^{139}Pr ε decay (4.41 h) 1981ArZW,1976Za03,1975Vy02

History

Type	Author	Citation	Literature Cutoff Date
Full Evaluation	P. K. Joshi, B. Singh, S. Singh, A. K. Jain	NDS 138, 1 (2016)	15-Oct-2016

Parent: ^{139}Pr: E=0.0; J^π=5/2$^+$; $T_{1/2}$=4.41 h *4*; Q(ε)=2129.1 *30*; %ε+%β^+ decay=100.0
^{139}Pr-J^π,$T_{1/2}$: From ^{139}Pr Adopted Levels.
^{139}Pr-Q(ε): From 2012Wa38.
1975Vy02 measured γ′s, x rays, and γγ-coincidences, β′s and ce′s, and ceγ(t) (mag spect, Ge(Li)).
1976Za03 measured γ′s.
1981ArZW measured γ′s and x rays and β′s.
Others: 1976KaYX, 1968De02, 1969Be65, 1963Bi20.
Level scheme is basically from 1976Za03; level at 1578 suggested by 1975Vy02 confirmed by 1981ArZW.

^{139}Ce Levels

E(level)	J^π †	$T_{1/2}$	Comments
0.0	3/2$^+$		%ε+%β^+=100
255.078 *16*	1/2$^+$	110 ps *20*	$T_{1/2}$: from 1975Vy02.
754.24 *8*	11/2$^-$	57.58 s *32*	%IT=100 $T_{1/2}$: from the Adopted Levels. Isomer production ratio=0.008 *2* (2000BeZV) discrepant with I(γ+ce)(725γ)=0.015 *3* (Evaluators).
1320.249 *20*	5/2$^+$		
1347.337 *10*	7/2$^+$		
1578.24 *22*	7/2$^-$		
1596.590 *20*	(3/2)$^+$		
1630.674 *18*	3/2$^+$		
1818.436 *22*	3/2$^+$,5/2$^+$		
1842.9 *10*	(7/2$^-$)		
1907.661 *23*	(3/2)$^+$		
1965.36 *24*	(3/2,5/2$^+$)		
1984.84 *7*	(3/2,5/2$^+$)		
2016.27 *4*	(3/2$^+$)		
2090.0 *10*	(3/2$^+$,5/2$^+$)		

† From Adopted Levels.

ε,β^+ radiations

Iγ(K x ray)=2.17×10^5 *22* (1981ArZW) compared to 1.71×10^5 *6* from the decay scheme relative to Iγ(1347γ)=1000.
ε/β^+=10.2 *11* (1981ArZW) compared to 11.08 *2* from decay scheme.
β/ce(K)(255γ)=1830 *60* (1975Vy02) compared to 460 *28* from decay scheme. It is not clear from the text of 1975Vy02 whether the Iβ^+ includes contributions from ^{139}Nd decay.

E(decay)	E(level)	Iε†	Log *ft*	I(ε+β^+)†	Comments
(39‡ *3*)	2090.0	<0.00047	>6.5	<0.00047	εL=0.727 *6*; εM+=0.273 *9*
(113 *3*)	2016.27	0.0132 *16*	6.62 *7*	0.0132 *16*	εK=0.723 *6*; εL=0.212 *5*; εM+=0.0653 *15*
(144 *3*)	1984.84	0.023 *3*	6.66 *7*	0.023 *3*	εK=0.763 *3*; εL=0.1822 *21*; εM+=0.0550 *7*
(164 *3*)	1965.36	0.0021 *6*	7.8 *1*	0.0021 *6*	εK=0.7772 *20*; εL=0.1715 *15*; εM+=0.0513 *5*
(221 *3*)	1907.661	0.063 *5*	6.69 *4*	0.063 *5*	εK=0.8015 *9*; εL=0.1533 *7*; εM+=0.04512 *22*
(286‡ *3*)	1842.9	0.0031 *11*	8.3 *2*	0.0031 *11*	εK=0.8151 *5*; εL=0.1432 *4*; εM+=0.04170 *13*
(311 *3*)	1818.436	0.072 *4*	6.97 *3*	0.072 *4*	εK=0.8185 *4*; εL=0.1407 *3*; εM+=0.04084 *10*

Continued on next page (footnotes at end of table)

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ϵ,β^+ radiations (continued)

E(decay)	E(level)	Iβ^+ †	Iε†	Log *ft*	I($\varepsilon+\beta^+$)†	Comments
(498 *3*)	1630.674		0.485 *17*	6.59 *1*	0.485 *17*	εK=0.8324 *2*; εL=0.1303 *1*; εM+=0.03735 *4*
(533 *3*)	1596.590		0.039 *4*	7.75 *5*	0.039 *4*	εK=0.8337 *2*; εL=0.12927 *9*; εM+=0.03700 *3*
(551‡ *3*)	1578.24		0.0132 *24*	8.3 *1*	0.0132 *24*	εK=0.8344 *1*; εL=0.12877 *8*; εM+=0.03684 *3*
(782 *3*)	1347.337		0.473 *11*	7.02 *1*	0.473 *11*	εK=0.8399; εL=0.12464 *4*; εM+=0.03546 *2*
(809 *3*)	1320.249		0.062 *4*	7.93 *3*	0.062 *4*	εK=0.8403; εL=0.12432 *4*; εM+=0.03535 *2*
2129 *3*	0.0	8.28 *10*	90.47 *11*	5.631 *5*	98.75 *4*	av Eβ=500.8 *14*; εK=0.7766 *6*; εL=0.10884 *9*; εM+=0.03071 *3* E(decay): from Eβ=1107 *3* (1981ArZW). Other: Eβ=1090 *10* (1975Vy02). I($\varepsilon+\beta^+$): 100-summed $\varepsilon+\beta^+$ feeding to excited states. See also normalization comment for gamma-ray intensities.

† Absolute intensity per 100 decays.

‡ Existence of this branch is questionable.

$\gamma(^{139}Ce)$

Iγ normalization: from ΣIγ(1+α)(to g.s.), I($\gamma^{\pm}$)=3.50×10^3 *8* (1976Za03. Other: 3.24×10^4 *16* (1981ArZW)) relative to Iγ(1347γ)=100, and theoretical ε/β$^+$ for the feeding to the ground state.

Except as noted all, Eγ and Iγ are from 1976Za03 and ce and coincidence data are from 1975Vy02. α(K)exp, normalized by 1975Vy02 to α(K)(255γ,M1)=0.0767, renormalized by evaluators to α(K)(255γ,M1+(68% *14*)E2)=0.0685 *23*.

E_γ	I_γ[&]	E_i(level)	J^π_i	E_f	J^π_f	Mult.[†]	δ[†]	α[a]	Comments
255.11 *2*	49.8 *14*	255.078	1/2$^+$	0.0	3/2$^+$	M1+E2	1.5 *5*	0.0840 *18*	α(K)=0.0680 *24*; α(L)=0.0126 *7*; α(M)=0.00270 *17* α(N)=0.00059 *4*; α(O)=9.0×10^{-5} *5*; α(P)=4.7×10^{-6} *4* K:L:M+=1000:191 *20*:50 *6*. K:L1:L2:L3=6.8 *20*:1.00:≤0.15:≤0.15 (1976KaYX).
354.00[‡] *10*	2.5 *5*	1984.84	(3/2,5/2$^+$)	1630.674	3/2$^+$				
587.37[b] *15*	1.5 *5*	1907.661	(3/2)$^+$	1320.249	5/2$^+$				E_γ: this γ ray is not confirmed in (p,nγ), treated as uncertain by the evaluators.
664.60[‡b] *15*	≤0.6[#]	1984.84	(3/2,5/2$^+$)	1320.249	5/2$^+$				I_γ: 8 *2* (1976Za03).
696.01[‡b] *10*	≤0.6[#]	2016.27	(3/2$^+$)	1320.249	5/2$^+$				E_γ: this γ ray is not confirmed in (p,nγ). I_γ: 9 *5* (1976Za03).
754.24 *8*	3.0 *5*	754.24	11/2$^-$	0.0	3/2$^+$	M4		0.0800	α(K)exp=0.056 *12* α(K)=0.0652 *10*; α(L)=0.01161 *17*; α(M)=0.00251 *4* α(N)=0.000557 *8*; α(O)=8.86×10^{-5} *13*; α(P)=5.96×10^{-6} *9*
824.0[#@b] *2*	2.8[#] *5*	1578.24	7/2$^-$	754.24	11/2$^-$	E2		0.00310 *5*	α(K)exp=0.0020 *8* α=0.00310 *5*; α(K)=0.00263 *4*; α(L)=0.000365 *6*; α(M)=7.65×10^{-5} *11* α(N)=1.689×10^{-5} *24*; α(O)=2.70×10^{-6} *4*; α(P)=1.90×10^{-7} *3*
1065.32[‡] *20*	0.52[#] *26*	1320.249	5/2$^+$	255.078	1/2$^+$				I_γ: 7 *4* (1976Za03).
1088.70[‡b] *10*	0.66[#] *23*	1842.9	(7/2$^-$)	754.24	11/2$^-$				Iγ=22 *5* (1976Za03) would lead to a possible intensity imbalance at the 754 level (−24 *10*) suggesting that either Iγ from 1976Za03 is incorrect or 1089γ is misassigned.
[x]1091.4[#@] *7*	≤0.3[#]								
1320.24 *2*	14.7 *2*	1320.249	5/2$^+$	0.0	3/2$^+$	M1,E2		0.00136 *21*	α(K)exp=0.0014 *5* α=0.00136 *21*; α(K)=0.00115 *18*; α(L)=0.000147 *21*; α(M)=3.1×10^{-5} *5* α(N)=6.8×10^{-6} *10*; α(O)=1.10×10^{-6} *17*; α(P)=8.5×10^{-8} *14*; α(IPF)=2.54×10^{-5} *4*
1341.50 *9*	1.0 *5*	1596.590	(3/2)$^+$	255.078	1/2$^+$				
1347.33 *1*	100.0	1347.337	7/2$^+$	0.0	3/2$^+$	E2		0.001123 *16*	α(K)exp=0.00076 *10*

From ENSDF

γ(^{139}Ce) (continued)

E_γ	I_γ[&]	E_i(level)	J_i^π	E_f	J_f^π	Mult.[†]	δ[†]	α[a]	Comments
									α=0.001123 *16*; α(K)=0.000938 *14*; α(L)=0.0001214 *17*; α(M)=2.53×10^{-5} *4* α(N)=5.60×10^{-6} *8*; α(O)=9.06×10^{-7} *13*; α(P)=6.82×10^{-8} *10*; α(IPF)=3.15×10^{-5} *5*
1375.56 *3*	32.5 *15*	1630.674	3/2$^+$	255.078	1/2$^+$	M1(+E2)	<1.2	0.00134 *11*	α(K)exp=0.00121 *17* α=0.00134 *11*; α(K)=0.00112 *10*; α(L)=0.000142 *11*; α(M)=2.96×10^{-5} *23* α(N)=6.6×10^{-6} *6*; α(O)=1.07×10^{-6} *9*; α(P)=8.3×10^{-8} *8*; α(IPF)=3.90×10^{-5} *6*
^{x}1517.2[‡] *4*	≤0.4[#]								
1563.38 *2*	8.8 *5*	1818.436	3/2$^+$,5/2$^+$	255.078	1/2$^+$	E2		0.000917 *13*	α(K)exp=0.00045 *19* α=0.000917 *13*; α(K)=0.000704 *10*; α(L)=8.99×10^{-5} *13*; α(M)=1.87×10^{-5} *3* α(N)=4.14×10^{-6} *6*; α(O)=6.71×10^{-7} *10*; α(P)=5.12×10^{-8} *8*; α(IPF)=0.0001002 *14*
1596.58 *2*	7.2 *6*	1596.590	(3/2)$^+$	0.0	3/2$^+$	M1,E2		0.00101 *12*	α(K)exp=0.0076 *26* α=0.00101 *12*; α(K)=0.00077 *10*; α(L)=9.8×10^{-5} *12*; α(M)=2.03×10^{-5} *25* α(N)=4.5×10^{-6} *6*; α(O)=7.3×10^{-7} *9*; α(P)=5.7×10^{-8} *8*; α(IPF)=0.0001147 *24*
1630.67 *2*	72.5 *20*	1630.674	3/2$^+$	0.0	3/2$^+$	E2		0.000881 *13*	α(K)exp=0.00055 *11* α=0.000881 *13*; α(K)=0.000650 *9*; α(L)=8.27×10^{-5} *12*; α(M)=1.719×10^{-5} *24* α(N)=3.81×10^{-6} *6*; α(O)=6.18×10^{-7} *9*; α(P)=4.73×10^{-8} *7*; α(IPF)=0.0001265 *18*
1652.58 *2*	8.2 *5*	1907.661	(3/2)$^+$	255.078	1/2$^+$				
^{x}1678.5[‡] *3*	≤0.3[#]								
1710.27 *24*	0.36 *9*	1965.36	(3/2,5/2$^+$)	255.078	1/2$^+$				
1729.89 *9*	1.9 *3*	1984.84	(3/2,5/2$^+$)	255.078	1/2$^+$				
1818.30 *4*	6.5 *4*	1818.436	3/2$^+$,5/2$^+$	0.0	3/2$^+$				E_γ: slightly poor fit, level-energy difference=1818.42.
1907.61 *5*	3.6 *4*	1907.661	(3/2)$^+$	0.0	3/2$^+$				
1965.66[‡b] *44*	≤0.15[#]	1965.36	(3/2,5/2$^+$)	0.0	3/2$^+$				I_γ: 1.2 *5* (1976Za03).
1985.04[‡b] *29*	≤0.15[#]	1984.84	(3/2,5/2$^+$)	0.0	3/2$^+$				I_γ: 1.6 *5* (1976Za03).
2016.25 *4*	2.5 *3*	2016.27	(3/2$^+$)	0.0	3/2$^+$				
2090[#b]	<0.10[#]	2090.0	(3/2$^+$,5/2$^+$)	0.0	3/2$^+$				

[†] From α(K)exp and conversion electron ratios, except as noted. δ's deduced by evaluators.
[‡] Not observed by 1975Vy02.

$^{139}_{58}Ce_{81}$-4

γ(^{139}Ce) (continued)

[#] From 1981ArZW. The 2090γ expected from a level near this energy in (d,t) was looked for but not observed by 1981ArZW.

[@] Not observed by 1976Za03. However, it is not clear from the discussion in 1976Za03 whether they have included all unplaced γ's in their table.

[&] For absolute intensity per 100 decays, multiply by 0.00473 *11*.

[a] Total theoretical internal conversion coefficients, calculated using the BrIcc code (2008Ki07) with Frozen orbital approximation based on γ-ray energies, assigned multipolarities, and mixing ratios, unless otherwise specified.

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

[x] γ ray not placed in level scheme.

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