^{169}Hf $\varepsilon+\beta^+$ decay (3.24 min)   1973Me09,1973FoYE

History

Type	Author	Citation	Literature Cutoff Date
Full Evaluation	M. Shamsuzzoha Basunia	NDS 209,1 (2026)	1-Oct-2025

Parent: ^{169}Hf: E=0.0; J$^\pi$=5/2$^-$; T$_{1/2}$=3.24 min 5; Q(ε)=3366 28; %ε+%β^+ decay=100

^{169}Hf-J$^\pi$,T$_{1/2}$: from ^{169}Hf Adopted Levels.

^{169}Hf-Q($\varepsilon+\beta^+$): from 2021Wa16.

1973Me09: sources from ^{170}Yb(^{3}He,4n); Yb oxide targets enriched to 67% in ^{170}Yb; measured Eγ, Iγ (Compton-suppressed Ge(Li) (FWHM=1.9 keV at 1332 keV), surface-barrier Ge(Li) (FWHM=0.8 keV at 122 keV)), Ice (Si(Li)), half-life of ^{169}Hf.

1973FoYE: sources from ^{168}Yb(α,3n) and ^{170}Yb(α,5n); measured Eγ, Iγ (Ge(Li), FWHM=1.4 keV at 100 keV, 2.3 keV at 1 MeV); measured Eγ, Iγ $\gamma\gamma$ coin; placed 72.9γ and 68.4γ.

1969Ar23: Hf sources from ^{169}Ta parent decay; measured Eγ, Iγ, γ(t), $\gamma\gamma$ coin using coaxial Ge(Li) and NaI(Tl) detectors, and β^+ data using a 2 cm x 2 cm anthracene crystal (14% energy resolution for 624-keV ce line from ^{137}Cs), also I($\gamma^\pm$).

1970At01: Measured Eγ, Iγ and half-life of ^{169}Hf.

1970Ch17: Measured Eγ, Iγ, I($\gamma^\pm$), and half-life of ^{169}Hf.

1975Gr44: Measured Eγ, Iγ and half-life of ^{169}Hf.

The decay scheme is tentative and incomplete. The measured I(K x ray) cannot be corrected for K conversion of possible 71γ and 85γ because their intensities are unknown; if significant, this would lower εK/β^+ and, hence, the calculated $\varepsilon+\beta^+$ feeding to the 493 level. However, a very large change in feeding to the 493 level would be required to invalidate the conclusion that this is an allowed, unhindered transition. Feeding to the (5/2$^-$) 43 level may be significant, but is unknown. There may also exist feeding to levels with E>493 that are as yet unknown.

^{169}Lu Levels

E(level)†	J$^{\pi\ddagger}$	T$_{1/2}$‡	Comments
0.0	7/2$^+$	34.06 h 5	
29.0 5	1/2$^-$	160 s 10	
42.9 6	(5/2$^-$)		
97.4 5	(1/2$^+$)		log $f^{1u}t$>8.5 implies %ε+%β^+ feeding<0.4 to this level.
113.8 6	(3/2$^+$)		log ft>5.9 implies %ε+%β^+<5 to this level.
123.49 15	(9/2)$^+$		log $f^{1u}t$>8.5 implies %ε+%β^+ feeding<0.4 to this level, consistent with intensity balance at this level.
186.7 6	(5/2$^+$)		
492.89 10	7/2$^-$		

† From least-squares fit to Eγ.
‡ From Adopted Levels.

ε,β^+ radiations

Additional information 1.

E(decay)	E(level)	Iβ^+ †	I$\varepsilon^\dagger$	Log ft	I($\varepsilon+\beta^+$)†	Comments
(2873 28)	492.89	>12.1	>75.9	<4.6	>88	av Eβ=834 12; εK=0.714 5; εL=0.1125 8; εM+=0.03576 22 E(decay): 2872 200 from measured Eβ+=1850 200 (1969Ar23). I($\varepsilon+\beta^+$): estimated in 1973Me09 from I(K x ray)=86 5 and I($\gamma^\pm$)=33.0 15, relative to Iγ=100 for 492.9γ (1973Me09).
(3179 28)	186.7	<1.0	<4.0	>5.9	<5	av Eβ=970 12; εK=0.659 6; εL=0.1035 9; εM+=0.03288 25 I($\varepsilon+\beta^+$): 6.8 from intensity imbalance; however, uncertainty may be large (1973FoYE do not state uncertainty in I(73γ)). <5% feeding is expected based on log ft>5.9 for first-forbidden transition.

Continued on next page (footnotes at end of table)

^{169}**Hf** $\varepsilon+\beta^+$ **decay (3.24 min)**   **1973Me09,1973FoYE** (continued)

ϵ,β^+ radiations (continued)

E(decay)	E(level)	Iβ^+ †	Iε†	Log ft	I($\varepsilon+\beta^+$)†	Comments
(3323‡ 28)	42.9					
(3366‡ 28)	0.0	<1.2	<3.7	>6.0	<5	av Eβ=1053 *13*; εK=0.622 *6*; εL=0.0976 *10*; εM+=0.03099 *26*
						I($\varepsilon+\beta^+$): from log ft>5.9 for first-forbidden transition.

† Absolute intensity per 100 decays.
‡ Existence of this branch is questionable.

^{169}**Hf** $\varepsilon+\beta^+$ **decay (3.24 min)**   **1973Me09,1973FoYE** (continued)

^{169}Hf $\varepsilon+\beta^+$ decay (3.24 min)   **1973Me09,1973FoYE (continued)**

$\gamma(^{169}$Lu)

Iγ normalization: from ΣI(γ+ce) 94 *6* from 492.9 keV level, based on the estimated total of >88% to satisfy K/β=5.2 *14-4* from measured I(K x ray)=86 *5* and
   I($\gamma^\pm$)=33.0 *15* relative to I(493γ)=100 (1973Me09). This normalization should be considered to be highly tentative. Other I($\gamma^\pm$)=27 (1969Ar23), 82 *20* relative to
   I(493γ)=100 (1970Ch17).
Iγ(K x ray)=86 *5*, I($\gamma^\pm$)=33.0 *15*, relative to Iγ=100 for 492.9γ (1973Me09).

E_γ[†]	I_γ[†][a]	E_i(level)	J_i^π	E_f	J_f^π	Mult.[‡]	α[&]	$I_{(\gamma+ce)}$[a]	Comments
(14.1[@])		42.9	(5/2$^-$)	29.0	1/2$^-$				
(16.4[@])		113.8	(3/2$^+$)	97.4	(1/2$^+$)			$\approx$3.7	$I_{(\gamma+ce)}$: since negligible $\varepsilon+\beta^+$ feeding of the 97 level is expected (ΔJ^π=2, no), the level scheme implies I(γ+ce)(16γ)$\approx$I(γ+ce)(68γ)=3.7.
(29.0 *5*)		29.0	1/2$^-$	0.0	7/2$^+$	E3	9.4$\times$10^4 *10*		α(L)=6.8$\times$10^4 *7*; α(M)=2.08$\times$10^4 *24* α(N)=4.9$\times$10^3 *6*; α(O)=5.4$\times$10^2 *6*; α(P)=0.346 *35* E$_\gamma$,Mult.: from Adopted Gammas.
68.4[@] *1*	1.9[#]	97.4	(1/2$^+$)	29.0	1/2$^-$	(E1)[@]	0.931 *13*		α(K)=0.754 *11*; α(L)=0.1379 *20*; α(M)=0.0311 *5* α(N)=0.00716 *10*; α(O)=0.000951 *14*; α(P)=3.88$\times$10^{-5} *6*
(70.9[@] *2*)		113.8	(3/2$^+$)	42.9	(5/2$^-$)	[E1]	0.852 *13*		α(K)=0.691 *11*; α(L)=0.1248 *20*; α(M)=0.0282 *5* α(N)=0.00648 *10*; α(O)=0.000864 *14*; α(P)=3.56$\times$10^{-5} *6*
72.9[@] *2*	0.7[#]	186.7	(5/2$^+$)	113.8	(3/2$^+$)	[M1,E2]	10.6 *15*		α(K)=4.6 *30*; α(L)=4.6 *34*; α(M)=1.1 *9* α(N)=0.26 *20*; α(O)=0.032 *23*; α(P)=3.4$\times$10^{-4} *23*
(84.8[@] *2*)		113.8	(3/2$^+$)	29.0	1/2$^-$	[E1]	0.538 *8*		α(K)=0.440 *7*; α(L)=0.0760 *12*; α(M)=0.01712 *26* α(N)=0.00395 *6*; α(O)=0.000534 *8*; α(P)=2.317$\times$10^{-5} *35*
123.6 *2*	5.0 *5*	123.49	(9/2)$^+$	0.0	7/2$^+$	M1,E2	1.76 *25*		α(K)=1.1 *5*; α(L)=0.47 *21*; α(M)=0.11 *6* α(N)=0.026 *13*; α(O)=0.0034 *14*; α(P)=8 E$_\gamma$: others: 123.2 (1970At01), 123 (1970Ch17), 123 (1975Gr44). I$_\gamma$: weighted average of 4.6 *5* (1973Me09) and 5.6 *6* (1970Ch17). Others: 8 (1970At01), 7 (1975Gr44). Mult.: from 1.16<α(exp)<5.0 (1973Me09 − scaled from 1.17<α(exp)<5.1) with α_1=0.0814(Bricc)/0.0823(1973Me09) for the 198.84 keV *3* 4$^+$ to 2$^+$ transition in 168Yb.
369.5 *2*	11.7 *8*	492.89	7/2$^-$	123.49	(9/2)$^+$	[E1]	0.01253 *18*		α(K)=0.01054 *15*; α(L)=0.001548 *22*; α(M)=0.000346 *5* α(N)=8.11$\times$10^{-5} *11*; α(O)=1.173$\times$10^{-5} *16*; α(P)=6.64$\times$10^{-7} *9* E$_\gamma$: others: 369.3 (1970At01), 368 (1970Ch17), 369 (1975Gr44). I$_\gamma$: weighted average of 11.6 *10* (1973Me09) and 11.9 *12* (1970Ch17). Others: 11 (1970At01), 13 (1975Gr44).
492.86 *10*	100	492.89	7/2$^-$	0.0	7/2$^+$	E1	0.00651 *9*		α(K)=0.00550 *8*; α(L)=0.000792 *11*; α(M)=0.0001765 *25* α(N)=4.14$\times$10^{-5} *6*; α(O)=6.04$\times$10^{-6} *8*; α(P)=3.53$\times$10^{-7} *5*

¹⁶⁹Hf ε+β⁺ decay (3.24 min)   1973Me09,1973FoYE (continued)

$\gamma(^{169}\text{Lu})$ (continued)

E$_\gamma$[†]	E$_i$(level)	Comments
		E$_\gamma$: others: 492.3 (1970At01), 491 (1970Ch17).
		I$_\gamma$: same value in 1970At01, 1970Ch17, and 1975Gr44.
		α(K)exp=0.004 *1* (1973Me09).

[†] From 1973Me09, except as noted.

[‡] From α(K)exp, as deduced from simultaneous measurement of Ice and Iγ, except where noted (detector calibration assumes α(L)=0.0814 (E2 theory) for 198.8γ in ¹⁶⁸Yb) (1973Me09). Same in the adopted dataset.

[#] From 1973FoYE; uncertainty unstated by authors.

[@] From Adopted Gammas.

[&] Additional information 2.

[a] For absolute intensity per 100 decays, multiply by ≈0.82.

^{169}**Hf** $\varepsilon + \beta^+$ **decay (3.24 min)**   **1973Me09,1973FoYE**

Decay Scheme

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

Legend

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

$5/2^-$ 0.0   3.24 min 5

$\%\varepsilon + \%\beta^+ = 100$

$Q_\varepsilon = 3366\ 28$

$^{169}_{72}\text{Hf}_{97}$

	$I\beta^+$	$I\varepsilon$	Log ft
$7/2^-$ 492.89	>12.1	>75.9	<4.6
$(5/2^+)$ 186.7	<1.0	<4.0	>5.9
$(9/2)^+$ 123.49			
$(3/2^+)$ 113.8			
$(1/2^+)$ 97.4			
$(5/2^-)$ 42.9			
$1/2^-$ 29.0 160 s 10			
$7/2^+$ 0.0 34.06 h 5	<1.2	<3.7	>6.0

492.86 E1 ≈83
369.5 [E1] ≈9.7
72.9 [M1,E2] ≈6.7
123.6 M1,E2 ≈11
84.8 [E1]
70.9 [E1]
16.4 ≈3.0
68.4 (E1) ≈3.0
14.1
29.0 E3

$^{169}_{71}\text{Lu}_{98}$