^{153}Gd ε decay

Type	Author	History Citation	Literature Cutoff Date
Full Evaluation	N. Nica	NDS 170, 1 (2020)	16-Aug-2020

Parent: ^{153}Gd: E=0.0; J^{π}=3/2^{-}; $T_{1/2}$=240.4 d *10*; Q(ε)=484.7 *7*; %ε decay=100.0

^{153}Gd-Q(ε): Earlier a series of measurements of the K-capture probability to the 172-keV level of ^{153}Eu (1960Le06, 1962Bl11, 1964Cr08,1967Bo11,1980Se01,1985Si03) indicated a decay energy of 235 to 280 keV. The problem with these measurements, or the or the interpretation thereof, has not been resolved.

The decay scheme and useful Iγ data are given by 1964Al09, 1964Ew04, 1974Se08, 1981Gr19, 1985Si03, 1988Ve05, 1988Su13, 1992Ch16, 1992Ch44, 1993Eg05, and 1995Ku34. Level $T_{1/2}$ are given by: 1965Me08, 1968Ma15, 1975Si07, 1978AnZP, and 1986Sa34. Other measurements include: 1996La21, 1994Co02, 1994MiZZ, 1992EgZY (see 1993Eg05), 1990GeZZ, 1989Po21, 1986Va16, 1980Se01, 1980BeYK, 1976Gu02, 1975Ba69, 1974Ma27, 1972De67, 1971Kr19, 1970Me26, 1967Bo11, 1964Cr08, 1962Bl11, 1962Bh01, 1961Gr39, 1960Su08, 1960Le06, 1958An34, 1954Mc10, 1949Ke01.

Additional information 1.

The magnitude of possible combined electron-nuclear radiation (CENR) is discussed in 1994Al45 and 1995Sa56.

^{153}Eu Levels

E(level)†	J^{π}‡	$T_{1/2}$#	Comments
0.0	5/2^{+}	stable	
83.36720 *13*	7/2^{+}	0.77 ns *5*	$T_{1/2}$: From 1986Sa34.
97.43103 *15*	5/2^{-}	0.180 ns *20*	$T_{1/2}$: From 1968Ma15; other: < 0.35 ns (1965Me08).
103.18016 *12*	3/2^{+}	3.87 ns *5*	$T_{1/2}$: Adopted value. 3.88 ns *4* is the weighted average of the values measured in ^{153}Gd ε decay only, 3.87 ns *10* (1986Sa34), 3.8 ns *1* (1978AnZP), 3.89 ns *10*, and 3.92 ns *7* (evaluator′s average of 4 values in 1965Me08).
151.6246? *12*	7/2^{-}		E(level): This level is known to exist from ^{153}Sm β- decay and ^{152}Eu(n,γ) and it is generally reported in this decay. The ε branch is 2nd forbidden, so the log*ft* is expected to be ≥ 11 (1973Ra10) which corresponds to I(ε) ≤ 0.015%.
172.85318 *13*	5/2^{+}		

† From least-squares fit to measured Eγ.
‡ From ^{153}Eu Adopted Levels.
\# Values are from ^{153}Gd decay only; see ^{153}Eu Adopted Levels for values from other production modes.

ε radiations

E(decay)	E(level)	Iε†	Log *ft*	Comments
(311.8 *7*)	172.85318	16.0 *5*	7.89 *1*	εK=0.8028 *2*; εL=0.15169 *9*; εM+=0.04553 *3*
(381.5 *7*)	103.18016	44.2 *10*	7.65 *1*	εK=0.8118; εL=0.14496 *6*; εM+=0.04319 *2*
(387.3 *7*)	97.43103	39.2 *5*	7.72 *1*	εK=0.8124; εL=0.14453 *6*; εM+=0.04304 *2*
(484.7 *7*)	0.0	<1	>9.5	εK=0.8199; εL=0.13899 *3*; εM+=0.04111 *1* Iε: Computed from γ intensity balance with the given Iγ normalization factor.

† Absolute intensity per 100 decays.

γ(^{153}Eu)

Iγ normalization: Weighted average of: 0.3015 *20* (2017ShZX, by digital coincidence counting), 0.290 *8* (measurement of Geidelman as quoted in 1992Ch16), 0.302 *6* (from I_{Kx} intensity analysis by 1981Gr19), 0.276 *10* (1997Ka47).

The internal conversion electron intensities are normalized to give α_K(exp)(97.43)=0.258 (E1 theory).

$I_{K x\alpha}$=327 *6* and $I_{K\beta}$=82.6 *14*. The reduced-χ^2 values for these averages are 4.8 and 6.3, respectively. See 1992Ch16, 1993Eg05, and 1995Ku34 for values for components of these two groups. The corresponding values calculated from the decay scheme are 333 *8* and 84.8 *24*, respectively.

E_γ[†]	I_γ[‡b]	E_i(level)	J^π_i	E_f	J^π_f	Mult.	α[&]	$I_{(\gamma+ce)}$[b]	Comments
14.06383 *20*	0.061 *9*	97.43103	5/2⁻	83.36720	7/2⁺	E1	10.89		α(L)=8.54 *12*; α(M)=1.90 *3* α(N)=0.405 *6*; α(O)=0.0479 *7*; α(P)=0.00189 *3* E_γ: From level energies. I_γ: Values range from 0.051 *5* to 0.146 *15* and reduced-χ^2=4.3.
19.81296 *19*		103.18016	3/2⁺	83.36720	7/2⁺	E2	3.22×10^3	0.7 *4*	ce(L)/(γ+ce)=0.775 *8*; ce(M)/(γ+ce)=0.180 *4* ce(N)/(γ+ce)=0.0395 *8*; ce(O)/(γ+ce)=0.00520 *11*; ce(P)/(γ+ce)=2.11×10^{-6} *5* α(L)=2.49×10^3 *4*; α(M)=578 *8* α(N)=127.1 *18*; α(O)=16.73 *24*; α(P)=0.00678 *10* E_γ: From level energies. I_γ: From I_{ce}(LM)=1.17 (1963Gr09) I(γ+ce)+1.3 and then from α=3290, Iγ=0.0004. The measured values are very different; they include 0.005 *1* (1974Se08), 0.089 *9* (1985Si03), 0.072 *11* (1988Su13), 0.006 *1* (1988Ve05), and 0.019 *3* (1995Ku34). $I_{(\gamma+ce)}$: From intensity balance at 83-keV level. Other: 1.3 from I_{ce}(LM)=1.17 (1963Gr09) and α′s.
^{x}21.2	0.075 *12*								I_γ: From 1988Su13 and 1995Ku34; other: < 0.03 (1993Eg05).
54.1934[@c] *4*		151.6246?	7/2⁻	97.43103	5/2⁻	M1(+E2)	18.4 *76*		α(K)=6.3 *28*; α(L)=9.3 *80*; α(M)=2.2 *19* α(N)=0.48 *42*; α(O)=0.065 *55*; α(P)=6.8×10^{-4} *35* I_γ: From limit of I(ε,151) ≤ 0.015%, if the 54 is the only γ from this level, Iγ(54) < 0.0026 for α=18.4. In contrast, the reported values include 0.058 *8* (1988Su13) and 0.027 *2* (1995Ku34). Therefore, there is a problem with this γ placement.
68.2557[@c] *5*		151.6246?	7/2⁻	83.36720	7/2⁺	E1	0.790		α(K)=0.657 *10*; α(L)=0.1042 *15*; α(M)=0.0225 *4* α(N)=0.00503 *7*; α(O)=0.000739 *11*; α(P)=5.20×10^{-5} *8* I_γ: The five reported values are reasonably consistent (reduced-χ^2=2.2) and an average of 0.056. However, if the ε feeding to this level is ≤0.015% with no γ feeding, even if this is the only γ from this level its Iγ is < 0.026 and if other γ depopulate this level. In the

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^{153}Gd ε decay (continued)

γ(^{153}Eu) (continued)

E_γ[†]	I_γ[‡b]	E_i(level)	J^π_i	E_f	J^π_f	Mult.	δ[#a]	α[&]	Comments
									^{153}Sm β- decay and ^{152}Eu(n,γ), the Iγ(151)/Iγ(68) ratio is between 5 and 9, so the limit may be much lower. Therefore, this γ may be misplaced.
69.67300 *13*	8.18 *21*	172.85318	5/2$^+$	103.18016	3/2$^+$	M1+E2	0.136 *4*	5.31	α(K)=4.39 *7*; α(L)=0.719 *12*; α(M)=0.1572 *25* α(N)=0.0358 *6*; α(O)=0.00555 *9*; α(P)=0.000485 *7*
75.42213 *23*	0.270 *8*	172.85318	5/2$^+$	97.43103	5/2$^-$	E1+M2	0.055 *10*	0.76 *7*	α(K)=0.62 *5*; α(L)=0.112 *13*; α(M)=0.025 *3* α(N)=0.0056 *7*; α(O)=0.00083 *11*; α(P)=6.3$\times10^{-5}$ *9*
83.36717 *21*	0.676 *14*	83.36720	7/2$^+$	0.0	5/2$^+$	M1+E2	0.81 *4*	3.76 *7*	α(K)=2.33 *4*; α(L)=1.11 *5*; α(M)=0.257 *12* α(N)=0.0573 *25*; α(O)=0.0080 *4*; α(P)=0.000230 *5* K:L1:L2:L3:M:N+=1.78:0.210:0.339:0.377:0.165:0.057.
89.48595 *22*	0.27 *4*	172.85318	5/2$^+$	83.36720	7/2$^+$	M1+E2	0.25 *10*	2.60 *7*	α(K)=2.11 *5*; α(L)=0.38 *7*; α(M)=0.085 *16* α(N)=0.019 *4*; α(O)=0.0029 *5*; α(P)=0.000230 *7*
97.43100 *21*	100	97.43103	5/2$^-$	0.0	5/2$^+$	E1		0.305	α(K)=0.256 *4*; α(L)=0.0382 *6*; α(M)=0.00823 *12* α(N)=0.00185 *3*; α(O)=0.000278 *4*; α(P)=2.13$\times10^{-5}$ *3*
103.18012 *17*	73.5 *6*	103.18016	3/2$^+$	0.0	5/2$^+$	M1+E2	0.119 *3*	1.694	α(K)=1.422 *20*; α(L)=0.213 *3*; α(M)=0.0462 *7* α(N)=0.01057 *15*; α(O)=0.001662 *24*; α(P)=0.0001568 *22* Additional information 2. δ: Computed with penetration parameter λ=5.3 *8*.
151.6245[@c] *12*		151.6246?	7/2$^-$	0.0	5/2$^+$	E1		0.0920	α(K)=0.0779 *11*; α(L)=0.01112 *16*; α(M)=0.00239 *4* α(N)=0.000541 *8*; α(O)=8.26$\times10^{-5}$ *12*; α(P)=6.88$\times10^{-6}$ *10* I_γ: The reported values are inconsistent, namely, < 0.01 (1992Ch44), 0.060 *15* (1988Su13), 0.02 *1* (1988Ve05), and 0.021 *1* (1995Ku34), 0.00163 *20* (2017ShZX).
172.85307 *21*	0.1304 *24*	172.85318	5/2$^+$	0.0	5/2$^+$	M1+E2	0.81 *8*	0.377	α(K)=0.296 *7*; α(L)=0.0637 *22*; α(M)=0.0142 *6* α(N)=0.00321 *12*; α(O)=0.000477 *15*; α(P)=3.00$\times10^{-5}$ *10*

[†] From 2000He14 Eγ evaluation with additions of values from ^{152}Eu(n,γ); all are on the energy scale for which the strong ^{198}Au line is 411.80205 *17* keV.
[‡] From weighted average of values from 1974Se08, 1985Si03 (values for photons below 60 keV omitted), 1988Su13, 1988Ve05, 1992Ch16, 1992Ch44, 1993Eg05, 1995Ku34, 2017ShZX. Significant discrepancies between these values are noted. Others: 1964Al09, 1964Ew04, 1967Bo11, 1981Gr19, 1990GeZZ, and 1996La21.
[#] From ^{153}Eu Adopted Gammas.
[@] From ^{152}Eu(n,γ).
[&] Additional information 3.
[a] If No value given it was assumed δ=1.00 for E2/M1, δ=1.00 for E3/M2 and δ=0.10 for the other multipolarities.
[b] For absolute intensity per 100 decays, multiply by 0.300 *3*.
[c] Placement of transition in the level scheme is uncertain.
[x] γ ray not placed in level scheme.

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Decay Scheme