^{135}Pr ε decay (24 min) 1972Ar08

History

Type	Author	Citation	Literature Cutoff Date
Full Evaluation	Balraj Singh, Alexander A. Rodionov And Yuri L. Khazov	NDS 109, 517 (2008)	22-Jan-2008

Parent: ^{135}Pr: E=0.0; $J^{\pi}=3/2^{(+)}$; $T_{1/2}$=24 min *1*; Q(ε)=3689 *16*; %ε+%$β^+$ decay=100.0
1972Ar08: Eγ, Iγ, γγ, ce, γce(t).
Others:
γ: 1973VaYZ, 1970Ab07, 1968BrZX, 1954Ha68.
ce: 1973VaYZ.
$β^+$: 1954Ha68.
$T_{1/2}$(^{135}Pr): 1973VaYZ, 1972Ek04, 1972Ar08, 1970Ab07, 1954Ha68.
Total decay energy of 2790 keV *117* calculated (by RADLIST code) from level scheme is much lower than the expected value of 3689 keV *16*.

^{135}Ce Levels

E(level)	J^{π}[†]	$T_{1/2}$	Comments
0.0	$1/2^{(+)}$		
82.67 *5*	$3/2^{(+)}$	0.53 ns *6*	$T_{1/2}$: from γce(t) (1972Ar08).
296.09[‡] *5*	$(5/2^+)$		
296.12[‡] *5*	$1/2^{(+)},3/2^{(+)}$		
620.93 *12*	$3/2^{(+)},5/2^{(+)}$		
696.5 *2*	$(1/2^+,3/2^+,5/2^+)$		
780.29 *15*	$(1/2^+,3/2^+,5/2^+)$		
806.90 *19*	$(1/2,3/2,5/2^+)$		
1016.83 *15*	$(1/2^+,3/2^+,5/2^+)$		
1367.4? *5*	$(1/2,3/2,5/2^+)$		
1728.7? *5*	(1/2,3/2,5/2)		
1834.9 *3*	(1/2,3/2,5/2)		
1950.6 *9*	$(1/2,3/2,5/2^+)$		
2020.6 *9*	$(1/2,3/2,5/2^+)$		

[†] From Adopted Levels.
[‡] The unresolved doublet of 296 levels was suggested by 1972Ar08 on the basis of γγ coin data in ^{135}Pr ε decay and differences in branching ratio: I(296γ)/I(213γ)=2.1 *3* (1972Ar08) in ^{135}Pr ε decay and I(296γ)/I(213γ)=0.25 *3* from Iγ′s in ^{135}Ce IT decay.

γ(^{135}Ce)

Eβ+=2500 *100* was measured by 1954Ha68.

ε, β$^+$ feedings and log *ft* values cannot be deduced since direct feeding of g.s. is unknown. From γ-ray intensity balance, all states seem to have direct ε,β$^+$ feeding, with large feedings expected for 82.6, 296.1 doublet and 620.9 levels.

α(K)exp: from 1973VaYZ. Calibration procedure not given.

Iγ(γ$^{\pm}$)<315 *50* (1972Ar08) relative to 100 for 213.45γ.

The level scheme cannot be normalized for intensities per 100 decays since β feeding of g.s. is unknown.

E_γ	I_γ	E_i(level)	J_i^π	E_f	J_f^π	Mult.[†]	δ	α[‡]	Comments
82.64 *7*	105 *11*	82.67	3/2$^{(+)}$	0.0	1/2$^{(+)}$	M1+E2	<0.4	2.19 *15*	α(K)=1.77 *4*; α(L)=0.33 *9*; α(M)=0.071 *21*; α(N+..)=0.018 *5* α(N)=0.015 *5*; α(O)=0.0024 *6*; α(P)=0.000133 *3* Mult.: from α(K)exp=2.9 *9* and K/L=12 *4*. Intensity balance in ^{135}Ce IT decay suggests E2 admixture. δ: from RUL(E2)=300. From ce data, δ(E2/M1)>1.5 (from α(K)exp) and 0.0 (from K/L). But K/L ratio from a ce spectrum in ^{135}Ce IT decay (figure 1 of 1970Dr04) seems much smaller than 12 *4* (1973VaYZ) and K/L(theory for M1)=7.3.
213.45[#] *6*	100 *10*	296.09	(5/2$^+$)	82.67	3/2$^{(+)}$	M1		0.1429	α(K)=0.1221 *18*; α(L)=0.01645 *23*; α(M)=0.00344 *5*; α(N+..)=0.000897 *13* α(N)=0.000763 *11*; α(O)=0.0001238 *18*; α(P)=9.40×10^{-6} *14* I$_\gamma$: almost all the intensity belongs with the 296.09 level, the placement from 296.12 level is uncertain. Mult.: α(K)exp=0.14 *2* (1973VaYZ), 0.11 *3* (1972Ar08) give M1,E2. K/L=7.9 *11* (1973VaYZ) gives M1.
213.45[#a] *6*		296.12	1/2$^{(+)}$,3/2$^{(+)}$	82.67	3/2$^{(+)}$				
296.12[&] *5*	≈25[&]	296.09	(5/2$^+$)	0.0	1/2$^{(+)}$	E2		0.0508	α(K)=0.0407 *6*; α(L)=0.00792 *12*; α(M)=0.001704 *24*; α(N+..)=0.000431 *6* α(N)=0.000371 *6*; α(O)=5.64×10^{-5} *8*; α(P)=2.68×10^{-6} *4* Mult.: from adopted gammas.
296.12[&] *5*	185[&] *25*	296.12	1/2$^{(+)}$,3/2$^{(+)}$	0.0	1/2$^{(+)}$	M1(+E2)	<0.9	0.0576 *22*	α(K)=0.0487 *24*; α(L)=0.0071 *3*; α(M)=0.00148 *7*; α(N+..)=0.000384 *15* α(N)=0.000328 *14*; α(O)=5.24×10^{-5} *14*; α(P)=3.6×10^{-6} *3* I$_\gamma$: total Iγ=210 *25*. Mult.: α(K)exp=0.045 *5* (1973VaYZ), 0.050 *15* (1972Ar08) give M1,E2; K/L=7.1 *10* (1973VaYZ) gives δ<0.9.

$^{135}_{58}$Ce$_{77}$-2

^{135}Pr ε decay (24 min) 1972Ar08 (continued)

$\gamma(^{135}Ce)$ (continued)

E_γ	I_γ	E_i(level)	J_i^π	E_f	J_f^π	Mult.[†]	δ	α[‡]	Comments
324.9[&] *2*	≈3.0[&]	620.93	3/2(+),5/2(+)	296.12	1/2(+),3/2(+)	M1,E2		0.042 *5*	α(K)=0.035 *5*; α(L)=0.00551 *21*; α(M)=0.00117 *6*; α(N+..)=0.000300 *11* α(N)=0.000257 *11*; α(O)=4.04×10^{-5} *7*; α(P)=2.6×10^{-6} *5* I_γ: total Iγ=6.0 *7*. α(K)exp=0.036 *7*, K/L=5.6 *14*.
324.9[&] *2*	≈3.0[&]	620.93	3/2(+),5/2(+)	296.09	(5/2+)	M1,E2		0.042 *5*	α(K)=0.035 *5*; α(L)=0.00551 *21*; α(M)=0.00117 *6*; α(N+..)=0.000300 *11* α(N)=0.000257 *11*; α(O)=4.04×10^{-5} *7*; α(P)=2.6×10^{-6} *5*
400.7[@] *5*	3.0[@] *3*	696.5	(1/2+,3/2+,5/2+)	296.12	1/2(+),3/2(+)	[M1,E2]		0.024 *4*	α(K)=0.020 *4*; α(L)=0.00295 *14*; α(M)=0.000621 *23*; α(N+..)=0.000160 *8* α(N)=0.000137 *6*; α(O)=2.18×10^{-5} *15*; α(P)=1.5×10^{-6} *4* Observed by 1973VaYZ only.
400.7[@] *5*	3.0[@] *3*	696.5	(1/2+,3/2+,5/2+)	296.09	(5/2+)	[M1,E2]		0.024 *4*	α(K)=0.020 *4*; α(L)=0.00295 *14*; α(M)=0.000621 *23*; α(N+..)=0.000160 *8* α(N)=0.000137 *6*; α(O)=2.18×10^{-5} *15*; α(P)=1.5×10^{-6} *4* Observed by 1973VaYZ only.
484.3[&] *3*	≈4[&]	780.29	(1/2+,3/2+,5/2+)	296.12	1/2(+),3/2(+)	M1,E2		0.014 *3*	α(K)=0.0121 *24*; α(L)=0.00172 *18*; α(M)=0.00036 *4*; α(N+..)=9.4×10^{-5} *10* α(N)=8.0×10^{-5} *8*; α(O)=1.28×10^{-5} *15*; α(P)=8.9×10^{-7} *21* I_γ: total Iγ=12.6 *20*. α(K)exp=0.014 *3* gives δ(E2/M1)<1.8 for the doublet.
484.3[&] *3*	≈8[&]	780.29	(1/2+,3/2+,5/2+)	296.09	(5/2+)	M1,E2		0.014 *3*	α(K)=0.0121 *24*; α(L)=0.00172 *18*; α(M)=0.00036 *4*; α(N+..)=9.4×10^{-5} *10* α(N)=8.0×10^{-5} *8*; α(O)=1.28×10^{-5} *15*; α(P)=8.9×10^{-7} *21*
538.2 *2*	62 *7*	620.93	3/2(+),5/2(+)	82.67	3/2(+)	M1(+E2)	<0.7	0.0123 *7*	α(K)=0.0105 *7*; α(L)=0.00140 *6*; α(M)=0.000292 *11*; α(N+..)=7.6×10^{-5} *3* α(N)=6.5×10^{-5} *3*; α(O)=1.05×10^{-5} *5*; α(P)=7.9×10^{-7} *6* α(K)exp=0.012 *2* (1973VaYZ), 0.011 *4* (1972Ar08).
[x]593.1 *3*	2.5 *5*								
613.8 *2*	13.7 *20*	696.5	(1/2+,3/2+,5/2+)	82.67	3/2(+)	M1(+E2)	<0.7	0.0088 *6*	α(K)=0.0076 *5*; α(L)=0.00100 *5*; α(M)=0.000209 *10*; α(N+..)=5.44×10^{-5} *25* α(N)=4.64×10^{-5} *21*; α(O)=7.5×10^{-6} *4*; α(P)=5.7×10^{-7} *4* Mult.,δ: from α(K)exp=0.0089 *16*. K/L=7.1 *25* gives δ=1.5 +*9*−*4*.

$^{135}_{58}Ce_{77}$-3

^{135}Pr ε decay (24 min) 1972Ar08 (continued)

$\gamma(^{135}Ce)$ (continued)

E_γ	I_γ	E_i(level)	J_i^π	E_f	J_f^π	Mult.[†]	δ	α[‡]	Comments
620.9 *2*	12 *2*	620.93	$3/2^{(+)},5/2^{(+)}$	0.0	$1/2^{(+)}$	E2(+M1)	>1.2	0.0067 *7*	α(K)=0.0057 *6*; α(L)=0.00081 *6*; α(M)=0.000170 *11*; α(N+..)=4.4×10^{-5} *3* α(N)=3.76×10^{-5} *25*; α(O)=6.0×10^{-6} *5*; α(P)=4.1×10^{-7} *5* α(K)exp=0.0052 *10*.
697.5[@] *2*	10.5[@] *15*	696.5	$(1/2^+,3/2^+,5/2^+)$	0.0	$1/2^{(+)}$	M1,E2		0.0057 *12*	α(K)=0.0049 *10*; α(L)=0.00066 *11*; α(M)=0.000138 *21*; α(N+..)=3.6×10^{-5} *6* α(N)=3.1×10^{-5} *5*; α(O)=4.9×10^{-6} *9*; α(P)=3.6×10^{-7} *9* α(K)exp=0.0064 *14* gives δ(E2/M1)<1 for the doublet.
697.5[@] *2*	10.5[@] *15*	780.29	$(1/2^+,3/2^+,5/2^+)$	82.67	$3/2^{(+)}$	M1,E2		0.0057 *12*	α(K)=0.0049 *10*; α(L)=0.00066 *11*; α(M)=0.000138 *21*; α(N+..)=3.6×10^{-5} *6* α(N)=3.1×10^{-5} *5*; α(O)=4.9×10^{-6} *9*; α(P)=3.6×10^{-7} *9*
720.6 *8*	3.5 *15*	1016.83	$(1/2^+,3/2^+,5/2^+)$	296.09	$(5/2^+)$	M1(+E2)	<1	0.0058 *6*	α(K)=0.0050 *5*; α(L)=0.00066 *5*; α(M)=0.000137 *10*; α(N+..)=3.6×10^{-5} *3* α(N)=3.03×10^{-5} *23*; α(O)=4.9×10^{-6} *4*; α(P)=3.7×10^{-7} *4* α(K)exp=0.0070 *25*.
724.4 *6*	3.0 *15*	806.90	$(1/2,3/2,5/2^+)$	82.67	$3/2^{(+)}$				
747 *1*	1.0 *6*	1367.4?	$(1/2,3/2,5/2^+)$	620.93	$3/2^{(+)},5/2^{(+)}$				
780.6 *10*	3.0 *7*	780.29	$(1/2^+,3/2^+,5/2^+)$	0.0	$1/2^{(+)}$	M1,E2		0.0044 *9*	α(K)=0.0037 *8*; α(L)=0.00050 *9*; α(M)=0.000104 *17*; α(N+..)=2.7×10^{-5} *5* α(N)=2.3×10^{-5} *4*; α(O)=3.7×10^{-6} *7*; α(P)=2.8×10^{-7} *7* α(K)exp=0.0037 *20*. Observed by 1973VaYZ only.
806.9 *2*	9.0 *15*	806.90	$(1/2,3/2,5/2^+)$	0.0	$1/2^{(+)}$				
934.1 *2*	6 *1*	1016.83	$(1/2^+,3/2^+,5/2^+)$	82.67	$3/2^{(+)}$	M1,E2		0.0029 *6*	α(K)=0.0025 *5*; α(L)=0.00032 *6*; α(M)=6.8×10^{-5} *11*; α(N+..)=1.8×10^{-5} *3* α(N)=1.50×10^{-5} *25*; α(O)=2.4×10^{-6} *5*; α(P)=1.8×10^{-7} *4* α(K)exp=0.0027 *14*.
1016.9 *2*	5.1 *7*	1016.83	$(1/2^+,3/2^+,5/2^+)$	0.0	$1/2^{(+)}$				
1107 *1*	0.7 *3*	1728.7?	$(1/2,3/2,5/2)$	620.93	$3/2^{(+)},5/2^{(+)}$				
[x]1131.0 *6*	1.3 *3*								
1143 *2*	0.3 *2*	1950.6	$(1/2,3/2,5/2^+)$	806.90	$(1/2,3/2,5/2^+)$				
1214.2 *8*	1.0 *3*	2020.6	$(1/2,3/2,5/2^+)$	806.90	$(1/2,3/2,5/2^+)$				
1284.6 *8*	1.0 *3*	1367.4?	$(1/2,3/2,5/2^+)$	82.67	$3/2^{(+)}$				
1367.3 *6*	1.6 *3*	1367.4?	$(1/2,3/2,5/2^+)$	0.0	$1/2^{(+)}$				

^{135}Pr ε decay (24 min) 1972Ar08 (continued)

$\gamma(^{135}Ce)$ (continued)

E_γ	I_γ	E_i(level)	J_i^π	E_f	J_f^π	Comments
1432.9 *6*	2.2 *4*	1728.7?	(1/2,3/2,5/2)	296.09	$(5/2^+)$	
[x]1460.8 *6*	1.3 *3*					
1538.9[&] *4*	≈3.8[&]	1834.9	(1/2,3/2,5/2)	296.12	$1/2^{(+)},3/2^{(+)}$	I_γ: total Iγ=7.6 *10*.
1538.9[&] *4*	≈3.8[&]	1834.9	(1/2,3/2,5/2)	296.09	$(5/2^+)$	
1646.0 *8*	1.4 *3*	1728.7?	(1/2,3/2,5/2)	82.67	$3/2^{(+)}$	
[x]1678.9 *6*	3.3 *5*					
[x]1707.4 *8*	0.6 *2*					
1751.9 *6*	3.6 *6*	1834.9	(1/2,3/2,5/2)	82.67	$3/2^{(+)}$	
[x]1755 *2*	0.7 *3*					
[x]1784 *1*	0.7 *2*					
[x]1845 *2*	0.6 *3*					
[x]1860 *2*	0.8 *3*					
1867 *2*	1.3 *5*	1950.6	$(1/2,3/2,5/2^+)$	82.67	$3/2^{(+)}$	
1937 *2*	0.6 *2*	2020.6	$(1/2,3/2,5/2^+)$	82.67	$3/2^{(+)}$	
1951 *1*	1.4 *4*	1950.6	$(1/2,3/2,5/2^+)$	0.0	$1/2^{(+)}$	
[x]1973 *1*	1.7 *3*					
2020 *1*	0.7 *2*	2020.6	$(1/2,3/2,5/2^+)$	0.0	$1/2^{(+)}$	
[x]2084 *2*	1.0 *5*					
[x]2107 *2*	1.4 *7*					
[x]2322 *3*	2.2 *10*					
[x]2356 *3*	0.6 *3*					

[†] From α(K)exp and K/L values (1973VaYZ).
[‡] 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.
[#] Multiply placed.
[@] Multiply placed with undivided intensity.
[&] Multiply placed with intensity suitably divided.
[a] Placement of transition in the level scheme is uncertain.
[x] γ ray not placed in level scheme.

$^{135}_{58}Ce_{77}$-5

^{135}Pr ε decay (24 min) 1972Ar08

Decay Scheme

Intensities: Relative I_γ
& Multiply placed: undivided intensity given
@ Multiply placed: intensity suitably divided

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)
Coincidence