^{181}Hf β^- decay 1974HeYW,1990He02,1988Bu13

Type	Author	History Citation	Literature Cutoff Date
Full Evaluation	S. -c. Wu	NDS 106, 367 (2005)	31-Aug-2005

Parent: ^{181}Hf: E=0.0; $J^\pi=1/2^-$; $T_{1/2}$=42.39 d *6*; Q(β^-)=1029.8 *21*; %β^- decay=100.0

1990He02: ^{181}Hf activity produced by ^{180}Hf(n,γ); coaxial Ge detector; Eγ, Iγ measured.

1988Bu13: ^{181}Hf activity produced by ^{180}Hf(n,γ); β-spectrometer; Geiger-Muller counter; Ge detector; measured I(ce), Eγ, Iγ.

1965Fu11: ^{181}Hf activity produced by ^{180}Hf(n,γ); Spectrometer, NaI(Tl) detector; measured Eβ, Eγ, Iβ, Iγ, $\beta\gamma$-, $\gamma\gamma$-coin.

1962El09: ^{181}Hf activity produced by ^{180}Hf(n,γ); long lens beta-ray spectrometer, Nai(Tl) scintillation counter; measured Iβ, I(ce), $\beta\gamma$-coin.

Other references: 1959Bo63, 1971Av02, 1969Bl12, 1976Ca11, 1979In02, 1969GuZW, 1977Fr10, 1961Mu03, 1965Fu11, 1966Al05, 1966As02, 1956Bo67.

^{181}Ta Levels

E(level)[†]	J^π[‡]	$T_{1/2}$	Comments
0.0	$7/2^+$	stable	
6.12 *10*	$9/2^-$		
136.252 *18*	$9/2^+$		
482.10 *4*	$5/2^+$	10.8 ns *1*	$T_{1/2}$: weighted average of 10.6 ns *4* (1961Ma47), 11.0 ns *2* (1961Na06), 11.0 ns *1* (1963Ma10), 10.4 ns *2* (1965So02), 10.3 ns *3* (1966Ho13), 11.2 ns *4* (1969Hr02), 10.56 ns *15* (1965Me08), and 11.0 ns *3* (1971Bo13). These values were measured by $\gamma\gamma$(t).
615.12 *4*	$1/2^+$	17.6 μs *2*	$T_{1/2}$: weighted average of 20.1 μs *7* (1948Bu14), 17.2 μs *2* (1953Ba60), 18.8 μs *5* (1953Mu60) measured by βce(t); and 17.83 μs *10* (1959Li44), 17.5 μs *8* (1960Be19), 17.23 μs *14* (1969FaZY), 18.1 μs *3* (1970Gl02) measured by $\beta\gamma$(t).
618.92 *5*	$3/2^+$	0.87 ns *2*	$T_{1/2}$: from $\beta\gamma$(t) (1965Sh16).

[†] From least-square fit to Eγ's.
[‡] From Adopted Levels.

β^- radiations

E(decay)	E(level)	Iβ^-[†‡]	Log *ft*	Comments
404	618.92	7 *3*	8.30 *25*	av Eβ= 119.4 *9* E(decay): from 1965Fu11.
405 *5*	615.12	93 *3*	7.18 *2*	av Eβ= 120.7 *9* E(decay): from 1953Ba81. Other values: 408 *8* (1952Fa14), 408 (1965Fu11).
547[#] *20*	482.10	<0.5	>9.9[1u]	av Eβ= 165.6 *9* E(decay): from 1962El09. Other value: ≈550 from 1959Bo63. Iβ^-: see comments on ground-state feeding.
1045[#] *30*	0.0	<0.0007	>13.7	av Eβ= 345.0 *11* E(decay): from 1962El09, other value ≈1050 from 1959Bo63. Iβ^-: a weak β-decay branch to this level was seen by 1959Bo63 and 1962El09, but not by 1965Fu11 where the limit was established. Direct feeding to this level is third-forbidden and should be negligible. Note also that weak, apparent feeding to the 482 level was observed by 1959Bo63 and 1962El09. Observation of these transitions in some experiments may indicate the existence of a $9/2^+$ ^{181}Hf β^- decaying isomer. Similar isomers are observed in ^{177}Hf and ^{179}Hf.

[†] From 1965Fu11.
[‡] Absolute intensity per 100 decays.
[#] Existence of this branch is questionable.

$\gamma(^{181}Ta)$

Iγ normalization: normalized assuming the sum of the total intensity to the ground state and the first excited state is 100.

E_γ [‡]	I_γ [†#]	E_i(level)	J_i^π	E_f	J_f^π	Mult.	δ	α [@]	$I_{(\gamma+ce)}$ [#]	Comments
3.90[&] *10*		618.92	$3/2^+$	615.12	$1/2^+$	[M1]		2684	5.6 *27*	α(M)= 2018 $I_{(\gamma+ce)}$: calculated from the measured β intensity and intensity balance.
6.3 *3*	0.0143 *5*	6.12	$9/2^-$	0.0	$7/2^+$	E1		70.5 *25*		α(M)= 24.3 I_γ: calculated by the evaluator from the intensity balance. Other values: 0.0125 *28* from I(6.2γ)/L_α x ray=0.0175 *38* and I(482γ)/L_α x ray=13.99 *4* from 1976Ca11. Mult.: from ^{181}W ε decay. α: anomalous E1 with penetration parameter λ=−9 *1* from 1969Bl12. The uncertainty in α is from the penetration parameter only. Note that this value for α is consistent with the intensity of the 476-keV γ feeding the 6-keV level. ce(M1):ce(M2):ce(M45):ce(M3)=1.9(2):3.3(3):1.7(2): 1 ce(N1):ce(N2):ce(N3):ce(N45)=1.6(4):2.3(4): 7.0(35):1 (1969Bl12).
133.021 *19*	53.8 *6*	615.12	$1/2^+$	482.10	$5/2^+$	E2		1.27		α(K)= 0.497; α(L)= 0.582; α(M)= 0.145; α(N+..)= 0.0420 Mult.: L1/L2=0.184 *2*, L2/L3=1.20 *1* (1983Bu18), L1/L23=0.1004 *12* (1989Ki23). Penetration parameters λ(1)=22 *4*, λ(2)=−11 *4* (1989Ki23).
136.260 *18*	7.27 *23*	136.252	$9/2^+$	0.0	$7/2^+$	M1+E2	+0.396 *11*	1.75 *1*		α(K)= 1.37; α(L)= 0.287; α(M)= 0.0670; α(N+..)= 0.0199 δ: from adopted gammas. δ=+0.41 *3* from α and sign from (136γ)(346γ)(θ); A_2=+0.224 *27*, A_4=−0.014 *7* averaged from 1971Av02, 1969Kl11, 1972BeYN, and 1970WiZO. I_γ: from ce(K)(136)/ce(K)(133)=0.3713 *10*, ce(L1)(136)/ce(L3)(133)=0.1084 *7* (1988Bu13); and α(K)exp(133)=0.497, Iγ(136γ+137γ)=8.34. Iγ=7.23 *31* from the ce(K) ratios and Iγ=7.33 *35* from the ce(L) ratios. Others: from Iγ(136):Iγ(137)=4.7 *2*:0.67 *12* (1971Av02) and Iγ(136+137)=8.34, Iγ=7.3 *13*.
136.86 *4*	1.07 *23*	618.92	$3/2^+$	482.10	$5/2^+$	M1		1.83		α(K)= 1.52; α(L)= 0.239; α(M)= 0.0541; α(N+..)= 0.0163 E_γ: from bent crystal spectrometer measurement (1956Bo67). I_γ: from Iγ(136+137)=8.34 and Iγ(136)=7.27 *23* (see

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$\gamma(^{181}Ta)$ (continued)

E_γ ‡	I_γ †#	E_i(level)	J_i^π	E_f	J_f^π	Mult.	δ	α @	Comments
									comment on 136γ).
									Mult.,δ: L1:L2:L3=1.0:0.095:<0.01 and %E2=1 *4* from 1966Al05; α(K)exp=2.2 *6* from 1971Av02.
345.93 *6*	18.78 *12*	482.10	5/2$^+$	136.252	9/2$^+$	E2		0.0544	α(K)= 0.0387; α(L)= 0.0120; α(M)= 0.00288; α(N+..)= 0.000821
									Mult.: Q from 133γ-(346γ)−136γ and 133γ-346γ angular correlations (1971Av02); BM2W <1 from RUL rules out M2.
475.99 *9*	0.873 *7*	482.10	5/2$^+$	6.12	9/2$^-$	M2+E3	0.5 *1*	0.168 *8*	α(K)= 0.154; α(L)= 0.0286; α(M)= 0.00662; α(N+..)= 0.00196
									I_γ: from 1990He02. Other values: 0.758 *22* (1977Fr10), 0.5 *1* (1971Av02), 0.92 *5* (1976Ca11), and 1.45 *20* (1974HeYW). The large, statistically significant, intensity variations reported for this transition may indicate the existence of a previously unreported β-decaying isomer in ^{181}Hf. See also the comments on possible β feeding to the ground state.
482.18 *9*	100.00 *14*	482.10	5/2$^+$	0.0	7/2$^+$	M1+E2	4.76 *4*	0.0295 *8*	α(K)= 0.0183; α(L)= 0.00416; α(M)= 0.000976; α(N+..)= 0.000283
									δ: from L1/L2=2.85 *3*, L2/L3=2.17 *3* (1983Bu18). Others: 6.2 *7* from (133γ)(482γ)(θ), A_2=−0.289 *11*, A_4=−0.074 *4*, averaged from 1971Av02, 1971Sc05, 1977Fr10, and 1969Va22.
									α: anomalous transition with penetration parameter λ=150 *1* (1988Bu13). λ=176 *15* (from 1971Av02, recalculated by the evaluator). α(K)exp weighted average of 0.026 *2*, 0.024 *1*, 0.023 *2*, and 0.021 *2* compiled by 1966Ha50 and 0.0234 *15* (1971Av02).
									Mult.: a small parity-violating E1 admixture to this transition has been investigated by many authors. A precise value for p(γ)=−6.1×10^{-6} *7* was measured by 1971Lo09. For additional values see 1967Lo04, 1967Va29, 1969Cr02, 1970Bo50, 1970Va20, 1971Bo03, 1971De01, 1972Li11, 1972Ku23, and 1974Sc21.
615.17 *11*	0.290 *22*	615.12	1/2$^+$	0.0	7/2$^+$	M3(+E4)		0.194	α(K)= 0.129 *19*; α(L)= 0.033 *4*
									δ: δ=0.7 *3* from α(K)exp=0.132 20 and K:L:M+=11.9 5:2.4 1:0.32 6 (1971Av02). See comment in adopted gammas.
618.66 *8*	0.0311 *15*	618.92	3/2$^+$	0.0	7/2$^+$	(E2)		0.0122	α(K)= 0.00958; α(L)= 0.00194
									Mult.: α(K)exp=0.009 *4* from 1988Bu13.

† From 1990He02, except where noted. The intensity of the 133γ was increased from 44.5 *10* to 53.8 *6*, and the 136γ+137γ doublet from 7.2 *3* to 8.34, the values given in the previous evaluation.

‡ Weighted average of values from 1956Bo67, 1974HeYW, and 1988Bu13.

For absolute intensity per 100 decays, multiply by 0.805 *4*.

@ Total theoretical internal conversion coefficients, calculated using the BrIcc code (2008Ki07) with Frozen orbital approximation based on γ-ray energies,

$^{181}_{73}Ta_{108}$-3

$\gamma(^{181}Ta)$ (continued)

assigned multipolarities, and mixing ratios, unless otherwise specified.
& Placement of transition in the level scheme is uncertain.

$^{181}_{73}Ta_{108}$-4

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Decay Scheme

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