 1	309.00	106 8		
216	2349.9			
218	2113.3			
223.3 2	2487.0	1.1 1		
238	1612.9			
241	2354.3			
243.6 2	1385.6	35.0 15		
263	2617.3			
268.9 2	1654.3	30.4 13		
270.0 20	2808.5	1.8 10		
282	1764.9			
283	2900.3			
293.3 5	1947.2	33.0 12		
293.9 8	3102.3	3.8 14		
294	3194.3			
317.3 3	2263.9	0.8 1		
321.5 3	2808.5	4.4 7		
325	1937.9			
332.5 1	641.50	123 6		
346.1 1	3448.4	4.0 14		
369	2133.9			
410	2113.3			
412	2349.9			
427.9 16	3530.4	<1		
443.2 1	1084.83	100 8		

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$^{180}\text{Hf}(^{238}\text{U}, ^{238}\text{U}'\gamma)$ 2001Ch10,1999Da09 (continued) $\gamma(^{180}\text{Hf})$ (continued)

$E\gamma$	E(level)	$I\gamma$	$E\gamma$	E(level)	$I\gamma$	$E\gamma$	E(level)	$I\gamma$
454	2587.9		539.5 3	2487.0	39.8 18	832.4 15	2487.0	0.5 2
459	2354.3		546	2900.3		1040.8 15	2426.5	0.2 1
481 3	2426.5	0.1 1	561.3 19	1947.2	8.4 6	1062	1703.3	
498	2847.9		577	3194.3		1065.9 17	1374.9	0.6 4
500.8 1	1142.17	24.9 17	609.1 10	2263.9	0.3 1	1101.1 7	2487.0	14.7 13
504	2617.3		639.4 15	3448.4	3.1 11	1394	1703.3	
511.7 3	1654.3	2.4 3	722.0 15	3530.4	<1			
535	3122.9		771.7 22	2426.5	1 1			

Coulomb Excitation 1977Ro08,1982Ha25

1982Ha25: ($^{86}\text{Kr}, ^{86}\text{Kr}'\gamma$) and ($^{136}\text{Xe}, ^{136}\text{Xe}'\gamma$) with $E=384\text{--}594$ MeV. Measured $E\gamma$, $I\gamma$ in coincidence with back-scattered particles using two Ge(Li) detectors at 0° and 90° and two position sensitive avalanche counters; deduced $B(E2)$ from yield analysis and $T_{1/2}$ from Doppler Shift Attenuation Method (DSAM).

1977Ro08: (α, α'), $E\alpha=11\text{--}17$ MeV. Measured $\sigma(\theta)$ at $\theta=90^\circ$ and 150° using Engle split-pole magnetic spectrograph with position sensitive proportional counter at focal plane (FWHM=18–25 keV). See 1977Ro26 and 1978Ro02 by similar authors where E2 and E4 reduced transition matrix elements to the 93.3 (2+) and 308.6 (4+) levels are determined.

Others: 1955He64 ($\alpha, \alpha'\gamma$), 1955Mc44 (p,p' γ), 1958Ch36 (p,p' γ), 1959Bi10 (p,p' γ), 1961Go09 (p,p' γ), 1961Ha21 (p,p' γ), 1963Gr04 ($^{16}\text{O}, ^{16}\text{O}'\gamma$), 1964De07 ($^{16}\text{O}, ^{16}\text{O}'\gamma$), 1974Va09 ($\alpha, \alpha'\gamma$), 1984Gu22 (Ar,Ar' γ), 1988Ne07 (α, α').

 ^{180}Hf Levels

$E(\text{level})^\dagger$	$J\pi^\dagger$	$T_{1/2}^\ddagger$	Comments
0.0 §	0+		
93.290 § 20	2+	1.50 ns 2	$B(E2)^\uparrow=4.73$ 5 (1977Ro08,1977Ro26). $T_{1/2}$: from $B(E2)=4.73$ 5 (1977Ro08,1977Ro26) and $\alpha=4.64$. Others: 1.44 ns 10 from $B(E2)=4.93$ 35 (1963Gr04), 1.63 ns 8 from $B(E2)=4.35$ 20 (1961Ha21), and 1.65 ns 11 from centroid shift method (1959Bi10). Others: 1955He64, 1955Mc44, 1961Go09, 1964De07, 1977Ro26. g-factor=0.263 15 from IPAD with $T_{1/2}=1.50$ ns 2 (1968Be04). This supercedes early result by same group of g=0.313 35 (1967Gi02). Other: 1961Bo25. $B(E2)^\uparrow$: others: 4.39 (1955He64), 4.3 7 (mean value for ^{178}Hf and ^{180}Hf , 1961Go09), 4.3 (1964De07). $B(E2)^\uparrow=2.1$ (1964Al25). $T_{1/2}$: from $B(E2)=2.1$ (1964Al25) and $\alpha=0.225$.
308.6 § 10	4+	86 ps	
640.9 § 15	6+	10.0 ps 7	
1084.1 § 18	8+	2.18 ps 11	
1199.5 7	2+	0.51 ps 5	$T_{1/2}$: from $B(E2)=0.113$ 7, weighted average of 0.114 7 (1977Ro08) and 0.110 11 (1974Va09), and (1199.7) γ –adopted branching=51% 4.
1630.6 § 20	10+	0.79 ps 4	
2272.6 § 23	12+	0.37 ps 3	

† From the Adopted Levels.

‡ From 1982Ha25, except where noted. Results of 1982Ha25 are weighted averages of lifetimes obtained using the Doppler Shift Attenuation Method (DSAM) and through Coulomb excitation yield measurements.

§ $K\pi=0+$ g.s. rotational band.

 $\gamma(^{180}\text{Hf})$

$E\gamma^\dagger$	E(level)	Mult.	δ	α	Comments
93.29 2	93.290	E2		4.64	$E\gamma$: from 1958Ch36.
215.3	308.6	E2		0.225	
332.3	640.9	E2		0.0586	
443.2	1084.1	E2		0.0264	
546.5	1630.6	E2		0.01552	
642.0	2272.6	E2		0.01060	

Continued on next page (footnotes at end of table)

Coulomb Excitation 1977Ro08,1982Ha25 (continued)
 $\gamma(^{180}\text{Hf})$ (continued)

$E\gamma^\dagger$	E(level)	Mult.	δ	α	Comments
1106.0	1199.5	M1+E2	9.6 +22-58	0.00338 18	δ : from $\gamma(\theta)$ in 1974Va09. Other: 0.7 2 is not favored when considering systematics of similar transitions in this region.
1199.7	1199.5	E2		0.00285 4	

 † From the Adopted Levels, except where noted.

Adopted Levels, Gammas

Q(β⁻)=702 3; S(n)=6648 3; S(p)=5760 3; Q(α)=2023 3 2012Wa38.
S(2n)=14478 syst 52; S(2p)=13174 3 (2012Wa38).
Other reactions:
⁹Be(²⁰⁸Pb,Xγ): 2002Pf01, 2012My01.
¹⁵⁴Sm(⁴⁰Ar,¹⁴N): 1983Va10.
¹⁶⁹Tm(¹⁶O,X): 2011Ya17.
¹⁷⁹Ta(n,γ): 1999Sc26.
¹⁸⁰Hf(p,n): 1977NoZU, 1981NoZX, 1982No09, 1985BaZA, 1986Ba84, 1987Ra23, 1989LaZS, 2011Ta22.
¹⁸⁰Ta(n,n'), ¹⁸⁰Ta(n,n'γ): 1975HaYR, 1999Ka03.
¹⁸⁰Ta(p,p'), ¹⁸⁰Ta(α,α'): 1986Is04, 1997Sc18, 1998Sc36.
¹⁸⁰W(n,p): 1975Qa01, 1983Ca23.
¹⁸¹Ta(e,e'n): 1975Ra39.
¹⁸¹Ta(π⁺,p), (π⁻,p): 1977Ja10, 1977Ja15, 1977ZiZZ, 1980Do07, 1980Mc03, 1981Mc09, 1998HuZY, 1998ZhZJ.
¹⁸¹Ta(n,2n): 1968Bo25, 1969Br01, 1972Mo15, 1973ArZI, 1977Ve07, 1975FrZW, 1975FrZT, 1974FrZG, 1978Da24, 1979Mi11, 1980Mc03, 1980Ry02, 1980Se07, 1981La09, 1982Lu07, 1983AdZY, 1985Lu07, 1985Fa09, 1987Lu05, 1989Pe04, 1989Sc20, 1996Si34, 1999ZhZY, 2007Sh15, 2009Lu09, 2011Zh26, 2011Sv02.
¹⁸¹Ta(pol p,p), (pol p,d): 1978WiZD.
¹⁸¹Ta(p,np): 1971DuZQ, 1973CaXK, 1984Ab05, 1988Ba83.
¹⁸¹Ta(¹⁵N,¹⁶N): 1966Ar17, 1972Ar35.
¹⁸¹Ta(¹⁶O,¹⁷O): 1977Vi02, 1982Ma08.

¹⁸⁰Ta Levels

Cross Reference (XREF) Flags

A ¹⁸⁰Hf β⁻ Decay (5.53 h)
B ¹⁷⁶Yb(¹¹B,α3nγ),(⁷Li,3nγ)
C ¹⁷⁹Hf(α,t),(³He,d)
D ¹⁸⁰Hf(p,nγ),(d,2nγ)
E ¹⁸⁰Hf(²³⁸U,Xγ)
F ¹⁸⁰Ta(γ,γ'): Target=9- Isomer
G Coulomb Excitation
H ¹⁸¹Ta(γ,n)
I ¹⁸¹Ta(p,d)
J ¹⁸¹Ta(d,t)

E(level) [†]	Jπ	XREF	T _{1/2} [‡]	Comments
0.0&	1+	ABCD F HI J	8.154 h 6	%β ⁻ =15 3; %ε=85 3. %β ⁻ ,%ε: deduced by evaluator from β ⁻ /ε=0.15 2 (1962Ga07), β ⁻ /ε=0.221 14 (1980Ry01), and β ⁻ /ε=0.18 3 (1974HeYW). Jπ: J=1 from log ft=5.97 to 2+ and log ft=5.71 to 0+ in ε decay to ¹⁸⁰ Hf. π from L(d,t)=L(p,d)=4. T _{1/2} : weighted average of 8.152 h 6 (1980Ry01), 8.15 h 3 (1999Be65), and 8.18 h 2 (2002Be18). Others: 8.00 h 5 (1950Wi67), 8.15 h 2 (1951Br87), 8.15 h 5 (1962Be52), 8.19 h (1962Fo10), 8.1 h 1 (1963Ra14), and 7.99 h 5 (1968Bo25). configuration=π7/2[404]v9/2[624]. Jπ: 40γ to 1+, band assignment; π=+ from L(d,t)=L(p,d)=4.
39.54& 5	2+	BCD HI J		

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Adopted Levels, Gammas (continued) ^{180}Ta Levels (continued)

E(level) [†]	J π	XREF	T _{1/2} [‡]	Comments
77.2 ⁿ 12	9-	ABCDEF G I	>7.1×10 ¹⁵ y	Q=+4.95 2; μ =4.825 11. E(level): weighted average of 78.0 10 from $^{181}\text{Ta}(p,d)$ (2002We01) and 75.5 14 from the difference between the ^{181}Ta neutron separation energy (S(n)=7576.8 keV 13) (2012Wa38), and the neutron thermal capture-state energy of 7652.3 keV 5 (from $^{180}\text{Ta}(>7.1\times 10^{15} \text{ y})(n,\gamma)$) (1981Co17). Other values: 73 keV 2, using S(n)=7579 keV 2 from $^{181}\text{Ta}(\gamma,n)$ (1981Co17); 77 keV 9, from mass doublets measurements (1980Sh06); 82 keV, from (α,t) (1983Wa01). J π : J=9 from high resolution collinear laser spectroscopy (2006Bi14). π consistent with population of 716 keV (J π =15/2+) and 1539 keV (J π =21/2+) levels in ^{181}Ta by (assumed E1) primary γ -rays in $^{180}\text{Ta}(>7.1\times 10^{15} \text{ y})(n,\gamma)$ E=thermal (1981Co17). Configuration=((π 9/2[514])+(ν 9/2[624])) and J π =9- are consistent with μ =4.77 5 (1980Bu09) and with reaction cross section ratio in (α,t) and ($^3\text{He},d$) (1983Wa01). T _{1/2} : from T _{1/2} (β^-)>1.7×10 ¹⁶ y and T _{1/2} (ϵ)>1.2×10 ¹⁶ y (2006Hu15). Other values: T _{1/2} >1.2×10 ¹⁵ y from T _{1/2} (β^-)>1.9×10 ¹⁵ y and T _{1/2} (ϵ)>3.0×10 ¹⁵ y (1985Cu03), >2.8×10 ¹³ y (1981No09), T _{1/2} (ϵ)>2.1×10 ¹³ y (1977Ar11), T _{1/2} (ϵ)>1.0×10 ¹³ y (1967Sa05), T _{1/2} >10 ¹⁰ y (1958Mi90), T _{1/2} (ϵ)>1.6×10 ¹³ y, T _{1/2} (β^-)>1.1×10 ¹³ y (1958Ba51). Others: 1955Eb14, 1958Eb09. μ : laser resonance spectroscopy (1994Wa34) Other: μ =4.77 5 from atomic beam (LASER fluor.) $\mu(1+J/2)$. J from fits of $\mu(1+J/2)$ (exp.) to $\mu(1+J/2)$ (theory) for different J values (1980Bu09,1989Ra17). Q: laser resonance spectroscopy (1994Wa34). J π : E1 108 γ to 1+. configuration= π 9/2[514] ν 9/2[624]. XREF: c(134). J π : 71 γ to 2+, band assignment; π =+ from L(d,t)=L(p,d)=6. XREF: c(134). XREF: c(181). J π : (M1) 40.7 γ to 1-, band assignment. XREF: c(181)J(172). J π : E1 100.8 γ to 9-, band head of K π =8+ band. configuration= π 7/2[404] ν 9/2[624]. XREF: c(181). J π : 74.0 γ to 3+; band assignment. J π : (M1) 63.1 γ to 2-; band assignment.
107.78 ⁱ 4	0-	B D	19.2 ns 7	
110.75 ^{&} 6	3+	BcD HI J		
130.38 ⁱ 7	1-	BcD		
171.12 ⁱ 6	2-	BcD		
177.87 ^f 11	8+	ABcD HI J	70.0 ns 14	
184.92 ^{&} 8	4+	BcD I J		
234.35 ⁱ 6	3-	BCD H		
258 2		H		
280.12 ⁿ 12	10-	BCDE G		
310.88 ^{&} 8	5+	B D HI J		
318.21 ⁱ 6	4-	BCD		
320.23 ^r 4	1+	D		
357.01 ^c 12	7+	BCD	42 ns 3	
370.82 ^r 4	2+	D H		
374.15 ^f 12	9+	B D I J		
416.32 ^{&} 10	6+	B D HI		
419.86 ⁱ 7	5-	BCD		
423.43 ^j 4	1-	B D I J		
425.8		I		
447.86 ^r 6	3+	D H		
463.62 ^g 13	7-	B D HI J	31.2 ns 19	
478.11 ^j 5	2-	B D I J		
505.28 ⁿ 12	11-	B DE G		

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Adopted Levels, Gammas (continued) ^{180}Ta Levels (continued)

E(level) [†]	J π	XREF	T _{1/2} [‡]	Comments
508.1? 3		B		
515.80 ^d 12	8+	B D H	<1 ns	J π : (M1) 159 γ to 7+, M1+E2 338 γ to 8+; band assignment.
520.04 ^a 9	4+	B D	37.4 ns 20	J π : M1+E2 209 γ to 5+, M1 409 γ to 3+.
x+519.0 ^b 10	(5)	B D	16.1 ns 19	configuration= $\pi 9/2[514]v1/2[521]$. E(level): x=72.2 in $^{176}\text{Yb}(^{11}\text{B},\alpha 3n\gamma),(^7\text{Li},3n\gamma)$. A 72.2-keV transition is not supported by ce data of $^{180}\text{Hf}(p,n\gamma),(d,2n\gamma)$, which propose x $\leq$ 80. J π : x transition to (4+).
538.5? 3		B		
544.20 ^j 6	3-	B D HIJ		J π : M1 373 γ to 4-, 226 γ to 2-; band assignment.
547.84 ⁱ 10	6-	B D		J π : (M1) 128 γ to 5-, 229.5 γ to 4-; band assignment.
547.90 ^r 9	4+	D		J π : 237 γ to 5+, 437 γ to 3+; band assignment.
549.32 ^t 7	3-	D I		J π : (M1) 71 γ to 2-, band assignment.
559.50 ^s 5	(2+)	cD		XREF: c(563). J π : (M1,E2) 239 γ to 1+, 449 γ to 3+, assignment as K π =2+ bandhead, configuration= $v9/2[624]-\pi 5/2[402]$. XREF: c(563)h(571).
572.2		c hI		XREF: c(563)h(571)I(576.8)J(571).
574.86 ^h 13	6-	BcD hIJ	<2 ns	J π : M1(+E2) 111 γ to 7-, band head of K π =6- band, $\pi 7/2[404]v5/2[512]$. T _{1/2} : other: $\approx$ 10 ns from ce- γ (t) in $^{180}\text{Hf}(p,n\gamma),(d,2n\gamma)$. XREF: c(563).
575.80 ^c 13	(8+)	BcD	<1 ns	J π : 219 γ to 7+, 398 γ to 8+; K π =8+ bandhead, configuration= $\pi 9/2[541]v7/2[514]$.
595.40 ^f 12	10+	B D IJ		J π : E2 418 γ to 8+; band assignment.
600.30 ^{&} 12	(7+)	B D I		J π : 184 γ to 6+, 289 γ to 5+; band assignment.
624.13 ^s 5	(3+)	D H		J π : (M1) 65 γ to (2+); band assignment.
641.55 ^a 12	(5+)	B D h		XREF: h(643). J π : 121 γ to 4+; band assignment.
645.63 ^t 9	(4-)	D hI		XREF: h(643). J π : 101 γ and 411 γ to 3-; band assignment.
653.50 ^u 6	1-	D I		J π : 175.5 γ to 2-, 230 γ to 1-, 283 γ to 2+, 333 γ to 1+; K π =1- bandhead with configuration= $v7/2[514]-\pi 5/2[402]$.
658.37 ^j 12	(4-)	B D IJ		J π : (M1) 114 γ to 3-; band assignment.
x+659.8 ^b 10	(6)	B D		J π : 141 γ to (5); band assignment.
663.79 ^v 9	(4-)	B D HI		J π : (M1) 114.5 γ to 3-; band assignment.
672.04 14		D		
676.36 ^r 10	(5+)	D		J π : 128.5 γ to 4+; band assignment.
680.5		I		
680.64 ^g 16	(8-)	B D IJ		XREF: I(682.7)J(671). J π : 271 γ to 7-; band assignment.
684.3 4		B D		
686.06 ⁱ 10	7-	B D		J π : 138 γ to 6-, 266 γ to 5-; band assignment.
708.11 ^u 6	2-	D		J π : 159 γ to 3-, 260 γ to 3+, 285 γ to 1-, 388 γ to 1+; band assignment.
717.3		I		
721.86 7	(4-)	B D HIJ	$\approx$ 3 ns	XREF: B(?)J(712). J π : 178 γ to 3-, L(p,d)=L(d,t)=1; K π =4- bandhead with configuration= $\pi 7/2[404]+v1/2[521]$. T _{1/2} : from ce- γ (t) in $^{180}\text{Hf}(p,n\gamma),(d,2n\gamma)$; given as a range from 1-5 ns.
723.45 ^d 13	9+	B D		J π : 208 γ to 8+, 367 γ to 7+; band assignment.
729.64 12		D		
731.16 9		D i		
735.22 ^{&} 13	(8+)	B D i		J π : 135 γ to (7+), 319 γ to 6+; band assignment.
738.54 12		D		
752.42 ⁿ 13	12-	B DE G		J π : 247 γ to 11-, 472 γ to 10-; band assignment.
756.80 15		D I		
763.62 ^h 15	7-	B D IJ		XREF: J(753). J π : 189 γ to 6-, 300 γ to 7-; π =- from L(p,t)=L(d,t)=3; band assignment.
775.8? 11		B		
784.33 ^v 9	(5-)	D I		J π : 466 γ to 4-, 550 γ to 3-; band assignment.

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Adopted Levels, Gammas (continued) ^{180}Ta Levels (continued)

E(level) [†]	J π	XREF	T _{1/2} [‡]	Comments
787.24 ^a 13	(6+)	B D		J π : 146 γ to (5+), 267 γ to 4+; band assignment.
787.94 ^u 9	(3-)	D i j		XREF: j(775).
				J π : L(d,t)=L(p,d)=1, 417 γ to 2+.
788.41 ^w 11	3-	D i j		XREF: j(775).
				J π : L(d,t)=L(p,d)=1, 310 γ to 2-, K π =3- bandhead with configuration $\pi 7/2[404]-\nu 1/2[521]$.
792.54 17		D H		
806.95 ^c 12	(9+)	B D		J π : (M1) 231 γ to (8+); band assignment.
809.39 ^s 11	(5-)	D i	≈ 2 ns	J π : 151 γ to (4-), 265 γ to 3-, K π =5- bandhead with possible configuration= $\pi 7/2[404]+\nu 3/2[512]$.
				T _{1/2} : from ce- γ (t) in $^{180}\text{Hf}(p,n\gamma),(d,2n\gamma)$; given as a range from 1-5 ns.
809.44 ^s 14		D i		
820 2		H		
x+821.4 ^b 10	(7)	B D		J π : 161.5 γ to (6), 302 γ to (5); band assignment.
830.70 13		B D		
836.16 16	5-	D I J		XREF: J(822).
				J π : from (p,d) and (d,t).
840.99 ^f 13	11+	B D		J π : 245.5 γ to 10+, 467 γ to 9+; band assignment.
857.11 ⁱ 13	8-	B D H		
862.1 3		B		
863.91 12		D		
865.86 16		D		
876.80 6	(2-)	D I		J π : possible configuration= $\pi 7/2[404]-\nu 3/2[512]$, K π =2-.
880.65 7		D		
884.15 13		D I		
891.94 [@] 15		B D I		
892.76 [@] 12		D h i j		
893.04 [@] 16		D h I j		
906.43 15		B D		
907.35 ^{#w} 10	4-	D I J		XREF: J(893).
				J π : from (p,d). L(p,d)=1.
915.90 7		D I		
922.82 ^g 15	(9-)	B D		J π : 242 γ to (8-), 459 γ to 7-; band assignment.
935.07 [#] 8		D j		XREF: j(893).
938.84 [#] 20		D j		XREF: j(893).
951.50 [#] 7		D I J		XREF: J(930).
956.34 ^d 13	10+	B D h		J π : 233 γ to 9+, 441 γ to 8+; band assignment.
956.59 ^a 15	(7+)	B D h		J π : 169 γ to (6+), 315 γ to (5+); band assignment.
973.0 [#]		I J		XREF: J(930).
976.64 ^h 14	8-	B D		J π : 296 γ to (8-), 402 γ to 6-; band assignment.
977.03 ^{&} 13	(9+)	B D		J π : 242 γ to (8+), 377 γ to (7+); band assignment.
986.2 [#]		I j		XREF: j(948).
991.64 [#] 12		D j		XREF: j(948).
996.49 8		D		
1003.7		I		
x+1003.9 ^b 10	(8)	B D F	≤ 35 ps	XREF: F(1087).
				J π : 182 γ to (7), 344 γ to (6); band assignment.
				T _{1/2} : from $^{180}\text{Ta}(\gamma,\gamma')$:Target=9- isomer.
1016.7 3		B D		
1020.73 ⁿ 14	13-	B E G		T _{1/2} : <5.5 h or >23 h from 2000Po16.
1030.64 ⁱ 13	9-	B D		J π : 268 γ to 12-, 515 γ to 11-; band assignment.
1035.0? 11		B		J π : 173.5 γ to 8-, 345 γ to 7-; band assignment.
1037.03 8		D		
1043.14 14		D		
1053.6 10		D		
1057.17 ^c 13	(10+)	B		J π : 250 γ to (9+), (E2) 481.5 γ to (8+); band assignment.
1062.6		I		
1075.9		I		
1080.0		I		
1100.75 15		D		
1110.08 ^f 14	12+	B		J π : 269 γ to 11+, 515 γ to 10+; band assignment.

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Adopted Levels, Gammas (continued) ^{180}Ta Levels (continued)

E(level) [†]	J π	XREF	T _{1/2} [‡]	Comments
1113.09 8		D		
1122 2		H		
1141.09& 14	(10+)	B		J π : 164 γ to (9+), 406 γ to (8+); band assignment.
1149.54 ^a 16	(8+)	B D		J π : 193 γ to (7+), 362 γ to (6+); band assignment.
1175.02 16		B		
1189.24 ^g 16	(10-)	B		J π : 266 γ to (9-), 509 γ to (8-); band assignment.
1205.18 12		D H		
x+1205.2 ^b 10	(9)	B F	≤ 7 ps	XREF: F(1300). J π : 201 γ to (8), 384 γ to (7); band assignment. T _{1/2} [‡] : from $^{180}\text{Ta}(\gamma, \gamma')$; Target=9- isomer.
1212.48 ^d 14	11+	B		J π : 256 γ to 10+, 489 γ to 9+; band assignment.
1216.3 ^h 3	(9-)	B		J π : 453 γ to 7-; band assignment.
1241.20 ⁱ 14	10-	B D		J π : 211 γ to 9-, 384 γ to 8-; band assignment.
1247 3		H		
1252.76 15		B		
1270.86 23		B		
1293.42 23		B		
1309.82 ⁿ 15	14-	B E GH		J π : 289 γ to 13-, (E2) 557.5 γ to 12-; band assignment.
1327.04 ^c 14	(11+)	B		J π : 270 γ to (10+), 520 γ to (9+); band assignment.
1339.09 ^m 13	11-	B G		J π : E2 258 γ from 13-, 1059 γ to 10-, 1262 γ to 9-.
1353.9 3		B H		
1363.8 ^a 7	(9+)	B		J π : 214 γ to (8+), 407.5 γ to (7+); band assignment.
1389.58 23		B		
1401.78 ^f 14	13+	B		J π : 291 γ to 12+, 561 γ to 11+; band assignment.
x+1425.7 ^b 10	(10)	B F		XREF: F(1510). J π : 220.5 γ to (9), 422 γ to (8); band assignment.
1427 4		H		
1435.83& 15	(11+)	B		J π : 295 γ to (10+), 459 γ to (9+); band assignment.
1447.28 ⁱ 15	11-	B D		J π : 206 γ to 10-, 417 γ to 9-; band assignment.
1452.39 ^o 22	15-	B E	31.2 μ s 14	J π : M1 143 γ to 14-, 432 γ to 13-; K π =15- bandhead with configuration= $\nu 9/2[624]\pi 7/2[404]\pi 5/2[402]\pi 9/2[514]$. T _{1/2} [‡] : other: 27 ns 8 from 2002Pf01.
1463.72 23		B		
1479.09 ^g 17	(11-)	B		J π : 290 γ to (10-), 556 γ to (9-); band assignment.
1490.36 ^d 15	12+	B		J π : 278 γ to 11+, 534 γ to 10+; band assignment.
1541.79 16		B		
1546.71 ^m 20	(12-)	B G		J π : 1042 γ to 11-, 1266 γ to 10-; band assignment.
1573.52 23		B		
1580.0 7		B		
1597.43 ^l 13	13-	B	≤ 1 ns	J π : E2 1092 γ to 11-, 845 γ to 12-. configuration= $\pi 9/2[514]\nu 5/2[512]\nu 9/2[624]\nu 3/2[512]$.
1616.49 ^c 16	(12+)	B f		J π : 289 γ to (11+), 560 γ to (10+); band assignment.
1618.94 ⁿ 16	15-	B fG		J π : 309 γ to 14-, 598 γ to 13-; band assignment.
1630.58& 16	(12+)	B f		J π : 195 γ to (11+), 490 γ to (10+); band assignment.
x+1662.3 ^b 10	(11)	B		J π : 237 γ to (10), 457 γ to (9); band assignment.
1671.59 15	(12)	B		J π : 332.5 γ to 11-, 1391.5 γ to 10-.
1698.99 ⁱ 16	12-	B		J π : 252 γ to 11-, 458 γ to 10-; band assignment.
1708.23 15		B	< 1 ns	
1715.55 ^f 15	14+	B		J π : (E2) 606 γ to 12+, 313.5 γ to 13+; band assignment.
1740 3		H		
1788.38 ^d 15	13+	B		J π : 576 γ to 11+, 298 γ to 12+; band assignment.
1790.80 ^g 19	(12-)	B		J π : 602 γ to (10-), 311.5 γ to (11-); band assignment.
1792.24 ^o 24	16-	B E		J π : (M1) 340 γ to 15-; band assignment.
1805.85 ^m 15	(13-)	B		1053 γ to (12-), 1301 γ to (11-); band assignment.
1822 3		H		
1841.39 15	(13-)	B		J π : 1090 γ to 12-, 1336 γ to 11-.
1863.5 3		B H		XREF: H(1866).
1880.07 ^l 15	(14-)	B		J π : 283 γ to 13-; band assignment.
1904.54 16		B f		XREF: f(1930).
1904.63 15		B F		
1924.97 ^c 17	(13+)	B f		XREF: f(1930). J π : 598 γ to (11+), 308 γ to (12+); band assignment.

Continued on next page (footnotes at end of table)

Adopted Levels, Gammas (continued) ^{180}Ta Levels (continued)

E(level) [†]	J π	XREF	T _{1/2} [‡]	Comments
1941.63 ^k 16	(14)	B f	<1 ns	XREF: f(1930). J π : D 344 γ to 13-.
1941.79 ⁱ 18	13-	B f		XREF: f(1930). J π : 495 γ to 11-, 243 γ to 12-; band assignment.
1947.12 ⁿ 16	16-	B fG		XREF: f(1930). J π : 637 γ to 14-, 328 γ to 15-; band assignment.
1968.52 ^{&} 16	(13+)	B		J π : 533 γ to (11+), 338 γ to (12+); band assignment.
1970.93 18		B		
2006.28 24		B		
2050.43 ^f 17	(15+)	B		J π : 649 γ to 13+; band assignment.
2071.23 24		B		
2105.26 ^d 16	14+	B		J π : 615 γ to 12+, 317 γ to 13+; band assignment.
2123.6 ^g 3	(13-)	B		J π : 644 γ to (11-), 335 γ to (12-); band assignment.
2124.93 ^m 24	(14-)	B		J π : 1372.5 γ to 12-; band assignment.
2157.26 ^o 25	17-	B E		J π : 365 γ to 16-, 705 γ to 15-; band assignment.
2160.1 4		B		
2182.70 ^l 15	(15-)	B		J π : 302 γ to (14-), 585 γ to 13-; band assignment.
2186.9 3		B		
2198.48 ^{&} 18	(14+)	B		J π : 568 γ to (12+); band assignment.
2258.7 3		B F		
2294.36 ⁿ 17	17-	B		J π : 676 γ to 15-, 347 γ to 16-; band assignment.
2321.03 ^k 19	(15)	B		J π : D 379 γ to (14); band assignment.
2328.0 7		B		
2341.6 3		B		
2354.5 3		B		
2402.61 ^e 17	(16+)	B		J π : 687 γ to 14+; band assignment.
2410.24 ^f 17	(16+)	B		J π : 695 γ to 14+; band assignment.
2438.50 ^d 18	15+	B f		XREF: f(2480). J π : 333 γ to 14+, 650 γ to 13+; band assignment.
2452.6 4		B f		XREF: f(2480).
2504.19 ^l 16	(16-)	B f		XREF: f(2480). J π : 321 γ to (15-), 624 γ to (14-); band assignment.
2545.3 ^o 3	18-	B		J π : 388 γ to 17-, 753 γ to 16-; band assignment.
2561.2 3		B		
2568.62 ^{&} 19	(15+)	B		J π : 600 γ to (13+); band assignment.
2588.3 ^p 3	(18+)	B E	22 ns 2	J π : stretched (E1) 431 γ to (17-), 1137 γ to (15-). configuration=v7/2[514]v9/2[624]v11/2[615]v9/2[514]. J π : 364 γ to 17-, 711 γ to 16-; band assignment.
2658.14 ⁿ 18	18-	B		J π : 258 γ to (16+), 611 γ to (15+); band assignment.
2660.65 ^e 17	(17+)	B		
2672.5 3		B		
2721.43 ^k 22	(16)	B D		J π : 400 γ to (15); band assignment.
2780.53 ^f 20	(17+)	B		J π : 730 γ to (15+).
2787.75 ^d 19	16+	B		J π : 349 γ to 15+; 682.5 γ to 14+; band assignment.
2843.6 ^{&} 4	(16+)	B		J π : 645 γ to (14+); band assignment.
2844.29 ^l 18	(17-)	B f		XREF: f(2880). J π : 340 γ to (16-), 662 γ to (15-); band assignment.
2899.8 ^q 3	(19-)	B Ef	<2 ns	XREF: f(2880). J π : stretched (E1) 311.5 γ to (18+), 742 γ to (17-).
2943.83 ^e 18	(18+)	B		J π : 283 γ to (17+), 534 γ to (16+); band assignment.
2954.5 ^o 3	19-	B		J π : 409 γ to 18-, 797 γ to 17-; band assignment.
2985.5 ^p 3	(19+)	B		J π : 397 γ to (18+); band assignment.
3041.57 ⁿ 20	(19-)	B		J π : 747 γ to 17-; band assignment.
3048.1 3		B		
3141.63 ^k 24	(17)	B		J π : 420 γ to (16); band assignment.
3148.3 ^d 3	17+	B		J π : 362 γ to 16+, 710 γ to 15+; band assignment.
3173.4 3		B		
3175? ^f 4	(18+)	B		
3200.9 ^l 4	(18-)	B		J π : 697 γ to (16-); band assignment.
3253.51 ^e 19	(19+)	B		J π : 310 γ to (18+), 593 γ to (17+); band assignment.
3309.1 ^q 3	(20-)	B E		J π : (M1) 409 γ to (19-); band assignment.
3383.9 ^o 3	20-	B		J π : 429 γ to 19-, 838 γ to 18-; band assignment.
3400.5 ^p 3	(20+)	B		J π : 415 γ to (19+), 812 γ to (18+); band assignment.
3435.4 ⁿ 3	(20-)	B		J π : 777 γ to 18-; band assignment.

Continued on next page (footnotes at end of table)

Adopted Levels, Gammas (continued) ^{180}Ta Levels (continued)

E(level) [†]	J π	XREF	T _{1/2} [‡]	Comments
3435.9 11		B		
3532.7 3		B		
3584.8? f 13	(19+)	B		J π : 804 γ to (17+); band assignment.
3678.9 10	(22-)	E	2.0 μ s 5	T _{1/2} : from comparison of 492 γ and 370 γ intensities in 365 γ gated spectrum in $^{180}\text{Hf}(^{238}\text{U},\text{X}\gamma)$.
				J π : (E2) 370 γ to (20-).
				configuration= $\nu 7/2[503]\nu 7/2[514]\nu 9/2[624]$
				$\pi 5/2[402]\pi 7/2[404]\pi 9/2[514]$.
3738.4 q 3	(21-)	B		J π : 429 γ to (20-); band assignment.
3828.7 o 3	21-	B		J π : 445 γ to 20-; band assignment.
3832.2 p 3	(21+)	B		J π : 432 γ to (20+), 847 γ to (19+); band assignment.
3855.5? n 4	(21-)	B		J π : 814 γ to (19-); band assignment.
4170.9 14		E		
x+4169.9 18	(23, 24, 25)		17 μ s 5	E(level): possibly the same level as 4171.0-keV level.
				T _{1/2} : from $\gamma\gamma(t)$ in $^{180}\text{Hf}(^{238}\text{U},\text{X}\gamma)$.
4186.7 q 3	(22-)	B		J π : 448 γ to (21-); band assignment.

[†] From a least-squares fit to E γ 's by evaluator, except where noted.

[‡] From $\gamma\gamma(t)$ in $^{176}\text{Yb}(^{11}\text{B},\alpha 3n\gamma),(^7\text{Li},3n\gamma)$, except where noted.

§ 809.35 and 809.44 may correspond to one common level.

A constant of 40–50 keV was added to the level energy from $^{181}\text{Ta}(d,t)$ by the evaluator for energy scale consistency.

@ 891.9-, 892.8-, and 893.0-keV levels may correspond to one common level.

& (A): K π =1+ band. Configuration= $\pi 7/2[404]\nu 9/2[624]$.

a (B): K=4+ band. Configuration= $\pi 9/2[514]\nu 1/2[521]$.

b (C): K=(5) band.

c (D): K π =7+ band. Configuration= $\pi 5/2[402]\nu 9/2[624]$.

d (E): K π =8+ band. Configuration= $\pi 9/2[514]\nu 7/2[503]$.

e (F): Side band of Band G. Configuration= $\pi 7/2[404]\nu 9/2[624]\otimes \nu^2 i_{13/2}$.

f (G): K π =8+ band. Configuration= $\pi 7/2[404]\nu 9/2[624]$.

g (H): K π =7- band. Configuration= $\pi 7/2[404]\nu 7/2[514]$.

h (I): K π =6- band. Configuration= $\pi 7/2[404]\nu 5/2[512]$.

i (J): K π =0- band. Configuration= $\pi 9/2[514]\nu 9/2[624]$.

j (K): K π =1- band. Configuration= $\pi 7/2[404]\nu 5/2[512]$.

k (L): K π =(14) band, 4-quasiparticle band. Configuration= $\pi 9/2[514]\pi 7/2[404]\pi 5/2[402]\nu 7/2[514]$ or $\pi 9/2[514]\pi 7/2[404]\pi 5/2[402]\nu 7/2[503]$.

l (M): K π =13- band. Configuration= $\pi 7/2[404]\nu 9/2[624]\nu 7/2[514]\nu 3/2[512]$.

m (N): K π =11- band, [9-] $\otimes \gamma$ -vibration.

n (O): K π =9- band. Configuration= $\pi 9/2[514]\nu 9/2[624]$.

o (P): K π =15- band. Configuration= $\nu 9/2[624]$ $\pi 9/2[514]\pi 7/2[404]\pi 5/2[402]$.

p (Q): K π =(18+) band. Configuration= $\nu 9/2[624]\nu 7/2[514]\nu 11/2[615]$ $\pi 9/2[514]$.

q (R): K π =(19-) band. Configuration= $\nu 9/2[624]\nu 7/2[514]\nu 1/2[510]$ $\pi 5/2[402]\pi 7/2[404]\pi 9/2[514]$.

r (S): K π =1+ band. Configuration= $\pi 9/2[514]\nu 7/2[514]$.

s (T): K π =(2+) band. Configuration= $\nu 9/2[624]\pi 5/2[402]$.

t (U): K π =3- band. Configuration= $\pi 7/2[404]\nu 1/2[510]$.

u (V): K π =1- band. Configuration= $\nu 7/2[514]-\pi 5/2[402]$.

v (W): K π =(4-) band. Configuration= $\pi 7/2[404]\nu 1/2[510]$.

w (X): K π =(3-) band. Configuration= $\pi 7/2[404]\nu 1/2[521]$.

 $\gamma(^{180}\text{Ta})$

E(level)	E γ [†]	I γ [†]	Mult. [‡]	δ [‡]	α	Comments
39.54	39.5 1	100				
107.78	107.69 5	100	E1		0.303	B(E1)(W.u.)=6.79 $\times 10^{-6}$ 25.
110.75	71.1 1	100				
130.38	(23)					
171.12	40.65 10	100 18	(M1)		10.25 17	
	63.2	≈ 14				
177.87	100.71 5	100	E1		0.360	B(E1)(W.u.)=2.18 $\times 10^{-6}$ 5.
						Mult.: $\alpha(\text{exp})=2.5$ 3 gives E1+M2 with $\delta=0.242$ 18.
						However, δ value is inconsistent with RUL for M2 transitions.

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Adopted Levels, Gammas (continued) $\gamma(^{180}\text{Ta})$ (continued)

E(level)	$E\gamma^{\dagger}$	$I\gamma^{\dagger}$	Mult. ‡	$\delta^{\ddagger}$	α	Comments
184.92	74.0 1 145.3 [#]	100 =8				
234.35	63.05 15	100	(M1)		2.82 5	
280.12	202.93 12	100				
310.88	125.85 15 200.2 1	100 ≈13				
318.21	83.87 5	100	(M1)		7.23	
320.23	280.7 1 320.2 1	66 4 100	M1 M1+E2	<1.1	0.242 0.14 3	
357.01	179.08 9	100	M1		0.834	B(M1)(W.u.)=5.0×10 ⁻⁵ 4.
370.82	50.6 1 260.1 1 331.3 1 370.8 1	1.7 4 59 4 45 3 100	M1 M1+E2	<1.1	0.297 0.095 20	
374.15	196.32 6	100	M1+E2	4.7 11	0.331 11	Mult.: D+Q from R(DCO) in ¹⁷⁶ Yb(¹¹ B,α3nγ),(⁷ Li,3nγ), Δπ=no from level scheme. δ: from R(DCO) in ¹⁷⁶ Yb(¹¹ B,α3nγ),(⁷ Li,3nγ).
416.32	105.4 1 231.4 1	100 9 44 4				
419.86	101.65 4 185.3 3	100 7 16 3	(M1)		4.16	
423.43	252.33 17 293.0 1 315.59 4 383.82 9	48 14 ≤3.4 100 4 18 4	M1 M1		0.323 0.1760	
447.86	423.5 1 262.8 1 337.2 1 408.4 1	9 2 32 3 25 3 100				
463.62	285.54 12	100	E1		0.0249	B(E1)(W.u.)=2.85×10 ⁻⁷ 18. δ: <0.3 from α(K)exp in ¹⁷⁶ Yb(¹¹ B,α3nγ)(⁷ Li,3nγ). Other: 0.65 19 from α(exp) also in ¹⁷⁶ Yb(¹¹ B,α3nγ)(⁷ Li,3nγ) gives M2 strength inconsistent with RUL.
478.11	54.6 3 243.74 5 307.2 1 347.4 3 438.7 1 478.2 1	100 18 32 3 ≤12 30 4 34 7 46 9				
505.28	225.20 6 428.12 8	100 3 22.4 9	M1+E2 (E2)	0.4	0.408 0.0301	Mult.: D+Q from R(DCO) in ¹⁷⁶ Yb(¹¹ B,α3nγ),(⁷ Li,3nγ), Δπ=no from level scheme. δ: from R(DCO) in ¹⁷⁶ Yb(¹¹ B,α3nγ),(⁷ Li,3nγ). δ: Q from R(DCO) in ¹⁷⁶ Yb(¹¹ B,α3nγ),(⁷ Li,3nγ), E2 from assumed band structure.
508.1?	378 [#]	100				
515.80	158.75 7 337.91 7 438.6 1	24 5 100 4 6.7 9	(M1) M1+E2 [E1]		1.170 0.116 11 0.00912	B(M1)(W.u.)>0.00077. B(E2)(W.u.)>0.28; B(M1)(W.u.)>0.00018. B(E1)(W.u.)>9.9×10 ⁻⁸ .
520.04	(71.8) 209.2 1 335.2 1 409.07 14	17 4 16 3 100 20	M1+E2 [M1] M1	0.8 4	0.43 8 0.1497 0.0882	B(E2)(W.u.)=0.027 19; B(M1)(W.u.)=4.4×10 ⁻⁶ 22. B(M1)(W.u.)=1.7×10 ⁻⁶ 4. B(M1)(W.u.)=5.7×10 ⁻⁶ 15.
x+519.0	x [#]					Eγ: x=72.2 in ¹⁷⁶ Yb(¹¹ B,α3nγ),(⁷ Li,3nγ). A 72.2-keV transition is not supported by ce data of ¹⁸⁰ Hf(p,nγ),(d,2nγ), which propose x≤80.
538.5?	114 [#]	100				
544.20	66.14 18 120.8 1 226.04 5 309.7 1	52 9 =2 13 2 ≤7				

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Adopted Levels, Gammas (continued) $\gamma(^{180}\text{Ta})$ (continued)

E(level)	$E\gamma^{\dagger}$	$I\gamma^{\dagger}$	Mult. ‡	α	Comments
544.20	373.0 1	100 6	M1	0.1126	
547.84	127.79 10	100 4	(M1)	2.16	
	229.7 5	5.9 10			
547.90	237.0 1	21 4			
	437.2 1	100 20			
549.32	(71.3)		(M1)	11.49	
	378.2 1				
559.50	188.8 1	2.0 4			
	239.2 1	13 3	(M1, E2)	0.27 11	
	429.3 1	≤ 15			
	448.7 1	53 11			
	519.9 1	100 20			
	559.6 1	23 5			
574.86	111.3 1	50 10	M1(+E2)	2.8 4	
	217.88 5	100 20	[E1]	0.0489	B(E1)(W.u.) $>3.5\times 10^{-6}$.
575.80	218.75 25	73 9			
	398.1 1	100 7			
595.40	221.20 5	69 3			
	417.5 1	100 4	E2	0.0321	
600.30	183.9 1	100 5			
	289.45 15	22.0 22			
624.13	64.63		(M1)	2.62	E γ : observed only in ce spectrum.
	176.2 1	22 5			
	253.3 1	78 16			
	303.9 1	63 13			
	624.3 1	100 20			
641.55	121.5 2	100			
645.63	101.4 1	100 $\S$			
	411.3 1	100 $\S$			
653.50	175.5 1	28 $\S$			
	230.1 1	100 $\S$			
	282.6 1	27 $\S$			
	333.2 1	51 $\S$			
658.37	114.15 15	100	(M1)	2.99	
x+659.8	140.8 1	100			
663.79	114.5 1	100 $\S$	(M1)	2.96	
	429.4 1	$\approx 70\mathcal{S}$			
672.04	152.0 1	100			
676.36	128.5 1				
	491.4 1				
680.64	217.0 2	100			
684.3	327.3 4	100			
686.06	138.21 5	100 4			
	266.4 1	8.0 10			
708.11	158.7 1	6 $\S$			
	260.4 1	32 $\S$			
	284.7 1	100 $\S$			
	337.2 1	15 $\S$			
	387.9 1	60 $\S$			
721.86	172.6 1	20 $\S$	[M1]	0.925	B(M1)(W.u.)=0.00013.
	177.68 5	100 $\S$	[M1]	0.853	B(M1)(W.u.)=0.00058.
723.45	147.8 3	1.3 4			
	207.6 1	100 4			
	349.15 15	21.5 12			
	366.4 4	8.5 10			
	546.0 2	4.2 11			
729.64	88.1 1	≈ 1			
	209.6 1	100			
731.16	412.9 1	55 $\S$			
	560.1 1	100 $\S$			
735.22	134.9 1	100 4			
	318.95 15	93 5			
738.54	96.9 1	20 4			

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Adopted Levels, Gammas (continued) $\gamma(^{180}\text{Ta})$ (continued)

E(level)	$E\gamma^{\dagger}$	$I\gamma^{\dagger}$	Mult. ‡	α	Comments
738.54	218.6 1	100 10			
752.42	247.10 14	100 3			
	472.3 1	55.0 18			
756.80	181.9 1	100			
763.62	188.75 15	89 9			
	300.0 1	100 10			
775.8?	668 [#]	100			
784.33	466.0 1	53 [§]			
	550.1 1	100 [§]			
787.24	145.65 10	100 7			
	267.22 14	10.1 19			
787.94	417.0 1	100			
788.41	310.3 1	100			
792.54	120.5 1	100			
806.95	231.1 1	100 6	(M1)	0.411	Mult.: D from R(DCO) in $^{176}\text{Yb}(^{11}\text{B},\alpha 3n\gamma),(^7\text{Li},3n\gamma)$; $\Delta\pi=\text{no}$ from assumed band structure.
	291.0 2	19 3			
	432.9 1	76 5			
	449.80 10	24 3			
	629.3 16	14 4			
809.39	151.0 1	100 [§]			
	265.2 1	100 [§]			
809.44	289.4 1	100			
x+821.4	161.54 7	100 7			
	302.1 3	29 7			
830.70	255.8 1	81			
	367.1 1	≈ 5			
	473.7 1	100			
836.16	261.3 1	100			
840.99	245.5 1	22.1 8			
	467.0 1	100 3			
857.11	171.2 2	100 3			
	309.1 1	8.4 9			
862.1	181.5 2	100			
863.91	343.8 1	100			
865.86	291.0 1	100			
876.80	398.8 1	13 [§]			
	453.3 1	100 [§]			
	556.7 1	16 [§]			
	705.5 1				
880.65	256.6 1	100 [§]			
	321.4 1	58 [§]			
	456.9 1	70 [§]			
884.15	154.5 1				
	242.6 1				
891.94	316.5 4	100 20			
	534.9 1	8 2			$I\gamma$: from $^{180}\text{Hf}(p,n\gamma), (d,2n\gamma)$. Other: 240 60 in $^{176}\text{Yb}(^{11}\text{B},\alpha 3n\gamma), (^7\text{Li},3n\gamma)$.
892.76	170.9 1	100			
893.04	154.5 1	100	(M1)	1.263	
906.43	149.6 1	≈ 10			
	331.6 1	100			
907.35	119.3 1	27 [§]			
	185.6 1	100 [§]			
915.90	492.4 1	42 [§]			
	545.2 1	22 [§]			
	595.6 1	100 [§]			
922.82	241.95 15	100 6			
	459.1 1	80 7			
935.07	457.0 1	100 [§]			
	614.8 1	70 [§]			
938.84	146.3 1	100	(M1)	1.473	
951.50	528.0 1	89 [§]			

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Adopted Levels, Gammas (continued) $\gamma(^{180}\text{Ta})$ (continued)

E(level)	$E\gamma^{\dagger}$	$I\gamma^{\dagger}$	Mult. ‡	α	Comments
951.50	580.7 1	100 §			
	631.3 1	95 §			
956.34	232.8 1	100 4			
	440.5 1	36.8 20			
	582.4 2	7.3 13			
956.59	169.3 1	100 7			
	315.2 2	42 7			
976.64	211.5 # 15	≤ 26			
	295.77 15	83 26			
	402.0 1	100 30			
	512.9 1				
977.03	241.8 1	100 4			
	376.7 1	35.4 22			
991.64	350.2 1	100 20			
	471.5 1	51 10			
996.49	548.6 1	61 §			
	625.7 1	100 §			
x+1003.9	182.3 2	100 7			
	344.1 1	60 10			
1016.7	186.0 3	100			
1020.73	268.23 10	100 3			
	515.45 15	93 3			
1030.64	173.5 1	100 3			
	344.70 10	14.3 12			
1035.0?	678 #	100			
1037.03	666.2 1	84 §			
	716.8 1	100 §			
1043.14	523.1 1	100			
1053.6	169.5	100			
1057.17	250.0 1	100 6			
	333.9 4	11 3			
	461.7 1	30 4			
	481.50 9	32 4	(E2)	0.0222	Mult.: Q from R(DCO) in $^{176}\text{Yb}(^{11}\text{B},\alpha 3n\gamma),(^7\text{Li},3n\gamma)$.
1100.75	459.2 1	100			
1110.08	268.9 1	15.1 7			
	514.6 1	100 3			
1113.09	665.2 1	100 §			
	742.3 1	63 §			
1141.09	164.0 1	60 3			
	405.9 1	100 5			
1149.54	192.9 3	100 11			
	362.3 1	83 13			I γ : from $^{176}\text{Yb}(^{11}\text{B},\alpha 3n\gamma),(^7\text{Li},3n\gamma)$. Other: 190 40 from $^{180}\text{Hf}(p,n\gamma),(d,2n\gamma)$.
1175.02	894.9 1	100			
1189.24	266.2 1	47 4			
	508.8 1	100 6			
1205.18	341.2 1	=60			
	685.2 1	100			
x+1205.2	200.8 1	84 8			
	383.7 1	100 9			
1212.48	256.0 1	100 4			
	489.1 1	75 4			
1216.3	452.7 3	100			
1241.20	210.7 2	100 4			
	384.0 1	10.8 11			
1252.76	878.6 1	100			
1270.86	896.7 2	100			
1293.42	1013.3 2	100			
1309.82	288.84 12	77 3			
	557.53 12	100 3	(E2)	0.01543	Mult.: Q from $\gamma(0)$ in $^{176}\text{Yb}(^{11}\text{B},\alpha 3n\gamma),(^7\text{Li},3n\gamma)$; E2 from assumed band structure.
1327.04	269.7 1	100 6			
	520.2 1	90 7			

Continued on next page (footnotes at end of table)

Adopted Levels, Gammas (continued) $\gamma(^{180}\text{Ta})$ (continued)

E(level)	$E\gamma^{\dagger}$	$I\gamma^{\dagger}$	Mult. ‡	α	Comments
1339.09	1058.8 2	6.2 8			
	1261.9 1	100 16			
1353.9	178.9 2	100			
1363.8	214	≈ 75			
	407.5	≈ 100			
1389.58	884.3 2	100			
1401.78	291.3 1	10.7 8			
	561.0 1	100 4			
x+1425.7	220.0 2	56 11			
	422.0 1	100 13			
1435.83	294.7 1	100 5			
	458.8 1	67 4			
1447.28	205.9 1	100 4			
	416.7 1	23.2 21			
1452.39	142.7 3	7.5 18	M1	1.581	B(M1)(W.u.)= 1.5×10^{-8} 4.
	431.6 2	100	[E2]	0.0294	B(E2)(W.u.)= 1.64×10^{-5} 10.
1463.72	1183.6 2	100			
1479.09	289.8 1	34 6			
	556.3 1	100 9			
1490.36	277.6 1	71 3			
	534.1 1	100 5			
1541.79	202.7 1	100			
1546.71	1042.3 3	35 8			
	1266.2 2	100 14			
1573.52	1293.4 2	100			
1580.0	1300.8	100			
1597.43	258.3 1	48 21	E2	0.1298	B(E2)(W.u.)>2.1. Mult.: Q from R(DCO) in $^{176}\text{Yb}(^{11}\text{B},\alpha 3n\gamma),(^{7}\text{Li},3n\gamma)$, RUL excludes M2.
	845.0 1	33.2 16	[M1]	0.01365	B(M1)(W.u.)> 6.4×10^{-6} .
	1092.2 1	100 4	E2	0.00360	B(E2)(W.u.)>0.0032. Mult.: Q from $\gamma(0)$ in $^{176}\text{Yb}(^{11}\text{B},\alpha 3n\gamma),(^{7}\text{Li},3n\gamma)$; assumed E2.
1616.49	289.3 1	100 9			
	559.6 2	68 10			
1618.94	308.9 1	49.3 21			
	598.3 1	100 3			
1630.58	194.7 1	50 3			
	489.5 1	100 5			
x+1662.3	236.8 2	22 8			
	457.3 1	100 13			
1671.59	332.5 1	100 11			
	1391.5 2	94 14			
1698.99	251.6 1	100 4			
	457.9 1	26.4 21			
1708.23	1334.1 1	100			
1715.55	313.5 1	6.2 5			
	605.6 1	100 4	(E2)	0.01268	Mult.: Q from R(DCO) in $^{176}\text{Yb}(^{11}\text{B},\alpha 3n\gamma),(^{7}\text{Li},3n\gamma)$, E2 from assumed band structure.
1788.38	297.9 1	37 3			
	576.1 1	100 5			
1790.80	311.5 4	13 4			
	601.6 1	100 8			
1792.24	339.8 1	100	(M1)	0.1443	Mult.: D from R(DCO) in $^{176}\text{Yb}(^{11}\text{B},\alpha 3n\gamma),(^{7}\text{Li},3n\gamma)$; (M1) from assumed band structure.
1805.85	1052.7 5	15 5			
	1300.6 1	100 8			
1841.39	1090	≈ 100			
	1336.1 1	≈ 100			
1863.5	1358.2 3	100			
1880.07	282.6 1	100			
1904.54	307.1 1	≈ 86			
	325.5	≈ 100			
1904.63	502.8 1	70 6			

Continued on next page (footnotes at end of table)

Adopted Levels, Gammas (continued) $\gamma(^{180}\text{Ta})$ (continued)

E(level)	$E\gamma^{\dagger}$	$I\gamma^{\dagger}$	Mult. ‡	α	Comments
1904.63	794.2 8	12 5			
	1063.7 1	100 10			
1924.97	308.2 2	27 5			
	598.0 1	100 8			
1941.63	344.2 1	100	D		Mult.: from R(DCO) in $^{176}\text{Yb}(^{11}\text{B},\alpha 3\text{n}\gamma),(^7\text{Li},3\text{n}\gamma)$.
1941.79	242.8 1	100 4			
	494.7 11	4.2 24			
1947.12	328.0 1	41.0 20			
	637.4 1	100 4			
1968.52	337.9 1	100 11			
	532.7 1	93 10			
1970.93	262.7 1	100			
2006.28	896.2 2	100			
2050.43	648.8 1	100			
2071.23	473.8 2	100			
2105.26	316.8 1	25 3			
	614.8 1	100 5			
2123.6	335	≈ 50			
	644.4 2	≈ 100			
2124.93	1372.5 2	100			
2157.26	364.9 1	100 3			
	705.4 4	2.3 8			
2160.1	1407.7 4	100			
2182.70	302.4 1	100 6			
	585.3 1	61 7			
2186.9	282.4 3	100			
2198.48	567.9 1	100			
2258.7	290.1 2	100 22			
	553.5 10	29 22			
2294.36	347.0 1	36 3			
	675.5 1	100 4			
2321.03	379.4 1	100	D		Mult.: from R(DCO) in $^{176}\text{Yb}(^{11}\text{B},\alpha 3\text{n}\gamma),(^7\text{Li},3\text{n}\gamma)$.
2328.0	875.7 11	100			
2341.6	373.1 2	100			
2354.5	474.4 2	100			
2402.61	687.0 1	100			
2410.24	694.6 1	100			
2438.50	332.5 2	38 7			
	650.3 1	100 9			
2452.6	1435.9 3	100			
2504.19	321.3 1	68 7			
	624.3 1	100 8			
2545.3	388.0 1	100 5			
	753.0 1	16.3 23			
2561.2	770.4 2	100			
2568.62	600.1 1	100			
2588.3	431.07 9	100	(E1)	0.00948	B(E1)(W.u.)= 1.11×10^{-7} 11. Mult.: D from R(DCO) in $^{176}\text{Yb}(^{11}\text{B},\alpha 3\text{n}\gamma),(^7\text{Li},3\text{n}\gamma)$, $\Delta\pi=\text{yes}$ from level scheme.
	1136.8	≈ 7	[E3]	0.00710	
2658.14	363.6 1	29 4			
	711.2 1	100 5			
2660.65	250.2 1	99 9			
	257.8 1	100 9			
	610.8 2	60 9			
2672.5	344.6 8	6 3			
	880.4 1	100 8	(D)		Mult.: from R(DCO) in $^{176}\text{Yb}(^{11}\text{B},\alpha 3\text{n}\gamma),(^7\text{Li},3\text{n}\gamma)$.
2721.43	400.4 1	100			
2780.53	730.1 1	100			
2787.75	349.0 9	22 12			
	682.5 1	100 12			
2843.6	645.1 3	100			
2844.29	339.8 6	27 12			

Continued on next page (footnotes at end of table)

Adopted Levels, Gammas (continued) $\gamma(^{180}\text{Ta})$ (continued)

E(level)	$E\gamma^\dagger$	$I\gamma^\dagger$	Mult. ‡	α	Comments
2844.29	661.6 1	100 13			
2899.8	311.5 1	100 5	(E1)	0.0202	B(E1)(W.u.) $>2.9\times 10^{-6}$. Mult.: D from R(DCO) in $^{176}\text{Yb}(^{11}\text{B},\alpha 3n\gamma),(^7\text{Li},3n\gamma)$, $\Delta\pi=\text{yes}$ from level scheme.
	354.4 2	12.1 19	[M1]	0.1290	B(M1)(W.u.) $>2.4\times 10^{-5}$.
	742.4 6	6.2 25	[E2]	0.00801	B(E2)(W.u.) >0.0011 .
2943.83	282.9 1	57 9			
	533.7 1	100 10			
	541.4 1	90 9			
2954.5	409.2 1	100 7			
	797.4 1	37 5			
2985.5	397.1 1	100			
3041.57	747.2 1	100			
3048.1	376.3 2	49 9			
	890.7 1	100 17			
3141.63	420.2 1	100			
3148.3	361.9 13	52 22			
	709.7 3	100 26			
3173.4	770.8 3	100			
3175?	765 [#] 4	100			
3200.9	696.7 4	100			
3253.51	309.7 1	73 13			
	592.8 2	100 13			
3309.1	409.3 1	100	(M1)	0.0880	Mult.: D from R(DCO) in $^{176}\text{Yb}(^{11}\text{B},\alpha 3n\gamma),(^7\text{Li},3n\gamma)$, (M1) from assumed band structure.
3383.9	429.4 1	100 14			
	838.2 2	68 10			
3400.5	415.0 1	100 9			
	812.4 2	85 10			
3435.4	777.3 3	100			
3435.9	890.6 11	100			
3532.7	632.9 1	100			
3584.8?	804.3 [#] 13	100			
3678.9	369.8	100	(E2)	0.0448	B(E2)(W.u.)=0.00065 17. Mult.: E2 or E3 from $\alpha(\text{exp})$ in $^{180}\text{Hf}(^{238}\text{U},\text{X}\gamma)$; E3 excluded by comparison to RUL.
3738.4	429.3 1	100			
3828.7	444.8 1	100			
3832.2	432.1 3	48 14			
	846.5 2	100 14			
3855.5?	813.9 [#] 4	100			
4170.9	492.0	100			
x+4169.9	x				$E\gamma$: x<60 keV.
4186.7	448.3 1	100			

[†] Weighted average of all available data, except where noted.[‡] From ce data in $^{176}\text{Yb}(^{11}\text{B},\alpha 3n\gamma),(^7\text{Li},3n\gamma)$ and $^{180}\text{Hf}(p,n\gamma),(d,2n\gamma)$, except where noted.[§] From $^{180}\text{Hf}(p,n\gamma),(d,2n\gamma)$ where authors (2002We01) state the values are indicative only.[#] Placement of transition in the level scheme is uncertain.

¹⁸⁰Hf β⁻ Decay (5.53 h) 1985Ke02,1992Ke04

Parent ¹⁸⁰Hf: E=1141.552 15; Jπ=8-; T_{1/2}=5.53 h 2; Q(g.s.)=-846 3; %β⁻ decay=0.31 8.

1985Ke02: ^{180m}Hf activity from thermal neutrons on ¹⁷⁹Hf. Measured Eγ, Iγ, γγ using Ge(Li) detector surrounded by 4πNaI array used as a veto for high multiplicity γ cascades from ^{180m}Hf IT decay.

1992Ke04: Similar experimental setup as 1985Ke02. Included a Si surface-barrier detector for measuring Eβ, Iβ and for vetoing conversion electrons from ^{180m}Hf IT decay.

A total energy release of 0.68 keV 21 is calculated for this decay scheme using the RADLST code, in agreement with the effective Q value of 0.9 keV 3.

¹⁸⁰Ta Levels

E(level) [†]	Jπ [†]	T _{1/2} [†]
0.0	1+	8.154 h 6
77.2 12	9-	>7.1×10 ¹⁵ y
177.87 11	8+	70.0 ns 14

[†] From the Adopted Levels.

β⁻ radiations

Eβ ⁻	E(level)	Iβ ^{-†}	Log ft	Comments
(118 3)	177.87	0.023 3	6.80 16	Iβ ⁻ : from absolute intensity of 100.7γ and α(100.7γ).
(218 4)	77.2	0.29 8	6.53 19	Iβ ⁻ : measured value reported as 0.29 5, with an additional systematic uncertainty of 0.06 (1992Ke04). Other: <1.4 from earlier measurement in 1985Ke02.

[†] For β⁻ intensity per 100 decays, multiply by 1.0 3.

γ(¹⁸⁰Ta)

Iγ normalization: As given in 1985Ke02 from experimental ratio of Iγ(100.7γ) to Iγ(93.3γ) in ¹⁸⁰Hf.

Eγ [‡]	E(level)	Iγ [§]	Mult. [†]	α
100.70 5	177.87	100	E1	0.360

[†] From the Adopted Gammas.

[‡] From 1985Ke02.

[§] For absolute intensity per 100 decays, multiply by 0.00017 5.

Decay Scheme

$^{176}\text{Yb}(^{11}\text{B},\alpha 3n\gamma),(^7\text{Li},3n\gamma)$ 1999Sa59,1998Dr07

2000Dr11: $^{176}\text{Yb}(^7\text{Li},3n\gamma)$, $E(^7\text{Li})=28$ MeV. Measured $E(\text{ce})$, $I(\text{ce})$, $E\gamma$, and $I\gamma$ using a superconducting solenoidal spectrometer operated in lens mode and a Compton-suppressed Ge detector. Revisions to the level scheme from 1998Dr07 are also given; some changes are based on the new results from 2000Dr11 and some are corrections of typographical errors.

1999Sa59: $^{176}\text{Yb}(^{11}\text{B},\alpha 3n\gamma)$, $E(^{11}\text{B})=52$ MeV for PEX array and 55, 57 MeV for NORDBALL array. Measured $E\gamma$, $I\gamma$, $\gamma\gamma$, $\gamma\gamma-\alpha$, $\gamma\gamma(\theta)(\text{DCO})$, and $\gamma\gamma(t)$ using PEX array and NORDBALL array. PEX array consisted of four Compton-suppressed Euroball Cluster detectors, one Clover detector, and 25 silicon detectors. The NORDBALL array consisted of 18 Compton-suppressed coaxial Ge detectors, two LEPS detectors, and 30 silicon detectors. Configuration assignments using BCS calculations.

1998Dr07, 1996Dr02: $^{176}\text{Yb}(^{11}\text{B},\alpha 3n\gamma)$, $E(^{11}\text{B})=55,65$ MeV and $^{176}\text{Yb}(^7\text{Li},3n\gamma)$, $E(^7\text{Li})=28$ MeV. Measured $E\gamma$, $I\gamma$, $\gamma\gamma(t)$, $\gamma(\theta)$, $\gamma\gamma$, and $\gamma-\alpha$ coincidences using the CAESAR array consisting of six Compton-suppressed HPGe detectors and a particle array with 14 fast/slow plastic combinations.

The level schemes of 1999Sa59 and 1998Dr07/2000Dr11 are in overall good agreement. Major discrepancies are noted in the comments. As the level scheme of 1999Sa59 is more extensive, it is in general adopted here.

 ^{180}Ta Levels

$E(\text{level})^\dagger$	$J\pi^\ddagger$	$T_{1/2}^\S$	Comments
0.0#	1+		
39.50# 10	2+		
77.1d 8	9-		
107.60i 10	0-	19.2 ns 7	$T_{1/2}$: weighted average of 23 ns 2 (1999Sa59) and 18.7 ns 7 (1998Dr07), both from $\gamma\gamma(t)$.
110.50# 15	3+		
130.48i 19	1-		
171.00i 17	2-		
177.76b 8	8+	70.0 ns 14	$T_{1/2}$: other: 50 ns 19 from $\gamma\gamma(t)$ in 1999Sa59.
184.34# 17	4+		
233.90i 20	3-		
279.93d 7	10-		
310.05# 18	5+		
317.80i 23	4-		
356.95 9	7+	42 ns 3	$K\pi=7+$, $\pi 5/2[402]v9/2[624]$. $T_{1/2}$: weighted average of 55 ns 12 (1999Sa59) and 41 ns 3 (1998Dr07), both from $\gamma\gamma(t)$.
374.03b 10	9+		
415.44# 19	6+		
419.51i 25	5-		
423.00j 15	1-		
463.07c 13	7-	31.2 ns 19	$T_{1/2}$: weighted average of 35 ns 5 (1999Sa59) and 30.5 ns 21 (1998Dr07), both from $\gamma\gamma(t)$.
477.46j 21	2-		
505.03d 7	11-		
508.1? 3	(2)		$E(\text{level})$: reported only in 2000Dr11.
515.64a 8	8+	<1 ns	
519.36@ 17	4+	37.4 ns 20	$T_{1/2}$: weighted average of 48 ns 8 (1999Sa59) and 36.7 ns 21 (1998Dr07), both from $\gamma\gamma(t)$. $J\pi$: assignment from 2000Dr11 based on $M1$ 409 γ to 3+. $J\pi$ assignment of 4(-) and 4 in 1998Dr07 and 1999Sa59, respectively.
538.5? 3	(2)		$E(\text{level})$: reported only in 2000Dr11, 1998Dr07.
543.73j 20	(3-)		
547.3i 3	6-		
574.22h 15	6-	<2 ns	
575.64e 10	8+	<1 ns	
591.6& 11	(5+)	16.1 ns 19	$T_{1/2}$: weighted average of 13 ns 5 (1999Sa59) and 16.6 ns 21 (1998Dr07), both from $\gamma\gamma(t)$. $J\pi$: proposed as (5-) in 1998Dr07 and 1999Sa59 based on tentative 4(-) assignment to 519.4-keV level.
595.26b 10	10+		
599.35# 19	7+		
641.18@ 19	5+		
657.73j 22	(4-)		
679.97c 15	8-		
683.85 14	(6)		$J\pi$: assignment from 1998Dr07.
685.7i 3	7-		
722.6? 5	(4)		$E(\text{level})$: 732.6 in Table 1 of 1998Dr07 seems a misprint. Level reported only by 1998Dr07, 2000Dr11.
723.21a 10	9+		
732.2& 11	(6+)		$J\pi$: proposed as (6-) in 1998Dr07 and 1999Sa59 based on (5-) assignment to 591.6-keV level.
734.22# 20	8+		
752.12d 9	12-		

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$^{176}\text{Yb}(^{11}\text{B},\alpha 3n\gamma),(^7\text{Li},3n\gamma)$ 1999Sa59,1998Dr07 (continued) ^{180}Ta Levels (continued)

E(level) [†]	J π [‡]	T _{1/2} [§]	Comments
762.89 ^h 15	7-		
775.8? 11	(2)		E(level): level reported only by 1998Dr07, 2000Dr11.
786.85 [@] 21	6+		
806.77 ^e 10	9+		
830.75 14	(6)		J π : assignment from 1998Dr07.
840.74 ^b 11	11+		
856.6 ⁱ 3	8-		
865.35 25	(7)		J π : assignment from 1998Dr07.
890.32 18	(7)		J π : assignment from 1998Dr07.
893.9 ^{&} 11	(7+)		J π : proposed as (7-) in 1998Dr07 and 1999Sa59 based on (6-) assignment to 732.2-keV level.
907.0 11	(7)		E(level): level reported only by 1998Dr07.
922.08 ^c 15	9-		
956.13 ^a 10	10+		
956.16 [@] 22	7+		
975.5 ^h 4	8-		
976.01 [#] 20	9+		
1016.45 17	(7)		J π : assignment from 1998Dr07.
1020.44 ^d 10	13-		
1030.2 ⁱ 3	9-		
1035.0? 11	(7)		E(level): level reported only by 1998Dr07.
1057.00 ^e 10	10+		
1076.2 ^{&} 11	(8+)		J π : proposed as (8-) in 1998Dr07 and 1999Sa59 based on (7-) assignment to 893.9-keV level.
1109.87 ^b 12	12+		
1140.07 [#] 21	10+		
1148.72 [@] 24	8+		
1174.84 ^o 13	(11)		J π : assignment from 1998Dr07.
1188.54 ^c 16	10-		
1212.27 ^a 11	11+		
1215.6 ^h 4	9-		
1240.7 ⁱ 3	10-		
1252.64 14			
1270.73 22			
1277.4 ^{&} 11	(9+)		J π : proposed as (9-) in 1998Dr07 and 1999Sa59 based on (8-) assignment to 1076.2-keV level.
1293.24 22			
1309.49 ^d 11	14-		
1326.87 ^e 12	11+		
1338.93 ⁿ 8	11-		
1353.74 24			
1363.9 [@] 5	9+		E(level): reported only in 1998Dr07, 2000Dr11.
1389.34 ^o 22			
1401.55 ^b 13	13+		
1434.80 [#] 21	11+		
1446.8 ⁱ 3	11-		
1452.0 ^r 8	15-	31.2 μs 14	T _{1/2} : from $\gamma\gamma(t)$ in 1996Dr02. Other: 30 μs 8 from $\gamma\gamma(t)$ in 1999Sa59.
1463.54 22			
1478.37 ^c 17	11-		
1490.15 ^a 12	12+		
1498.0 ^{&} 11	(10+)		J π : proposed as (10-) in 1998Dr07 and 1999Sa59 based on (9-) assignment to 1277.4-keV level.
1541.63 13			
1546.51 ⁿ 18	(12)		
1573.34 22			
1580.7 4	(12)		E(level): reported only by 1998Dr07.
1597.20 ^m 9	13-	<1 ns	T _{1/2} : Other: <2.4 ns from $\gamma\gamma(t)$ in 1998Dr07.
1616.31 ^e 14	12+		
1618.62 ^d 12	15-		
1629.55 [#] 22	12+		E(level): as proposed in 1999Sa59. The 12+ member of the 1+ ground state band is proposed in 1998Dr07, 2000Dr11 at 1774 keV with two tentative depopulating transitions of 337 keV and 532 keV. Both transitions are placed as depopulating the 1967-keV level (13+ member of the 1+ g.s. band) in 1999Sa59.
1671.43 ^p 12	(12)		J π : assignment from 1998Dr07.
1698.5 ⁱ 3	12-		
1708.14 ^g 14	11(+)	<1 ns	

Continued on next page (footnotes at end of table)

$^{176}\text{Yb}(^{11}\text{B},\alpha 3n\gamma),(^7\text{Li},3n\gamma)$ 1999Sa59,1998Dr07 (continued) ^{180}Ta Levels (continued)

E(level) [†]	J $\pi^{\ddagger}$	T _{1/2} [§]	Comments
1715.34 ^b 14	14+		
1734.7 ^{&} 11	(11+)		J π : proposed as (11-) in 1998Dr07 and 1999Sa59 based on (10-) assignment to 1498.0-keV level.
1788.16 ^a 13	13+		
1790.12 ^c 19	12-		
1791.9 ^r 8	16-		
1805.61 ⁿ 12	(13)		
1841.14 13	(13-)		J π : assignment from 1998Dr07.
1863.2 ^p 3			
1879.83 ^m 12	14-		
1904.20 ^l 14	13		
1904.40 14			
1924.80 ^e 15	13+		
1941.3 ⁱ 3	13-		
1941.40 ^k 14	14(+)	<1 ns	
1946.80 ^d 13	16-		
1967.47 [#] 23	13+		
1970.84 ^g 17	12(+)		
2006.08 24			
2050.21 ^b 16	15+		
2071.00 22			
2105.05 ^a 14	14+		
2122.8 ^c 3	13-		
2124.63 ⁿ 22	(14)		
2156.9 ^r 8	17-		
2159.8 ^p 4			
2182.46 ^m 12	15-		
2186.6 ^l 4	14		
2197.45 [#] 24	14+		
2261.0 ^g 3	13(+)		
2294.05 ^d 13	17-		
2320.80 ^k 17	15(+)		
2327.6 ^q 10	(16+)		
2343.9 3			
2354.24 24			
2402.39 ^f 16	16+		E(level): band assignment from 1999Sa59. 1998Dr07 identify level as member of $\nu 9/2[624]\pi 7/2[404]$ band.
2410.03 ^b 16	16+		E(level): band assignment from 1999Sa59. Not assigned to a particular band structure in 1998Dr07.
2438.29 ^a 16	15+		
2456.3 ^p 4			
2503.95 ^m 13	16-		
2544.9 ^r 8	18-		
2562.3 8			
2567.58 [#] 25	15+		
2587.9 ^s 8	18(+)	22 ns 2	T _{1/2} : weighted average of 22 ns 5 (1999Sa59) and 22 ns 2 (1998Dr07), both from $\gamma\gamma(t)$.
2657.82 ^d 15	18-		
2660.43 ^f 16	17+		
2672.1 ^q 8	(17+)		
2721.20 ^k 20	16(+)		
2780.31 ^b 19	17+		
2787.54 ^a 17	16+		
2842.5 [#] 4	16+		
2844.05 ^m 16	17-		E(level): as proposed by 1999Sa59. The 17- band member is reported at 2860 keV and decaying by a 676 γ in 1998Dr07.
2899.4 ^t 8	19-	<2 ns	
2943.61 ^f 16	18+		
2954.2 ^r 8	19-		
2985.1 ^s 8	19(+)		
3041.25 ^d 17	19-		
3047.8 ^q 8	(18+)		
3141.40 ^k 22	17(+)		

Continued on next page (footnotes at end of table)

¹⁷⁶Yb(¹¹B,α3nγ),(⁷Li,3nγ) 1999Sa59,1998Dr07 (continued)

¹⁸⁰Ta Levels (continued)

E(level) [†]	Jπ [‡]	Comments
3148.1 ^a 4	17+	E(level): as proposed by 1999Sa59. The 17+ band member is reported at 3136 keV and decaying by a tentative 696γ in 1998Dr07.
3173.7 ^b 4	18+	
3173.2 4		
3200.7 ^m 5	18-	
3253.29 ^f 18	19+	
3308.6 ^t 8	20-	
3383.5 ^r 8	20-	
3400.1 ^s 8	20(+)	
3435.1 ^d 4	20-	
3435.5 ^q 14	(19+)	
3532.3 8		
3582.9 ^b 14	(19+)	
3738.0 ^t 8	21-	
3828.3 ^r 8	21-	
3831.8 ^s 8	21(+)	
3853.4 ^d 5	(21-)	
4186.3 ^t 8	22-	E(level): as proposed by 1999Sa59. A (22), 4201-keV level decaying by a 462γ is proposed by 1998Dr07.

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

[‡] From multiplicities of γ transitions and assumed band structure. The Jπ assignments from 1999Sa59 and 1998Dr07/2000Dr11 are in good agreement; exceptions are noted in the comments.

§ From γγ(t) in 1999Sa59, except where noted.

(A): Kπ=1+ band, π7/2+[404]v9/2+[624].

@ (B): K=4+ band, π9/2-[514]v1/2-[521].

& (C): K=(5+) band, π9/2-[514]v1/2-[510] (2000Dr11).

a (D): Kπ=8+ band, π9/2-[514]v7/2-[503].

b (E): Kπ=8+ band, π7/2+[404]v9/2+[624].

c (F): Kπ=7- band, π7/2+[404]v7/2-[514].

d (G): Kπ=9- band, π9/2-[514]v9/2+[624].

e (H): Kπ=8+ band, π9/2-[514]v7/2-[514].

f (I): Kπ=8+ band, π7/2+[404]v9/2+[624]⊗[v_{i13/2}²].

g (J): Kπ=11+ band, π7/2+[404]v9/2+[624]v1/2-[510]v7/2-[514].

h (K): Kπ=6- band, π7/2+[404]v5/2-[512].

i (L): Kπ=0- band, π9/2-[514]v9/2+[624].

j (M): Kπ=1- band, π7/2+[404]v5/2-[512].

k (N): Kπ=14(+) band, 4-quasiparticle band.

l (O): K=13 band, π7/2+[404]v9/2+[624]v7/2-[514]v3/2-[512].

m (P): Kπ=13- band, v9/2+[624]v5/2-[512]v3/2-[512] π9/2-[514] (1999Sa59) or v9/2+[624]v7/2-[514]v1/2-[510] π9/2-[514] (1998Dr07).

n (Q): Kπ=11- band, v9/2+[624]π9/2-[514]⊗(γ-vibration).

o (R): Octupole band.

p (S): β band.

q (T): K=(16) band, v9/2+[624] π5/2+[402]π7/2+[404]π9/2-[514] ⊗ (octupole vibration).

r (U): Kπ=15- band, v9/2+[624] π9/2-[514]π7/2+[404]π5/2-[402].

s (V): Kπ=18(+) band, v9/2+[624]v7/2-[514]v11/2+[615] π9/2-[514].

t (W): Kπ=19- band, v9/2+[624]v7/2-[514]v1/2-[510] π5/2+[402]π7/2+[404]π9/2-[514].

γ(¹⁸⁰Ta)

Eγ [†]	E(level)	Iγ [‡]	Mult.§	δ	α	Iγ@	Comments
(23 [#])	130.48						
39.5 1	39.50	2.1 4				9.5 22	
40.7 1	171.00	7.3 8	(M1)		10.21 17	11 2	Mult.: from intensity balance in 1998Dr07.
55.4 3	477.46	5.9 16				14 3	
62.9 1	233.90	16.4 14	(M1)		2.84	37 3	Mult.: from intensity balance in 1998Dr07.
63.2 [#]	171.00					=1.5	
65.6 3	543.73	4.5 16				=7	
71.0 1	110.50	3.5 5				22 4	

Continued on next page (footnotes at end of table)

$^{176}\text{Yb}(^{11}\text{B},\alpha 3n\gamma),(^7\text{Li},3n\gamma)$ 1999Sa59,1998Dr07 (continued) $\gamma(^{180}\text{Ta})$ (continued)

$E\gamma^{\dagger}$	E(level)	$I\gamma^{\ddagger}$	Mult. [§]	δ	α	$I\gamma^{\oplus}$	Comments
72.2	591.6		M1 (+E2)		12.6 16	=1.5	$\alpha(\text{exp})=10$ from intensity balance (1998Dr07). Mult.: from $\alpha(\text{exp})$.
73.9 1	184.34	3.6 6				=14	
83.9 1	317.80	8.1 4	(M1)		7.22	12.0 15	Mult.: from intensity balance in 1998Dr07.
100.6 1	177.76	69.0 20	E1		0.361	130 12	$\alpha(\text{exp})=2.5 3$ (1999Sa59) from intensity balance. Mult.: $\alpha(\text{exp})$ gives E1+M2 with $\delta=0.242 18$. However, δ value is inconsistent with RUL for M2 transition. $A_2=-0.06 5$ (1998Dr07).
101.7 1	419.51	10.2 5	(M1)		4.16	20.5 15	Mult.: from intensity balance in 1998Dr07.
105.4 1	415.44	6.7 6				6.7 11	
107.6 1	107.60	60 5	E1		0.303	160 12	$\alpha(\text{exp})=0.03 3$ (1999Sa59) from intensity balance. Mult.: from $\alpha(\text{exp})$. $A_2=-0.01 3$ (1998Dr07).
111.1 1	574.22	2.63 19	M1 (+E2)		2.8 4	=6	$\alpha(\text{exp})=2.6 5$ (1999Sa59) from intensity balance. Mult.: from $\alpha(\text{exp})$.
114.#&	538.5?						
114.0 1	657.73	1.7 5				7.8 21	
121.8 1	641.18	2.52 24				7.0 12	
125.7 1	310.05	25 3				9.9 15	
127.6 1	547.3	13.6 5	(M1)		2.17	24.0 22	$A_2=-0.31 13$. Mult.: from intensity balance in 1998Dr07.
134.8 1	734.22	7.3 3				2.9 8	
138.3 1	685.7	12.6 5				23 3	$A_2=-0.19 9$ (1998Dr07).
140.6 1	732.2	1.95 22				9.5 10	
142.4#	1452.0		(M1)		1.590	3.0 7	$\alpha(\text{exp})=1.8 3$ (1996Dr02) from intensity balance. Mult.: from $\alpha(\text{exp})$.
145.6 1	786.85	3.10 22				5.8 8	
147.8 3	723.21	0.24 8					
158.6 1	515.64	5.9 3	(M1)		1.173	6.4 9	Mult.: from conversion coefficient limit in 1998Dr07.
161.5 1	893.9	6.9 5				7.3 7	
164.0 1	1140.07	3.73 17				2.1 4	
169.2 1	956.16	2.76 19				2.6 5	
170.9 1	856.6	15.9 5				25.0 23	$A_2=-0.20 9$ (1998Dr07).
173.5 1	1030.2	12.0 4				18.8 19	$A_2=-0.10 23$ (1998Dr07).
178.#&	722.6?						
178.9 1	356.95	17.2 10	M1		0.836	16.4 12	$\alpha(\text{exp})=0.96 10$ (1999Sa59) from intensity balance. Mult.: from $\alpha(\text{exp})$. $A_2=-0.14 3$ (1998Dr07).
178.9 2	1353.74	0.64 11					
181.5 2	865.35	0.62 11				0.7 2	
182.1 1	1076.2	4.2 3				3.4 9	
183.9 1	599.35	15.5 7				10.1 16	$A_2=+0.21 12$ (1998Dr07).
185.3#	419.51					3.2 5	$I\gamma: I\gamma(185\gamma)/I\gamma(102\gamma)\leq 0.19$ (1998Dr07).
185.7 1	1016.45	0.70 10				0.5 2	
188.6 1	762.89	1.28 13				0.5 2	
192.5 1	1148.72	1.28 14				1.3 3	
194.7 1	1629.55	1.74 12					
196.2 1	374.03	63.7 23	D+Q	4.7 11	0.49 18	26.2 18	R(DCO)=1.4 2 (1334 γ gated) (1999Sa59). $\delta(\text{E2/M1})$ given as 3.6 to 5.8 in 1999Sa59 based on R(DCO). $A_2=+0.02 7$ (1998Dr07).

Continued on next page (footnotes at end of table)

$^{176}\text{Yb}(^{11}\text{B},\alpha 3n\gamma),(^7\text{Li},3n\gamma)$ 1999Sa59,1998Dr07 (continued) $\gamma(^{180}\text{Ta})$ (continued)

$E\gamma^{\dagger}$	E(level)	$I\gamma^{\ddagger}$	Mult. [§]	δ	α	$I\gamma^{\oplus}$	Comments
200.8 1	1277.4	2.25 23				1.5 3	
202.7 1	279.93	140 4				216 8	$A_2=+0.20$ 7 (1998Dr07).
	1541.63	0.79 22					
205.9 1	1446.8	5.34 21				8.5 14	
207.5 1	723.21	18.5 7				6.2 13	
209.3 1	519.36	1.1 4				5.5 6	
210.0& 1	975.5	≤ 0.09					
210.5 1	1240.7	11.2 4				16.0 15	$A_2=-0.45$ 24 (1998Dr07).
214.#&	722.6?						
	1363.9					=0.6	
216.8 1	679.97	5.7 3				4.4 6	
218.0#	574.22					5.1 6	
218.5 1	575.64	7.1 4				2.4 3	
220.0 2	1498.0	0.91 17				0.8 2	
221.1 1	595.26	24.4 8				9.0 16	
225.0 1	505.03	98 3	D+Q	0.4		142 9	R(DCO)=1.1 1 (1092 γ E2 gated) (1999Sa59). δ : from R(DCO) analysis. $A_2=+0.17$ 9 (1998Dr07). I γ : I γ (230 γ)/I γ (128 γ) ≤ 0.19 (1998Dr07). I γ : I γ (231 γ)/I γ (105 γ)=0.50 13 (1998Dr07).
229.7 5	547.3	0.80 13				3.2 4	
231.0 5	415.44	3.1 3				3.4 4	
231.0 1	806.77	4.7 3	D			0.9 2	R(DCO)=0.7 2 (398 γ gated) (1999Sa59).
232.8 1	956.13	12.7 5				3.3 5	
236.8 2	1734.7	0.32 12				=0.4	
241.7 1	976.01	8.9 4				4.8 6	
241.8 1	922.08	2.33 14				2.0 4	
242.8 1	1941.3	2.89 13				=3	
245.4 1	840.74	8.2 3				2.4 3	
246.9 1	752.12	49.8 16				67 4	$A_2=+0.20$ 9 (1998Dr07).
250.0 1	1057.00	4.02 23				=0.8	
250.2 1	2660.43	0.89 8					
251.6 1	1698.5	4.21 18				4.0 6	
252.1 1	423.00	8.5 5				13.6 17	$A_2=-0.18$ 4 (1998Dr07).
256.0#	830.75					1.2 4	
256.0 1	1212.27	7.2 3				1.5 3	
257.8 1	2660.43	0.90 8					
258.3 1	1597.20	9.2 4	Q			12 3	R(DCO)=1.2 2 (1262 γ gated) (1999Sa59).
262.7 1	1970.84	1.26 13					
266.2 1	1188.54	1.25 10				1.0 2	
266.4 1	685.7	1.01 12				3.4 8	I γ : I γ (266 γ)/I γ (138 γ) ≤ 0.16 (1998Dr07).
268.2 7	786.85	0.34 20				1.8 3	I γ : I γ (268 γ)/I γ (146 γ)=0.31 6 (1998Dr07).
268.2 1	1020.44	26.8 9				48 3	$A_2=+0.10$ 5 (1998Dr07).
268.9 1	1109.87	4.13 20				2.0 3	
269.7 1	1326.87	2.79 18				=0.5	
277.6 1	1490.15	3.39 16				1.0 3	
282.4 3	2186.6	0.37 11					
282.6 1	1879.83	6.4 3				6 1	
282.9 1	2943.61	0.53 8					
285.3 1	463.07	14.3 9	E1 (+M2)	<0.3	0.10 6	16.3 22	$\alpha(\text{exp})=0.30$ 11 (1999Sa59) from intensity balance, $\alpha(\text{K})\text{exp}\leq 0.08$ (2000Dr11). Mult., δ : from $\alpha(\text{K})\text{exp}$. Other: 0.65 19 from $\alpha(\text{exp})$ gives M2 strength inconsistent with RUL. $A_2=-0.13$ 4 (1998Dr07).
288.8 1	1309.49	14.0 5				21 3	
289.3 1	599.35	3.3 3				5.7 9	I γ : I γ (289 γ)/I γ (184 γ)=0.56 11 (1998Dr07).
	1616.31	1.80 16					
289.8 1	1478.37	0.46 9				0.4 2	
290.1 2	2261.0	0.41 9					

Continued on next page (footnotes at end of table)

$^{176}\text{Yb}(^{11}\text{B},\alpha 3n\gamma),(^7\text{Li},3n\gamma)$ 1999Sa59,1998Dr07 (continued) $\gamma(^{180}\text{Ta})$ (continued)

$E\gamma^{\dagger}$	E(level)	$I\gamma^{\ddagger}$	Mult. [§]	δ	α	$I\gamma^{\oplus}$	Comments
291.0 2	806.77	0.90 14					
291.3 1	1401.55	1.78 14				0.6 2	
294.7 1	1434.80	3.41 17				2.5 6	
295.0 5	975.5	0.29 9					
297.9 1	1788.16	1.41 10				0.5 1	
299.9 1	762.89	1.45 15				1.7 3	
302.4 8	893.9	2.0 5				2.0 4	$I\gamma$: $I\gamma(302\gamma)/I\gamma(162\gamma)=0.28$ 6 (1998Dr07).
302.4 1	2182.46	2.15 13				=1.5	
307.0 1	1904.20	2.62 20				=3	$R(\text{DCO})=1.4$ 7 (1092 γ E2 gated) (1999Sa59).
308.2 2	1924.80	0.59 12					
308.9 1	1618.62	7.2 3				10.9 15	
309.1 1	856.6	1.34 14				6.3 11	$I\gamma$: $I\gamma(309\gamma)/I\gamma(171\gamma)=0.17$ 6 (1998Dr07).
309.7 1	3253.29	0.46 8					
311.5 4	1790.12	0.20 7				=0.4	
311.5 1	2899.4	3.22 15	D			11.0 15	$R(\text{DCO})=0.9$ 2 (431 γ gated) (1999Sa59). $A_2=-0.40$ 17 (1998Dr07).
313.5 1	1715.34	1.03 9					
315.2 2	956.16	1.17 19				2.0 6	$I\gamma$: $I\gamma(315\gamma)/I\gamma(169\gamma)=0.78$ 16 (1998Dr07).
315.4 1	423.00	12.7 5	M1		0.1763	26.3 20	$\alpha(\text{K})_{\text{exp}}=0.23$ 3 (2000Dr11). Mult.: from $\alpha(\text{K})_{\text{exp}}$. $A_2=-0.11$ 3 (1998Dr07).
316.1 1	890.32	1.31 17				0.5 2	
316.8 1	2105.05	0.72 9				=0.2	
318.8 1	734.22	6.8 4				3.9 7	$I\gamma$: $I\gamma(319\gamma)/I\gamma(135\gamma)=1.4$ 6 (1998Dr07).
321.3 1	2503.95	0.96 10				=1	
325.5 [#]	1904.20					=3.5	
326.9 1	683.85	2.2 3				2.5 3	
328.0 1	1946.80	3.32 16				6.2 10	
332 [#]	907.0					0.6 2	
332.5 1	1671.43	2.08 23				2.2 6	
332.5 2	2438.29	0.41 8					
333.9 4	1057.00	0.45 12					
335 [#]	2122.8					=0.2	
335.1 1	519.36	0.55 23				6.8 8	
337.8 1	515.64	22.3 10	M1+E2	0.72 19	0.116 11	19.2 15	$\alpha(\text{K})_{\text{exp}}=0.094$ 9 (2000Dr11). Mult., δ : from $\alpha(\text{K})_{\text{exp}}$. $R(\text{DCO})=1.1$ 3 (441 γ E2 gated) (1999Sa59). $A_2=+0.35$ 5 (1998Dr07).
337.9 1	1967.47	0.96 11					
339.8 1	1791.9	48.2 18	(D)			22.1 18	$R(\text{DCO})=0.73$ 28 (880 γ gated) (1999Sa59). $A_2=+0.28$ 12 (1998Dr07).
339.8 6	2844.05	0.21 9					
344.1 1	1076.2	2.5 4				5.2 8	$I\gamma$: $I\gamma(344\gamma)/I\gamma(182\gamma)=1.5$ 2 (1998Dr07).
344.2 1	1941.40	8.8 4	D			8.0 15	$R(\text{DCO})=0.7$ 2 (1092 γ E2 gated) (1999Sa59).
344.6 8	2672.1	0.15 9					
344.7 1	1030.2	1.71 14				5.4 10	$I\gamma$: $I\gamma(345\gamma)/I\gamma(174\gamma)=0.19$ 6 (1998Dr07).
346.8 1	477.46	1.79 23				3.8 8	
347.0 1	2294.05	1.73 12				2.4 7	
349.0 1	723.21	3.98 23				2.8 7	
349.0 9	2787.54	0.16 9					
354.4 2	2899.4	0.39 6					
361 ^{#&}	956.13						
361.9 13	3148.1	0.14 6					
362.1 2	1148.72	1.06 16				1.7 3	$I\gamma$: $I\gamma(362\gamma)/I\gamma(193\gamma)=1.3$ 4 (1998Dr07).
363.6 1	2657.82	0.75 10				=1	
364.9 1	2156.9	23.9 8				11.6 16	$A_2=-0.06$ 4 (1998Dr07).

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$^{176}\text{Yb}(^{11}\text{B},\alpha 3n\gamma),(^7\text{Li},3n\gamma)$ 1999Sa59,1998Dr07 (continued) $\gamma(^{180}\text{Ta})$ (continued)

$E\gamma^{\dagger}$	E(level)	$I\gamma^{\ddagger}$	Mult. [§]	α	$I\gamma^{\oplus}$	Comments
366.4 4	723.21	1.58 18			0.8 2	
372.8 1	543.73	6.8 4			3.6 5	
373.1 2	2343.9	0.35 8				
376.3 2	3047.8	0.42 8				
376.7 1	976.01	3.15 20			2.4 5	$I\gamma$: $I\gamma(377\gamma)/I\gamma(242\gamma)=0.50$ 2 (1998Dr07).
378.#&	508.1?					
379.4 1	2320.80	4.29 19	D		4.0 9	$R(\text{DCO})=1.2$ 2 (344 γ gated) (1999Sa59).
383.7 1	1277.4	2.2 3			2.5 3	$I\gamma$: $I\gamma(384\gamma)/I\gamma(201\gamma)=1.6$ 4 (1998Dr07).
384.0#	423.00				=1	
384.0 1	1240.7	1.21 12			3.8 8	$I\gamma$: $I\gamma(384\gamma)/I\gamma(211\gamma)=0.30$ 7 (1998Dr07).
388.0 1	2544.9	6.5 3			2.2 3	
397.1 1	2985.1	2.44 13			8.8 7	
398.1 1	575.64	9.2 6			5.6 7	
400.4 1	2721.20	1.55 10			=3	
401.8 5	975.5	0.35 11				
402.#&	865.35					
405.9 1	1140.07	6.2 3			3.0 6	$I\gamma$: $I\gamma(406\gamma)/I\gamma(164\gamma)=1.4$ 7 (1998Dr07).
407.5#	1363.9				=0.8	
408.8 1	519.36	3.6 14	M1	0.0883	45 12	$\alpha(\text{K})_{\text{exp}}=0.082$ 7, $\alpha(\text{L})_{\text{exp}}\leq 0.021$, $\alpha(\text{M})_{\text{exp}}=0.004$ (2000Dr11). Mult.: from $\alpha(\text{K})_{\text{exp}}$. $A_2=-0.16$ 5 (1998Dr07).
409.2 1	2954.2	2.43 17			=1.5	
409.3 1	3308.6	2.04 14	D		=2.2	$R(\text{DCO})=1.1$ 2 (312 γ gated) (1999Sa59).
415.0 1	3400.1	0.74 7			0.5 1	
416.7 1	1446.8	1.24 11			3.2 7	$I\gamma$: $I\gamma(417\gamma)/I\gamma(206\gamma)=0.6$ 2 (1998Dr07).
417.5 1	595.26	35.4 13	E2	0.0321	15.0 13	$\alpha(\text{K})_{\text{exp}}=0.020$ 3 (2000Dr11). Mult.: from $\alpha(\text{K})_{\text{exp}}$. $A_2=+0.24$ 7 (1998Dr07). $I\gamma$: $I\gamma(418\gamma)/I\gamma(221\gamma)=2.3$ 4 (1998Dr07).
420.2 1	3141.40	0.73 7				
422.0 1	1498.0	1.62 21			1.4 4	$I\gamma$: $I\gamma(422\gamma)/I\gamma(220\gamma)=1.9$ 7 (1998Dr07).
424.0#&	423.00					
428.0 1	505.03	22.1 9	Q		37 3	$R(\text{DCO})=1.1$ 4 (1092 γ E2 gated) (1999Sa59). $A_2=+0.33$ 10 (1998Dr07). $I\gamma$: $I\gamma(428\gamma)/I\gamma(225\gamma)=0.29$ 2 (1998Dr07).
429.3 1	3738.0	0.47 10			=3	
429.4 1	3383.5	1.00 14				
431.0 1	2587.9	9.6 4	D		22.9 15	$A_2=-0.20$ 6 (1998Dr07).
431.7	1452.0				40	$E\gamma$: from 1998Dr07.
432.1 3	3831.8	0.27 8				
432.8 1	806.77	3.56 23			=1	
438.6 1	515.64	1.50 19				
440.5 1	956.13	4.67 25			1.8 3	$I\gamma$: $I\gamma(441\gamma)/I\gamma(233\gamma)=0.58$ 5 (1998Dr07).
444.8 1	3828.3	0.54 7				
448.3 1	4186.3	0.57 5				
449.8 1	806.77	1.11 16			=4	
452.7 3	1215.6	0.47 10				
457.3 1	1734.7	1.47 19			=1	
457.9 1	1698.5	1.11 9				
458.8 1	1434.80	2.30 15			=1.5	
459.1 1	922.08	1.86 16			1.3 3	$I\gamma$: $I\gamma(459\gamma)/I\gamma(242\gamma)=1.15$ 2 (1998Dr07).
461.7 1	1057.00	1.20 15				
466.8 1	840.74	36.8 12			13.0 18	$I\gamma$: $I\gamma(467\gamma)/I\gamma(245\gamma)=7.4$ 18 (1998Dr07).
472.3 1	752.12	27.5 9			41.2 20	$A_2=+0.17$ 7 (1998Dr07). $I\gamma$: $I\gamma(472\gamma)/I\gamma(247\gamma)=0.44$ 3 (1998Dr07).
473.8 1	830.75	2.0 3			1.5 3	
473.8 2	2071.00	1.15 23				
474.4 2	2354.24	0.63 14				
481.5 1	1057.00	1.30 16	Q		1.6 3	$R(\text{DCO})=1.2$ 3 (398 γ gated).
489.1 1	1212.27	5.4 3			1.8 3	$I\gamma$: $I\gamma(489\gamma)/I\gamma(256\gamma)=1.20$ 14 (1998Dr07).
489.5 1	1629.55	3.51 18				
494.7 11	1941.3	0.12 7				

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$^{176}\text{Yb}(^{11}\text{B},\alpha 3n\gamma),(^7\text{Li},3n\gamma)$ 1999Sa59,1998Dr07 (continued) $\gamma(^{180}\text{Ta})$ (continued)

$E\gamma^{\dagger}$	E(level)	$I\gamma^{\ddagger}$	Mult. [§]	$I\gamma^{\oplus}$	Comments
502.8 1	1904.40	1.31 11			
508.8 1	1188.54	2.68 16		1.0 3	$I\gamma: I\gamma(509\gamma)/I\gamma(266\gamma)=1.66$ 4 (1998Dr07).
514.6 1	1109.87	27.4 9		11.0 15	$I\gamma: I\gamma(515\gamma)/I\gamma(269\gamma)=5.0$ 9 (1998Dr07).
515.4 1	1020.44	24.4 8		50 4	$A_2=+0.19$ 14 (1998Dr07). $I\gamma: I\gamma(515\gamma)/I\gamma(268\gamma)=0.94$ 10 (1998Dr07).
520.2 1	1326.87	2.50 19			
532.7 1	1967.47	0.89 10			
533.7 1	2943.61	0.93 9			
534.1 1	1490.15	4.76 23		1.4 3	$I\gamma: I\gamma(534\gamma)/I\gamma(278\gamma)=1.40$ 19 (1998Dr07).
535#	890.32			1.2 3	
541.4 1	2943.61	0.84 8			
546.0 2	723.21	0.78 20			
553.5 10	2261.0	0.12 9			
556.3 1	1478.37	1.37 12		1.1 2	$I\gamma: I\gamma(556\gamma)/I\gamma(290\gamma)=2.7$ 9 (1998Dr07).
557.5 1	1309.49	18.3 6	Q	33.7 22	$A_2=+0.37$ 13 (1998Dr07). $I\gamma: I\gamma(558\gamma)/I\gamma(289\gamma)=1.25$ 12 (1998Dr07).
559.6 2	1616.31	1.23 18			
561.0 1	1401.55	16.7 6		6.1 9	$I\gamma: I\gamma(561\gamma)/I\gamma(291\gamma)=5.2$ 18 (1998Dr07).
567.9 1	2197.45	1.85 13			
576.1 1	1788.16	3.82 19		0.9 3	$I\gamma: I\gamma(576\gamma)/I\gamma(298\gamma)=1.7$ 4 (1998Dr07).
582.4 2	956.13	0.93 16			
585.3 1	2182.46	1.32 16		=4.0	
592.8 2	3253.29	0.63 8			
598.0 1	1924.80	2.20 18			
598.3 1	1618.62	14.6 5		22 2	$I\gamma: I\gamma(598\gamma)/I\gamma(309\gamma)=2.0$ 3 (1998Dr07).
600.1 1	2567.58	1.22 11			
601.6 1	1790.12	1.56 12		=0.7	
605.6 1	1715.34	16.7 6	Q	5.6 9	$R(\text{DCO})=1.1$ 2 (687 γ gated) (1999Sa59).
610.8 2	2660.43	0.54 8			
614.8 1	2105.05	2.92 16		0.9 2	
624.3 1	2503.95	1.42 12		2.6 3	
629.3 16	806.77	0.65 21			
632.9 1	3532.3	0.59 7			
637.4 1	1946.80	8.1 3		12.0 15	
644.4 2	2122.8	0.53 8		=0.4	
645.1 3	2842.5	0.37 7			
648.8 1	2050.21	4.97 23		2.0 4	
650.3 1	2438.29	1.09 10		0.6 2	
661.6 1	2844.05	0.78 10			
668#&	775.8?			=1	
675.5 1	2294.05	4.84 21		11.0 18	
678#	1035.0?	14 2		1.4 2	
682.5 1	2787.54	0.73 9		0.5 1	
687.0 1	2402.39	4.12 20		1.5 3	
694.6 1	2410.03	4.98 22		2.3 4	
696.7 4	3200.7	0.34 8			
705.4 4	2156.9	0.56 20		1.4 2	$I\gamma: I\gamma(705\gamma)/I\gamma(365\gamma)=0.13$ 4 (1998Dr07).
709.7 3	3148.1	0.27 7			
711.2 1	2657.82	2.57 14		=6	
730.1 1	2780.31	1.32 11		1.0 2	
742.4 6	2899.4	0.20 8			
747.2 1	3041.25	1.15 10		4.5 10	
753.0 1	2544.9	1.06 15		0.6 2	$I\gamma: I\gamma(753\gamma)/I\gamma(388\gamma)=0.29$ 11 (1998Dr07).
765& 4	3173?	0.05 6			
770.4 2	2562.3	0.86 16			
770.8 3	3173.2	0.31 7			
777.3 3	3435.1	0.33 8		=2.5	
794.2 8	1904.40	0.22 9			
797.4 1	2954.2	0.91 11		0.5 1	$I\gamma: I\gamma(797\gamma)/I\gamma(409\gamma)=0.25$ 8 (1998Dr07).
804.3& 13	3582.9?	0.11 6		=0.5	
812.4 2	3400.1	0.55 8		0.6 1	$I\gamma: I\gamma(812\gamma)/I\gamma(415\gamma)=1.0$ 3 (1998Dr07).
813.9& 4	3853.4?	0.22 6		=2	
838.2 2	3383.5	0.68 10			

Continued on next page (footnotes at end of table)

$^{176}\text{Yb}({}^{11}\text{B},\alpha 3n\gamma),({}^7\text{Li},3n\gamma)$ 1999Sa59,1998Dr07 (continued) $\gamma(^{180}\text{Ta})$ (continued)

$E\gamma^\dagger$	E(level)	$I\gamma^\ddagger$	Mult.§	$I\gamma^\oplus$	Comments
845.0 1	1597.20	6.3 3		7.4 18	
846.5 2	3831.8	0.56 8		=0.7	
875.7 11	2327.6	0.17 11			
878.6 1	1252.64	2.09 25			
880.4 1	2672.1	2.64 22	(D)		R(DCO)=0.7 3 (340 γ M1 gated) (1999Sa59).
884.3 2	1389.34	1.16 17			
890.6 11	3435.5	0.21 11			
890.7 1	3047.8	0.86 15			
894.9 1	1174.84	3.3 3		=8	
896.2 2	2006.08	1.17 16			
896.7 2	1270.73	1.3 3			
1013.3 2	1293.24	2.5 3			
1042.3 3	1546.51	0.93 20			
1052.7 5	1805.61	0.50 15			
1058.8 2	1338.93	2.3 3			
1063.7 1	1904.40	1.87 19			
1090 [#]	1841.14			=6	
1092.2 1	1597.20	19.0 7	Q	26 3	$A_2=+0.23$ 9 (1998Dr07).
1183.6 2	1463.54	2.2 3			
1261.9 1	1338.93	37 6		22 3	
1266.2 2	1546.51	2.7 4			
1293.4 2	1573.34	2.2 3			
1300.6 1	1805.61	3.2 3			
1300.8 [#]	1580.7			=10	
1334.1 1	1708.14	5.7 4			
1336.1 1	1841.14	2.64 23		=6	
1358.2 3	1863.2	1.10 18			
1372.5 2	2124.63	1.30 18			
1391.5 2	1671.43	2.0 3			
1407.7 4	2159.8	0.63 14			
1435.9 3	2456.3	0.74 13			

[†] From 1999Sa59, except where noted. 2002We01 have noted that the energies between 250 keV and 500 keV have a systematic discrepancy of about 0.4 keV compared with those from 1998Dr07 or 2002We01 ($^{180}\text{Hf}(\text{p},n\gamma),(\text{d},2n\gamma)$).

[‡] From 1999Sa59 at $E({}^{11}\text{B})=57$ MeV.

[§] From $\gamma(0)$ and R(DCO) in 1998Dr07 and 1999Sa59, respectively, except where noted.

[#] Observed only by 1998Dr07.

[⊕] From 1998Dr07. Authors state that values are indicative only, as they are from a number of different measurements.

[&] Placement of transition in the level scheme is uncertain.

 $^{179}\text{Hf}(\alpha,t),({}^3\text{He},\text{d})$ 1983Wa01

$J\pi(^{179}\text{Hf})=7/2+$.

$E(\alpha)=62.2$ MeV. Measured $\sigma(\theta)$ at $\theta=10^\circ$ and 15° using magnetic spectrometer and 50 cm long multiwire proportional counter (FWHM ≤ 25 keV). $E(\text{d})=36$ MeV. Measured $\sigma(\theta)$ at $\theta=15^\circ$ and 35° using magnetic spectrometer and position sensitive telescope with three resistive wire proportional counters (FWHM=20–40 keV).

 ^{180}Ta Levels

E(level) [†]	$J\pi^\ddagger$	$L^\S$	Comments
0.0 [#]	(1+)		
40 [#]	(2+)		
82 [@]	(9-)		
134			Complex peak. Possible components: $J\pi=3+$, configuration= $((\pi 7/2[404])-(\nu 9/2[624]))$; and $J\pi=1-$, configuration= $((\pi 9/2[514])-(\nu 9/2[624]))$.
181		4	Complex peak. Possible components: $J\pi=8+$, configuration= $((\pi 7/2[404])+(\nu 9/2[624]))$; $J\pi=2-$, configuration= $((\pi 9/2[514])-(\nu 9/2[624]))$; and $J\pi=4+$, configuration= $((\pi 7/2[404])-(\nu 9/2[624]))$.
235 ^{&}	(3-)		
285 [@]	(10-)		Complex peak at 296 keV ($L=2$) in (${}^3\text{He},\text{d}$).

Continued on next page (footnotes at end of table)

$^{179}\text{Hf}(\alpha, t), (^3\text{He}, d)$ 1983Wa01 (continued) **^{180}Ta Levels (continued)**

E(level) [†]	$J\pi^{\ddagger}$	L [§]	Comments
320&	(4-)		Complex peak. Possible contamination from 482-keV level in ^{181}Ta .
361 ^a	(7+)	2	
426&	(5-)		Complex peak. Possible contamination from 615- and 619-keV levels in ^{181}Ta .
563		2	Complex peak. Possible components: $J\pi=2+$, configuration= $((\pi 5/2[402])-(\nu 9/2[624]))$; $J\pi=6-$, configuration= $((\pi 9/2[514])-(\nu 9/2[624]))$; and $J\pi=8+$, configuration= $((\pi 5/2[402])+(\nu 9/2[624]))$.

[†] From (α, t) .[‡] Authors made spin, parity, and configuration assignments on the bases of a comparison between experimental and theoretical cross sections for each reaction separately, on the comparison between $\sigma(\alpha, t)/\sigma(^3\text{He}, d)$ experimental and theoretical ratios, and on rotational structure with Coriolis coupling included.[§] From comparison of measured angular distributions in $(^3\text{He}, d)$ with DWBA calculations.# $K\pi=(1+)$ rotational band probable configuration= $((\pi 7/2+[404])-(\nu 9/2+[624]))$.@ $K\pi=(9-)$ rotational band probable configuration= $((\pi 9/2-[514])+(\nu 9/2+[624]))$.& $K\pi=(0-)$ rotational band probable configuration= $((\pi 9/2-[514])-(\nu 9/2+[624]))$.^a $K\pi=(7+)$ rotational band probable configuration= $((\pi 5/2+[402])+(\nu 9/2+[624]))$. **$^{180}\text{Hf}(p, n\gamma), (d, 2n\gamma)$ 2002We01**E(p)=8.9 MeV, E(d)=12.4 MeV. Measured $E\gamma$, $I\gamma$, $\gamma\gamma$, E(ce), I(ce), ce- γ coincidences using an array of 5 Compton-suppressed HPGe detectors for γ -rays and iron-free orange spectrometer for electrons. **^{180}Ta Levels**

E(level) [†]	$J\pi^{\ddagger}$	$T_{1/2}$	Comments
0.0&	1+		
39.54& 5	2+		
77.1 ⁱ 8	9-	$>7.1 \times 10^{15}$ y	E(level), $T_{1/2}$: from the Adopted Levels.
107.78 ^h 4	0-		
110.77& 7	3+		
130.49 ^h 6	1-		
171.11 ^h 5	2-		
177.85 ^e 5	8+		
184.93& 8	4+		
234.35 ^h 6	3-		
280.10 ⁱ 10	10-		
310.92& 8	5+		
318.22 ^h 6	4-		
320.24 ^j 5	1+		
356.94 ^c 7	7+		
370.82 ^j 5	2+		
374.20 ^e 7	9+		
416.36& 10	6+		
419.86 ^h 8	5-		
423.48 ^k 4	1-		
447.87 ^j 6	3+		
463.49 ^f 7	7-		
478.08 ^k 5	2-		
505.40 ⁱ 15	11-		
515.83 ^d 9	8+		
519.97 ^a 8	4+		
x+519.97 ^b	(5)		E(level): x=72.2 in 1999Sa59 and 1998Dr07. However, existence of 72.2 transition is not confirmed in ce data of 2002We01, which propose x≤80.
544.23 ^k 6	3-		
547.70 ^h 10	6-		
547.92 ^j 9	4+		
549.34 ^m 7	3-		
559.52 ^l 5	2+		
574.79 ^g 7	6-	≈ 10 ns	$T_{1/2}$: from ce- $\gamma(t)$.
575.95 ^c 9	(8+)		

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$^{180}\text{Hf}(\text{p},\text{n}\gamma),(\text{d},2\text{n}\gamma)$ 2002We01 (continued) ^{180}Ta Levels (continued)

E(level) [†]	$J\pi^{\ddagger}$	$T_{1/2}$	Comments
595.46 ^e 9	10+		
600.44 ^{&} 11	7+		
624.14 ^l 6	3+		
641.43 ^a 9	5+		
645.64 ^m 9	(4-)		
653.51 ⁿ 6	1-		
658.49 ^k 10	(4-)		
x+660.75 ^b 10	(6)		
663.80 ^o 9	(4-)		
671.97 13	(4)		
676.38 ^j 11	5+		
680.74 ^f 10	8-		
684.54 12			
685.89 ^h 11	7-		
708.13 ⁿ 6	2-		
708.62 [?] ^l 12	(4+)		
721.92 7	4-	=3 ns	E(level): not included in Adopted Levels. Proposed configuration= $\pi 7/2+[404]+v1/2-[521]$, $K\pi=4-$. $T_{1/2}$: from $\text{ce}-\gamma(\text{t})$. Given as a range from 1-5 ns.
723.52 ^d 10	9+		
729.55 10			
731.17 9			
735.45 ^{&} 12	8+		
738.45 11	(5)		
752.70 ⁱ 18	12-		
756.72 11			
763.62 ^g 9	7-		
784.34 [?] ^o 9	(5-)		
787.15 ^a 11	6+		
787.82 [?] ⁿ 11	(3-)		
788.32 ^p 10	3-		
792.47 16	(5)		
807.18 ^c 10	(9+)		
809.37 ^s 13	(5-)		
809.46 ^s 10	(5-)	=3 ns	Possible configuration= $\pi 7/2+[404]+v3/2-[512]$, $K\pi=(5-)$. $T_{1/2}$: from $\text{ce}-\gamma(\text{t})$. Given as a range from 1-5 ns.
x+822.42 ^b 13	(7)		
830.57 9			
836.09 12			
841.23 ^e 10	11+		
857.19 ^h 12	8-		
863.84 11			
866.95 13			
876.80 7	(2-)		Possible configuration= $\pi 7/2+[404]-v3/2-[512]$, $K\pi=2-$.
880.68 7			
884.04 12			
891.76 [#] 10			
892.82 [#] 12			
892.95 [#] 15	(6)		
906.35 [@] 11			
907.57 ^{@p} 10	4-		
915.92 7			
922.84 ^f 14	9-		
935.06 8			
938.77 19	(6)		
951.52 7			
956.32 ^d 14	10+		
956.45 ^a 14	7+		
976.58 ^g 9	8-		
977.35 ^{&} 16	9+		
991.55 11			
996.50 9			
x+1004.88 ^b 13	(8)		
1016.87 13			

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$^{180}\text{Hf}(\text{p},\text{n}\gamma),(\text{d},2\text{n}\gamma)$ 2002We01 (continued) ^{180}Ta Levels (continued)

E(level) [†]	J $\pi^{\ddagger}$
1030.69 ^h 16	9-
1037.03 9	
1043.07 13	
1053.5 6	
1100.63 13	
1113.10 9	
1149.55 ^a 14	8+
1205.10 11	
1241.59 ^h 19	10-
1447.49 ^h 21	11-

[†] From a least-squares fit to $E\gamma$ by evaluator, assuming $\Delta(E\gamma)=0.5$ keV when not specified.

[‡] As proposed in 2002We01. Rotational bands identified according to band structures and configuration assigned based on BCS calculations.

§ 809.37 and 809.46 may correspond to one common level.

891.76, 892.82, and 892.95 may correspond to one common level.

@ 906.35 and 907.57 may correspond to one common level.

& (A): $\nu 9/2+[624]-\pi 7/2+[404]$, $K\pi=1+$ band.

a (B): $\pi 9/2-[514]-\nu 1/2-[521]$, $K\pi=4+$ band.

b (C): Band based on (5).

c (D): $\pi 5/2+[402]+\nu 9/2+[624]$, $K\pi=7+$ band.

d (E): $\pi 9/2-[514]+\nu 7/2-[503]$, $K\pi=8+$ band.

e (F): $\pi 7/2+[404]+\nu 9/2+[624]$, $K\pi=8+$ band.

f (G): $\pi 7/2+[404]+\nu 7/2-[514]$, $K\pi=7-$ band.

g (H): $\pi 7/2+[404]+\nu 5/2-[512]$, $K\pi=6-$ band.

h (I): $\pi 9/2-[514]-\nu 9/2+[624]$, $K\pi=0-$ band.

i (J): $\pi 9/2-[514]+\nu 9/2+[624]$, $K\pi=9-$ band.

j (K): $\pi 9/2-[514]-\nu 7/2-[514]$, $K\pi=1+$ band.

k (L): $\pi 7/2+[404]-\nu 5/2-[512]$, $K\pi=1-$ band.

l (M): $\nu 9/2+[624]-\pi 5/2+[402]$, $K\pi=2+$ band.

m (N): $\pi 7/2+[404]-\nu 1/2-[510]$, $K\pi=3-$ band.

n (O): $\nu 7/2-[514]-\pi 5/2+[402]$, $K\pi=1-$ band.

o (P): $\pi 7/2+[404]+\nu 1/2-[510]$, $K\pi=4-$ band.

p (Q): $\pi 7/2+[404]-\nu 1/2-[521]$, $K\pi=3-$ band.

 $\gamma(^{180}\text{Ta})$

E(level)	$E\gamma$	$I\gamma^{\dagger}$	Mult. [‡]	$\delta^{\ddagger}$	α	Comments
39.54	39.5 1					
107.78	107.7 1 5					
110.77	71.2 1					
130.49	(22.7 [#])					
171.11	40.6 1					
177.85	100.7 5 5					
184.93	74.1 1	100				
	145.3 ^{&}	=8				
234.35	63.2 1					
280.10	203.0 1					
310.92	126.0 1	100				
	200.2 1	=13				
318.22	83.8 6 5					
320.24	280.7 1	66 4	M1		0.242	$\alpha(\text{K})_{\text{exp}}=0.25$ 5.
	320.2 1	100	M1+E2	<1.1	0.14 3	$I\gamma(320.2\gamma)/I\gamma(315.6\gamma)=50/100$.
						$\alpha(\text{K})_{\text{exp}}=0.12$ 3.
						$I\gamma(179.1\gamma)/I\gamma(315.6\gamma)=25/100$.
356.94	179.1 2 5					
370.82	50.6 1	1.7 4				
	260.1 1	59 4	M1		0.297	$\alpha(\text{K})_{\text{exp}}=0.25$ 5.
	331.3 1	45 3				
	370.8 1	100	M1+E2	<1.1	0.095 20	$I\gamma(370.8\gamma)/I\gamma(315.6\gamma)=39/100$.
						$\alpha(\text{K})_{\text{exp}}=0.08$ 2.
374.20	196.3 5 5					

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$^{180}\text{Hf}(\text{p},\text{n}\gamma),(\text{d},2\text{n}\gamma)$ 2002We01 (continued) $\gamma(^{180}\text{Ta})$ (continued)

E(level)	E γ	I $\gamma^{\dagger}$	Mult. ‡	$\delta^{\ddagger}$	α	Comments
416.36	105.4 1	100 20				
	231.4 1	36 7				
419.86	101.64 5					
	185.51 [@]					
423.48	252.39 5	37 3	M1		0.323	$\alpha(\text{K})_{\text{exp}}=0.29$ 6. I γ : 2.9 5, with authors indicating possible contamination.
	293.0 1	≤ 3.4				
	315.63 5	100	M1		0.1760	$\alpha(\text{K})_{\text{exp}}=0.16$ 3.
	383.8 1	18 4				
	423.5 1	9 2				
447.87	262.8 1	32 3				
	337.2 1	25 3				
	408.4 1	100				E γ : 408.5 in Table X of 2002We01.
463.49	285.60 5					I $\gamma(285.6\gamma)/I\gamma(315.6\gamma)=23/100$.
478.08	54.5 1	273 50				
	243.74 5	88 8				
	307.2 1	≤ 33				E γ : 306.9 in Table X of 2002We01. I γ : 27 6, with authors indicating possible contamination.
	347.53 5	100				I $\gamma(347.5\gamma)/I\gamma(315.6\gamma)=11/100$.
	367.4 ^{&}	≤ 15				
	438.7 1	93 19				
	478.2 1	126 25				
505.40	225.3 1					
515.83	158.9 1	12 3				
	338.0 1	100 20				
519.97	71.8					E γ : observed only in ce spectrum.
	209.1 1	16 3	M1+E2	0.8 4	0.43 8	$\alpha(\text{K})_{\text{exp}}=0.34$ 7.
	335.2 1	16 3				
	409.14 5	100 20	M1		0.0881	I $\gamma(409.1\gamma)/I\gamma(315.6\gamma)=98/100$. $\alpha(\text{K})_{\text{exp}}=0.10$ 2.
	480.3 ^{&}	≈ 1.5				
x+519.97	x					E γ : x=72.2 in 1999Sa59 and 1998Dr07. However, existence of 72.2 transition is not confirmed in ce data of 2002We01, which propose x ≤ 80 .
544.23	66.2 1	49 10				
	120.8 1	≈ 2				
	226.04 5	13 2				
	309.7 1	≤ 7				E γ : 309.9 in Table X of 2002We01. I γ : 5 2, with authors indicating possible contamination.
	359.2 ^{&}	≈ 2				
	373.07 5	100	M1		0.1125	I $\gamma(373.1)/I\gamma(315.6)=41/100$. $\alpha(\text{K})_{\text{exp}}=0.09$ 2.
	433.4 ^{&}	≤ 3				
	504.6 ^{&}	≈ 3				
547.70	127.84 5					
	229.49 [@]					
547.92	237.0 1	21 4				
	363.0 ^{&}	≤ 10				
	437.2 1	100 20				
549.34	71.3		(M1)		11.49	E γ : observed only in ce spectrum. Mult.: from ce data; no details given. I $\gamma(378.2\gamma)/I\gamma(315.6\gamma)=14/100$.
	378.2 1	100				
559.52	188.8 1	2.0 4				
	239.2 1	13 3	(M1, E2)		0.27 11	Mult.: E1 excluded by ce data.
	429.3 1	≤ 15				
	448.7 1	53 11				
	519.9 1	100 20				I $\gamma(519.9\gamma)/I\gamma(315.6\gamma)=56/100$.
	559.6 1	23 5				
574.79	111.32 5	50 10				
	217.88 5	100 20				
575.95	219.0 1	50 10				
	398.1 1	100 20				

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$^{180}\text{Hf}(\text{p},\text{n}\gamma),(\text{d},2\text{n}\gamma)$ 2002We01 (continued) $\gamma(^{180}\text{Ta})$ (continued)

E(level)	E_γ	$I_\gamma^\dagger$	Mult. [‡]	α	Comments
595.46	221.22 5				
600.44	184.0 1	100 20			
	289.6 1	29 6			
624.14	64.7		(M1)	2.62	E_γ : observed only in ce spectrum. Mult.: from ce data; no details given.
	176.2 1	22 5			
	253.3 1	78 16			
	303.9 1	63 13			
	624.3 1	100 20			$I_\gamma(624.3\gamma)/I_\gamma(315.6\gamma)=12/100$.
641.43	121.44 5				
645.64	101.4 1	100 §			
	411.3 1	100 §			
653.51	175.5 1	28 §			
	230.1 1	100 §			
	282.6 1	27 §			
	333.2 1	51 §			
	653.4 & 1				
658.49	114.3 1		(M1)	2.97	Mult.: from comparison of I_γ in $\gamma\gamma$ and ce- γ spectra.
	180.4 @ &				
x+660.75	140.8 1				
663.80	114.5 1	100 §	(M1)	2.96	Mult.: from comparison of I_γ in $\gamma\gamma$ and ce- γ spectra.
	429.4 1	≈ 70 §			
671.97	152.0 1				
676.38	128.5 1				
	491.4 1				
680.74	217.2 1				
684.54	327.6 1				
685.89	138.19 5				
	266.1 @				
708.13	158.7 1	≈ 6 §			
	230.06 @ &				
	260.4 1	32 §			
	284.7 1	100 §			
	337.2 1	15 §			
	387.9 1	60 §			
	708.0 &				
708.62?	149.1 1				
721.92	172.6 1	≈ 20 §			
	177.68 5	100 §			
723.52	207.7 1	100			
	349.3 1	≤ 10			
729.55	88.1 1	≈ 1			
	209.6 1	100			
731.17	412.9 1	55 §			
	560.1 1	100 §			
735.45	135.0 1	76 §			
	319.1 1	100 §			
738.45	96.9 1	20 4			
	218.6 1	100 20			
752.70	247.3 1				
756.72	181.9 1				
763.62	188.9 1	92 18			
	300.1 1	100 20			
784.34?	466.0 1	53 §			
	550.1 1	100 §			
787.15	145.7 1	100 20			
	267.2 1	10 2			
787.82?	417.0 1				
788.32	310.3 1				
792.47	120.5 1				
807.18	231.2 1	100			
	433.0 1	≈ 70			
809.37	289.4 1				

Continued on next page (footnotes at end of table)

$^{180}\text{Hf}(\text{p},\text{n}\gamma),(\text{d},2\text{n}\gamma)$ 2002We01 (continued) $\gamma(^{180}\text{Ta})$ (continued)

E(level)	E_γ	$I_\gamma^\dagger$	Mult. ‡	α	Comments
809.46	151.0 1	100 §			
	265.2 1	100 §			
x+822.42	161.6 1				
830.57	255.8 1	81			
	367.1 1	≈ 5			
	473.6 1	100			
836.09	261.3 1				
841.23	245.6 1	18 4			
	467.2 1	100 20			
857.19	171.30 5				
	309.49 @				
863.84	343.8 1				
866.95	291.0 1				
876.80	398.8 1	13 §			
	453.3 1	100 §			
	556.7 1	16 §			
	705.5 1				
880.68	256.6 1	100 §			
	321.4 1	58 §			
	456.9 1	70 §			E_γ : level-energy difference=457.2.
884.04	154.5 1				
	242.6 1	100			
891.76	316.9 1	100 20			
	534.9 1	8 2			
892.82	170.9 1				
892.95	154.5 1		(M1)	1.263	
906.35	149.6 1	≈ 10			
	331.6 1	100			
907.57	119.3 1	27 §			
	185.6 1	100 §			
915.92	492.4 1	42 §			
	545.2 1	22 §			
	595.6 1	100 §			
922.84	242.1 1				
935.06	457.0 1	100 §			
	614.8 1	70 §			
	934.9 & 1				
938.77	146.3 1		(M1)	1.473	
951.52	528.0 1	89 §			
	580.7 1	100 §			
	631.3 1	95 §			
956.32	232.8 1	100			
956.45	169.4 1				
976.58	213.0 1				
	295.8 1				
	402.0 1				
	512.9 1				
977.35	241.9 1				
991.55	350.2 1	100 20			
	471.5 1	51 10			
996.50	548.6 1	61 §			
	625.7 1	100 §			
x+1004.88	182.4 1	100			
	344.2 1	83			
1016.87	186.3 1				
1030.69	173.5 1				
1037.03	666.2 1	84 §			
	716.8 1	100 §			
1043.07	523.1 1				
1053.5	169.5 @				
1100.63	459.2 1				
1113.10	665.2 1	100 §			
	742.3 1	63 §			

Continued on next page (footnotes at end of table)

$^{180}\text{Hf}(\text{p},\text{n}\gamma),(\text{d},2\text{n}\gamma)$ 2002We01 (continued) $\gamma(^{180}\text{Ta})$ (continued)

E(level)	E_γ	$I_\gamma^\dagger$
1149.55	193.2 1	53 10
	362.3 1	100 20
1205.10	341.2 1	=60
	685.2 1	100
1241.59	210.9 1	
1447.49	205.9 1	

† 2002We01 make a general statement of 20% uncertainty on I_γ which has been included by the evaluator. I_γ 's from the first excited $K\pi=1+$ and $1-$ are given more precisely in Table X. Some transitions are indicative values only, as noted.

‡ From conversion electron data, except where noted.

§ Indicative values only.

$^\#$ γ not observed but implied from $\gamma\gamma$ coin. Energy is from level-energy difference.

$^\@$ Transition shown in level scheme figures 11–14 of 2002We01. Energy from level-energy difference.

$^\&$ Placement of transition in the level scheme is uncertain.

 $^{180}\text{Hf}(^{238}\text{U},\text{X}\gamma)$ 2000Wh04

$E(^{238}\text{U})=1.6$ GeV, beam chopped at 8.25/16.5 μs and 2/4 ms on/off cycles. Measured E_γ , I_γ , $\gamma\gamma$, γ -x-ray and γ -t coincidences using Gammasphere array consisting of 98 HPGe and 3 x-ray detectors, all with Compton-suppression.

 ^{180}Ta Levels

E(level) †	$J\pi^\ddagger$	$T_{1/2}$	Comments
77.1	9-		
280.0	10-		
505.4	11-		
752.3	12-		
1020.9	13-		
1309.7	14-		
1452.5	15-		
1792.4	16-		
2157.8	17-		
2589.2	18(+)		
2901.0	19-		
3310.5	20-		
3680.3 §	(22-)	2.0 μs 5	$T_{1/2}$: from comparison of 492 γ and 370 γ intensities in 365 γ gated spectrum. $J\pi$: (E2) 370 γ to 20-. configuration= $\nu 7/2[503]\nu 7/2[514]\nu 9/2[624]$ $\pi 5/2[402]\pi 7/2[404]\pi 9/2[514]$.
4172.3			
4172.3+x §	(23, 24, 25)	17 μs 5	$T_{1/2}$: from $\gamma\gamma(t)$. $J\pi$: 492 γ or 492 γ -x γ cascade to (22-). E(level): possibly same level as 4172.3-keV level. $J\pi$: proposed configuration of $\nu 7/2[514]\nu 9/2[624]\nu 11/2[615]$ $\pi 5/2[402]\pi 7/2[404]\pi 9/2[514]$ would suggest $J\pi=24+$.

† From least-squares fit to E_γ by the evaluator. The energy of the 77.1-keV isomeric level is taken from the Adopted Levels.

‡ From the Adopted Levels, except where noted.

§ Proposed as the six quasiparticle isomers predicted in 1998Dr07 and 1999Sa59.

 $\gamma(^{180}\text{Ta})$

E_γ	E(level)	Mult.	Comments
x	4172.3+x		E_γ : x<60.
143.0	1452.5		
202.7	280.0		
225.1	505.4		
246.9	752.3		

Continued on next page (footnotes at end of table)

$^{180}\text{Hf}(^{238}\text{U}, \text{X}\gamma)$ 2000Wh04 (continued) **$\gamma(^{180}\text{Ta})$ (continued)**

$E\gamma$	E(level)	Mult.	Comments
268.3	1020.9		
288.8	1309.7		
311.8	2901.0		
339.8	1792.4		
365.2	2157.8		
369.8	3680.3	(E2)	$\alpha(\text{exp})=0.09\ 8$ from intensity balance. Mult.: E2 or E3 from $\alpha(\text{exp})$; E3 excluded by comparison to RUL.
409.5	3310.5		
428.5	505.4		
431.3	2589.2		
431.5	1452.5		
472.3	752.3		
492.0	4172.3		
515.5	1020.9		
557.6	1309.7		
705	2157.8		
1136.8	2589.2	[E3]	$I\gamma: I\gamma(1137\gamma)/I\gamma(431\gamma)=7\%$.

 $^{180}\text{Ta}(\gamma, \gamma')$: Target=9- Isomer 2002Be18, 2002La01

The ^{180}Ta (Target=9- isomer)(γ, γ') reaction is important in nuclear astrophysics for explaining the abundance of ^{180}Ta in stellar matter. The unusually large integrated cross section ($\sigma \Gamma$) for the ^{180}Ta (Target=9- isomer) (γ, γ') ^{180}Ta (8.1 h) reaction reported by 1988Co04, 1989Ca19 have raised the concern that evolution of this isotope may be affected by photoexcitation at the s-process temperatures. However, the energies of the resonant states (2.8–3.6 MeV) measured by 1990Co24 are high enough to insure the survival of this nucleus in an s-process environment. A disagreement between 1992Ne02 and 1990Co24 regarding the magnitude of the integrated cross sections still remains an open question.

2002Be18, 2001Vo13, 1999Be65: Target: Ta_2O_5 target enriched 5.45% $^{180\text{m}}\text{Ta}$ containing 6.7 mg of $^{180\text{m}}\text{Ta}$ ($>1.2 \times 10^{15}$ y); 123 mg/cm² of Ta_2O_5 powder and natural Ta metal targets. Bremsstrahlung with 1.5 MeV end point energy. Measured $E\gamma$, $I\gamma$ in photon scattering experiment with three Ge detectors at 90°, 127°, and 150°. The detector at 127° was surrounded by a BGO anti-Compton shield. In activation measurement, measured $E\gamma$, $I\gamma$, x-rays with two high resolution LEP detectors; deduced $T_{1/2}$ of ground state.

2002La01: Target: natural Ta disc of diameter 40 mm and thickness 0.33 mm. Projectile: 1.85 PBq ^{60}Co source. Planar Ge detector surrounded by NaI anti-coincidence shield. Partial lifetime for intermediate states.

2001Wa45: Interpretation of the states observed in 2002Be18, 1999Be65.

1990Co24: Target: 99.95% enriched ^{180}Ta containing ^{180}Ta ($>1.2 \times 10^{15}$ y) in its natural abundance. Bremsstrahlung from tantalum irradiated with electrons. Fourteen different endpoints of the bremsstrahlung were arranged to span the interval from 2 to 5 MeV. Uncertainties in the end points were less than 50 keV. Standard calculations provided the photon flux for the various electron energies, and these calculated values were verified using the $^{87}\text{Sr}(\gamma, \gamma')^{87}\text{Sr}$ (2.8 h) reaction. A measurement of HF K x-ray with α decay rate consistent with $T_{1/2}=8.1$ h suggested that these high-energy states cascade through the levels of ^{180}Ta leading finally to the ground state. Detector: hyperpure germanium. Measured integrated cross sections of $\sigma \Gamma=120$ mb keV 20 and $\sigma \Gamma=350$ mb keV 50 for depopulating ^{180}Ta ($>1.2 \times 10^{15}$ y) through resonant states at 2.8 MeV 1 and 3.6 MeV 1, respectively. The 3.6 MeV resonance has not yet been observed in other experiment.

Others: 1988Ca04, 1989Ca19, 1992Ca01, 1992Ca01, 1992Ne02, 1994Ka54, 1995BeZX, 1997Be58, 1997Be76, 1998BeZY, 1998Ka14, 1999Bi08, 1999Bi21, 1999To05, 2001Kn02, 2001So17, 2002Ga14, 2011Vy02.

 ^{180}Ta Levels

$E(\text{level})^\dagger$	$J\pi$	$T_{1/2}$	Comments
0.0	1+	8.18 h 2	$T_{1/2}$: from $K\alpha$ x-ray(t) (2002Be18). Other: 8.15 h 3, early result by same group (1999Be56).
77.1 8	9-	$>7.1 \times 10^{15}$ y	$E(\text{level}), T_{1/2}$: from the Adopted Levels.
1087 10		≤ 35 ps	$T_{1/2}$: from partial meanlife of 40 ps 11 (2002La01). $E(\text{level})$: identified as the 1076 keV $J\pi=(8+)$ level in 2001Wa45.
1300 20		≤ 7 ps	$E(\text{level})$: identified as the 1278 keV $J\pi=(9+)$ level in 2001Wa45. $T_{1/2}$: from partial meanlife of 9.3 ps 4 (2002La01).
1510 20			$E(\text{level})$: identified as the 1499 keV $J\pi=(10+)$ level in 2001Wa45.
1630 30			
1930 50			

Continued on next page (footnotes at end of table)

$^{180}\text{Ta}(\gamma, \gamma')$: Target=9- Isomer 2002Be18,2002La01 (continued) **^{180}Ta Levels (continued)**E(level)[†]

2240 20
 2480 60
 2720 30
 2880 40

[†] From 2002Be18, except for the 1087-keV level which is from 1999Be65. Excitation energy of the 9- isomer (77 keV) has been added by the evaluator to the energies given in 2002Be18 and 1999Be65.

Coulomb Excitation 2003Lo01,1997Lo05

1997Lo05: ($^{32}\text{S}, ^{32}\text{S}'$) with $E(^{32}\text{S})=125$ MeV and ($^{58}\text{Ni}, ^{58}\text{Ni}'$) with $E(^{58}\text{Ni})=225$ MeV. Measured $E\gamma$, $I\gamma$, $\gamma\gamma$, and γ -particle coincidences using 24 PIN diodes and 5 Compton-suppressed Ge detectors for the ^{32}S beam experiment and 55 PIN diodes and the NORDBALL array for the ^{58}Ni experiment. Similar results also presented in 1996Lo19.
 2003Lo01: ($^{58}\text{Ni}, ^{58}\text{Ni}'$), $E(^{58}\text{Ni})=225$ MeV. Measured $E\gamma$, $I\gamma$, $\gamma\gamma$, and particle- γ coincidences using NORDBALL array consisting of 20 Ge detectors and 55 PIN diodes placed at backwards angles. Also used ^{36}S at $E=1.8-3.5$ MeV/nucleon and ^{64}Ni at $E=2.0-2.4$ MeV/nucleon for activation experiments. Earlier results presented in 1999Lo13.
 Others: ($^{136}\text{Xe}, ^{136}\text{Xe}'$), 2001Sc22, 1997Vo11; (p,p'), (α, α'), 1998Sc36, 1997Sc18; ($^{32}\text{S}, ^{32}\text{S}'$), ($^{36}\text{S}, ^{36}\text{S}'$), 1994Sc26.

 ^{180}Ta Levels

E(level) [†]	$J\pi^{\ddagger}$	E(level) [†]	$J\pi^{\ddagger}$	E(level) [†]	$J\pi^{\ddagger}$
77.1 § & 8	9- §	1136.1 ? @ 10	(7-) @	1546.2 # 10	12- #
280.20 & 10	10-	1291.2 ? @ 10	(8-) @	1620.0 & 5	15-
505.50 & 12	11-	1310.7 & 4	14-	1947.7 & 7	16-
752.9 & 3	12-	1339.1 # 10	11- #		
1021.4 & 3	13-	1450 ? @	(9-) @		

[†] From a least-squares fit to $E\gamma$ by evaluator.

[‡] As proposed by 1997Lo05 and based on assumed band structure, except where noted.

§ From the Adopted levels.

From 2003Lo01.

@ From from 2003Lo01; due to tentative assignment, level is not included in the Adopted Levels.

& (A): Rotational band build on 9- isomer.

 $\gamma(^{180}\text{Ta})$

E(level)	$E\gamma^{\dagger}$	$I\gamma$	Mult.#	α	E(level)	$E\gamma^{\dagger}$	$I\gamma$	Mult.#	α
280.20	203.1 1				1310.7	289.2 3	100	(M1)	0.223
505.50	225.3 1	100	(M1)	0.441		558.0 4	102 34	(E2)	0.01540
	428.4 2	22.1 10	(E2)	0.0300	1339.1	1262 [‡]			
752.9	247.4 6	100	(M1)	0.341 6	1450?	947 § @			
	472.7 6	49 11	(E2)	0.0232	1546.2	1266 [‡]			
1021.4	268.5 3	100	(M1)	0.273	1620.0	309.1 5	100	(M1)	0.186
	515.9 3	85 12	(E2)	0.0186		598.7 4	92 46	(E2)	0.01303
1136.1?	1059 §				1947.7	327.4 9	100	(M1)	0.159 3
1291.2?	1011 §					637.1 7	140 90	(E2)	0.01128

[†] From 1997Lo05, except where noted.

[‡] From 2003Lo01.

§ From 2003Lo01; due to tentative assignment γ is not included in the Adopted Gammas.

As proposed by 1997Lo05 based on assumed rotational band structure.

@ Placement of transition in the level scheme is uncertain.

$^{181}\text{Ta}(\gamma, n)$ 1984Co03

Capture γ -rays from (n, γ) on Al ($E_\gamma=7724$ MeV), Cu ($E_\gamma=7915$ MeV), Cr ($E_\gamma=7939$, 8485, 8512, 8884, and 9720 MeV), and Ni ($E_\gamma=8121$, 8533, and 8999 MeV). Measured neutron energies and intensities using a high-resolution gridded ^3He ionization chamber (FWHM=13–20 keV). Earlier result from same group given in 1981Co17.

Others: 1974Ba68, 1974La21, 1975Wo07, 1976ShZR, 1976LoZW, 1976Ha32, 1984Be25, 1984Be55, 1984Wo04, 1984Le09, 1985Be55, 1985Le24, 1987Da29, 1990GoZK, 1994Ka38, 1995KaZT, 1996BeZZ, 1996KaZP, 1998Le39, 2000Le02, 2000To02, 2003Ut01, 2003Ut02, 2006Go17, 2007GoZZ, 2012Is03.

A Q value of 7579 keV 2 was determined in 1981Co17. Using this value, and 7652.3 keV 5 for the Q value of the $^{180}\text{Ta}(n, \gamma)^{181}\text{Ta}$ reaction, also measured in 1981Co17, the energy of the long-lived ^{180}Ta isomer can be calculated at 73 keV 2.

 ^{180}Ta Levels

E(level)	E(level)	E(level)
0.0	514 3	959 3
39 2	542 2	1122 2
109 2	571 2	1205 2
179 2	624 2	1247 3
231 2	643 2	1307 2
258 2	666 3	1351 2
309 2	720 2	1427 4
365 3	793 2	1740 3
413 2	820 2	1822 3
442 2	857 2	1866 3
466 3	897 3	

 $^{181}\text{Ta}(p, d)$ 2002We01, 1983Wa01

$J\pi(^{181}\text{Ta})=7/2+$.

2002We01: E(p)=22 MeV. Measured deuteron spectra at 40° with Q3D spectrometer (FWHM=4 keV).

1983Wa01, 1979Wa05, 1978Wa17: E(p)=19 MeV. Measured $\sigma(\theta)$ using magnetic spectrometer and four solid state position sensitive detectors (FWHM $\leq$ 15 keV); DWBA analysis.

Others: 1974KhZX, 1975IsZW.

 ^{180}Ta Levels

E(level) [†]	$J\pi^{\dagger}$	$L^{\ddagger}$	C ² S [§]	E(level) [†]	$J\pi^{\dagger}$	$L^{\ddagger}$	C ² S [§]	E(level) [†]	$J\pi^{\dagger}$	$L^{\ddagger}$	C ² S [§]
0.0 ^{&}	1+	4	1.4	576.8 ^a	6–	3	0.67	808.5 ^e	(5–)		
39.8 ^{&}	2+	4	1.7	596.6 ^{&}	10+			836.4 ^d	5–	3	0.67
78.0 10	9–			600.3 ^{&}	7+			876.5 ^e	(2–)		
111.1 ^{&}	3+	6	1.7	646.3 ^c	(4–)			884.5			
178.9 ^{&}	8+	5(+6)	0.91 [#]	654.1				891.3			
185.6 ^{&}	4+		0.91	658.4 ^a	(4–)	3	1.1 [@]	895.0			
310.8 ^{&}	5+	6	0.91	663.3 ^c	(4–)		1.1	907.7 ^d	4–	1	1.2
375.8 ^{&}	9+	6	1.2	680.5				914.5			
416.5 ^{&}	6+			682.7 ^b	8–			952.6			
423.2 ^a	1–	3	0.77	717.3				973.0			
425.8				722.3 ^d	4–	1	1.1	977.3 ^a	8–		
465.2 ^b	7–			733.4				986.2			
477.4 ^a	2–	3	1.2	758.1				1003.7			
544.0 ^a	3–	3	0.83	763.6 ^a	7–	3	1.0	1062.6			
548.4 ^c	3–			784.0 ^c	(5–)			1075.9			
572.2				788.0 ^d	3–	1	1.0	1080.0			

[†] From 2002We01.

[‡] From comparison of measured angular distributions with DWBA calculations (1983Wa01).

[§] C²S=(1/N) ($\sigma(\text{exp})/\sigma(\text{DWBA})$), N=2.29 (1983Wa01).

[#] Possible contribution from the 186, $J\pi=4+$ level.

[@] Possible contribution from the 663, $J\pi=(4-)$ level.

[&] 9/2+[624] neutron transferred.

^a 5/2–[512] neutron transferred.

^b 7/2–[514] neutron transferred.

^c 1/2–[510] neutron transferred.

Footnotes continued on next page

$^{181}\text{Ta}(\text{p},\text{d})$ 2002We01,1983Wa01 (continued) **^{180}Ta Levels (continued)**

d 1/2-[521] neutron transferred.

e 3/2-[512] neutron transferred.

 $^{181}\text{Ta}(\text{d},\text{t})$ 1983De43 $J\pi(^{181}\text{Ta})=7/2+$.E(d)=17.4 MeV. Measured $\sigma(\theta)$ for $\theta=7.5^\circ$ to 90° in 7.5° steps using QDDD spectrometer (FWHM=20 keV); DWBA analysis. **^{180}Ta Levels**

E(level)	$J\pi^\dagger$	$L^\ddagger$	$C^2S^\S$	E(level)	$J\pi^\dagger$	$L^\ddagger$	$C^2S^\S$	E(level)	$J\pi^\dagger$	$L^\ddagger$	$C^2S^\S$
0.0 [#]	1+	4	1.09	462 ^b 4	7-	5	0.638	753 ^a 5	7-	3	0.544
45 [#] 2	2+	4	2.79	476 ^{&} 4	2-	3	0.480	775 ^c 5	3-	1	0.983
114 [#] 2	3+	6	1.30	545 ^{&} 4	3-	3	0.643	822 ^d 5	5-	3	0.587
172 [@] 5	8+	4	0.690	571 ^a 4	6-	3	0.565	875 ^c 8	4-	3	0.227
187 [#] 2	4+	6	0.348	592 [@] 3	10+	6	1.95	893 6			
312 [#] 3	5+	6	1.16	652 ^{&} 4	4-	3	1.43	930 2			
376 [@] 4	9+	6	1.42	671 ^b 6	8-	5	0.720	948 ^d 2	6-		0.468
420 ^{&} 4	1-	3	0.555	712 ^d 5	4-	1	0.951				

[†] Spin, parity, and configuration assignments are based on comparison between experimental and theoretical cross sections, on rotational structure, and on measured L-transfers.[‡] From comparison of measured angular distributions and DWBA calculations.[§] $C^2S=(1/N)(\sigma(\text{exp})/\sigma(\text{DWBA}))$, $N=1.33$. C^2S values are for $\theta=60^\circ$, except for members of the $K=1-$ rotational band, for which $\theta=30^\circ$.Note that a typical normalization factor for a (d,t) reaction is $N=3.33$.[#] $K\pi=1+$ rotational band; probable configuration= $((\pi 7/2[404])-(\nu 9/2[624]))$.[@] $K\pi=8+$ rotational band; probable configuration= $((\pi 7/2[404])+(\nu 9/2[624]))$.[&] $K\pi=1-$ rotational band; probable configuration= $((\pi 7/2[404])-(\nu 5/2[512]))$.^a $K\pi=6-$ rotational band; probable configuration= $((\pi 7/2[404])+(\nu 5/2[512]))$.^b $K\pi=7-$ rotational band; probable configuration= $((\pi 7/2[404])+(\nu 7/2[514]))$.^c $K\pi=3-$ rotational band; probable configuration= $((\pi 7/2[404])-(\nu 1/2[521]))$.^d $K\pi=4-$ rotational band; probable configuration= $((\pi 7/2[404])+(\nu 1/2[521]))$.

Adopted Levels, Gammas

Q(β^-)=-3801 21; S(n)=8412 15; S(p)=6567.8 5; Q(α)=2515.0 10 2012Wa38.
 S(2n)=15372 15; S(2p)=11778.8 3 (2012Wa38).
 Q(2e)=143.20 27 from Penning Trap measurement (2012Dr01).
 Other reactions:
 2002Pf01: Be($^{208}\text{Pb},\text{X}\gamma$), E=1 GeV/nucleon. Measured $T_{1/2}$ of 3265, 14- isomer.
 1994Ji02: Atomic-beam laser spectroscopy, measured isotope shift relative to ^{182}W .
 1980KoZK: $^{180}\text{W}(^{86}\text{Kr},^{86}\text{Kr}')$, measured yrast band energies up to 10+ level.
 1977Dr03: $^{181}\text{Ta}(\text{d},3\text{n})$, E=24 MeV. Measured delayed γ 's from 8- isomer.
 1976Ha46: $^{182}\text{W}(^{12}\text{C},^{14}\text{C})$, E=70 MeV. Measured $\sigma(\theta)$ to 0+ and 2+ (103 keV) levels.

 ^{180}W Levels**Cross Reference (XREF) Flags**

A ^{180}Ta β^- Decay	E $^{176}\text{Yb}(^9\text{Be},5\text{n}\gamma)$	I $^{181}\text{Ta}(\text{p},2\text{n}\gamma)$
B ^{180}Re ε Decay	F $\text{Hf}(\alpha,\text{xn}\gamma)$	J $^{182}\text{W}(\text{p},\text{t})$
C ^{180}W IT Decay (5.47 ms)	G $^{180}\text{W}(\gamma,\gamma')$: Mossbauer	K $^{186}\text{W}(\text{n},7\text{n}\gamma)$
D $^{136}\text{Xe}(^{48}\text{Ca},4\text{n}\gamma)$	H $^{180}\text{W}(\text{d},\text{d}')$	

E(level) [†]	J $\pi^{\ddagger}$	XREF	$T_{1/2}^{\S}$	Comments
0.0 [#]	0+	ABCDEFGHIJK	1.8 $\times 10^{18}$ y 2	% α =100. $T_{1/2}$: from 2004Co26. Others: 1.0 $\times 10^{18}$ y +7-3 (2005Zd04) which supersedes the values from 2003Da05, 2003Bi13, 2002Bi16, and 1995Ge17, $\geq 2.7 \times 10^{17}$ y (2003Ce01), $> 1.1 \times 10^{15}$ y (1960Be13), $> 9 \times 10^{14}$ y (1961Ma05). $T_{1/2}$: 2 ε decay not observed. $T_{1/2}(2\varepsilon 0\nu) \geq 1.3 \times 10^{18}$ y, $T_{1/2}(2\varepsilon 2\nu) \geq 6.6 \times 10^{17}$ y (2011Be39,2009Be27) which supersedes the values from 2003Da09 and 2003Da24.
103.561 [#] 16	2+	ABCDEFGHIJK	1.28 ns 5	$\mu=0.509$ 34. $J\pi$: E2 103.6 γ to 0+. μ : from $^{180}\text{W}(\gamma,\gamma')$:Mossbauer. Recalculated for consistency with standard (1973Zi03,1989Ra17). $T_{1/2}$: from ^{180}Ta β^- decay.
337.559 [#] 24	4+	BCDEF HIJK		$J\pi$: E2 234.0 γ to 2+.
688.46 [#] 3	6+	CDEF HIJK		$J\pi$: E2 350.9 γ to 4+.
1006.381 [@] 19	2-	B EF I	7.4 ns 4	$J\pi$: E1+M2 903 γ to 2+, 669 γ to 4+, 1006 γ to 0+. $T_{1/2}$: from $\gamma\gamma(\text{t})$ in ^{180}Re ε decay. Other: ≈ 5.5 ns from centroid-shift analysis in $^{176}\text{Yb}(^9\text{Be},5\text{n}\gamma)$.
1082.374 [@] 20	3-	B EF HIJ		$J\pi$: 76.0 γ to 2-, 744.8 γ to 4+; band assignment.
1117.31 ^{&} 3	2+	B HIJ		$J\pi$: 1014 γ to 2+, 1117 γ to 0+, L(p,t)=(2).
1138.47 [#] 3	8+	CDEF I K		$J\pi$: E2 450 γ to 6+; band assignment.
1184.893 [@] 20	4-	B EF IJ		$J\pi$: 102.5 γ to 3-, E2 178.5 γ to 2-, 847.4 γ to 4+; band assignment.
1232.67 ^{&} 3	3+	B IJ		$J\pi$: 895.3 γ to 4+, 1129.1 γ to 2+; band assignment.
1307.575 [@] 23	5-	EF hI		XREF: h(1319). $J\pi$: M1+E2 123 γ to 4-, E2 225.2 γ to 3-; band assignment.
1322.09 19	(2+)	hIJ		XREF: h(1319). $J\pi$: 984 γ to 4+, 1218.8 γ to 2+, 1322 γ to 0+.
1360.51 ^{&} 4	4+	IJ		$J\pi$: (E2) 1257 γ to 2+, 1023 γ to 4+; band assignment.
1380.8 3	0+	J		$J\pi$: L(p,t)=0.
1461.82 [@] 3	6-	EF I		$J\pi$: E2 277 γ to 4-, 154 γ to 5-; band assignment.
1472.1 4	(0+)	J		$J\pi$: L(p,t)=(0).
1513.6 4	0+	J		$J\pi$: L(p,t)=0.
1529.05 ^c 4	8-	CDEF I	5.47 ms 9	$J\pi$: E1 390.6 γ to 8+, $\gamma(0)$ in $\text{Hf}(\alpha,\text{xn}\gamma)$. $T_{1/2}$: weighted average of 5.24 ms 19 from $\text{Hf}(\alpha,\text{xn}\gamma)$ and 5.53 ms 10 from $^{181}\text{Ta}(\text{p},2\text{n}\gamma)$. configuration=(v7/2[514])(v9/2[624]).
1535.63 ^{&} 6	5+	I		$J\pi$: 847 γ to 6+, 1198 γ to 4+, band assignment.
1568.17 11		I		
1587.27 5	2+	B J		$J\pi$: L(p,t)=2.
1624.23 [@] 3	7-	EF I		$J\pi$: E2 317 γ to 5-, 162 γ to 6-; band assignment.
1632.92 5	(1-,2)	B h j		XREF: h(1637j)(1635).
1634.67 4	(3,4+)	hIj		$J\pi$: 550.5 γ to 3-, log ft=6.7 in ^{180}Re ε decay from (1)- parent. XREF: h(1637j)(1635). $J\pi$: 450 γ to 4-, 517 γ to 2+, 1297 γ to 4+.

Continued on next page (footnotes at end of table)

Adopted Levels, Gammas (continued) ^{180}W Levels (continued)

E(level) [†]	J $\pi^{\ddagger}$	XREF	T _{1/2} [§]	Comments
1639.80 ^a 3	(5-)	EF I	19.2 ns 3	J π : 179 γ to 6-, 279 γ to 4+, 455 γ to 4-, 951 γ to 6+. T _{1/2} : from $^{181}\text{Ta}(p,2n\gamma)$. Other: 24 ns 7 from Hf(α ,xn γ). configuration=(v1/2[521])(v9/2[624]).
1664.18 [#] 4	10+	DEF I K		J π : E2 526 γ to 8+; band assignment.
1689.4 5	0+	h J		XREF: h(1692). J π : L(p,t)=0.
1693.60 15		h I		XREF: h(1692).
1702.98 ^{&} 8	6+	I		J π : 1014 γ to 6+, 1365.5 γ to 4+; band assignment.
1725.59 ^c 5	9-	DEF h I j		XREF: h(1737j)(1740). J π : 196.5 γ to 8-; band assignment.
1729.85 7	(4+, 5, 6+)	h I j		XREF: h(1737j)(1740). J π : 1041 γ to 6+, 1392 γ to 4+.
1764.42 ^a 3	(6-)	EF I		J π : 125 γ to (5-); band member.
1768.4 5	0+	J		J π : L(p,t)=0.
1784.96 7	(4+, 5+)	I		J π : 552 γ to 3+, 1096 γ to 6+.
1814.88 12	(2+, 3)	B H		J π : 809 γ to 2-, 1477 γ to 4+, 1711 γ to 2+. Log $ft=7.5$ in ^{180}Re ε decay from (1)- parent favors J $\pi=2+$.
1830.85 [@] 4	8-	EF h I		XREF: h(1824). J π : E2 369 γ to 6-, 207 γ to 7-; band assignment.
1831.70 3	2-	B h		XREF: h(1824). J π : log $ft=5.0$ in ^{180}Re ε decay from (1)- parent, 599 γ to 3+.
1851.15 6		I		
1855.20 16		I		
1911.58 ^a 4	(7-)	EF I J		J π : D+Q 147 γ to (6-), 272 γ to (5-); band assignment.
1918.13 19	(4+, 5, 6+)	I		J π : 1230 γ to 6+, 1581 γ to 4+.
1926.44 16	(6+, 7, 8+)	I		J π : 788 γ to 8+, 1238 γ to 6+.
1932.20 ^{&} 11	7+	I		J π : 794 γ to 8+, 12434 γ to 6+; band assignment.
1932.3 6	(0+)	J		J π : L(p,t)=(0).
1945.07 ^c 6	10-	DEF I J		J π : E2 416 γ to 8-, M1 219.5 γ to 9-; band assignment.
1954.53 15		I		
2024.57 [@] 8	9-	EF I		J π : E2 400 γ to 7-; band assignment.
2036.7 6	0+	J		J π : L(p,t)=0.
2059.35 12		I J		
2082.55 ^a 6	(8-)	EF I J		XREF: J(2095). J π : E2 318 γ to (6-), M1+E2 171 γ to (7-); band assignment.
2117.52 12		I		
2127.39 9		I		
2133.09 ^b 9	(8+)	E I		J π : 995 γ to 8+; band head of Fermi-aligned $i_{13/2}^2$ band.
2164 10		J		
2176.80 5		B		
2181.6 6	0+	J		J π : L(p,t)=0.
2187.00 ^c 11	11-	DEF I		J π : E2 461 γ to 9-, M1 242 γ to 10-; band assignment.
2203 10		J		
2212 6		H J		E(level): from (d,d'). Other: 2212 10 from (p,t).
2227.85 9		B		
2235.19 [#] 11	12+	DEF I K		J π : E2 571 γ to 10+; band assignment.
2256.65 [?] 6		B j		XREF: j(2265).
2273.70 ^a 7	(9-)	EF I j		XREF: j(2265). J π : E2 362 γ to (7-), D 191.5 γ to (8-); band assignment.
2274.0 ^b 5	(9+)	E		J π : 141 γ to (8+); band assignment.
2284.00 [@] 15	10-	EF I		J π : E2 453 γ to 8-; band assignment.
2293 10		J		
2326.8 7	0+	J		
2348 6		H J		E(level): from (d,d'). Other: 2356 10 in (p,t).
2400 10		J		
2415.77 4	2-	B		J π : log $ft=5.7$ in ^{180}Re ε decay from (1)- parent, 1183 γ to 3+.
2423.9 ^b 4	(10+)	E		J π : 150 γ to (9+), 1285 γ to 8+; band assignment.
2435.18 3	2-	B		J π : log $ft=5.8$ in ^{180}Re ε decay from (1)- parent, 1203 γ to 3+.
2451.61 ^c 13	12-	DEF I		J π : E2 507 γ to 10-; band assignment.
2494.5 ^a 7	(10-)	E		J π : 221 γ to (9-), 412 γ to (8-); band assignment.
2501.17 [@] 13	11-	EF I		J π : E2 477 γ to 9-; band assignment.
2522.58 7		B		
2531.51 9		B		

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Adopted Levels, Gammas (continued) ^{180}W Levels (continued)

E(level) [†]	J $\pi^{\ddagger}$	XREF	T _{1/2} [§]	Comments
2546.87 9		B		
2589.1 ^b 5	(11+)	E		J π : E2 315 γ to (9+); band assignment.
2722.9 ^a 10	(11-)	E		J π : 449 γ to (9-); band assignment.
2736.8 ^c 4	13-	DEF		J π : E2 549 γ to 11-, M1 285 γ to 12-; band assignment.
2763.6 ^b 5	(12+)	E		J π : E2 340 γ to (10+), 175 γ to (11+); band assignment.
2813.4 [@] 10	12-	EF		J π : E2 529 γ to 10-; band assignment.
2822.9 [#] 7	14+	DEF		J π : E2 588 γ to 12+; band assignment.
2884.12 5	2-	B		J π : log ft=5.6 in ^{180}Re ϵ decay from (1)- parent, 1651.5 γ to 3+.
2910.02? 9		B		
2966.2 ^b 6	(13+)	E		J π : E2 377 γ to (11+), 202 γ to (12+); band assignment.
3000.5 ^a 12	(12-)	E		J π : 506 γ to (10-); band assignment.
3042.7 ^c 4	14-	DEF		J π : E2 591 γ to 12-, M1 306 γ to 13-; band assignment.
3047.5 [@] 10	13-	EF		J π : E2 546 γ to 11-; band assignment.
3176.3 ^b 6	(14+)	E		J π : E2 413 γ to (12+); band assignment.
3248.4 ^a 14	(13-)	E		J π : 526 γ to (11-); band assignment.
3264.9 3	14-	DEF	2.3 μs 2	J π : (M1) 222 γ to 14-, 813 γ to 12-. T _{1/2} : from 2.3 μs 2 in Be(^{208}Pb ,X) (2002Pf01) and 2.3 μs 2 from Hf(α ,xn γ). configuration=(v7/2[514]v9/2[624])(π 5/2[402] π 7/2[404]).
3356.1 8		E		
3368.3 ^c 7	15-	E		J π : E2 632 γ to 13-; band assignment.
3389.8 7	(15+)	DEF	8.6 ns 6	J π : (E1) 125 γ to 14-. T _{1/2} : other: =3.5 ns from centroid-shift analysis in ^{176}Yb (^9Be ,5n γ). configuration=(v7/2[514]v9/2[624])(π 5/2[402] π 9/2[514]).
3411.2 [@] 14	(14-)	EF		J π : 598 γ to 12-; band assignment.
3412.7 [#] 10	16+	DEF		J π : E2 590 γ to 14+, band assignment.
3421.8 ^b 8	(15+)	E		J π : E2 455 γ to (13+), (M1+E2) 246 γ to (14+); band assignment.
3515.2 9		D		
3529.1 7		E		
3547.9 ^h 12	(16+)	DEF	20.3 ns 6	J π : (M1) 158 γ to (15+). T _{1/2} : other: =4.2 ns from centroid-shift analysis in ^{176}Yb (^9Be ,5n γ). configuration=(v7/2[514]v9/2[624])(π 7/2[404] π 9/2[514]).
3581.6 8		E		
3605.8 9		E		
3656.7 [@] 14	15-	E		J π : E2 609 γ to 13-; band assignment.
3695.5 ^b 8	(16+)	E		J π : E2 519 γ to (14+); band assignment.
3697.8 7		E		
3713.0 ^c 8	16-	E		J π : E2 671 γ to 14-; band assignment.
3745.0 9		DE		
3831.5 9		D		
3845.4 ^a 17	(15-)	E		J π : 597 γ to (13-); band assignment.
3888.2 ^h 15	(17+)	EF		J π : 340 γ to (16+); band assignment.
3898.0 ^d 8	(16-)	E		J π : 250 γ from (17-); band assignment.
3967.2 ^b 10	(17+)	E		J π : E2 545 γ to (15+); band assignment.
4002.0 12		DE		
4017.4 [#] 13	(18+)	DEF		J π : (E2) 604.5 γ to 16+; band assignment.
4066.2 [@] 17	(16-)	E		J π : 655 γ to (14-); band assignment.
4074.9 ^c 12	(17-)	E		J π : 707 γ to 15-; band assignment.
4147.8 ^d 6	(17-)	DE		J π : 435 γ to 16-, 780 γ to 15-.
4248.9 ^h 15	(18+)	EF		J π : 361 γ to (17+), 701 γ to (16+); band assignment.
4269.9 11		DE		
4320.4 [@] 17	(17-)	E		J π : 664 γ to 15-; band assignment.
4339.4 ^b 11	(18+)	E		J π : E2 644 γ to (16+); band assignment.
4416.7 ^d 9	(18-)	E		J π : 519 γ to (16-); band assignment.
4455.9 ^c 13	(18-)	E		J π : 743 γ to 16-; band assignment.
4525.7 18		E		
4554.2 12		DE		
4606.6 ^b 14	(19+)	E		J π : E2 639 γ to (17+); band assignment.
4628.8 ^h 16	(19+)	EF		J π : 380 γ to (18+), 741 γ to (17+); band assignment.
4673.1 [#] 14	(20+)	DE		J π : E2 655.5 γ to (18+); band assignment.
4711.4 ⁱ 9	(19-)	DE		J π : 295 γ to (18-), 564 γ to 17-.

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Adopted Levels, Gammas (continued) ^{180}W Levels (continued)

E(level) [†]	J $\pi^{\ddagger}$	XREF	T _{1/2} [§]	Comments
4761.2@ 20	(18-)	E		J π : 695 γ to (16-); band assignment.
4845.9?c 16	(19-)	E		J π : 771 γ to (17-); band assignment.
4852.9i 11	(20-)	DE		J π : 142 γ to (19-); band assignment.
4857.3 12		DE		
5024.8h 16	(20+)	E		J π : 396 γ to (19+), (E2) 776 γ to (18+); band assignment.
5027.4?@ 20	(19-)	E		J π : 707 γ to (17-); band assignment.
5029.7?d 13	(20-)	E		J π : 613 γ to (18-); band assignment.
5095.3b 15	(20+)	E		J π : E2 756 γ to (18+); band assignment.
5128.7i 12	(21-)	DE		J π : 276 γ to (20-); band assignment.
5178.5 12		DE		
5339.8b 17	(21+)	E		J π : E2 733 γ to (19+).
5402.2# 14	(22+)	DE		J π : 729 γ to (20+); band assignment.
5434.8h 17	(21+)	E		J π : 410 γ to (20+), 806 γ to (19+); band assignment.
5454.2i 12	(22-)	DE		J π : 326 γ to (21-), 601 γ to (20-); band assignment.
5518.8 13		DE		
5745.4?@ 22	(21-)	E		J π : 718 γ to (19-); band assignment.
5815.8i 12	(23-)	DE		J π : 362 γ to (22-), 687 γ to (21-); band assignment.
5859.3h 17	(22+)	E		J π : 424 γ to (21+), 835 γ to (20+); band assignment.
5877.5 12	(22-)	DE		J π : 359 γ to (21-), 699 γ to (20-); band assignment.
5975.4 12	(23-)	DE	<0.7 ns	J π : 521 γ to (22-), 847 γ to (21-).
				T _{1/2} : from centroid-shift analysis in $^{176}\text{Yb}(^9\text{Be},5n\gamma)$.
6115.2 12	(23-)	DE	≈ 1.4 ns	J π : 661 γ to (22-), 986 γ to (21-).
				T _{1/2} : from centroid-shift analysis in $^{176}\text{Yb}(^9\text{Be},5n\gamma)$.
6162.8?b 20	(23+)	E		J π : 823 γ to (21+); band assignment.
6207.9i 13	(24-)	E		J π : 392 γ to (23-), 735.5 γ to (22-); band assignment.
6211.9# 14	(24+)	DE		J π : 809.5 γ to (22+); band assignment.
6292.6?h 18	(23+)	E		J π : 433 γ to (22+), 858 γ to (21+); band assignment.
6304.2g 13	(24+)	DE	<0.7 ns	J π : 189 γ to (23-).
				T _{1/2} : from centroid-shift analysis in $^{176}\text{Yb}(^9\text{Be},5n\gamma)$.
6626.6i 14	(25-)	E		J π : 418.5 γ to (24-), 811 γ to (23-); band assignment.
6734.1g 15	(25+)	DE		J π : 430 γ to (24+); band assignment.
7070.2i 15	(26-)	E		J π : 444 γ to (25-), 862 γ to (24-); band assignment.
7101.4# 17	(26+)	E		J π : 889.5 γ to (24+); band assignment.
7177.4g 15	(26+)	DE		J π : 443 γ to (25+), 873 γ to (24+); band assignment.
7634.1g 16	(27+)	D		J π : 456 γ to (26+), 900 γ to (25+); band assignment.
8067.4?# 20	(28+)	E		J π : 966 γ to (26+); band assignment.

[†] From a least-squares fit to E γ , by evaluator, for levels connected by γ -rays. The remaining level energies are from the indicated dataset.

[‡] Assignments are based mainly on band structures and on γ -ray multiplicities and decay patterns. Additional arguments are included in the comments.

[§] From beam- $\gamma(t)$ in Hf(α ,xn γ), except where noted.

(A): g.s. band.

@ (B): K π =2- octupole rotational band.

& (C): K π =2+ γ vibrational band.

a (D): K π =(5-) rotational band.

b (E): K π =(8+) band. Interpreted as a Fermi-aligned i_{13/2}², t-band.

c (F): K π =8- rotational band.

d (G): K π =16- band.

g (J): K=(24+) band.

h (K): K π =(16+) band.

i (L): K π =(19-) band.

 $\gamma(^{180}\text{W})$

E(level)	E $\gamma^{\dagger}$	I $\gamma^{\dagger}$	Mult. [‡]	δ	α	Comments
103.561	103.568 18	100	E2		3.40	B(E2)(W.u.)=140 6. Mult.: from ce ratios in ^{180}Re ϵ decay.
337.559	233.99 3	100	E2		0.184	Mult.: from ce(K)/ce(L) in Hf(α ,xn γ) and $^{181}\text{Ta}(p,2n\gamma)$.

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Adopted Levels, Gammas (continued) $\gamma(^{180}\text{W})$ (continued)

E(level)	$E_{\gamma}^{\dagger}$	$I_{\gamma}^{\dagger}$	Mult. [‡]	δ	α	Comments
688.46	350.898 7	100	E2		0.0538	Mult.: from ce(K)/ce(L) in Hf(α ,xn γ) and $^{181}\text{Ta}(p,2n\gamma)$.
1006.381	668.84 10	0.45 3	[M2]		0.0736	B(M2)(W.u.)=0.0044 4. I γ : from ^{180}Re ε decay. Other: 1.14 from $^{181}\text{Ta}(p,2n\gamma)$.
	902.814 13	100 3	E1+M2	-0.31 5	0.0048 8	B(E1)(W.u.)=3.5 $\times 10^{-8}$ 3; B(M2)(W.u.)=0.019 6. Mult., δ : from $\gamma\gamma(\theta)$ and ce data in ^{180}Re ε decay. δ : Other: -0.16 7 from $^{181}\text{Ta}(p,2n\gamma)$.
	1006.34 6	0.547 21	[M2]		0.0236	B(M2)(W.u.)=0.00069 5. I γ : from ^{180}Re ε decay. Other: 0.91 from $^{181}\text{Ta}(p,2n\gamma)$.
1082.374	75.987 10	68 3				I γ : from ^{180}Re ε decay. Other: 57 from $^{181}\text{Ta}(p,2n\gamma)$.
	744.79 3	100 7				
1117.31	1013.71 8	100 4				
	1117.27 4	84 3				
1138.47	450.018 20	100	E2		0.0274	Mult.: from $\alpha(\text{K})\text{exp}$ and ce(K)/ce(L) in Hf(α ,xn γ) and $^{181}\text{Ta}(p,2n\gamma)$.
1184.893	102.513 10	22				
	178.516 10	100 10	E2 [§]		0.454	
	847.35 4	39 13				I γ : from ^{180}Re ε decay. Other: 25 from $^{181}\text{Ta}(p,2n\gamma)$.
	1081.52 12	7.0				
1232.67	895.26 10	16				
	1129.12 4	100				
1307.575	122.688 20	24.4 17	M1+E2		2.2 5	I γ : from Hf(α ,xn γ). Other: 25 3 from $^{176}\text{Yb}(^9\text{Be},5n\gamma)$, 9.3 from $^{181}\text{Ta}(p,2n\gamma)$. Mult.: D+Q from $\gamma(\theta)$ in $^{176}\text{Yb}(^9\text{Be},5n\gamma)$, $\Delta\pi=\text{no}$ from level scheme.
	225.189 20	100 6	E2 [§]		0.208	
	619.24 22	4.0				
	969.83 18	6.0				
1322.09	984.2 3	60				
	1218.8 3	100				
	1322.2 4	60				
1360.51	1022.92 6	100				
	1257.16 9	59	(E2) [#]		0.00289	
1461.82	154.23 4	2.3 8				I γ : from $^{176}\text{Yb}(^9\text{Be},5n\gamma)$. Other: 4.5 from $^{181}\text{Ta}(p,2n\gamma)$.
	276.941 20	100 8	E2		0.1083	
1529.05	67					E γ : observed only in $^{176}\text{Yb}(^9\text{Be},5n\gamma)$.
	390.581 15	100	E1		0.01230	B(E1)(W.u.)<6.43 $\times 10^{-13}$ 11. Mult.: from $\alpha(\text{K})\text{exp}$ in Hf(α ,xn γ) and $^{181}\text{Ta}(p,2n\gamma)$.
1535.63	847.0	12.0				
	1198.07 6	100				
1568.17	879.6 [@] 3	50				
	1230.62 11	100				
1587.27	580.8 1	100 17				
	1483.69 6	92 8				
	1587.2 3	16 3				
1624.23	162.43 5	2.9				
	316.63 3	100	E2		0.0724	
1632.92	550.52 6	100 8				
	626.7 2	35 13				
	1529.30 11	47 3				
1634.67	401.84 12	69				
	450.0 5	27				
	517.37 4	100				
	552.0 3	15				
	1297.4 3	19				
1639.80	179.1	8.3				
	279.31 4	33				
	332.24 3	100 8				

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Adopted Levels, Gammas (continued) $\gamma(^{180}\text{W})$ (continued)

E(level)	$E_{\gamma}^{\dagger}$	$I_{\gamma}^{\dagger}$	Mult. [‡]	α	Comments
1639.80	454.88 3	112 9			I γ : weighted average of 115 8 from Hf(α ,xn γ) and 86 23 from $^{176}\text{Yb}(^9\text{Be},5n\gamma)$. Other: 73 from $^{181}\text{Ta}(p,2n\gamma)$.
	951.25 12	10			
1664.18	525.71 3	100	E2	0.0185	
1693.60	1356.04 15	100			
1702.98	1014.49 10	100			
	1365.46 13	47			
1725.59	196.54 3	100	M1+E2	0.51 19	Mult.: D+Q from $\gamma(0)$ in $^{176}\text{Yb}(^9\text{Be},5n\gamma)$, $\Delta\pi$ = no from assumed band structure.
1729.85	1041.40 7	100			
	1392.22 16	42			
1764.42	124.63 2	100			
1784.96	424.50 8	100			
	552.4 2	50			
	1096.3 2	38			
	1447.2 2	88			
1814.88	808.9 3	100 19			
	1477.3 3	44 16			
	1711.3 2	81 13			
1830.85	206.7 7	1.9 9			I γ : from $^{176}\text{Yb}(^9\text{Be},5n\gamma)$. Other: 3.1 from $^{181}\text{Ta}(p,2n\gamma)$.
	369.02 3	100 6	E2	0.0467	
1831.70	599.0 2	1.50 19			
	714.43 7	2.82 19			
	749.34 5	11.3 4			
	825.36 5	100 3	M1	0.01564	Mult.: from $\alpha(\text{K})\text{exp}$ in ^{180}Re ϵ decay.
	1727.8 1	0.57 7			
1851.15	211.35 5	100			
1855.20	1166.74 16	100			
1911.58	147.16 2	100 8	M1+E2	1.2 4	Mult.: D+Q from $\gamma(0)$ in $^{176}\text{Yb}(^9\text{Be},5n\gamma)$, $\Delta\pi$ = no from assumed band structure.
	271.75 5	98 6			
1918.13	1229.6 2	100			
	1581.2 6	60			
1926.44	788.0 3	14			
	1237.96 18	100			
1932.20	794	13			
	1243.73 11	100			
1945.07	219.49 4	102 8	M1	0.515	I γ : weighted average of 89 5 from Hf(α ,xn γ) and 107 3 from $^{176}\text{Yb}(^9\text{Be},5n\gamma)$. Others: 100 20 in $^{136}\text{Xe}(^{48}\text{Ca},4n\gamma)$ and 220 in $^{181}\text{Ta}(p,2n\gamma)$. Mult.: D from $\gamma(0)$ in Hf(α ,xn γ), $\Delta\pi$ =no from level scheme.
	415.94 10	100 5	E2	0.0337	
1954.53	319.74@ 17	100			
	1266.2 3	63			
	1617.6 5	25			
2024.57	194.0	1.3 7			
	400.26 8	100 4	E2	0.0374	
	886.6 2	16			
2059.35	329.5 1	100			
2082.55	170.95 5	23 5	M1+E2	0.8 3	Mult.: D+Q from $\gamma(0)$ in $^{176}\text{Yb}(^9\text{Be},5n\gamma)$, $\Delta\pi$ = no from assumed band structure. I γ : from $^{176}\text{Yb}(^9\text{Be},5n\gamma)$. Others: 145 10 from Hg(α ,xn γ) and 63 from $^{181}\text{Ta}(p,2n\gamma)$.
	318.24 11	100 24	E2	0.0714	I γ : from Hg(α ,xn γ). Other: 160 from $^{181}\text{Ta}(p,2n\gamma)$.
2117.52	979.05 12	100			
2127.39	988.92 8	100			
2133.09	603.4@				
	994.62 8				
2176.80	1059.42 6	100 5			
	2073.5 2	20 3			
	2176.9 1	28 3			

Continued on next page (footnotes at end of table)

Adopted Levels, Gammas (continued) $\gamma(^{180}\text{W})$ (continued)

E(level)	$E_{\gamma}^{\dagger}$	$I_{\gamma}^{\dagger}$	Mult. [‡]	α	Comments
2187.00	241.91 14	74 9	M1	0.394	I γ : weighted average of 79.7 24 from $^{176}\text{Yb}(^9\text{Be},5n\gamma)$ and 60 4 from Hf(α ,xn γ). Other: 170 from $^{181}\text{Ta}(p,2n\gamma)$. Mult.: D from $\gamma(\theta)$ in Hf(α ,xn γ), $\Delta\pi$ =no from level scheme.
2227.85	461.43 13 995.14 9 1110.7 2 1145.4 4	100 6 100 10 78 9 14 8	E2	0.0257	
2235.19	571.0 1	100	E2	0.01520	
2256.65?	1250.22& 6 2153.24 11	<65& 100 6			
2273.70	191.5 3	37 11	M1	0.752	Mult.: D from $\gamma(\theta)$ in Hf(α ,xn γ), $\Delta\pi$ =no from level scheme. I γ : from $^{176}\text{Yb}(^9\text{Be},5n\gamma)$. Others: 25 from $^{181}\text{Ta}(p,2n\gamma)$, 104 14 from Hf(α ,xn γ).
2274.0	362.10 6 141.2	100 22 100 8	E2 (M1+E2)	0.0493 1.4 4	
2284.00	548.7 453.15 14	16 8 100	E2	0.0269	
2415.77	782.6 2 828.5@ 2 1183.11 7 1298.44 5 1333.4 2 1409.40 5 2312.1 2	5.8 19 8 4 24.0 19 74.0 19 11.6 12 100 4 3.9 8			
2423.9	150.0	47 6	(M1+E2)	1.2 4	Mult.: D+Q from $\gamma(\theta)$ in $^{176}\text{Yb}(^9\text{Be},5n\gamma)$, $\Delta\pi$ =no from level scheme.
2435.18	698.2 759.7 1285.2 847.8& 1 1202.6 1 1250.22& 6 1317.85 6 1352.80 5 1428.8 1 2331.87 11	23 3 100 6 70 12 <13& 28.7 23 <23& 63 3 100 7 13 3 30.3 16			
2451.61	264.7 6 506.56 12	46 3 100 5	E2	0.22 10 0.0203	I γ : from Hf(α ,xn γ). Other: ≤ 110 from $^{181}\text{Ta}(p,2n\gamma)$.
2494.5	221.0 411.8	11 4 100 21			
2501.17	476.6 1	100	E2§	0.0237	
2522.58	935.2 2 1290.0 1 1405.2 1 1516.0 5	52 13 62 9 100 10 75 14			
2531.51	699.7@ 2 1449.2 2 1525.14 11	100 30 18 6 84 5			
2546.87	1314.2 1 1429.5 2	36 9 100 18			
2589.1	165.1	100 5	(M1+E2)	0.9 3	Mult.: D+Q from $\gamma(\theta)$ in $^{176}\text{Yb}(^9\text{Be},5n\gamma)$, $\Delta\pi$ =no from level scheme.
2722.9	315.4 643.5 449.2	15 5 12 5 100	E2§	0.0733	
2736.8	285.3 549.1	17 3 100 2	M1 E2	0.251 0.01669	Mult.: D from $\gamma(\theta)$ in Hf(α ,xn γ), $\Delta\pi$ =no from level scheme.
2763.6	174.5	9.0 17	M1+E2	0.73 25	
	339.6 528.3 1099.6	17 3 100 7 40 10	E2§ (E2)§	0.0591 0.00373	Mult.: D+Q from $\gamma(\theta)$ in $^{176}\text{Yb}(^9\text{Be},5n\gamma)$, $\Delta\pi$ =no from level scheme.

Continued on next page (footnotes at end of table)

Adopted Levels, Gammas (continued) $\gamma(^{180}\text{W})$ (continued)

E(level)	$E_{\gamma}^{\dagger}$	$I_{\gamma}^{\dagger}$	Mult. [‡]	α	Comments
2813.4	529.4	100	E2	0.0182	
2822.9	587.6	100	E2	0.01421	
2884.12	1069.4 2	15 3			
	1651.45 11	31.6 22			
	1766.74 11	41 4			
	1801.75 11	65 4			
	1877.70 10	100 4			
	2780.6 2	6.2 9			
2910.02?	1678.0 3	72 19			
	1792.3 3	59 16			
	1903.6 1	100 13			
2966.2	202.4	27 4	(M1+E2)	0.47 18	Mult.: D+Q from $\gamma(0)$ in $^{176}\text{Yb}(^9\text{Be},5n\gamma)$, $\Delta\pi=\text{no}$ from level scheme.
	376.9	100 5	E2 §	0.0441	
3000.5	506.0	100			
3042.7	306.1	18.7 16	M1	0.208	Mult.: D from $\gamma(0)$ in $\text{Hf}(\alpha, xn\gamma)$, $\Delta\pi=\text{no}$ from level scheme.
	591.2	100 5	E2	0.01401	
3047.5	546.3	100	E2	0.01690	
3176.3	353.3@				
	413.0	40 6	E2 §	0.0344	
	940.9	100 5	E2 §	0.00510	
3248.4	525.5	100			
3264.9	222.3 3	82 4	(M1)	0.497	B(M1)(W.u.)= 2.31×10^{-7} 25. Mult.: from $\alpha(\text{exp})$ in $\text{Hf}(\alpha, xn\gamma)$.
	298.4		[E1]	0.0232	
	528.0 3	100 6			
	813.4 3	87 4	[E2]	0.00689	B(E2)(W.u.)= 3.2×10^{-6} 4.
3356.1	91.3	100	D+Q §		
3368.3	325.6	100.0 23			
	631.7	26.0 17	E2 §	0.01201	
3389.8	125.0	100	(E1)	0.210	B(E1)(W.u.)= 1.04×10^{-5} 8. Mult.: from $\alpha(\text{exp})$ in $\text{Hf}(\alpha, xn\gamma)$.
3411.2	597.8	100			
3412.7	589.6	100	E2	0.01410	
3421.8	245.7	6 3	(M1+E2)	0.27 11	Mult.: D+Q from $\gamma(0)$ in $^{176}\text{Yb}(^9\text{Be},5n\gamma)$, $\Delta\pi=\text{no}$ from level scheme.
	455.4	100 11	E2 §	0.0266	
3515.2	250	100			
3529.1	173.2		D+Q		
	264				
3547.9	158.1	100	(M1)	1.288	B(M1)(W.u.)=0.000120 5.
3581.6	316.7 ^a	100			
3605.8	216.0	100			
3656.7	609.2	100	E2 §	0.01306	
3695.5	519.0	100 20	E2 §	0.0191	
	872.8	97 20			
3697.8	168.6	21 4			
	308.0	12 5			
	433.0	100 20			
3713.0	670.5	100	E2 §	0.01050	
3745.0	139.1	34 3			
	355.3	100 8			
3831.5	316 ^a	100			
3845.4	597.0	100			
3888.2	340.4	100	M1+E2		Mult.: D+Q from $\gamma(0)$ in $\text{Hf}(\alpha, xn\gamma)$, $\Delta\pi=\text{no}$ from level scheme.
3898.0	316.7 ^a	100			
3967.2	271.7@		(M1+E2)	0.20 9	Mult.: (D+Q) from $\gamma(0)$ in $^{176}\text{Yb}(^9\text{Be},5n\gamma)$, $\Delta\pi=\text{no}$ from level scheme.
	545.4		(E2) §	0.01696	
4002.0	257.1	100			
4017.4	604.5	100	(E2) §	0.01330	
4066.2	655.0	100			
4074.9	706.6	100			

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Adopted Levels, Gammas (continued) $\gamma(^{180}\text{W})$ (continued)

E(level)	$E_{\gamma}^{\dagger}$	$I_{\gamma}^{\dagger}$	Mult. [‡]	α	Comments
4147.8	249.9	41 25			
	316				
	435				
	450.0	100 10			
	542@				
	565.9	29 9			
	779.7	7.4 8			
4248.9	360.9	100 6	M1+E2		Mult.: D+Q from $\gamma(0)$ in $\text{Hf}(\alpha, \text{xn}\gamma)$, $\Delta\pi=\text{no}$ from level scheme.
	700.9	19 5			
4269.9	267.7	100 13			
	524.9	40 6			
4320.4	663.7	100			
4339.4	643.9		E2 §	0.01150	
	926.8@				
4416.7	518.9	100 21			
	703.6	41 5			
4455.9	742.9	100			
4525.7	276.8	100			
4554.2	284.3	100 30			
	552.5	13 4			
4606.6	639.4	100	E2 §	0.01169	
4628.8	379.8	100 10			
	740.5	73 7			
4673.1	655.5	100	E2 §	0.01104	
4711.4	294.8	19 3			
	563.6	100 9			
4761.2	695.0	100			
4845.9?	771.0@	100			
4852.9	141.6	100			
4857.3	303.2	100 17			
	587.3	30 12			
5024.8	396.3	100 10			
	776.0	78 17	(E2) §	0.00762	
5027.4?	707.0@	100			
5029.7?	613@	100			
5095.3	755.9	100	E2 §	0.00806	
5128.7	276.0	100			
5178.5	321.3	100 17			
	624.3	30 13			
5339.8	733.2	100	E2 §	0.00861	
5402.2	728.9	100			
5434.8	409.9	100 13			
	805.6	87 24			
5454.2	325.5	100 9			
	601.4	21 4			
5518.8	340.5	100 8			
	661.4	7.8 25			
5745.4?	718@	100			
5815.8	361.5	100 10			
	687.0	37 5			
5859.3	423.9				
	835@				
5877.5	358.8	100 17			
	699.1	72 11			
5975.4	159.7				
	521@				E γ : observed only in $^{136}\text{Xe}(^{48}\text{Ca}, 4\text{n}\gamma)$.
	846.8				
6115.2	237.7				
	299.1				
	661.2				
	986.4				
6162.8?	823.0@	100			
6207.9	392.0				

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Adopted Levels, Gammas (continued) $\gamma(^{180}\text{W})$ (continued)

E(level)	$E_{\gamma}^{\dagger}$	$I_{\gamma}^{\dagger}$	E(level)	$E_{\gamma}^{\dagger}$	$I_{\gamma}^{\dagger}$
6207.9	753.5		6734.1	430.0	100
6211.9	809.5	100	7070.2	443.6	
6292.6?	433@			862.3	
	858@		7101.4	889.5	100
6304.2	(92)		7177.4	443.0	
	189.1			873.1	
	328.9		7634.1	456.3	
6626.6	418.5			900.4	
	811.1		8067.4?	966@	100

† Weighted average of all available data, except where noted.

‡ From $\gamma(\theta)$ and $\gamma\gamma(\theta)$ in $\text{Hf}(\alpha, \text{x}\gamma)$, except where noted.

§ From $\gamma(\theta)$ in $^{176}\text{Yb}(^9\text{Be}, 5\text{n}\gamma)$. Stretched Q transitions are assumed to be E2 in character.

$^{\#}$ From $\text{p}\gamma(\theta)$ in $^{181}\text{Ta}(\text{p}, 2\text{n}\gamma)$. Stretched Q transitions are assumed to be E2 in character.

@ Placement of transition in the level scheme is uncertain.

& Multiply placed; undivided intensity given.

a Multiply placed.

 ^{180}Ta β^- Decay 1980Ry01, 1962Ga07

Parent ^{180}Ta : $E=0.0$; $J\pi=1+$; $T_{1/2}=8.154$ h 6; $Q(\text{g.s.})=702$ 3; $\% \beta^-$ decay=15 3.

1980Ry01: ^{180}Ta activity from $\text{Ta}(\text{n}, 2\text{n})$ with $E(\text{n})=14$ MeV. Measured E_{γ} , I_{γ} , $\beta-\gamma$, and γ -x-ray coincidences using $\text{Ge}(\text{Li})$ and LEPS detectors and a $4\pi\beta$ proportional counter.

1962Ga07: ^{180}Ta activity from $^{180}\text{Hf}(\text{d}, 2\text{n})$ with $E(\text{d})=11$ MeV. Measured E_{γ} , I_{γ} , Ice, $\beta\gamma$ coincidences.

Others: 1974HeYW, 1965Hu02, 1963De21, 1962Fo05, 1951Br87.

A total energy release of 105 keV 15 is calculated for this decay scheme using the RADLST code, in good agreement with the effective Q value of 105 keV 21.

 ^{180}W Levels

E(level) †	$J\pi^{\ddagger}$	$T_{1/2}$	Comments
0.0	0+	1.8×10^{18} y 2	$T_{1/2}$: from the Adopted Levels.
103.6 2	2+	1.28 ns 5	$T_{1/2}$: weighted average of 1.33 ns 5 (1962Fo05), 1.19 ns 4 (1963De21), and 1.37 ns 3 (1965Hu02).

† From E_{γ} .

‡ From the Adopted Levels.

 β^- radiations

$E\beta^-$	E(level)	$I\beta^-^{\dagger}$	Log ft	Comments
(598 3)	103.6	3.6 7	7.06 9	$E\beta^-$: other: 610 15 (1962Ga07), =600 (1951Br87).
(702 3)	0.0	10.4 15	6.84 7	$E\beta^-$: other: 710 15 (1962Ga07), 705 15 (1951Br87).

† Absolute intensity per 100 decays.

 $\gamma(^{180}\text{W})$

I_{γ} normalization: From decay scheme using $\Sigma(I(\gamma+\text{ce})(93\gamma \text{ with } \epsilon) + (I(\gamma+\text{ce})(104\gamma \text{ with } \beta^-)))=100\%$;

$I\beta(\text{g.s.})/I\beta(104)=3.00$ 45 (1962Ga07); $I\epsilon(\text{g.s.})/I\epsilon(93)=2.36$ 9 (weighted average of 2.20 33 (1962Ga07) and 2.37 9 (1980Ry01)); $I_{\gamma}(104\gamma)/I_{\gamma}(93\gamma)=0.180$ 35, $\text{Ge}(\text{Li})$ (1974HeYW); and theoretical conversion coefficients for the 104 and 93 g.s. transitions in ^{180}W and ^{180}Hf , respectively. $I\beta(\text{g.s.})/I\beta(103.6 \text{ keV})=4.22$ 31 measured by 1980Ry01 in a 4π $\beta\gamma$ coin experiment "critically depends" on the detector's efficiency response to the β^- particle energy, and it may be less reliable than the value given by 1962Ga07.

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^{180}Ta β^- Decay 1980Ry01,1962Ga07 (continued) $\gamma(^{180}\text{W})$ (continued)

$E\gamma^\dagger$	E(level)	$I\gamma^{\ddagger\S}$	Mult.	α	Comments
103.6 2	103.6	18.0 35	E2	3.39 6	Mult.: from $\alpha(K)\text{exp}=0.92\ 23$ (1962Ga07).

 † From 1974HeYW. ‡ From 1974HeYW, relative to $I\gamma(93.4\gamma$ with $\epsilon)=100$. § For absolute intensity per 100 decays, multiply by 0.048 10. **^{180}W IT Decay (5.47 ms)**Parent ^{180}W : E=1529.05 4; $J\pi=8^-$; $T_{1/2}=5.47$ ms 9; %IT decay=100.An additional 67-keV transition depopulating the 1529.05-keV level is reported in $^{176}\text{Yb}(^9\text{Be},5n\gamma)$. However, no intensity is given for this transition. ^{180}W Levels

E(level) †	$J\pi^\dagger$	$T_{1/2}^\dagger$
0.0	0+	
103.561	2+	
337.559	4+	
688.46	6+	
1138.47	8+	
1529.05	8-	5.47 ms 9

 † From the Adopted Levels. $\gamma(^{180}\text{W})$ $I\gamma$ normalization: From $\Sigma I(\gamma+\text{ce})(\text{to g.s.})=100$.

$E\gamma^\dagger$	E(level)	$I\gamma^{\ddagger\#}$	Mult. §	α	Comments
103.568 18	103.561	20 4	E2	3.40	$I\gamma$: weighted average of 19 4 (1966Bu08) and 24 7 (1981Av04). $\alpha(L)\text{exp}=2.42$ (1966Bu08).
233.99 3	337.559	100 10	E2	0.184	$I\gamma$: weighted average of 100 10 (1966Bu08) and 100 17 (1981Av04). $\alpha(K)\text{exp}=0.11$ (1967Bo08), $\alpha(K)/\alpha(L)$ exp=2.1 5 (1967Bo08), 2.1 3 (1966Bu08).
350.898 7	688.46	101 10	E2	0.0538	$I\gamma$: weighted average of 110 11 (1966Bu08) and 94 10 (1981Av04). $\alpha(K)\text{exp}=0.039\ 10$ (1967Bo08), 0.036 (1966Bu08); $\alpha(K)/\alpha(L)$ exp=3.6 10 (1967Bo08), 3.1 4 (1966Bu08).
390.581 15	1529.05	100 8	E1	0.01230	$I\gamma$: weighted average of 120 12 (1966Bu08) and 92 8 (1981Av04). $\alpha(K)\text{exp}=0.012\ 4$ (1967Bo08), 0.0083 (1966Bu08).
450.018 20	1138.47	117 8	E2	0.0274	$I\gamma$: weighted average of 117 12 (1966Bu08) and 118 8 (1981Av04).

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^{180}W IT Decay (5.47 ms) (continued) $\gamma(^{180}\text{W})$ (continued)

$E\gamma^\dagger$	E(level)	$I\gamma^\ddagger$	Mult.§	α	Comments
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$\alpha(\text{K})_{\text{exp}}=0.018\ 3$ (1967Bo08), 0.017 (1966Bu08); $\alpha(\text{K})/\alpha(\text{L})\ \text{exp}=3.6\ 11$ (1967Bo08), 4.8 11 (1966Bu08).

† From the Adopted Gammas.

‡ Weighted average of delayed $I\gamma$'s from 1966Bu08 and 1981Av04 from $\text{Hf}(\alpha, \text{xn}\gamma)$.

§ From the Adopted Levels. Support from ce measurements provided in the comments.

For absolute intensity per 100 decays, multiply by 1.14 23.

Decay Scheme

Intensities: $I(\gamma+\text{ce})$ per
100 parent decays
%IT=100

^{180}Re ϵ Decay 1980Ma14, 1967Go22

Parent ^{180}Re : $E=0.0$; $J\pi=(1)^-$; $T_{1/2}=2.46\ \text{min}$ 3; $Q(\text{g.s.})=3801\ 21$; $\%e+\%\beta^+$ decay=100.

1980Ma14: ^{180}Re activity produced through the $^{182}\text{W}(\text{p}, 3\text{n})$ reaction with $E(\text{p})=27\ \text{MeV}$. Measured $E\gamma$, $I\gamma$, $\gamma\gamma$, and $\gamma(\text{t})$ using two coaxial $\text{Ge}(\text{Li})$ detectors and a LEPS detector.

1967Go22: ^{180}Re activity produced through the $^{182}\text{W}(\text{p}, 3\text{n})$ reaction (target of natural tungsten) with $E(\text{p})=35\ \text{MeV}$.

Measured $E\gamma$, $I\gamma$, $\gamma\gamma$, $\gamma\gamma(\theta)$, $\gamma\gamma(\text{t})$, $E(\text{ce})$, $I(\text{ce})$, $\gamma-\beta$, and γ -x-ray coincidences using $\text{Ge}(\text{Li})$ and $\text{NaI}(\text{Tl})$ detectors for γ -rays, a $\text{Si}(\text{Li})$ detector for electrons and a double focusing beta spectrometer for β s.

A total energy release of 3800 keV 150 is calculated for this decay scheme using the RADLST code, in good agreement with $Q=3801\ \text{keV}\ 21$.

Others: 1968Be53, 1968Ha39, 1967Ho12.

 ^{180}W Levels

$E(\text{level})^\dagger$	$J\pi^\ddagger$	$T_{1/2}^\S$	Comments
0.0	0+		
103.54 3	2+		
337.51 4	4+		
1006.35 3	2-	7.4 ns 4	$J\pi$: 2 from $\gamma\gamma(\theta)$ in 1967Go02, π from $\log ft=4.5$ from (1)- parent.
1082.36 4	3-		
1117.31 3	2+		
1185.07 6	(4-)		
1232.64 4	3+		
1587.26 5	2+		
1632.90 6	(1-, 2)		
1814.85 12	(2+, 3)		
1831.69 4	2-		$J\pi$: $\log ft=5.0$ from (1)- parent, 599 γ to 3+.
2176.79 6			
2227.82 9			
2256.63? 6			
2415.75 4	2-		$J\pi$: $\log ft=5.7$ from (1)- parent, 1183 γ to 3+.

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^{180}Re ϵ Decay 1980Ma14,1967Go22 (continued) **^{180}W Levels (continued)**

$E(\text{level})^\dagger$	$J\pi^\ddagger$	Comments
2435.21 4	2-	$J\pi$: log $ft=5.8$ from (1)- parent, 1203 γ to 3+.
2522.56 7		
2531.49 9		
2546.84 10		
2884.10 6	2-	$J\pi$: log $ft=5.6$ from (1)- parent, 1651 γ to 3+.
2909.99? 10		

 † From least-squares fit to $E\gamma$ by evaluator. ‡ From the adopted levels. In cases where spin is constrained by data from ^{180}Re ϵ decay, details are included in the comments. § From $\gamma\gamma(t)$ in 1967Go22. **β^+, ϵ Data**

$E\epsilon$	$E(\text{level})$	$I\beta^{+\ddagger}$	$I\epsilon^\ddagger$	Log ft	$I(\epsilon+\beta^+)^\dagger\ddagger$	Comments
(891 21)	2909.99?		0.07 1	6.45 7	0.07 1	
(917 21)	2884.10		0.505 2	5.617 24	0.505 2	
(1254 21)	2546.84		0.141 21	6.46 7	0.141 21	
(1270 21)	2531.49		0.18 3	6.36 8	0.18 3	
(1278 21)	2522.56		0.182 15	6.37 4	0.182 15	
(1366 21)	2435.21		0.75 4	5.81 3	0.75 4	
(1385 21)	2415.75		0.95 4	5.72 3	0.95 4	
(1544 21)	2256.63?	0.00021 4	0.14 1	6.65 4	0.14 1	
(1573 21)	2227.82	0.00026 5	0.14 1	6.67 4	0.14 1	
(1624 21)	2176.79	0.00047 7	0.18 1	6.59 3	0.18 1	
(1969 21)	1831.69	0.164 14	11.5 4	4.953 21	11.7 4	
(1986 21)	1814.85	0.00052 16	0.034 10	7.49 13	0.035 10	
(2168 21)	1632.90	0.0076 9	0.27 3	6.67 5	0.28 3	
(2214 21)	1587.26	0.0052 10	0.16 3	6.90 8	0.17 3	
(2684 21)	1117.31	0.011 5	0.12 5	7.22 20	0.13 6	
(2795 21)	1006.35	8.3 5	71 4	4.48 3	79 4	$E\beta=1800$ keV 60 $\beta\gamma$ coin (1967Go22), 1760 keV 40 (1967Ho12).
(3697 § 21)	103.54	≤ 3.2	≤ 7.8	≥ 5.7	≤ 11	

 † From an intensity balance at each level by evaluator. The $I\gamma$ normalization of 0.91 3 is used which assumes no ϵ branch to the g.s. An upper limit on the intensity to the g.s. of $I(\epsilon+\beta^+)=8\%$ is obtained from a lower limit of log $ft=5.9$. Such a branch would change the log ft values by a maximum of 0.1 units. ‡ Absolute intensity per 100 decays. § Existence of this branch is questionable. **$\gamma(^{180}\text{W})$**

K x-ray relative intensity=87 15 (1967Go22). Other: 105 (1967Ho12).

 $I\gamma$ normalization: From $\Sigma I(\gamma+\text{ce})$ (to g.s.)=100% and assuming no ϵ population of the g.s. An upper limit on the intensity to the g.s. of $I(\epsilon+\beta^+)=8\%$ is obtained from a lower limit of log $ft=5.9$. The corresponding normalization would become 0.84 3.

$E\gamma^\ddagger$	$E(\text{level})$	$I\gamma^\S$	Mult.	δ	α	Comments
75.99 5	1082.36	0.196 10	[M1, E2]		11.3 9	$I\gamma$: other: ≈ 0.7 (1967Go22).
103.57 5	103.54	24.7 7	E2		3.40	Mult.: from ce(K):ce(L1):ce(L2):ce(L3)=19.3:2.55:25.1:23.2 (1968Ha39). Other: 1968Be53.
x 131.5 14		0.121 5				
x 173.91 10		0.10 2				
178.74 10	1185.07	0.079 8	[E2]		0.452	
233.99 5	337.51	0.88 3	[E2]		0.184	$I\gamma$: other: 0.5 1 (1967Go22).
550.52 6	1632.90	0.187 15				
580.8 1	1587.26	0.124 21				
599.0 2	1831.69	0.165 21				
626.7 2	1632.90	0.066 24				
668.80 6	1006.35	0.45 3	[M2]		0.0736	
699.7@ 2	2531.49	0.10 3				

Continued on next page (footnotes at end of table)

^{180}Re ϵ Decay 1980Ma14,1967Go22 (continued) $\gamma(^{180}\text{W})$ (continued)

$E\gamma^\dagger$	E(level)	$I\gamma^\S$	Mult.	δ	α	Comments
714.43 6	1831.69	0.310 21				
744.84 6	1082.36	0.289 21	[E1]		0.00312	I γ : other: 0.7 2 (1967Go22).
749.34 5	1831.69	1.24 4				
782.6 2	2415.75	0.030 10				
808.9 3	1814.85	0.032 6				
825.36 5	1831.69	11.0 3	M1		0.01564	$\alpha(\text{K})_{\text{exp}}=0.014$ 3 (1967Go22). Mult.: from $\alpha(\text{K})_{\text{exp}}$. δ : <0.6 from $\alpha(\text{K})_{\text{exp}}$.
828.5@ 2	2415.75	0.04 2				
847.80 10	1185.07	0.031 10	[E1]		0.00243	
	2435.21	0.031 10				
902.84 5	1006.35	100 3	E1+M2	-0.31 5	0.0047 8	$\alpha(\text{K})_{\text{exp}}=0.0040$ 6 (1967Go22). Mult., δ : from $\alpha(\text{K})_{\text{exp}}$ and $A_2=+0.47$ 7, $A_4=-0.10$ 15 for $902\gamma-103\gamma(0)$, assuming a $J=2-2-0$ cascade.
935.2 2	2522.56	0.036 9				
995.14 9	2227.82	0.078 8				
1006.31 5	1006.35	0.547 21	[M2]		0.0236	
1013.73 5	1117.31	0.82 3	[M1,E2]		0.0069 25	I γ : other: 1.2 3 (1967Go22).
$\times 1024.9^\dagger$ 19		0.15 5				
$\times 1036.0$ 4		0.011 4				
1059.42 6	2176.79	0.131 7				
1069.4 2	2884.10	0.034 6				
$\times 1082.6$ 4		0.015 5				
1110.7 2	2227.82	0.061 7				
1117.28 5	1117.31	0.691 21	[E2]		0.00362	
1129.14 5	1232.64	0.495 21				
1145.4 4	2227.82	0.011 6				
1183.11 7	2415.75	0.124 10				
1202.6 1	2435.21	0.089 7				I γ : other: 0.27 8 (1967Go22).
$\times 1228^\dagger$ 3		0.3 1				
1250.22 6	2256.63?	0.062 10				
	2435.21	0.062 10				
1290.0 1	2522.56	0.043 6				
1298.44 5	2415.75	0.382 10				
1314.2 1	2546.84	0.041 10				
1317.85 6	2435.21	0.196 10				I γ : other: 0.30 7 (1967Go22).
1333.4 2	2415.75	0.060 6				
1352.80 5	2435.21	0.310 21				
1405.2 1	2522.56	0.069 7				
1409.40 5	2415.75	0.516 21				I γ : other: 1.2 1 (1967Go22).
1428.8 1	2435.21	0.041 10				
1429.5 2	2546.84	0.114 21				
1449.2 2	2531.49	0.018 6				
1477.3 3	1814.85	0.014 5				
1483.69 6	1587.26	0.114 10				I γ : other: 0.29 6 (1967Go22).
1516.0 5	2522.56	0.052 10				
1525.14 11	2531.49	0.084 5				
1529.30 11	1632.90	0.087 5				
$\times 1545^\dagger$ @ 4		0.14 14				
$\times 1561.0$ 6		0.006 4				
1587.2 3	1587.26	0.020 4				
$\times 1595.5$ 4		0.011 4				
1651.45 11	2884.10	0.073 5				
1678.0 3	2909.99?	0.023 6				
1711.3 2	1814.85	0.026 4				
1727.8 1	1831.69	0.063 8				
1766.74 11	2884.10	0.095 9				
1792.3 3	2909.99?	0.019 5				
1801.75 11	2884.10	0.157 10				
$\times 1815.6$ 4		0.018 4				
$\times 1820.5^\dagger$ 22		0.10 5				
$\times 1838.4^\dagger$ 22		0.13 4				

Continued on next page (footnotes at end of table)

^{180}Re ϵ Decay 1980Ma14,1967Go22 (continued) $\gamma(^{180}\text{W})$ (continued)

$E\gamma^{\ddagger}$	E(level)	$I\gamma^{\S\#}$	$E\gamma^{\ddagger}$	E(level)	$I\gamma^{\S\#}$
$^{\times}1839.6\ 3$		0.018 4	$^{\times}2182.30\ 14$		0.029 3
$^{\times}1867.4^{\dagger}\ 22$		0.05 3	$^{\times}2196.0\ 6$		0.003 2
$1877.70\ 10$	2884.10	0.231 10	$^{\times}2204.64\ 11$		0.153 7
$1903.6\ 1$	2909.99?	0.032 4	$^{\times}2232.9\ 3$		0.013 3
$^{\times}1939.1\ 3$		0.011 3	$^{\times}2242^{\dagger}\ 4$		0.03 2
$^{\times}1991.1\ 3$		0.021 4	$^{\times}2258.40\ 14$		0.044 4
$^{\times}2027.2\ 5$		0.014 4	$2312.1\ 2$	2415.75	0.020 4
$^{\times}2034^{\dagger}\ 3$		0.05 2	$2331.87\ 11$	2435.21	0.094 5
$^{\times}2066.9\ 5$		0.013 3	$^{\times}2341\ 4$		<0.1
$2073.5\ 2$	2176.79	0.026 4	$^{\times}2408.4\ 4$		0.006 2
$^{\times}2096.0\ 3$		0.013 3	$^{\times}2475.5\ 4$		0.007 2
$^{\times}2142.2\ 4$		0.017 3	$2780.6\ 2$	2884.10	0.0144 21
$2153.24\ 11$	2256.63?	0.095 6	$^{\times}2889.8\ 3$		0.017 3
$^{\times}2165.7\ 5$		0.004 2	$^{\times}3340.7\ 5$		0.006 2
$2176.9\ 1$	2176.79	0.037 4			

† Observed only by 1967Go22. γ -rays were not confirmed by 1980Ma14.

‡ From 1980Ma14.

§ From 1980Ma14. These are in general in agreement with the results of 1967Go22. In cases where the measured values differ by more than 1σ , the values from 1967Go22 are included in the comments.

$^{\#}$ For absolute intensity per 100 decays, multiply by 0.91 3.

$^{\@}$ Placement of transition in the level scheme is uncertain.

$^{\times}$ γ ray not placed in level scheme.

^{180}Re ϵ Decay 1980Ma14,1967Go22 (continued)

Decay Scheme

Intensities: I(γ + ϵ) per 100 parent decays

(1)- 0.0 2.46 min
 $^{180}_{75}\text{Re}_{105}$
 $\% \epsilon + \% \beta^+ = 100$
 $Q^+ = 3801^{21}$

^{180}Re ϵ Decay 1980Ma14,1967Go22 (continued)

Decay Scheme (continued)

 Intensities: I(γ +ce) per 100 parent decays

$(1)-$ 0.0 2.46 min
 $^{180}_{75}\text{Re}_{105}$
 $\% \epsilon + \% \beta^+ = 100$
 $Q^+ = 3801^{21}$

$^{136}\text{Xe}(^{48}\text{Ca},4n\gamma)$ 1992YeZW,1985Pe07

1992YeZW, 1992YeZZ: $^{136}\text{Xe}(^{48}\text{Ca},4n\gamma)$, E not given, cryogenically frozen target. Measured $E\gamma$, $I\gamma$, $\gamma\gamma$, $\gamma\gamma(t)$ using the TESSA3 array consisting of 12 Compton-suppressed Ge detectors.

1985Pe07: $^{48}\text{Ca}(^{136}\text{Xe},4n\gamma)$, E=584 MeV. Measured $E\gamma$, $I\gamma$, $\gamma\gamma$, $\gamma\gamma(t)$. ^{180}W nuclei were stopped in a Pb catcher foil behind the target and delayed γ -rays were observed with two Ge and ten NaI detectors.

Other: 2000Po16, $^{48}\text{Ca}(^{136}\text{Xe},4n\gamma)$, searched for long-lived, high-K isomers, none identified.

 ^{180}W Levels

$E(\text{level})^\dagger$	$J\pi^\ddagger$	$E(\text{level})^\dagger$	$J\pi^\ddagger$	$E(\text{level})^\dagger$	$J\pi^\ddagger$
0.0 $\S$	0+	3263.4 @	14-	4855 $\&$	(20-)
103.9 $\S$	2+	3388	15+	5127	(22)
337.9 $\S$	4+	3412 $\S$	16+	5176 $\&$	(21-)
688.2 $\S$	6+	3513	(15)	5401 $\S$	22+
1138.0 $\S$	8+	3546	16+	5452	(23)
1528.3 $\#$	8-	3743 $\&$	(16-)	5517 $\&$	(22-)
1663.6 $\S$	10+	3829	(16)	5813	(24)
1724.8 $\#$	9-	4000 $\&$	(17-)	5875 $\&$	(23-)
1944.2 $\#$	10-	4017 $\S$	18+	5973	(24)
2186.4 $\#$	11-	4145	(17)	6113	(24)
2234.8 $\S$	12+	4268 $\&$	(18-)	6210 $\S$	24+
2450.0 $\#$	12-	4552 $\&$	(19-)	6302 a	(25)
2735 $\#$	13-	4672 $\S$	20+	6732 a	(26)
2822 $\S$	14+	4709	(19)	7175 a	(27)
3041 $\#$	14-	4850	(21)	7631 a	(28)

† From a least-squares fit to $E\gamma$ by evaluator.

‡ From band structure.

$\S$ (A): $K\pi=0+$ g.s. rotational band.

$\#$ (B): $K\pi=8-$ band. Configuration= $\nu 7/2[514]9/2[624]$.

@ (C): $K\pi=14-$ bandhead. Configuration= $\nu 7/2[514]9/2[624]\pi 5/2[402]7/2[404]$.

$\&$ (D): $K\pi=(16-)$ band.

a (E): $K=(25)$ band.

 $\gamma(^{180}\text{W})$

$E\gamma^\dagger$	$E(\text{level})$	$I\gamma^\ddagger$	$E\gamma^\dagger$	$E(\text{level})$	$I\gamma^\ddagger$	$E\gamma^\dagger$	$E(\text{level})$	$I\gamma^\ddagger$
(93)	6302		321	5176		528.1 ‡	3263.4	20 2
103.9 ‡	103.9	39 3	326	5452		549.0 ‡	2735	18 2
125	3388		329	6302		552 @	4552	
141	4850		341	5517		564	4709	
158	3546		$\times 341.5^\ddagger$		6 1	571.2 $\S$	2234.8	
160	5973		350.3 ‡	688.2	100 3	587 @	4855	
189	6302		355	3743		587.5 $\S$	2822	
196.5 ‡	1724.8	36 2	358	5875		589.7 $\S$	3412	
219.2 ‡	1944.2	20 2	361	5813		591.1 ‡	3041	15 2
222.4 ‡	3263.4	21 2	390.3 ‡	1528.3	102 3	602 @	5452	
234.0 ‡	337.9	120 4	$\times 393.7^\ddagger$		16 2	605	4017	
238	6113		416.0 ‡	1944.2	20 2	624 @	5176	
$\times 244.2^\ddagger\#$		6 1	$\times 422.8^\ddagger\#$		17 2	655	4672	
250	3513		$\times 429.7^\ddagger\#$		10 2	662 @	5517	
$\times 250.1^\ddagger\#$		21 2	430	6732		687 @	5813	
257	4000		$\times 434.4^\ddagger$		3 1	$\times 689.2^\ddagger$		5 1
268	4268		443	7175		699 @	5875	
276	5127		449.8 ‡	1138.0	98 3	$\times 727.8^\ddagger$		8 1
$\times 276.4^\ddagger\#$		24 2	$\times 455.6^\ddagger\#$		17 2	729	5401	
284	4552		456	7631		$\times 754.5^\ddagger$		3 1
$\times 285.1^\ddagger$		5 2	461.6 ‡	2186.4	16 2	809	6210	
$\times 298.9^\ddagger\#$		25 2	$\times 494.6^\ddagger\#$		9 1	813.3 ‡	3263.4	15 2
303	4855		505.8 ‡	2450.0	25 3	846	5973	
316	3829		521	5973		873 @	7175	
	4145		525 $\text{@}\&$	4268		899 @	7631	
$\times 320.7^\ddagger\#$		13 1	525.6 $\S$	1663.6				

† From 1992YeZW, except where noted.

Footnotes continued on next page

$^{136}\text{Xe}(^{48}\text{Ca},4n\gamma)$ 1992YeZW,1985Pe07 (continued) **$\gamma(^{180}\text{W})$ (continued)**

‡ From 1985Pe07.

§ Transition energy not given in 1992YeZW, value taken from Hf(α ,xn γ) by evaluator.# These γ -rays decay with a $T_{1/2}$ of ≈ 20 ns, suggesting the existence of an isomeric state with that half-life.

@ Transition included in Fig. 2 of 1992YeZW but no transition energy indicated. Energy determined from level energy difference.

& Placement of transition in the level scheme is uncertain.

* γ ray not placed in level scheme. **$^{176}\text{Yb}(^9\text{Be},5n\gamma)$ 1993YeZX,1993Wa11,2002Fa19**2002Fa19: E(^9Be)=65 MeV. Measured E γ , I γ for ground state band transitions using Compton-suppressed HPGe detectors and a fourteen element BGO filter.1993YeZX, 1993Wa11: E(^9Be)=55 MeV. Measured E γ , I γ , $\gamma\gamma$, $\gamma(\theta)$, $\gamma(t)$ using CAESAR array consisting of six Compton-suppressed HPGe detectors. 1993YeZX is the thesis providing a full description of the experiment whereas 1993Wa11 presents a subset of the results. **^{180}W Levels**

E(level) [†]	J π [‡]	T _{1/2} [§]	E(level) [†]	J π [‡]	T _{1/2} [§]	E(level) [†]	J π [‡]	T _{1/2} [§]
0.0#	0+		3001.3 ^e	(12-)		4606.0@	19+	
103.5#	2+		3041.7&	14-		4627.8 ^f	19+	
337.5#	4+		3047.5 ^a	13-		4672.3#	20+	
688.2#	6+		3175.8@	14+		4710.6 ^d	19-	
1006.3 ^a	2-	≈ 5.5 ns	3249.3 ^e	(13-)		4761 ^a	18-	
1082.5 ^a	3-		3264.0 ^b	14-		4844.9?&	(19-)	
1138.2#	8+		3355.1	(14)		4852.2 ^d	20-	
1184.9 ^a	4-		3367.3&	15-		4856.6	(19-)	
1307.8 ^a	5-		3388.9	15+	≈ 3.5 ns	5023.9 ^f	20+	
1461.8 ^a	6-		3410.8 ^a	14-		5027 ^a	19-	
1528.8&	8-		3412.0#	16+		5028.9?c	(20-)	
1624.1 ^a	7-		3421.2@	15+		5094.8@	20+	
1640.1 ^e	(5-)		3528.2	(15)		5128.2 ^d	21-	
1663.6#	10+		3546.9 ^f	16+	≈ 4.2 ns	5177.8	(20-)	
1725.2&	9-		3580.7	(15)		5339.3@	21+	
1764.9 ^e	(6-)		3605.0	(15)		5401#	22+	
1830.4 ^a	8-		3657 ^a	15-		5433.8 ^f	21+	
1911.9 ^e	(7-)		3695.0@	16+		5453.7 ^d	22-	
1944.7&	10-		3696.9	(16)		5518.1	(21-)	
2024.4 ^a	9-		3712.2&	16-		5745 ^a	(21-)	
2083.3 ^e	(8-)		3744.2	(15-)		5815.2 ^d	23-	
2132.3@	8+		3846 ^e	(15-)		5858 ^f	22+	
2186.6&	11-		3887.4 ^f	17+		5876.9	(22-)	
2234.9#	12+		3897.2 ^c	16-		5974.9	(23-)	<0.7 ns
2273.5@	9+		3966.6@	17+		6114.6	(23-)	≈ 1.4 ns
2274.6 ^e	(9-)		4001.2	(16-)		6162?@	23+	
2283.6 ^a	10-		4016.8#	18+		6207.4 ^d	24-	
2423.4@	10+		4066 ^a	16-		6211#	24+	
2450.6&	12-		4073.9&	17-		6292?f	(23+)	
2495.3 ^e	(10-)		4147.0 ^c	17-		6303.8	(24+)	<0.7 ns
2501.0 ^a	11-		4248.0 ^f	18+		6626.1 ^d	25-	
2588.6@	11+		4269.1	(17-)		6733.8	(25+)	
2723.8 ^e	(11-)		4320 ^a	17-		7069.7 ^d	26-	
2735.7&	13-		4338.9@	18+		7100#	26+	
2763.1@	12+		4415.9 ^c	18-		7176.8	(26+)	
2812.9 ^a	12-		4455.1&	18-		8066?#	(28+)	
2822.3#	14+		4525	(19)				
2965.5@	13+		4553.5	(18-)				

† From a least-squares fit to E γ , by evaluator.

‡ As given in 1993YeZX.

§ From centroid-shift analysis in 1993YeZX.

(A): g.s. band.

@ (B): $K\pi=8+$ band. Interpreted as a Fermi-aligned $i_{13/2}^2$ band with configuration (v7/2[633])(v9/2[624]).

Footnotes continued on next page

$^{176}\text{Yb}(^9\text{Be},5n\gamma)$ $^{1993}\text{YeZX},^{1993}\text{Wa11},^{2002}\text{Fa19}$ (continued) **^{180}W Levels (continued)**& (C): $K\pi=8-$ band. ($\nu 9/2[624](\nu 7/2[514])$ configuration.a (D): $K\pi=2-$ band.b $K\pi=14-$ bandhead. Four qp-isomer with configuration ($\nu 9/2[624](\nu 7/2[514])(\pi 7/2[404])(\pi 5/2[402])$).c (E): $K\pi=16-$ band.d (F): $K\pi=19-$ band.e (G): $K\pi=(5-)$ band.f (H): $K\pi=16+$ band. $\gamma(^{180}\text{W})$

$E\gamma^\dagger$	E(level)	$I\gamma^\ddagger$	Mult.§	$I\gamma^\&$	Comments
67	1528.8				
76.1	1082.5	12.6 16		8.9 33	
91.3	3355.1	5.5 10	D+Q		Mult.: $A_2/A_0=-0.96$ 27.
103.5	103.5	121 19		51.4 17	$A_2/A_0=-0.15$ 33.
122.8	1307.8	17.3 20	D+Q		Mult.: $A_2/A_0=-1.04$ 23.
124.9	1764.9	25 4			
125.0	3388.9	84 13			
139.1	3744.2	8.4 8			$A_2/A_0=+0.15$ 21.
141.2	2273.5	6.1 5	D+Q@		
141.6	4852.2	10.8 13			
147.0	1911.9	15.9 17	D+Q		Mult.: $A_2/A_0=-0.69$ 21.
150.0	2423.4	4.9 6	D+Q		Mult.: $A_2/A_0=-0.23$ 24.
154.0	1461.8	1.5 5			
158.0	3546.9	33.5 14			$A_2/A_0=+0.26$ 18.
159.7	5974.9	6.7 7			$A_2/A_0=-0.15$ 23.
162.0	1624.1	1.6 4			
165.1	2588.6	12.7 6	D+Q		Mult.: $A_2/A_0=-0.92$ 10.
168.6	3696.9	3.2 6			
171.3	2083.3	5.8 12	D+Q		Mult.: $A_2/A_0=-1.3$ 3.
173.2	3528.2	7.1 9	D+Q		Mult.: $A_2/A_0=-0.41$ 8.
174.5	2763.1	1.6 3	D+Q@		
178.7	1184.9	37.3	Q	8 4	Mult.: $A_2/A_0=+0.12$ 10.
189.1	6303.8				
191.4	2274.6	10 3			
194.0	2024.4	1.0 5			
196.3	1725.2	197 3	D+Q	92 6	Mult.: $A_2/A_0=-0.92$ 2.
202.2	2965.5	8.6 12	D+Q		Mult.: $A_2/A_0=-0.85$ 22.
206.0	1830.4	1.0 5			
216.0	3605.0	7.4 12			
219.2	1944.7	86 3	D+Q	56.8 24	Mult.: $A_2/A_0=-1.04$ 6.
221.0	2495.3	2.6 9			
222.1	3264.0			62 3	
225.2	1307.8	70 3	Q		Mult.: $A_2/A_0=0.15$ 9.
234.0	337.5	567 17	Q	433 12	Mult.: $A_2/A_0=+0.18$ 6.
237.7	6114.6	3.9 8			
241.9	2186.6	68.5 21	D+Q	24 4	Mult.: $A_2/A_0=-1.11$ 6.
245.7	3421.2	1.0 5	D+Q@		
249.9	4147.0	10 6			
257.1	4001.2	14 5			
264.0	2450.6				$E\gamma$: included in Fig. 3.1 of 1993YeZX but not listed in author's Table 3.1.
264	3528.2				
267.7	4269.1	10.0 13			
271.7#a	3966.6		(D+Q)@		
271.8	1911.9	17 4			
276.0	5128.2	14.1 16			
276.8	4525	68 5			$A_2/A_0=+0.23$ 1.
276.9	1461.8	64 5		7.9 20	
284.3	4553.5	27 7			$A_2/A_0=-0.3$ 5.
285.0	2735.7	12.8 7		48.1 32	
294.8	4710.6	6.1 11			
298.4	3264.0	3.2 6			
299.1	6114.6				

Continued on next page (footnotes at end of table)

$^{176}\text{Yb}(^9\text{Be},5n\gamma)$ $^{1993}\text{YeZX},^{1993}\text{Wa11},^{2002}\text{Fa19}$ (continued) $\gamma(^{180}\text{W})$ (continued)

$E\gamma^{\dagger}$	E(level)	$I\gamma^{\ddagger}$	Mult. §	$I\gamma^{\&}$	Comments
303.2	4856.6	7.6 13			
306.0	3041.7	10.5 6		27.6 17	
308.0	3696.9	1.8 7			
315.4	2588.6	1.9 6	Q@		
316.6	1624.1				$E\gamma$: included in Fig. 3.1 of 1993YeZX but not listed in author's Table 3.1.
316.7 ^c	3580.7	144 ^c 8			
	3897.2	144 ^c 8			
318.3	2083.3	25 6			
321.3	5177.8	10.1 17			
325.5	5453.7	10.6 10			
325.6	3367.3	173 4			$A_2/A_0=0.17$ 4.
328.9	6303.8	9.7 14			$A_2/A_0=-0.3$ 3.
332.2	1640.1	22 6			$A_2/A_0=-0.6$ 5.
339.6	2763.1	3.0 6	Q@		
340.5	5518.1	36 3			
340.6	3887.4	59.2 21			
350.7	688.2	483 13	Q	544 14	Mult.: $A_2/A_0=+0.19$ 6.
353.3 ^{#a}	3175.8				
355.3	3744.2	24.6 19			
358.8	5876.9	7.2 12			
360.7	4248.0	35.2 21			$A_2/A_0=+0.38$ 12.
361.5	5815.2	17.3 18			
362.8	2274.6	27 6			
368.9	1830.4	54 3	Q		Mult.: $A_2/A_0=+0.20$ 10.
376.9	2965.5	31.3 17	Q		Mult.: $A_2/A_0=+0.18$ 13.
379.6	4627.8	11.3 11			$A_2/A_0=+0.30$ 24.
390.6	1528.8			660 12	
392.0	6207.4				
396.3	5023.9	9.6 10			$A_2/A_0=+0.51$ 18.
					$I\gamma$: evaluator assumes 9.6 1 is a misprint.
400.2	2024.4	76 3	Q		Mult.: $A_2/A_0=+0.23$ 9.
409.9	5433.8	6.7 9			$A_2/A_0=+0.4$ 3.
411.8	2495.3	24 5			
413.0	3175.8	4.7 7	Q@		
415.9	1944.7	80.5 15	Q	83 5	Mult.: $A_2/A_0=+0.25$ 4.
418.5	6626.1	6.1 10			$A_2/A_0=+0.5$ 4.
423.9	5858	12 3			
430.0	6733.8				
433.0	3696.9	15 3			
433 ^a	6292?				
435	4147.0				
443.0	7176.8	3.2 8			
443.6	7069.7				
449.2	2723.8	37 5			
450.0 ^b	1138.2	437 ^b 12	Q	554 ^b 18	Mult.: $A_2/A_0=+0.19$ 6.
	4147.0	24.3 ^b 25			
453.2	2283.6	76 15	(Q)		Mult.: $A_2/A_0=+0.4$ 4.
455.2	1640.1	19 5			
455.4	3421.2	15.7 17	Q@		
461.4	2186.6	86 5	(Q)	69 8	Mult.: $A_2/A_0=+0.07$ 11.
476.6	2501.0	53.7 11	Q		Mult.: $A_2/A_0=+0.22$ 4.
505.9	2450.6	86.2 21	Q	142 8	Mult.: $A_2/A_0=+0.21$ 5.
506.0	3001.3	16 5			
518.9	4415.9	7.5 16			
519.0	3695.0	3.0 6	Q@		
524.9	4269.1	4.0 6			
525.5 ^b	1663.6	276 ^b 13	Q		Mult.: $A_2/A_0=+0.22$ 11.
	3249.3	17 ^b 6			
528.3	2763.1	17.7 13			
529.3	2812.9	28 3	(Q)		Mult.: $A_2/A_0=+0.10$ 24.
542 ^a	4147.0				
545.4	3966.6	12.2 20	(Q)		Mult.: $A_2/A_0=-0.2$ 6.

Continued on next page (footnotes at end of table)

$^{176}\text{Yb}(^9\text{Be},5n\gamma)$ $^{1993}\text{YeZX},^{1993}\text{Wa11},^{2002}\text{Fa19}$ (continued) $\gamma(^{180}\text{W})$ (continued)

$E\gamma^{\dagger}$	E(level)	$I\gamma^{\ddagger}$	Mult. §	$I\gamma^{\&}$	Comments
546.5	3047.5	27.8 1	Q		Mult.: $A_2/A_0=+0.7$ 3.
548.7	2273.5	1.0 5			
549.1	2735.7	81.8 17	Q	86 5	Mult.: $A_2/A_0=+0.21$ 6.
552.5	4553.5	3.4 10			
563.6	4710.6	32 3			
565.9	4147.0	7.0 23			
571.4	2234.9	186 5	Q		Mult.: $A_2/A_0=+0.23$ 6.
587.3	4856.6	2.3 9			
587.4	2822.3	117 6	Q		Mult.: $A_2/A_0=+0.36$ 3.
589.7	3412.0	65 3	Q		Mult.: $A_2/A_0=+0.37$ 11.
591.2	3041.7	51.1 24	Q	138 9	Mult.: $A_2/A_0=+0.11$ 10.
597.0	3846	11 7			
597.9	3410.8	19 3			
601.4	5453.7	2.2 4			
603.4 ^{#a}	2132.3				
604.8	4016.8	34.2 18	(Q)		Mult.: $A_2/A_0=-0.17$ 11.
609.2	3657	10.7 22	Q		Mult.: $A_2/A_0=+0.33$ 22.
613 ^a	5028.9?				
624.3	5177.8	3.0 13			
631.7	3367.3	45 3	Q		Mult.: $A_2/A_0=+0.20$ 13.
639.4	4606.0	3.7 7	Q [@]		
643.5	2588.6	1.5 6			
643.9	4338.9	3.1 6	Q [@]		
655.0	4066	7 5			
655.5	4672.3	17 5	Q		Mult.: $A_2/A_0=+0.26$ 7.
661.2	6114.6				
661.4	5518.1	2.8 9			
663.7	4320	4.1 26			
670.5	3712.2	30.3 16	Q		Mult.: $A_2/A_0=+0.21$ 11.
687.0	5815.2	6.4 9	Q		Mult.: $A_2/A_0=+0.5$ 3.
695.0	4761	5.9 22			
698.2	2423.4	2.4 3			
699.1	5876.9	5.2 8			
700.9	4248.0	6.7 17			
703.6	4415.9	3.1 4			
706.6	4073.9	5.7 5			
707.0	5027	3.1 8			
718 ^a	5745				
728.9	5401	5.4 2			
733.2	5339.3	1.9 4	Q [@]		
740.5	4627.8	8.2 8			
742.9	4455.1	1.1 3			
745 ^a	1082.5				
753.5	6207.4				
755.9	5094.8	1.5 5	Q [@]		
759.7	2423.4	10.5 6			$A_2/A_0=+0.09$ 12.
771.0 ^a	4844.9?	3.2 8			$A_2/A_0=-0.2$ 5.
776.0	5023.9	7.5 16	(Q)		Mult.: $A_2/A_0=+0.5$ 5.
779.7	4147.0	1.8 2			
805.6	5433.8	5.8 16			
809.5	6211	5.5 5			$A_2/A_0=0.003$ 20.
811.1	6626.1				
813.4	3264.0			94 5	
823.0 ^{#a}	6162?				
835 ^a	5858				
846.8	5974.9				
858 ^a	6292?				
862.3	7069.7	1.0 5			
872.8	3695.0	2.9 6			
873.1	7176.8				
889.5	7100	1.8 2			
902.8	1006.3	89 7		8 4	
926.8 ^{#a}	4338.9				

Continued on next page (footnotes at end of table)

$^{176}\text{Yb}(^9\text{Be},5n\gamma)$ $^{1993}\text{YeZX},^{1993}\text{Wa11},^{2002}\text{Fa19}$ (continued) **$\gamma(^{180}\text{W})$ (continued)**

$E\gamma^\dagger$	E(level)	$I\gamma^\ddagger$	Mult.§	Comments
940.9	3175.8	11.7 6	Q	Mult.: $A_2/A_0=+0.34$ 11.
966 ^a	8066?			
986.4	6114.6			
994.1	2132.3	5.4 9		$A_2/A_0=+0.0$ 4.
1099.6	2763.1	7.1 18	(Q)	Mult.: $A_2/A_0=+0.7$ 5.
1285.2	2423.4	7.4 13		$A_2/A_0=-0.2$ 3.

[†] From 1993YeZX, except where noted.

[‡] Prompt $I\gamma$ from 1993YeZX. Measured during beam bursts (=40 ns) and normalized to the total intensity (prompt and delayed) of the 234 γ , $I\gamma(234\gamma)(\text{prompt}+\text{delayed})=1000$.

§ From $\gamma(0)$ in 1993YeZX, except where noted. A_2/A_0 values are included in the comments.

From 1993Wa11.

@ From 1993Wa11. Authors state that for the band built on the 2132-keV, 8+ level, the cascade transitions are D/Q in character and the crossover transitions are Q in character based on their angular distribution analysis. However, no details are given apart from the A_2 coefficients for a few sample transitions.

& Delayed $I\gamma$ from 1993YeZX. Measured between beam bursts (=40 ns) and normalized to the total intensity (prompt and delayed) of the 234 γ , $I\gamma(234\gamma)(\text{prompt}+\text{delayed})=1000$.

^a Placement of transition in the level scheme is uncertain.

^b Multiply placed; intensity suitably divided.

^c Multiply placed; undivided intensity given.

 $^{180}\text{W}(\gamma,\gamma')$: Mossbauer $^{1975}\text{Bo38},^{1973}\text{Zi02},^{1972}\text{He01}$ **^{180}W Levels**

$E(\text{level})^\dagger$	$J\pi^\dagger$	Comments
0.0	0+	
103.6	2+	g=0.260 17. g: from 1973Zi02. Q/Q(2+, ^{182}W)=0.983 22, measured isomer shift (1973Zi02); Q/Q(2+, ^{182}W)=0.98 3, measured isomer shift, Mossbauer conversion electron spectroscopy (1975Bo08); Q/Q(2+, ^{182}W)=1.031 43, Mossbauer following Coulomb excitation (1972He01). Other: 1971Zi01.

[†] From the Adopted Levels.

 $^{180}\text{W}(\text{d},\text{d}')$ $^{1971}\text{Gu17}$

$E(\text{d})=12.1$ MeV. Measured $\sigma(\theta)$ at $\theta=90^\circ$ and 125° using broad-range magnetic spectrograph and nuclear emulsions.

 ^{180}W Levels

E(level)	$J\pi$	Comments
0.0 ^{†‡}	0+ [†]	
103.6 ^{†‡}	2+ [†]	
337.5 ^{†‡}	4+ [†]	
689? ^{†‡}	6+ [†]	
1082.2	3-	
1118 [§] 2	(2+)	$J\pi$: based on large cross section in (d,d').
1319.6	(4+, 5-)	E(level): composite peak.
1637.6		
1692.6		
1737.6		
1814.6		

Continued on next page (footnotes at end of table)

$^{180}\text{W}(\text{d},\text{d}') \quad ^{1971}\text{Gu17 (continued)}$ **^{180}W Levels (continued)**

E(level)

2212 6

2348 6

† From the Adopted Levels.

‡ (A): $K\pi=0+$ g.s. rotational band.§ (B): $K\pi=(2+)$ γ -vibrational band. **$^{181}\text{Ta}(\text{p},2\text{n}\gamma) \quad ^{1979}\text{Ma08}$**

E(p)=17 MeV. Measured $E\gamma$, $I\gamma$, $\gamma\gamma$ coin, $p\gamma(\theta)$, $p\gamma(t)$, excitation function using Ge(Li) and LEPS detectors. Subset of results are published in 1978Sh09.

Others: 1984Zh02, 1971Ko17, 1967Co20, 1967Co26, 1967Bo08, 1967Iv04, 1966Gr04, 1963Re02, 1960Mo19.

 ^{180}W Levels

E(level)†	$J\pi^\ddagger$	$T_{1/2}$	Comments
0.0@	0+		
103.567@ 5	2+		
337.557@ 11	4+		
688.456@ 15	6+		
1006.396# 18	2-		
1082.386# 18	3-		
1117.22& 6	2+		
1138.475@ 25	8+		
1184.898# 19	4-		
1232.68& 4	3+		
1307.581# 19	5-		
1322.10 19			
1360.49& 3	4+		
1461.836# 21	6-		
1529.05§ 3	8-	5.53 ms 10	$T_{1/2}$: from 1967Co20, 1967Co26. Other: 1967Iv04 report a $T_{1/2}$ of 5.2 ms 5 for a level in ^{180}W , however, do not assign the value to a specific level.
1535.63& 6	5+		
1568.17 10			
1624.21# 3	7-		
1634.59 ^b 6	(3-)		
1639.805 ^a 24	5	19.2 ns 3	$T_{1/2}$: from 1979Ma08.
1664.19@ 4	10+		
1693.60 15			
1702.98& 8	6+		
1725.59§ 4	9-		
1729.85 7			
1764.44 ^a 3	6		
1784.95 7			
1830.85# 4	8-		
1851.16 6			
1855.20 16			
1911.59 ^a 3	7		
1918.13 19			
1926.44 16			
1932.19& 11	7+		
1945.07§ 5	10-		
1954.45 15			
2024.49# 8	9-		
2059.35 12			
2082.55 ^a 5	8		
2117.53 12			
2127.40 8			
2133.10 8			

Continued on next page (footnotes at end of table)

$^{181}\text{Ta}(\text{p},2\text{n}\gamma)$ 1979Ma08 (continued) **^{180}W Levels (continued)**

E(level) [†]	$J\pi^{\ddagger}$
2186.98 [§] 12	11-
2235.19 [@] 11	12+
2273.70 ^a 7	9
2284.00 [#] 14	10-
2451.63 [§] 13	12-
2501.09 [#] 13	11-

[†] From a least-squares fit to E_{γ} by evaluator.[‡] Spin, parity, and configuration assignments from 1979Mo08; based on band structure and γ -ray angular distribution results.[§] (A): $K\pi=8-$ band. Probable configuration= $((\pi 7/2[404])+(\pi 9/2[514]))+(\nu 7/2[514])+(\nu 9/2[624])$.[#] (B): $K\pi=2-$ octupole rotational band. 1979Ma08 suggest that there is a significant 2-q π component with a configuration of $((\pi 5/2[402])+(\pi 9/2[514]))$.[@] (C): $K\pi=0+$ g.s. rotational band.[&] (D): $K\pi=2+$ γ rotational band.^a (E): $K=5$ rotational band.^b (F): $K\pi=(3-)$ bandhead. $\gamma(^{180}\text{W})$

$E_{\gamma}^{\dagger}$	E(level)	I_{γ}	Mult. [‡]	δ	α	Comments
75.987 10	1082.386	20				
102.513 20	1184.898	22				
103.567 20	103.567	280	E2			Mult.: from $\alpha(K)\text{exp}=3.0$ 5 (1967Co26).
^x 105.15 25		3				
122.688 20	1307.581	14				
124.631 20	1764.44	21				
^x 126.26 26		2				
147.156 20	1911.59	14				
154.232 35	1461.836	5				
162.43 5	1624.21	2				
170.948 50	2082.55	5				
178	1639.805	5				
178.509 20	1184.898	100				
191.5 3	2273.70	1				
^x 195.3		5				
196.54 3	1725.59	50				
206.7 7	1830.85	1				
211.35 5	1851.16	11				
219.49 4	1945.07	13				
225.189 20	1307.581	150	(Q)			
233.985 30	337.557	1000	E2			Mult.: from $\text{ce}(K)/\text{ce}(L)=2.1$ 3 (1967Co26), $\text{ce}(K)/\text{ce}(L)=2.1$ 5, $\alpha(K)\text{exp}=0.11$ (1967Bo08).
^x 235.80 15		8				
241.92 16	2186.98	5				
^x 258.84 17		3				
264.7 6	2451.63	≤ 9				
271.75 5	1911.59	13				
276.941 20	1461.836	110	(Q)			
279.306 35	1639.805	20				
^x 285.15 16		4				
316.625 30	1624.21	70	(Q)			
318.24 11	2082.55	8				
319.74 [§] 17	1954.45	8				
329.5 1	2059.35	9				
332.241 30	1639.805	60				
350.898 10	688.456	660	E2			Mult.: from $\alpha(K)\text{exp}=0.039$ 10, $\text{ce}(K)/\text{ce}(L)=3.6$ 10 (1967Bo08).
^x 353.11 38		3				
362.10 6	2273.70	4				
369.015 30	1830.85	32	(Q)			
390.579 30	1529.05	170	E1			Mult.: from $\alpha(K)\text{exp}=0.012$ 4 (1967Bo08).

Continued on next page (footnotes at end of table)

$^{181}\text{Ta}(\text{p},2\text{n}\gamma)$ 1979Ma08 (continued) $\gamma(^{180}\text{W})$ (continued)

$E\gamma^{\dagger}$	E(level)	$I\gamma$	Mult. ‡	δ	α	Comments
400.26 8	2024.49	25	(Q)			
401.84 12	1634.59	18				
$\times$ 409.10 11		7				
415.94 10	1945.07	6	(Q)			
$\times$ 419.47 15		7				
424.50 8	1784.95	8				
$\times$ 447.44 14		5				
450.0 5	1634.59	7				
450.02 3	1138.475	240	E2			Mult.: from $\alpha(\text{K})_{\text{exp}}=0.018$ 3, $\text{ce}(\text{K})/\text{ce}(\text{L})=3.6$ 11 (1967Bo08).
453.15 14	2284.00	7				
454.88 3	1639.805	44				
461.39 17	2186.98	3				
$\times$ 465.71 5		15				
476.6 1	2501.09	2				
$\times$ 493.83 15		5				
506.56 12	2451.63	8				
517.37 4	1634.59	26				
525.71 3	1664.19	27	(Q)			
$\times$ 534.4 $\S$ 3		1				
552.0 3	1634.59	4				
552.4 2	1784.95	4				
571.0 1	2235.19	4				
$\times$ 609.24		4				
619.24 22	1307.581	6				$E\gamma$: value of 609.24 in Table 1 of 1979Ma08 is considered a misprint by the evaluator.
669.09 15	1006.396	5				
$\times$ 669.32 10		12				
$\times$ 673.46 $\S$ 13		8				
$\times$ 724.10 10		10				
$\times$ 741.57 14		7				
744.78 3	1082.386	35				
$\times$ 755.3 3		4				
780 $\S$	1117.22	≤ 2				
$\times$ 780.54 8		18				
788.0 3	1926.44	3				
794	1932.19	2				
847.0	1535.63	3				
847.20 5	1184.898	25				
$\times$ 853.4 2		5				
$\times$ 859.5 19		5				
$\times$ 876.7 4		2				
879.6 $\S$ 3	1568.17	4				
886.6 $\S$ 2	2024.49	4				
895.26 10	1232.68	7				
902.84 2	1006.396	440	E1+M2	-0.16 7	0.0029 8	Mult.: from $A_2=0.47$ 7, $A_4=-0.10$ 15 from $\gamma(0)$ in (p,2n γ), and $\alpha(\text{K})_{\text{exp}}=0.0046$ 6 (^{180}Re ϵ decay). Additional E3 mixing with $\delta(\text{E3/E1})=-0.64$ 17 is consistent with these data (1971Ko17).
951.25 12	1639.805	6				
969.83 18	1307.581	9				
979.05 12	2117.53	9				
984.2 3	1322.10	3				
988.92 8	2127.40	9				
994.62 8	2133.10	8				
1006.46 10	1006.396	4				
$\times$ 1011.82 15		11				
1013.4 2	1117.22	29				
1014.49 10	1702.98	30				
1022.92 6	1360.49	29				
1041.40 7	1729.85	19				
$\times$ 1066.8 3		3				
$\times$ 1077.7 5		2				
1081.52 12	1184.898	7				

Continued on next page (footnotes at end of table)

$^{181}\text{Ta}(\text{p}, 2\text{n}\gamma)$ 1979Ma08 (continued) $\gamma(^{180}\text{W})$ (continued)

$E\gamma^\dagger$	E(level)	I_γ	Mult. ‡	$E\gamma^\dagger$	E(level)	I_γ
$\times 1089.5\ 6$		1		1322.2 4	1322.10	3
1096.3 2	1784.95	3		$\times 1333.0\ 2$		7
$\times 1100.1\ 4$		2		1356.04 15	1693.60	10
1117.24 7	1117.22	20		1365.46 13	1702.98	14
1129.09 4	1232.68	44		1392.22 16	1729.85	8
1166.74 16	1855.20	10		1447.2 2	1784.95	7
1198.07 6	1535.63	25		$\times 1458.2\ 5$		3
1218.8 3	1322.10	5		$\times 1461.1\ 5$		3
1229.6 2	1918.13	5		$\times 1476.4\ 5$		3
1230.62 11	1568.17	8		$\times 1483.6\ 3$		7
1237.96 18	1926.44	22		$\times 1505.5\ 3$		4
1243.73 11	1932.19	15		$\times 1529.8\ 5$		3
1257.16 9	1360.49	17	(Q)	1581.2 6	1918.13	3
1266.2 3	1954.45	5		1617.6 5	1954.45	2
1297.4 3	1634.59	5		$\times 1632.9\ 6$		3
1302 §	1639.805	≤ 1		$\times 1778.8\ 5$		3

† From 1979Ma08. Uncertainties are increased from those given in Table 1 to reflect the systematic uncertainty stated by the authors to be ≈ 20 eV at 200 keV and ≈ 50 eV at 1 MeV.

‡ From $\gamma(\theta)$ in 1979Ma08, except where noted. The angular distribution coefficients A_2 and A_4 have large uncertainties due to low statistics. Therefore, only those coefficients which indicated stretched Q transitions are used to tentatively assign multipolarities.

§ Placement of transition in the level scheme is uncertain.

$\times$ γ ray not placed in level scheme.

 $^{182}\text{W}(\text{p}, \text{t})$ 1980Mo11, 2006Me25

2006Me25: E(p)=25 MeV. Measured $\sigma(\theta)$ for $\theta=5^\circ$, 17.5° , and 30° using Q3D magnetic spectrometer and 1 m focal plane detector; DWBA analysis using CHUCK3 code.

1980Mo11: E(p)=21 MeV. Measured $\sigma(\theta)$ using multiangle spectrograph and photographic emulsions (FWHM=20 keV); DWBA and CCBA analysis. Subset of results presented in 1977Mo15.

Other: 1973Oo01, 1972Ma15.

 ^{180}W Levels

$E(\text{level})^\dagger$	$J\pi^\#$	$L^\ddagger$	Comments
0.0	0+	0	
104 3	(2+)	(2)	E(level): weighted average of 109 5 (1980Mo11) and 102 3 (1972Ma15).
335 3	(4+)	(4)	E(level): weighted average of 332 5 (1980Mo11) and 336 3 (1972Ma15).
688 5			
746? 10			
831? 10			
1012? 10			
1037.6 $\frac{7}{2}$ 3			E(level): indicated as a probable contaminant by 2006Me25. Level is not adopted by the evaluator. E(level): other: 1034 10 (1980Mo11).
1083 5			
1120 5	(2+)	(2)	
1190 5			
1229 5			
1321 5			
1359 5			
1380.8 $\frac{3}{2}$ 3	0+	0 $\frac{3}{2}$	E(level): other: 1382 5 (1980Mo11).
1472.1 $\frac{1}{2}$ 4	(0+)	(0) $\frac{1}{2}$	E(level): other: 1470 5 (1980Mo11).
1513.6 $\frac{3}{2}$ 4	0+	0	E(level): other: 1516 5 (1980Mo11).
1589 5	2+	2	
1635 5			
1689.4 $\frac{1}{2}$ 5	0+	0	E(level): other: 1695 5 (1980Mo11).
$\approx 1740^\S$			
1768.4 $\frac{1}{2}$ 5	0+	0 $\frac{1}{2}$	

Continued on next page (footnotes at end of table)

$^{182}\text{W}(\text{p},\text{t})$ 1980Mo11,2006Me25 (continued) **^{180}W Levels (continued)**

$E(\text{level})^\dagger$	$J\pi^\#$	$L^\ddagger$	$E(\text{level})^\dagger$	$J\pi^\#$	$L^\ddagger$	$E(\text{level})^\dagger$	$J\pi^\#$	$L^\ddagger$
1824 5			2095 10			2293 10		
1906 5			2164 10			2326.8 ‡ 7	0+	0 ‡
1932.3 ‡ 6	(0+)	(0) ‡	2181.6 ‡ 6	0+	0 ‡	2356 10		
1944 5			2203 10			2400 10		
2036.7 ‡ 6	0+	0 ‡	2212 10					
2057 10			2265 10					

† From 1980Mo11, except where noted. L values come from a comparison of measured cross sections with calculated values (DWBA and coupled-channel Born approximation (CCBA)) at various angles.

‡ From 2006Me25. L=0 is identified by comparing the ratio of the cross section at 5° and 17.5°.

$^\#$ Doublet.

$^\#$ From measured L value.

 $^{186}\text{W}(\text{n},7\text{n}\gamma)$ 2000Ya22

E(n)=250–600 MeV. Measured E_γ , I_γ using Kentucky Gamma-ray Spectrometer composed of 4 HPGe detectors.

 ^{180}W Levels

$E(\text{level})$	$J\pi$
0.0	0+
104	2+
338	4+
689	6+
1139	8+
1665	10+
2236	12+

 $\gamma(^{180}\text{W})$

E_γ	$E(\text{level})$
234	338
351	689
450	1139
526	1665
571	2236

 $\text{Hf}(\alpha,\text{xn}\gamma)$ 1979FaZR,1966Bu08,1981Av04

1981Av04: $^{177}\text{Hf}(\alpha,\text{n}\gamma)$, E=25–29 MeV. Measured E_γ , I_γ , $\gamma(\text{t})$ using a Ge(Li) detector.

1979FaZR: $^{180}\text{Hf}(\alpha,4\text{n}\gamma)$, E(α)=48 MeV. Measured E_γ , I_γ , $\gamma\gamma$, $\gamma(\theta)$, and $\gamma(\text{t})$ using Ge(Li) detectors.

1966Bu08: $^{178}\text{Hf}(\alpha,2\text{n}\gamma)$, E(α)=23 MeV. Measured E_γ , I_γ , $\gamma\gamma$, $\gamma\gamma(\theta)$ using three NaI(Tl) detectors and E(ce) and I(ce) using an electron spectrometer of single wedge-gap type.

Others: 1980Go18, 1977Go15, 1976Be47, 1972Fe08, 1969Mi03, 1965La02, 1955So54.

 ^{180}W Levels

$E(\text{level})^\dagger$	$J\pi^\ddagger$	$T_{1/2}^\S$	Comments
0.0 $^\#$	0+		
103.6 $^\#$	2+		
337.8 $^\#$	4+		
689.0 $^\#$	6+		
1006.2@ 6	2–		

Continued on next page (footnotes at end of table)

Hf(α ,xn γ) 1979FaZR,1966Bu08,1981Av04 (continued) ^{180}W Levels (continued)

E(level) [†]	$J\pi^{\ddagger}$	$T_{1/2}^{\S}$	Comments
1082.4@ 11	3-		
1138.6# 9	8+		
1184.8@ 11	4-		
1307.7@ 11	5-		
1461.4@ 13	6-		
1529.6& 10	8-	5.2 ms 2	$T_{1/2}$: weighted average of 5.2 ms 2 (1966Bu08) and 5.6 ms 6 (1981Av04). $T_{1/2}$: Other: 5.5 ms 3 isomer was identified in 1955So54, however, no assignment to a particular level was given.
1624.3@ 15	7-		
1640.2 ^a 12	(5)	24 ns 7	$J\pi$: proposed configuration of $\nu 9/2[624]\nu 1/2[521]$ would mean negative parity for the band.
1664.3# 14	10+		
1726.1& 12	9-		
1765.1 ^a 14	(6)		
1830.3@ 16	8-		
1911.9 ^a 14	(7)		
1945.6& 12	10-		
2024.4@ 18	9-		
2083.2 ^a 15	(8)		
2187.5& 14	11-		
2235.6# 17	12+		
2274.6 ^a 16	(9)		
2283.5@ 19	10-		
2451.4& 14	12-		
2501.1@ 21	11-		
2736.7& 15	13-		
2812.9@ 22	12-		
2823.2# 20	14+		
3042.7& 15	14-		
3047.4@ 23	13-		
3264.8 15	14-	2.3 μ s 2	Proposed four qp-isomer with configuration $(\nu 9/2[624])(\nu 7/2[514])(\pi 7/2[404])(\pi 5/2[402])$ (1979FaZR).
3389.8 18	15+	8.6 ns 6	Proposed four qp-state with configuration $(\nu 9/2[624])(\nu 7/2[514])(\nu 5/2[512])(\nu 9/2[624])$ (1979FaZR).
3410.7@ 24	14-		
3412.8# 22	16+		
3547.9 ^b 21	16+	20.3 ns 6	
3888.2 ^b 23	17+		
4016 [#] 3	18+		
4249 ^b 3	18+		
4629 ^b 3	19+		

[†] From a least-squares fit to $E\gamma$ by evaluator.[‡] Spin and parity assignments from 1979FaZR based on γ -ray multiplicities and assumed band structure.[§] From beam- $\gamma(t)$ in $^{180}\text{Hf}(\alpha,4n\gamma)$ (1979FaZR), except where noted.# (A): $K\pi=0+$ g.s. rotational band.@ (B): $K\pi=2-$ octupole vibrational band.& (C): $K\pi=8-$ band. Proposed configuration of $(\nu 9/2[624])(\nu 7/2[514])$ (1979FaZR).^a (D): $K\pi=(5)$ band. Proposed configuration of $(\nu 9/2[624])(\nu 1/2[521])$ (1979FaZR).^b (E): $K\pi=16+$ band. Proposed 4-qp configuration of $(\nu 9/2[624])(\nu 7/2[514])(\pi 7/2[404])(\pi 9/2[514])$ (1979FaZR). $\gamma(^{180}\text{W})$

A_2 and A_4 coefficients from $\gamma(0)$ in 1979FaZR. The A_2 coefficients measured by 1966Bu08 are consistent with stretched E2 multiplicities for 448 γ , 350 γ , 234 γ , and 103 γ , and with E1 multipolarity for 390 γ , assuming a $J\pi=8-,8+,6+,4+,2+,0+$ cascade.

$E\gamma^{\dagger}$	E(level)	$I\gamma^{\dagger}$	Mult. [#]	α	Comments
76.1	1082.4	0.77 8			
103.6 [‡] 4	103.6	20 [§] 4	E2	3.45	Mult.: from $\alpha(K)_{\text{exp}}=2.42$ (1966Bu08).
122.8	1307.7	2.05 14			$A_2=+0.24$ 6, $A_4=+0.17$ 9.
124.9	1765.1				

Continued on next page (footnotes at end of table)

Hf(α , $n\gamma$) 1979FaZR,1966Bu08,1981Av04 (continued) $\gamma(^{180}\text{W})$ (continued)

$E_{\gamma}^{\dagger}$	E(level)	$I_{\gamma}^{\dagger}$	Mult.#	α	Comments
125.0	3389.8		(E1)		Mult.: from α (exp) determined from intensity balance in 1979FaZR; in spectrum gated on 340.3 γ , intensity of 125.0 γ is significantly larger than the 158.1 γ suggesting E1 for the former and M1 for the latter.
146.9	1911.9	1.58 13	D		$A_2=-0.55$ 7, $A_4=+0.12$ 12.
158.1	3547.9	4.09 23	(M1)		Mult.: from α (exp) determined from intensity balance in 1979FaZR; in spectrum gated on 340.3 γ , intensity of 125.0 γ is significantly larger than the 158.1 γ suggesting E1 for the former and M1 for the latter.
171.3	2083.2	1.21 9	D		$A_2=-0.48$ 12, $A_4=-0.07$ 20.
178.7	1184.8	≤ 6.0			
179.1	1640.2				
191.4	2274.6	1.50 19	D		$A_2=-0.33$ 4, $A_4=+0.05$ 9.
196.5	1726.1	25.9 15			
219.5	1945.6	13.2 8	D		$A_2=-0.47$ 3, $A_4=+0.10$ 5.
222.1	3264.8	5.8 3	(M1)		Mult.: from α (exp)=0.55 4 (1979FaZR). α (exp): from intensity balance in delayed γ spectrum (1979FaZR). $A_2=+0.24$ 4, $A_4=-0.05$ 6.
225.2	1307.7	8.4 5	Q		
234.2 $\ddagger$ 2	337.8	100 $\S$ 9	E2	0.186	Mult.: from ce(K)/ce(L)=2.1 3 (1966Bu08). $A_2=-0.63$ 5, $A_4=-0.03$ 7.
241.8	2187.5	8.5 5	D		
264.0	2451.4	7.9 5			
271.7	1911.9	1.54 10			
276.9	1461.4	7.7 4	Q		$A_2=+0.26$ 2, $A_4=0.04$ 3.
285.3	2736.7	2.43 19	D		$A_2=-0.46$ 1, $A_4=-0.19$ 1.
306.1	3042.7	1.58 10	D		$A_2=-0.47$ 6, $A_4=+0.11$ 9.
316.6	1624.3	11.1 6	Q		$A_2=+0.34$ 4, $A_4=+0.02$ 6.
318.0	2083.2	0.83 7	Q		$A_2=+0.46$ 9, $A_4=-0.50$ 17.
332.2	1640.2	3.03 18			
340.3	3888.2	3.02 20	D+Q		$A_2=+0.48$ 7, $A_4=+0.13$ 12.
351.2 $\ddagger$ 6	689.0	101 $\S$ 8	E2	0.0541	Mult.: from α (K)exp=0.036, ce(K)/ce(L)=3.1 4 (1966Bu08). $A_2=+0.38$ 6, $A_4=+0.09$ 10.
361.0	4249	1.01 9	D+Q		$A_2=+0.24$ 5, $A_4=+0.17$ 8.
362.8	2274.6	1.44 11	Q		$A_2=+0.29$ 2, $A_4=+0.04$ 4.
368.9	1830.3	5.4 3	Q		
380.1	4629				
391.0 $\ddagger$ 2	1529.6	101 $\S$ 13	E1	0.0123	Mult.: from α (K)exp=0.0083 (1966Bu08). $A_2=+0.30$ 3, $A_4=-0.03$ 4.
400.1	2024.4	8.7 5	Q		$A_2=+0.17$ 3, $A_4=0.00$ 4.
415.9	1945.6	14.8 8	Q		Mult.: from α (K)exp=0.017, ce(K)/ce(L)=4.8 11 (1966Bu08). $A_2=+0.29$ 6, $A_4=-0.23$ 10.
449.6 $\ddagger$ 6	1138.6	117 $\S$ 10	E2	0.0277	
453.2	2283.5	4.9 3	Q		
455.3	1640.2	3.47 26			
461.4	2187.5	14.1 8	Q		$A_2=+0.16$ 3, $A_4=-0.01$ 4.
476.7	2501.1	5.3 3			
505.9	2451.4	17.1 9	Q		$A_2=+0.15$ 3, $A_4=-0.04$ 5.
525.7	1664.3	27.4 16	Q		$A_2=+0.29$ 3, $A_4=-0.05$ 5.
528.0	3264.8	7.1 4			
529.4	2812.9	2.9 3	Q		$A_2=+0.24$ 8, $A_4=-0.12$ 15.
546.3	3047.4	2.51 16	Q		$A_2=+0.35$ 9, $A_4=-0.07$ 5.
549.1	2736.7	11.1 6	Q		$A_2=+0.17$ 3, $A_4=+0.07$ 5.
571.3	2235.6	15.5 9	Q		$A_2=+0.31$ 4, $A_4=-0.01$ 6.
587.6	2823.2	8.9 5	Q		$A_2=+0.32$ 4, $A_4=+0.02$ 6.
589.6	3412.8	4.8 3	Q		$A_2=+0.36$ 4, $A_4=-0.08$ 6.
591.2	3042.7	9.2 5	Q		$A_2=+0.13$ 4, $A_4=-0.03$ 5.
597.8	3410.7	3.8 3			
604.5	4016	2.80 18			
668.0	1006.2				
813.4	3264.8	6.2 3			
902.8	1006.2	20.3 12			
1006.4	1006.2				

 $\dagger$ From $^{180}\text{Hf}(\alpha,4n\gamma)$ (1979FaZR), except where noted. $\ddagger$ From $^{177}\text{Hf}(\alpha,n\gamma)$ (1981Av04). $\S$ Weighted averages of delayed I_{γ} from 1966Bu08 and 1981Av04.# From $\gamma(0)$ in 1979FaZR, except where noted.

Adopted Levels, Gammas

$Q(\beta^-) = -1475.27$; $S(n) = 7320.30$; $S(p) = 3829.26$; $Q(\alpha) = 3100.50$ 2012Wa38.

$S(2n) = 16330.40$; $S(2p) = 9820$ (syst) 60 (2012Wa38).

 ^{180}Re Levels

Most of the adopted levels are from $^{176}\text{Yb}(^{10}\text{B}, 6n\gamma)$, $^{174}\text{Yb}(^{11}\text{B}, 5n\gamma)$. The band structures observed in $^{170}\text{Er}(^{14}\text{N}, 4n\gamma)$, $^{181}\text{Ta}(\alpha, 5n\gamma)$ are similar, however, differ in bandhead energy and assigned spin. Configuration assignments are taken from 2005El10.

Cross Reference (XREF) Flags

A ^{180}Os ϵ Decay
 B $^{170}\text{Er}(^{14}\text{N}, 4n\gamma)$, $^{181}\text{Ta}(\alpha, 5n\gamma)$
 C $^{176}\text{Yb}(^{10}\text{B}, 6n\gamma)$, $^{174}\text{Yb}(^{11}\text{B}, 5n\gamma)$

E(level) [†]	$J\pi^{\ddagger}$	XREF	$T_{1/2}^{\S}$	Comments
0.0 ^d	(1) ⁻	A C	2.46 min 3	$\% \epsilon + \% \beta^+ = 100$; $\mu = 1.56$ 17. $J\pi$: 20.1 γ E1 from 1+; direct feeding to $J\pi = 2^-$, 1006 level in ^{180}W . μ : Static Nuclear Orientation with gamma detection (1992Bo39). $T_{1/2}$: weighted average of 2.42 min 7 (1955Fi30), 2.45 min 10 (1966Ho16), 2.6 min 2 (1977Ha24), and 2.47 min 3 (2009Fa01). Configuration: $\pi 5/2[402]v7/2[514]$.
20.10 10	1+	A	88 ns 3	$J\pi$: directly fed in ^{180}Os ϵ decay ($J\pi = 0^+$). $T_{1/2}$: from $\gamma\gamma(t)$ in ^{180}Os ϵ decay. Configuration: $\pi 9/2[514]v7/2[514]$.
49.9 ^d 7	(2) ⁻	A		$J\pi$: 49.8 γ M1 to (1) ⁻ , band assignment.
74.6 7	(2) ⁺	A		$J\pi$: 54.4 γ to 1+, band assignment.
218.2 6		A		
249.9 7		A		
349.2 6		A		
401.7 8		A		
668.7 7		A		
717.1 7		A		
0.0+x [#]	(5 ⁺)	BC		$J\pi$: assigned as (4 ⁻ , 5 ⁻) in $^{170}\text{Er}(^{14}\text{N}, 4n\gamma)$, $^{181}\text{Ta}(\alpha, 5n\gamma)$.
x+45.8 [@] 5	(6 ⁺)	C		
x+70.6 ^{&} 5	(7 ⁺)	C		
x+123.4 [#] 5	(7 ⁺)	C		
x+162.8 ^{&} 6	(8 ⁺)	BC		$J\pi$: assigned as (6 ⁻) in $^{170}\text{Er}(^{14}\text{N}, 4n\gamma)$, $^{181}\text{Ta}(\alpha, 5n\gamma)$.
x+177.8 ^a 6	(7 ⁻)	C		
x+205.2 ^c 6	8 ⁺	BC		$J\pi$: assigned as (6 ⁻) in $^{170}\text{Er}(^{14}\text{N}, 4n\gamma)$, $^{181}\text{Ta}(\alpha, 5n\gamma)$.
x+230.1 [@] 5	(8 ⁺)	BC		
x+266.6 ^b 6	(8 ⁻)	BC		
x+284.2 ^d 6	9 ⁻	BC	75.1 ns 14	$T_{1/2}$: weighted average of 75.6 ns 14 from $\gamma\gamma(t)$ in $^{176}\text{Yb}(^{11}\text{B}, 5n\gamma)$ and 73 ns 3 from $\gamma\gamma(t)$ in $^{170}\text{Er}(^{14}\text{N}, 4n\gamma)$, $^{181}\text{Ta}(\alpha, 5n\gamma)$. Other: 78 ns 9 from $\gamma(t)$ in $^{176}\text{Yb}(^{10}\text{B}, 6n\gamma)$. $J\pi$: assigned as (7 ⁺) in $^{170}\text{Er}(^{14}\text{N}, 4n\gamma)$, $^{181}\text{Ta}(\alpha, 5n\gamma)$. Configuration: $\pi 9/2[514]v9/2[624]$.
x+312.3 ^{&} 5	(9 ⁺)	BC		
x+363.2 [#] 5	(9 ⁺)	BC		
x+370.9 ^a 6	(9 ⁻)	BC		
x+414.1 ^c 6	9 ⁺	BC		
x+418.6 ^d 6	10 ⁻	BC		
x+495.1 ^{&} 5	(10 ⁺)	BC		
x+523.1 [@] 5	(10 ⁺)	BC		
x+526.7 ^b 6	(10 ⁻)	BC		
x+595.3 ^d 6	11 ⁻	BC		
x+642.5 ^c 6	10 ⁺	BC		
x+672.2 ^a 6	(11 ⁻)	BC		
x+696.5 [#] 5	(11 ⁺)	BC		
x+715.7 ^{&} 5	(11 ⁺)	BC		
x+805.4 ^d 6	12 ⁻	BC		
x+888.5 ^c 6	11 ⁺	BC		
x+902.3 ^b 6	(12 ⁻)	BC		
x+905.5 [@] 5	(12 ⁺)	BC		
x+949.4 ^{&} 5	(12 ⁺)	BC		
x+1043.0 ^d 6	13 ⁻	BC		
x+1079.4 ^a 6	(13 ⁻)	BC		

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Adopted Levels, Gammas (continued) ^{180}Re Levels (continued)

$E(\text{level})^{\dagger}$	$J\pi^{\ddagger}$	XREF	$T_{1/2}^{\S}$	Comments
x+1132.1# 5	(13+)	BC		
x+1150.0c 6	12+	BC		
x+1204.9& 5	(13+)	BC		
x+1304.4d 6	14-	BC		
x+1379.2@ 6	(14+)	BC		
x+1386.8b 6	(14-)	BC		
x+1403.0 6	(12-)	BC		
x+1425.3c 6	13+	BC		
x+1482.3& 6	(14+)	BC		
x+1566.8e 6	13+	BC	73.4 ns 16	$T_{1/2}$: weighted average of 74.2 ns 14 from $\gamma\gamma(t)$ in $^{174}\text{Yb}(^{11}\text{B},5n\gamma)$ and 70 ns 3 from $\gamma\gamma(t)$ in $^{170}\text{Er}(^{14}\text{N},4n\gamma), ^{181}\text{Ta}(\alpha,5n\gamma)$. Other: 67 ns 9 from $\gamma(t)$ in $^{176}\text{Yb}(^{10}\text{B},6n\gamma)$. $J\pi$: assigned as (11-) in $^{170}\text{Er}(^{14}\text{N},4n\gamma), ^{181}\text{Ta}(\alpha,5n\gamma)$.
x+1586.1a 6	(15-)	BC		
x+1587.5d 6	15-	BC		
x+1643.4# 5	(15+)	BC		
x+1669.8 6	(13-)	BC		
x+1701.2f 6	14-	BC	<5.6 ns	$J\pi$: assigned as (10+) in $^{170}\text{Er}(^{14}\text{N},4n\gamma), ^{181}\text{Ta}(\alpha,5n\gamma)$.
x+1712.0c 6	14+	BC		
x+1755.6g 6	15-	C	<5.6 ns	
x+1768.1& 6	(15+)	BC		
x+1846.9e 6	(14+)	BC		
x+1876.1h 6	16+	BC		$J\pi$: assigned as (11-) in $^{170}\text{Er}(^{14}\text{N},4n\gamma), ^{181}\text{Ta}(\alpha,5n\gamma)$.
x+1888.6d 6	16-	BC		
x+1926.5@ 6	(16+)	BC		
x+1930.2f 6	15-	BC		
x+1969.0b 6	(16-)	BC		
x+2008.1c 6	15+	BC		
x+2045.7g 6	16-	BC		
x+2075.4& 6	(16+)	BC		
x+2140.0h 6	17+	BC		
x+2148.5e 6	(15+)	BC		
x+2161.5f 6	16-	BC		
x+2186.4a 6	(17-)	BC		
x+2205.6d 6	17-	BC		
x+2222.8# 6	(17+)	BC		
x+2310.0c 6	16+	BC		
x+2356.7g 6	17-	BC		
x+2375.7& 6	(17+)	BC		
x+2416.1h 6	18+	BC		
x+2421.2f 6	17-	BC		
x+2474.3e 6	(16+)	BC		
x+2533.0d 6	18-	BC		
x+2537.2@ 7	(18+)	BC		
x+2617.1c 6	17+	BC		
x+2633.1b 7	(18-)	C		
x+2683.8g 6	18-	BC		
x+2693.6& 6	(18+)	C		
x+2707.4h 6	19+	BC		
x+2710.4f 6	18-	BC		
x+2861.0# 6	(19+)	BC		
x+2867.4a 6	(19-)	BC		
x+2872.7d 6	19-	BC		
x+2922.3c 6	18+	BC		
x+3002.7f 6	19-	C		
x+3015.0h 6	20+	BC		
x+3051.9 6	18+	C		
x+3069.0 6	(18+)	C		
x+3122.8 6	(18+)	C		
x+3203.2@ 7	(20+)	BC		
x+3209.9d 6	20-	BC		
x+3234.7c 6	(19+)	BC		
x+3327.5f 6	20-	C		

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Adopted Levels, Gammas (continued) ^{180}Re Levels (continued)

E(level) [†]	J π [‡]	XREF	T _{1/2} [§]	Comments
x+3339.4 ^h 6	21+	BC		
x+3353.1 ^{?b} 7	(20-)	C		
x+3369.6 ⁶	(19-)	C		
x+3408.5 ⁶	(20+)	C		
x+3471.8 ⁱ 6	21-	BC	9.0 μ s 7	T _{1/2} : from beam pulse- γ (t) in $^{174}\text{Yb}(^{11}\text{B},5n\gamma)$.
x+3550.1 [#] 6	(21+)	BC		
x+3551.4 ^d 6	21-	BC		
x+3616.0 ^a 6	(21-)	BC		
x+3668.5 ^f 6	21-	BC		
x+3680.5 ^h 6	22+	BC		
x+3851.3 ⁱ 7	22-	C		
x+3861.9 ^d 6	22-	BC		
x+3895.8 ^j 6	(22+)	C		
x+3911.0 [@] 8	(22+)	BC		
x+4025.7 ^f 7	22-	BC		
x+4038.0 ^h 6	23+	C		
x+4205.8 ^d 6	23-	BC		
x+4240.9 ⁱ 7	23-	C		
x+4269.8 ^j 7	(23+)	C		
x+4300.2 [#] 7	(23+)	C		
x+4392.1 ^f 7	23-	C		
x+4412.1 ^{?a} 6	(23-)	C		
x+4412.6 ^h 6	24+	BC		
x+4525.6 ^d 6	24-	BC		
x+4637.6 ⁱ 7	24-	C		
x+4643.7 [@] 9	(24+)	C		
x+4651.8 ^j 7	(24+)	C		
x+4802.0 ^h 6	25+	BC		
x+4888.7 ^d 6	(25-)	BC		
x+5040.5 ^j 7	(25+)	C		
x+5048.1 ⁱ 9	(25-)	C		
x+5102.9 ^{?#} 7	(25+)	C		
x+5206.2 ^h 6	26+	C		
x+5436.1 ^j 7	(26+)	C		
x+5455.3 ⁱ 9	(26-)	C		
x+5838.3 ^j 7	(27+)	C		
x+6249.9 ^j 8	(28+)	C		
x+6673.6 ^j 8	(29+)	C		

[†] From a least-squares fit to E γ , by evaluator.

[‡] Spin and parity assignments from $^{176}\text{Yb}(^{10}\text{B},6n\gamma)$, $^{174}\text{Yb}(^{11}\text{B},5n\gamma)$. The level scheme is constructed around the bands built on the 8+, 205.1+x level and the 9- 284.2+x level. The spins of these levels were established by considering signature splittings, g-factors, systematics, bandhead energies and quasiparticle alignments and comparing to theoretical predictions in 1994Ja19. Within bands, spin and parity assignments are based on rotational structure, γ -ray multiplicities and decay patterns. Assignments of $^{176}\text{Yb}(^{10}\text{B},6n\gamma)$, $^{174}\text{Yb}(^{11}\text{B},5n\gamma)$ do not agree with those from $^{170}\text{Er}(^{14}\text{N},4n\gamma)$, $^{181}\text{Ta}(\alpha,5n\gamma)$. The former are adopted as many additional linking transitions between bands were identified. Discrepancies in bandhead spin assignments are indicated in the comments.

[§] From $\gamma\gamma$ (t) in $^{174}\text{Yb}(^{11}\text{B},5n\gamma)$, except where noted.

(A): K π =(4+) band, α =1. Configuration=v7/2[514]@ π 1/2[541].

@ (B): K π =(4+) band, α =0. Configuration=v7/2[514]@ π 1/2[541].

& (C): K π =(7+) band. Configuration=v9/2[624]@ π 5/2[402].

a (D): K π =(5-) band, α =1. Configuration=v9/2[624]@ π 1/2[541].

b (E): K π =(5-) band, α =0. Configuration=v9/2[624]@ π 1/2[541].

c (F): K π =8+ band. Configuration=v7/2[514]@ π 9/2[514].

d (G): K π =9- band. Configuration=v9/2[624]@ π 9/2[514].

e (H): K π =13+ band. 4qp band with configuration=v(7/2[514],9/2[624],5/2[512])@ π (5/2[402]).

f (I): K π =14- band. 4qp band with configuration=v(7/2[514],9/2[624],7/2[633])@ π (5/2[402]).

g (J): K π =15- band. 4qp band with configuration=v(7/2[514],9/2[624],5/2[512])@ π (9/2[514]).

h (K): K π =16+ band. 4qp band with configuration=v(7/2[514],9/2[624],7/2[633])@ π (9/2[514]).

i (L): K π =21- band. 6qp band with configuration=v(7/2[514],9/2[624],5/2[512])@ π (5/2[402],9/2[514],7/2[404]).

j (M): K π =(22+) band. 6qp band with configuration=v(7/2[514],9/2[624],7/2[633])@ π (5/2[402],9/2[514],7/2[404]).

Adopted Levels, Gammas (continued)

$\gamma(^{180}\text{Re})$						
E(level)	$E_{\gamma}^{\dagger}$	$I_{\gamma}^{\dagger}$	Mult. [‡]	$\delta^{\ddagger}$	α	Comments
20.10	20.1 ^{\$} 1	100	E1 [#]		5.80 12	B(E1)(W.u.)=4.37×10 ⁻⁵ 18.
49.9	49.8 ^{\$}	100	M1 [#]		6.82	
74.6	54.4 ^{\$}		M1 [#]		5.26	
	74.6 ^{\$}		E1 [#]		0.800	
218.2	218.2					
249.9	31.6					
	200.1					
	250.0					
349.2	329.0					
	349.1					
401.7	183.8					
	401.5					
668.7	319.4					
	450.4					
717.1	48.2					
	667.0					
	717.4					
x+45.8	45.8 5	100				
x+70.6	(25.0)					Mult.: M1 is consistent with non observation of the 25 γ .
x+123.4	77.5 2	100	M1&		10.73 17	
x+162.8	92.2 6	100	M1		6.53 16	
x+177.8	132.0 ^b 3	100				
x+205.2	42.4 3	11 5	M1&		10.9 3	
	134.5 2	100 25	M1+E2		1.8 5	
x+230.1	106.3 5	100 30	M1+E2@	-0.10 9	4.33 9	
	184.3 1	47 15	E2		0.422	I γ : other: 150 30 in $^{170}\text{Er}(^{14}\text{N},4n\gamma)$, $^{181}\text{Ta}(\alpha,5n\gamma)$.
x+266.6	88.5 2	100	M1(+E2)	-0.04 4	7.34 12	Mult.: D(+Q) from $\gamma(\theta)$ in $^{170}\text{Er}(^{14}\text{N},4n\gamma)$, $^{181}\text{Ta}(\alpha,5n\gamma)$, $\Delta\pi=\text{no}$ from level scheme.
x+284.2	79.1 2	16 3	E1		0.695 11	B(E1)(W.u.)=6.1×10 ⁻⁷ 13. I γ : from $^{170}\text{Er}(^{14}\text{N},4n\gamma)$, $^{181}\text{Ta}(\alpha,5n\gamma)$. Other: 2.6 5 from $^{176}\text{Yb}(^{10}\text{B},6n\gamma)$, $^{174}\text{Yb}(^{11}\text{B},5n\gamma)$. B(E1)(W.u.)=1.05×10 ⁻⁶ 12.
	121.4 2	100 8	E1		0.232	
x+312.3	149.3 2	100 10	M1+E2@	+0.23 2	1.610 25	
	241.8 1	24.5 23				
x+363.2	133.2 2	29 6	M1(+E2)	-0.05 6	2.28	Mult.: D(+Q) from $\gamma(\theta)$ in $^{170}\text{Er}(^{14}\text{N},4n\gamma)$, $^{181}\text{Ta}(\alpha,5n\gamma)$, $\Delta\pi=\text{no}$ from level scheme.
	239.7 2	100 14	E2		0.176	
x+370.9	104.1 1	100 15	M1(+E2)	-0.02 4	4.61	Mult.: D(+Q) from $\gamma(\theta)$ in $^{170}\text{Er}(^{14}\text{N},4n\gamma)$, $^{181}\text{Ta}(\alpha,5n\gamma)$, $\Delta\pi=\text{no}$ from level scheme.
	193.3 2	40 9				
x+414.1	208.7 2	100 11	M1+E2@	+0.21 2	0.629 10	
	251.3 1	7.1 11				E γ , I γ : observed only in $^{170}\text{Er}(^{14}\text{N},4n\gamma)$, $^{181}\text{Ta}(\alpha,5n\gamma)$.
x+418.6	134.4 1	100 11	M1+E2@		1.8 5	
x+495.1	182.5 2	100 16	M1+E2@	+0.41 9	0.86 3	
	332.5 4	46 5	E2		0.0652	
x+523.1	159.7 2	25 8	M1+E2@	-0.37 23	1.28 10	
	210.9 3	32 6				
	293.0 2	100 17	E2		0.0946	
x+526.7	155.7 1	100 6				
	260.3 2	59 10	E2		0.1359	
x+595.3	176.7 1	100 8				
	311.2 2	47 5				I γ : from $^{176}\text{Yb}(^{10}\text{B},6n\gamma)$, $^{176}\text{Yb}(^{11}\text{B},5n\gamma)$. Other: 10.7 16 in $^{170}\text{Er}(^{14}\text{N},4n\gamma)$, $^{181}\text{Ta}(\alpha,5n\gamma)$.
x+642.5	228.4 1	100 9	M1+E2@	+0.28 5	0.481 11	
	437.3 1	14 3	E2		0.0307	
x+672.2	145.4 1	77 15				I γ : from $^{170}\text{Er}(^{14}\text{N},4n\gamma)$, $^{181}\text{Ta}(\alpha,5n\gamma)$. Other: I γ (145 γ)/I γ (301.5 γ)=4.1 36 in $^{176}\text{Yb}(^{10}\text{B},6n\gamma)$, $^{176}\text{Yb}(^{11}\text{B},5n\gamma)$.
	301.5 2	100 14	(E2)		0.0868	
x+696.5	173.4 2	13 5	M1+E2@	-1.3 10	0.7 3	

Continued on next page (footnotes at end of table)

Adopted Levels, Gammas (continued) $\gamma(^{180}\text{Re})$ (continued)

E(level)	$E_{\gamma}^{\dagger}$	$I_{\gamma}^{\dagger}$	Mult. [‡]	$\delta^{\ddagger}$	α	Comments
x+696.5	201.6 3 333.3 1 384.3 3	40 30 100 17 37 6	E2		0.0647	
x+715.7	220.5 1 352.6 2 403.3 3	74 11 55 13 100 18	M1+E2@	+0.23 3	0.537 9	I γ : from $^{176}\text{Yb}(^{10}\text{B},6\text{n}\gamma)$, $^{174}\text{Yb}(^{11}\text{B},5\text{n}\gamma)$. Other: 143 21 in $^{170}\text{Er}(^{14}\text{N},4\text{n}\gamma)$, $^{181}\text{Ta}(\alpha,5\text{n}\gamma)$.
x+805.4	210.0 1 386.9 1	100 4 25 4	M1+E2@ E2	+0.25 3	0.612 10 0.0426	
x+888.5	245.9 5 474.4 2	100 9 44 7	M1+E2& E2	+0.20 2	0.400 7 0.0249	δ : other: 0.9 +5-3 from $\alpha(\text{K})\text{exp}$ in $^{176}\text{Yb}(^{10}\text{B},6\text{n}\gamma)$, $^{174}\text{Yb}(^{11}\text{B},5\text{n}\gamma)$.
x+902.3	229.9 1 375.8 1	74 13 100 17	E2		0.0461	
x+905.5	382.4 1 410.5 2	100 10 30 4	E2		0.0440	
x+949.4	233.5 2 253.1 3	65 8 42 8				
x+1043.0	454.3 2 237.5 1	100 17 100 8	E2 M1+E2@	+0.27 4	0.0278 0.432 8	
x+1079.4	447.6 1 177.0 2	56 4 42 11	E2		0.0289	
x+1132.1	407.2 2 416.3 2	100 10 26 12				
x+1150.0	435.6 1 261.5 1	100 17 100 13	E2		0.0311	I γ : from $^{176}\text{Yb}(^{10}\text{B},6\text{n}\gamma)$, $^{174}\text{Yb}(^{11}\text{B},5\text{n}\gamma)$. 261.5 γ is multiply placed with undivided intensity in $^{170}\text{Er}(^{14}\text{N},4\text{n}\gamma)$, $^{181}\text{Ta}(\alpha,5\text{n}\gamma)$.
x+1204.9	507.4 1 255.5 1 489.3 2	30 7 100 16 67 12	E2&		0.0211	I γ : from $^{176}\text{Yb}(^{10}\text{B},6\text{n}\gamma)$, $^{176}\text{Yb}(^{11}\text{B},5\text{n}\gamma)$. Other: 140 30 in $^{170}\text{Er}(^{14}\text{N},4\text{n}\gamma)$, $^{181}\text{Ta}(\alpha,5\text{n}\gamma)$.
x+1304.4	508.4 2 261.1 4	9.8 24 82 8	M1+E2@		0.24 11	I γ : from $^{176}\text{Yb}(^{10}\text{B},6\text{n}\gamma)$, $^{174}\text{Yb}(^{11}\text{B},5\text{n}\gamma)$. 261 γ is multiply placed with undivided intensity in $^{170}\text{Er}(^{14}\text{N},4\text{n}\gamma)$, $^{181}\text{Ta}(\alpha,5\text{n}\gamma)$.
x+1379.2	499.0 1 473.7 3	100 9 100	(E2)		0.0250	
x+1386.8	307.6 2 484.5 2	26 6 100 14				
x+1403.0	807.8 2 984.6 2	30 7 100 15	E2		0.00488	
x+1425.3	275.2 1 536.8 2	100 11 50 6	M1+E2@ E2	+0.33 7	0.283 9 0.0184	
x+1482.3	277.5 2 532.9 4	52 10 100 20	M1+E2@ E2	+0.19 3	0.288 5 0.0187	
x+1566.8	141.3 2 163.9 1 262.4 1 416.8 1	18 3 30 4 18 4 100 8	M1 E1 [E1] M1		1.93 0.1071 0.0327 0.0987	B(M1)(W.u.)= 5.4×10^{-6} 10. B(E1)(W.u.)= 5.6×10^{-8} 8. B(E1)(W.u.)= 8.2×10^{-9} 19. B(M1)(W.u.)= 1.18×10^{-6} 12. Mult.: other: M1+E2 with $\delta=1.0$ 2 from $\alpha(\text{K})\text{exp}$ in $^{176}\text{Yb}(^{10}\text{B},6\text{n}\gamma)$, $^{174}\text{Yb}(^{11}\text{B},5\text{n}\gamma)$.
x+1586.1	523.6 2 678.3 2 761.1 3 199.2 4	32 4 84 8 21 4 9 4	[E1] E2 [E1]		0.00669 0.01070 0.00312	B(E1)(W.u.)= 1.83×10^{-9} 25. B(E2)(W.u.)=0.000212 23. B(E1)(W.u.)= 3.9×10^{-10} 8.
x+1587.5	506.5 2 283.2 6	100 17 26 16	E2 M1+E2@	+0.15 4	0.0212 0.275 5	I γ : from $^{176}\text{Yb}(^{10}\text{B},6\text{n}\gamma)$, $^{176}\text{Yb}(^{11}\text{B},5\text{n}\gamma)$. Other: 130 15 in $^{170}\text{Er}(^{14}\text{N},4\text{n}\gamma)$, $^{181}\text{Ta}(\alpha,5\text{n}\gamma)$.
x+1643.4	544.5 1 511.3 1	100 8 100	E2		0.01776	
x+1669.8	1074.4 3	100				
x+1701.2	134.4 1	100 11	E1		0.179	B(E1)(W.u.) $>1.3\times 10^{-5}$.

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Adopted Levels, Gammas (continued) $\gamma(^{180}\text{Re})$ (continued)

E(level)	$E_{\gamma}^{\dagger}$	$I_{\gamma}^{\dagger}$	Mult. [‡]	$\delta^{\ddagger}$	α	Comments
x+1701.2	895.3 8	5.3 13				
x+1712.0	286.7 1	100 19	M1+E2@	+0.34 8	0.252 9	
	562.1 2	79 11	E2		0.01647	
x+1755.6	54.8 5		M1&		5.15 16	
	(85.4)	a				
x+1768.1	286.0 3	66 12	M1+E2@		0.19 9	
	563.2 2	100 5				
x+1846.9	280.2 1	100	M1+E2@	+2.2 7	0.139 25	
x+1876.1	120.5 1	100	E1		0.237	
x+1888.6	301.1 1		(M1+E2)		0.16 8	Mult.: (D+Q) from $\gamma(\theta)$ in $^{170}\text{Er}(^{14}\text{N},4n\gamma)$, $^{181}\text{Ta}(\alpha,5n\gamma)$, $\Delta\pi=\text{no}$ from level scheme.
	584.2 1	100	E2		0.01504	
x+1926.5	547.3 1	100				
x+1930.2	229.0 1	100				
x+1969.0	382.5 ^b 3	74 25				
	582.3 2	100 50				
x+2008.1	296.1 1	79 16	M1+E2@	+0.10 2	0.245	
	583.0 2	100 24	E2		0.01511	
x+2045.7	290.3 3	100	(M1)		0.260	Mult.: (D) from $\gamma(\theta)$ in $^{176}\text{Yb}(^{10}\text{B},6n\gamma)$, $^{176}\text{Yb}(^{11}\text{B},5n\gamma)$, $\Delta\pi=\text{no}$ from level scheme.
x+2075.4	307.4 3	100 10				
	593.1 3	76 18				I γ : from $^{176}\text{Yb}(^{10}\text{B},6n\gamma)$, $^{176}\text{Yb}(^{11}\text{B},5n\gamma)$. Other: 175 60 in $^{170}\text{Er}(^{14}\text{N},4n\gamma)$, $^{181}\text{Ta}(\alpha,5n\gamma)$.
x+2140.0	263.9 1	100	M1+E2@	+0.50 16	0.296 22	
x+2148.5	301.6 2	64 13				
	581.5 2	100 17				
x+2161.5	231.2 1	100 14	M1+E2@	+0.34 8	0.456 15	
	460.5 2	31 6				
x+2186.4	600.3 2	100 18				
x+2205.6	316.9 2	49 10	M1+E2@	+0.42 14	0.186 12	
	618.3 2	100 10	E2		0.01318	
x+2222.8	579.4 2	100	E2		0.01533	
x+2310.0	301.9 1	100 12				
	598.0 2	65 12	E2&		0.01424	
x+2356.7	310.9 1	100 10				
	601.1 2	74 ^a 9				
x+2375.7	300.5 5	60 7				
	607.4 5	100 12	E2		0.01373	
x+2416.1	276.1 2	100 9	M1+E2&	0.70 +15-20	0.238 24	δ : from $\alpha(\text{K})\text{exp}$ in $^{176}\text{Yb}(^{10}\text{B},6n\gamma)$, $^{176}\text{Yb}(^{11}\text{B},5n\gamma)$. Other: +0.6 3 from $\gamma(\theta)$ in $^{170}\text{Er}(^{14}\text{N},4n\gamma)$, $^{181}\text{Ta}(\alpha,5n\gamma)$.
	540.0 1	28 4	E2		0.0181	
x+2421.2	259.8 2	100 11				
	491.1 3	47 15				
x+2474.3	325.7 2	55 26				E γ : from $^{170}\text{Er}(^{14}\text{N},4n\gamma)$, $^{181}\text{Ta}(\alpha,5n\gamma)$. Other: 324.5 2 in $^{176}\text{Yb}(^{10}\text{B},6n\gamma)$, $^{176}\text{Yb}(^{11}\text{B},5n\gamma)$.
	627.5 2	100 26				E γ : from $^{170}\text{Er}(^{14}\text{N},4n\gamma)$, $^{181}\text{Ta}(\alpha,5n\gamma)$. Other: 626.1 2 in $^{176}\text{Yb}(^{10}\text{B},6n\gamma)$, $^{176}\text{Yb}(^{11}\text{B},5n\gamma)$.
x+2533.0	327.3 ^b 1	45 9	(M1+E2)		0.13 6	Mult.: (D+Q) from $\gamma(\theta)$ in $^{170}\text{Er}(^{14}\text{N},4n\gamma)$, $^{181}\text{Ta}(\alpha,5n\gamma)$, $\Delta\pi=\text{no}$ from level scheme.
	644.4 1	100 10	E2		0.01200	
x+2537.2	610.7 2	100				
x+2617.1	307.1 1	58 7				I γ : from $^{176}\text{Yb}(^{10}\text{B},6n\gamma)$, $^{176}\text{Yb}(^{11}\text{B},5n\gamma)$. Other: 116 21 from $^{170}\text{Er}(^{14}\text{N},4n\gamma)$, $^{181}\text{Ta}(\alpha,5n\gamma)$.
	608.9 2	100 13				
x+2633.1	664.1 2	100				
x+2683.8	327.1 2	100 15	(M1+E2)		0.13 6	Mult.: (D+Q) from $\gamma(\theta)$ in $^{170}\text{Er}(^{14}\text{N},4n\gamma)$, $^{181}\text{Ta}(\alpha,5n\gamma)$, $\Delta\pi=\text{no}$ from level scheme.
	638.1 1	63 15	(E2)		0.01227	

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Adopted Levels, Gammas (continued) $\gamma(^{180}\text{Re})$ (continued)

E(level)	$E_{\gamma}^{\dagger}$	$I_{\gamma}^{\dagger}$	Mult. [‡]	$\delta^{\ddagger}$	α	Comments
x+2693.6	317.9 1 618.2 2					
		a				
x+2707.4	291.2 2 567.5 3	100 17 66 9	M1+E2 E2	+0.47 14	0.229 15 0.01610	
x+2710.4	289.6 3 548.4 3	100 20 96 18	E2		0.01746	I_{γ} : from $^{170}\text{Er}(^{14}\text{N},4n\gamma)$, $^{181}\text{Ta}(\alpha,5n\gamma)$. Other: 22 18 from $^{176}\text{Yb}(^{10}\text{B},6n\gamma)$, $^{176}\text{Yb}(^{11}\text{B},5n\gamma)$.
x+2861.0	638.2 2	100	(E2)		0.01226	
x+2867.4	681.0 3	100				
x+2872.7	339.7 2 667.1 1	39 6 100 11	M1+E2@		0.12 6	
x+2922.3	305.2 2	25 6				I_{γ} : from $^{176}\text{Yb}(^{10}\text{B},6n\gamma)$, $^{176}\text{Yb}(^{11}\text{B},5n\gamma)$. Other: 160 40 from $^{170}\text{Er}(^{14}\text{N},4n\gamma)$, $^{181}\text{Ta}(\alpha,5n\gamma)$.
	612.3 2	100 15				
x+3002.7	292.1 4 319.2 4	100 50 a				
	581.5 1	80 30				
x+3015.0	307.5 1 599.2 3	100 10 85 17	M1+E2& E2&	1.2 +5-3	0.140 22 0.01417	
x+3051.9	(912.2 3) 1175.8 1	27 6 100 30	E2&		0.00344	
x+3069.0	929.0 2 1192.9 2	100 13 100 30	(E2)&		0.00335	
x+3122.8	982.8 2 1246.7 1	32 7 100 24				
x+3203.2	666.0 2	100	(E2)		0.01114	
x+3209.9	337.2 2 676.7 2	50 15 100 18	M1+E2@		0.12 6	
x+3234.7	312.5 3	18 6				I_{γ} : from $^{176}\text{Yb}(^{10}\text{B},6n\gamma)$, $^{176}\text{Yb}(^{11}\text{B},5n\gamma)$. Other: 150 40 from $^{170}\text{Er}(^{14}\text{N},4n\gamma)$, $^{181}\text{Ta}(\alpha,5n\gamma)$.
	617.4 5	100 13	(E2)		0.01323	
x+3327.5	325.1 3 616.9 4	100 40 50 40				
x+3339.4	324.4 4 632.0 2	98 27 100 21	M1+E2 E2	+0.53 21	0.166 17 0.01254	
x+3353.1?	720.0 ^b 2	100				
x+3369.6	300.5 4 317.7 4	80 30 100 30				
	1164.1 3	23 7				
x+3408.5	285.7 1	100	E2&		0.1020	
x+3471.8	(62.9)	a				
	102.2 1	18 8	E2&		3.78	B(E2)(W.u.)=0.009 5.
	456.8 6	100 8	E1&		0.00898	B(E1)(W.u.)=1.3×10 ⁻¹⁰ 4.
x+3550.1	689.1 2	100 ^a				
x+3551.4	341.5 1 679.1 2	64 13 100 11	M1+E2@ (E2)		0.11 6 0.01067	
x+3616.0	748.6 2	100				
x+3668.5	341.0 1 665.7 2		(E2)		0.01115	
x+3680.5	341.0 1 665.6 2	100 30 100 30				
x+3851.3	380.0 4	100				
x+3861.9	310.5 4 651.8 2	45 9 100 17	M1+E2@		0.15 7	
x+3895.8	424.0 2	100				
x+3911.0	707.8 4	100				
x+4025.7	357.1 4 697.0 10	82 25 100 35				
x+4038.0	357.8 2 698.7 2					
		a				
x+4205.8	343.9 2 654.6 2	100 40 92 23	M1+E2@		0.11 6	
x+4240.9	389.5 2	100 60				

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Adopted Levels, Gammas (continued) $\gamma(^{180}\text{Re})$ (continued)

E(level)	$E\gamma^{\dagger}$	$I\gamma^{\dagger}$	Mult. ‡	α	E(level)	$E\gamma^{\dagger}$	$I\gamma^{\dagger}$	Mult. ‡	α
x+4240.9	768.3 5	60 50			x+4888.7	363.0 2	67 33	M1+E2 [@]	0.10 5
x+4269.8	374.0 1	100				683.2 3	100 50		
x+4300.2	750.1 2	100			x+5040.5	388.7 2	100 40		
x+4392.1	366.3 3	38 20				771.2 4	50 30		
	724.1 5	100 50			x+5048.1	410.5 5	100		
x+4412.1?	796.0 ^b 2	100			x+5102.9?	802.7 ^b 2	100		
x+4412.6	375.6 4	50 22			x+5206.2	404.2 2	a		
	731.7 2	100 50				794.1 2	a		
x+4525.6	319.8 2	50 30	M1+E2 [@]	0.14 7	x+5436.1	395.7 3	100 50		
	663.2 3	100 40				784.2 4	60 30		
x+4637.6	396.6 1	100 50			x+5455.3	407.2 3	100		
	786.8 3	19 14			x+5838.3	402.5 6	80 50		
x+4643.7	732.7 5	100				797.7 3	100 50		
x+4651.8	381.9 1	100 40			x+6249.9	411.7 4	a		
	756.1 3	23 13				813.5 6			
x+4802.0	389.2 2	100 70			x+6673.6	423.7 2	a		
	764.2 2	100 50				835.6 6			

[†] Weighted average of $^{170}\text{Er}(^{14}\text{N},4n\gamma)$, $^{181}\text{Ta}(\alpha,5n\gamma)$ and $^{176}\text{Yb}(^{10}\text{B},6n\gamma)$, $^{174}\text{Yb}(^{11}\text{B},5n\gamma)$, except where noted.

[‡] From $\gamma(\theta)$, DCO ratios, and conversion electron data in $^{170}\text{Er}(^{14}\text{N},4n\gamma)$, $^{181}\text{Ta}(\alpha,5n\gamma)$, except where noted.

[§] From ^{180}Os ϵ decay.

[#] From ce data in ^{180}Os ϵ decay.

[@] D+Q from $\gamma(\theta)$ in $^{170}\text{Er}(^{14}\text{N},4n\gamma)$, $^{181}\text{Ta}(\alpha,5n\gamma)$, $\Delta\pi=\text{no}$ from level scheme.

[&] From ce data in $^{176}\text{Yb}(^{10}\text{B},6n\gamma)$, $^{174}\text{Yb}(^{11}\text{B},5n\gamma)$.

a Weak transition.

b Placement of transition in the level scheme is uncertain.

 ^{180}Os ϵ Decay 1968Ha39,1968Ko10

Parent ^{180}Os : E=0.0; $J\pi=0+$; $T_{1/2}=21.5$ min 4; Q(g.s.)=1475 27; $\% \epsilon + \% \beta^+$ decay=100.

1968Ha39: ^{180}Os activity produced in $^{182}\text{W}(\alpha,6n)$, E(α)=75 MeV. Measured E(ce), I(ce) using permanent magnet spectrograph and x-ray film.

1968Ko10: ^{180}Os activity produced in $^{184}\text{W}(^3\text{He},7n)$, E(^3He)=70 MeV. Measured $E\gamma$, $I\gamma$, $\gamma\gamma$, $\gamma(t)$ using Si(Li) and NaI(Tl) detectors.

Other: 1967Ho12, observed no γ -rays with $E\gamma > 40$ keV in the decay of ^{180}Os .

A total energy release of 700 keV 60 is calculated for the decay scheme using the RADLST code, compared with Q=1475 keV 27, indicating the decay scheme is incomplete.

 ^{180}Re Levels

Level scheme is that proposed by 1968Ha39 and should be considered tentative.

E(level)	$J\pi^{\dagger}$	$T_{1/2}$	Comments
0.0 [‡]	(1)−	2.46 min 3	$T_{1/2}$: from the Adopted Levels.
20.1 [§] 1	1+	87.5 ns 27	$T_{1/2}$: from $\gamma\gamma(t)$ with K x-ray−20.1 γ (1968Ko10).
49.8 [‡]	(2)−		
74.6 [§]	(2)+		
218.2			
249.9			
349.2			
401.8			
668.6			
717.0			

[†] From the Adopted Levels.

[‡] (A): $K\pi=1-$ band. Probable configuration= $((v7/2[514])-(\pi5/2[402]))$.

[§] (B): $K\pi=1+$ band. Probable configuration= $((\pi9/2[514])-(v7/2[514]))$.

^{180}Os ϵ Decay 1968Ha39,1968Ko10 (continued) β^+, ϵ Data

$E\epsilon$	E(level)	$I\beta^+\dagger$	$I\epsilon\dagger$	Log ft	$I(\epsilon+\beta^+)\dagger$
(1450 30)	20.1	<0.063	<99.9	>4.7	<100

$\dagger$ Absolute intensity per 100 decays.

 $\gamma(^{180}\text{Re})$

K x-ray intensity=79.1%, L x-ray intensity=33% 12 (1968Ko10). K x-ray intensity=84.6% 90 (1967Ho12).

$I\gamma$ normalization: From (K x-ray(Re)+K x-ray(W))/20.1 γ =10.2 18 for a ^{180}Os source in equilibrium with ^{180}Re (1968Ko10) and assuming that ^{180}Re decays 92.8% by electron capture to ^{180}W , and using theoretical $\epsilon K(\text{exp})/\epsilon$ ratios and γ -ray conversion coefficients. The normalization factor is consistent with 100% ϵ feeding to the 20-keV level.

$E\gamma$	E(level)	$I\gamma\dagger$	Mult.	α	Comments
20.1 1	20.1	100	E1	5.80 12	Mult.: from $\alpha(\text{L})\text{exp}\leq 6$ (1968Ko10), and $\text{ce}(\text{M1}):\text{ce}(\text{M2}):\text{ce}(\text{M3}):\text{ce}(\text{M4})+\text{ce}(\text{M5})=7.0:7.5:10:5.6$ (1968Ha39).
31.6	249.9				
48.2	717.0				
49.8	49.8		M1	6.82	Mult.: from $\text{ce}(\text{L1}):\text{ce}(\text{L2}):\text{ce}(\text{L3})=75:10:\text{weak}$ (1968Ha39).
54.4	74.6		M1	5.26	Mult.: from $\text{ce}(\text{L1}):\text{ce}(\text{L2}):\text{ce}(\text{L3}):\text{ce}(\text{M})=50:=5:\text{weak}:15$ (1968Ha39).
74.6	74.6		E1	0.800	Mult.: from $\text{ce}(\text{L1}):\text{ce}(\text{L2}):\text{ce}(\text{M})=9:3:4$ (1968Ha39).
^x 104.0					
^x 107.0					
^x 113.7					
183.8	401.8				
200.1	249.9				
218.2	218.2				
250.0	249.9				
319.4	668.6				
329.0	349.2				
349.1	349.2				
401.5	401.8				
450.4	668.6				
^x 485.7					
667.0	717.0				
717.4	717.0				

$\dagger$ For absolute intensity per 100 decays, multiply by 0.17 4.

^x γ ray not placed in level scheme.

Decay Scheme

Intensities: $I(\gamma+\text{ce})$ per 100 parent decays

$^{170}\text{Er}(^{14}\text{N},4n\gamma)$, $^{181}\text{Ta}(\alpha,5n\gamma)$ 1990Ve07

$^{170}\text{Er}(^{14}\text{N},4n\gamma)$: $E(^{14}\text{N})=71$ MeV. Measured $E\gamma$, $I\gamma$, $\gamma\gamma$, $\gamma\gamma(t)$, $\gamma\gamma(\theta)$ (DCO) using OSIRIS spectrometer consisting of six Compton-suppressed HPGe detectors. Measured $E(\text{ce})$, $I(\text{ce})$ (in energy range of 200–600 keV) using a mini-orange spectrometer; deduced conversion coefficients.

$^{181}\text{Ta}(\alpha,5n\gamma)$: $E(\alpha)=35\text{--}90$ MeV. Measured $E\gamma$, $I\gamma$, excitation function, $\gamma\gamma$, $\gamma\gamma(t)$, $\gamma(\theta)$ using four Ge(Li) detectors and four BGO detectors (filter for high-multiplicity cascades).

 ^{180}Re Levels

The ^{180}Re level scheme consists of three groups of levels (and rotational bands) with no γ -ray transitions interconnecting them, where six well-identified rotational bands, and one uncertain one, have been identified. The corresponding level energies are on different scales unrelated to the ground state.

Configuration assignments are based on energy systematics of Nilsson orbitals in neighboring odd-A nuclei; on the comparison of gyromagnetic ratios deduced from experimental γ -ray branchings and mixing ratios with theoretical values calculated for various quasiparticle Nilsson configurations; and on a comparison of rotational band alignments with values for neighboring odd-proton and odd-neutron nuclei. Spin and configuration assignments should be considered tentative, because the de-excitation of the bandheads to ^{180}Re g.s. is unknown.

E(level) [†]	$J\pi^{\ddagger}$	$T_{1/2}^e$	E(level) [†]	$J\pi^{\ddagger}$	E(level) [†]	$J\pi^{\ddagger}$
0.0+x	(4-,5-)		2403.7+x 3	(14-)	651.0+y ^b 3	(6-)
92.2+x 2	(6-)		2462.4+x& 3	(16+)	670.0+y ^a 3	(7-)
134.6+x § 2	(6-)		2546.6+x § 3	(15-)	860.1+y ^b 3	(7-)
213.4+x& 2	(7+)	73 ns 3	2558.8+x# 3	(13+)	903.5+y ^a 3	(8-)
343.4+x § 2	(7-)		2582.3+x@ 4	(14-)	1086.7+y ^b 3	(8-)
347.8+x& 2	(8+)		2639.7+x 3	(14+)	1159.2+y ^a 3	(9-)
524.6+x& 2	(9+)		2801.9+x& 3	(17+)	1333.8+y ^b 4	(9-)
571.9+x § 2	(8-)		2851.9+x § 3	(16-)	1436.9+y ^a 3	(10-)
734.6+x& 2	(10+)		2878.3+x# 3	(14+)	1597.9+y ^b 5	(10-)
817.8+x § 2	(9-)		2889.8+x@ 4	(15-)	1722.7+y ^a 4	(11-)
972.2+x& 2	(11+)		3139.1+x& 3	(18+)	1881.1+y ^b 5	(11-)
1079.3+x § 2	(10-)		3164.8+x § 3	(17-)	2029.9+y ^a 4	(12-)
1233.7+x& 2	(12+)		3203.0+x# 4	(15+)	2177.4+y ^b 5	(12-)
1332.3+x 2	(10+)		3214.3+x@ 4	(16-)	2330.2+y ^a 5	(13-)
1354.7+x § 2	(11-)		3480.8+x& 3	(19+)	2492.0+y ^b 6	(13-)
1496.0+x ^d 2	(11-)	70 ns 3	3543.8+x# 4	(16+)	2815.5+y ^b 6	(14-)
1516.7+x& 2	(13+)		3555.5+x@ 4	(17-)	3158.1+y ^b 7	(15-)
1630.4+x# 2	(10+)		3791.0+x& 3	(20+)	3505.1+y ^b 8	(16-)
1641.4+x § 2	(12-)		3913.1+x@ 4	(18-)	3866.0+y ^b 8	(17-)
1750.8+x@ 4	(11-)		4135.0+x& 3	(21+)	0.0+z ^c	(7-)
1776.4+x 2	(12-)		4287.8+x@ 5	(19-)	89.0+z ^c 2	(8-)
1818.0+x& 3	(14+)		4454.9+x& 4	(22+)	193.5+z ^c 2	(9-)
1859.4+x 3	(11+)		4677.1+x@ 5	(20-)	349.3+z ^c 2	(10-)
1920.9+x# 3	(11+)		4818.1+x& 4	(23+)	494.9+z ^c 2	(11-)
1937.6+x § 3	(13-)		0.0+y	(1-)	725.0+z ^c 3	(12-)
2014.6+x@ 4	(12-)		25.0+y ^a 4	(3-)	902.1+z ^c 3	(13-)
2077.9+x 3	(13-)		78.1+y ^b 2	(2-)	1209.4+z ^c 3	(14-)
2090.6+x 3	(12+)		117.2+y ^a 3	(4-)	1408.4+z ^c 3	(15-)
2135.0+x& 3	(15+)		184.5+y ^b 2	(3-)	1791.9+z ^c 3	(16-)
2231.7+x# 3	(12+)		266.6+y ^a 3	(5-)	2008.8+z ^c 4	(17-)
2239.5+x § 3	(14-)		318.0+y ^b 2	(4-)	2689.6+z ^c 5	(19-)
2290.9+x@ 4	(13-)		449.2+y ^a 3	(6-)	3438.4+z ^c 6	(21-)
2350.5+x 3	(13+)		477.5+y ^b 2	(5-)		

[†] From a least-squares fit to $E\gamma$, except where noted.

[‡] Spin and parity assignments proposed by 1990Ve07; based on measured γ -ray multiplicities, decay patterns, angular distribution measurements, assumed band structure and comparison of gyromagnetic ratios deduced from experimental γ -ray branchings and mixing ratios with theoretical values calculated for various quasiparticle Nilsson configurations. Assignments differ from those proposed in $^{176}\text{Yb}(^{10}\text{B},6n\gamma)$, $^{174}\text{Yb}(^{11}\text{B},5n\gamma)$. See the Adopted Levels for values adopted by the evaluator.

§ $K\pi=(6-)$ two quasiparticle band. Configuration= $((\pi 5/2[402])(\nu 7/2[514]))$ singlet.

$K\pi=(10+)$ four quasi-particle band. Configuration= $((\pi 5/2[402])(\pi 7/2[404])(\pi 1/2[541])(\nu 7/2[514]))10+$.

@ $K\pi=(11-)$ four quasi-particle band. Configuration= $((\pi 5/2[402])(\pi 7/2[404])(\pi 1/2[541])(\nu 9/2[624]))11-$.

& $K\pi=(7+)$ two quasiparticle band. Configuration= $((\pi 5/2[402])(\nu 9/2[624]))$ triplet.

a $K\pi=(3-)$ two quasiparticle band. Configuration= $((\pi 5/2[402])(\nu 1/2[521]))$ singlet.

b $K\pi=(2-)$ two quasiparticle band. Configuration= $((\pi 5/2[402])(\nu 1/2[521]))$ triplet.

c $K\pi=(7-)$ two quasiparticle band. Configuration= $((\pi 1/2[541])(\nu 9/2[624]))$.

d Configuration= $((\pi 5/2[402])(\pi 9/2[514])(\pi 1/2[541])(\nu 7/2[514]))$ 11-.

e From $\gamma\gamma(t)$ measurement.

$^{170}\text{Er}(^{14}\text{N},4n\gamma)$, $^{181}\text{Ta}(\alpha,5n\gamma)$ 1990Ve07 (continued) $\gamma(^{180}\text{Re})$

$E\gamma^\dagger$	E(level)	$I\gamma^\dagger$	Mult. §	$\delta^\S$	α	Comments
(25.0)	25.0+y					
42.6 3	134.6+x	8.0 4				
$\times 54.0 \frac{3}{4}$						
78.1 3	78.1+y					
78.6 3	213.4+x	31 6	E1		0.718	$\alpha(\text{exp})=0.8\ 3$ from transition intensity balance. Mult.: D from $\gamma(0)$; E1 from $\alpha(\text{exp})$.
88.9 4	89.0+z	13 3	D(+Q)	-0.04 4		
92.2@ 2	92.2+x	52@ 5	M1			$\alpha(\text{exp})=7.2\ 4$ from transition intensity balance. Mult.: from $\alpha(\text{exp})$.
	117.2+y	52@ 5	(D+Q)			
104.3 2	193.5+z	20 3	D(+Q)	-0.02 4		
106.3 2	184.5+y	15 4	D+Q	-0.10 9		
120.4 3	1750.8+x	47 7	E1		0.240	$\alpha(\text{exp})=0.4\ 2$ from transition intensity balance. Mult.: D from $\gamma(0)$; E1 from $\alpha(\text{exp})$.
121.3 3	213.4+x	195 16	E1		0.235	$\alpha(\text{exp})=0.2\ 2$ from transition intensity balance. Mult.: D from $\gamma(0)$; E1 from $\alpha(\text{exp})$.
133.2 3	318.0+y	8 3	D(+Q)	-0.05 6		
134.2 1	1630.4+x	83 12	E1		0.180	$\alpha(\text{exp})=0.4\ 1$ from transition intensity balance. Mult.: from $\alpha(\text{exp})$.
134.4 1	347.8+x	73 7	D+Q $^\#$			
134.5 3	134.6+x	36 22	M1+E2			$\alpha(\text{exp})=2.0\ 8$ from transition intensity balance. Mult.: from $\alpha(\text{exp})$.
141.3 2	1496.0+x	5.7 13	M1		1.99	$\alpha(\text{exp})=2.1\ 3$ from transition intensity balance. Mult.: from $\alpha(\text{exp})$.
145.6 2	494.9+z	12.3 24				
149.3 2	266.6+y	49 11	D+Q	+0.23 2		
155.6 2	349.3+z	17 3				
159.4 2	477.5+y	5.1 17	D+Q	-0.37 23		
163.9 1	1496.0+x	10.3 17	E1		0.108	$\alpha(\text{exp})=0.4\ 3$ from transition intensity balance. Mult.: from $\alpha(\text{exp})$.
173.4 2	651.0+y	3.8 13	D+Q	-1.3 10		
176.7 1	524.6+x	90 7	D+Q	+0.20 2		
177.0 2	902.1+z	6.9 17				
182.5 2	449.2+y	43 7	D+Q	+0.41 9		
184.5 2	184.5+y	22 4	Q			
193.5 2	193.5+z	7.2 12				
198.9 2	1408.4+z	1.5 6				
201.6 3	651.0+y	7.7 17				
208.8 1	343.4+x	82 9	D+Q	+0.21 2		
210.0 1	734.6+x	66 7	D+Q	+0.25 3		
211.1 3	477.5+y	8.9 18				
220.7 2	670.0+y	20 3	D+Q	+0.23 3		
228.4 1	571.9+x	74 7	D+Q	+0.28 5		
229.0 1	1859.4+x	15.0 13				
230.1 2	725.0+z	12.0 24				
231.2 1	2090.6+x	8.1 11	D+Q	+0.34 8		
233.3 2	903.5+y	13.0 20				
237.5 1	972.2+x	46 5	D+Q	+0.27 4		
240.1 2	318.0+y	35 7	Q			
241.3 4	266.6+y	10 3				
246.0 1	817.8+x	54 5	D+Q	+0.20 2		
251.1 3	343.4+x	5.8 9				
252.3 3	903.5+y	7.5 15				
255.6 2	1159.2+y	7.4 16				
259.9 1	2350.5+x	5.6 6				
260.4 2	349.3+z	11.1 21	Q			
261.5@ 1	1079.3+x	42@ 7				
	1233.7+x	42@ 7	D+Q $^\#$			
262.4 1	1496.0+x	5 3				
263.8 1	2014.6+x	37 3	D+Q	+0.50 16		
275.3 1	1354.7+x	17.9 20	D+Q	+0.33 7		
276.3 1	2290.9+x	19.8 17	D+Q	+0.6 3		
277.6 2	1436.9+y	4.8 10	D+Q	+0.19 3		

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$^{170}\text{Er}(^{14}\text{N},4n\gamma), ^{181}\text{Ta}(\alpha,5n\gamma)$ 1990Ve07 (continued) $\gamma(^{180}\text{Re})$ (continued)

$E\gamma^{\dagger}$	E(level)	$I\gamma^{\dagger}$	Mult. §	$\delta^{\S}$	α	Comments
280.2 1	1776.4+x	4.0 7	D+Q	+2.2 7		
283.1 1	1516.7+x	22.4 25	D+Q	+0.15 4		
286.1 4	1722.7+y	4.9 10	D+Q			
286.7 1	1641.4+x	5.7 11	D+Q	+0.34 8		
289.2 2	2639.7+x	2.8 6				
290.5 1	1920.9+x	21.0 19				
291.4 1	2582.3+x	9.6 16	D+Q	+0.47 14		
293.0 2	477.5+y	29 5	Q			
296.2 1	1937.6+x	6.2 18	D+Q	+0.10 2		
300.6 5	2330.2+y	2.0 10				
301.2 1	1818.0+x	14.6 16	(D+Q)			
301.5 2	494.9+z	15.9 22	(Q)			
301.6 2	2077.9+x	3.0 6				
302.0 2	2239.5+x	4.0 13				
305.2 2	2851.9+x	2.2 5				
307.2 2	2546.6+x	2.8 5				
307.4 2	1209.4+z	3.6 10				
307.5 1	2889.8+x	5.9 6				
307.5 3	2029.9+y	3.1 12				
310.1 2	3791.0+x	1.8 8	D+Q $^{\#}$			
310.8 1	2231.7+x	7.0 7				
311.2 2	524.6+x	9.6 14				
312.7 2	3164.8+x	1.6 4				
317.0 2	2135.0+x	8.2 14	D+Q	+0.42 14		
319.6 2	2878.3+x	2.0 9				
319.8 2	4454.9+x	1.1 5	D+Q $^{\#}$			
324.6 2	3214.3+x	4.7 13	D+Q	+0.53 21		
325.7 2	2403.7+x	1.2 6				
327.1 2	2558.8+x	4.6 7	(D+Q)			
327.3 2	2462.4+x	5.1 10	(D+Q)			
332.6 4	449.2+y	23 3	Q			
333.2 2	651.0+y	35 6	Q			
337.2 2	3139.1+x	3.1 10	D+Q $^{\#}$			
339.6 2	2801.9+x	4.9 11	D+Q $^{\#}$			
341.0 1	3555.5+x	3.4 12				
341.5 2	3480.8+x	2.6 10	D+Q $^{\#}$			
344.0 2	4135.0+x	1.3 5	D+Q $^{\#}$			
357.5 2	3913.1+x	1.6 6				
363.0 2	4818.1+x	0.4 2	D+Q $^{\#}$			
374.7 2	4287.8+x	0.9 4				
375.7 2	725.0+z	18 3	Q			
382.6 3	860.1+y	29 3	Q			
384.5 3	651.0+y	13.7 22				
386.9 1	734.6+x	20.2 21	Q			
389.1 2	4677.1+x	0.9 6				
403.4 2	670.0+y	14 3				
407.3 2	902.1+z	24 4				
410.9 3	860.1+y	9.9 15				
416.7 3	1086.7+y	4.7 12				
416.8 1	1496.0+x	34 3	M1	0.1018	$\alpha(\text{K})_{\text{exp}}=0.090$ 20. Mult.: from $\alpha(\text{K})_{\text{exp}}$.	
435.7 3	1086.7+y	23 4	Q			
437.3 1	571.9+x	10.3 21	Q			
447.6 1	972.2+x	24 3	E2		$\alpha(\text{K})_{\text{exp}}=0.018$ 4. Mult.: Q from $\gamma(0)$; E2 from $\alpha(\text{K})_{\text{exp}}$.	
454.3 2	903.5+y	18 3	Q			
$\times 457.2^{\frac{1}{2}} 2$						
460.4 2	2090.6+x	2.4 4				
473.7 3	1333.8+y	17.0 23	(Q)			
474.4 2	817.8+x	21.5 23	E2	0.0251	$\alpha(\text{K})_{\text{exp}}=0.019$ 4. Mult.: Q from $\gamma(0)$; E2 from $\alpha(\text{K})_{\text{exp}}$.	
484.3 2	1209.4+z	15.0 21	Q			
489.4 2	1159.2+y	10.6 21				

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$^{170}\text{Er}(^{14}\text{N},4\text{n}\gamma)$, $^{181}\text{Ta}(\alpha,5\text{n}\gamma)$ 1990Ve07 (continued) $\gamma(^{180}\text{Re})$ (continued)

$E\gamma^{\dagger}$	E(level)	$I\gamma^{\dagger}$	Mult. [§]	α	Comments
491.0 2	2350.5+x	3.1 6			
499.0 1	1233.7+x	24.4 24			
506.4 2	1408.4+z	18 3	Q		
507.4 1	1079.3+x	18.8 20			
511.2 3	1597.9+y	19 3			
524.0 2	1496.0+x	12.4 21			
533.6 4	1436.9+y	9.4 24	Q		
536.9 1	1354.7+x	9.3 14	Q		
540.1 1	2290.9+x	5.8 5	Q		
544.5 1	1516.7+x	17.2 17	Q		
547.3 3	1881.1+y	12.0 16			
549.0 2	2639.7+x	2.7 5	Q		
562.0 2	1641.4+x	4.4 6	Q	0.0166	
563.4 2	1722.7+y	6.8 14			
567.7 2	2582.3+x	6.6 9	Q		
579.5 3	2177.4+y	10.4 19	Q		
581.3 2	2077.9+x	4.7 8			
582.5 2	1791.9+z	7.2 17			
583.0 2	1937.6+x	5.0 11	Q		
584.4 2	1818.0+x	16.9 19	E2	0.0152	$\alpha(\text{K})_{\text{exp}}=0.009$ 3. Mult.: Q from $\gamma(\theta)$; E1 from $\alpha(\text{K})_{\text{exp}}$.
592.7 5	2029.9+y	5.4 18			
598.1 2	2239.5+x	2.4 6	(Q)		
599.0 2	2889.8+x	5.0 10	(Q)		
600.4 3	2008.8+z	10.5 18			
601.2 2	2231.7+x	5.2 6			
607.2 5	2330.2+y	4.3 10	Q		
608.5 2	2546.6+x	2.4 6			
610.9 3	2492.0+y	7.2 9			
612.5 3	2851.9+x	1.4 4			
618.3 2	2135.0+x	14.7 23	E2	0.0133	$\alpha(\text{K})_{\text{exp}}=0.016$ 6. Mult.: (Q) from $\gamma(\theta)$; E2 from $\alpha(\text{K})_{\text{exp}}$.
618.4 2	3164.8+x	1.1 5	(Q)		
627.5 2	2403.7+x	2.3 6			
632.0 2	3214.3+x	4.8 10	Q		
638.1 2	2558.8+x	3.5 7	(Q)		
638.1 3	2815.5+y	6.4 14	(Q)		
644.2 2	3203.0+x	1.3 6	(Q)		
644.4 1	2462.4+x	11.6 23	E2	0.0121	$\alpha(\text{K})_{\text{exp}}=0.011$ 4. Mult.: (Q) from $\gamma(\theta)$; E2 from $\alpha(\text{K})_{\text{exp}}$.
646.5 2	2878.3+x	2.3 9			
651.8 2	3791.0+x	2.2 11			
654.4 2	4135.0+x	2.8 12			
663.4 3	4454.9+x	0.9 4			
665.5 3	3543.8+x	1.2 6	(Q)		
665.6 2	3555.5+x	3.5 11	(Q)		
666.1 3	3158.1+y	3.8 8	(Q)		
667.0 2	2801.9+x	10.7 20			
676.6 2	3139.1+x	6.5 20			
678.5 1	1496.0+x	28 4	E2	0.0108	$\alpha(\text{K})_{\text{exp}}=0.012$ 4. Mult.: Q from $\gamma(\theta)$, E2 from $\alpha(\text{K})_{\text{exp}}$.
679.0 2	3480.8+x	5.9 15	(Q)		
680.8 3	2689.6+z	6.6 14			
683.3 2	4818.1+x	0.6 3			
689.6 5	3505.1+y	2.3 10			
698.9 2	3913.1+x	2.3 8			
707.9 4	3866.0+y	1.1 4			
731.6 2	4287.8+x	1.8 9			
748.8 3	3438.4+z	3.3 12			
761.7 2	1496.0+x	9.7 19			
764.2 2	4677.1+x	0.9 4			
807.8 2	1332.3+x	4.1 8			
984.8 2	1332.3+x	11.3 24	Q [#]		

Footnotes continued on next page

$^{170}\text{Er}(^{14}\text{N},4n\gamma)$, $^{181}\text{Ta}(\alpha,5n\gamma)$ 1990Ve07 (continued) **$\gamma(^{180}\text{Re})$ (continued)**

[†] From $^{170}\text{Er}(^{14}\text{N},4n\gamma)$, E=71 MeV.

[‡] Delayed transition which feeds the $K\pi=(11-)$ rotational band.

[§] From $\gamma(\theta)$ measured in $^{181}\text{Ta}(\alpha,5n\gamma)$, except where noted.

[#] From R(DCO) measurement, no details given by authors.

[@] Multiply placed; undivided intensity given.

^x γ ray not placed in level scheme.

 $^{176}\text{Yb}(^{10}\text{B},6n\gamma)$, $^{174}\text{Yb}(^{11}\text{B},5n\gamma)$ 2005El10,1987Kr20

2005El10: E(^{11}B)=71 MeV. Measured $E\gamma$, $I\gamma$, $\gamma\gamma$, $\gamma\gamma(\theta)(\text{DCO})$, $\gamma(t)$ using the CAESAR array consisting of six Compton-suppressed n-type coaxial HPGe detectors and two small-volume unsuppressed planar Ge detectors (LEPS). Measured ϵ with the Super- ϵ electron spectrometer consisting of a superconducting magnet transporter and a Si(Li) detector with an antipositron baffle. Subset of results given in 2003El11.

1987Kr20: E(^{10}B)=45, 50, 55, 50, 60, 65, 70, and 73 MeV. Measured $E\gamma$, $I\gamma$, $\gamma\gamma$, $\gamma(t)$, $\gamma(\theta)$ using one Compton-suppressed Ge(Li) detector and an intrinsic Ge detector. Also used the $^{181}\text{Ta}(\alpha,5n\gamma)$ reaction at E(α)=55 MeV as a cross check of their results.

 ^{180}Re Levels

The level scheme is that of 2005El10. Most band structures observed in 1987Kr20 are similar to those reported by 2005El10, but differ in bandhead energy and assigned spin. 1987Kr20 report a 46.3-keV level with $T_{1/2}=66$ ns 20. Such a transition was not observed by 2005El10 or by 1990Ve07 in $^{170}\text{Er}(^{14}\text{N},4n\gamma)$, $^{181}\text{Ta}(\alpha,5n\gamma)$ and is not included in the Adopted Levels. 1987Kr20 also report a band composed of 191.1 γ , 297.8 γ , 386.4 γ , 465.6 γ , and 514.6 γ , with no linking transitions to any other levels. This band was not observed by 2005El10 or by 1990Ve07 in $^{170}\text{Er}(^{14}\text{N},4n\gamma)$, $^{181}\text{Ta}(\alpha,5n\gamma)$ and is not included in the Adopted Levels.

1987Kr20 observed γ -ray transitions consistent with the decay of the (1)- ground state. They suggest that the (5+), 0.0+x level observed in reactions studies cascades down through highly converted (and possibly isomeric) low energy transitions.

E(level) [†]	J π [‡]	$T_{1/2}$ [§]	Comments
0.0	(1)-		E(level),J π : from the Adopted Levels.
0.0+x [@]	(5+)		
45.8+x [#] 5	(6+)		
70.6+x ^b 6	(7+)		
123.5+x [@] 6	(7+)		
162.8+x ^b 6	(8+)		
177.8+x ^a 6	(7-)		
205.1+x ^c 6	8+		
230.1+x [#] 5	(8+)		
266.5+x ^{&} 6	(8-)		
284.2+x ^d 6	9-	75.6 ns 14	$T_{1/2}$: other: 78 ns 9 from $\gamma(t)$ in 1987Kr20.
312.4+x ^b 6	(9+)		
363.1+x [@] 6	(9+)		
370.7+x ^a 6	(9-)		
413.7+x ^c 6	9+		
418.5+x ^d 7	10-		
495.1+x ^b 6	(10+)		
523.0+x [#] 6	(10+)		
526.5+x ^{&} 6	(10-)		
595.3+x ^d 7	11-		
642.1+x ^c 7	10+		
672.0+x ^a 7	(11-)		
696.4+x [@] 6	(11+)		
715.7+x ^b 6	(11+)		
805.2+x ^d 7	12-		
888.1+x ^c 7	11+		
902.1+x ^{&} 7	(12-)		
905.4+x [#] 6	(12+)		
949.3+x ^b 6	(12+)		
1042.6+x ^d 7	13-		
1079.3+x ^a 7	(13-)		
1132.0+x [@] 6	(13+)		

Continued on next page (footnotes at end of table)

$^{176}\text{Yb}(^{10}\text{B},6\text{n}\gamma), ^{174}\text{Yb}(^{11}\text{B},5\text{n}\gamma)$ 2005El10,1987Kr20 (continued) ^{180}Re Levels (continued)

E(level) [†]	J $\pi^{\ddagger}$	T _{1/2} [§]	Comments
1149.5+x ^c 7	12+		
1204.8+x ^b 6	(13+)		
1303.7+x ^d 7	14-		
1379.0+x [#] 8	(14+)		
1386.7+x ^{&} 7	(14-)		
1403.0+x 7	(12-)		
1424.7+x ^c 7	13+		
1482.1+x ^b 6	(14+)		
1566.1+x ^e 7	13+	74.2 ns 14	T _{1/2} : other: 67 ns 9 from $\gamma(t)$ in 1987Kr20.
1586.0+x ^a 7	(15-)		
1586.9+x ^d 7	15-		
1643.3+x [@] 6	(15+)		
1669.7+x 7	(13-)		
1700.4+x ^f 7	14-	<5.6 ns	
1711.8+x ^c 7	14+		
1754.9+x ^g 8	15-	<5.6 ns	
1768.0+x ^b 6	(15+)		
1846.3+x ^e 7	(14+)		
1875.4+x ^h 8	16+		
1887.9+x ^d 7	16-		
1926.3+x [#] 8	(16+)		
1929.5+x ^f 8	15-		
1968.7+x ^{&} 7	(16-)		
2007.7+x ^c 7	15+		
2044.8+x ^g 8	16-		
2075.3+x ^b 6	(16+)		
2139.3+x ^h 8	17+		
2147.9+x? ^e 7	(15+)		
2161.2+x ^f 8	16-		
2186.2+x ^a 7	(17-)		
2204.8+x ^d 7	17-		
2222.7+x [@] 6	(17+)		
2309.6+x ^c 7	16+		
2355.8+x ^g 8	17-		
2375.6+x ^b 7	(17+)		
2415.1+x ^h 8	18+		
2420.2+x ^f 8	17-		
2472.4+x ^e 7	(16+)		
2532.2+x ^d 7	18-		
2537.0+x [#] 9	(18+)		
2616.7+x ^c 7	17+		
2632.8+x ^{&} 7	(18-)		
2682.9+x ^g 8	18-		
2693.5+x ^b 7	(18+)		
2706.3+x ^h 8	19+		
2709.5+x ^f 8	18-		
2860.9+x [@] 6	(19+)		
2867.4+x ^a 8	(19-)		
2871.9+x ^d 7	19-		
2921.8+x ^c 7	18+		
3001.7+x ^f 8	19-		
3014.1+x ^h 8	20+		
3051.2+x 8	18+		
3068.3+x 8	(18+)		
3122.1+x 8	(18+)		
3202.9+x [#] 9	(20+)		
3209.5+x ^d 7	20-		
3233.9+x ^c 7	(19+)		
3326.8+x ^f 8	20-		
3338.0+x ^h 8	21+		
3352.8+x? ^{&} 8	(20-)		
3368.9+x 7	(19-)		
3407.8+x 8	(20+)		

Continued on next page (footnotes at end of table)

$^{176}\text{Yb}(^{10}\text{B},6\text{n}\gamma)$, $^{174}\text{Yb}(^{11}\text{B},5\text{n}\gamma)$ 2005El10,1987Kr20 (continued) **^{180}Re Levels (continued)**

E(level) [†]	J π [‡]	T _{1/2} [§]	Comments
3471.0+x ⁱ 8	21-	9.0 μs 7	T _{1/2} : from beam pulse- γ (t) in $^{174}\text{Yb}(^{11}\text{B},5\text{n}\gamma)$ using sum of 261 γ , 264 γ , 286 γ , 457 γ , and 678 γ (2005El10).
3550.0+x [@] 7	(21+)		
3551.0+x ^d 7	21-		
3615.8+x ^a 8	(21-)		
3667.3+x ^f 8	21-		
3679.6+x ^h 8	22+		
3850.5+x ⁱ 8	22-		
3861.9+x ^d 8	22-		
3895.0+x ^j 8	(22+)		
3910.5+x [#] 11	(22+)		
4023.5+x ^f 8	22-		
4036.7+x ^h 8	23+		
4205.7+x ^d 8	23-		
4240.1+x ⁱ 8	23-		
4269.1+x ^j 8	(23+)		
4300.1+x [@] 7	(23+)		
4390.2+x ^f 8	23-		
4411.9+x ^a 8	(23-)		
4412.2+x ^h 8	24+		
4525.2+x ^d 8	24-		
4636.8+x ⁱ 8	24-		
4643.2+x [#] 12	(24+)		
4651.0+x ^j 8	(24+)		
4801.3+x ^h 8	25+		
4888.2+x ^d 8	(25-)		
5039.8+x ^j 8	(25+)		
5047.3+x ⁱ 10	(25-)		
5102.8+x [@] 7	(25+)		
5205.9+x ^h 8	26+		
5435.4+x ^j 8	(26+)		
5454.5+x ⁱ 10	(26-)		
5837.5+x ^j 8	(27+)		
6249.2+x ^j 9	(28+)		
6672.9+x ^j 9	(29+)		

[†] From a least-squares fit to E γ by evaluator.[‡] As proposed in 2005El10 based on γ -ray multiplicities, decay patterns, assumed rotational structure and gyromagnetic ratios.[§] From $\gamma\gamma$ (t) in $^{174}\text{Yb}(^{11}\text{B},5\text{n}\gamma)$ (2005El10), except where noted.[#] (A): K π =(4+), α =0. Configuration=v7/2[514] $\otimes$ π 1/2[541].[@] (B): K π =(4+), α =1. Configuration=v7/2[514] $\otimes$ π 1/2[541].[&] (C): K π =(5-), α =0. Configuration=v9/2[624] $\otimes$ π 1/2[541].^a (D): K π =(5-), α =1. Configuration=v9/2[624] $\otimes$ π 1/2[541].^b (E): K π =(7+). Configuration=v9/2[624] $\otimes$ π 5/2[402].^c (F): K π =8+. Configuration=v7/2[514] $\otimes$ π 9/2[514].^d (G): K π =9-. Configuration=v9/2[624] $\otimes$ π 9/2[514].^e (H): K π =13+, 4-qp band. Configuration=v(7/2[514],9/2[624],5/2[512]) $\otimes$ π (5/2[402]).^f (I): K π =14-, 4-qp band. Configuration=v(7/2[514],9/2[624],7/2[633]) $\otimes$ π (5/2[402]).^g (J): K π =15-, 4-qp band. Configuration=v(7/2[514],9/2[624],5/2[512]) $\otimes$ π (9/2[514]).^h (K): K π =16+, 4-qp band. Configuration=v(7/2[514],9/2[624],7/2[633]) $\otimes$ π (9/2[514]).ⁱ (L): K π =21-, 6-qp band. Configuration=v(7/2[514],9/2[624],5/2[512]) $\otimes$ π (5/2[402],9/2[514], 7/2[404]). The spin-parity of 5048 and 5455 levels in this band are considered as tentative based on e-mail reply from p.m. Walker on November 21, 2005, since the placements of 799.2 γ and 809.2 γ have now been removed.^j (M): K π =(22+); 6-qp band. Configuration=v(7/2[514],9/2[624],7/2[633]) $\otimes$ π (5/2[402],9/2[514], 7/2[404]).

$^{176}\text{Yb}(^{10}\text{B},6\text{n}\gamma), ^{174}\text{Yb}(^{11}\text{B},5\text{n}\gamma)$ 2005El10,1987Kr20 (continued) $\gamma(^{180}\text{Re})$

R(DCO) values are given in 2005El10, however, the gating transition used to extract the R(DCO) ratio is not explicitly stated. Since an unambiguous determination of the dipole/quadrupole nature of the transition can not be made from the ratios alone, these values are omitted here.

Conversion electron data are from 2005El10 and A_2 coefficients are from 1987Kr20.

$E\gamma^\dagger$	E(level)	$I\gamma^\dagger$	Mult. ‡	$\delta^\S$	Comments
(25.0)	70.6+x				
42.4 3	205.1+x	7 3	M1		$\alpha(\text{exp})=13$ 4. $\alpha(\text{exp})$ from transition intensity balance.
45.8 5	45.8+x	18 3			
54.8 5	1754.9+x	6 3	M1		$\alpha(\text{exp})=7$ 2. $\alpha(\text{exp})$ from transition intensity balance.
(62.9)	3471.0+x	$\S$			
77.5 2	123.5+x	3.6 12	M1		$\alpha(\text{exp})=8.3$ 3. $\alpha(\text{exp})$ from transition intensity balance.
79.1 2	284.2+x	2.0 4			
(85.4)	1754.9+x	$\S$			
88.5 2	266.5+x	7.0 17			
92.2 6	162.8+x	8.5 12	D		Mult.: from $A_2=-0.7$ 2.
102.2 1	3471.0+x	2.1 10	E2		$\alpha(\text{exp})=2.5$ 9. $\alpha(\text{exp})$ from transition intensity balance.
104.1 1	370.7+x	7.9 18			
106.3 5	230.1+x	7.2 20			
120.5 1	1875.4+x	33 7	E1		$\alpha(\text{exp})=0.6$ 3. $\alpha(\text{exp})$ from transition intensity balance. Mult.: from $A_2<0$, but with large uncertainty.
121.4 2	284.2+x	77 22	(D)		
132.0@ 3	177.8+x	4.5 14			
133.2 2	363.1+x	2.4 5			
134.1 4	1700.4+x	16.0 17			
134.3 4	418.5+x	10 3			
134.5 2	205.1+x	61 15			
141.4 2	1566.1+x	3.8 10	M1		$\alpha(\text{exp})=1.9$ 2. $\alpha(\text{exp})$ from transition intensity balance.
145.3 1	672.0+x	3.7 8			
149.5 4	312.4+x	21.8 22	D		Mult.: from $A_2=-0.4$ 2.
155.7 1	526.5+x	24.8 15			
159.8 1	523.0+x	2.2 5			
163.1 8	1566.1+x	6.0 8			
173.4 3	696.4+x	1.7 8			
176.8 2	595.3+x	21.1 17			
177.1 6	1079.3+x	5.1 6			
182.5 6	495.1+x	15.4 29			
184.3 1	230.1+x	3.4 11			
193.1 2	370.7+x	4.7 10			
199.8 3	1586.0+x	3.1 13			
201.2 8	696.4+x	6.0 6			
208.6 2	413.7+x	37.7 14	(D)		Mult.: from $A_2<0$, but with large uncertainty.
209.9 4	805.2+x	31.9 13	D		Mult.: from $A_2=-0.31$ 16.
210.6 4	523.0+x	2.6 13			
220.5 1	715.7+x	2.8 4			
228.4 4	642.1+x	35 3	D		Mult.: from $A_2=-0.3$ 1.
229.1 2	1929.5+x	6.8 11			
229.9 1	902.1+x	13 3			
231.4 3	2161.2+x	6 3			
233.6 2	949.3+x	3.2 6			
237.4 2	1042.6+x	20.7 16			
239.6 1	363.1+x	7.4 10			
241.8 1	312.4+x	5.5 5			
245.9 5	888.1+x	29 3	M1+E2	0.9 +5-3	$\alpha(\text{K})\text{exp}=0.23$ 5.
252.9 3	949.3+x	2.3 10			
255.5 1	1204.8+x	8.2 13			
259.5 2	2420.2+x	9 4			
260.3 2	526.5+x	12 4			
261.1 4	1303.7+x	9.6 9			
261.4 5	1149.5+x	31 4			

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$^{176}\text{Yb}(^{10}\text{B},6\text{n}\gamma), ^{174}\text{Yb}(^{11}\text{B},5\text{n}\gamma)$ 2005El10,1987Kr20 (continued) $\gamma(^{180}\text{Re})$ (continued)

$E\gamma^{\dagger}$	E(level)	$I\gamma^{\dagger}$	Mult. ‡	$\delta^{\ddagger}$	Comments
262.4 2	1566.1+x	3.8 7			
263.9 1	2139.3+x	29.9 15			
275.2 1	1424.7+x	13.9 23			
275.9 1	2415.1+x	25 5	M1+E2	0.70 +15-20	$\alpha(\text{K})_{\text{exp}}=0.190$ 25; DCO=1.06 2.
277.3 4	1482.1+x	3.3 16			
280.2@ 2	1846.3+x	5.6 24			
283.2 6	1586.9+x	3.0 20			
285.7 1	3407.8+x	6.0 20	E2		$\alpha(\text{K})_{\text{exp}}=0.077$ 12.
285.9 4	1768.0+x	4.2 13			
287.2 4	1711.8+x	4.2 19			
289.9 2	2709.5+x	12 5			
290.0 1	2044.8+x	4.4 14	(D)		Mult.: from $A_2 < 0$, but with large uncertainty.
291.1 1	2706.3+x	6.6 15			
292.1 4	3001.7+x	6 3			
293.0 2	523.0+x	6.7 22			
295.9 2	2007.7+x	4.9 9			
300.3 6	2375.6+x	6.5 7			
300.5 4	3368.9+x	2.5 10			
301.0 1	1887.9+x	7.5 8			
301.6@ 2	2147.9+x?	§			
301.7 4	672.0+x	0.9 8			
301.8 1	2309.6+x	11.1 13			
305.1 3	2921.8+x	3.1 7			
307.1 1	2616.7+x	9.7 11			
307.2 6	2075.3+x	6.2 6			
307.4 2	3014.1+x	6.9 24	M1+E2	1.2 +5-3	$\alpha(\text{K})_{\text{exp}}=0.107$ 20.
307.8 3	1386.7+x	9 3			
310.9 2	3861.9+x	1.0 2			
311.0 4	595.3+x	10.0 10			
311.0 2	2355.8+x	6.2 22			
312.1 3	3233.9+x	2.9 9			
316.9 2	2204.8+x	3.5 13			
317.7 4	3368.9+x	3.0 10			
317.9 1	2693.5+x	6.5 20			
319.2 4	3001.7+x	§			
319.6 5	4525.2+x	0.7 4			
323.8 3	3338.0+x	6.9 24			
324.5@ 2	2472.4+x	§			
325.1 3	3326.8+x	8 3			
327.1 2	2682.9+x	6.2 10			
327.3 1	2532.2+x	3.3 7			
331.9 8	495.1+x	6.5 7			
333.3 1	696.4+x	6.5 15			
336.9 6	3209.5+x	2.3 8			
339.8 2	2871.9+x	2.3 4			
340.9 2	3667.3+x	4.2 22			
341.0 8	3679.6+x	9 3			
341.5 1	3551.0+x	3.2 5			
343.4 6	4205.7+x	2.4 9			
352.6 2	715.7+x	2.1 5			
356.6 2	4023.5+x	6.2 25			
357.8 2	4036.7+x	3.8 22			
363.0@ 2	4888.2+x?	§			
366.3 3	4390.2+x	2.3 12			
374.0 1	4269.1+x	4.8 13			
375.8 1	902.1+x	14 3			
	4412.2+x	7.0 5			
380.0 4	3850.5+x	4.1 8			
381.9 1	4651.0+x	3.0 11			
382.4 1	905.4+x	17 3			
382.5@ 3	1968.7+x	7.4 25			
383.7 6	696.4+x	2.0 7			
386.7 6	805.2+x	6.9 7			

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$^{176}\text{Yb}(^{10}\text{B},6\text{n}\gamma), ^{174}\text{Yb}(^{11}\text{B},5\text{n}\gamma)$ 2005El10,1987Kr20 (continued) $\gamma(^{180}\text{Re})$ (continued)

$E\gamma^{\dagger}$	E(level)	$I\gamma^{\dagger}$	Mult. ‡	$\delta^{\ddagger}$	Comments
388.7 2	5039.8+x	1.5 6			
389.5 2	4240.1+x	1.9 12			
389.5 4	4801.3+x	6.7 10			
395.7 3	5435.4+x	1.1 5			
396.6 1	4636.8+x	3.6 19			
402.5 6	5837.5+x	0.6 4			
403.4 2	715.7+x	3.8 7			
404.2 2	5205.9+x	§			
407.2 2	1079.3+x	10.0 10			
407.2 3	5454.5+x	§			
410.5 2	905.4+x	4.5 8			
410.5 5	5047.3+x	4.5 20			
411.7 4	6249.2+x	§			
416.3 1	1132.0+x	5.4 11			
416.6 4	1566.1+x	19.8 15	M1+E2	1.0 2	$\alpha(\text{K})\text{exp}=0.054$ 6.
423.7 2	6672.9+x	§			
424.0 2	3895.0+x	10.7 11			
435.6 1	1132.0+x	10.2 23			
437.0 4	642.1+x	4.5 16	E2		Mult.: Q from $A_2=+0.3$ 1, E2 from assumed band structure.
447.3 4	1042.6+x	12.1 11	E2		$\alpha(\text{K})\text{exp}=0.023$ 10. Mult.: $A_2=+0.7$ 2 is consistent with E2 character.
454.1 6	949.3+x	5.5 17			
456.8 6	3471.0+x	11.8 10	E1		$\alpha(\text{K})\text{exp}=0.0084$ 10.
460.6 2	2161.2+x	4.6 21			
473.6 6	1379.0+x	14 3			
474.3 8	888.1+x	16.3 19	E2		$\alpha(\text{K})\text{exp}=0.026$ 6. Mult.: $A_2=+0.24$ 2 is consistent with E2 character.
484.6 1	1386.7+x	28 6			
489.2 2	1204.8+x	5.5 10			
491.7 5	2420.2+x	1.8 19			
498.6 4	1303.7+x	11.7 11			
506.5 2	1586.0+x	16 5			
507.4 3	1149.5+x	9.2 22	E2		$\alpha(\text{K})\text{exp}=0.020$ 3; $\alpha(\text{L})\text{exp}=0.005$ 2.
508.4 2	1204.8+x	0.8 2			
511.3 1	1643.3+x	7.2 17			
523.5 1	1566.1+x	6.0 9			
532.7 2	1482.1+x	5.1 10			
536.6 2	1424.7+x	6.6 13	E2		Mult.: Q from $A_2=+0.37$ 7, E2 from assumed band structure.
539.7 3	2415.1+x	4.0 22			
544.3 4	1586.9+x	12.8 10			
547.3 1	1926.3+x	9.5 24			
548.2 1	2709.5+x	2.6 21			
562.3 3	1711.8+x	3.8 13			
563.2 2	1768.0+x	7.3 4			
567.0 3	2706.3+x	2.8 16			
579.4 2	2222.7+x	5.2 16			
581.5 1	3001.7+x	4.6 19			
581.8@ 2	2147.9+x?	§			
582.2 4	1968.7+x	10 5			
583.0 3	2007.7+x	6.7 16			
584.2 1	1887.9+x	8.9 13			
593.2 3	2075.3+x	4.7 11			
597.7 4	2309.6+x	8.0 20	E2		Mult.: Q from $A_2=0.52$ 14, E2 from assumed band structure.
599.7 3	3014.1+x	6 4	E2		$\alpha(\text{K})\text{exp}=0.012$ 2.
600.2 2	2186.2+x	16 6			
601.0 2	2355.8+x	§			
607.6 6	2375.6+x	10.7 13			
609.0 1	2616.7+x	16.7 22			
610.6 2	2537.0+x	8 3			
612.2 2	2921.8+x	12.3 18			
616.9 4	3326.8+x	4 3			
617.2@ 1	3233.9+x	15.8 21			
618.2 2	2693.5+x	§			

Continued on next page (footnotes at end of table)

$^{176}\text{Yb}(^{10}\text{B},6\text{n}\gamma), ^{174}\text{Yb}(^{11}\text{B},5\text{n}\gamma)$ 2005El10,1987Kr20 (continued) $\gamma(^{180}\text{Re})$ (continued)

$E_{\gamma}^{\dagger}$	E(level)	$I_{\gamma}^{\dagger}$	Mult. ‡	Comments
618.3 8	2204.8+x	9.7 10		
626.1@ 2	2472.4+x	§		
631.9 5	3338.0+x	5 5		
638.1 1	2682.9+x	2.8 11		
638.2 2	2860.9+x	3.9 15		
644.5 6	2532.2+x	7.0 7		
651.6 6	3861.9+x	2.3 4		
654.8 2	4205.7+x	2.1 4		
663.0 4	4525.2+x	2.0 9		
664.1 2	2632.8+x	5 3		
665.5 1	3679.6+x	8 4		
665.9 2	3202.9+x	6.9 20		
666.0 4	3667.3+x	§		
667.1 1	2871.9+x	6.2 7		
676.9 4	3209.5+x	4.5 8		
678.1 1	1566.1+x	16.9 23	E2	$\alpha(\text{K})_{\text{exp}}=0.008$ 1.
679.3 2	3551.0+x	4.4 5		
681.2 3	2867.4+x	6 4		
682.6@ 4	4888.2+x?	1.0 4		
689.1 2	3550.0+x	§		
696.5 1	4023.5+x	5 3		
698.7 2	4036.7+x	§		
707.6 6	3910.5+x	2.2 10		
720.0@ 2	3352.8+x?	§		
724.1 5	4390.2+x	6 3		
731.8 2	4412.2+x	§		
732.7 5	4643.2+x	2.0 10		
748.4 2	3615.8+x	§		
750.1 2	4300.1+x	§		
756.1 3	4651.0+x	0.7 4		
761.0 1	1566.1+x	3.8 5		
764.2 2	4801.3+x	§		
768.3 5	4240.1+x	1.2 10		
771.2 4	5039.8+x	0.7 4		
784.2 4	5435.4+x	0.7 3		
786.8 3	4636.8+x	0.7 5		
794.1 2	5205.9+x	§		
796.0@ 2	4411.9+x?	§		
797.7 3	5837.5+x	0.8 4		
x799.2# 4		0.4 3		
802.7@ 2	5102.8+x?	§		
807.8 6	1403.0+x	1.9 7		
x809.2# 4		0.4 3		
813.5 6	6249.2+x	0.6 2		
835.6 6	6672.9+x	3 2		
895.3 8	1700.4+x	0.8 2		
912.2 3	3051.2+x	1.3 3		
929.0 2	3068.3+x	1.5 2		
982.8 2	3122.1+x	1.3 3		
984.5 1	1403.0+x	8.7 13		
1074.4 3	1669.7+x	2.3 10		
1164.1 3	3368.9+x	0.7 2		
1175.8 1	3051.2+x	4.8 16	E2	$\alpha(\text{K})_{\text{exp}}=0.003$ 1.
1192.9 2	3068.3+x	1.5 4	(E2)	$\alpha(\text{K})_{\text{exp}}=0.005$ 2.
				Mult.: M1 or E2 from $\alpha(\text{K})_{\text{exp}}$, (E2) from assumed band structure.
1246.7 1	3122.1+x	4.1 10		

 † From 2005El10. ‡ From conversion electron data of 2005El10, except where noted.

§ Weak transition.

Placements of 799.2 γ from 5047.9, 25- level and 809.2 γ from 5455.2, 26- level in band #9 (see Fig. 2 in 2005El10) have been removed based on e-mail reply from P.M. Walker on November 21, 2005. These γ -rays do not fit in the level scheme as shown in Fig. 2 and Table I of 2005El10.

Footnotes continued on next page

$^{176}\text{Yb}(^{10}\text{B},6\text{n}\gamma), ^{174}\text{Yb}(^{11}\text{B},5\text{n}\gamma)$ 2005El10,1987Kr20 (continued)

$\gamma(^{180}\text{Re})$ (continued)

@ Placement of transition in the level scheme is uncertain.

^x γ ray not placed in level scheme.

Adopted Levels, Gammas

Q(β^-)=-6384 27; S(n)=9414 23; S(p)=5066 30; Q(α)=3850 30 2012Wa38.
S(2n)=16961 21; S(2p)=8531 22 (2012Wa38).

180Os Levels**Cross Reference (XREF) Flags**A 180Ir ϵ DecayB 184Pt α DecayC 48Ti(136Xe,4n γ)D 150Nd(36S,6n γ), 150Nd(34S,4n γ)E 150Nd(36S,6n γ): DelayedF 166Er(18O,4n γ), 168Er(16O,4n γ)G 169Tm(14N,3n γ)

E(level) [†]	J $\pi^{\ddagger}$	XREF	T _{1/2} [§]	Comments
0.0 [#]	0+	ABCDEF	21.5 min 4	% ϵ +% β^+ =100. T _{1/2} : weighted average of 23 min 3 (1965Be32), 21 min 2 (1966Be41), 21.7 min 6 (1966Ho16), 23 min 2 (1968Ko10) following the decay of 20 γ , 19.8 min 10 (1969Hu03), and 22.0 min 8 (1970Ar15). T _{1/2} =25.5 min 4 also obtained by 1968Ko10 from a $\gamma\gamma$ -coin measurement disagrees with all the other values and may be affected by a systematic uncertainty. The 0.4-min uncertainty reported by 1968Ko10 may represent only the deviation of the experimental points in the decay curve.
132.11 [#] 10	2+	A CDEFG	0.67 ns 7	J π : E2 132 γ to 0+. T _{1/2} : from centroid shift method in 168Er(16O,4n γ). Other: 0.80 ns +21-14 from RDM in 150Nd(34S,4n γ).
408.63 [#] 13	4+	A CDEFG	27.0 ps 35	J π : E2 276.5 γ to 2+.
736.4 ^j 6	0+	A		J π : E0 736 transition to 0+.
795.07 [#] 15	6+	A CDEFG	6.7 ps 17	J π : E2 386 γ to 4+.
831.09 ^j 19	2+	A DEF		J π : E0+M1+E2 699 γ to 2+.
870.44 [@] 18	2+	A EF		J π : E2 870 γ to 0+.
1022.85 [@] 17	3+	A EF		J π : M1+E2 891 γ to 2+, E2 614 γ to 4+, $\gamma\gamma$ (θ) in 180Ir ϵ decay.
1052.66 ^j 20	4+	A EF		J π : E0+M1+E2 644 γ to 4+.
1196.83 [@] 17	4+	A EF		J π : E0+M1+E2 788 γ to 4+.
1257.45 [#] 20	8+	CDEFG	6.9 ps 14	J π : E2 462 γ to 6+.
1375.4 5	3-	A		J π : E1 505 γ to 2+, 967 γ to 4+.
1378.95 ^j 19	6+	A EF		J π : E0+M1+E2 584 γ to 6+.
1405.55 [@] 18	5+	A EF		J π : M1+E2 610 γ to 6+, M1+E2 997 γ to 4+.
1514.63 ^c 22	4-	A D F		J π : E1+M2 492 γ to 3+, E1+M2 1106 γ to 4+; band member. E(level): there are discrepancies in some depopulating transitions from the closely spaced 1514.6-keV and 1515.56-keV levels. 150Nd(36S,6n γ):Delayed reports only the 1515.6-keV, 4+ level and places all transitions from this level, whereas, other studies resolve the two levels and their depopulating transitions. See Adopted Gammas for further information.
1515.67 19	4+	A DEF		J π : E2 645 γ to 2+.
1604.44 ^d 19	5-	A DEF		J π : E1 408 γ to 4+, E1+M2 809 γ to 6+.
1627.33 [@] 22	6+	EF		J π : E2 1219 γ to 4+, 832 γ to 6+.
1761.43 ^c 21	6-	D F		J π : E2 247 γ to 4-, E1+M2 966 γ to 6+.
1767.63 [#] 23	10+	CDEFG		J π : 510 γ E2 to 8+.
1862.54 ^d 19	7-	CDEF	<0.21 ns	J π : E2 258 γ to 5-, E1(+M2) 605 γ to 8+. T _{1/2} : from centroid shift in 168Er(16O,4n γ). Other: 17 ns 3 from γ (t) in 150Nd(36S,6n γ):Delayed.
1877.12 17	6+	DEF		J π : E2 362 γ to 4+, M1+E2 1082 γ to 6+.
1881.1 [@] 3	7+	F		J π : (E2) 475.5 γ to 5+, M1+E2 1086 γ to 6+.
1928.76 ^{&} 20	7-	DEF	15.2 ns 12	J π : E1 52 γ to 6+, (E1) 671 γ to 8+. T _{1/2} : from γ (t) in 168Er(16O,4n γ). Others: 15.9 ns 21 from $\gamma\gamma$ (t) in 168Er(16O,4n γ), 17 ns 3 from 150Nd(36S,6n γ), 150Nd(34S,4n γ), and 26 ns 3 from γ (t) in 150Nd(36S,6n γ):Delayed. configuration=v7/2[514]v7/2[633].
1987.0 ^a 4	8-	D		E(level),J π : observation of a 184 γ populating the 7-, 1929-keV level in 150Nd(36S,6n γ), 150Nd(34S,4n γ) results in an energy shift and change of J π to the band members observed in 166Er(18O,4n γ), 168Er(16O,4n γ). See the latter dataset for additional comments.
2086.2 ^c 3	8-	D F		J π : E2 325 γ to 6-.
2113.1 ^{&} 4	9-	D F		J π : M1+E2 126 γ to 8-, 184 γ to 7-.
2175.69 ^d 21	9-	CDEF		J π : E2 313 γ to 7-, E1 408 γ to 10+.
2275.9 ^a 4	10-	D F		J π : E2 289 γ to 8-, M1+E2 163 γ to 9-.

Continued on next page (footnotes at end of table)

Adopted Levels, Gammas (continued) ^{180}Os Levels (continued)

E(level) [†]	J $\pi^{\ddagger}$	XREF	T _{1/2} [§]	Comments
2286.06 ^b 24	(7-, 8-)	D F		J π : M1+E2 423 γ to 7-, 110.5 γ to 9-.
2308.9 [#] 3	12+	CDEFG		J π : E2 541 γ to 10+.
2410.8 [@] 3	9+	F		J π : E2 530 γ to 7+.
2429.1 ^g 5		D F		
2463.0 ^c 3	10-	D F		J π : E2 377 γ to 8-, M1(+E2) 287 γ to 9-.
2467.1 ^{&} 4	11-	D F		J π : E2 354 γ to 9-, M1+E2 191 γ to 10-.
2544.32 ^d 24	11-	CDEF		J π : E2 369 γ to 9-, E1(+M2) 777 γ to 10+.
2599.1 ^g 4		D F		
2635.7 ^k 3		F		
2675.41 ^b 25	(9-, 10-)	D F		J π : E2 398 γ to (7-, 8-), D(+Q) 908 γ to 10+.
2683.4 ^a 4	12-	D F		J π : E2 407 γ to 10-, M1+E2 216 γ to 11-.
2695.3 ^h 3	12+	DEF		J π : E2 312 γ from 14+, 387 γ to 12+.
2875.3 [#] 3	14+	CDEFG		J π : E2 566 γ to 12+.
2915.5 ^g 3		D F		
2918.8 ^{&} 4	13-	D F		J π : E2 451.5 γ to 11-, M1+E2 236 γ to 12-.
2919.6 ^c 3	12-	D F		J π : E2 456.5 γ to 10-, M1+E2 375 γ to 11-.
2925.4 ^k 3		F		
2982.0 ^d 3	13-	CDEF		J π : E2 438 γ to 11-, E1 673 γ to 12+.
3007.9 ^h 3	14+	DEF		J π : E2 699 γ to 12+.
3139.3 ^b 3	(11-, 12-)	D F		J π : 464 γ to (9-, 10-), band assignment.
3176.3 ^a 4	14-	D F		J π : E2 493 γ to 12-.
3246.3 ^k 3		F		
3342.8 ^g 4		D F		
3402.7 ^h 3	16+	DEF		J π : E2 395 γ to 14+, E2 527 γ to 14+.
3442.7 ^{&} 4	15-	D F		J π : E2 524 γ to 13-, M1+E2 266.4 γ to 14-.
3452.1 ^c 4	14-	D F		J π : E2 532 γ to 12-, M1+E2 468 γ to 13-.
3476.4 ^d 3	15-	CDEF		J π : E2 494 γ to 13-, E1 601 γ 14+.
3494.8 ⁱ 4	16+	CDEF		J π : E2 620 γ to 14+.
3629.2 ^k 3		F		
3656.7 ^b 3	(13-, 14-)	D F		J π : E2 517 γ to (11-, 12-).
3703.8 ^f 5	(11, 12)	D	≤ 5 ns	T _{1/2} : from $\gamma\gamma(t)$ in $^{150}\text{Nd}(^{36}\text{S}, 6n\gamma)$, $^{150}\text{Nd}(^{34}\text{S}, 4n\gamma)$. J π : D(+Q) 1020 γ to 12-, D(+Q) 1237 γ to 11-.
3735.3 ^a 4	16-	D F		J π : E2 559 γ to 14-.
3855.7 ^e 7	(12, 13)	D		J π : (D+Q) 152 γ (11, 12).
3886.5 ^g 5		D F		
3925.9 ^h 4	18+	DEF		J π : E2 523 γ to 16+.
3981.7 ^d 3	17-	DEF		J π : E2 505 γ to 15-.
4027.6 ^c 5	16-	D F		J π : E2 576 γ to 14-.
4031.3 ^{&} 4	17-	D F		J π : E2 589 γ to 15-.
4037.5 ^f 7	(13, 14)	D		J π : 182 γ to (12, 13), 334 γ to (11, 12).
4067.5 ^k 6		F		
4134.6 ⁱ 4	18+	CDEF		J π : E2 640 γ to 16+.
4200.8 ^b 4	(15-, 16-)	D F		J π : E2 544 γ to (13-, 14).
4248.5 ^e 7	(14, 15)	D		J π : 211 γ to (13, 14), 393 γ to (12, 13).
4342.4 ^a 5	18-	D F		J π : E2 607 γ to 16-.
4486.6 ^f 7	(15, 16)	D		J π : 238 γ to (14, 15), 449 γ to (13, 14).
4497.0 ^d 4	19-	DEF		J π : E2 515 γ to 17-.
4531.8 ^g 6		D F		J π : E2 645 γ to (16+).
4542.7 ^h 4	20+	DEF		J π : E2 617 γ to 18+.
4581.0 ^k 7		F		
4599.6 ^c 6	18-	D F		J π : E2 572 γ to 16-.
4651.4 ^{&} 5	19-	D F		J π : E2 620 γ to 17-.
4750.7 ^e 8	(16, 17)	D		J π : 264 γ to (15, 16), 502 γ to (14, 15).
4770.2 ^b 6	(17-, 18-)	D F		J π : E2 569 γ E2 (15-, 16-).
4821.4 ⁱ 5	20+	D F		J π : E2 687 γ to 18+.
4978.2 ^a 5	20-	D F		J π : E2 636 γ to 18-.
5037.2 ^f 8	(17, 18)	D		J π : 287 γ to (16, 17), 551 γ to (15, 16).
5045.0 ^d 4	21-	D F		J π : E2 548 γ to 19-.
5136.2 ^k 7		F		
5164.6 ^c 7	(20-)	D F		J π : 565 γ to 18-, band assignment.
5236.5 ^h 5	22+	D F		J π : E2 694 γ to 20+.
5255.0 ^g 7		D F		
5293.8 ^{&} 6	21-	D F		J π : E2 642 γ to 19-.

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Adopted Levels, Gammas (continued) ^{180}Os Levels (continued)

E(level) [†]	J $\pi^{\ddagger}$	XREF	Comments
5348.0 ^e 8	(18, 19)	D	J π : 311 γ to (17,18), 597 γ to (16,17).
5387.4 ^b 7	(19-, 20-)	D F	J π : E2 617 γ to (17-,18-).
5550.9 ⁱ 6	22+	D F	J π : E2 730 γ to 20+.
5561.6 11		E	J π : J $\geq$ 19, tentative assignment with dipole transition assumed (1993Ve01).
5625.7 ^a 6	22-	D F	J π : E2 648 γ to 20-.
5666.5 ^d 5	23-	D F	J π : E2 622 γ to 21-.
5731.5 ^k 11		F	
5787.7 ^c 8	(22-)	D F	J π : E2 623 γ to (20-).
5951.5 ^{&} 7	23-	D F	J π : E2 658 γ to 21-.
5981.3 ^h 6	24+	D F	J π : E2 745 γ to 22+.
6024.8 ^g 8		D F	
6055.5 ^b 7	(21-, 22-)	D F	J π : E2 668 γ to (19-,20-).
6298.1 ^a 7	(24-)	D F	J π : 672 γ to 22-, band assignment.
6323.6 ⁱ 8	(24+)	D F	J π : (E2) 773 γ to 22+.
6373.3 ^k 15		F	
6378.0 ^d 6	25-	D F	J π : E2 712 γ to 23-.
6496.3 ^c 8	(24-)	D F	J π : 709 γ to (22-), band assignment.
6653.0 ^{&} 10	(25-)	D F	J π : 702 γ to 23-, band assignment.
6766.5 ^h 6	26+	D F	J π : E2 785 γ to 24+.
6772.5 ^b 12	(23-, 24-)	D F	J π : 717 γ to (21-,22-).
6823.9 ^g 10		D	
7030.8 ^a 8	(26-)	D F	J π : (E2) 733 γ to 24-.
7144.9 ⁱ 13	(26+)	D	J π : 821 γ to (24+), band assignment.
7179.7 ^d 8	(27-)	D	J π : 802 γ to 25+, band assignment.
7290.4 ^c 10	(26-)	D	J π : 794 γ to (24-), band assignment.
7431.1 ^{&} 11	(27-)	D	J π : 778 γ to (25-), band assignment.
7535.4 ^b 13	(25-, 26-)	D	J π : 763 γ to (23-,24-).
7614.7 ^h 8	(28+)	D	J π : 848 γ to 26+, band assignment.
7664.8 ^g 11		D	
7842.5 ^a 10	(28-)	D	J π : 812 γ to (26-), band assignment.
8014.6 ⁱ 14	(28+)	D	J π : 870 γ to (26+), band assignment.
8063.6 ^d 9	(29-)	D	J π : 884 γ to (27-), band assignment.
8303.2 ^{&} 12	(29-)	D	J π : 872 γ to (27-), band assignment.
8348.5 ^b 14	(27-, 28-)	D	J π : 813 γ to (25-,26-).
8554.0 ^h 9	(30+)	D	J π : 939 γ to (28+), band assignment.
8573.0 ^g 12		D	
8739.8 ^a 11	(30-)	D	J π : 897 γ to (28-), band assignment.
8918.3 ⁱ 15	(30+)	D	J π : 904 γ to (28+).
9021.9 ^d 11	(31-)	D	J π : 958 γ to (29-).
9220.3 ^b 15	(29-, 30-)	D	J π : 872 γ to (27-,28-).
9276.7 ^{&} 13	(31-)	D	J π : 974 γ to (29-), band assignment.
9595.4 ^h 11	(32+)	D	J π : 1041 γ to (30+), band assignment.
9717.3 ^a 12	(32-)	D	J π : 978 γ to (30-), band assignment.
9845.6 ⁱ 15	(32+)	D	J π : 927 γ to (30+), band assignment.
10049.7 ^d 12	(33-)	D	J π : 1028 γ to (31-), band assignment.
10152.1 ^b 16	(31-, 32-)	D	J π : 932 γ to (29-,30-), band assignment.
10737.1 [?] h 12	(34+)	D	J π : 1142 γ to (32+), band assignment.
11146.9 [?] b 17	(33-, 34-)	D	J π : 995 γ to (31-,32-), band assignment.

[†] From a least-squares fit to E γ by evaluator.[‡] Spin and parity assignments are based on measured γ -ray multiplicities, decay patterns, angular distributions, assumed rotational structure and on deduced gyromagnetic ratios and angular momentum alignment for the various rotational bands in $^{150}\text{Nd}(^{36}\text{S},6\text{n}\gamma)$, $^{150}\text{Nd}(^{34}\text{S},4\text{n}\gamma)$ and $^{166}\text{Er}(^{18}\text{O},4\text{n}\gamma)$, $^{168}\text{Er}(^{16}\text{O},4\text{n}\gamma)$.[§] From RDM in $^{150}\text{Nd}(^{36}\text{S},6\text{n}\gamma)$, $^{150}\text{Nd}(^{34}\text{S},4\text{n}\gamma)$, except where noted.# (A): K π =0+ g.s. rotational band.@ (B): K π =2+ γ -vibrational band.& (C): K π =7- rotational band, α =1.a (D): K π =7- rotational band, α =0.b (E): K π =(7-,8-) rotational band.c (F): Low K rotational band (K=1-3) with configuration v9/2[624]v7/2[514] and strong mixing with either π 5/2[402] π 9/2[514] or π 5/2[402] π 1/2[541]. α =0.d (G): Low K rotational band (K=1-3) with configuration v9/2[624]v7/2[514] and strong mixing with either π 5/2[402] π 9/2[514] or π 5/2[402] π 1/2[541]. α =1.

Footnotes continued on next page

Adopted Levels, Gammas (continued) ^{180}Os Levels (continued)^e (H): Rotational band.^f (I): Rotational band.^g (J): Rotational Band. $K\pi=(7+)$ suggested for the bandhead at 2429 keV in $^{150}\text{Nd}(^{36}\text{S},6n\gamma)$, $^{150}\text{Nd}(^{34}\text{S},4n\gamma)$.^h (K): $K\pi=14+$ rotational band.ⁱ (L): $K\pi=16+$ rotational band.^j (M): $K\pi=0+$ β -vibrational band.^k (N): Rotational band. $K\pi=(8-)$ suggested for the bandhead at 2636 keV in $^{150}\text{Nd}(^{36}\text{S},6n\gamma)$, $^{150}\text{Nd}(^{34}\text{S},4n\gamma)$. $\gamma(^{180}\text{Os})$

E(level)	$E_{\gamma}^{\dagger}$	$I_{\gamma}^{\dagger}$	Mult. [‡]	$\delta^{\ddagger}$	α	Comments
132.11	132.1 1	100	E2 [#]		1.464	B(E2)(W.u.)=141 15.
408.63	276.5 1	100	E2 [#]		0.1169	B(E2)(W.u.)=192 25.
736.4	604.1		E2		0.01452	Mult.: Q from $\gamma\gamma(\theta)$ in ^{180}Ir ϵ decay; $\Delta\pi=\text{no}$ from level scheme.
	736.3		E0 [#]			
795.07	386.4 1	100	E2		0.0444	B(E2)(W.u.)=160 40.
831.09	94.5@	=2@	[E2]		5.49	
	422.3@	4.1@ 14	E2 [#]		0.0350	
	699.0 2	100@ 5	E0+M1+E2 [#]	<-9	0.0498& 22	δ : from $\gamma\gamma(\theta)$ in ^{180}Ir ϵ decay.
	831.5@	3.6@ 14	[E2]		0.00723	
870.44	461.8@ 5	6.3@ 11	E2 [#]		0.0278	E_{γ} : from $^{150}\text{Nd}(^{36}\text{S},6n\gamma)$:Delayed.
	738.0 3	25.6@ 23	E0+M1+E2 [#]	+5.4 +36-17	0.0463& 42	I_{γ} : other: 32 16 in $^{150}\text{Nd}(^{36}\text{S},6n\gamma)$:Delayed.
						δ : from $\gamma\gamma(\theta)$ in ^{180}Ir ϵ decay. Other: >6 from $\gamma(\theta)$ in $^{166}\text{Er}(^{18}\text{O},4n\gamma)$, $^{168}\text{Er}(^{16}\text{O},4n\gamma)$.
						I_{γ} : other: 42 9 in $^{166}\text{Er}(^{18}\text{O},4n\gamma)$, $^{168}\text{Er}(^{16}\text{O},4n\gamma)$
	870.5 3	100.0@ 23	E2 [#]		0.00657	
1022.85	614.1@ 3	18.6@ 24	E2 [#]		0.01399	I_{γ} : other: 41 17 in $^{150}\text{Nd}(^{36}\text{S},6n\gamma)$:Delayed.
	890.8 2	100@ 8	M1+E2 [#]	+8.8 +27-17	0.00638 11	δ : from $\gamma\gamma(\theta)$ in ^{180}Ir ϵ decay. Other: -7 3 from $\gamma(\theta)$ in $^{166}\text{Er}(^{18}\text{O},4n\gamma)$, $^{168}\text{Er}(^{16}\text{O},4n\gamma)$.
1052.66	222.0@	9.3@ 17	[E2]		0.235	
	257.9@	2.5@ 9	[E2]		0.1450	
	644.1 3	100@ 6	E0+M1+E2 [#]	-3.5 +5-7	0.120& 5	δ : from $\gamma\gamma(\theta)$ in ^{180}Ir ϵ decay.
	920.9@	17.4@ 12	[E2]		0.00586	
1196.83	327.0@	6.5@ 24	[E2]		0.0709	
	401.9@	5.9@ 12	[E2]		0.0399	
	788.2 2	100@ 18	E0+M1+E2 [#]	+1.3 1	0.0154& 13	δ : from $\gamma\gamma(\theta)$ in ^{180}Ir ϵ decay. Other: +1.8 4 from $\gamma(\theta)$ in $^{166}\text{Er}(^{18}\text{O},4n\gamma)$, $^{168}\text{Er}(^{16}\text{O},4n\gamma)$.
	1064.7 3	44@ 3	E2 [#]		0.00439	I_{γ} : other: 97 18 in $^{166}\text{Er}(^{18}\text{O},4n\gamma)$, $^{168}\text{Er}(^{16}\text{O},4n\gamma)$.
1257.45	462.3 2	100	E2		0.0277	B(E2)(W.u.)=63 13.
1375.4	352.3@	94@ 6	[E1]		0.01675	
	505.0@	100@ 6	E1 [#]		0.00750	
	544.3@	79@ 6	E1 [#]		0.00640	
	967.1@	13@ 3	[E1]		0.00207	
	1243.0@	53@ 3	[E1]		1.35×10^{-3}	
1378.95	326.3@ 2	61 15	[E2]		0.0714	I_{γ} : weighted average of 58 21 from ^{180}Ir ϵ decay, 59 18 from $^{150}\text{Nd}(^{36}\text{S},6n\gamma)$:Delayed, and 64 15 from $^{166}\text{Er}(^{18}\text{O},4n\gamma)$, $^{168}\text{Er}(^{16}\text{O},4n\gamma)$.
	583.8 3	100 18	E0+M1+E2 [#]	-1.6 +3-4	0.059& 10	δ : from $\gamma\gamma(\theta)$ in ^{180}Ir ϵ decay. Other: -0.20 20 from $\gamma(\theta)$ in $^{166}\text{Er}(^{18}\text{O},4n\gamma)$, $^{168}\text{Er}(^{16}\text{O},4n\gamma)$.
	969.9@	13@ 6	[E2]		0.00528	
1405.55	382.5 3	7.4 19	[E2]		0.0457	I_{γ} : from ^{180}Ir ϵ decay. Others: 40 12 from $^{150}\text{Nd}(^{36}\text{S},6n\gamma)$:Delayed and 38 16 from $^{166}\text{Er}(^{18}\text{O},4n\gamma)$, $^{168}\text{Er}(^{16}\text{O},4n\gamma)$.
	610.3 3	39 11	M1+E2 [#]	+4 1	0.0157 11	δ : from $\gamma\gamma(\theta)$ in ^{180}Ir ϵ decay.
						I_{γ} : weighted average of 26 11 from ^{180}Ir EC ϵ decay and 55 12 from $^{150}\text{Nd}(^{36}\text{S},6n\gamma)$:Delayed.

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Adopted Levels, Gammas (continued) $\gamma(^{180}\text{Os})$ (continued)

E(level)	$E\gamma^{\dagger}$	$I\gamma^{\dagger}$	Mult. [‡]	$\delta^{\ddagger}$	α	Comments
1405.55	996.94 24	100 14	M1+E2 [#]	-2.4 4	0.0059 4	I γ : weighted average of ^{180}Ir ϵ decay, $^{150}\text{Nd}(^{36}\text{S},6n\gamma)$:Delayed, and $^{166}\text{Er}(^{18}\text{O},4n\gamma)$, $^{168}\text{Er}(^{16}\text{O},4n\gamma)$. δ : from $\gamma\gamma(\theta)$ in ^{180}Ir ϵ decay. Other: -12 4 from $\gamma(\theta)$ in $^{166}\text{Er}(^{18}\text{O},4n\gamma)$, $^{168}\text{Er}(^{16}\text{O},4n\gamma)$.
1514.63	318.1 [@]	17 [@] 3				E γ : placed from 1515.6-keV, 4+ level in $^{150}\text{Nd}(^{36}\text{S},6n\gamma)$:Delayed.
	492.0 3	100 [@] 6	E1+M2 [#]	+0.23 +10-9	0.018 10	δ : from $\gamma\gamma(\theta)$ in ^{180}Ir ϵ decay. E γ : placed from 1515.6-keV, 4+ level in $^{150}\text{Nd}(^{36}\text{S},6n\gamma)$:Delayed.
	1106.0 3	71 [@] 6	E1+M2 [#]	+0.17 +4-0	0.0022 3	δ : from $\gamma\gamma(\theta)$ in ^{180}Ir ϵ decay. Other: -0.8 7 from $\gamma(\theta)$ in $^{166}\text{Er}(^{18}\text{O},4n\gamma)$, $^{168}\text{Er}(^{16}\text{O},4n\gamma)$. E γ : placed from 1515.6-keV, 4+ level in $^{150}\text{Nd}(^{36}\text{S},6n\gamma)$:Delayed.
1515.67	644.9 3	100 [@] 30	E2		0.01252	
	684.6 3	76 [@] 7	(E2)		0.01096	
	1383.8 3	58 30				E γ , I γ : from $^{150}\text{Nd}(^{36}\text{S},6n\gamma)$:Delayed.
1604.44	90.3 10	6 4				
	225.3 3	10 4				
	407.6 3	45 4	E1 [#]		0.01201	
	809.3 3	100 14	E1+M2	+0.10 4	0.0034 5	δ : from $\gamma\gamma(\theta)$ in ^{180}Ir ϵ decay. Other: +0.02 5 from $\gamma(\theta)$ in $^{166}\text{Er}(^{18}\text{O},4n\gamma)$, $^{168}\text{Er}(^{16}\text{O},4n\gamma)$.
	1195.9 3	19 4	E1+M2	+0.1 3	0.0016 21	Mult.: D(+Q) from $\gamma(\theta)$ in $^{166}\text{Er}(^{18}\text{O},4n\gamma)$, $^{168}\text{Er}(^{16}\text{O},4n\gamma)$, $\Delta\pi=\text{yes}$ from level scheme.
1627.33	430.6 3	43 13	[E2]		0.0333	
	832.4 5	100 30				
	1218.7 5	90 30	E2		0.00338	
1761.43	157.1 5	18 11	M1+E2	+0.25 12	1.51 6	Mult.: D+Q from $\gamma(\theta)$ in $^{166}\text{Er}(^{18}\text{O},4n\gamma)$, $^{168}\text{Er}(^{16}\text{O},4n\gamma)$, $\Delta\pi=\text{no}$ from level scheme.
	247.0 3	93 25	E2		0.1662	
	355.9 3	100 25	E1		0.01636	Mult.: D from $\gamma(\theta)$ in $^{166}\text{Er}(^{18}\text{O},4n\gamma)$, $^{168}\text{Er}(^{16}\text{O},4n\gamma)$, $\Delta\pi=\text{yes}$ from level scheme.
	966.3 3	89 18	E1+M2	-0.35 30	0.005 6	
1767.63	510.1 2	100	E2		0.0217	
1862.54	101.4 7	1.6 16				
	235.3 3	14 8	[E1]		0.0442	B(E1)(W.u.) $>4.5\times 10^{-6}$. I γ : other: 50 17 from $^{150}\text{Nd}(^{36}\text{S},6n\gamma)$:Delayed.
	258.0 3	74 14	E2		0.1449	B(E2)(W.u.) >12 .
	483.4 3	33 6	E1+M2	+0.09 8	0.010 5	B(E1)(W.u.) $>1.2\times 10^{-6}$. Mult.: D+Q from $\gamma(\theta)$ in $^{166}\text{Er}(^{18}\text{O},4n\gamma)$, $^{168}\text{Er}(^{16}\text{O},4n\gamma)$, $\Delta\pi=\text{yes}$ from level scheme.
	604.8 3	100 17	E1(+M2)	+0.05 5	0.0054 9	I γ : Other: ≤ 14 from $^{150}\text{Nd}(^{36}\text{S},6n\gamma)$:Delayed.
	1067.5 3	5 3	[E1]		1.73×10^{-3}	B(E1)(W.u.) $>1.9\times 10^{-6}$. B(E1)(W.u.) $>1.7\times 10^{-8}$.
1877.12	361.4 3	100 17	E2		0.0534	E γ : from $^{166}\text{Er}(^{18}\text{O},4n\gamma)$, $^{168}\text{Er}(^{16}\text{O},4n\gamma)$. Other: 363.2 5 in $^{150}\text{Nd}(^{36}\text{S},6n\gamma)$, $^{150}\text{Nd}(^{34}\text{S},4n\gamma)$.
	471.3 3	34 8				
	498.4 5	14 12				E γ , I γ : from $^{150}\text{Nd}(^{36}\text{S},6n\gamma)$:Delayed.
	680.2 ^a 5	≤ 8	[E2]		0.01112	E γ , I γ : from $^{150}\text{Nd}(^{36}\text{S},6n\gamma)$:Delayed.
	824.6 3	12 7	[E2]		0.00735	E γ , I γ : from $^{150}\text{Nd}(^{36}\text{S},6n\gamma)$:Delayed.
	1082.1 3	51 8	M1+E2	-0.6 3	0.0079 10	I γ : from $^{150}\text{Nd}(^{36}\text{S},6n\gamma)$:Delayed. Others: 15 8 from $^{150}\text{Nd}(^{36}\text{S},6n\gamma)$, $^{150}\text{Nd}(^{34}\text{S},4n\gamma)$ and 62 12 from $^{166}\text{Er}(^{18}\text{O},4n\gamma)$, $^{168}\text{Er}(^{16}\text{O},4n\gamma)$.

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Adopted Levels, Gammas (continued) $\gamma(^{180}\text{Os})$ (continued)

E(level)	$E\gamma^{\dagger}$	$I\gamma^{\dagger}$	Mult. ‡	$\delta^{\ddagger}$	α	Comments
1877.12	1468.5 3	45 9	E2		0.00243	$I\gamma$: from $^{150}\text{Nd}(^{36}\text{S},6n\gamma)$:Delayed. Others: 8 8 from $^{150}\text{Nd}(^{36}\text{S},6n\gamma)$, $^{150}\text{Nd}(^{34}\text{S},4n\gamma)$ and 42 8 from $^{166}\text{Er}(^{18}\text{O},4n\gamma)$, $^{168}\text{Er}(^{16}\text{O},4n\gamma)$.
1881.1	475.5 3 1086.2 4	100 33 53 20	(E2) M1+E2	<-8	0.0258 0.0067 25	Mult.: D+Q from $\gamma(\theta)$ in $^{166}\text{Er}(^{18}\text{O},4n\gamma)$, $^{168}\text{Er}(^{16}\text{O},4n\gamma)$, $\Delta\pi=\text{no}$ from level scheme.
1928.76	51.6 2 301.6 5 324.0 7	100 25 35 7	E1 [E1] (E2)		0.456 8 0.0241 0.0729 12	B(E1)(W.u.)= 3.8×10^{-5} 12. $E\gamma$: from $^{150}\text{Nd}(^{36}\text{S},6n\gamma)$:Delayed. B(E2)(W.u.)=0.023 6. Mult.: (Q) from R(DCO) in $^{150}\text{Nd}(^{36}\text{S},6n\gamma)$, $^{150}\text{Nd}(^{34}\text{S},4n\gamma)$, $\Delta\pi=\text{no}$ from level scheme.
	550.0 3 670.9 4 1133.8 4 (59)	 33 8 49 10	[E1] (E1) E1(+M2)		0.00626 0.00417 0.00156 12	$E\gamma$: from $^{150}\text{Nd}(^{36}\text{S},6n\gamma)$:Delayed. B(E1)(W.u.)= 5.7×10^{-9} 17. B(E1)(W.u.)= 1.8×10^{-9} 5.
1987.0 2086.2	223.3 4	14 4	M1+E2	+0.28 5	0.555 13	Mult.: D+Q from $\gamma(\theta)$ in $^{166}\text{Er}(^{18}\text{O},4n\gamma)$, $^{168}\text{Er}(^{16}\text{O},4n\gamma)$, $\Delta\pi=\text{no}$ from level scheme.
	324.9 3 126.2 3	100 14 92 25	E2 M1+E2	-1.4 3	0.0723 2.13 14	Mult.: D+Q from $\gamma(\theta)$ in $^{166}\text{Er}(^{18}\text{O},4n\gamma)$, $^{168}\text{Er}(^{16}\text{O},4n\gamma)$, large value of δ favors M1+E2 assignment.
	184.0 5	100 33				$E\gamma$: observed only in $^{150}\text{Nd}(^{36}\text{S},6n\gamma)$, $^{150}\text{Nd}(^{34}\text{S},4n\gamma)$.
2175.69	313.1 2 408.2 3	100 8 22 4	E2 E1		0.0805 0.01197	Mult.: D from $\gamma(\theta)$ in $^{150}\text{Nd}(^{36}\text{S},6n\gamma)$, $^{150}\text{Nd}(^{34}\text{S},4n\gamma)$, $\Delta\pi=\text{yes}$ from level scheme.
	918.6 3	11 4	E1(+M2)	-0.01 11	0.0023 5	Mult.: D+Q from $\gamma(\theta)$ in $^{166}\text{Er}(^{18}\text{O},4n\gamma)$, $^{168}\text{Er}(^{16}\text{O},4n\gamma)$, $\Delta\pi=\text{yes}$ from level scheme.
2275.9	162.9 3	48 8	M1+E2	-0.94 16	1.06 7	Mult.: D+Q from $\gamma(\theta)$ in $^{166}\text{Er}(^{18}\text{O},4n\gamma)$, $^{168}\text{Er}(^{16}\text{O},4n\gamma)$, $\Delta\pi=\text{no}$ from level scheme.
	289.0 3 110.5 3 423.4 3 1028.7 3	100 16 23 8 100 14 45 9	E2 E2 M1+E2 E1(+M2)		0.1022 2.92 6 0.093 9 0.0019 15	Mult.: D(+Q) from $\gamma(\theta)$ in $^{166}\text{Er}(^{18}\text{O},4n\gamma)$, $^{168}\text{Er}(^{16}\text{O},4n\gamma)$, $\Delta\pi=\text{yes}$ from level scheme.
2308.9 2410.8	541.2 2 529.7 3 1153.4 3	100 100 31 44 19	E2 E2		0.0188 0.0198	
2463.0	287.4 3	14 4	M1(+E2)	-0.07 20	0.290 13	Mult.: D+Q from $\gamma(\theta)$ in $^{166}\text{Er}(^{18}\text{O},4n\gamma)$, $^{168}\text{Er}(^{16}\text{O},4n\gamma)$, $\Delta\pi=\text{no}$ from level scheme.
	376.7 3 191.3 4 353.9 3	100 13 24 5 100 15	E2 M1+E2 E2		0.0476 0.51 4 0.0566	
2544.32	368.6 2 776.7 3	100 10 3.9 13	E2 E1(+M2)	-0.01 25	0.0506 0.003 4	Mult.: D+Q from $\gamma(\theta)$ in $^{166}\text{Er}(^{18}\text{O},4n\gamma)$, $^{168}\text{Er}(^{16}\text{O},4n\gamma)$, $\Delta\pi=\text{yes}$ from level scheme.
						$E\gamma$: from $^{166}\text{Er}(^{18}\text{O},4n\gamma)$, $^{168}\text{Er}(^{16}\text{O},4n\gamma)$.
2599.1	170.0 3 321.9 5	100 43 85 57				
2635.7	172.9 3 460.0 3 549.7 3	17 17 50 17 100 90				
2675.41	389.4 2	100 10	D+Q E2		0.0435	

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Adopted Levels, Gammas (continued) $\gamma(^{180}\text{Os})$ (continued)

E(level)	$E\gamma^{\dagger}$	$I\gamma^{\dagger}$	Mult. ‡	$\delta^{\ddagger}$	α	Comments
2675.41	500.0 3	5.9 20	D(+Q)	+0.10 20	0.0229	$I\gamma$: from $^{150}\text{Nd}(^{36}\text{S},6n\gamma), ^{150}\text{Nd}(^{34}\text{S},4n\gamma)$. Other: 51 14 in $^{166}\text{Er}(^{18}\text{O},4n\gamma), ^{168}\text{Er}(^{16}\text{O},4n\gamma)$.
2683.4	907.8 3 216.4 4	47 9 22 5	D(+Q) M1+E2	-0.05 12 -2.5 5	0.00234 0.307 24	Mult.: D+Q from $\gamma(\theta)$ in $^{166}\text{Er}(^{18}\text{O},4n\gamma), ^{168}\text{Er}(^{16}\text{O},4n\gamma)$, $\Delta\pi=\text{no}$ from level scheme.
2695.3	407.4 3 387.2 5	100 14 100	E2		0.0385	
2875.3	566.1 2	100	E2		0.01690	
2915.5	220.7 ^a 3 316.1 3	8 4 100 17	E2		0.0783	
2918.8	1147.5 3 235.6 3	33 13 11 3	(E2) M1+E2	-1.8 5	0.00379 0.27 5	Mult.: D+Q from $\gamma(\theta)$ in $^{166}\text{Er}(^{18}\text{O},4n\gamma), ^{168}\text{Er}(^{16}\text{O},4n\gamma)$, $\Delta\pi=\text{no}$ from level scheme.
2919.6	451.5 3 374.7 6	100 15 18 4	E2 M1+E2		0.0294 0.10 5	Mult.: D+Q from $\gamma(\theta)$ in $^{166}\text{Er}(^{18}\text{O},4n\gamma), ^{168}\text{Er}(^{16}\text{O},4n\gamma)$, $\Delta\pi=\text{no}$ from level scheme.
2925.4	456.5 3 289.9 3	100 12 100 40	E2		0.0286	
2982.0	380.9 3 462.0 ^a 10 437.8 2 673.2 3	20 10 30 20 100 19 5 4	E2 E1		0.0319 0.00414	Mult.: D from $\gamma(\theta)$ in $^{166}\text{Er}(^{18}\text{O},4n\gamma), ^{168}\text{Er}(^{16}\text{O},4n\gamma)$, $\Delta\pi=\text{yes}$ from level scheme.
3007.9	312.0 3 699.3 2	18 5 100 10	(E2) E2		0.0814 0.01046	
3139.3	464.1 2 593.3 15	100 10 5.7 20				
3176.3	830.1 3 257.3 4	18 7 10 3	M1		0.393	Mult.: D from R(DCO) in $^{150}\text{Nd}(^{36}\text{S},6n\gamma), ^{150}\text{Nd}(^{34}\text{S},4n\gamma)$, $\Delta\pi=\text{no}$ from level scheme.
3246.3	493.0 3 264.4 3 321.0 3 326.8 ^b 5 702.3 5 782.9 5	100 18 <44 100 33 44 22 22 11 33 22	E2 E2		0.0236 0.0749	
3342.8	427.3 3	100	E2		0.0340	
3402.7	394.9 3 527.3 2	48 5 100 8	E2 E2		0.0419 0.0200	
3442.7	266.4 3	8 2	M1+E2	-0.98 21	0.25 3	Mult.: D+Q from $\gamma(\theta)$ in $^{166}\text{Er}(^{18}\text{O},4n\gamma), ^{168}\text{Er}(^{16}\text{O},4n\gamma)$, $\Delta\pi=\text{no}$ from level scheme.
3452.1	523.8 2 467.6 14	100 10 18 5	E2 M1+E2	+0.41 7	0.0203 0.072 3	Mult.: D+Q from $\gamma(\theta)$ in $^{166}\text{Er}(^{18}\text{O},4n\gamma), ^{168}\text{Er}(^{16}\text{O},4n\gamma)$, $\Delta\pi=\text{no}$ from level scheme.
3476.4	532.3 3 494.4 2 601.1 5	100 18 100 13 9 4	E2 E2 E1		0.0196 0.0234 0.00521	Mult.: D from $\gamma(\theta)$ in $^{166}\text{Er}(^{18}\text{O},4n\gamma), ^{168}\text{Er}(^{16}\text{O},4n\gamma)$, $\Delta\pi=\text{yes}$ from level scheme.
3494.8	619.5 2	100	E2		0.01371	
3629.2	153.1 5 176.2 5 383.1 3 647.6 5 709.5 3	<18 18 9 100 27 18 9 18 9	D+Q			

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Adopted Levels, Gammas (continued) $\gamma(^{180}\text{Os})$ (continued)

E(level)	$E\gamma^{\dagger}$	$I\gamma^{\dagger}$	Mult. ‡	$\delta^{\ddagger}$	α	Comments
3656.7	517.4 2	100	E2		0.0210	
3703.8	1020.2 5	100 30	D(+Q)	-0.5 +2-20		
	1236.9 5	55 18	D(+Q)			
3735.3	291.9 10	8 3	M1+E2	-10 41	0.1009 25	Mult.: D+Q from $\gamma(0)$ in $^{166}\text{Er}(^{18}\text{O},4n\gamma)$, $^{168}\text{Er}(^{16}\text{O},4n\gamma)$, $\Delta\pi=\text{no}$ from level scheme.
	559.0 3	100 10	E2		0.01741	
3855.7	151.9 5	100	(D+Q)			
3886.5	543.7 3	100	E2		0.0186	
3925.9	523.2 2	100	E2		0.0204	
3981.7	505.4 2	100 10	E2		0.0222	
	538.9 5	42 13	E2 §		0.0190	
4027.6	575.5 3	100	E2		0.01625	
4031.3	295.8 3	10 3	M1+E2		0.18 9	Mult.: D+Q from $\gamma(0)$ in $^{166}\text{Er}(^{18}\text{O},4n\gamma)$, $^{168}\text{Er}(^{16}\text{O},4n\gamma)$, $\Delta\pi=\text{no}$ from level scheme.
	554.9 5	38 11	E2 §		0.0177	
	588.7 3	100 12	E2		0.01542	
4037.5	181.5 5	100				
	333.7 5	93				
4067.5	438.3 5	100				
4134.6	639.8 2	100	E2		0.01274	
4200.8	544.1 2	100	E2 §		0.0186	
4248.5	210.6 5	100 40				
	393.2 5	75 25				
4342.4	311.1 3	<6				
	607.2 3	100 20	E2		0.01435	
4486.6	238.2 5	75 25				
	449.1 5	100 40				
4497.0	515.3 2	100	E2		0.0212	
4531.8	645.3 3	100	E2 §		0.01250	
4542.7	616.8 2	100	E2		0.01385	
4581.0	513.5 3	100	E2 §		0.0213	
4599.6	572.0 3	100	E2		0.01649	
4651.4	309.3 8	<6	M1+E2	-5.5 23	0.088 9	Mult.: D+Q from $\gamma(0)$ in $^{166}\text{Er}(^{18}\text{O},4n\gamma)$, $^{168}\text{Er}(^{16}\text{O},4n\gamma)$, $\Delta\pi=\text{no}$ from level scheme.
	620.0 3	100 15	E2 §		0.01369	
4750.7	263.8 5	45 15				
	502.2 5	100 30				
4770.2	569.4 5	100	E2		0.01667	
4821.4	686.8 2	100	E2		0.01088	
4978.2	326.8 ^b 8	6 6				
	635.9 3	100 24	E2		0.01292	
5037.2	286.8 5	100 30				
	550.8 5	22 11				
5045.0	548.0 2	100	E2		0.0182	
5136.2	555.2 3	100	E2		0.01769	
5164.6	565.0 4	100				
5236.5	693.8 2	100	E2		0.01064	
5255.0	723.2 3	100	(E2) §		0.00972	
5293.8	316.0 8	10 10				
	642.3 5	100 30	E2 §		0.01263	
5348.0	311.3 5	20 6				
	596.8 5	100 30				
5387.4	617.2 2	100	E2 §		0.01383	
5550.9	729.5 4	100	E2 §		0.00954	
5561.6	1427.0	100				$E\gamma, I\gamma$: from $^{150}\text{Nd}(^{36}\text{S},6n\gamma)$:Delayed.
5625.7	647.5 3	100	E2		0.01241	
5666.5	621.5 2	100	E2		0.01361	
5731.5	595.3 8	100				
5787.7	623.1 3	100	E2		0.01353	
5951.5	657.7 4	100	E2		0.01198	

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Adopted Levels, Gammas (continued) $\gamma(^{180}\text{Os})$ (continued)

E(level)	$E\gamma^\dagger$	$I\gamma^\dagger$	Mult. ‡	α
5981.3	744.8 3	100	E2	0.00912
6024.8	769.8 5	100	§	
6055.5	668.1 3	100	E2§	0.01157
6298.1	672.4 4	100		
6323.6	772.7 5	100	(E2)	0.00843
6373.3	641.8 10	100	(E2)	0.01265
6378.0	711.5 4	100	E2§	0.01007
6496.3	708.6 3	100		
6653.0	701.5 6	100		
6766.5	785.2 3	100	E2§	0.00815
6772.5	717.0	100		
6823.9	799.1 5	100		
7030.8	732.7 4	100	(E2)	0.00945
7144.9	821.3	100		
7179.7	801.7 5	100		
7290.4	794.1 5	100		
7431.1	778.1 5	100		
7535.4	762.9 5	100		
7614.7	848.2 5	100		
7664.8	840.9 5	100		
7842.5	811.7 5	100		
8014.6	869.7 5	100		
8063.6	883.9 5	100		
8303.2	872.1 5	100		
8348.5	813.1 5	100		
8554.0	939.3 5	100		
8573.0	908.2 5	100		
8739.8	897.3 5	100		
8918.3	903.7 5	100		
9021.9	958.3 5	100		
9220.3	871.8 5	100		
9276.7	973.5 5	100		
9595.4	1041.4 5	100		
9717.3	977.5 5	100		
9845.6	927.3 5	100		
10049.7	1027.8 5	100		
10152.1	931.8 5	100		
10737.1?	1141.7 ^a 5	100		
11146.9?	994.8 ^a 5	100		

[†] From weighted average of ^{180}Ir ϵ decay, $^{150}\text{Nd}(^{36}\text{S},6n\gamma)$, $^{150}\text{Nd}(^{34}\text{S},4n\gamma)$, and $^{166}\text{Er}(^{18}\text{O},4n\gamma)$, $^{168}\text{Er}(^{16}\text{O},4n\gamma)$, except where noted.

[‡] From $\gamma(\theta)$ and conversion electron data in $^{166}\text{Er}(^{18}\text{O},4n\gamma)$, $^{168}\text{Er}(^{16}\text{O},4n\gamma)$, except as noted. Stretched Q transitions from $\gamma(\theta)$ are assumed to be E2 in character.

§ From R(DCO) in $^{150}\text{Nd}(^{36}\text{S},6n\gamma)$, $^{150}\text{Nd}(^{34}\text{S},4n\gamma)$. Stretched Q transitions are assumed to be E2 in character.

From conversion electron data in ^{180}Ir ϵ decay.

@ From ^{180}Ir ϵ decay.

& From sum of $\alpha(\text{K})\text{exp}$, $\alpha(\text{L})\text{exp}$, and $\alpha(\text{M})\text{exp}$ from ^{180}Ir ϵ decay.

^a Placement of transition in the level scheme is uncertain.

^b Multiply placed.

^{180}Ir ϵ Decay 1994Ki01,1992Bo19,1973HaVR

Parent ^{180}Ir : $E=0.0$; $J\pi=(5+)$; $T_{1/2}=1.5$ min I ; $Q(\text{g.s.})=6384$ 27; $\% \epsilon + \% \beta^+$ decay=100.

1994Ki01: ^{180}Ir activity produced by $^{166}\text{Er}(^{19}\text{F},5n)$, $E(^{19}\text{F})=108$ MeV. Measured $E\gamma$, $I\gamma$, $\gamma\gamma$ coin, $\gamma\gamma(\theta)$, $I(\text{ce})$, and $\text{ce}-\gamma$ coin using CAESAR array consisting of 6 Compton-suppressed HPGe detectors and a superconducting solenoid electron spectrometer operated in lens mode.

1992Bo19: ^{180}Ir activity produced by $^{148}\text{Nd}(^{36}\text{Ar},p3n)$, $E(^{36}\text{Ar})=240$ MeV. Measured $E\gamma$, $I\gamma$, $\gamma\gamma$ coin, E x-ray, I x-ray, γ -x-ray coin using two Ge detectors.

1973HaVR: ^{180}Ir activity produced by $^{169}\text{Tm}(^{16}\text{O},5n)$, $E(^{16}\text{O})=125$ MeV. Measured $E\gamma$, $I\gamma$, $\gamma\gamma$ coin using Ge(Li) detectors.

A total energy release of 6430 keV $I60$ for this decay scheme is calculated by the RADLST code, in agreement with the Q value of 6382 keV 27. However, due to the large Q value and the experimental ≈ 2 MeV γ -ray energy cut-off, the decay scheme is considered to be incomplete.

 ^{180}Os Levels

1992Bo19 propose a $8+$, 1256 level (depopulated by a 461.7 γ) and a $7-$, 1862 level (depopulated by 257.6 γ , 604.5 γ , and 1066.6 γ) which are not observed by 1994Ki01. All depopulating γ 's (with the exception of the 1066.6 γ) are given alternate placements in 1994Ki01. As the direct population of $7-$ and $8+$ states from a (4,5) parent is unlikely, the level scheme of 1994Ki01 is adopted here.

$E(\text{level})^\dagger$	$J\pi^\ddagger$	$E(\text{level})^\dagger$	$J\pi^\ddagger$	$E(\text{level})^\dagger$	$J\pi^\ddagger$
0.0 §	0+	870.44@ 19	2+	1405.8@ 3	5+
132.1 § 2	2+	1022.80@ 18	3+	1514.98 21	4-
408.65 § 13	4+	1052.82# 22	4+	1515.6 4	4+
736.3# 4	0+	1196.94@ 19	4+	1604.1 3	5-
795.06 § 16	6+	1375.35 25	3-		
831.00# 18	2+	1379.02# 23	6+		

† From a least-squares fit to $E\gamma$'s by evaluator.

‡ From the Adopted Levels.

§ (A): g.s. band.

(B): $K\pi=0+$ band.

@ (C): $K\pi=2+$ γ -vibrational band.

 β^+, ϵ Data

$E\epsilon$	$E(\text{level})$	$I\beta^+\%$	$I\epsilon\%$	$\text{Log } ft^\ddagger$	$I(\epsilon+\beta^+)^\dagger\%$
(4780 30)	1604.1	1.3 4	1.4 4	6.52 14	2.7 8
(4870 30)	1515.6	4.7 9	4.6 8	6.01 9	9.3 17
(4870 30)	1514.98	3.3 2	3.1 2	6.18 4	6.4 4
(4980 30)	1405.8	2.0 4	1.8 4	6.44 10	3.8 8
(5000 30)	1379.02	0.96 21	0.84 19	6.77 11	1.8 4
(5010 30)	1375.35	3.3 2	2.8 1	6.25 4	6.1 3
(5190 30)	1196.94	7.2 10	5.5 7	5.99 7	12.7 17
(5330 30)	1052.82	6.7 5	4.6 3	6.09 5	11.3 8
(5360 30)	1022.80	4.6 7	3.1 5	6.26 8	7.7 12
(5510 30)	870.44	2.8 11	1.7 6	6.55 17	4.5 17
(5550 30)	831.00	4.6 7	2.8 4	6.34 8	7.4 11
(5590 30)	795.06	1.4 6	0.9 4	6.86 20	2.3 10
(5980 30)	408.65	17 3	7.9 13	5.95 8	25 4

† From an intensity balance at each level.

‡ Due to the large Q value (6.4 MeV) of the decay and the experimental ≈ 2 MeV γ -ray energy cut-off, the decay scheme is considered incomplete. The $\text{log } ft$ values should therefore be considered lower limits.

§ Absolute intensity per 100 decays.

 $\gamma(^{180}\text{Os})$

1973HaVR observe tentative unplaced transitions of 846.0 5 with $I\gamma=5.8$ 6, 1014.0 5 with $I\gamma=2.6$ 3, and 1330.3 5 with $I\gamma=10.4$ 6. These transitions are not observed by 1994Ki01 or 1992Bo19, and thus, not included in the adopted gammas.

$I\gamma$ normalization: intensity balance at 131 level suggests no direct feeding to this level. Decay scheme normalization deduced by evaluator assuming no direct feeding to g.s. and 131 level, and using $I(\gamma+\text{ce})(\text{g.s.}+131)$ level, excluding 131 γ =100%.

Continued on next page (footnotes at end of table)

^{180}Ir ϵ Decay 1994Ki01,1992Bo19,1973HaVR (continued) $\gamma(^{180}\text{Os})$ (continued)

$E_{\gamma}^{\dagger}$	E(level)	$I_{\gamma}^{\pm b}$	Mult. [§]	δ^a	α	Comments
94.5@	831.00	$\approx 0.4^{\circ}$	[E2]		5.49	
132.1 1	132.1	68 15	E2		1.464	I_{γ} : from intensity balance at 132 level assuming no ϵ feeding to this level. Others: $I_{\gamma}=84.6$ 20 (1994Ki01), $I_{\gamma}=45$ 2 (1992Bo19), and $I_{\gamma}=95$ 5 (1973LaZC). $\alpha(L)\text{exp}=0.737$ 24, $\alpha(M)\text{exp}=0.186$ 6 (1994Ki01).
222.0@	1052.82	1.6@ 3	[E2]		0.235	
257.9@	1052.82	0.43@ 16	[E2]		0.1450	E_{γ} : placement from 1994Ki01. A 257.6 3 transition with $I_{\gamma}=0.8$ 2 is placed by 1992Bo19 from a 7- level at 1861.
276.5 1	408.65	100.0 16	E2		0.1169	$\alpha(K)\text{exp}=0.073$ 3, $\alpha(L)\text{exp}=0.033$ 2, $\alpha(M)\text{exp}=0.0081$ 4 (1994Ki01).
318.1@	1514.98	1.1@ 2	[E1]		0.0213	
326.3 2	1379.02	1.1 4	[E2]		0.0714	
327.0@	1196.94	1.1@ 4	[E2]		0.0709	
352.3@	1375.35	3.2@ 2	[E1]		0.01675	
383.1@	1405.8	0.4@ 1	[E2]		0.0455	
386.4 1	795.06	12.0 6	E2		0.0444	I_{γ} : weighted average of values from 1994Ki01 and 1992Bo19. Other: $I_{\gamma}=6.2$ 6 (1973HaVR). $\alpha(L)\text{exp}=0.0097$ 4, $\alpha(M)\text{exp}=0.0032$ 11 (1994Ki01).
401.9@	1196.94	1.0@ 2	[E2]		0.0399	
407.5@	1604.1	1.4@ 1	E1		0.01201	$\alpha(K)\text{exp}\leq 0.014$ (1994Ki01).
422.3@	831.00	0.9@ 3	E2		0.0350	$\alpha(K)\text{exp}\leq 0.03$ (1994Ki01). Mult.: E1 or E2 from $\alpha(K)\text{exp}$, $\Delta J=2$ from level scheme requires E2.
461.6@	870.44	1.1@ 2	E2		0.0278	$\alpha(K)\text{exp}\leq 0.025$ (1994Ki01). Mult.: E1 or E2 from $\alpha(K)\text{exp}$, $\Delta J=2$ from level scheme requires E2. E_{γ} : placement from 1994Ki01. A 461.7 4 transition with $I_{\gamma}=1.3$ 5 is placed by 1992Bo19 from a 8+ level at 1256.
492.2 2	1514.98	6.5 4	E1+M2	+0.23 +10-9	0.018 10	$\alpha(K)\text{exp}=0.005$ 3 (1994Ki01). $A_2=+0.06$ 11. δ : Other: 0.00 9 from $\alpha(K)\text{exp}$.
505.0@	1375.35	3.4@ 2	E1		0.00750	$\alpha(K)\text{exp}\leq 0.008$ (1994Ki01).
544.3@	1375.35	2.7@ 2	E1		0.00640	$\alpha(K)\text{exp}=0.0057$ 13 (1994Ki01).
583.9 3	1379.02	1.9 5	E0+M1+E2	-1.6 +3-4	0.059& 10	$\alpha(K)\text{exp}=0.059$ 10 (1994Ki01). $A_2=+0.05$ 9, $A_4=+0.09$ 9. $A_2=+0.5$ 3, $A_4=+1.1$ 3.
604.1@	736.3	2.0@ 2	E2		0.01452	Mult.: Q from $\gamma\gamma(0)$, $\Delta\pi=\text{no}$ from level scheme. E_{γ} : placement from 1994Ki01. A 604.5 5 transition with $I_{\gamma}=1.3$ 4 is placed by 1992Bo19 from a 7- level at 1861.
610.7@	1405.8	1.4@ 6	M1+E2	+4 1	0.0157 11	$\alpha(K)\text{exp}\leq 0.011$ (1994Ki01). $A_2=-0.2$ 2, $A_4=-0.2$ 2.
614.1 3	1022.80	3.9 5	E2		0.01399	$\alpha(K)\text{exp}\leq 0.013$ (1994Ki01). $A_2=+0.03$ 13, $A_4=-0.17$ 15.
644.2 3	1052.82	17.2 10	E0+M1+E2	-3.5 +5-7	0.120& 5	$\alpha(K)\text{exp}=0.098$ 5, $\alpha(L)\text{exp}=0.0179$ 9 $\alpha(M)\text{exp}=0.0044$ 7 (1994Ki01). $A_2=-0.02$ 5, $A_4=+0.16$ 5.
644.8# 5	1515.6	10# 3	[E2]		0.01252	E_{γ} : 1994Ki01 report observation of a 4+ level at 1515, however, no depopulating transitions from such a level are given in their Table 5.
684.9# 4	1515.6	7.6# 7	[E2]		0.01095	E_{γ} : 1994Ki01 report observation of a 4+ level at 1515, however, no depopulating transitions from such a level are given in their Table 5.
698.9 2	831.00	22.1 11	E0+M1+E2	<-9	0.0498& 22	$\alpha(K)\text{exp}=0.0412$ 14, $\alpha(L)\text{exp}=0.0070$ 17 $\alpha(M)\text{exp}=0.0016$ 4 (1994Ki01). $A_2=+0.02$ 9, $A_4=+0.28$ 9.
736.3	736.3		E0			E_{γ} : from 1994Ki01.

Continued on next page (footnotes at end of table)

^{180}Ir ϵ Decay 1994Ki01,1992Bo19,1973HaVR (continued) $\gamma(^{180}\text{Os})$ (continued)

$E\gamma^\dagger$	E(level)	$I\gamma^{\ddagger b}$	Mult.§	δ^a	α	Comments
738.2	870.44	4.5 4	E0+M1+E2	+5.4 +36-17	0.0463& 42	$\alpha(\text{K})\text{exp}=0.041$ 4, $\alpha(\text{L})\text{exp}=0.0053$ 14 (1994Ki01). $A_2=-0.18$ 14, $A_4=+0.28$ 14.
788.3 2	1196.94	17 3	E0+M1+E2	+1.3 1	0.0154& 13	$I\gamma$: weighted average of values from 1994Ki01 and 1992Bo19. Other: $I\gamma=9.1$ 9 (1973HaVR). $\alpha(\text{K})\text{exp}=0.0154$ 13 (1994Ki01). $A_2=-0.15$ 8, $A_4=+0.09$ 9.
809.0 4	1604.1	3.2 14	E1+M2	+0.10 4	0.0034 5	$\alpha(\text{K})\text{exp}=0.015$ 3 (1994Ki01). $A_2=-0.19$ 15. δ : Other: 0.70 15 from $\alpha(\text{K})\text{exp}$.
831.5@	831.00	0.8@ 3	[E2]		0.00723	
870.5 3	870.44	17.6 4	E2		0.00657	$\alpha(\text{K})\text{exp}=0.0052$ 5 (1994Ki01).
890.7 2	1022.80	21.0 17	M1+E2	+8.8 +27-17	0.00638 11	$\alpha(\text{K})\text{exp}=0.0049$ 3, $\alpha(\text{L})\text{exp}=0.0008$ 2 (1994Ki01). $A_2=-0.11$ 6, $A_4=-0.11$ 6. δ : Other: >6 from $\alpha(\text{K})\text{exp}$.
920.9@	1052.82	3.0@ 2	[E2]		0.00586	
967.1@	1375.35	0.45@ 11	[E1]		0.00207	
969.9@	1379.02	0.25@ 11	[E2]		0.00528	$I\gamma$: from 1994Ki01. Others: $I\gamma=7.3$ 7 (1973HaVR).
997.0 4	1405.8	5.4 13	M1+E2	-2.4 4	0.0059 4	$\alpha(\text{K})\text{exp}=0.004$ (1994Ki01). $A_2=-0.36$ 19, $A_4=-0.05$ 12.
1064.7 4	1196.94	7.5 5	E2		0.00439	$I\gamma$: from 1994Ki01. Others: 17 2 (1992Bo19), 14.4 14 (1973HaVR). $\alpha(\text{K})\text{exp}=0.0032$ 3 (1994Ki01). $A_2=+0.12$ 10, $A_4=+0.04$ 11.
1106.4 4	1514.98	4.6 4	E1+M2	+0.17 +4-0	0.0022 3	$\alpha(\text{K})\text{exp}=0.0025$ 11 (1994Ki01). $A_2=+0.14$ 11. δ : Other: 0.28 13 from $\alpha(\text{K})\text{exp}$.
1195.4@	1604.1	0.6@ 3	E1(+M2)	+0.1 3	0.0016 21	Mult., δ : from the Adopted Gammas.
1243.0@	1375.35	1.8@ 1	[E1]		1.35×10^{-3}	

† Weighted average of values from 1994Ki01, 1992Bo19, and 1973HaVR, uncertainties for 1994Ki01 assumed similar to those of 1992Bo19.

‡ Weighted average of values from 1994Ki01, 1992Bo19, and 1973HaVR, except where noted.

§ From conversion electron data in 1994Ki01, except where noted.

From 1992Bo19.

@ From 1994Ki01.

& From sum of $\alpha(\text{K})\text{exp}$, $\alpha(\text{L})\text{exp}$, and $\alpha(\text{M})\text{exp}$.

^a From $\gamma\gamma(\theta)$ in 1994Ki01.

^b For absolute intensity per 100 decays, multiply by 0.52 3.

¹⁸⁰Ir ε Decay 1994Ki01,1992Bo19,1973HaVR (continued)

¹⁸⁴Pt α Decay 1995Bi01

Parent ¹⁸⁴Pt: E=0.0; Jπ=0⁺; T_{1/2}=17.3 min 2; Q(g.s.)=4598 8; %α decay=1.7×10⁻³ 7.
 α branching=0.0017% 7 was obtained by 1995Bi01. %α=0.0010 was adopted by 1989Fi11 from the earlier measurements of 1963Gr08 and 1966Si08.

¹⁸⁰Os Levels

E(level)	Jπ
0.0	0+

α radiations

Eα	E(level)	Iα [‡]	HF [†]	Comments
4502 10	0.0	94 6	1.0	Eα: measured by 1995Bi01. Eα=4490 15 is adopted in 1989Fi11 from Eα=4480 20 and 4500 20 measured by 1963Gr08 and 1966Si08, respectively. Iα: only one α group has been observed. Iα deduced by evaluator assuming by assuming that hindrance factors for possible α's to the first 2+, 132 level and the second 0+, 736 level should be larger than that for the 4502-keV α giving Iα(4373α to 2+)<12.3, Iα(3771α to 0+ at 736)<0.0004 per 100 α decays. Iα(4502α)=94 6 (Iα>87.8) per 100 α decays is used to calculate the radius parameter.

[†] r₀(¹⁸⁰Os)=1.536 31 is calculated by requiring HF(4502α)=1.0.

[‡] For α intensity per 100 decays, multiply by 1.7×10⁻⁵ 7.

$^{48}\text{Ti}(^{136}\text{Xe},4n\gamma)$ 1985Pe07

$E(^{136}\text{Xe})=622$ MeV. Measured $E\gamma$, $I\gamma$, $\gamma\gamma$, $\gamma\gamma(t)$ of delayed transitions using the recoil shadow technique with a ^{208}Pb catcher foil and an array of two Ge(Li) detectors and ten NaI detectors. Delayed transitions were investigated in the 110 ns time window between the 1 ns beam bursts.

 ^{180}Os Levels

$\gamma\gamma(t)$ data showed the existence of two isomeric states feeding the observed levels, one with $T_{1/2}=130$ ns and $J\geq 18$ which feeds the states with $J=10-18$ and another with $T_{1/2}=20$ ns and $J\geq 8$ which feeds lower-spin states.

$E(\text{level})^\dagger$	$J\pi^\ddagger$	$E(\text{level})^\dagger$	$J\pi^\ddagger$	$E(\text{level})^\dagger$	$J\pi^\ddagger$
0.0 §	0+	1770.2 §	10+	2879 §	14+
132.9 §	2+	1864.6	7-	2983	13-
409.9 §	4+	2178.1	9-	3477	15-
796.6 §	6+	2311.7 §	12+	3499 §	16+
1259.4 §	8+	2547	11-	4139 §	18+

† From a least-squares fit to $E\gamma$ by evaluator.

‡ From the Adopted Levels.

§ g.s. band.

 $\gamma(^{180}\text{Os})$

All γ 's presented in 1985Pe07 are ascribed to the $T_{1/2}=130$ ns isomer decay. In addition, the γ 's originating from below the 8+ level of the g.s. band were found to have a $T_{1/2}=20$ ns component.

$E\gamma$	$E(\text{level})$	$I\gamma$	$E\gamma$	$E(\text{level})$	$I\gamma$	$E\gamma$	$I\gamma$
132.9	132.9	49 10	541.5	2311.7	48 3	^x 699.1	9 2
277.0	409.9	105 5	566.8	2879	33 3	^x 832.5	7 2
^x 287.0		14 2	^x 577.4		12 2	^x 891.9	7 2
313.5	2178.1	11 2	598.2	3477	8 2	^x 902.7	8 2
368.9	2547	9 2	605.2	1864.6	8 2	^x 969.4	6 2
386.7	796.6	95 5	620.5	3499	16 2	^x 997.7	4 1
462.8	1259.4	80 5	639.4	4139	10 2	^x 1426.8	6 2
493.7	3477	12 2	^x 645.9		6 2		
510.8	1770.2	72 4	671.8	2983	7 2		

^x γ ray not placed in level scheme.

 $^{150}\text{Nd}(^{36}\text{S},6n\gamma), ^{150}\text{Nd}(^{34}\text{S},4n\gamma)$ 1999Li03,1990Ka11

1999Li03: $E(^{36}\text{S})=177$ MeV. Measured $E\gamma$, $I\gamma$, $\gamma\gamma$, $\gamma\gamma(0)(\text{DCO})$ using OSIRIS and GASP arrays. The OSIRIS array consisted of 12 Compton-suppressed Ge detectors and 48 BGO crystals. The GASP array consisted of 40 Compton-suppressed Ge detectors and 80 BGO inner-ball detectors.

1990Ka11: $E(^{34}\text{S})=157$ MeV. Measured $E\gamma$, $I\gamma$ with an intrinsic Ge detector at 0° in coincidence with an 8-element Na(Tl) Sum Spectrometer; deduced $T_{1/2}$ using the Recoil-Distance method and the Argonne plunger device.

Other: 1987Rz01 using $^{150}\text{Nd}(^{34}\text{S},4n\gamma)$ measured $E\gamma$ - $E\gamma$ correlations with an array of six Compton-suppressed Ge detectors; suggested superdeformation at high spins with an axis ratio of 1.76.

 ^{180}Os Levels

$E(\text{level})^\dagger$	$J\pi^\ddagger$	$T_{1/2}^\S$	Comments
0.0@	0+		
132.00@ 20	2+	0.80 ns +21-14	
408.5@ 3	4+	27.0 ps 35	
794.7@ 3	6+	6.7 ps 17	
830.9 5	2+		
1257.1@ 4	8+	6.9 ps 14	
1514.6 5	4+		
1514.9 § 6	4-		
1604.9 ^c 4	5-		
1761.8 § 5	6-		
1766.6@ 4	10+		

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$^{150}\text{Nd}(^{36}\text{S},6n\gamma), ^{150}\text{Nd}(^{34}\text{S},4n\gamma)$ 1999Li03,1990Ka11 (continued) ^{180}Os Levels (continued)

E(level) [†]	J $\pi^{\ddagger}$	T _{1/2} [§]	Comments
1862.9 ^c 4	7-		
1877.2 4	6+		
1928.2 ^{&} 4	7-	17 ns 3	T _{1/2} : from 1999Li03.
1987.0 ^a 6	8-		
2086.7 ^g 5	8-		
2113.0 ^{&} 6	9-		
2176.1 ^c 4	9-		
2276.1 ^a 6	10-		
2285.6 ^b 4	(9-)		
2308.0 [@] 4	12+		
2428.8 ^f 10	(7+)		
2463.2 ^g 5	10-		
2467.5 ^{&} 6	11-		
2545.5 ^c 4	11-		
2598.7 ^f 8	(9+)		
2674.7 ^b 4	(11-)		
2684.0 ^a 6	12-		
2695.1 ^h 6	12+		
2874.3 [@] 5	14+		
2914.7 ^f 6	(11+)		
2918.9 ^g 5	12-		
2919.8 ^{&} 6	13-		
2983.3 ^c 5	13-		
3007.1 ^h 5	14+		
3138.5 ^b 5	(13-)		
3176.6 ^a 6	14-		
3341.7 ^f 8	(13+)		
3401.9 ^h 5	16+		
3443.7 ^{&} 6	15-		
3450.9 ^g 6	14-		
3477.5 ^c 5	15-		
3493.7 ⁱ 5	16+		
3656.0 ^b 5	(15-)		
3704.3 ^e 7	(11)-	≤5 ns [#]	
3735.2 ^a 6	16-		
3856.2 ^d 8	(12)-		
3885.2 ^f 10	(15+)		
3925.0 ^h 5	18+		
3982.8 ^c 5	17-		
4026.7 ^g 8	16-		
4031.7 ^{&} 6	17-		
4038.0 ^e 8	(13)-		
4133.4 ⁱ 6	18+		
4200.1 ^b 5	(17-)		
4249.0 ^d 8	(14)-		
4342.7 ^a 7	18-		
4487.1 ^e 8	(15)-		
4498.0 ^c 6	19-		
4530.1 ^f 11	(17+)		
4541.7 ^h 6	20+		
4598.9 ^g 9	18-		
4651.8 ^{&} 8	19-		
4751.2 ^d 9	(16)-		
4769.2 ^b 6	(19-)		
4820.2 ⁱ 6	20+		
4978.2 ^a 8	20-		
5037.7 ^e 9	(17)-		
5046.0 ^c 6	21-		
5163.8 ^g 10	20-		
5235.5 ^h 6	22+		
5253.4 ^f 12	(19+)		
5294.1 ^{&} 9	21-		
5348.5 ^d 9	(18)-		

Continued on next page (footnotes at end of table)

$^{150}\text{Nd}(^{36}\text{S},6n\gamma), ^{150}\text{Nd}(^{34}\text{S},4n\gamma)$ 1999Li03,1990Ka11 (continued) **^{180}Os Levels (continued)**

E(level) [†]	$J\pi^{\ddagger}$	E(level) [†]	$J\pi^{\ddagger}$	E(level) [†]	$J\pi^{\ddagger}$
5386.5 ^b 6	(21-)	6770.3 ^b 9	(25-)	8553.6 ^h 12	30+
5549.5 ⁱ 8	22+	6822.6 ^f 14	(23+)	8571.8 ^f 16	(27+)
5625.7 ^a 10	22-	7031.2 ^a 12	26-	8740.2 ^a 14	30-
5667.6 ^c 6	23-	7143.7 ⁱ 10	26+	8917.1 ⁱ 13	30+
5787.0 ^g 12	22-	7180.2 ^c 9	27-	9022.4 ^c 12	31-
5951.2 ^{&} 10	23-	7289.3 ^g 14	26-	9218.1 ^b 13	(31-)
5980.4 ^h 8	24+	7430.2 ^{&} 13	27-	9275.8 ^{&} 14	31-
6023.5 ^f 13	(21+)	7533.2 ^b 11	(27-)	9595.0 ^h 13	32+
6054.4 ^b 8	(23-)	7614.3 ^h 11	28+	9717.8 ^a 15	32-
6298.4 ^a 11	24-	7663.5 ^f 15	(25+)	9844.4 ⁱ 14	32+
6322.4 ⁱ 9	24+	7842.9 ^a 13	28-	10050.2 ^c 13	33-
6378.5 ^c 8	25-	8013.4 ⁱ 12	28+	10149.9 ^b 14	(33-)
6495.2 ^g 13	24-	8064.1 ^c 11	29-	10736.7 [?] h 14	34+
6652.1 ^{&} 12	25-	8302.3 ^{&} 14	29-	11144.7 [?] b 15	(35-)
6766.1 ^h 9	26+	8346.3 ^b 12	(29-)		

[†] From a least-squares fit to $E\gamma$ by evaluator.[‡] As proposed in 1999Li03 based on DCO ratios, assumed band structure, and γ -decay pattern.[§] From Recoil-Distance method in 1990Ka11, except where noted.# From $\gamma\gamma(t)$ in 1999Li03.

@ (A): g.s. band.

& (B): ($\pi=-, \alpha=1$), AE to AEBC.a (C): ($\pi=-, \alpha=0$), AF to AFBC.b (D): ($\pi=-, \alpha=1$), AG to AGBC or ABCG to ABCGEF.c (E): ($\pi=-, \alpha=1$), BF to BFAD.d (F): ($\nu 7/2[633]\nu 7/2[514]$) _{γ} ($\pi 9/2[514]\pi 1/2[541]$) ($\pi=-, \alpha=0$).e (G): ($\nu 7/2[633]\nu 7/2[514]$) _{γ} ($\pi 9/2[514]\pi 1/2[541]$) ($\pi=-, \alpha=1$).f (H): ($\pi=+, \alpha=1$), AC to ACEF.g (I): ($\pi=-, \alpha=0$), BE to BEAD.h (J): ($\pi=+, \alpha=0$), ground band to AB, AB to ABEF.i (K): ($\pi=+, \alpha=0$), ground band to BC, BC to BCEF. $\gamma(^{180}\text{Os})$

R(DCO) from 1999Li03 using OSIRIS spectrometer. With detector setup R(DCO) is defined as 1 for stretched quadrupole or unstretched pure dipole transitions and 0.66 for stretched pure dipole or unstretched pure quadrupole transitions.

$E\gamma^{\ddagger}$	E(level)	$I\gamma^{\ddagger}@$	Mult. #	$\delta^{\#}$	Comments
51.7	1928.2				$E\gamma$: from 1989Kr01.
(59)	1987.0				
111.3 5	2285.6	1.5 5			
126.0 5	2113.0	1.1 3	D		DCO=0.33 14.
132.0 2	132.00	63 7	Q		DCO=1.07 20.
151.9 5	3856.2	0.6 2	(D+Q)		DCO=1.0 4.
163.1 5	2276.1	1.0 3	D		DCO=0.34 10.
169.9 5	2598.7	0.2 1			
181.5 5	4038.0	1.5 5			
184.0 5	2113.0	1.2 4			
191.9 5	2467.5	0.9 3	D		DCO=0.28 20.
210.6 5	4249.0	0.8 3			
217.1 5	2684.0	0.8 3	D		DCO=0.32 17.
223.5 5	2086.7	0.6 2	D(+Q)		DCO=0.87 16.
235.8 5	2919.8	0.9 3	D		DCO=0.42 11.
238.2 5	4487.1	0.6 2			
247.5 5	1761.8	0.7 2	Q		DCO=0.9 3.
256.6 5	3176.6	0.9 3	D		DCO=0.3 3.
258.0 5	1862.9	7.6 23			
263.8 5	4751.2	0.9 3			
266.7 5	3443.7	1.0 3	D		DCO=0.42 22.
276.3 2	408.5	100 10	Q		DCO=1.03 6.
286.8 5	5037.7	0.9 3			

Continued on next page (footnotes at end of table)

$^{150}\text{Nd}(^{36}\text{S},6\text{n}\gamma), ^{150}\text{Nd}(^{34}\text{S},4\text{n}\gamma)$ 1999Li03,1990Ka11 (continued) $\gamma(^{180}\text{Os})$ (continued)

$E\gamma^\dagger$	E(level)	$I\gamma^\ddagger@$	Mult.#	$\delta^\#$	Comments
287.8 5	2463.2	1.0 3			
289.1 5	2276.1	2.4 7	Q		DCO=0.89 15.
290.2 5	3735.2	0.9 3			
295.8 5	4031.7	1.2 4			
311.3 5	4342.7	0.1 1			
	5348.5	0.7 2			
312.1 5	3007.1	2.6 8			
313.1 2	2176.1	10.6 11	Q		DCO=1.19 16.
316.0 5	2914.7	0.3 1	Q		DCO=1.00 17.
322.8 5	1928.2	1.9 6	(Q)		DCO=0.8 3.
324.9 5	2086.7	4.2 13	Q		DCO=0.93 13.
333.7 5	4038.0	1.4 4			
353.6 5	2467.5	4.1 12	Q		DCO=0.94 8.
363.2 5	1877.2	1.3 4			
368.5 2	2545.5	16.0 16	Q		DCO=1.04 12.
373.7 5	2918.9	0.7 2			
376.2 5	2463.2	5.1 15	Q		DCO=1.14 21.
386.2 2	794.7	93 9	Q		DCO=1.02 7.
387.2 5	2695.1	3.7 11			
389.3 2	2674.7	10.2 10	Q		DCO=0.84 12.
393.2 5	4249.0	0.6 2			
395.1 2	3401.9	13.2 13	Q		DCO=0.97 10.
407.3 5	2684.0	4.2 13	Q		DCO=0.93 8.
408.6 5	2176.1	2.8 8	D		DCO=0.74 22.
422.8 5	2285.6	6.4 19			
427.0 5	3341.7	1.1 3	Q		DCO=0.83 19.
437.8 2	2983.3	17.6 18	Q		DCO=1.03 14.
449.1 5	4487.1	0.8 3			
451.4 5	2919.8	8.6 26	Q		DCO=1.09 7.
456.1 5	2918.9	4.2 13	Q		DCO=1.12 24.
462.3 2	1257.1	99 10	Q		DCO=0.95 7.
464.1 2	3138.5	13.9 14			
466.9 5	3450.9	0.7 2			
492.8 5	3176.6	7.6 23	Q		DCO=0.99 11.
494.4 2	3477.5	14.8 15	Q		DCO=1.01 15.
499.8 5	2674.7	0.6 2			
502.2 5	4751.2	2.0 6			
505.3 2	3982.8	10.2 10	Q		DCO=0.98 14.
510.0 2	1766.6	91 9	Q		DCO=0.98 6.
515.2 2	4498.0	18.5 19	Q		DCO=1.12 22.
517.5 2	3656.0	20.5 21	Q		DCO=1.12 7.
523.1 2	3925.0	19.4 20	Q		DCO=0.99 5.
523.8 2	3443.7	11.0 11	Q		DCO=1.03 9.
527.3 2	3401.9	29 3	Q		DCO=0.95 7.
532.7 5	3450.9	4.1 12	Q		DCO=0.86 22.
538.9 5	3982.8	4.3 13	Q		DCO=1.13 25.
541.2 2	2308.0	76 8	Q		DCO=1.13 7.
543.5 5	3885.2	4.2 13	Q		DCO=0.9 3.
544.1 2	4200.1	18.1 18	Q		DCO=1.15 7.
548.0 2	5046.0	15.6 16	Q		DCO=0.89 13.
550.8 5	5037.7	0.2 1			
554.9 5	4031.7	2.7 8	Q		DCO=1.02 23.
558.9 5	3735.2	9.2 9	Q		DCO=0.89 14.
564.9 5	5163.8	3.8 11			
566.1 2	2874.3	62 6	Q		DCO=1.08 8.
569.1 2	4769.2	15.4 15	Q		DCO=1.03 11.
572.2 5	4598.9	4.0 12	Q		DCO=0.96 19.
575.8 5	4026.7	5.2 16	Q		DCO=1.08 19.
588.3 5	4031.7	7.1 21	Q		DCO=0.93 11.
591.8 5	3138.5	1.0 3			
596.8 5	5348.5	3.5 11			
604.7 5	1862.9	8.7 26	D		DCO=0.64 7.
607.2 5	4342.7	8.6 25	Q		DCO=1.08 11.

Continued on next page (footnotes at end of table)

$^{150}\text{Nd}(^{36}\text{S},6n\gamma), ^{150}\text{Nd}(^{34}\text{S},4n\gamma)$ 1999Li03,1990Ka11 (continued) $\gamma(^{180}\text{Os})$ (continued)

$E\gamma^\dagger$	E(level)	$I\gamma^\ddagger @$	Mult.#	$\delta^\#$	Comments
616.7 2	4541.7	16.8 17	Q		DCO=1.01 7.
617.3 2	5386.5	14.1 14	Q		DCO=1.01 16.
619.4 2	3493.7	21.6 22	Q		DCO=1.01 6.
620.1 5	4651.8	8.2 25	Q		DCO=0.91 17.
621.6 2	5667.6	13.1 13	Q		DCO=0.91 16.
623.2 5	5787.0	4.3 13			
635.5 5	4978.2	6.9 21	Q		DCO=0.96 18.
639.7 2	4133.4	17.9 18	Q		DCO=1.02 7.
642.3 5	5294.1	7.2 22	Q		DCO=1.10 15.
644.9 5	4530.1	6.0 6	Q		DCO=1.11 21.
647.5 5	5625.7	7.0 21	(Q)		DCO=0.85 21.
657.1 5	5951.2	3.5 11	Q		DCO=1.0 3.
667.9 5	6054.4	7.5 23	Q		DCO=1.0 3.
670.2 5	1928.2	0.6 2			
672.7 5	6298.4	6.3 19			
684.7 5	1514.6	0.8 3			
686.8 2	4820.2	12.9 13	Q		DCO=0.97 14.
693.8 2	5235.5	13.9 14	Q		DCO=1.04 10.
699.4 2	3007.1	11.8 12	Q		DCO=1.06 17.
699.8 5	830.9	0.6 2			
700.9 5	6652.1	1.5 5			
708.2 5	6495.2	3.3 10			
710.9 5	6378.5	7.6 23	Q		DCO=0.94 25.
715.9 5	6770.3	4.8 14			
723.3 5	5253.4	2.3 7	(Q)		DCO=0.78 15.
729.3 5	5549.5	8.2 25	Q		DCO=1.05 17.
732.8 5	7031.2	4.3 13			
744.9 5	5980.4	9.8 10	Q		DCO=1.08 18.
762.9 5	7533.2	3.0 9			
770.1 5	6023.5	2.9 9	(Q)		DCO=0.9 4.
772.8 5	6322.4	8.4 25	(Q)		DCO=0.8 4.
778.1 5	7430.2	2.1 6			
783.5 5	2545.5	0.7 2	D		DCO=0.6 3.
785.7 5	6766.1	6.4 19	Q		DCO=1.1 3.
794.1 5	7289.3	0.9 3			
799.1 5	6822.6	1.2 4			
801.7 5	7180.2	5.1 15			
810.0 5	1604.9	3.0 9	D		DCO=0.76 23.
811.7 5	7842.9	1.6 5			
813.1 5	8346.3	1.5 5			
821.3 5	7143.7	4.1 12			
829.7 5	3138.5	4.2 13			
840.9 5	7663.5	1.3 4			
848.2 5	7614.3	7.4 22			
869.7 5	8013.4	1.7 5			
871.8 5	9218.1	0.6 2			
872.1 5	8302.3	0.5 2			
883.9 5	8064.1	1.5 5			
$\times 895^\S$					
897.3 5	8740.2	1.7 5			
903.7 5	8917.1	0.8 3			
907.7 5	2674.7	4.9 15	D		DCO=0.7 3.
908.2 5	8571.8	0.8 3			
919.0 5	2176.1	2.6 8			
927.3 5	9844.4	0.6 2			
931.8 5	10149.9	0.6 2			
939.3 5	8553.6	1.4 4			
$\times 948^\S$					
958.3 5	9022.4	1.3 4			
966.8 5	1761.8	1.1 3	D		DCO=1.6 6.
973.5 5	9275.8	0.2 1			
977.5 5	9717.8	0.3 1			
994.8& 5	11144.7?	0.4 1			

Continued on next page (footnotes at end of table)

$^{150}\text{Nd}(^{36}\text{S},6\text{n}\gamma), ^{150}\text{Nd}(^{34}\text{S},4\text{n}\gamma)$ 1999Li03,1990Ka11 (continued) $\gamma(^{180}\text{Os})$ (continued)

$E\gamma^\dagger$	E(level)	$I\gamma^\ddagger@$	Mult.#	$\delta^\#$	Comments
^x 1004§					
1020.2 5	3704.3	1.1 3	D(+Q)	-0.5 +2-20	DCO=0.38 13.
1027.8 5	10050.2	1.0 3			
1027.9 5	2285.6	2.9 9			
1041.4 5	9595.0	0.5 2			
^x 1077§					
1082.1 5	1877.2	0.2 1			
1106.4 5	1514.9	0.2 1			
1133.8 5	1928.2	1.3 4			
1141.7& 5	10736.7?	0.2 1			
1148.1 5	2914.7	0.1 1			
1196.1 5	1604.9	0.5 2			
1236.9 5	3704.3	0.6 2	D(+Q)		DCO=1.9 7.
1468.6 5	1877.2	0.1 1			

[†] Uncertainty assigned by evaluator as 0.2 keV for $I\gamma>10$ and 0.5 keV for $I\gamma<10$, based on a general statement by 1999Li03.

[‡] Uncertainty assigned by evaluator as 10% for $I\gamma>10$ and 30% for $I\gamma<10$, based on a general statement by 1999Li03.

§ In coincidence with Band(K).

From R(DCO) in 1999Li03.

@ From the $^{150}\text{Nd}(^{36}\text{S},6\text{n}\gamma)$ reaction at $E(^{36}\text{S})=177$ MeV; normalized to $I\gamma(276\gamma)=100$.

& Placement of transition in the level scheme is uncertain.

^x γ ray not placed in level scheme.

 $^{150}\text{Nd}(^{36}\text{S},6\text{n}\gamma)$: Delayed 1993Ve01

$E(^{36}\text{S})=177$ MeV. Measured $E\gamma$, $I\gamma$, $\gamma\gamma$, $\gamma\gamma(t)$, beam- $\gamma(t)$ in time range of 37–83 ns (beam pulsed every 90 ns) using 12 Compton-suppressed HPGe detectors and a sum-energy and γ -ray multiplicity filter of 48 BGO scintillators.

 ^{180}Os Levels

An additional isomer with $T_{1/2}=41$ ns 10 was observed which de-excites by 108.6, 566.2, 665.8, 700, and 1073.4 γ -ray transitions. Due to low-statistics the position and exact de-excitation pattern could not be determined.

$E(\text{level})^\dagger$	$J\pi^\ddagger$	$T_{1/2}^\S$	Comments
0.0	0+		
132.17 23	2+		
408.7 3	4+		
795.1 3	6+		
831.2 4	2+		
870.43 23	2+		
1023.1 3	3+		
1052.5 3	4+		
1196.8 3	4+		
1257.6 3	8+		
1378.8 3	6+		
1405.6 3	5+		
1515.7 3	4+		
1604.4 3	5-		
1627.3 3	6+		
1767.9 11	10+		
1862.6 3	7-	17 ns 3	$T_{1/2}$: isomeric nature of this level is not confirmed in subsequent studies.
1877.1 3	6+		
1928.8 3	7-	26 ns 3	
2175.8 11	9-		
2309.1 13	12+		
2544.6 15	11-		
2696.0 13	12+		
2875.2 15	14+		
2982.4 18	13-		
3008.1 14	14+		

Continued on next page (footnotes at end of table)

$^{150}\text{Nd}(^{36}\text{S},6n\gamma)$: Delayed 1993Ve01 (continued) **^{180}Os Levels (continued)**

$E(\text{level})^\dagger$	$J\pi^\ddagger$	$T_{1/2}^\S$	Comments
3402.5 16	16+		
3476.9 20	15-		
3494.9 18	16+		
3925.8 19	18+		
3982.5 23	17-		
4134.9 21	18+		
4498.0 25	19-		
4542.9 21	20+		
5561.9 23			
5849 3		12 ns 4	E(level): level and its isomeric character not observed in either $^{150}\text{Nd}(^{36}\text{S},6n\gamma)$, $^{150}\text{Nd}(^{34}\text{S},4n\gamma)$ or $^{166}\text{Er}(^{18}\text{O},4n\gamma)$, $^{168}\text{Er}(^{16}\text{O},4n\gamma)$ reactions and thus not included in the Adopted Levels. J π : ≥ 20 from the assumption that the 286.8 γ and 1427 γ are both $\Delta J=1$ character.

† From a least-squares fit to $E\gamma$ by evaluator. $\Delta E\gamma=1$ keV assumed when not given.

‡ From the Adopted Levels.

§ From beam- $\gamma(t)$ measurements. Results are confirmed by $\gamma\gamma(t)$ analysis.

 $\gamma(^{180}\text{Os})$

$E\gamma^\dagger$	$E(\text{level})$	$I\gamma^\dagger$	Comments
51.7	1928.8		E γ : included in Fig. 5 of 1993Ve01, but not in Table 1.
132.2 3	132.17	65 13	
235.5 3	1862.6	2.1 7	
258.0 3	1862.6	3.5 11	
276.4 3	408.7	53 8	
286.8	5849		
301.6 5	1928.8	1.7 6	
312.0	3008.1		
313.2	2175.8		
318.7 5	1515.7	1.1 4	E γ : placed from 1514.6-keV level in Adopted Levels.
324.4 3	1928.8	6.3 11	
326.4 3	1378.8	1.3 4	
326.5 8	1196.8	≤ 0.2	
361.4 3	1877.1	7.6 13	
368.8	2544.6		
382.5 3	1405.6	1.7 5	
386.3 3	795.1	36 6	
387.0	2696.0		
394.4	3402.5		
407.6 3	1604.4	3.9 7	
430.6 3	1627.3	1.0 4	
437.8	2982.4		
461.8 5	870.43	1.2 6	
462.4 3	1257.6	13.3 20	
471.3 3	1877.1	3.3 7	
483.4 5	1862.6	≤ 0.6	E γ : placed from 1514.6-keV level in Adopted Levels.
492.8 3	1515.7	4.8 9	
494.5	3476.9		
498.4 5	1877.1	1.1 9	
505.6	3982.5		
510.3	1767.9		
515.5	4498.0		
523.3	3925.8		
527.3	3402.5		
541.2	2309.1		
550.0 3	1928.8	2.6 5	
566.2	2875.2		
583.6 3	1378.8	2.2 5	
604.9 3	1862.6	4.2 7	
610.3 3	1405.6	2.3 5	
614.4 5	1023.1	1.7 7	

Continued on next page (footnotes at end of table)

$^{150}\text{Nd}(^{36}\text{S},6n\gamma)$: Delayed 1993Ve01 (continued) **$\gamma(^{180}\text{Os})$ (continued)**

$E\gamma^\dagger$	E(level)	$I\gamma^\dagger$	Comments
617.1	4542.9		
619.7	3494.9		
640.0	4134.9		
643.9 5	1052.5	2.2 4	
645.0 3	1515.7	2.6 5	
671.1 3	1928.8	3.6 5	
680.2 5	1877.1	≤ 0.6	
684.5	1515.7		E γ : included in Fig. 5 of 1993Ve01, but not in Table 1.
699.0 3	831.2	2.7 7	
699.0	3008.1		
738.0 3	870.43	1.4 6	
788.0 3	1196.8	2.5 6	
809.2 3	1604.4	3.0 6	
824.6 3	1877.1	0.9 5	
832.4 3	1627.3	0.9 5	
870.4 3	870.43	3.8 11	
891.0 3	1023.1	4.1 6	
928.0	2696.0		
996.9 3	1405.6	4.2 6	
1064.7 3	1196.8	1.7 6	
1082.1 3	1877.1	3.9 6	
1107.2 5	1515.7	1.5 5	E γ : placed from 1514.6-keV level in Adopted Levels.
1133.8 3	1928.8	4.9 7	
1195.8 5	1604.4	0.9 6	
1218.7 3	1627.3	0.7 6	
1383.8 3	1515.7	1.5 7	
1427.0	5561.9		
1468.5 3	1877.1	3.4 7	

† 1993Ve01 provide detailed information only for γ -rays de-exciting the 7- isomers at 1863 keV and 1929 keV. γ -rays observed from the depopulation of the higher spin isomers are given in Fig. 1 of 1993Ve01 with no details on $\Delta E\gamma$ or $I\gamma$.

 $^{166}\text{Er}(^{18}\text{O},4n\gamma), ^{168}\text{Er}(^{16}\text{O},4n\gamma)$ 1988Li02,1990Dr02,2005Mo33

2005Mo33: E(^{16}O)=80 MeV. Measured E γ , $I\gamma$, deduced $T_{1/2}$ using delayed coincidence method with a pulsed beam. γ -rays detected with a low-energy photon (LEP) Ge detector positioned at 0° to the beam direction.

1990Dr02: E(^{16}O)=87 MeV. Measured E γ , $I\gamma$, E(ce), I(ce) using a Compton-suppressed Ge detector and a superconducting, solenoidal electron spectrometer operated in lens mode coupled to a cooled Si(Li) detector (FWHM=2.6 keV); determined $\alpha(\text{K})$, $\alpha(\text{L})$, and $\alpha(\text{M})$ coefficients.

1988Li02: E(^{18}O)=85 MeV. Measured E γ , $I\gamma$, $\gamma\gamma$ coin, $\gamma(0)$, E(ce), I(ce) using five Compton-suppressed Ge detectors and a mini-orange electron spectrometer with a Si(Li) detector. A subset of results were published earlier in 1982Ne14 and 1982Ne01. A later work by the same first author using the $^{150}\text{Nd}(^{36}\text{S},6n\gamma)$ reaction (1999Li03) finds some discrepancies with the results presented in 1988Li02. Differences are noted in the comments, see also the $^{150}\text{Nd}(^{36}\text{S},6n\gamma), ^{150}\text{Nd}(^{34}\text{S},4n\gamma)$ dataset.

1982Dr03: E(^{16}O)=92 MeV. Measured E γ , $I\gamma$, $\gamma\gamma$ coin, $\gamma(0)$, $\gamma\gamma(t)$, E(ce), I(ce) using two Ge(Li) detectors (one with Compton-suppression), a LEPS detector, and a mini-orange spectrometer with a cooled Si(Li) detector.

Others: 1999ShZW, 1983Ne14, 1983Dr17, 1981Dr06, 1980Dr10.

 ^{180}Os Levels

E(level) †	$J\pi^\ddagger$	$T_{1/2}^\S$	Comments
0.0#	0+		
132.21# 24	2+	0.67 ns 7	
408.7# 3	4+		
795.1# 3	6+		
831.1h 3	2+		
870.40@ 24	2+		
1023.1@ 3	3+		
1052.6h 4	4+		

Continued on next page (footnotes at end of table)

$^{166}\text{Er}(^{18}\text{O},4n\gamma), ^{168}\text{Er}(^{16}\text{O},4n\gamma)$ 1988Li02,1990Dr02,2005Mo33 (continued) **^{180}Os Levels (continued)**

E(level) [†]	J $\pi^{\ddagger}$	T _{1/2} [§]	Comments
1196.8@ 3	4+		
1257.5# 3	8+		
1379.0h 3	6+		
1405.6@ 3	5+		
1514.6a 3	4-		
1515.6 3	4+		
1604.4c 3	5-		
1627.4@ 3	6+		
1761.3a 3	6-		
1767.9# 4	10+		
1862.6c 3	7-	≤ 0.21 ns	
1877.1 3	6+		
1881.2@ 4	7+		
1928.7& 3	7-	15.2 ns 14	T _{1/2} : from beam- $\gamma(t)$ using 1134 γ in 2005Mo33. Authors state a similar result is obtained by analysis of the long-lived components of the time distributions of the ground state band transitions. Other: 15.9 ns 21 from $\gamma\gamma(t)$ (1982Dr03). configuration: v7/2[633]v7/2[514].
1955.8fl 4	(8+)		
2055.0& 4	8-		
2086.2a 4	8-		
2175.9c 3	9-		
2217.8& 4	9-		
2276.7fl 4	(10+)		
2286.3d 4	7-		
2309.1# 4	12+		
2409.0& 4	10-		
2410.9@ 4	9+		
2428.7? 6			
2463.1a 4	10-		
2544.6c 4	11-		
2598.8g 5	(10+)		
2625.1& 4	11-		
2635.9b 4	8-		
2675.9d 4	9-		
2694.4f 4	(12+)		
2696.0kl 4			
2860.6& 5	12-		
2875.3# 4	14+		
2915.1g 4	(12+)		
2919.9a 4	12-		
2925.6b 4	10-		
2982.2c 4	13-		
3008.1e 4	14+j		
3118.2& 5	13-		
3139.3d 4	11-		
3200.4fl 4	(14+)		
3246.5b 4	12-		
3342.5g 5	(14+)		
3384.5& 5	14-		
3402.5e 5	16+i j		
3452.4a 5	14-		
3476.5c 4	15-		
3495.0# 5	16+		
3629.5b 4	14-		
3656.4d 5	13-		
3677.2& 5	15-		
3886.3g 6	(16+)		
3925.8e 5	18+j		
3973.2& 5	16-		
3982.1c 5	17-		
4027.8a 6	16-		
4067.8b 7	16-		
4135.0# 6	18+		

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$^{166}\text{Er}(^{18}\text{O},4n\gamma), ^{168}\text{Er}(^{16}\text{O},4n\gamma)$ 1988Li02,1990Dr02,2005Mo33 (continued) **^{180}Os Levels (continued)**

$E(\text{level})^\dagger$	$J\pi^\ddagger$	$E(\text{level})^\dagger$	$J\pi^\ddagger$	$E(\text{level})^\dagger$	$J\pi^\ddagger$
4200.5 ^d 6	15-	5551.7 [#] 10	(22+)	6972.1 ^{&} 12	(25-)
4284.3 ^{&} 6	17-	5567.7 ^{&} 7	21-	7018.7 ^{c1} 9	(27-)
4497.6 ^c 7	19-	5667.1 ^c 8	23-	7094.3 ^{#1} 16	(26+)
4531.8 ^g 7	(18+)	5731.8 ^b 11	(22-)	7149.6 ^{a1} 13	(26-)
4543.0 ^e 6	20+ ^j	5788.0 ^a 12	22-	7290.9 ^{&1} 11	(26-)
4581.3 ^b 7	18-	5893.6 ^{&} 8	22-	7531.4 ^{d1} 9	(25-)
4593.2 ^{&} 6	18-	5981.7 ^e 8	24+ ^j	7532.9 ^{g1} 14	(26+)
4599.7 ^a 6	18-	6023.9 ^g 12	(22+)	7544.9 ^{e1} 9	(28+) ^j
4770.6 ^d 7	17-	6055.5 ^d 8	(21-)	7616.7 ^{c1} 9	(29-)
4821.8 [#] 7	20+	6239.5 ^{&} 11	(23-)	7652.5 ^{&1} 14	(27-)
4920.2 ^{&} 6	19-	6324.2 [#] 13	(24+)	7821.3 ^{#1} 17	(28+)
5045.7 ^c 7	21-	6373.6 ^b 15	(24-)	8136.4 ^{7d1} 14	(27-)
5136.5 ^b 8	20-	6378.8 ^c 8	(25-)	8219.1 ^{7g1} 16	(28+)
5164.9 ^a 12	20-	6496.7 ^a 13	24-	8268.0 ^{e1} 9	(30+) ^j
5235.7 ^{&} 7	20-	6595.7 ^{&} 9	(24-)	8294.6 ^{7c1} 10	(31-)
5236.9 ^e 7	22+ ^j	6766.7 ^e 8	(26+) ^j	8554.0 ^{#1} 19	(30+)
5254.9 ^g 7	(20+)	6772.9 ^d 9	(23-)	9375.3 ^{7#1} 21	(32+)
5387.3 ^d 7	19-	6817.1 ^{g1} 13	(24+)		

[†] From a least-squares fit to $E\gamma$ by evaluator.[‡] Spin and parity assignments are based on measured γ -ray multiplicities, decay patterns, and assumed band structure.[§] From centroid shift technique in $^{168}\text{Er}(^{16}\text{O},4n\gamma)$ (2005Mo33), except where noted.[#] (A): $K\pi=0+$ g.s. rotational band.[@] (B): $K\pi=2+$ γ -vibrational band.[&] (C): $K\pi=7-$ rotational band. 1999Li03 in the $^{150}\text{Nd}(^{36}\text{S},6n\gamma)$ reaction, identify a new state at 1987-keV which is assigned as the 8- member of this band. As a result, the excited band members given here differ from those in the $^{150}\text{Nd}(^{36}\text{S},6n\gamma), ^{150}\text{Nd}(^{34}\text{S},4n\gamma)$ dataset and in the Adopted Levels by 59 keV and $\Delta J=1$.^a (D): Low K rotational band ($K=1-3$) with configuration $\nu 9/2[624]\nu 7/2[514]$ and strong mixing with either $\pi 5/2[402]\pi 9/2[514]$ or $\pi 5/2[402]\pi 1/2[541]$. $\alpha=0$.^b (E): $K\pi=8-$ rotational band. Configuration: $\nu 9/2[624]\nu 1/2[770]$.^c (F): Low K rotational band ($K=1-3$) with configuration $\nu 9/2[624]\nu 7/2[514]$ and strong mixing with either $\pi 5/2[402]\pi 9/2[514]$ or $\pi 5/2[402]\pi 1/2[541]$. $\alpha=1$.^d (G): $K\pi=7-$ rotational band.^e (H): Rotational band.^f (I): $K\pi=8+$ rotational band.^g (J): Rotational band.^h (K): $K\pi=0+$ β -vibrational band.ⁱ $J\pi=14+$ was originally assigned by 1988Li02 based on M1+E2 for 527γ . A measurement of the conversion electron spectrum with significantly better energy resolution suggested an E2 multipolarity for this γ -ray, and consequently, $J\pi=16+$ for this level (1990Dr02). See also 1983Ne14, 1983Dr17.^j Spin assignments from 1982Dr03. These differ from those proposed by 1988Li02 by $\Delta J=2$; see comment on 3403 level.^k Level decays by D(+Q) 928γ to $10+$, and is populated by Q 312γ from $14+$. Data are inconsistent.^l Level is not adopted based on results from 1999Li03 using the $^{150}\text{Nd}(^{36}\text{S},6n\gamma)$ reaction. $\gamma(^{180}\text{Os})$

$E\gamma^\dagger$	$E(\text{level})$	$I\gamma^\dagger$	Mult. [‡]	$\delta^\ddagger$	Comments
51.6 2	1928.7	7.2 18	E1		$E\gamma$: from 1982Dr03. $I\gamma$: from $I\gamma(51\gamma)/I\gamma(1134\gamma)=2.1\ 3$ (1982Dr03) and $I\gamma(1134\gamma)=3.5\ 7$ (1988Li02). Mult.: from $\alpha(\text{exp})$ deduced from intensity balance in 1982Dr03.
90.3 10	1604.4	0.3 2			
101.4 7	1862.6	0.1 1			
110.2 3	2286.3	0.5 3	Q		
126.3 3	2055.0	3.8 8	D+Q	-1.4 3	
132.2 3	132.21	61 4	Q		
153.1 5	3629.5	0.1 1	D+Q		
157.1 5	1761.3	0.5 3	D+Q	+0.25 12	
^x 158.9 3		0.2 1	D(+Q)	-0.10 10	
162.8 3	2217.8	2.5 5	D+Q	-0.94 16	

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$^{166}\text{Er}(^{18}\text{O},4n\gamma), ^{168}\text{Er}(^{16}\text{O},4n\gamma)$ $^{1988}\text{Li02}, ^{1990}\text{Dr02}, ^{2005}\text{Mo33}$ (continued) $\gamma(^{180}\text{Os})$ (continued)

$E\gamma^{\dagger}$	E(level)	$I\gamma^{\dagger}$	Mult. ‡	$\delta^{\ddagger}$	Comments
170.1 3	2598.8	0.7 3			
172.9 3	2635.9	0.1 1			
176.2 5	3629.5	0.2 1			
^x 176.5 3		0.3 2	D+Q		
191.1 3	2409.0	1.9 6	D+Q	-1.8 3	
202.4@ 6	3402.5	0.4 2			
216.1 3	2625.1	1.8 5	D+Q	-2.5 5	
^x 216.3 3		0.4 2			
220.7 3	2915.1	0.2 1			
223.0 5	2086.2	0.8 4	D+Q	+0.28 5	
225.3 3	1604.4	0.5 2			
235.3 3	1862.6	0.9 5			
235.5 3	2860.6	0.9 3	D+Q	-1.8 5	
246.8 3	1761.3	2.6 7	Q		
257.6 3	3118.2	0.5 2			
258.0 3	1862.6	4.4 10	Q		
264.4 3	3246.5	0.2 2			
266.3 3	3384.5	0.4 1	D+Q	-0.98 21	
276.4 3	408.7	124 9	E2		Mult.: from $\alpha(\text{L})\text{exp}=0.032\ 6$ (1982Dr03).
287.2 3	2463.1	0.6 2	D(+Q)	-0.07 20	
289.0 3	2217.8	4.7 9	Q		
289.9 3	2925.6	1.0 4			
292.5 3	3677.2	0.2 1	D+Q	-10 41	
295.8 3	3973.2	0.1 1	D+Q		
309.3 8	4593.2	0.1 1	D+Q	-5.5 23	
311.1 3	4284.3	0.1 1			
312.0 3	3008.1	0.9 3	(Q)		
313.2 3	2175.9	13.0 10	Q		
316.0 8	5235.7	0.1 1			
316.2 3	2915.1	2.4 4	Q		
320.9 5	2276.7	1.3 6			$E\gamma$: not reported in $^{150}\text{Nd}(^{36}\text{S},6n\gamma)$; not included in the Adopted Gammas.
321.0 3	3246.5	0.9 3	Q		
321.9 5	2598.8	0.6 4			
324.4 3	1928.7	2.5 5			
324.9 3	2086.2	6.2 10	Q		
325.2 3	3200.4	0.8 4			
326.4 5	1379.0	2.1 5	Q		
326.8# 5	3246.5	0.4# 2			
326.8# 8	4920.2	0.1# 1			
354.0 3	2409.0	7.1 12	Q		
355.9 3	1761.3	2.8 7	D		
361.4 3	1877.1	5.0 10	Q		
368.8 3	2544.6	10.3 10	Q		
375.1 3	2919.9	0.7 2	D+Q		
376.9 3	2463.1	5.3 8	Q		
380.9 3	2925.6	0.2 1			
382.5 3	1405.6	2.1 9	(Q)		
383.1 3	3629.5	1.1 3			
385.0@ 10	2694.4	0.7 5			
386.3 3	795.1	114 8	E2		Mult.: from $\alpha(\text{K})\text{exp}=0.033\ 6$ (1988Li02); $\alpha(\text{K})\text{exp}=0.033\ 5$, $\alpha(\text{L})\text{exp}=0.011\ 3$ (1982Dr03).
389.7 3	2675.9	3.5 12	Q		
^x 392.6 3		0.2 1			
394.4 3	3402.5	5.6 8	E2		Mult.: from $\alpha(\text{K})\text{exp}=0.028\ 6$ (1990Dr02).
407.4 3	2625.1	6.4 10	Q		
407.6 3	1604.4	3.4 8			
408.0 3	2175.9	2.7 7			
417.7 3	2694.4	1.8 5	Q		
^x 418.6 3		2.0 8			
423.6 3	2286.3	2.2 3	M1+E2	-0.40 20	Mult.: D+Q from $\gamma(0)$, M1+E2 from $\alpha(\text{K})\text{exp}=0.058\ 17$ (1988Li02). δ : Other: 0.9 +8-5 from $\alpha(\text{K})\text{exp}$.
427.4 3	3342.5	2.3 4	Q		

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$^{166}\text{Er}(^{18}\text{O},4n\gamma), ^{168}\text{Er}(^{16}\text{O},4n\gamma)$ **1988Li02,1990Dr02,2005Mo33 (continued)** $\gamma(^{180}\text{Os})$ (continued)

$E\gamma^{\dagger}$	E(level)	$I\gamma^{\dagger}$	Mult. ‡	$\delta^{\ddagger}$	Comments
430.6 3	1627.4	1.0 3			
437.8 3	2982.2	10.6 20	Q		
438.3 5	4067.8	1.7 5			
451.6 3	2860.6	6.6 11	Q		
456.7 3	2919.9	3.7 5	Q		
460.0 3	2635.9	0.3 1			
462.0@ 10	2925.6	0.3 2			
462.4 3	1257.5	76 6	E2		Mult.: from $\alpha(\text{K})\text{exp}=0.0197$ 9 (1990Dr02); $\alpha(\text{K})\text{exp}=0.025$ 6, $\alpha(\text{L})\text{exp}<0.009$ (1982Dr03); and $\alpha(\text{K})\text{exp}=0.019$ 3 (1988Li02).
463.1 10	3139.3	6.3 25			
470.5 10	3452.4	0.6 2	D+Q	+0.41 7	
471.3 3	1877.1	1.7 4			
475.5 3	1881.2	1.5 5	(Q)		
483.4 3	1862.6	2.1 4	D+Q	+0.09 8	
491.6 3	1514.6	1.8 6	D		
493.1 3	3118.2	5.7 10	Q		
494.5 3	3476.5	11.6 15	Q		
500.1 3	2675.9	1.8 5	D(+Q)	+0.10 20	
505.6 3	3982.1	5.9 15	Q		
506.1 3	3200.4	1.9 8			
508.7 3	2276.7	1.3 7			$E\gamma$: not reported in $^{150}\text{Nd}(^{36}\text{S},6n\gamma)$; not included in the Adopted Gammas.
510.3 3	1767.9	65 5	E2		Mult.: from $\alpha(\text{K})\text{exp}=0.014$ 1, $\alpha(\text{L1})\text{exp}+\alpha(\text{L2})\text{exp}=0.0027$ 3 (1990Dr02); $\alpha(\text{K})\text{exp}=0.019$ 7 (1988Li02).
513.5 3	4581.3	1.9 8	Q		
515.5 4	4497.6	5.5 10	Q		
517.1 3	3656.4	5.8 12	Q		
523.3 3	3925.8	13.5 20	(E2)		Mult.: from $\alpha(\text{K})\text{exp}(523\gamma \text{ doublet})=0.014$ 2 (1990Dr02); $\alpha(\text{K})\text{exp}=0.019$ 12 (1988Li02).
523.9 3	3384.5	5.0 11	(E2)		Mult.: from $\alpha(\text{K})\text{exp}(524\gamma \text{ doublet})=0.014$ 2 (1990Dr02); $\alpha(\text{K})\text{exp}=0.019$ 12 (1988Li02). Other: 1982Dr03.
527.3 3	3402.5	9.7 8	E2		Mult.: from $\alpha(\text{K})\text{exp}=0.015$ 2, $\alpha(\text{L})\text{exp}=0.004$ 1 (1990Dr02). $\alpha(\text{K})\text{exp}=0.050$ 15 measured by 1988Li02 is inaccurate because of contribution from nearby transitions to the conversion electron intensity, that could not be resolved in their measurement. Consequently, the M1+E2 multipolarity assigned by 1988Li02 seems to be incorrect. Other: 1982Dr03.
529.7 3	2410.9	1.6 5	Q		
532.2 3	3452.4	2.8 5	Q		
541.2 3	2309.1	44 3	E2		Mult.: from $\alpha(\text{K})\text{exp}=0.0131$ 4 (1990Dr02); $\alpha(\text{K})\text{exp}=0.016$ 3 (1988Li02); $\alpha(\text{K})\text{exp}=0.0166$ 21, $\alpha(\text{L})\text{exp}=0.0042$ 9 (1982Dr03).
543.8 3	3886.3	2.1 4	Q		
544.1 3	4200.5	4.6 10			
548.1 3	5045.7	4.4 15	Q		
549.7 3	2635.9	0.6 6	D+Q		
555.2 3	5136.5	1.1 4	Q		
559.1 3	3677.2	3.5 6	Q		
565.2 10	5164.9	2.0 5			
566.2 3	2875.3	34 3	E2		Mult.: from $\alpha(\text{K})\text{exp}=0.013$ 1, $\alpha(\text{L})\text{exp}=0.0029$ 2 (1990Dr02); $\alpha(\text{K})\text{exp}=0.014$ 2 (1982Dr03).
570.1 3	4770.6	4.0 7	Q		
571.9 3	4599.7	1.9 5	Q		
575.4 3	4027.8	2.5 5	Q		
583.6 3	1379.0	3.3 6	E0+M1(+E2)	-0.20 20	Mult.: from $\alpha(\text{K})\text{exp}=0.094$ 7 (1990Dr02); $\alpha(\text{K})\text{exp}=0.055$ 22 (1988Li02); $\alpha(\text{K})\text{exp}=0.090$ 9 (1982Dr03).
588.7 3	3973.2	2.3 3	Q		
594.7 5	3139.3	0.2 2			
595.3 8	5731.8	0.7 3			
597.9 3	7616.7	0.3 2	(Q)		
601.1 5	3476.5	1.0 5	D		
604.9 3	1862.6	6.4 11	E1(+M2)	+0.05 5	Mult.: from $\alpha(\text{K})\text{exp}<0.006$ (1982Dr03).

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$^{166}\text{Er}(^{18}\text{O},4n\gamma), ^{168}\text{Er}(^{16}\text{O},4n\gamma)$ **1988Li02,1990Dr02,2005Mo33 (continued)** $\gamma(^{180}\text{Os})$ (continued)

$E\gamma^\dagger$	E(level)	$I\gamma^\dagger$	Mult. ‡	$\delta^\ddagger$	Comments
605.0@ 10	8136.4?				
607.2 3	4284.3	3.0 6	Q		
616.7 3	5387.3	1.8 6			
617.1 3	4543.0	12.3 15	(E2)		Mult.: from $\alpha(\text{K})\text{exp}(620\gamma \text{ doublet})=0.010 \ 2$ (1988Li02); $\alpha(\text{K})\text{exp}=0.013 \ 2$ (1982Dr03).
619.7 3	3495.0	16.0 15	(E2)		Mult.: from $\alpha(\text{K})\text{exp}(620\gamma \text{ doublet})=0.010 \ 2$ (1988Li02); $\alpha(\text{K})\text{exp}=0.013 \ 2$ (1982Dr03).
619.9 3	4593.2	2.0 3			
621.4 3	5667.1	3.6 8			
623.1 3	5788.0	1.4 4	Q		
636.0 3	4920.2	1.7 4	Q		
639.9 3	7018.7	0.4 2			
640.0 3	4135.0	7.9 8	Q		
641.8 10	6373.6	0.4 2	(Q)		
642.3 5	5235.7	1.0 3			
643.9 3	1052.6	3.2 10	E0+M1+E2		Mult.: from $\alpha(\text{K})\text{exp}=0.081 \ 4$, $\alpha(\text{L})\text{exp}=0.0012 \ 1$ (1990Dr02); $\alpha(\text{K})\text{exp}=0.085 \ 25$ (1988Li02); $\alpha(\text{K})\text{exp}=0.094 \ 8$ (1982Dr03). $\delta=-0.8 \ 4$. $A_2=-0.10 \ 5$ suggests dipole (1988Li02).
645.0 3	1515.6	2.0 8	Q		
645.5 3	4531.8	1.7 4			
647.5 3	5567.7	1.0 3	Q		
647.6 5	3629.5	0.2 1			
652.9 3	7149.6	0.5 2	Q		
657.9 3	5893.6	0.4 2	Q		
668.2 3	6055.5	1.1 4	(Q)		
671.1 3	1928.7	2.4 6	(E1)		Mult.: E1 or E2 from $\alpha(\text{K})\text{exp}=0.006 \ 5$ (1988Li02), $\gamma(0)$ favors D.
671.8 8	6239.5	0.8 3			
673.2 3	2982.2	0.5 4	D		
677.9@ 3	8294.6?	0.1 1			
680.4 8	7652.5	0.1 1	(Q)		
684.5 3	1515.6	3.0 8	(Q)		
686.2@ 9	8219.1?	0.4 2			
686.8 3	4821.8	4.0 5	E2		Mult.: from $\alpha(\text{K})\text{exp}=0.009 \ 3$ (1988Li02).
693.9 3	5236.9	5.6 8	Q		
695.2 5	7290.9	0.1 1			
698.3 3	1955.8	1.0 5			
699.0# 3	831.1	3.5# 8			Mult.: $\alpha(\text{K})\text{exp}(699\gamma \text{ doublet})=0.025 \ 7$ (1988Li02). $\alpha(\text{K})\text{exp}(699\gamma \text{ doublet})=0.043 \ 6$ (1990Dr02). Transition may contain a significant E0 component (1990Dr02).
	3008.1	5.5# 6			Mult.: $\alpha(\text{K})\text{exp}=0.012$ (consistent with E2) if other member of the 699 γ doublet is M1+E2+E0 (1990Dr02).
702.1 5	6595.7	0.2 1			
702.3 5	3246.5	0.2 1			
708.7 3	6496.7	0.6 2			
709.5 3	3629.5	0.2 1			
711.7 3	6378.8	1.6 4			
715.8 5	7532.9	0.3 2			
717.4 3	6772.9	0.4 2			
723.1# 3	5254.9	0.7# 3			
	8268.0	0.5# 3			
727.0 7	7821.3	0.5 2	(Q)		
729.9 7	5551.7	1.8 4	(Q)		
732.6 5	6972.1	0.2 1	(Q)		
732.7 7	8554.0	0.3 2			
738.0 3	870.40	2.7 6	D+Q	>6	
744.8 3	5981.7	3.2 8	Q		
758.5 3	7531.4	0.1 1	(Q)		
769.0 9	6023.9	0.5 3			
770.1 9	7094.3	0.5 2			
772.5 9	6324.2	0.7 2	(Q)		
776.7 3	2544.6	0.3 2	D(+Q)	-0.01 25	
778.2 3	7544.9	0.7 3			

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$^{166}\text{Er}(^{18}\text{O},4n\gamma)$, $^{168}\text{Er}(^{16}\text{O},4n\gamma)$ **1988Li02,1990Dr02,2005Mo33 (continued)** $\gamma(^{180}\text{Os})$ (continued)

$E\gamma^\dagger$	E(level)	$I\gamma^\dagger$	Mult. ‡	$\delta^\ddagger$	Comments
782.9 5	3246.5	0.3 2			
785.0 3	6766.7	1.1 3			
788.1 3	1196.8	3.4 7	(M1+E2)	+1.8 4	Mult.: $\alpha(\text{K})\text{exp}<0.009$ suggests E2, E1, or M1+E2 with $\delta>1.7$ (1982Dr03). Level scheme requires M1+E2.
793.2 5	6817.1	0.5 3	Q		
809.2 3	1604.4	5.1 7	E1(+M2)	+0.02 5	Mult.: from $\alpha(\text{K})\text{exp}=0.002$ 1 (1988Li02).
821.3 [@] 10	9375.3?				
830.3 3	3139.3	0.9 3			
832.4 5	1627.4	2.3 8			
870.4 3	870.40	6.5 7	Q		
891.0 3	1023.1	4.4 7	M1+E2	-7 3	Mult.: from $\alpha(\text{K})\text{exp}=0.007$ 3 (1988Li02). δ : Other: >0.7 from $\alpha(\text{K})\text{exp}$.
907.9 3	2675.9	1.6 3	D(+Q)	-0.05 12	
918.4 3	2175.9	1.3 3	D(+Q)	-0.01 11	
928.0 3	2696.0	0.6 2	D(+Q)	+0.6 9	E γ : not reported in $^{150}\text{Nd}(^{36}\text{S},6n\gamma)$; not included in the Adopted Gammas.
966.1 3	1761.3	2.5 5	E1+M2	-0.35 30	Mult.: $\alpha(\text{K})\text{exp}<0.005$ (1988Li02) and δ from $\gamma(\theta)$ consistent only with E1+M2.
996.9 3	1405.6	5.5 10	M1+E2	-12 4	Mult.: from $\alpha(\text{K})\text{exp}=0.011$ 6 (1988Li02).
1029.0 3	2286.3	1.0 2	D(+Q)	+0.02 24	
^x 1050.5 [§] 3		0.6 3	Q		
1064.7 3	1196.8	3.3 6	Q		
1067.5 3	1862.6	0.3 2			
1082.1 3	1877.1	3.1 6	M1+E2	-0.6 3	Mult.: from $\alpha(\text{K})\text{exp}=0.015$ 8 (1988Li02); $\alpha(\text{K})\text{exp}=0.010$ 2 (1982Dr03).
1086.2 4	1881.2	0.8 3	D+Q	<-8	
^x 1093.4 [§] 3		0.3 2	(Q)		
1105.8 3	1514.6	1.8 4	E1+M2	-0.8 7	Mult.: E1 or E2 from $\alpha(\text{K})\text{exp}<0.005$ (1988Li02), D from $\gamma(\theta)$ rules out E2.
1133.8 6	1928.7	3.5 7	E1(+M2)	+0.02 6	Mult.: E1 or E2 from $\alpha(\text{K})\text{exp}<0.004$ (1982Dr03), D from $\gamma(\theta)$ rules out E2.
1147.3 3	2915.1	0.8 3	(Q)		
1153.4 3	2410.9	0.7 3			
1195.8 3	1604.4	1.0 2	D(+Q)	+0.1 3	
1218.7 5	1627.4	2.1 7	Q		
^x 1240.2 [§] 3		0.5 2			
1418.3 3	2675.9	0.2 1			E γ : not reported in $^{150}\text{Nd}(^{36}\text{S},6n\gamma)$; not included in the Adopted Gammas.
1468.5 3	1877.1	2.1 4	Q		
1492.6 10	2286.3	0.3 2			E γ : not reported in $^{150}\text{Nd}(^{36}\text{S},6n\gamma)$; not included in the Adopted Gammas.

[†] From $^{166}\text{Er}(^{18}\text{O},4n\gamma)$, E=85 MeV (1988Li02), except where noted.[‡] From $\gamma(\theta)$ of 1988Li02 and 1982Dr03, except where noted.[§] Original placement by 1988Li02 is inconsistent with the current spins and parities assigned to the corresponding levels. Later work by the same first author (1999Li03) found no evidence for the placement of this transition using the $^{150}\text{Nd}(^{36}\text{S},6n\gamma)$ reaction. See also 1983Ne14, 1983Dr17.

Multiply placed; intensity suitably divided.

@ Placement of transition in the level scheme is uncertain.

^x γ ray not placed in level scheme.

 $^{169}\text{Tm}(^{14}\text{N}, 3n\gamma)$ 1967Bu02

$\text{E}(^{14}\text{N})$ not given. Measured $\text{E}\gamma$, $\text{I}\gamma$, $\text{E}(\text{ce})$, $\text{I}(\text{ce})$ using a $\text{Ge}(\text{Li})$ detector and a single-gap wedge type electron spectrometer. Similar results are presented in 1967Bu18.

 ^{180}Os Levels

$\text{E}(\text{level})^\dagger$	$\text{J}\pi^\ddagger$
0.0	0+
132.2 3	2+
408.5 8	4+
795.1 13	6+
1257.3 17	8+
1767.5 22	10+
2309 3	12+
2875 3	14+

† From a least-squares fit to $\text{E}\gamma$ by evaluator.

‡ From the Adopted Levels.

 $\gamma(^{180}\text{Os})$

$\text{E}\gamma^\dagger$	$\text{E}(\text{level})$	$\text{I}\gamma^\ddagger$	Mult. §
132.2 3	132.2	100 20	E2
276.3 7	408.5	88 18	E2
^x 365		35 7	(E1)
386.6 10	795.1	74 15	E2
462.2 12	1257.3	72 14	E2
510.2 13	1767.5	42 9	E2
541.0 14	2309	34 7	E2
566.4 14	2875	25 5	E2
^x 618		30 6	(E1)
^x 643		17 3	(M1)

† $\Delta\text{E}\gamma$ from a general statement by the authors that energies are accurate to $\pm 0.25\%$.

‡ $\Delta\text{I}\gamma$ from a general statement by the authors that intensities are accurate to $\pm 20\%$.

§ Authors state that multipolarities were determined from K/L ratios, however, no details are given.

x γ ray not placed in level scheme.

Adopted Levels, Gammas

$Q(\beta^-) = -3542$ 24; $S(n) = 7970$ 24; $S(p) = 2247$ 27; $Q(\alpha) = 4660$ 40 2012Wa38.
 $S(2n) = 17868$ 29; $S(2p) = 6900$ 40 (2012Wa38).

 ^{180}Ir Levels

Cross Reference (XREF) Flags

A ^{180}Pt ϵ Decay (56 s)
 B ^{184}Au α Decay (47.6 s)
 C $^{154}\text{Sm}(^{31}\text{P}, 5n\gamma)$

E(level) [†]	$J\pi^{\ddagger}$	XREF	$T_{1/2}$	Comments
0.0 §	(5+)	BC	1.5 min 1	$\% \epsilon + \% \beta^+ = 100$. $J\pi$: direct feeding to 4+, 5, and 6+ states in ^{180}Os . $T_{1/2}$: weighted average of 1.5 min 1 (1972Ak03) and 1.5 min 2 (1973LaZC). Others: 1971Na27, 1992Bo19. E(level): doubly-decoupled band observed in $^{154}\text{Sm}(^{31}\text{P}, 5n\gamma)$ assigned to the ground state by evaluator.
80.4 5		B		configuration= $\pi 1/2[541]v1/2[521]$; doubly-decoupled band. $E\gamma = 80.4$ observed in ^{184}Au α -decay. $E\gamma = 80.6$ from ^{180}Pt ϵ -decay is probably the same transition.
98.22 [#] 19	(6+)	C		
113.5		B		$E\gamma = 113.5$ observed in ^{184}Au α -decay. $E\gamma = 113.0$ from ^{180}Pt ϵ -decay is probably the same transition.
164.00 § 10	(7+)	C		
167		B		
180.80 [@] 17	(7+)	C		$J\pi$: (E2) 274 γ from (9+).
212.4 5		B		
296.94 [#] 20	(8+)	C		$J\pi$: D+Q 115 γ to (7+).
441.83 [@] 19	(9+)	C		$J\pi$: (E2) 278 γ to (7+).
454.50 § 14	(9+)	C		
623.92 [#] 22	(10+)	C		
825.3 [@] 21	(11+)	C		
847.80 § 18	(11+)	C		
1057.20 [#] 23	(12+)	C		
1302.57 [@] 23	(13+)	C		
1328.8 § 4	(13+)	C		
1571.18 [#] 24	(14+)	C		
1846.39 [@] 24	(15+)	C		
1876.8 § 5	(15+)	C		
2120.16 [#] 25	(16+)	C		
2179.2 4	(16+)	C		
2385.4 [@] 3	(17+)	C		
2406.8 § 7	(17+)	C		
2495.8 7	(17+)	C		
2622.2 [#] 4	(18+)	C		
2882.7 [@] 4	(19+)	C		
2902.3 § 9	(19+)	C		
3162.2 [#] 4	(20+)	C		
3452.7 [@] 6	(21+)	C		
3752.5 [#] 5	(22+)	C		
4394.0 [#] 7	(24+)	C		
5089.3 [#] 9	(26+)	C		
0+y&	J	C		$J\pi$: based on a comparison of similar band in ^{178}Re , 2002Zh01 suggest $J\pi = (8-)$ for the bandhead.
91.19+y ^a 22	J+1	C		
146.48+y& 22	J+2	C		
345.63+y ^a 24	J+3	C		
431.53+y& 24	J+4	C		
733.2+y ^a 3	J+5	C		
852.1+y& 3	J+6	C		
1224.4+y ^a 4	J+7	C		
1389.7+y& 3	J+8	C		
1797.9+y ^a 4	J+9	C		
2021.5+y& 3	J+10	C		
2441.9+y ^a 4	J+11	C		

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Adopted Levels, Gammas (continued) ^{180}Ir Levels (continued)

E(level) [†]	$J\pi^{\ddagger}$	XREF	Comments
2721.5+y& 3	J+12	C	
3139.6+y ^a 4	J+13	C	
3458.3+y& 5	J+14	C	
3859.6+y ^a 7	J+15	C	
0+z	(7+)	C	J π : (E1) 78.5 γ from (8-).
78.49+z ^b 10	(8-)	C	J π : (M1) 95.3 γ from (9-).
173.7+z ^c 4	(9-)	C	J π : from comparison of the (9-) to (7-) transition energies in similar bands in neighboring Ir and Re nuclei.
304.7+z ^b 4	(10-)	C	
461.1+z ^c 5	(11-)	C	
648.4+z ^b 5	(12-)	C	
858.7+z ^c 5	(13-)	C	
1089.2+z ^b 5	(14-)	C	
1336.7+z ^c 5	(15-)	C	
1599.1+z ^b 5	(16-)	C	
1876.0+z ^c 5	(17-)	C	
2165.9+z ^b 5	(18-)	C	
2470.1+z ^c 5	(19-)	C	
2787.3+z ^b 5	(20-)	C	
3119.4+z ^c 6	(21-)	C	
3466.2+z ^b 6	(22-)	C	
3823.9+z ^c 6	(23-)	C	
4196.2+z ^b 8	(24-)	C	
4575.2+z ^c 8	(25-)	C	
0+u ^d	J ₁	C	
147.1+u ^e 3	J ₁ +1	C	
315.4+u ^d 3	J ₁ +2	C	
501.5+u ^e 4	J ₁ +3	C	
701.6+u ^d 4	J ₁ +4	C	
915.3+u ^e 4	J ₁ +5	C	
1141.9+u ^d 4	J ₁ +6	C	
1381.8+u ^e 4	J ₁ +7	C	
1634.2+u ^d 4	J ₁ +8	C	
1900.8+u ^e 4	J ₁ +9	C	
2179.0+u ^d 5	J ₁ +10	C	
2465.2+u ^e 5	J ₁ +11	C	
2765.5+u ^d 6	J ₁ +12	C	
3087.5+u ^e 6	J ₁ +13	C	
3399.5+u ^d 6	J ₁ +14	C	
3740.8+u ^e 8	J ₁ +15	C	

[†] From a least-squares fit to E γ 's by evaluator.[‡] From $^{154}\text{Sm}(^{31}\text{P},5n\gamma)$ based on DCO ratios, intraband B(M1)/B(E2) ratios, systematics of band properties in neighboring nuclei and proposed configurations. Further support for band head assignments is given in the comments.[§] (A): Doubly-decoupled band, $\pi 1/2[541]v1/2[521]$, $\alpha=1$.[#] (B): $\pi 1/2[541]v5/2[512]$, $\alpha=0$. $\pi 1/2[541]v7/2[514]$ is also possible but less likely. Band crossing is observed at $\hbar\omega=0.26$ MeV.[@] (C): $\pi 1/2[541]v5/2[512]$, $\alpha=1$. $\pi 1/2[541]v7/2[514]$ is also possible.[&] (D): $\pi 1/2[541]v(i_{13/2})$, $\alpha=0$. Band crossing is observed at $\hbar\omega=0.35$ MeV.^a (E): $\pi 1/2[514]v(i_{13/2})$, $\alpha=1$.^b (F): $\pi 9/2[514]v(i_{13/2})$, $\alpha=0$. Main component from $i_{13/2}$ orbital is 7/2[633].^c (G): $\pi 9/2[514]v(i_{13/2})$, $\alpha=1$. Main component from $i_{13/2}$ orbital is 7/2[633].^d (H): $\pi(5/2[402]$ or $9/2[514])v9/2[624]$.^e (I): $\pi(5/2[402]$ or $9/2[514])v9/2[624]$. $\gamma(^{180}\text{Ir})$

E(level)	E $\gamma^{\ddagger}$	I $\gamma^{\ddagger}$	Mult. [‡]	α
80.4	80.4 [§] 5			
113.5	113.5 [§] 5			
164.00	164.0 ^I	100	E2 [#]	0.690
180.80	82.5 ^I	100		

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Adopted Levels, Gammas (continued) $\gamma(^{180}\text{Ir})$ (continued)

E(level)	$E\gamma^\dagger$	$I\gamma^\dagger$	Mult. [‡]	α	E(level)	$E\gamma^\dagger$	$I\gamma^\dagger$	Mult. [‡]	α
212.4	212.4 [§] 5				2441.9+y	644.0 1			
296.94	115.8 3	86 27	(M1+E2)		2721.5+y	700.0 1		(E2)	0.01092
	198.8 1	100			3139.6+y	418.0 5	≤ 7		
441.83	145.0 3	71 21	(M1+E2)			697.8 3	100		
	261.0 1	100	(E2)	0.1450	3458.3+y	736.8 3	100		
	277.8 5		(E2)	0.1196 18	3859.6+y	720.0 5	100		
454.50	273.7 1	69	(E2)	0.1251	78.49+z	78.5 1	100	(E1) #	0.727
	290.5 1	100	(E2)	0.1044	173.7+z	95.3 3	100	(M1) #	7.03 12
623.92	182.0 5	17 5	(M1+E2)		304.7+z	131.0 3	100	(M1+E2)	
	327.0 1	100	(E2)	0.0737	461.1+z	156.4 1	100	(M1+E2)	
825.3	201.5 5	16 5	(M1+E2)			287.5 5	19 3	(E2)	
	383.5 1	100	(E2)	0.0471	648.4+z	187.3 1	100	(M1+E2)	
847.80	393.3 1	100	(E2)	0.0440		343.8 3	50 8	(E2)	0.0638
1057.20	231.8 5	12 4	(M1+E2)		858.7+z	210.3 1	100	(M1+E2)	
	433.3 1	100	(E2)	0.0341		397.8 3	86 12	(E2)	0.0427
1302.57	245.3 5	11 3			1089.2+z	230.3 3	70 11	(M1+E2)	
	477.2 1	100	(E2)	0.0267		440.8 1	100	(E2)	0.0326
1328.8	481.0 3	100	(E2)	0.0261	1336.7+z	247.5 3	48 7	(M1+E2)	
1571.18	268.5 5	14 6				477.9 1	100	(E2)	
	514.0 1	100	(E2)	0.0222	1599.1+z	262.3 5	35 5	(M1+E2)	
1846.39	275.3 5	10 3				510.0 1	100	(E2)	0.0226
	543.8 1	100	(E2)	0.0194	1876.0+z	277.0 5	29 5	(M1+E2)	
1876.8	548.0 3	100	(E2)	0.0190		539.3 1	100	(E2)	0.0198
2120.16	273.5 5	10 3			2165.9+z	289.8 5	29 5	(M1+E2)	
	549.0 1	100	(E2)	0.0190		566.8 1	100	(E2)	0.01758
2179.2	608.0 3	100	(E2)	0.01495	2470.1+z	304.3 5	20 4		
2385.4	265.5 5	≤ 20				594.1 1	100	(E2)	0.01576
	539.0 1	100	(E2)	0.0198	2787.3+z	317.3 5	22 6		
2406.8	530.0 5	100	(E2)	0.0206		621.4 3	100	(E2)	0.01423
2495.8	619.0 5	100			3119.4+z	332.0 5	19 4		
2622.2	236.5 5	≤ 29				649.3 3	100		
	443.0 5	53	(E2)		3466.2+z	346.8 5	50 25		
	502.0 3	100	(E2)	0.0235		678.8 5	100		
2882.7	260.5 5	≤ 48			3823.9+z	704.5 3	100		
	497.5 3	100	(E2)	0.0240	4196.2+z	730.0 5	100		
2902.3	495.5 5	100	(E2)	0.0243	4575.2+z	751.3 5	100		
3162.2	280.0 5	≤ 42			147.1+u	147.1 3	100	(M1+E2)	
	539.8 3	100	(E2)	0.0197	315.4+u	168.3 1	100	(M1+E2)	
3452.7	570.0 5	100	(E2)	0.01735		315.5 5	37 11		
3752.5	590.3 3	100	(E2)	0.01600	501.5+u	186.0 3	100	(M1+E2)	
4394.0	641.5 5	100	(E2)	0.01324		354.8 3	69 20	(E2)	0.0584
5089.3	695.3 5	100			701.6+u	200.3 3	96 29	(M1+E2)	
91.19+y	91.2 3	100	(M1+E2)			386.0 3	100	(E2)	0.0463
146.48+y	55.3 1	100			915.3+u	213.5 3	55 7	(M1+E2)	
	146.5 3	40 10				413.8 3	100	(E2)	0.0384
345.63+y	199.1 1	100	(M1+E2)		1141.9+u	226.5 5	41 12	(M1+E2)	
	254.4 3	38 10				440.3 1	100	(E2)	0.0327
431.53+y	85.5 3	17 5			1381.8+u	240.0 5	30 9	(M1+E2)	
	285.1 1	100	(E2)	0.1105		466.5 1	100	(E2)	0.0282
733.2+y	301.8 3	100	(M1+E2)		1634.2+u	252.3 5	26 8		
	387.5 3	89 20				492.3 1	100	(E2)	0.0247
852.1+y	118.8 5	5.6 15			1900.8+u	266.5 5	30 9		
	420.6 1	100	(E2)	0.0368		519.0 1	100	(E2)	0.0217
1224.4+y	372.3 3	94 13	(M1+E2)		2179.0+u	278.2 5	25 9		
	491.2 3	100				544.8 3	100	(E2)	0.0193
1389.7+y	537.6 1	100	(E2)	0.0199	2465.2+u	564.4 3	100	(E2)	0.01776
1797.9+y	408.1 3	65 13	(M1+E2)		2765.5+u	586.5 3	100	(E2)	0.01624
	573.5 3	100			3087.5+u	622.3 3	100		
2021.5+y	631.8 1	100	(E2)	0.01370	3399.5+u	634.0 3	100		
2441.9+y	420.5 5				3740.8+u	653.3 5	100		

[†] From $^{154}\text{Sm}(^{31}\text{P}, 5n\gamma)$, except where noted.

Adopted Levels, Gammas (continued) $\gamma(^{180}\text{Ir})$ (continued)

‡ From DCO ratios in $^{154}\text{Sm}(^{31}\text{P}, 5n\gamma)$, except where noted. As these transitions are placed within rotational band structures, Q transitions are assumed E2 and D+Q transitions assumed M1+E2.

§ From ^{184}Au α decay (47.6 s).

From $\alpha(\text{exp})$ in $^{154}\text{Sm}(^{31}\text{P}, 5n\gamma)$.

 ^{180}Pt ϵ Decay (56 s) $^{1993}\text{Me13}$

Parent ^{180}Pt : E=0.0; J π =0+; T $_{1/2}$ =56 s 3; Q(g.s.)=3542 24; % ϵ +% β^+ decay=100.

$^{1993}\text{Me13}$: ^{180}Pt activity produced by $^{148}\text{Nd}(^{88}\text{Ar}, 6n)$, E=173–201 MeV. Measured E γ , I γ , $\gamma\gamma$ coin, T $_{1/2}$.

 $\gamma(^{180}\text{Ir})$

E γ	I γ
^x 80.6 †	45 3
^x 95.2 †	100
^x 113.0	16 3
^x 123.3	<20

† Observed in coincidence.

^x γ ray not placed in level scheme.

 ^{184}Au α Decay (47.6 s) $^{1995}\text{Bi01}$

Parent ^{184}Au : E=68.46 4; J π =2+; T $_{1/2}$ =47.6 s 14; Q(g.s.)=5234 5; % α decay $\leq$ 0.0160.

^{184}Au –% α decay: % α =0.013 3 (1995Bi01). $^{1995}\text{Bi01}$ assumed the α –decay is from the 69 keV isomeric state of ^{184}Au , yet it is possible the decay comes from both ground state and the 69 keV state. Other: <0.022 4 (1970Ha18).

$^{1995}\text{Bi01}$: ^{184}Au activity produced in Ta(^{12}C , X) with E(^{12}C)=153 MeV. Channel selection performed with FeBIAD ion source and a mass separator. Measured E α , I α , E γ , $\gamma\gamma$ –, $\gamma\alpha$ –, and $\alpha\alpha$ –coincidences using a Si(Li) detector for α particles and electrons and a Ge(Li) detector for γ – and x–rays.

Other: 1970Ha18.

 ^{180}Ir Levels

E(level)†
0.0
80.4 5
113.5 5
167‡ 5
212.4 5

† From E γ , except where noted.

‡ From E α .

 α radiations

$^{1995}\text{Bi01}$ assumed the α –decay is from the 69 keV isomeric state of ^{184}Au , yet it is possible the decay comes from both ground state and the 69 keV state.

All α 's, except those of 5187 keV, are in coincidence with the K $_{\alpha}$ x–rays.

E α †	E(level)	I α †#	HF‡§	Comments
4980 5	212.4	10.7 5	>10	
5024 5	167	10.3 5	>19	
5065 15	113.5	6.5 5	>57	E α : Other: 5066 20 (1970Ha18).
5109 5	80.4	46.7 5	>12	E α : Other: 5108 15 (1970Ha18).
5187 5	0.0	25.7 5	>50	E α : Other: 5172 15 (1970Ha18).

† From $^{1995}\text{Bi01}$.

Footnotes continued on next page

¹⁸⁴Au α Decay (47.6 s) ¹⁹⁹⁵Bi01 (continued)

α radiations (continued)

[‡] From ¹⁹⁹⁵Bi01, assuming the α-decay is from the 69 keV isomeric state of ¹⁸⁴Au.

[§] r₀=1.515.

[#] For α intensity per 100 decays, multiply by ≤0.00016.

γ(¹⁸⁰Ir)

Eγ [†]	E(level)	Eγ [†]	E(level)	Eγ [†]	E(level)
x50.2 [§]		113.5 5	113.5	x183.8 [‡]	
x55.3 [#]		x130.4 [‡]		x197.9 [‡]	
80.4 5	80.4	x142.6 [§]		212.4 5	212.4
x89.7 [‡]		x171.7 [‡]			

[†] From ¹⁹⁹⁵Bi01. Uncertainty not given, evaluator assumed ΔEγ=0.5 keV.

[‡] In coincidence with Eα=4980 keV.

[§] In coincidence with Eα=5024 keV.

[#] In coincidence with Eα=5109 keV.

^x γ ray not placed in level scheme.

Decay Scheme

¹⁵⁴Sm(³¹P,5nγ) ²⁰⁰²Zh01

E(³¹P)=150 to 170 MeV. Measured E_γ, I_γ, γγ, γγ(θ)(DCO) using array of 12 Compton-suppressed HPGe detectors. Most measurements were done at 160 MeV. Subset of results published in ¹⁹⁹⁹Zh26.

¹⁸⁰Ir Levels

E(level) [†]	Jπ [‡]	Comments
0+x [§]	(5+)	E(level): this state may correspond to the ground state of ¹⁸⁰ Ir.
98.22+x [#]	(6+)	
164.00+x [§]	(7+)	
180.80+x [@]	(7+)	
296.94+x [#]	(8+)	
441.83+x [@]	(9+)	
454.50+x [§]	(9+)	
623.92+x [#]	(10+)	
825.36+x [@]	(11+)	
847.80+x [§]	(11+)	
1057.20+x [#]	(12+)	
1302.57+x [@]	(13+)	
1328.8+x [§]	(13+)	
1571.18+x [#]	(14+)	
1846.39+x [@]	(15+)	
1876.8+x [§]	(15+)	
2120.16+x [#]	(16+)	
2179.2+x	(16+)	

Continued on next page (footnotes at end of table)

$^{154}\text{Sm}(^{31}\text{P}, 5n\gamma)$ 2002Zh01 (continued) ^{180}Ir Levels (continued)

E(level) [†]	$J\pi^{\ddagger}$	E(level) [†]	$J\pi^{\ddagger}$	E(level) [†]	$J\pi^{\ddagger}$
2385.4+x [@] 3	(17+)	2021.5+y ^{&} 3	(18-)	3466.2+z ^b 6	(22-)
2406.8+x [§] 7	(17+)	2441.9+y ^a 4	(19-)	3823.9+z ^c 6	(23-)
2495.8+x 7	(17+)	2721.5+y ^{&} 3	(20-)	4196.2+z ^b 8	(24-)
2622.2+x [#] 4	(18+)	3139.6+y ^a 4	(21-)	4575.2+z ^c 8	(25-)
2882.7+x [@] 4	(19+)	3458.3+y ^{&} 5	(22-)	0+u ^d	J
2902.3+x [§] 9	(19+)	3859.6+y ^a 7	(23-)	147.1+u ^e 3	J+1
3162.2+x [#] 4	(20+)	0+z	(7+)	315.4+u ^d 3	J+2
3452.7+x [@] 6	(21+)	78.49+z ^b 10	(8-)	501.5+u ^e 4	J+3
3752.5+x [#] 5	(22+)	173.7+z ^c 4	(9-)	701.6+u ^d 4	J+4
4394.0+x [#] 7	(24+)	304.7+z ^b 4	(10-)	915.3+u ^e 4	J+5
5089.3+x [#] 9	(26+)	461.1+z ^c 5	(11-)	1141.9+u ^d 4	J+6
0+y ^{&}	(8-)	648.4+z ^b 5	(12-)	1381.8+u ^e 4	J+7
91.19+y ^a 22	(9-)	858.7+z ^c 5	(13-)	1634.2+u ^d 4	J+8
146.48+y ^{&} 22	(10-)	1089.2+z ^b 5	(14-)	1900.8+u ^e 4	J+9
345.63+y ^a 24	(11-)	1336.7+z ^c 5	(15-)	2179.0+u ^d 5	J+10
431.53+y ^{&} 24	(12-)	1599.1+z ^b 5	(16-)	2465.2+u ^e 5	J+11
733.2+y ^a 3	(13-)	1876.0+z ^c 5	(17-)	2765.5+u ^d 6	J+12
852.1+y ^{&} 3	(14-)	2165.9+z ^b 5	(18-)	3087.5+u ^e 6	J+13
1224.4+y ^a 4	(15-)	2470.1+z ^c 5	(19-)	3399.5+u ^d 6	J+14
1389.7+y ^{&} 3	(16-)	2787.3+z ^b 5	(20-)	3740.8+u ^e 8	J+15
1797.9+y ^a 4	(17-)	3119.4+z ^c 6	(21-)		

[†] From a least-squares fit to E γ 's by the evaluator.[‡] As given in 2002Zh01, 1999Zh26 based on DCO ratios, intraband B(M1)/B(E2) ratios, systematics of band properties in neighboring nuclei and proposed configurations.[§] (A): Doubly-decoupled band, $\pi 1/2[541]v1/2[521]$, $\alpha=1$.[#] (B): $\pi 1/2[541]v5/2[512]$, $\alpha=0$. $\pi 1/2[541]v7/2[514]$ is also possible but less likely. Band crossing is observed at $\hbar\omega=0.26$ MeV.[@] (C): $\pi 1/2[541]v5/2[512]$, $\alpha=1$. $\pi 1/2[541]v7/2[514]$ is also possible.[&] (D): $\pi 1/2[541]v(i_{13/2})$, $\alpha=0$. Band crossing is observed at $\hbar\omega=0.35$ MeV.^a (E): $\pi 1/2[514]v(i_{13/2})$, $\alpha=1$.^b (F): $\pi 9/2[514]v(i_{13/2})$, $\alpha=0$. Main component from $i_{13/2}$ orbital is $7/2[633]$.^c (G): $\pi 9/2[514]v(i_{13/2})$, $\alpha=1$. Main component from $i_{13/2}$ orbital is $7/2[633]$.^d (H): $\pi(5/2[402]$ or $9/2[514])v9/2[624]$.^e (I): $\pi(5/2[402]$ or $9/2[514])v9/2[624]$. $\gamma(^{180}\text{Ir})$

E $\gamma^{\ddagger}$	E(level)	I $\gamma^{\ddagger}$	Mult.	α	Comments
55.3 1	146.48+y	≥ 25.0			
78.5 1	78.49+z	37.5	(E1)	0.747	DCO=1.08 15. $\alpha(\text{exp})=0.89$ 20 from $I\gamma(95.3\gamma)/I\gamma(78.5\gamma)=0.23$ 5 in 156 γ gated spectrum and assuming pure M1 for the 95.3 γ . Mult.: from $\alpha(\text{exp})$.
82.5 1	180.80+x	≥ 21.7			
85.5 3	431.53+y	10.0			
91.2 3	91.19+y	≥ 13.7	D+Q		DCO=1.5 5.
95.3 3	173.7+z	11.4	(M1)	7.29	$\alpha(\text{exp})=8.0$ 20 from $I\gamma(131\gamma)/I\gamma(95.3\gamma)=2.3$ 6 in 156 γ gated spectrum and assuming pure M1 for the 131 γ . Mult.: from $\alpha(\text{exp})$. DCO=0.55 10.
115.8 3	296.94+x	≥ 16.0	D+Q		
118.8 5	852.1+y	5.0			
131.0 3	304.7+z	13.0	D		DCO=1.8 5.
145.0 3	441.83+x	15.0	D+Q		DCO=0.47 10.
146.5 3	146.48+y	≥ 13.6			$I\gamma(146.5)/I\gamma(55.3)=0.40$ 10.
147.1 3	147.1+u	12.5	D+Q		DCO=1.7 5.
156.4 1	461.1+z	22.3	D+Q		DCO=1.20 15.
164.0 1	164.00+x	≥ 52.0	E2	0.699	DCO=0.95 15. Mult.: Q from DCO, authors state use of an intensity balance to determine E2 character but provide no details. DCO=1.13 20.
168.3 1	315.4+u	21.8	D+Q		DCO=0.52 10.
182.0 5	623.92+x	6.7	D+Q		

Continued on next page (footnotes at end of table)

$^{154}\text{Sm}(^{31}\text{P},5n\gamma)$ 2002Zh01 (continued) $\gamma(^{180}\text{Ir})$ (continued)

$E\gamma^{\dagger}$	E(level)	$I\gamma^{\ddagger}$	Mult.	Comments
186.0 3	501.5+u	18.0	D+Q	DCO=1.1 3.
187.3 1	648.4+z	24.7	D+Q	DCO=1.20 20.
198.8 1	296.94+x	≥ 20.0		$I\gamma(198.8)/I\gamma(115.8)=1.2$ 4.
199.1 1	345.63+y	≥ 48.4	D+Q	DCO=0.50 8.
200.3 3	701.6+u	14.0	D+Q	DCO=1.28 20.
201.5 5	825.36+x	6.1	D+Q	DCO=0.50 10.
210.3 1	858.7+z	21.8	D+Q	DCO=1.24 20.
213.5 3	915.3+u	10.5	D+Q	DCO=1.3 3.
226.5 5	1141.9+u	8.5	D+Q	DCO=1.3 4.
230.3 3	1089.2+z	17.0	D+Q	DCO=1.13 20.
231.8 5	1057.20+x	7.1	D+Q	DCO=0.52 10.
236.5 5	2622.2+x	≤ 5.0		
240.0 5	1381.8+u	7.6	D+Q	DCO=1.6 5.
245.3 5	1302.57+x	4.0		
247.5 3	1336.7+z	14.5	D+Q	DCO=1.24 20.
252.3 5	1634.2+u	5.5		
254.4 3	345.63+y	≥ 18.6		$I\gamma(254.4)/I\gamma(199.1)=0.38$ 10.
260.5 5	2882.7+x	≤ 5.0		
261.0 1	441.83+x	20.5	Q	DCO=0.94 15. $I\gamma(261.0)/I\gamma(145.0)=1.4$ 4.
262.3 5	1599.1+z	8.9	D+Q	DCO=1.23 20.
265.5 5	2385.4+x	≤ 5.0		
266.5 5	1900.8+u	4.0		
268.5 5	1571.18+x	7.0		
273.5 5	2120.16+x	3.0		
273.7 1	454.50+x	24.0	Q	DCO=0.95 15.
275.3 5	1846.39+x	4.5		
277.0 5	1876.0+z	8.0	D+Q	DCO=1.30 20.
277.8 5	441.83+x		Q	DCO=1.08 15.
278.2 5	2179.0+u	3.0		
280.0 5	3162.2+x	≤ 5.0		
285.1 1	431.53+y	52.4	Q	DCO=1.10 15. $I\gamma(285.1)/I\gamma(85.5)=5.8$ 17.
287.5 5	461.1+z	4.5	Q	DCO=1.31 20. $I\gamma(287.5)/I\gamma(156.4)=0.19$ 3.
289.8 5	2165.9+z	6.8	D+Q	DCO=1.4 4.
290.5 1	454.50+x	35.0	Q	DCO=1.04 15.
301.8 3	733.2+y	≤ 25.7	D+Q	DCO=0.48 7.
304.3 5	2470.1+z	5.6		
315.5 5	315.4+u	8.0		$I\gamma(315.5)/I\gamma(168.3)=0.37$ 11.
317.3 5	2787.3+z	4.3		
327.0 1	623.92+x	51.6	Q	DCO=1.07 15. $I\gamma(327.0)/I\gamma(182.0)=6.1$ 17.
332.0 5	3119.4+z	3.6		
343.8 3	648.4+z	18.0	Q	DCO=1.06 20. $I\gamma(343.8)/I\gamma(187.3)=0.50$ 8.
346.8 5	3466.2+z	4.0		
354.8 3	501.5+u	11.5	Q	DCO=1.00 20. $I\gamma(354.8)/I\gamma(186.0)=0.69$ 20.
372.3 3	1224.4+y	≤ 16.4	D+Q	DCO=0.40 10.
383.5 1	825.36+x	38.2	Q	DCO=0.94 15. $I\gamma(383.5)/I\gamma(201.5)=6.3$ 21.
386.0 3	701.6+u	15.0	Q	DCO=0.88 20. $I\gamma(386.0)/I\gamma(200.3)=1.0$ 3.
387.5 3	733.2+y	≤ 23.5		$I\gamma(387.5)/I\gamma(301.8)=0.89$ 20.
393.3 1	847.80+x	23.0	Q	DCO=1.06 15.
397.8 3	858.7+z	17.4	Q	DCO=1.01 15. $I\gamma(397.8)/I\gamma(210.3)=0.86$ 12.
408.1 3	1797.9+y	≤ 14.1	D+Q	DCO=0.40 6.
413.8 3	915.3+u	19.0	Q	DCO=1.10 20. $I\gamma(413.8)/I\gamma(213.5)=1.8$ 5.
418.0 5	3139.6+y	≤ 1.0		
420.5 5	2441.9+y			

Continued on next page (footnotes at end of table)

$^{154}\text{Sm}(^{31}\text{P}, 5n\gamma)$ 2002Zh01 (continued) $\gamma(^{180}\text{Ir})$ (continued)

$E\gamma^{\dagger}$	E(level)	$I\gamma^{\ddagger}$	Mult.	Comments
420.6 1	852.1+y	100	Q	DCO=1.02 15. $I\gamma(420.6)/I\gamma(118.8)=18$ 5.
433.3 1	1057.20+x	51.2	Q	DCO=0.99 15. $I\gamma(433.3)/I\gamma(231.8)=8.7$ 29.
440.3 1	1141.9+u	21.0	Q	DCO=1.05 20. $I\gamma(440.3)/I\gamma(226.5)=2.4$ 7.
440.8 1	1089.2+z	21.3	Q	DCO=1.10 20. $I\gamma(440.8)/I\gamma(230.3)=1.41$ 21.
443.0 5	2622.2+x	9.0	Q	DCO=0.92 20.
466.5 1	1381.8+u	23.7	Q	DCO=1.02 20. $I\gamma(466.5)/I\gamma(240.0)=3.3$ 10.
477.2 1	1302.57+x	53.0	Q	DCO=0.94 15. $I\gamma(477.2)/I\gamma(245.3)=9.5$ 24.
477.9 1	1336.7+z	27.3	Q	DCO=1.05 15. $I\gamma(477.9)/I\gamma(247.5)=2.1$ 3.
481.0 3	1328.8+x	18.0	Q	DCO=1.05 15.
491.2 3	1224.4+y	≤ 17.8		$I\gamma(491.2)/I\gamma(372.3)=1.06$ 15.
492.3 1	1634.2+u	21.0	Q	DCO=1.10 20. $I\gamma(492.3)/I\gamma(252.3)=3.8$ 11.
495.5 5	2902.3+x	5.8	Q	DCO=0.96 20.
497.5 3	2882.7+x	10.4	Q	DCO=0.95 15.
502.0 3	2622.2+x	17.0	Q	DCO=1.00 15.
510.0 1	1599.1+z	26.8	Q	DCO=1.00 15. $I\gamma(510.0)/I\gamma(262.3)=2.9$ 5.
514.0 1	1571.18+x	53.0	Q	DCO=0.97 15. $I\gamma(514.0)/I\gamma(268.5)=7.5$ 35.
519.0 1	1900.8+u	20.2	Q	DCO=0.87 20. $I\gamma(519.0)/I\gamma(266.5)=3.3$ 10.
530.0 5	2406.8+x	7.0	Q	DCO=1.02 15.
537.6 1	1389.7+y	74.0	Q	DCO=1.03 15.
539.0 1	2385.4+x	25.6	Q	DCO=0.96 15.
539.3 1	1876.0+z	24.8	Q	DCO=1.00 15. $I\gamma(539.3)/I\gamma(277.0)=3.5$ 6.
539.8 3	3162.2+x	12.0	Q	DCO=0.92 15.
543.8 1	1846.39+x	45.0	Q	DCO=0.96 15. $I\gamma(543.8)/I\gamma(275.3)=9.9$ 31.
544.8 3	2179.0+u	14.6	Q	DCO=1.08 20. $I\gamma(544.8)/I\gamma(278.2)=4.0$ 15.
548.0 3	1876.8+x	18.0	Q	DCO=1.08 15.
549.0 1	2120.16+x	32.8	Q	DCO=1.02 15. $I\gamma(549.0)/I\gamma(273.5)=10.5$ 33.
564.4 3	2465.2+u	15.0	Q	DCO=0.91 25.
566.8 1	2165.9+z	22.0	Q	DCO=1.06 15. $I\gamma(566.8)/I\gamma(289.8)=3.5$ 6.
570.0 5	3452.7+x	8.0	Q	DCO=0.80 20.
573.5 3	1797.9+y	≤ 15.5		$I\gamma(573.5)/I\gamma(408.1)=1.5$ 3.
586.5 3	2765.5+u	12.0	Q	DCO=1.10 25.
590.3 3	3752.5+x	12.0	Q	DCO=1.10 20.
594.1 1	2470.1+z	20.0	Q	DCO=1.00 20. $I\gamma(594.1)/I\gamma(304.3)=5.1$ 10.
608.0 3	2179.2+x	15.0	Q	DCO=0.90 15.
619.0 5	2495.8+x	6.0		
621.4 3	2787.3+z	16.0	Q	DCO=0.93 20. $I\gamma(621.4)/I\gamma(317.3)=4.5$ 12.
622.3 3	3087.5+u	12.3		
631.8 1	2021.5+y	53.8	Q	DCO=1.17 25.
634.0 3	3399.5+u	10.1		
641.5 5	4394.0+x	6.0	Q	DCO=1.08 20.
644.0 1	2441.9+y	22.0		
649.3 3	3119.4+z	15.7		$I\gamma(649.3)/I\gamma(332.0)=5.3$ 12.
653.3 5	3740.8+u	7.8		
678.8 5	3466.2+z	8.9		$I\gamma(678.8)/I\gamma(346.8)=2.0$ 10.
695.3 5	5089.3+x	5.0		

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 $^{154}\text{Sm}(^{31}\text{P}, 5\text{n}\gamma)$ 2002Zh01 (continued)

 $\gamma(^{180}\text{Ir})$ (continued)

$E\gamma^\dagger$	E(level)	$I\gamma^\ddagger$	Mult.	Comments
697.8 3	3139.6+y	14.0		
700.0 1	2721.5+y	31.7	Q	DCO=0.92 25.
704.5 3	3823.9+z	12.8		
720.0 5	3859.6+y	9.8		
730.0 5	4196.2+z	≤ 4.0		
736.8 3	3458.3+y	15.5		
751.3 5	4575.2+z	≤ 4.0		

† Uncertainties assigned by the evaluator as 0.1 keV for $I\gamma > 20$, 0.3 keV for $I\gamma = 10-20$, 0.5 keV for $I\gamma < 10$, based on a general comment by 2002Zh01.

‡ 2002Zh01 given only a general statement that uncertainties are 5-30%. Branching ratios are given in the comments.

Adopted Levels, Gammas

$Q(\beta^-) = -8841$ 23; $S(n) = 10239$ 14; $S(p) = 3645$ 16; $Q(\alpha) = 5240$ 30 2012Wa38.
 $S(2n) = 18581$ 15; $S(2p) = 5469$ 17; $Q(\epsilon p) = 1295$ 20 (2012Wa38).

 ^{180}Pt Levels

Cross Reference (XREF) Flags

A ^{180}Au ϵ Decay
 B ^{181}Hg ϵp Decay
 C ^{184}Hg α Decay
 D (HI,xn γ)

E(level) [†]	J π	XREF	T _{1/2} [‡]	Comments
0.0 [§]	0+	ABCD	56 s 3	% ϵ +% β^+ =99.7; % α =0.3. T _{1/2} : weighted average of 60 s 3 (1993Me13), 50 s 5 (1966Si08), and 53 s 4 (1968De01). % α : from 1966Si08. $\delta\langle r^2 \rangle = -0.360$ 11 relative to ^{194}Pt (2000Le40). $\mu = +0.64$ 12.
153.24 [§] 7	2+	ABCD	374 ps 35	J π : E2 153 γ to 0+; band member. μ : from IPAC (1998Br33). Other: +0.70 16 from PDCO (extracted from Fig 19 of 2002Ro36 by evaluator).
410.73 [§] 8	4+	AB D	22.9 ps 28	XREF: B(?). $\mu = +1.6$ 6. J π : E2 258 γ to 2+; band member. μ : from PDCO (extracted from Fig 19 of 2002Ro36 by evaluator).
478.13 [#] 15	0+	A CD		J π : E0 478 transition to 0+.
677.48 [@] 8	2+	A		J π : E0+E2 524 γ to 2+.
757.06 [§] 15	6+	A D	≤ 35 ps	J π : E2 346.5 γ to 4+; band member.
861.39 [#] 7	2+	A		J π : E0+M1+E2 708 γ to 2+, E2 861 γ to 0+.
962.68 [@] 10	3(+)	A D		J π : J=3 from $\gamma\gamma(0)$ in ^{180}Au ϵ decay; (E2) 809 γ to 2+, 552 γ to 4+; band member.
1049.25 [@] 13	(4+)	A		J π : (M1+E2) 639 γ to 4+, 896 γ to 2+; band member.
1177.7 7	0+	A		J π : (E2) 1024 γ to 2+, $\gamma\gamma(0)$ in ^{180}Au ϵ decay.
1181.49 [§] 18	8+	D		J π : E2 424 γ to 6+; band member.
1187.22 18	2+	A D		J π : E0+M1+E2 1034 γ to 2+.
1248.18 [#] 15	(4+)	A D		J π : 1095 γ to 2+, 837 γ to 4+; band member.
1315.24 [@] 14	(5+)	D		J π : E2 352 γ to 3(+), 905 γ to 4+, possible 558 γ to 6+.
1351.11 18	2+	A		J π : E0+(M1+E2) 490 γ to 2+.
1387.6 7		A		
1491.2 7		A		
1535.0 5	(2+, 3, 4+)	A		J π : 1124 γ to 4+, 1382 γ to 2+.
1587.64 ^b 18	(4, 5+)	D		J π : 625 γ to 3(+), 272 γ to (5+).
1614.70 ^{&} 15	(5-, 4+)	D		J π : 858 γ to 6+, 1204 γ to 4+; systematics of negative parity bands in neighboring Os isotopes favors the J π =5- assignment.
1649.90 [#] 19	(6+)	D		J π : 402 γ to (4+); band member.
1674.28 [§] 23	10+	D		J π : E2 493 γ to 8+; band member.
1727.24 [@] 17	(7+)	D		J π : E2 412 γ to (5+), 970 γ to 6+.
1815.03 ^b 16	(6, 7+)	D		J π : (E2) 227 γ to (4, 5+); band member.
1852.20 ^{&} 17	(7-, 6+)	D		J π : E2 238 γ to (4+, 5-); band member.
1915.34 ^c 19	(6, 7+)	D		J π : 328 γ to (4, 5+), 600 γ to (5+).
2012.23 ^b 21	(7, 8+)	D		J π : 362 γ to (6+), 831 γ to 8+.
2107.24 ^b 17	(8, 9+)	D		J π : (E2) 380 γ to (7+), (E2) 292 γ to (6, 7+); band member.
2161.9 3		D		
2168.94 ^{&} 23	(9-, 8+)	D		J π : E2 317 γ to (6+, 7-), 495 γ to 10+; band member.
2182.92 ^c 18	(8, 9+)	D		J π : (E2) 268 γ to (6, 7+); band member.
2198.4 [?] @ 7	(9+)	D		J π : 471 γ to (7+), 1017 γ to 8+; band member.
2229.2 [§] 3	12+	D		J π : E2 555 γ to 10+; band member.
2286.65 ^a 19	(8, 9)	D		J π : (D) 179 γ to (8, 9+), 275 γ to (7, 8+).
2401.6 [?] 7		D		
2444.34 ^a 21	(9, 10)	D		J π : (D) 158 γ to (8, 9-).
2455.0 ^e 3	(9, 10)	D		J π : (D) 286 γ to (8+, 9-).
2556.7 ^{&} 3	(11-, 10+)	D		J π : E2 388 γ to (8+, 9-); band member.
2557.98 ^c 21	(10, 11+)	D		J π : 375 γ to (8, 9+); band member.
2626.10 ^a 22	(10, 11)	D		J π : (E2) 340 γ to (8, 9), (D) 182 γ to (9, 10); band member.
2764.7 ^d 3	(12+)	D		J π : (E2) 1090 γ to 10+.

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Adopted Levels, Gammas (continued) ^{180}Pt Levels (continued)

E(level) [†]	J π	XREF	Comments
2834.20 ^a 24	(11,12)	D	J π : E2 390 γ to (9,10), (D) 208 γ to (10,11); band member.
2841.6 [§] 3	14+	D	J π : E2 612 γ to 12+; band member.
2872.7 ^e 3	(11,12)	D	J π : (E2) 418 γ to (9,10); band member.
3006.3 ^c 3	(12,13+)	D	J π : 448 γ to (10-,11+); band member.
3007.8 ^{&} 4	(13-,12+)	D	J π : E2 451 γ to (10+,11-); band member.
3050.5 ^a 3	(12,13)	D	J π : (D) 216 γ to (11,12), 425 γ to (10,11); band member.
3208.8 ^d 3	(14+)	D	J π : (E2) 444 γ to (12+), (E2) 980 γ to 12+; band member.
3301.9 ^a 3	(13,14)	D	J π : 251 γ to (12,13), E2 468 γ to (11,12); band member.
3361.3 ^e 4	(13,14)	D	J π : E2 489 γ to (11,12); band member.
3504.9 [§] 4	16+	D	J π : E2 663 γ to 14+; band member.
3507.1 ^{&} 4	(15-,14+)	D	J π : E2 499 γ to (12+,13-); band member.
3510.2 ^c 4	(14,15+)	D	J π : 504 γ to (12,13+); band member.
3544.7 ^a 8	(14,15)	D	J π : (D) 243 γ to (13,14), 494 γ to (12,13); band member.
3571.6 4		D	
3676.6 ^d 3	(16+)	D	J π : (E2) 468 γ to (14+), (E2) 835 γ to 14+; band member.
3832.9 ^a 3	(15,16)	D	J π : E2 531 γ to (13,14); band member.
3911.1 ^e 4	(15,16)	D	J π : E2 550 γ to (13,14); band member.
4044.2 ^{&} 4	(17-,16+)	D	J π : E2 537 γ (E2) to (14+,15-); band member.
4063.4 ^c 4	(16,17+)	D	J π : 553 γ to (14,15+); band member.
4099.7 ^a 13	(16,17)	D	J π : (E2) 555 γ to (14,15); band member.
4126.0 4		D	
4180.9 ^d 4	(18+)	D	J π : (E2) 505 γ (E2) to (16+), (E2) 676 γ to 16+; band member.
4252.7 [§] 4	18+	D	J π : E2 747 γ to 16+; band member.
4420.9 ^a 11	(17,18)	D	J π : (E2) 588 γ to (15,16); band member.
4512.5 ^e 5	(17,18)	D	J π : E2 601 γ to (15,16); band member.
4639.8 ^{&} 5	(19-,18+)	D	J π : E2 596 γ to (16+,17-); band member.
4661.1 ^c 5	(18,19+)	D	J π : 598 γ to (16,17+); band member.
4676.3 5		D	
4709.7 ^a 16	(18,19)	D	J π : (E2) 610 γ to (16,17); band member.
4804.4 ^d 4	(20+)	D	J π : (E2) 623 γ (E2) to (18+); band member.
4984.6 [§] 4	20+	D	J π : E2 732 γ to 18+; band member.
5062.9 ^a 15	(19,20)	D	J π : (E2) 642 γ to (17,18); band member.
5160.6 ^e 5	(19,20)	D	J π : (E2) 648 γ to (17,18); band member.
5289.3 ^{&} 5	(21-,20+)	D	J π : (E2) 650 γ to (18+,19-); band member.
5293.0 ^c 5	(20,21+)	D	J π : 632 γ to (18,19+); band member.
5399.8 11		D	
5468.2 ^d 5	(22+)	D	J π : (E2) 664 γ to (20+); band member.
5728.5 [§] 8	22+	D	J π : (E2) 744 γ to 20+; band member.
5753.9 ^a 18	(21,22)	D	J π : 691 γ to (19,20); band member.
5852.6 ^e 11	(21,22)	D	J π : 692 γ to (19,20); band member.
5938.0 ^c 11	(22,23+)	D	J π : 645 γ to (20,21+); band member.
5947.6 ^{&} 6	(23-,22+)	D	J π : 658 γ to (20+,21-); band member.
6007.3 9		D	
6178.7 ^d 5	(24+)	D	J π : (E2) 710 γ to (22+); band member.
6490.9 ^a 20		D	
6525.6 11		D	
6551.5 [§] 13	(24+)	D	J π : 823 γ to 22+; band member.
6580.6 ^e 15	(23,24)	D	J π : 728 γ to (21,22); band member.
6618.4 ^{&} 6	(25-,24+)	D	J π : 671 γ to (22+,23-); band member.
6935.8 ^d 5	(26+)	D	J π : (E2) 757 γ to (24+); band member.
7237.6 [?] 15		D	
7434.5 [§] 16	(26+)	D	J π : 883 γ to (24+); band member.

[†] From a least-squares fit to E γ by evaluator.[‡] From RDM measurements in (HI,xn γ), except where noted.[§] (A): K π =0+ g.s. rotational band.# (B): K π =0+ β -vibrational band.@ (C): K π =2+ γ -vibrational band.& (D): K π =(5-,4+) rotational band.^a (E): K π =(8,9-) rotational band.^b (F): K π =(4,5+) rotational band.^c (G): K π =(6,7+) rotational band.^d (H): K π =(12+) rotational band.^e (I): K π =(9,10) rotational band.

Adopted Levels, Gammas (continued)

$\gamma(^{180}\text{Pt})$						
E(level)	$E_{\gamma}^{\dagger}$	$I_{\gamma}^{\dagger}$	Mult. [‡]	$\delta^{\oplus}$	α	Comments
153.24	153.3\$ 1	100	E2		0.922	B(E2)(W.u.)=154 15.
410.73	257.6\$ 1	100	E2		0.1569	Mult.: from ce data in (HI,xn γ). B(E2)(W.u.)=310 40.
478.13	324.7\$ 2		[E2]		0.0781	Mult.: from ce data in (HI,xn γ).
677.48	478\$		E0#			
	199.4\$ 4	1.7\$ 14	[E2]		0.363 6	
	267.0\$ 5	1.0\$ 7	[E2]		0.1403 22	
	524.3\$ 1	100\$ 2	E0+E2#		0.072 6	α : from sum of α (K)exp, α (L)exp, and α (M)exp in ^{180}Au ϵ decay.
	677.5\$ 1	36\$ 3	[E2]		0.01227	
757.06	346.5 2	100	E2		0.0649	B(E2)(W.u.) $\geq$ 50. Mult.: from ce data in (HI,xn γ).
861.39	184.3\$ 5	1.6\$ 10				
	382.9\$ 3	14\$ 3	(E2)#		0.0492	
	450.7\$ 1	19.3\$ 21	(E2)#		0.0321	
	708.2\$ 1	16\$ 2	E0+M1+E2#	2.0 +36-11	0.24 10	α : from sum of α (K)exp and α (L)exp in ^{180}Au ϵ decay.
	861.3\$ 1	100\$ 7	E2#		0.00739	
962.68	285.8\$ 4	3.2\$ 6				
	551.9\$ 1	12.8\$ 16				
	809.4\$ 1	100\$ 4	(E2)#		0.00840	
1049.25	372.0\$ 4	15\$ 4	[E2]		0.0532	
	638.5\$ 1	100\$ 13	(M1+E2)#		0.028 14	
	895.8\$	17\$ 8	[E2]		0.00682	
1177.7	500.3\$	13\$ 8	[E2]		0.0247	
	1024.3\$	100\$ 10	(E2)#		0.00522	
1181.49	424.3 2	100	E2		0.0375	Mult.: from ce data in (HI,xn γ).
1187.22	326.2\$ 5	$\leq$ 3\$				
	708.9\$	2.5\$ 17	[E2]		0.01112	
	776.6\$ 4	5.6\$ 13	[E2]		0.00916	
	1033.9\$ 2	100\$ 4	E0+M1+E2#	>5.7	0.00523 13	
1248.18	386.6\$ 3	90\$ 40	[E2]		0.0479	
	571.9\$	$\approx$ 27\$	[E2]		0.0180	
	837.4\$ 4	40\$ 30				
	1094.5\$ 3	100\$ 21	[E2]		0.00459	
1315.24	352.5 2	19 6	E2		0.0618	
	558& 1					
	904.6 2	100 9	(M1+E2)		0.012 5	Mult.: D+Q from DCO ratio in (HI,xn γ), $\Delta\pi$ =no from level scheme.
1351.11	388.0\$ 5	17\$ 10				
	490\$		E0(+M1+E2)#		0.05 3	
	673.7\$	$\approx$ 7\$				
	872.9\$ 3	100\$ 11	E2#		0.00719	
	940.6\$ 3	80\$ 30	[E2]		0.00618	
	1197.8\$ 4	22\$ 4				
	1351.4\$	$\approx$ 69\$	[E2]		0.00309	
1387.6	710.4\$	50\$ 30				
	1234.1\$	100\$ 30				
1491.2	528.2\$	40\$ 30				
	814.0\$	100\$ 50				
1535.0	571.7\$	21\$ 14				
	858.1\$	32\$ 18				
	1124.0\$	100\$ 10				
	1382.0\$	75\$ 14				
1587.64	272.2 2	90 30				
	625 1	100 40				
	1177 1	50 20				
1614.70	366.2 2	61 7				
	858.0 2	100 15				
	1204.0 2	71 15				
1649.90	401.8 2	100				
1674.28	492.8 2	100	E2		0.0257	Mult.: from ce data in (HI,xn γ).

Continued on next page (footnotes at end of table)

Adopted Levels, Gammas (continued) $\gamma(^{180}\text{Pt})$ (continued)

E(level)	$E_{\gamma}^{\dagger}$	$I_{\gamma}^{\dagger}$	Mult. [‡]	α	Comments
1727.24	412.2 2 970.3 2	58 15 100 19	E2 (M1+E2)	0.0404 0.010 5	Mult.: (D+Q) from DCO ratio in (HI,xn γ), $\Delta\pi$ =no from level scheme.
1815.03	200 1 227.4 2 499.7 2 1057.8 2	 24 3 100 11 71 6	 E2 E2 (D)	 0.234 0.0248	
1852.20	202.3 2 237.6 2 670.6 2	9 3 33 1 100 9	 E2	 0.203	
1915.34	327.5 2 600.2& 2				
2012.23	160 1 198 1 362.4 2 397 1 831 1				
2107.24	292.2 2 379.9 2 925.7 2	100 10 25 4 28 4	(E2) (E2)	0.1065 0.0503	
2161.9	347& 1 980&a 1				
2168.94	316.7 2 494.7 2		E2	0.0839	
2182.92	267.5 2 367.6 2 456.1 2		(E2)	0.1395	
2198.4?	471 1 1017 1				
2229.2	554.8 2	100	E2	0.0193	
2286.65	125 1 179.4 2 274.5 2 434.5& 2	 59 18 100 14	(D)		
2401.6?	1221& 1	100			
2444.34	157.7 2 282.4 2 337.0 2	31 9 53 13 100 19	(D)		
2455.0	286 1 347.7 2	14 4 100 29	(D) (D)		
2556.7	387.8 2	100	E2	0.0475	
2557.98	375.1 2 450.7 2				
2626.10	181.7 2 339.6 2	29 10 100 19	(D) (E2)	0.0687	
2764.7	364 1 536 1 1090.5 2	 25 21 100 17	(E2)	0.00462	
2834.20	208.0 2 379&	23 5	(D)		
	389.8 2 612.2 2	100 36 100	E2 E2	0.0469 0.01538	
2841.6	417.7 2		(E2)	0.0390	
2872.7	429& 1				
3006.3	448.3 2	100			
3007.8	451.1 2	100	E2	0.0320	
3050.5	216.0 2 424.6 2		(D)		
3208.8	367 1 444.3 2 980 ^a 1	 100 20 100 ^a 10	(E2) (E2)	0.0333 0.00570	
3301.9	251.2 2 467.8 2	13 3 100 18	E2	0.0292	

Continued on next page (footnotes at end of table)

Adopted Levels, Gammas (continued) $\gamma(^{180}\text{Pt})$ (continued)

E(level)	$E_{\gamma}^{\dagger}$	$I_{\gamma}^{\dagger}$	Mult. [‡]	α
3361.3	488.6 2	100	E2	0.0262
3504.9	663.2 2	100	E2	0.01286
3507.1	499.1 2	100	E2	0.0249
3510.2	503.9 2	100		
3544.7	243 1		(D)	
	494 1			
3571.6	563.9 2	100		
3676.6	467.9 2	100 13	(E2)	0.0292
	835.0 2	57 10	(E2)	0.00787
3832.9	531.0 2	100	E2	0.0214
3911.1	549.8 2	100	E2	0.0197
4044.2	537.1 2	100	E2	0.0208
4063.4	553.2 2	100		
4099.7	555 1	100	(E2)	0.0193
4126.0	554.5 2			
	618.8 2			
4180.9	505 1	32 8	(E2)	0.0242
	675.8 2	100 21	(E2)	0.01234
4252.7	576.2 2	55 18		
	747 1	100 12	E2	0.00994
4420.9	588 1	100	(E2)	0.01686
4512.5	601.4 2	100	E2	0.01601
4639.8	595.6 2	100	E2	0.01637
4661.1	597.7 2	100		
4676.3	550.3 2			
	632& 1			
4709.7?	610& 1	100	(E2)	0.01550
4804.4	552& 1	7 5		
	623.5 2	100 16	(E2)	0.01475
4984.6	732.0 2		E2	0.01038
	803& 1			
5062.9	642 1	100	(E2)	0.01382
5160.6	648.1 2	100	(E2)	0.01353
5289.3	649.5 2	100	(E2)	0.01347
5293.0	631.9 2	100		
5399.8	760 1	100		
5468.2	485& 1			
	663.7 2		(E2)	0.01284
5728.5	744 1		(E2)	0.01002
	924& 1			
5753.9	691 1	100		
5852.6	692 1	100		
5938.0?	645& 1	100		
5947.6	658.3 2	100		
6007.3	718 1	100		
6178.7	710.5 2	100	(E2)	0.01106
6490.9?	737& 1	100		
6525.6	578 1	100		
6551.5	823& 1	100		
6580.6	728 1	100		
6618.4	611& 1			
	670.8 2			
6935.8	757.1 2	100	(E2)	0.00966
7237.6?	712& 1	100		
7434.5	883& 1	100		

[†] From (HI,xn γ), except where noted.[‡] From DCO ratios in (HI,xn γ), except where noted. Transitions with measured Q character are adopted here as pure E2.[§] From ^{180}Au ϵ decay.[#] From angular distribution coefficients and electron conversion coefficients in ^{180}Au ϵ decay.[@] From $\gamma\gamma(\theta)$ in ^{180}Au ϵ decay.

& Placement of transition in the level scheme is uncertain.

^a Multiply placed; intensity suitably divided.

^{180}Au ϵ Decay 1999Da18,1990De04

Parent ^{180}Au : $E=0.0$; $J\pi=?$; $T_{1/2}=8.4$ s 6; $Q(\text{g.s.})=8841$ 23; $\% \epsilon + \% \beta^+$ decay ≤ 98.2 .

1999Da18: ^{180}Au activity produced in $^{149}\text{Sm}(^{35}\text{Cl},4n)$, $E(^{35}\text{Cl})=170$ MeV. Measured $E\gamma$, $I\gamma$, $E(\text{ce})$, $I(\text{ce})$, $\gamma\gamma$, $\gamma\gamma(\theta)$, and $(\text{ce})-\gamma$ coincidences using the CAESAR array consisting of 6 Compton-Suppressed HPGe detectors and a superconducting electron spectrometer operated in Lens mode with a cooled Si(Li) detector.

1998Br33: ^{180}Au activity produced in $^{149}\text{Sm}(^{35}\text{Cl},4n)$, $E(^{35}\text{Cl})=168$ MeV. Measured $E\gamma$, $I\gamma$, $\gamma\gamma(\theta, \text{H}, \text{t})$ using GASP array consisting of 40 Compton-suppressed HPGe detectors; deduced g -factor of first 2^+ state using implantation decay technique.

1990De04: ^{180}Au activity produced by 200-MeV protons on targets of Pt-B alloy. Channel selection using magnet and electrostatic separation. Measured $E\gamma$, $I\gamma$, and $\gamma\gamma$ coincidences using four Ge detectors.

1977Hu05: ^{180}Au activity produced by 600-MeV protons on Pb targets. Measured $E\gamma$, $I\gamma$, $\beta\gamma$ coin with Ge(Li) detectors and a scintillator.

The decay scheme is incomplete, as the g.s. feeding is not known and the highest observed level energy of ≈ 1.5 MeV is significantly smaller than the Q value of ≈ 8.8 MeV. Thus, the $I\gamma$ normalization and β feedings are not included in this evaluation.

 ^{180}Pt Levels

$E(\text{level})^\dagger$	$J\pi^\ddagger$	Comments
0.0 §	0+	
153.26 § 7	2+	$g=+0.32$ 6. g : from IPAC (1998Br33).
410.79 § 9	4+	
478.17 # 15	0+	
677.46 @ 8	2+	
757.1 § 5	6+	
861.41 # 8	2+	
962.72 @ 10	3(+)	
1049.29 @ 13	(4+)	
1177.6 3	0+	
1187.23 18	2+	
1248.13 # 19	(4+)	
1351.20 16	2+	
1387.5 3		
1491.3 3		
1535.02 20	(2+, 3, 4+)	

† From a least-squares fit to $E\gamma$'s by evaluator.

‡ From the Adopted Levels.

§ g.s. band.

$K\pi=0^+$ band.

@ $K\pi=2^+$ γ -band.

 $\gamma(^{180}\text{Pt})$

$\alpha(\text{K})$, $\alpha(\text{L})$, $\alpha(\text{M})$, and A_{22}/A_0 , A_{44}/A_0 values are from 1999Da18.

$E\gamma^\dagger$	$E(\text{level})$	$I\gamma^\dagger$	Mult. ‡	δ^a	α	Comments
153.3 1	153.26	100 3	E2		0.922	$E\gamma=152.2$ 3, $I\gamma=100$ (1977Hu05).
184.3 # 5	861.41	0.3 # 2				
199.4 4	677.46	0.5 4	[E2]		0.363 6	
257.6 1	410.79	23.6 9	E2@		0.1569	$E\gamma=256.4$ 3, $I\gamma=30$ 6 (1977Hu05). $\alpha(\text{K})_{\text{exp}}=0.116$ 24. $A_{22}/A_0=0.10$ 4, $A_{44}/A_0=-0.017$ 24.
267.0 # 5	677.46	0.3 # 2	[E2]		0.1403 22	
285.8 4	962.72	0.61 12				
324.7 2	478.17	14.0 6	[E2]		0.0781	$E\gamma=324.0$ 3, $I\gamma=18$ 3, from a 1183 (2+) level (1977Hu05). $A_{22}/A_0=0.45$ 6, $A_{44}/A_0=0.84$ 6.
326.2 # 5	1187.23	≤ 0.3 #				
$\times 343.4$ & 3		14 3				
346.3 §	757.1	0.6 § 2	E2		0.0650	
372.0 4	1049.29	0.45 11	[E2]		0.0532	
382.9 3	861.41	2.7 5	(E2)@		0.0492	$\alpha(\text{K})_{\text{exp}} < 0.11$.
386.6 3	1248.13	1.0 § 5	[E2]		0.0479	$I\gamma$: other: ≤ 0.3 (1990De04).
388.0 # 5	1351.20	0.5 # 3				

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^{180}Au ϵ Decay 1999Da18,1990De04 (continued) $\gamma(^{180}\text{Pt})$ (continued)

$E_{\gamma}^{\dagger}$	E(level)	$I_{\gamma}^{\dagger}$	Mult. ‡	δ^a	α	Comments
450.7 1	861.41	3.7 4	(E2) [@]		0.0321	$E_{\gamma}=450.5$ 5, $I_{\gamma}=7$ (1977Hu05). $\alpha(\text{K})\text{exp}<0.072$. $\alpha(\text{K})\text{exp}>1.0$.
478 [§]	478.17		E0 [@]			$X(\text{E0}/\text{E2})=0.026$ 2. $\alpha(\text{K})\text{exp}>0.30$. α : from $\alpha(\text{K})\text{exp}$.
490 [§]	1351.20		E0 (+M1+E2) [@]		0.05 3	
500.3 [§]	1177.6	0.5 [§] 3	[E2]		0.0247	
524.3 1	677.46	28.6 6	E0+E2 [@]		0.072 6	$E_{\gamma}=524.2$ 3, $I_{\gamma}=44$ 7 (1977Hu05). $\alpha(\text{K})\text{exp}=0.057$ 5, $\alpha(\text{L})\text{exp}=0.010$ 2, $\alpha(\text{M})\text{exp}=0.005$ 2. $A_{22}/A_0=-0.02$ 4, $A_{44}/A_0=0.24$ 5. δ : <-11 from $\gamma\gamma(0)$ (1999Da18). α : from sum of $\alpha(\text{K})\text{exp}$, $\alpha(\text{L})\text{exp}$, and $\alpha(\text{M})\text{exp}$.
528.2 [§]	1491.3	0.6 [§] 4				
551.9 1	962.72	2.4 3				$E_{\gamma}=552.4$ 4, $I_{\gamma}=6.5$ (1977Hu05).
571.7 [§]	1535.02	0.6 [§] 4				
571.9 [§]	1248.13	≈ 0.3 [§]	[E2]		0.0180	
638.5 1	1049.29	2.7 4	(M1+E2)		0.028 14	$\alpha(\text{K})\text{exp}<0.06$. Mult.: E1, M1, E2 from $\alpha(\text{K})\text{exp}$; $\Delta\pi=\text{no}$ from level scheme.
673.7 [§]	1351.20	≈ 0.2 [§]				
677.5 1	677.46	10.2 9	[E2]		0.01227	$E_{\gamma}=676.5$ 4, $I_{\gamma}=20$ 4 (1977Hu05).
708.2 1	861.41	3.0 9	E0+M1+E2 [@]	2.0 +36-11	0.24 10	$E_{\gamma}=707.7$ 5, $I_{\gamma}=4$ (1977Hu05). $A_{22}/A_0=0.21$ 10, $A_{44}/A_0=0.034$ 19. $\alpha(\text{K})\text{exp}=0.21$ 10, $\alpha(\text{L})\text{exp}=0.034$ 19; unresolved from the 708.9 γ . α : from $\alpha(\text{K})\text{exp}+\alpha(\text{L})\text{exp}$.
708.9 [§]	1187.23	0.3 [§] 2	[E2]		0.01112	
710.4 [§] 5	1387.5	0.6 [§] 4				
776.6 4	1187.23	0.67 16	[E2]		0.00916	
809.4 1	962.72	18.8 7	(E2)		0.00840	$E_{\gamma}=808.4$ 4, $I_{\gamma}=30$ 6 (1977Hu05). $\alpha(\text{K})\text{exp}<0.012$. $A_{22}/A_0=-0.19$ 6, $A_{44}/A_0=-0.15$ 7. Mult.: E1 or E2 from $\alpha(\text{K})\text{exp}$. E2 favored from level scheme. δ : <-13 from $\gamma\gamma(0)$ (1999Da18).
814.0 [§]	1491.3	1.4 [§] 7				
837.4 4	1248.13	0.4 3				
858.1 [§]	1535.02	0.9 [§] 5				
861.3 1	861.41	19.2 13	E2 [@]		0.00739	$E_{\gamma}=859.7$ 6, $I_{\gamma}=35$ 7 (1977Hu05). $\alpha(\text{K})\text{exp}=0.0054$ 12.
872.9 3	1351.20	2.9 3	E2		0.00719	$\alpha(\text{K})\text{exp}<0.036$. Mult.: E1, M1, E2 from $\alpha(\text{K})\text{exp}$; E2 from level scheme.
895.8 [§]	1049.29	0.4 [§] 2	[E2]		0.00682	
940.6 3	1351.20	2.3 9	[E2]		0.00618	
1024.3 [§]	1177.6	4.0 [§] 4	(E2)		0.00522	$\alpha(\text{K})\text{exp}<0.009$. $A_{22}/A_0=0.31$ 18, $A_{44}/A_0=0.90$ 20. Mult.: E1 or E2 from $\alpha(\text{K})\text{exp}$, E2 from level scheme.
1033.9 [#] 2	1187.23	12.0 [#] 5	E0+M1+E2	>5.7	0.00523 13	$\alpha(\text{K})\text{exp}=0.0087$ 19. $A_{22}/A_0=-0.09$ 9, $A_{44}/A_0=0.20$ 11. $E_{\gamma}=1032.1$ 7, $I_{\gamma}=23$ 5 from a 1183 (2+) level (1977Hu05).
1094.5 3	1248.13	1.12 23	[E2]		0.00459	
1124.0 [§]	1535.02	2.8 [§] 3				
1197.8 4	1351.20	0.65 11				
1234.1 [§] 3	1387.5	1.3 [§] 4				
1351.4 [§]	1351.20	≈ 2.0 [§]	[E2]		0.00309	
1382.0 [§]	1535.02	2.1 [§] 4				

Footnotes continued on next page

^{180}Au ϵ Decay 1999Da18,1990De04 (continued) $\gamma(^{180}\text{Pt})$ (continued)

[†] From weighted average of data from 1999Da18 and 1990De04, except as noted. Uncertainties of 0.2 to 0.5 keV assumed for $E\gamma$'s from 1999Da18. Values from 1977Hu05 are included in the comments when available.

[‡] From the Adopted Gammas, except where noted.

[§] From 1999Da18.

[#] From 1990De04, not observed in 1999Da18.

[@] From $\alpha(\text{K})\text{exp}$, $\alpha(\text{L})\text{exp}$ (1999Da18).

[&] Observed only in 1977Hu05.

^a From $\gamma\gamma(\theta)$ in 1999Da18.

^x γ ray not placed in level scheme.

Decay Scheme

Intensities: relative I_γ

^{181}Hg ϵp Decay $^{1972}\text{Ho18}$ (continued)**Delayed protons (continued)**

† For intensity per 100 decays, multiply by 1.3×10^{-4} 3.

$\gamma(^{180}\text{Pt})$

E_{γ}	E(level)
150 15	150

Decay Scheme **^{184}Hg α Decay $^{1994}\text{Wa23}$**

Parent ^{184}Hg : $E=0.0$; $J\pi=0^+$; $T_{1/2}=30.87$ s 26; $Q(\text{g.s.})=5662$ 4; $\% \alpha$ decay=1.26 20.

^{184}Hg activity produced in $^{148}\text{Nd}(^{40}\text{Ca}, 4n)$, $E(^{40}\text{Ca})=200$ MeV. Measured $E\alpha$, $I\alpha$, $E(\text{ce})$, α -ce-t and α -x-ray-t coincidences using a PIPS detector for α 's, a LEPS detector for x-rays and a plastic scintillator for ce's.

The absolute intensity of the 5535-keV α was obtained by 1970Ha18 to be 1.25% 20 from their measurements of α/K x-ray ratio. The measured $I(\text{K x-ray})$ was corrected by 1970Ha18 for K x-ray's due to conversion electrons.

In agreement with this intensity, 1980Sc09 obtained $I\alpha(5535\alpha)=1.11\%$ 6 from comparison of the intensities of parent and daughter activities in the same spectrum. The α branchings used for the daughter nuclei are not given in 1980Sc09. A 30% correction was applied by 1980Sc09 to the daughter line for the escaped recoiled nuclei.

In deducing the total α branching, $I\alpha(5535\alpha)=1.25\%$ 20 is adopted here and the 5380 and 5055 α intensities are added to $I\alpha(5535\alpha)$. $I\alpha(5380\alpha)/I\alpha(5535\alpha)=40$ 8/9960 8, as adopted in 1989Fi11, and $I\alpha(5055\alpha)=0.0020\%$ 4, measured by 1994Wa13, are used.

 ^{180}Pt Levels

$E(\text{level})^{\dagger}$	$J\pi^{\dagger}$
0.0	0^+
153	2^+
478	0^+

† From the Adopted Levels.

 α radiations

$E\alpha^{\ddagger}$	E(level)	$I\alpha^{\ddagger\#}$	HF §	Comments
5055 15	478	0.16 3	2.5 5	$E\alpha$: from 1994Wa13.
5380 15	153	0.40 8	47 10	$E\alpha$: other: 5379 15 (1994Wa23).
5539 5	0.0	99.44 10	1.0	$E\alpha$: weighted average of 5539 5 (1976To06) and 5535 15 (1970Ha18). This α line was used by 1994Wa13 for calibration.

† From 1970Ha18, except where noted.

‡ α intensities per 100 α decays. They are deduced from the intensity ratios given above.

§ $r_0(^{180}\text{Pt})=1.512$ 11 is calculated from $\text{HF}(5535\alpha)=1.0$.

$^{\#}$ For α intensity per 100 decays, multiply by 0.0126 20.

(HI,xn γ) 1990De04,2006Wi15

2006Wi15: $^{122}\text{Sn}(^{62}\text{Ni},4n\gamma)$, $E(^{62}\text{Ni})=265$ MeV. Measured $T_{1/2}$ of 4+, 411 level with Recoil Distance Doppler Shift method (RDM) using eight Compton-suppressed Clover detectors and the New Yale Plunger Device.

2002Ro36: $\text{Gd}(^{29}\text{Si},xn\gamma)$, $E(^{29}\text{Si})=145$ MeV. Measured $E\gamma$, $I\gamma(\theta, \text{H})$, $\gamma\gamma$ using CAESAR array consisting of seven Compton-suppressed Ge detectors; deduced g -factor of first 2+ and 4+ levels as well as the average g -factor of high-spin states using PDCO from oriented nuclei. Similar results on the average g -factor of high-spin states is presented in 2002Ro12.

1990De04: $^{144}\text{Nd}(^{40}\text{Ar},4n\gamma)$, $E(^{40}\text{Ar})=170\text{--}200$ MeV. Measured $E\gamma$, $I\gamma$, excitation function, $\gamma\gamma$ and $\gamma\gamma(\theta)(\text{DCO})$ using HERA array consisting of 20 BGO Compton-suppressed Ge detectors; measured $\gamma(\theta)$ and $T_{1/2}$ using one BGO Compton-suppressed Ge detector, a NaI sum spectrometer and a plunger device; measured $E(\text{ce})$, $I(\text{ce})$ using two mini-orange spectrometers.

Level scheme is from 1990De04.

 ^{180}Pt Levels

$E(\text{level})^\dagger$	$J\pi^\ddagger$	$T_{1/2}^\S$	Comments
0.0#	0+		
153.30# 20	2+	374 ps 35	$g=+0.35$ 8.
			g : from PDCO (2002Ro36).
410.8# 3	4+	22.9 ps 28	$g=+0.40$ 15.
			$T_{1/2}$: from RDM in 2006Wi15. Other: 52 ps 10 from RDM in 1990De04.
			g : from PDCO (2002Ro36).
478	0+		
757.2# 3	6+	≤ 35 ps	
962.7& 3	3+		
1181.6# 3	8+		
1187	(2+)		
1248.4@ 3	(4+)		
1315.3& 3	5+		
1587.7 ^c 3	(4, 5+)		
1614.8 ^a 3	(4+, 5-)		
1650.1@ 3	(6+)		
1674.4# 3	10+		
1727.3& 3	(7+)		
1815.1 ^c 3	(6, 7+)		
1852.3 ^a 3	(6+, 7-)		
1915.4 ^d 3	(6-, 7+)		
2012.4 ^c 3	(7, 8+)		
2107.4 ^c 3	(8, 9+)		
2162.0 4			
2169.1 ^a 3	(8+, 9-)		
2183.0 ^d 3	(8-, 9+)		
2198.5?& 8	(9+)		
2229.3# 4	12+		
2286.8 ^b 3	(8, 9-)		
2401.7? 8			
2444.5 3	(9, 10)		
2455.1 ^f 3	(9, 10)		
2556.9 ^a 4	(10+, 11-)		
2558.1 ^d 3	(10-, 11+)		
2626.2 ^b 3	(10, 11)		
2764.8 ^e 4	(12+)		
2834.3 ^b 3	(11, 12)		
2841.7# 4	14+		
2872.8 ^f 4	(11, 12)		
3006.4 ^d 4	(12-, 13+)		
3008.0 ^a 4	(12+, 13-)		
3050.7 ^b 4	(12, 13)		
3209.0 ^e 4	(14+)		
3302.0 ^b 4	(13, 14)		
3361.4 ^f 4	(13, 14)		
3505.1# 4	16+		
3507.2 ^a 5	(14+, 15-)		
3510.3 ^d 4	(14-, 15+)		
3544.8 ^b 8	(14, 15)		
3571.7 5			
3676.7 ^e 4	(16+)		

Continued on next page (footnotes at end of table)

(HI,xn γ) 1990De04,2006Wi15 (continued) **^{180}Pt Levels (continued)**

E(level) [†]	J $\pi^{\ddagger}$	E(level) [†]	J $\pi^{\ddagger}$	E(level) [†]	J $\pi^{\ddagger}$
3833.0 ^b 4	(15, 16)	4709.8 ^b 16	(18, 19)	5947.7 ^a 6	(22+, 23-)
3911.2 ^f 5	(15, 16)	4804.6 ^e 5	(20+)	6007.5 9	
4044.3 ^a 5	(16+, 17-)	4984.7 [#] 5	20+	6178.8 ^e 6	(24+)
4063.5 ^d 5	(16-, 17+)	5063.0 ^b 15	(19, 20)	6491.0 ^b 20	
4099.8 ^b 13	(16, 17)	5160.7 ^f 6	(19, 20)	6525.7 12	
4126.1 5		5289.4 ^a 6	(20+, 21-)	6551.6 [#] 13	(24+)
4181.0 ^e 5	(18+)	5293.1 ^d 5	(20-, 21+)	6580.7 ^f 15	(23, 24)
4252.8 [#] 4	18+	5399.9 11		6618.5 ^a 6	(24+, 25-)
4421.0 ^b 11	(17, 18)	5468.3 ^e 5	(22+)	6935.9 ^e 6	(26+)
4512.6 ^f 5	(17, 18)	5728.6 [#] 8	22+	7237.7 [?] 15	
4639.9 ^a 5	(18+, 19-)	5754.0 ^b 18	(21, 22)	7434.6 [?] 16	(26+)
4661.2 ^d 5	(18-, 19+)	5852.7 ^f 11	(21, 22)		
4676.4 5		5938.1 ^d 11	(22-, 23+)		

[†] From a least-squares fit to E γ by evaluator.[‡] Spin and parity assignments from 1990De04; based on γ -ray multipolarities deduced from measurements of angular distributions, DCO ratios, and conversion coefficients. Rotational band structures are based on systematics of rotational properties observed in nearby nuclei, on angular momentum alignments, and on the comparison of experimental γ -ray reduced transition probabilities with theoretical values.[§] From RDM in 1990De04, except where noted. From $\gamma(t)$ measurements 1990De04 find no transitions with $T_{1/2} > 3.5$ ns.[#] g.s. band.[@] K π =0+ Band.[&] K π =2+ γ -vibrational band.^a K π =(4+, 5-) rotational band.^b K π =(8, 9-) rotational band.^c K π =(4, 5+) rotational band.^d K π =(6-, 7+) rotational band.^e K π =(12+) rotational band.^f K π =(9, 10) rotational band. $\gamma(^{180}\text{Pt})$

DCO ratio is defined as $I\gamma(79^\circ, \text{gated on E2 at } 36^\circ)/I\gamma(36^\circ, \text{gated on E2 at } 79^\circ)$. Theoretical values are DCO=1.0 for $\Delta J=2$ quadrupole and $\Delta J=0$ dipole transitions; DCO=1.2 (weakly aligned) to 2.0 (completely aligned) for $\Delta J=0$ quadrupole and $\Delta J=1$ dipole transitions, DCO=0.85 to 5 for mixed E2/M1 transitions depending on δ and the degree of alignment.

E γ	E(level)	I $\gamma^{\ddagger}$	Mult. [§]	α	I(γ +ce) [†]	Comments
125 1	2286.8					
153.3 2	153.30	56 2	E2	0.922	108 4	$\alpha(L)_{\text{exp}}=0.3$ 1. DCO=1.20 1. Mult.: from $\alpha(L)_{\text{exp}}$ and $\gamma(0)$.
157.7 2	2444.5	1.0 ^a 3	(D)	1.82	2.8 8	DCO=1.6 2.
160 1	2012.4					DCO=0.5 5.
179.4 2	2286.8	1.3 ^a 4	(D)	1.266	3 1	DCO=1.1 2.
181.7 2	2626.2	1.2 ^a 4	(D)	1.221	2.6 9	DCO=2.1 3.
198 1	2012.4					
200 1	1815.1					DCO=1.4 5.
202.3 2	1852.3	0.9 ^a 3		0.904	1.7 6	DCO=1.1 1.
208.0 2	2834.3	0.9 2	(D)	0.837	1.7 4	DCO=2.3 8.
216.0 2	3050.7	0.8 2	(D)	0.754	1.5 3	DCO=1.9 3.
227.4 2	1815.1	1.5 2	Q	0.234	1.8 2	DCO=0.95 15.
237.6 2	1852.3	3.3 1	Q	0.203	4.0 1	DCO=1.05 4.
243 1	3544.8		(D)			DCO=1.8 5.
251.2 2	3302.0	0.5 ^a 1		0.496	0.8 2	
257.6 2	410.8	86.4	E2	0.1569	100.0	$\alpha(K)_{\text{exp}}=0.11$ 3, $\alpha(L)_{\text{exp}}=0.09$ 3. DCO=1.145 11. Mult.: from $\alpha(K)_{\text{exp}}$.
267.5 2	2183.0		(Q)	0.1395		DCO=1.3 3.
272.2 2	1587.7	0.9 ^a 3		0.398	1.3 5	
274.5 2	2286.8	2.2 ^a 3		0.389	3.1 4	DCO=0.69 14.
282.4 2	2444.5	1.7 ^{&} 4		0.1181	1.9 4	DCO=1.9 5.

Continued on next page (footnotes at end of table)

(HI,xn γ) 1990De04,2006Wi15 (continued) $\gamma(^{180}\text{Pt})$ (continued)

E_{γ}	E(level)	$I_{\gamma}^{\ddagger}$	Mult. [§]	α	$I(\gamma+ce)^{\dagger}$	Comments
286 1	2455.1	0.3 ^a 1	(D)	0.348 6	0.4 1	DCO=0.9 6.
292.2 2	2107.4	6.0 5	(Q)	0.1065	6.7 6	DCO=1.0 1.
316.7 2	2169.1	13.3 2	Q	0.0839	14.4 2	DCO=1.05 3.
327.5 2	1915.4				@	
337.0 2	2444.5	3.2 ^a 6		0.223	3.9 8	DCO=0.96 8.
339.6 2	2626.2	4.2 8	(Q)	0.0687	4.5 9	DCO=1.0 2.
346.5 2	757.2	82.2 7	E2	0.0649	87.5 7	$\alpha(K)\text{exp}=0.07$ 3, $\alpha(L)\text{exp}=0.02$ 1. DCO=1.004 8. Mult.: from $\alpha(K)\text{exp}$, $\alpha(L)\text{exp}$.
347 ^b 1	2162.0					
347.7 2	2455.1	2.1 ^a 6	(D)	0.205	2.5 7	DCO=1.5 3.
352.5 2	1315.3	1.0 3	Q	0.0618	1.1 3	DCO=0.4 4 (dipole gated).
362.4 2	2012.4					
364 1	2764.8					
366.2 2	1614.8	2.5 ^a 3		0.178	3.0 4	DCO=0.9 1.
367 1	3209.0				@	
367.6 2	2183.0					
375.1 2	2558.1	2.1& 4		0.0520	2.2 4	
379 ^b	2834.3					
379.9 2	2107.4	1.5 3	(Q)	0.0503	1.6 3	DCO=1.2 5.
387.8 2	2556.9	16.1 2	Q	0.0475	16.9 2	DCO=0.92 2.
389.8 2	2834.3	3.9 14	Q	0.0469	4.1 15	DCO=1.13 12.
397 1	2012.4					DCO=1.4 6.
401.8 2	1650.1	1.2& 3		0.0432	1.3 3	
412.2 2	1727.3	1.5 4	Q	0.0404	1.6 4	DCO=0.3 3 (dipole gated).
417.7 2	2872.8	2.4 4	(Q)	0.0390	2.5 4	DCO=0.8 3.
424.3 2	1181.6	67.3 8	E2	0.0375	69.8 8	$\alpha(K)\text{exp}=0.05$ 2. DCO=0.917 9. Mult.: from $\alpha(K)\text{exp}$.
424.6 2	3050.7					
429 ^b 1	2872.8					
434.5 ^b 2	2286.8					
444.3 2	3209.0	2.0 4	(Q)	0.0333	2.1 4	DCO=1.4 4.
448.3 2	3006.4	3.8& 5		0.0325	3.9 5	
450.7 2	2558.1				@	
451.1 2	3008.0	13.4 10	Q	0.0320	13.8 10	DCO=0.94 2.
456.1 2	2183.0					
467.8 2	3302.0	3.9 7	Q	0.0292	4.0 7	DCO=1.0 1.
467.9 2	3676.7	3.0 4	(Q)	0.0292	3.1 4	DCO=1.4 4.
471 1	2198.5?					
485 ^b 1	5468.3				@	
488.6 2	3361.4	3.2 6	Q	0.0262	3.3 6	DCO=1.13 20.
492.8 2	1674.4	51.2 5	E2	0.0257	52.5 5	$\alpha(K)\text{exp}=0.03$ 1. DCO=0.847 9. Mult.: from $\alpha(K)\text{exp}$.
494 1	3544.8					
494.7 2	2169.1					DCO=1.3 3.
499.1 2	3507.2	10.7 10	Q	0.0249	11 1	DCO=0.98 3.
499.7 2	1815.1	6.3 7	Q	0.0248	6.5 7	DCO=1.25 10.
503.9 2	3510.3	4.9& 5		0.0243	5.0 5	
505 1	4181.0	2.3 6	(Q)	0.0242	2.4 6	DCO=0.83 23.
531.0 2	3833.0	3.0 5	Q	0.0214	3.1 5	DCO=0.92 12.
536 1	2764.8	0.6 ^a 5		0.0650	0.6 5	
537.1 2	4044.3	7.2 9	Q	0.0208	7.4 9	DCO=0.81 3.
549.8 2	3911.2	1.8 3	Q	0.0197	1.8 3	DCO=1.02 20.
550.3 2	4676.4				1.6 3	DCO=1.3 2.
551.9 2	962.7				@	
552 ^b 1	4804.6	0.3& 2		0.0195	0.3 2	
553.2 2	4063.5					
554.5 2	4126.1				1.1 2	
554.8 2	2229.3	36.1 7	Q	0.0193	36.8 7	DCO=0.910 12.
555 1	4099.8		(Q)			DCO=1.1 2.
558 ^b 1	1315.3				@	

Continued on next page (footnotes at end of table)

(HI,xn γ) 1990De04,2006Wi15 (continued) $\gamma(^{180}\text{Pt})$ (continued)

E_{γ}	E(level)	$I_{\gamma}^{\ddagger}$	Mult. [§]	α	$I(\gamma+\text{ce})^{\ddagger}$	Comments
563.9 2	3571.7				2.4 3	DCO=1.2 2.
576.2 2	4252.8	1.8& 6		0.01767	1.8 6	
578 1	6525.7					
588 1	4421.0	2.3 5	(Q)	0.01686	2.3 5	DCO=0.7 2.
595.6 2	4639.9	4.2 6	Q	0.01637	4.3 6	DCO=1.19 5.
597.7 2	4661.2	3.0& 3		0.01624	3.1 3	
600.2 ^b 2	1915.4					
601.4 2	4512.6	1.3 3	Q	0.01601	1.3 3	DCO=1.13 15.
610 ^b 1	4709.8?		(Q)			DCO=0.9 3.
611 ^b 1	6618.5					
612.2 2	2841.7	26.0 12	Q	0.01538	26.5 12	DCO=0.978 16.
618.8 2	4126.1				3.2 4	DCO=0.89 9.
623.5 2	4804.6	4.4 7	(Q)	0.01475	4.5 7	DCO=0.87 11.
625 1	1587.7	1.0& 4		0.01468	1.0 4	DCO=0.8 6.
631.9 2	5293.1					
632 ^b 1	4676.4					
642 1	5063.0	2.4 4	(Q)	0.01382	2.4 4	DCO=1.0 3.
645 ^b 1	5938.1?					
648.1 2	5160.7	0.8 3	(Q)	0.01353	0.8 3	DCO=0.7 5.
649.5 2	5289.4	3.9 7	(Q)	0.01347	4.0 7	DCO=0.83 6.
658.3 2	5947.7					
663.2 2	3505.1	14.2 8	Q	0.01286	14.4 8	DCO=0.886 15.
663.7 2	5468.3	3 1	(Q)	0.01284	3 1	DCO=1.1 2.
670.6 2	1852.3	10.1& 9		0.01255	10.2 9	DCO=1.27 10.
670.8 2	6618.5					
675.8 2	4181.0	7.1 15	(Q)	0.01234	7.2 15	DCO=0.83 7.
691 1	5754.0	1.0& 5		0.01175	1.0 5	
692 1	5852.7	0.6& 3		0.01172	0.6 3	
707 ^b 1	1187					
710.5 2	6178.8	2.0 4	(Q)	0.01106	2.0 4	DCO=1.0 3.
712 ^b 1	7237.7?					
718 1	6007.5					
728 1	6580.7	0.4& 2		0.01050	0.4 2	
732.0 2	4984.7	0.8 5	Q	0.01038	0.8 5	DCO=0.99 9.
737 ^b 1	6491.0?					
744 1	5728.6	1.2 3	(Q)	0.01002	1.2 3	DCO=0.8 4.
747 1	4252.8	3.3 4	Q		3.3 4	DCO=1.1 1.
757.1 2	6935.9	0.9 2	(Q)		0.9 2	DCO=0.9 4.
760 1	5399.9					
803 ^b 1	4984.7				@	
809.4 2	962.7	2.3 5	(D+Q)	0.015 7	2.3 5	DCO=0.9 7.
823 ^b 1	6551.6	0.8& 2			0.8 2	
831 1	2012.4					DCO=3 1.
835.0 2	3676.7	1.7 3	(Q)	0.00787	1.7 3	DCO=0.8 2.
837.4	1248.4					
858.0 2	1614.8	4.1& 6		0.00745	4.1 6	DCO=1.0 1.
883 ^b 1	7434.6?	0.9& 3			0.9 3	
904.6 2	1315.3	5.4 5	(D+Q)	0.012 5	5.5 5	DCO=2.0 4.
924 ^b 1	5728.6				@	
925.7 2	2107.4	1.7 ^a 3		0.01592	1.7 3	DCO=2.7 14.
970.3 2	1727.3	2.6 ^a 5	(D+Q)	0.01413	2.6 5	DCO=1.5 4.
980 ^{#c} 1	2162.0					
	3209.0	2.0 ^c 2	(Q)		2.0 ^c 2	DCO=0.5 2.
1017 1	2198.5?					
1057.8 2	1815.1	4.5 ^a 4	(D)	0.01136	4.6 4	DCO=1.7 4.
1090.5 2	2764.8	2.4 4	(Q)	0.00462	2.4 4	DCO=0.6 6.
1093.4 10	1248.4	1.0& 5		0.00460	1.0 5	
1177 1	1587.7	0.5 ^a 2		0.00868	0.5 2	
1204.0 2	1614.8	2.9 ^a 6		0.00821	2.9 6	DCO=1.3 3.
1221 ^b 1	2401.7?					

[†] For E(^{40}Ar)=180 MeV. Authors measured I_{γ} and reported $I(\gamma+\text{ce})$. Correction for conversion electrons with indicated multipolarity and taking Q transitions as pure E2 and D transitions as pure M1.

(HI,xn γ) 1990De04,2006Wi15 (continued)

 $\gamma(^{180}\text{Pt})$ (continued)

‡ Deduced by evaluator using $I(\gamma+ce)$ and theoretical α for the indicated multipolarity.

§ From DCO ratios except where noted.

Placement from 2162.1 level is uncertain.

@ Weak.

& E2 multipolarity assumed by evaluator in calculating $I\gamma$ from $I(\gamma+ce)$.

a M1 multipolarity assumed by evaluator in calculating $I\gamma$ from $I(\gamma+ce)$.

b Placement of transition in the level scheme is uncertain.

c Multiply placed; intensity suitably divided.

Adopted Levels

$Q(\beta^-) = -5344.24$; $S(n) = 8677.23$; $S(p) = 615.22$; $Q(\alpha) = 5840.18$ 2012Wa38.

$Q(\epsilon p) = 5192.24$; $S(2n) = 19410.60$; $S(2p) = 3920.28$ (2012Wa38).

 ^{180}Au Levels

E(level)	$T_{1/2}$	Comments
0.0	8.4 s 6	$\% \alpha \geq 1.8$; $\% \epsilon + \% \beta^+ \leq 98.2$ (1986Ke03). $T_{1/2}$: weighted average of 8.1 s 3 (1977Hu05) and 9.7 s 6 (1993BoZK).

 ^{180}Hg ϵ Decay 1977Hu05

Parent ^{180}Hg : $E = 0.0$; $J\pi = 0^+$; $T_{1/2} = 2.59$ s 1; $Q(\text{g.s.}) = 5344.24$; $\% \epsilon + \% \beta^+$ decay = 52.2.

^{180}Hg activity produced by protons on Pb at $E_p = 600$ MeV. Measured $E\gamma$, $I\gamma$, $\beta\gamma$ coin using Ge(Li) detector and a scintillator.

 $\gamma(^{180}\text{Au})$

$E\gamma$	$I\gamma$
^x 125.0 4	9.7 20
^x 300.5 3	100
^x 381.2 4	69 14
^x 405.0 5	= 17
^x 450.5 5	= 16
^x 479.9 4	23.0 45

^x γ ray not placed in level scheme.

 ^{184}Tl α Decay 1980Sc09,1976To06

Parent ^{184}Tl : $E = 0.0$; $J\pi = (2^-)$; $T_{1/2} = 10.1$ s 5; $Q(\text{g.s.}) = 6296.26$; $\% \alpha$ decay = 2.1 7.

^{184}Tl -J: from systematics (2012Au07), $\pi s1/2$ coupled to $\nu p3/2$ configuration.

1980Sc09: ^{184}Tl activity from $^{142}\text{Nd}(^{48}\text{Ti}, p9n)$, $E(^{48}\text{Ti}) = 278$ MeV. Channel selection using FEBIAD and mass separation with GSI online facility. Measured $E\alpha$, $I\alpha$ using surface barrier detector.

1976To06: ^{184}Tl activity from $^{180}\text{W}(^{14}\text{N}, 10n)$, $E(^{14}\text{N}) = 168$ MeV. Channel selection using UNISOR isotope separator. Measured $E\alpha$, $I\alpha$, and $T_{1/2}$.

 α radiations

$E\alpha$	$I\alpha^{\dagger\ddagger}$	Comments
5987 4	40 2	$E\alpha$: weighted average of 5988 5 (1976To06) and 5983 10 (1980Sc09).
6066 15	6 1	$E\alpha$: from 1980Sc09.
6161 4	54 3	$E\alpha$: weighted average of 6162 5 (1976To06) and 6155 10 (1980Sc09).

[†] From 1980Sc09.

[‡] For α intensity per 100 decays, multiply by 0.021 7.

Adopted Levels, Gammas

$Q(\beta^-) = -10990$ 60; $S(n) = 11400$ 30; $S(p) = 2551$ 17; $Q(\alpha) = 6258.4$ 24 2012Wa38.

$S(2n) = 20077$ 17; $S(2p) = 2831$ 16; $Q(\epsilon p) = 4729$ 15 (2012Wa38).

 ^{180}Hg Levels

Cross Reference (XREF) Flags

A ^{180}Tl ϵ Decay (1.09 s)

B ^{184}Pb α Decay (490 ms)

C $^{92}\text{Zr}(^{90}\text{Zr}, 2n\gamma)$

D $^{94}\text{Mo}(^{88}\text{Sr}, 2n\gamma)$

E $^{144}\text{Sm}(^{39}\text{K}, p2n\gamma)$

F $^{147}\text{Sm}(^{36}\text{Ar}, 3n\gamma)$

G $^{90}\text{Zr}(^{90}\text{Zr}, \gamma)$

E(level) [†]	J π	XREF	T _{1/2} [@]	Comments
0.0 [‡]	0+	ABCDEF	2.59 s 1	% ϵ +% β^+ =52 2; % α =48 2. T _{1/2} : weighted average of 2.60 s 1 (2013KoZR), 2.59 s 2 (2000Ko48), 2.6 s 8 (1996Pa01), 2.56 s 2 (1993Wa03), 2.6 s 3 (1986Si19), 3.0 s 3 (1977Hu05), and 2.9 s 3 (1970Hu18). Other: 5.9 s 8 (1968De01). % α : weighted average of 48 2 (1999To11), 47 5 (1986Si19), and 49 5 (1982HeZM).
419.8 4	0+	A F		J π : E0 420 transition to 0+.
434.24 [‡] 11	2+	A CDEF	12 ps 2	J π : E2 434 γ to 0+, band member. T _{1/2} : from range of 10 ps<T _{1/2} <14 ps in $^{94}\text{Mo}(^{88}\text{Sr}, 2n\gamma)$.
601.60 13	2+	A F		J π : large E0 component in 167 γ to 2+. E(level): The relative order of the 602 γ –797 γ cascade is reversed in $^{92}\text{Zr}(^{90}\text{Zr}, 2n\gamma)$ giving a level at 797.2 rather than at 601.6. The evaluator adopts the ϵ decay ordering since I γ (602 γ)>I γ (797 γ) in that decay. The I γ data from $^{92}\text{Zr}(^{90}\text{Zr}, 2n\gamma)$ are consistent with this order.
706.27 [‡] 14	4+	A CDEF	19.5 ps 8	J π : E2 272 γ to 2+, band member.
1032.21 [‡] 17	6+	A CDEF	8.8 ps 4	J π : E2 326 γ to 4+, band member.
1091.5 4	(2+, 1)	A		J π : 672 γ to 0+; systematics and non observation of a transition to the g.s. favor J π =2+.
1175.6 10		C		
1204.00 20		A		
1223.77 15	(3-, 4+)	A		J π : 622 γ to 2+, 573 γ from 5(-).
1399.38 16	(3-)	A C		J π : 798 γ to 2+, E2 398 γ from 5(-).
1437.2 [‡] 6	8+	CDEF	2.29 ps 21	J π : E2 404.5 γ to 6+, band member.
1468.79 15	(3-, 4+)	A		J π : 1035 γ to 2+, 329 γ from 5(-).
1504.34 22	(6+)	A C		J π : (E2) 798 γ to 4+.
1663.1 5		A		
1797.48 [§] 16	5(-)	A CD		J π : $\Delta J=1$, D 765 γ to 6+, $\Delta J=1$, D 1091 γ to 4+; $\pi=-$ is suggested by 2000Ko48 based on decay pattern and theoretical comparisons.
1840.5 5		A		
1869.3 4		C		
1914.0 [‡] 6	10+	CDEF		J π : E2 477 γ to 8+, band member.
2022.10 17		A		
2041.89 [§] 25	7(-)	CD		J π : E2 244 γ to 5(-), D 605 γ to 8+, band member.
2057.3 7	(6+)	C		J π : (E2) 620 γ to 8+, population intensity.
2068.7 [#] 5	(6)	C		J π : $\Delta J=0$, D+Q 1036 γ to 6+.
2322.9 5	(8+)	C		J π : E2 819 γ to (6+).
2348.74 16	(4, 5-)	A		J π : 551 γ to 5(-), 949 γ to (3-), direct $\epsilon+\beta^+$ feeding from (5-) parent.
2359.1 [§] 3	9(-)	CD	7.1 ps 8	J π : E2 317 γ to 7(-), band member.
2368.8 9		C		
2371.5 [#] 4	(8)	C		J π : E2 302 γ to (6), band member.
2456.3 [‡] 6	12+	C E		J π : E2 542 γ to 10+, band member.
2487.76 24		A		
2524.0 8	(8+)	C		J π : 466 γ to (6+), 610 γ to 10+.
2741.3 [#] 6	(10)	C		J π : E2 370 γ to (8), band member.
2748.8 [§] 4	11(-)	CD		J π : E2 390 γ to 9(-), band member.
3041.2 12	(10+)	C		J π : 517 γ to (8+).
3055.7 [‡] 6	14+	C E		J π : E2 599 γ to 12+, band member.
3161.6 [#] 7	(12)	C		J π : E2 420 γ to (10), band member.
3199.6 [§] 11	13(-)	C		J π : E2 451 γ to 11(-), band member.
3616.5 [#] 8	(14)	C		J π : E2 455 γ to (12), band member.
3688.6 [§] 11	15(-)	C		J π : E2 489 γ to 13(-), band member.
3704.5 [‡] 7	16+	C E		J π : E2 645 γ to 14+, band member.
4106.5 [#] 11	(16)	C		J π : 490 γ to (14), band member.

Continued on next page (footnotes at end of table)

Adopted Levels, Gammas (continued) ^{180}Hg Levels (continued)

E(level) [†]	J π	XREF	Comments
4194.7 $\frac{\S}{12}$	17(-)	C	J π : E2 506 γ to 15(-), band member.
4388.5 $\frac{\ddagger}{8}$	18+	C	J π : E2 684 γ to 16+, band member.
4627.4 $\frac{?}{14}$	(18)	C	J π : 521 γ to (16), band member.
4733.9 $\frac{\S}{14}$	(19-)	C	J π : 539 γ to 17(-), band member.
5091.5 $\frac{\ddagger}{12}$	(20+)	C	J π : 703 γ to 18+, band member.
5309.6 $\frac{?}{17}$	(21-)	C	J π : 576 γ to (19-), band member.
5803.4 $\frac{?}{14}$	(22+)	C	J π : 712 γ to (20+), band member.

[†] From a least squares fit to E γ by evaluator. $\ddagger$ (A): g.s. band. $\S$ (B): 5(-) band.

(C): (6) band.

@ From Recoil Distance Doppler-Shift measurements in $^{94}\text{Mo}(^{88}\text{Sr},2n\gamma)$. $\gamma(^{180}\text{Hg})$

E(level)	E γ [†]	I γ [†]	Mult. [‡]	α	I(γ +ce)	Comments
419.8	420.3		E0 $\frac{\S}{}$		100	Mult.: K/L=5.8 25 (2011Pa24).
434.24	434.24 $\frac{\#}{12}$	100	E2 $\frac{\S}{}$	0.0383		B(E2)(W.u.)=49 9. Mult.: K/L=3.0 8 (2011Pa24).
601.60	167.0 $\frac{@}{2}$	13.6 $\frac{@}{8}$	E0(+M1, E2) $\frac{\S}{}$	3.5 4		α : deduced from I(γ +ce) in ^{180}Tl ϵ decay (1.09 s). Mult.: K/L=6.6 20 (2011Pa24).
	181.8 $\frac{@}{5}$	0.66 $\frac{@}{4}$	[E2]	0.545 10		
	601.6 $\frac{@}{2}$	100 $\frac{@}{5}$	[E2]	0.01748		
706.27	104.7 $\frac{@}{5}$	2.6 $\frac{@}{7}$	[E2]	4.57 12		B(E2)(W.u.)=770 220. I γ : calculated in ^{180}Tl ϵ decay from relative branching of 105 γ and 272 γ and conversion coefficient. I γ leads to rather large B(E2) strength.
	272.32 $\frac{\#}{16}$	100 $\frac{@}{6}$	E2 $\frac{\S}{}$	0.1427		B(E2)(W.u.)=249 24. Mult.: K/L=2.0 3 (2011Pa24).
1032.21	325.96 $\frac{\#}{9}$	100	E2 $\frac{\S}{}$	0.0835		B(E2)(W.u.)=267 13. Mult.: K/L=2.5 4 (2011Pa24).
1091.5	657.3 $\frac{@}{5}$	100 $\frac{@}{20}$				
	671.6 $\frac{@}{5}$	79 $\frac{@}{4}$				
1175.6	741.4 8	100				
1204.00	498.1 $\frac{@}{5}$	37 $\frac{@}{6}$				
	602.4 $\frac{@}{5}$	43 $\frac{@}{6}$				
	769.7 $\frac{@}{2}$	100 $\frac{@}{6}$				
1223.77	517.4 $\frac{@}{2}$	18.4 $\frac{@}{22}$				
	622.0 $\frac{@}{2}$	100 $\frac{@}{5}$				
	789.4 $\frac{@}{2}$	56 $\frac{@}{6}$				
1399.38	692.9 $\frac{\#}{2}$	53 $\frac{@}{4}$	[E1]	0.00459		
	797.7 $\frac{@}{2}$	100 $\frac{@}{40}$	[E1]	0.00350		
1437.2	404.5 1	100	E2	0.0460		B(E2)(W.u.)=360 40.
1468.79	867.1 $\frac{@}{2}$	25 3				
	1034.6 $\frac{@}{2}$	100 11				
1504.34	472.5 $\frac{@}{5}$	22 $\frac{@}{4}$				
	797.98 $\frac{\#}{18}$	100 $\frac{@}{40}$	(E2)	0.00950		
1663.1	1228.9 $\frac{@}{5}$	100				
1797.48	328.6 $\frac{@}{2}$	90 $\frac{@}{60}$				
	398.24 $\frac{\#}{18}$	100 $\frac{@}{7}$	E2	0.0480		
	573.4 $\frac{@}{2}$	55 $\frac{@}{7}$				
	765.3 $\frac{\#}{4}$	52 3	[E1]	0.00379		
	1091.22 $\frac{\#}{18}$	79 3	[E1]	0.00197		
1840.5	1134.2 $\frac{@}{5}$	100				
1869.3	837.5 4	100	(D)			
1914.0	476.8 1	100	E2	0.0303		
2022.10	553.0 $\frac{@}{2}$	32 $\frac{@}{4}$				
	798.1 $\frac{@}{2}$	100 $\frac{@}{7}$				

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Adopted Levels, Gammas (continued) $\gamma(^{180}\text{Hg})$ (continued)

E(level)	$E_{\gamma}^{\dagger}$	$I_{\gamma}^{\dagger}$	Mult. ‡	α	Comments
2022.10	1316.5@ 2	42.4@ 22			
2041.89	244.4 2	100 5	E2	0.201	
	604.7 4	81 7	[E1]	0.00601	
	1010& 1	<28	[E1]	0.00226	
2057.3	620.1 4	100	(E2)	0.01633	
2068.7	563.6 8	83 22			
	1036.0 8	100 22	D+Q		
2322.9	818.6 4	100	E2	0.00902	
2348.74	326.8@ 2	58@ 9			
	551.1@ 2	31@ 4			
	880.3@ 2	52@ 4			
	948.9@ 2	36@ 11			
	1125.1@ 2	100@ 5			
2359.1	317.2 2	100	E2	0.0903	B(E2)(W.u.)=380 50.
2368.8	499.5 8	100			
2371.5	302.4 4	83 14	E2	0.1040	
	502.6 4	100 17			
	934.0& 8	<34			
2456.3	542.3 1	100	E2	0.0222	
2487.76	1455.4@ 5	38 6			
	1781.5@ 2	100 19			
2524.0	466.4 8	100 35			
	610.2 8	75 15			
2741.3	369.8 4	100	E2	0.0586	
2748.8	389.7 2	100	E2	0.0508	
3041.2	517.2 8	100			
3055.7	599.4 2	100	E2	0.01762	
3161.6	420.3 4	100	E2	0.0416	
3199.6	450.8	100	E2	0.0348	
3616.5	454.9 4	100	E2	0.0340	
3688.6	489.0 4	100	E2	0.0284	
3704.5	648.8 4	100	E2	0.01477	
4106.5	490.0 8	100			
4194.7	506.1 4	100	E2	0.0262	
4388.5	684.0 4	100	E2	0.01316	
4627.4?	520.9& 8	100			
4733.9	539.2 8	100			
5091.5	703.0 8	100			
5309.6?	575.7& 8	100			
5803.4?	711.9& 8	100			

 † From $^{92}\text{Zr}(^{90}\text{Zr}, 2n\gamma)$, except where noted. ‡ From angular distribution coefficients and/or angular anisotropy coefficients in $^{92}\text{Zr}(^{90}\text{Zr}, 2n\gamma)$, except where noted. Q transitions are taken as stretched E2. § From K/L ratio in $^{147}\text{Sm}(^{36}\text{Ar}, 3n\gamma)$. $^{\#}$ Weighted average of ^{180}Tl ε decay (1.09 s) and $^{92}\text{Zr}(^{90}\text{Zr}, 2n\gamma)$.@ From ^{180}Tl ε decay (1.09 s).

& Placement of transition in the level scheme is uncertain.

^{180}Tl ϵ Decay (1.09 s) 2011El07

Parent ^{180}Tl : $E=0.0$; $J\pi=(5-)$; $T_{1/2}=1.09$ s 1; $Q(\text{g.s.})=10990$ 60; $\% \epsilon + \% \beta^+$ decay=94 4.

2011El07: ^{180}Tl activity produced from spallation of UC_x with $E(p)=1.4$ GeV and separated with resonant laser ionization technique and the High Resolution Separator. Measured $E\gamma$, $I\gamma$, $\gamma\gamma$, $E(\text{ce})$, $I(\text{ce})$ using a Miniball cluster detector (consisting of three HPGe crystals) and two Si detectors.

Other: 2013El08, deduced asymmetric fission of excited levels populated in ^{180}Tl decay.

The decay scheme is most likely incomplete, as the highest observed level is at only ≈ 2.5 MeV compared with the large Q value for the decay (10.99 MeV). A total energy release of 9.6 MeV 3 is calculated for this decay scheme using the RADLST code, compared with the effective Q value of 10.3 keV 4.

 ^{180}Hg Levels

$E(\text{level})^\dagger$	$J\pi^\ddagger$	$E(\text{level})^\dagger$	$J\pi^\ddagger$	$E(\text{level})^\dagger$	$J\pi^\ddagger$
0.0	0+	1091.4 4	(2+, 1)	1663.0 5	
419.7 4	0+	1203.87 23		1797.26 19	5(-)
434.13 15	2+	1223.60 19	(3-, 4+)	1840.2 5	
601.47 15	2+	1399.20 19	(3-)	2021.90 20	
706.01 18	4+	1468.62 18	(3-, 4+)	2348.56 19	(4, 5-)
1031.82 24	6+	1504.1 3	(6+)	2487.5 3	

† From a least-squares fit to $E\gamma$ by evaluator.

‡ From the Adopted Levels.

 β^+, ϵ Data

$E\epsilon$	$E(\text{level})$	$I\beta^{+\ddagger}$	$I\epsilon^\ddagger$	$\text{Log } ft$	$I(\epsilon+\beta^+)^\dagger^\ddagger$
(8500 60)	2487.5	1.3 3	0.27 5	6.0	1.6 3
(8640 60)	2348.56	16.5 13	3.12 25	4.9	19.6 15
(8970 60)	2021.90	6.5 9	1.1 1	5.4	7.6 10
(9150 60)	1840.2	0.69 8	0.11 1	6.4	0.80 9
(9190 60)	1797.26	5.2 11	0.81 18	5.5	6.0 13
(9330 60)	1663.0	0.50 13	0.075 19	6.6	0.58 15
(9490 60)	1504.1	4.0 12	0.57 17	5.7	4.6 14
(9770 60)	1223.60	7.6 14	0.98 18	5.5	8.6 16
(9790 60)	1203.87	4.1 4	0.52 5	5.8	4.6 4
(9960 60)	1031.82	8.7 10	1.1 1	5.5	9.8 11
(10280 60)	706.01	21 4	2.3 4	5.2	23 4

† From an intensity balance at each level. Feedings are considered to be upper limits given the large Q value of the decay (10.99 MeV) and the highest observed level at only ≈ 2.5 MeV.

‡ For intensity per 100 decays, multiply by 1.00 5.

 $\gamma(^{180}\text{Hg})$

$I\gamma$ normalization, $I(\gamma+\text{ce})$ normalization: From $\Sigma I(\gamma+\text{c.e.})$ (to g.s.)=94 4. Direct feeding of the ground state is not expected ($\Delta J=5$).

$E\gamma^\dagger$	$E(\text{level})$	$I\gamma^\ddagger^\#$	Mult. §	α	$I(\gamma+\text{ce})^\#$	Comments
104.7 5	706.01	1.4 4	[E2]	4.57 12		$I\gamma$: calculated from $I\gamma(272\gamma)$, the relative branching ratio of the 272γ (89%) and 105γ (11%) determined from $\gamma\gamma$ coincidences, and $\alpha(E2)=4.575$ for the 105γ .
167.0 2	601.47	3.3 2	$E0(+M1+E2)$	3.5 4	15 1	$\text{ce}(\text{K})/(\gamma+\text{ce})=0.39$ 17; $\text{ce}(\text{L})/(\gamma+\text{ce})=0.13$ 4; $\text{ce}(\text{M})/(\gamma+\text{ce})=0.033$ 11; $\text{ce}(\text{N})/(\gamma+\text{ce})=0.008$ 3; $\text{ce}(\text{O})/(\gamma+\text{ce})=0.0015$ 5. $\text{ce}(\text{P})/(\gamma+\text{ce})=5 \times 10^{-5}$ 5. α : deduced from $I(\gamma+\text{ce})$.
181.8 5	601.47	0.16 1	[E2]	0.545 10		$I(\gamma+\text{ce})$: from $\gamma\gamma$ coincidence spectrum gated on 622γ which populates the 602 level.
272.0 2	706.01	54 3	E2	0.1433		$I\gamma$: determined from γ spectrum gated on K electron of 421γ .
325.8 2	1031.82	15.3 10	E2	0.0836		
326.8 2	2348.56	5.6 9				
328.6 2	1797.26	2.7 17				

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^{180}Tl ϵ Decay (1.09 s) 2011El07 (continued) $\gamma(^{180}\text{Hg})$ (continued)

$E\gamma^\dagger$	E(level)	$I\gamma^\ddagger$	Mult.§	α	$I(\gamma+\text{ce})^\#$	Comments
398.2 2	1797.26	2.9 2	E2	0.0480		
421 20	419.7		E0		1.04 5	ce(K)/ce(tot)=0.85 18. I($\gamma+\text{ce}$): from $\Sigma I(\gamma+\text{c.e.})$ feeding the 420 level. Direct feeding of $J\pi=0+$ is not expected. E γ : from Si spectrum gated on 272 γ and 671 γ .
434.0 2	434.13	100 3	E2	0.0383		
472.5 5	1504.1	1.1 2				
498.1 5	1203.87	1.3 2				
517.4 2	1223.60	3.4 4				
551.1 2	2348.56	3.0 4				
553.0 2	2021.90	2.9 4				
573.4 2	1797.26	1.6 2				
601.6 2	601.47	24.3 12	E2	0.01748		
602.4 5	1203.87	1.5 2				
622.0 2	1223.60	18.5 9				
657.3 5	1091.4	1.0 2				
671.6 5	1091.4	0.79 4				I γ : determined from conversion electron spectrum.
692.9 2	1399.20	2.4 2	[E1]	0.00459		
765.4 5	1797.26	1.5 1	[E1]	0.00379		
769.7 2	1203.87	3.5 2				
789.4	1223.60	10.4 12				
797.7 2	1399.20	4.5 17	[E1]	0.00350		
798.0 2	1504.1	5.1 18	(E2)	0.00950		
798.1 2	2021.90	9.2 6				
867.1 2	1468.62	1.9 2				
880.3 2	2348.56	5.0 4				
948.9 2	2348.56	3.5 11				
1034.6 2	1468.62	7.5 8				
1091.2 2	1797.26	2.3 1	[E1]	0.00197		
1125.1 2	2348.56	9.7 5				
1134.2 5	1840.2	1.1 1				
1228.9 5	1663.0	0.8 2				
1316.5 2	2021.90	3.9 2				
1455.4 5	2487.5	0.6 1				
1781.5 2	2487.5	1.6 3				

† Uncertainties taken as 0.2 keV for $I\gamma>1.5\%$ and 0.5 keV for $I\gamma\leq 1.5\%$ from a general statement by 2011El07.

‡ Intensities relative to $I\gamma(434\gamma)=100$; values do not include a correction for summing.

§ From the Adopted Gammas.

$^\#$ For absolute intensity per 100 decays, multiply by 0.73 4.

¹⁸⁰Tl ε Decay (1.09 s) 2011El07 (continued)

Decay Scheme

Intensities: I(γ+ce) per 100 parent decays

¹⁸⁴Pb α Decay (490 ms)

Parent ¹⁸⁴Pb: E=0.0; Jπ=0+; T_{1/2}=490 ms 25; Q(g.s.)=6774 3; %α decay=80 15.

¹⁸⁰Hg Levels

E(level)	Jπ
0.0	0+

α radiations

Eα	E(level)	HF†	Comments
6627 6	0.0	1.00	Eα: weighted average of 6625 10 (1999To11), 6626 6 (1998Co27), 6634 10 (1987To09), 6632 10 (1980Sc09), and 6618 10 (1980Du02). Iα: only one α group has been observed.

† Calculations requiring HF(6627α)=1.0 yield r₀(¹⁸⁰Hg)=1.508 10 for α branching of 80%.

$^{90}\text{Zr}(^{90}\text{Zr},\gamma)$ 1986Si19

$E(^{90}\text{Zr})=358$ MeV. Measured $E\gamma$, $I\gamma$, $\gamma(\theta)$, total γ -ray energy and average multiplicity using an array of 20 NaI detectors covering a geometry of 90% of 4π . Channel selection using the SHIP velocity filter and α - γ coincidences using a position sensitive detector telescope.

Others: 1986Sc07, 1986Ke03.

 $\gamma(^{180}\text{Hg})$

γ -ray assignments proposed by 1986Si19 are included in the comments, however, due to poor energy resolution and statistics (603 γ -ray events were detected), these are not adopted.

$E\gamma$	$I\gamma$	Comments
^x 194 9	26.2 76	$E\gamma$: tentatively placed as 2+ to 0+ transition.
^x 282 11	29.6 88	$E\gamma$: tentatively placed as 4+ to 2+ transition.
^x 342 14	24.9 90	$E\gamma$: tentatively placed as 6+ to 4+ transition.
^x 467 15	24.6 87	

^x γ ray not placed in level scheme.

 $^{92}\text{Zr}(^{90}\text{Zr},2n\gamma)$ 2000Ko48

$^{92}\text{Zr}(^{90}\text{Zr},2n\gamma)$, $E=380$ MeV. Includes: $^{91}\text{Zr}(^{90}\text{Zr},n\gamma)$ at 380 MeV and $^{90}\text{Zr}(^{90}\text{Zr},\gamma)$ at 369 MeV. Measured $E\gamma$, $I\gamma$, $\gamma\gamma$, and $\gamma(\theta)$ using Gammasphere array consisting of 101 Compton-suppressed HPGe detectors. Channel selection performed with recoil-decay tagging technique using Fragment Mass Analyzer with a PPAC and DSSD at the focal plane. Measured $E\alpha$, $T_{1/2}$, recoil- γ - γ and α - γ - γ coincidences.

 ^{180}Hg Levels

$E(\text{level})^\dagger$	$J\pi^\ddagger$	$T_{1/2}$	Comments
0.0 §	0+	2.59 s 2	$T_{1/2}$: from recoil- $\alpha(t)$.
434.30 § 10	2+		
706.70 § 14	4+		
797.2 6	(2+)		
1032.70 § 17	6+		E(level): the relative order of the 602 γ -797 γ cascade is reversed in ^{180}Tl ε decay (1.09 s), giving a level at 602. The evaluator adopts the ε decay ordering since $I\gamma(602\gamma)>I\gamma(797\gamma)$ in that decay. The $^{92}\text{Zr}(^{90}\text{Zr},2n\gamma)$ $I\gamma$ data are consistent with this order.
1175.7 8			
1399.5 5	(3-)		
1437.22 § 20	8+		
1504.8 4	6+		
1797.8 # 3	5-		
1869.8 4	(6-)		
1914.02 § 22	10+		
2042.2 # 4	7-		
2057.4 5	(6+)		
2069.3 @ 5	(6-)		
2323.4 6	8+		
2359.4 # 4	9-		
2369.3 9	(8-)		
2372.1 @ 5	(8-)		
2456.32 § 25	12+		
2524.0 7	(8+)		
2741.9 @ 7	(10-)		
2749.1 # 5	11-		
3041.2 11	(10+)		
3055.7 § 4	14+		
3162.2 @ 8	(12-)		
3199.9 # 5	13-		
3617.1 @ 9	(14-)		
3688.9 # 7	15-		
3704.5 § 5	16+		
4107.1 @ 12	(16-)		
4195.0 # 8	17-		
4388.5 § 7	18+		

Continued on next page (footnotes at end of table)

$^{92}\text{Zr}(^{90}\text{Zr}, 2n\gamma)$ 2000Ko48 (continued) ^{180}Hg Levels (continued)

$E(\text{level})^\dagger$	$J\pi^\ddagger$
4628.0?@ 14	(18-)
4734.2# 11	(19-)
5091.5§ 11	(20+)
5309.9?# 14	(21-)
5803.4?§ 13	(22+)

† From a least-squares fit to $E\gamma$'s by evaluator.

‡ As proposed by 2000Ko48 based on $\gamma(\theta)$ measurements, decay patterns and comparisons of population intensities.

§ (A): g.s. band.

(B): 5- band.

@ (C): (6-) band.

 $\gamma(^{180}\text{Hg})$

R=angular anisotropy ratio, derived from several angles (see 2000Ko48 for details). R>1 suggests $\Delta J=2$, stretched quadrupole or $\Delta J=1$, M1+E2 with positive δ . R<1 suggests $\Delta J=1$, dipole or $\Delta J=1$, M1+E2 with negative δ .

$E\gamma^\dagger$	$E(\text{level})$	$I\gamma^\ddagger$	Mult.§	α	Comments
244.4 2	2042.2	10.7 5	E2	0.201	Mult.: $A_2=+0.31$ 13; R=1.39 25.
272.4 1	706.70	72.5 24	E2	0.1426	Mult.: $A_2=+0.24$ 6, $A_4=-0.12$ 8; R=1.30 6.
302.4 4	2372.1	2.4 4	E2	0.1040	Mult.: R=1.3 4.
317.2 2	2359.4	15.4 7	E2	0.0903	Mult.: $A_2=+0.36$ 9.
326.0 1	1032.70	67.5 22	E2	0.0835	Mult.: $A_2=+0.29$ 6, $A_4=-0.09$ 6; R=1.28 6.
369.8 4	2741.9	8.1 6	E2	0.0586	Mult.: $A_2=+0.54$ 20; R=1.2 3.
389.7 2	2749.1	12.0 6	E2	0.0508	Mult.: $A_2=+0.30$ 11; R=1.26 13.
398.4 4	1797.8	2.5 5	E2	0.0479	Mult.: R=1.1 5.
404.5 1	1437.22	50.3 17	E2	0.0460	Mult.: $A_2=+0.33$ 7, $A_4=-0.03$ 10; R=1.34 8.
420.3 4	3162.2	5.6 5	E2	0.0416	Mult.: R=1.2 3.
434.3 1	434.30	100 3	E2	0.0383	Mult.: $A_2=+0.28$ 6, $A_4=-0.06$ 8; R=1.22 5.
450.8 2	3199.9	10.1 5	E2	0.0348	Mult.: $A_2=+0.53$ 20; R=1.33 22.
454.9 4	3617.1	3.4 4	E2	0.0340	Mult.: R=1.3 3.
466.4 8	2524.0	2.0 7			
476.8 1	1914.02	28.2 12	E2	0.0303	Mult.: $A_2=+0.46$ 12, $A_4=-0.03$ 16; R=1.33 15.
489.0 4	3688.9	5.0 7	E2	0.0284	Mult.: R=1.6 5.
490.0 8	4107.1	1.3 3			
499.5 8	2369.3	1.3 4			
502.6 4	2372.1	2.9 5			
506.1 4	4195.0	3.2 6	E2	0.0262	Mult.: R=1.5 5.
517.2 8	3041.2	1.9 3			
520.9# 8	4628.0?	<1.0			
539.2 8	4734.2	1.8 5			
542.3 1	2456.32	21.5 10	E2	0.0222	Mult.: $A_2=+0.37$ 17, $A_4=+0.03$ 22; R=1.72 23.
563.6 8	2069.3	1.5 4			
575.7# 8	5309.9?	<1.0			
599.4 2	3055.7	13.5 8	E2	0.01762	Mult.: $A_2=+0.43$ 19; R=1.10 25.
602.3 8	1399.5	<2.0			
604.7 4	2042.2	8.7 7	D		Mult.: $A_2=-0.6$ 3; R=0.54 17.
610.2 8	2524.0	1.5 3			
620.1 4	2057.4	5.0 5	E2	0.01633	Mult.: $A_2=+0.50$ 11; R=1.29 16.
648.8 4	3704.5	8.1 5	E2	0.01477	Mult.: R=1.28 21.
684.0 4	4388.5	3.1 4	E2	0.01316	Mult.: R=1.21 25.
692.9 8	1399.5	<2.0			
703.0 8	5091.5	1.0 2			
711.9# 8	5803.4?	<0.8			
741.4 8	1175.7	<1.0			
765.2 8	1797.8	1.7 4	D		Mult.: R=0.65 19.
797.3 8	797.2	<2.0			
797.9 4	1504.8	3.9 5	E2	0.00950 14	Mult.: R=1.11 13.
818.6 4	2323.4	2.1 6	E2	0.00902 13	Mult.: R=1.37 22.
837.5 4	1869.8	2.8 4	(D)		Mult.: R=1.13 19.
934.0# 8	2372.1	<1.0			
1010# 1	2042.2	<3.0			

Continued on next page (footnotes at end of table)

$^{92}\text{Zr}(^{90}\text{Zr}, 2n\gamma)$ 2000Ko48 (continued) $\gamma(^{180}\text{Hg})$ (continued)

$E\gamma^{\dagger}$	E(level)	$I\gamma^{\ddagger}$	Mult. §	Comments
1036.0 8	2069.3	1.8 4	(D)	Mult.: R=1.9 3.
1091.3 4	1797.8	4.6 5	D	Mult.: R=0.73 14.

† $\Delta E\gamma=0.1$ keV for $I\gamma>20$, 0.2 keV for $10<I\gamma<20$, 0.4 keV for $2<I\gamma<10$, and 0.8 keV for $I\gamma<2$, based on a general statement by 2000Ko48.

‡ Intensity relative to $I\gamma(434\gamma)=100$.

§ From angular distribution coefficients and/or angular anisotropy ratios. Stretched Q transitions are assumed to be E2.

Placement of transition in the level scheme is uncertain.

 $^{94}\text{Mo}(^{88}\text{Sr}, 2n\gamma)$ 2009Gr09

$E(^{88}\text{Sr})=300$ MeV. Measured $E\gamma$, $I\gamma$, $T_{1/2}$ with Recoil Distance Doppler-Shift method using JUROGAM array consisting of 43 Compton-suppressed HPGe detectors and the Koln plunger device. Channel selection performed with recoil-decay tagging technique using RITU gas filled spectrometer, a MultiWire Proportional Counter and two DSSDs; measured recoil- α - γ coincidences. Lifetime analysis using the Differential Decay Curve Method.

 ^{180}Hg Levels

$E(\text{level})^{\dagger}$	$J\pi^{\dagger}$	$T_{1/2}^{\ddagger}$	Comments
0.0	0+		
434.2	2+	12 ps 2	$T_{1/2}$: authors give $10 \text{ ps} < T_{1/2} < 14 \text{ ps}$ from assumption that unobserved feeding time varies from prompt to that of the 4+ state lifetime.
706.3	4+	19.5 ps 8	
1032.2	6+	8.8 ps 4	
1437.2	8+	2.29 ps 21	
1797.5	5(-)		
1914.0	10+		
2041.9	7(-)		
2359.1	9(-)	7.1 ps 8	
2748.8	11(-)		

† From the Adopted Levels.

‡ From Recoil Distance Doppler-Shift measurements.

 $\gamma(^{180}\text{Hg})$

$E\gamma^{\dagger}$	E(level)	$E\gamma^{\dagger}$	E(level)	$E\gamma^{\dagger}$	E(level)
244.4	2041.9	389.7	2748.8	604.7	2041.9
272.4	706.3	404.5	1437.2	765.3	1797.5
317.2	2359.1	434.3	434.2	1091.2	1797.5
326.0	1032.2	476.8	1914.0		

† From the Adopted Gammas.

$^{144}\text{Sm}(^{39}\text{K}, \text{p}2\text{n}\gamma)$ 1988Dr05

$E(^{39}\text{K})=183$ MeV. Measured $E\gamma$, $I\gamma$, $\gamma\gamma$ coin, $\text{p}-\gamma\gamma$ coin, $\gamma(\theta)$ using HERA array consisting of 21 Compton-suppressed HPGe detectors and a silicon detector for protons.

 ^{180}Hg Levels

<u>$E(\text{level})^\dagger$</u>	<u>$J\pi^\ddagger$</u>
0.0§	0+
434.1§	2+
706.3§	4+
1032.1§	6+
1436.5§	8+
1913.2§	10+
2454.7§	12+
3054.2§	(14+)
3702§	(16+)

† From a least-squares fit to $E\gamma$'s by evaluator.

‡ As suggested by 1988Dr05. Assignments are based on $\gamma(\theta)$ and assumed rotational structure.

§ g.s. band.

 $\gamma(^{180}\text{Hg})$

<u>$E\gamma$</u>	<u>$E(\text{level})$</u>	<u>$I\gamma$</u>	<u>Mult.†</u>	<u>α</u>	<u>Comments</u>
272.2	706.3	85 2	E2	0.1429	Mult.: $\alpha(\text{exp})$ from transition intensity balance supports an E2 multipolarity.
325.8	1032.1	71 1	E2	0.0836	
404.4	1436.5	47 1	E2 ‡	0.0461	
434.1	434.1	100	E2	0.0383	
476.7	1913.2	28 1	E2	0.0303	
541.5	2454.7	15 1	E2 ‡	0.0223	
599.5	3054.2	11 2		0.01762	
^x 605.0		6 1			
^x 609.1		7 2			
^x 619.8		6 1			
^x 628.4		4 1			
648	3702	5 1		0.01481	

† Based on measured anisotropies and DCO ratios. Quadrupole transitions are assumed to be E2.

‡ From DCO ratio only.

^x γ ray not placed in level scheme.

 $^{147}\text{Sm}(^{36}\text{Ar}, 3\text{n}\gamma)$ 2011Pa24

$E(^{36}\text{Ar})=168$ MeV. Measured $E(\text{ce})$, $I(\text{ce})$ using SACRED spectrometer consisting of 25-element segmented Si detector and a solenoidal magnet. Channel selection performed with the recoil-decay tagging technique using the RITU gas-filled spectrometer and a position-sensitive Si strip detector; measured recoil- α -(ce) coincidences.

 ^{180}Hg Levels

<u>$E(\text{level})^\dagger$</u>	<u>$J\pi^\dagger$</u>
0.0	0+
420	0+
434	2+
601	2+
706	4+
1032	6+
1436	8+
1913	10+

† From the Adopted Levels.

$^{147}\text{Sm}(^{36}\text{Ar}, 3n\gamma)$ 2011Pa24 (continued) $\gamma(^{180}\text{Hg})$

Combined K and L transition intensities given normalized to 100 for the 272 γ ; approximate values read by the evaluator from Fig. 1 of 2011Pa24.

$E\gamma$	E(level)	Mult. [†]	Comments
167 3	601	E0	K/L=6.6 20; Ice(K+L)=66. Ice(167)=3% <i>I</i> relative to Ice(434)+I γ (434).
272	706	E2	K/L=2.0 3; Ice(K+L)=100.
326	1032	E2	K/L=2.5 4; Ice(K+L)=55.
404	1436		Ice(K+L)=29.
420 3	420	E0	K/L=5.8 25; Ice(K+L)=13.
434	434	E2	K/L=3.0 8; Ice(K+L)=22.
477	1913		Ice(K+L)=26.

[†] From measured K/L ratio. Values given in comments were read by the evaluator from Fig. 3 of 2011Pa24.

Adopted Levels

$Q(\beta^-) = -7330$ 60; $S(n) = 9050$ 70; $S(p) = -370$ 70; $Q(\alpha) = 6710$ 50 2012Wa38.

$Q(\epsilon p) = 8440$ 60; $S(2n) = 20610$ 120 (syst); $S(2p) = 1510$ 80 (2012Wa38).

2010An13, 2013El08: $U(p, X)$, $E = 1.4$ GeV. Measured $E\alpha$, $I\alpha$, $T_{1/2}$, $E\gamma$, x-rays, fission fragments.

 ^{180}Tl Levels

E(level)	$J\pi$	$T_{1/2}$	Comments
0.0	(5-)	1.09 s 1	$\% \epsilon + \% \beta^+ = 94$ 4; $\% \epsilon \text{SF} = 3.2 \times 10^{-3}$ 2; $\% \alpha = 6$ 4. $T_{1/2}$: from 2010An13. Others: 1.1 s 2 (2013KoZR), 0.94 s 25 (2013El08, from β -delayed fission(t)), 1.5 s 2 (1998To14), 0.97 s +9-8 (1987La23), 1.9 s 9 (1993BoZK), and 0.70 s +12-9 (1987La23). $J\pi$: direct feeding to 4+ and 6+ states in ^{180}Hg ; proposed configuration of $\pi 3s_{1/2}$ coupled with $\nu 1h_{9/2}$ (2013KoZR, 2011El07). $\% \epsilon + \% \beta^+, \% \alpha$: from 2010An13. $\% \alpha$: other: 7 5 from 2003An27. $\% \epsilon \text{SF}$: from 2013El08. Others: 3.6×10^{-3} 7 (2010An13, earlier analysis of same data in 2013El08), $\approx 1.0 \times 10^{-4}$ from 1987La23.

 ^{184}Bi α Decay (13 ms) 2003An27

Parent ^{184}Bi : $E = 0.0 + x$; $J\pi = ?$; $T_{1/2} = 13$ ms 2; $Q(g.s.) = 8020$ 50; $\% \alpha$ decay = 100.

^{184}Bi activity from $^{93}\text{Nb}(^{94}\text{Mo}, 3n)$, $E(^{94}\text{Mo}) = 380$ to 480 MeV. Channel selection with velocity filter SHIP. Measured $E\alpha$, $\alpha\gamma$ -coin, α -decay branching ratio using position-sensitive Si detector and a coaxial HPGe detector.

 α radiations

$E\alpha$	Comments
7194 20	$E\alpha$: in coincidence with $E\gamma = 124$ 1.
7240 120	$E\alpha$: $E(\alpha) = 7120-7350$, complex structure with contributions from many α -decays.

 $\gamma(^{180}\text{Tl})$

$E\gamma$	
x124 1	^x γ ray not placed in level scheme.

 ^{184}Bi α Decay (6.6 ms) 2003An27

Parent ^{184}Bi : $E = 0.0 + y$; $J\pi = ?$; $T_{1/2} = 6.6$ ms 15; $Q(g.s.) = 8020$ 50; $\% \alpha$ decay = 100.

^{184}Bi activity from $^{93}\text{Nb}(^{94}\text{Mo}, 3n)$, $E(^{94}\text{Mo}) = 380$ to 480 MeV. Channel selection with velocity filter SHIP. Measured $E\alpha$, $\alpha\gamma$ -coin, α -decay branching ratio using position-sensitive Si detector and a coaxial HPGe detector.

 α radiations

$E\alpha$	Comments
7220 15	$E\alpha$: in coincidence with $E\gamma = 449$ 1.
7445 35	
7790 60	$E\alpha$: $E(\alpha) = 7730-7850$, complex structure with contributions from many α -decays. Assignment to ^{184}Bi α decay is tentative.

 $\gamma(^{180}\text{Tl})$

$E\gamma$	
x449 1	^x γ ray not placed in level scheme.

Adopted Levels, Gammas

S(n)=12050 80; S(p)=940 40; Q(α)=7419 5 2012Wa38.

Q(εp)=7710 30; S(2n)=21641 28; S(2p)=191 18 (2012Wa38).

1996To08: $^{144}\text{Sm}(^{40}\text{Ca},4n)$, E=230 MeV. Measured Eα, Iα; deduced evidence for ^{180}Pb .1999To11: $^{90}\text{Zr}(^{92}\text{Mo},2n)$, E=410 MeV. Measured Eα, T_{1/2}; deduced α-branching ratio.2009An20: $^{144}\text{Sm}(^{40}\text{Ca},4n)$, E=196 MeV. Measured Eα, (recoil)α, αα correlations, T_{1/2}, α-branching ratios. **^{180}Pb Levels****Cross Reference (XREF) Flags**A $^{92}\text{Mo}(^{90}\text{Zr},2n\gamma)$

E(level) [†]	Jπ [‡]	XREF	T _{1/2}	Comments
0.0	0+	A	4.1 ms 3	%α=100. T _{1/2} : weighted average of 4.1 ms 3 (2010Ra12) and 4.2 ms 5 (2009An20), both from (recoil)α correlations. Others: 4.5 ms 11 (1999To11) and 4 ms +4-2 (1996To08).
1168 § 1	(2+)	A		
1446 § 1	(4+)	A		
1758 § 2	(6+)	A		
2138 § 2	(8+)	A		

[†] From Eγ.[‡] From yrast structure and systematics of even A=182-188 Pb nuclei.

§ (A): Band based on (2+). Prolate structure based on systematics of heavier Pb isotopes and beyond-mean-field calculations (2010Ra12).

 $\gamma(^{180}\text{Pb})$

E(level)	Eγ	Iγ	Mult.	α
1168	1168 1	100	[E2]	0.00494
1446	278 1	100	[E2]	0.145 3
1758	312 1	100	[E2]	0.1029 18
2138	380 1	100	[E2]	0.0591 10

 $^{92}\text{Mo}(^{90}\text{Zr},2n\gamma)$ 2010Ra12

E(^{90}Zr)=400 MeV. Measured Eα, T_{1/2} using RITU recoil separator for channel selection and 300-μm double-sided silicon strip detector. Measured Eγ, Iγ, (recoil)αγ coin with the recoil decay tagging technique and the JUROGAM II array comprised of 24 EUROGAM HPGe clover detectors and 15 EUROGAM phase one HPGe detectors. Similar results presented in 2011PaZT. Subset of results presented in 2010Ju02.

Cross section for population of ^{180}Pb in this reaction is estimated to be 10 nb. **^{180}Pb Levels**

E(level) [†]	Jπ [‡]	T _{1/2}	Comments
0.0	0+	4.1 ms 3	T _{1/2} : from (recoil)α correlations.
1168 § 1	(2+)		
1446 § 1	(4+)		
1758 § 2	(6+)		
2138 § 2	(8+)		

[†] From Eγ.[‡] From yrast structure and systematics of even A=182-188 Pb nuclei.

§ (A): Band based on (2+). Prolate structure based on systematics of heavier Pb isotopes and beyond-mean-field calculations (2010Ra12).

				$^{92}\text{Mo}(^{90}\text{Zr}, 2n\gamma)$	$^{210}\text{Ra12}$ (continued)
				$\gamma(^{180}\text{Pb})$	
E_γ	$E(\text{level})$	I_γ	Mult.	α	
278 1	1446	93 21	[E2]	0.145 3	
312 1	1758	56 17	[E2]	0.1029 18	
380 1	2138	33 14	[E2]	0.0591 10	
1168 1	1168	100 33	[E2]	0.00494	

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