^{154}Lu $\varepsilon+\beta^+$ decay 1988Vi02

Type	Author	History Citation	Literature Cutoff Date
Full Evaluation	N. Nica	NDS 200,2 (2025)	22-Aug-2022

Parent: ^{154}Lu: E=62 *12*; $J^\pi=(9^+)$; $T_{1/2}$=1.12 s *8*; Q(ε)=10270 *syst*; %ε+%β^+ decay=100

^{154}Lu-E: Additional information 1.

^{154}Lu-J^π: Additional information 2.

^{154}Lu-Q($\varepsilon+\beta^+$): Additional information 3.

^{154}Lu-Q($\varepsilon+\beta^+$): 10270 *200* (2021Wa16).

^{154}Lu-%ε+%β^+ decay: Value (%ε+%β^+=100) assumed by evaluator from lack of reported α decays and the fact that the half-life is comparable to that calculated for the ε decay, namely 1.18 s (2019Mo01).

Additional information 4.

1988Vi02: Produced by Mo(^{64}Zn,x) with E=285 MeV. The studies were done on-line at the OASIS facility. The products were mass-separated and the A=154 mass fraction was transported to a counting area, collected on a tape and transported (within 65 ms) for spectroscopic study. A ΔE-E particle telescope and a variety of Ge detectors were used to record coincidences. In addition, γ singles, γ(t), K x-ray and annihilation radiation were measured.

1981Ho10: Produced by bombardment of targets with ^{58}Ni or ^{107}Ag ions with energies of 4.4-5.9 MeV/mass unit. Products separated in velocity selector and α measured with Si detector. ^{154}Lu identified by growth and decay characteristic of its daughter.

1984HaZD: Produced by bombardment of targets of ^{96}Mo and ^{96}Ru with 250-260 MeV ^{58}Ni and ^{60}Ni ions. γ and X rays measured with Ge detectors. Q values were determined from Kx/β^+ ratios.

α emission following this ε decay has been reported from levels between 3 and 6 MeV with I_α=0.03% (1988Vi02). Similarly, proton emission has been reported from levels between 6.5 and 9 MeV, with I_p=0.06% (1988Vi02).

Data are from 1988Vi02, unless otherwise noted. Others: 1984HaZD, 1981Ho10.

Since Q(ε) ≈ 10 MeV and only a few γ's are reported and placed, the proposed decay scheme is clearly incomplete. Thus, it is not possible to quote reliable intensities for the $\varepsilon+\beta^+$ transitions from these data.

^{154}Yb Levels

E(level)[†]	J^π[‡]	$T_{1/2}$	Comments
0[&]	0^+[#]	0.409 s *2*	$T_{1/2}$: From Adopted Levels.
821.3[&] *2*	(2^+)[#]		
1516.0[&] *3*	(4^+)[#]		
1949.6[&] *4*	(6^+)[#]		
2046.2[&] *4*	(8^+)[@]	28 ns *2*	$T_{1/2}$: From $\gamma\gamma$(t) in ^{106}Cd(^{54}Fe,α2pγ) (1993Zh10, using the three strongest transitions below and above it). 1988Vi02 report $T_{1/2}$=45 ns *10* and assign that lifetime to this level.

[†] Additional information 5.

[‡] From the systematics of the even-even N=84 nuclides in this mass region (1988Vi02).

[#] Configuration=$((\pi h^6_{11/2})(\nu f^2_{7/2}))$.

[@] Configuration=$((\pi h^6_{11/2})(\nu h_{9/2})(\nu f_{7/2}))$.

[&] Seq.(A): Yrast sequence of positive-parity levels.

ε,β^+ radiations

E(decay)	E(level)	Log *ft*	$I(\varepsilon+\beta^+)$[†#]
(8286 *syst*)	2046.2	≥4.4	≤56[‡]
(8382[@] *syst*)	1949.6	≥4.7	≤29[‡]

[†] 1988Vi02 show these values as upper limits only, since the decay scheme is only fragmentary and, as a result, much of the strength of the observed deexciting γ's may be from the feeding of their parent levels by the γ decay of higher-lying, but

Continued on next page (footnotes at end of table)

^{154}Lu $\varepsilon+\beta^+$ decay 1988Vi02 (continued)

ε,β^+ radiations (continued)

unreported, excited states.

‡ 1988Vi02 report significant $\varepsilon+\beta^+$ feeding from ^{154}Lu to these two levels and from this conclude that J^π for the ^{154}Lu parent is (7^+). They also indicate that this $\varepsilon+\beta^+$ feeding pattern suggests a similar structure for these two final states. The odd proton and odd neutron in the ^{154}Lu parent state are in the π $h_{11/2}$ and ν $f_{7/2}$ orbitals, respectively. The implied low log*ft* values indicate strong Gamow-Teller transitions, which in this case would be π $h_{11/2}\rightarrow\nu$ $h_{9/2}$. It is now believed, however, that the configurations of the two ^{154}Yb final states are quite different (see the discussion in the ^{106}Cd(^{54}Fe,α2pγ) data set, as well as those in the original studies (1993Zh10 and 1996Zh09)). Only one of these states, the (8^+) level, can be fed by a strong Gamow-Teller transition. The transition to the (6^+) level would be π $h_{11/2}\rightarrow$ ν $f_{7/2}$. It will be much weaker (and, possibly, may not take place).

Absolute intensity per 100 decays.

@ Existence of this branch is questionable.

$\gamma(^{154}Yb)$

Iγ normalization: Normalized to give 99.91% feeding to ground state from 821γ alone; however due to the incompleteness of the level scheme it is likely to have other γ branches to the g.s., which in fact rather makes the normalization factor an upper limit. The value 99.91% allows for 0.06% proton emission and 0.03% α emission from high-energy (3 to 9 MeV) levels (1988Vi02).

E_γ	I_γ‡	E_i(level)	J_i^π	E_f	J_f^π	Mult.	α†	Comments
96.6 *2*	12 *3*	2046.2	(8^+)	1949.6	(6^+)	E2	3.67 *6*	α(K)=1.096 *16*; α(L)=1.964 *33*; α(M)=0.484 *8* α(N)=0.1104 *19*; α(O)=0.01267 *22*; α(P)=4.69×10^{-5} *7* %I$\gamma\leq$12 Mult.: From α_K(exp)=1.3 *3*. Value determined from the intensity of the Yb K x rays relative to Iγ(96.8) measured in coincidence with positrons in the ^{154}Lu ε decay.
433.6 *2*	83 *2*	1949.6	(6^+)	1516.0	(4^+)	[E2]	0.0259 *4*	α(K)=0.01994 *28*; α(L)=0.00459 *6*; α(M)=0.001069 *15* α(N)=0.0002477 *35*; α(O)=3.24×10^{-5} *5*; α(P)=1.078×10^{-6} *15* %I$\gamma\leq$83
694.7 *2*	97 *2*	1516.0	(4^+)	821.3	(2^+)	[E2]	0.00810 *11*	α(K)=0.00659 *9*; α(L)=0.001173 *16*; α(M)=0.000267 *4* α(N)=6.23×10^{-5} *9*; α(O)=8.51×10^{-6} *12*; α(P)=3.68×10^{-7} *5* %I$\gamma\leq$96
821.3 *2*	100	821.3	(2^+)	0	0^+	[E2]	0.00560 *8*	α(K)=0.00461 *6*; α(L)=0.000770 *11*; α(M)=0.0001743 *24* α(N)=4.07×10^{-5} *6*; α(O)=5.63×10^{-6} *8*; α(P)=2.59×10^{-7} *4* %Iγ<99.4

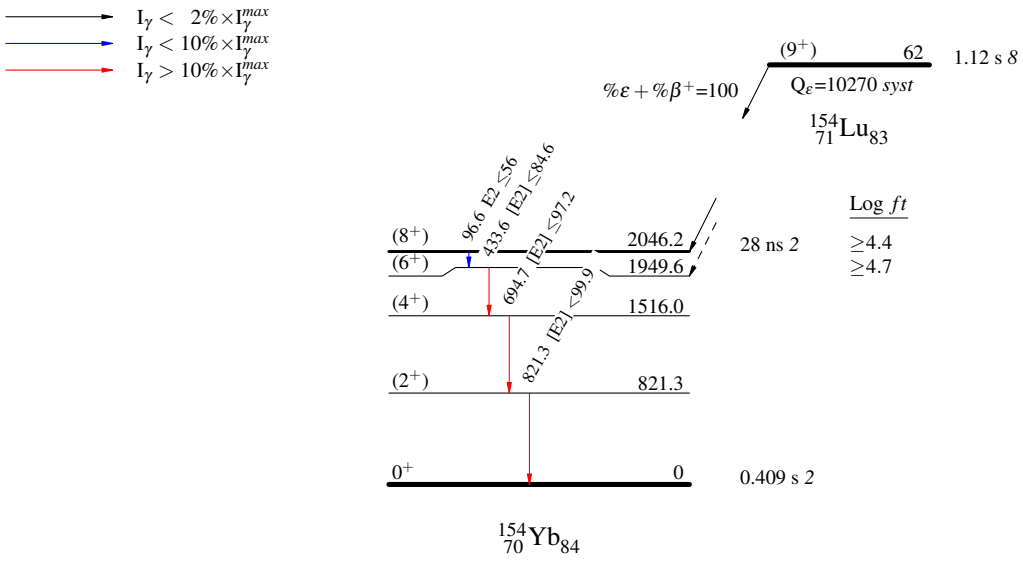
† Additional information 6.

‡ For absolute intensity per 100 decays, multiply by ≤0.9935.

^{154}Lu $\varepsilon+\beta^+$ decay 1988Vi02

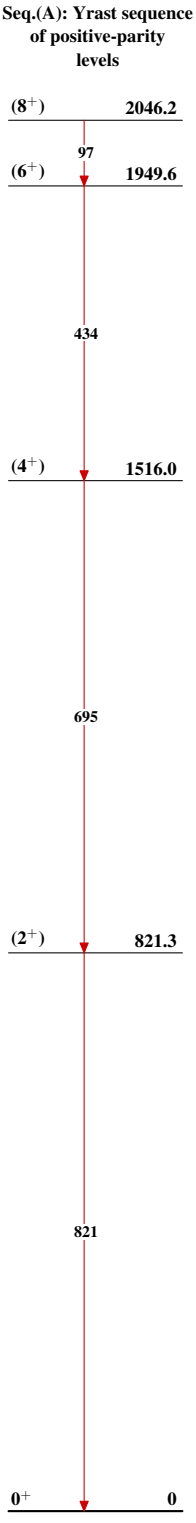
Decay Scheme

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



$^{154}_{70}Yb_{84}$

^{154}Lu ε decay 1988Vi02



$^{154}_{70}Yb_{84}$