^{138}Pr ε decay (1.45 min) 1974Bu03

Type	Author	History Citation	Literature Cutoff Date
Full Evaluation	Jun Chen	NDS 146, 1 (2017)	30-Sep-2017

Parent: ^{138}Pr: E=0.0; J$^{\pi}$=1^{+}; $T_{1/2}$=1.45 min *5*; Q(ε)=4437 *10*; %ε+%β^{+} decay=100.0
^{138}Pr-J$^{\pi}$,$T_{1/2}$: From Adopted Levels of ^{138}Pr.
^{138}Pr-Q(ε): From 2017Wa10.
1974Bu03: Source of ^{138}Pr was prepared at JINR. Ions were separated and selected with an electromagnetic separator and implanted into aluminum foil. γ rays were detected with Ge(Li) detectors (FWHM=0.7 keV at Eγ=40 keV, 2.3 and 2.9 keV at Eγ=1 MeV); conversion electrons were detected with a β-ray spectrometer incorporating Si(Li) detectors (FWHM=2.5-3.0 keV at K788.7 line of ^{138}Pr). Measured Eγ, Iγ, E(ce), I(ce), βγ-coin. Deduced levels, J, π, γ and β branching ratios, conversion coefficients, γ-ray multipolarities. See also 1971Af05 from the same group.
1971Ju01: Source of ^{138}Pr was prepared by the (p,n) reaction on enriched ^{138}Ce target in the form of cerium oxide or cerium chloride, bombarded with E=10 MeV protons. γ rays were detected with a Ge(Li) detector (FWHM=5 keV at Eγ= 1 MeV). Measured Eγ, Iγ. Deduced levels.
1970Ho28: ^{138}Pr source was prepared by (p,p3n) reaction with 99.999% pure praseodymium dioxide target bombarded with 48-MeV protons from the McGill University Synchrocyclotron. γ rays were detected with a Ge(Li) detector. Measured Eγ, Iγ. Deduced levels.
Others: 1965Ba45, 1966Gr15, 1971Af01.
Additional information 1.
The total average radiation energy released by ^{138}Pr ε decay is 4442 keV *20* (calculated by evaluator using the computer program RADLST). This value agrees well with Q(ε)=4437 keV *10* (2017Wa10) and shows the completeness of the decay scheme.
The decay scheme is that of 1974Bu03.

^{138}Ce Levels

E(level)†	J$^{\pi}$‡	$T_{1/2}$‡	E(level)†	J$^{\pi}$‡	$T_{1/2}$‡	E(level)†	J$^{\pi}$‡	$T_{1/2}$‡
0.0	0^{+}		2136.5 *10*	4^{+}		2642.3 *3*	2^{+}	66 fs *32*
788.69 *8*	2^{+}	1.98 ps *4*	2236.51 *15*	2^{+}	56.8 fs *35*	2903.16 *21*	(1,2^{+})	
1476.88 *11*	0^{+}		2339.80 *13*	0^{+}		3177.4? *7*		
1510.45 *17*	2^{+}	0.834 ps *20*	2470.96 *15*	(1,2^{+})	109 fs *6*			

† From a least-squares fit to γ-ray energies.
‡ From Adopted Levels.

ε,β^{+} radiations

End-point energy Eβ+=3415 *10* (1971Af05). Other: 3440 *40* (1966Gr15).
β^{+}≤2.5%, ε/β^{+}≥40, Q(ε)<1750 keV (1974BaZU).

E(decay)	E(level)	Iβ^{+} ‡	Iε‡	Log *ft*	I(ε+β^{+})†‡	Comments
(1260 *10*)	3177.4?		0.009 *5*	6.91 *25*	0.009 *5*	εK=0.8445; εL=0.12106 *5*; εM+=0.03427 *2*
(1534 *10*)	2903.16	0.00029 *7*	0.053 *13*	6.31 *11*	0.053 *13*	av Eβ=239.8 *44*; εK=0.8413 *4*; εL=0.11942 *8*; εM+=0.03375 *3*
(1795 *10*)	2642.3	0.00086 *23*	0.033 *9*	6.65 *12*	0.034 *9*	av Eβ=353.9 *44*; εK=0.8255 *10*; εL=0.11639 *17*; εM+=0.03287 *5*
(1966 *10*)	2470.96	0.0047 *10*	0.088 *19*	6.31 *10*	0.093 *20*	av Eβ=429.0 *44*; εK=0.8048 *15*; εL=0.11309 *23*; εM+=0.03192 *7*
(2097 *10*)	2339.80	0.034 *7*	0.41 *8*	5.70 *9*	0.44 *9*	av Eβ=486.7 *44*; εK=0.7827 *19*; εL=0.1098 *3*; εM+=0.03097 *8*
(2200 *10*)	2236.51	0.022 *4*	0.20 *4*	6.06 *8*	0.22 *4*	av Eβ=532.3 *45*; εK=0.7616 *22*; εL=0.1066 *4*;

Continued on next page (footnotes at end of table)

^{138}Pr ε decay (1.45 min) 1974Bu03 (continued)

ϵ,β^+ radiations (continued)

E(decay)	E(level)	Iβ^+ ‡	Iε‡	Log *ft*	I($\varepsilon+\beta^+$)†‡	Comments
						εM+=0.03008 *10*
(2301 *10*)	2136.5	0.00015 *9*	0.011 *7*	9.9^{2u} *3*	0.011 *7*	av Eβ=615.7 *45*; εK=0.8272 *3*; εL=0.1242 *1*; εM+=0.03540 *4*
(2927 *10*)	1510.45	0.059 *14*	0.11 *3*	6.56 *11*	0.17 *4*	av Eβ=857.1 *46*; εK=0.552 *4*; εL=0.0767 *5*; εM+=0.02160 *13*
(2960 *10*)	1476.88	0.32 *5*	0.55 *10*	5.87 *8*	0.87 *15*	av Eβ=872.3 *46*; εK=0.541 *4*; εL=0.0752 *5*; εM+=0.02118 *13*
(3648 *10*)	788.69	0.52 *9*	0.36 *7*	6.24 *8*	0.88 *16*	av Eβ=1186.6 *46*; εK=0.3468 *24*; εL=0.0480 *4*; εM+=0.01350 *10*
4437 *10*	0.0	74.0 *4*	23.2 *3*	4.606 *16*	97.2 *5*	av Eβ=1552.4 *47*; εK=0.2030 *14*; εL=0.02797 *19*; εM+=0.00787 *6* E(decay): from 1971Af05. Iβ^+: Other: I(3415β^+)=74% *15* from I(ce 1477γ)/I(3415β^+)=0.00035 *5* (1966Gr15).

† From γ+ce intensity balance at each level.
‡ Absolute intensity per 100 decays.

γ(^{138}Ce)

Iγ normalization: From I(ce 1477γ)/I(3415β^{+})=0.00035 *5* (1966Gr15), I(ce(K) 789γ)/I(ce 1477γ)=0.277 *17* (1971Af05), ε/β^{+}(3415β^{+})=0.314 (from Log *ft* program), α(K)(789γ)=0.00291 (E2 theory, from BrIcc program) and ΣI(γ+ce to g.s.)+I(3415β^{+})(1+ε/β^{+})=100.
α(K)exp from 1971Af05.

E_γ[‡]	I_γ[‡a]	E_i(level)	J^π_i	E_f	J^π_f	Mult.[&]	δ	α[†]	$I_{(\gamma+ce)}$[a]	Comments
^{x}581.0[#] *5*	2.2 *5*									Additional information 2.
688.2 *1*	34.2 *17*	1476.88	0$^+$	788.69	2$^+$	E2		0.00473		α(K)=0.00400 *6*; α(L)=0.000576 *8*; α(M)=0.0001211 *17* α(N)=2.67×10^{-5} *4*; α(O)=4.24×10^{-6} *6*; α(P)=2.87×10^{-7} *4* Additional information 9. Mult.: α(K)exp=0.0045 *8* (1971Af05).
722.3 *3*	3.2 *4*	1510.45	2$^+$	788.69	2$^+$	M1		0.00629		α(K)=0.00541 *8*; α(L)=0.000700 *10*; α(M)=0.0001458 *21* α(N)=3.24×10^{-5} *5*; α(O)=5.27×10^{-6} *8*; α(P)=4.08×10^{-7} *6* Additional information 11.
^{x}755.0[#] *6*	0.6 *2*									Additional information 3.
^{x}772.0[#] *6*	0.50 *25*									
788.7 *1*	100	788.69	2$^+$	0.0	0$^+$	E2		0.00342		α(K)=0.00291 *4*; α(L)=0.000407 *6*; α(M)=8.52×10^{-5} *12* α(N)=1.88×10^{-5} *3*; α(O)=3.01×10^{-6} *5*; α(P)=2.10×10^{-7} *3* Additional information 8. E_γ: E(γ) (1971Af05).
^{x}1081.9 *4*	1.8 *3*									Additional information 4.
^{x}1092.1 *7*	0.45 *25*									
^{x}1172.8[b] *9*	0.25 *15*									
^{x}1248[@] *1*	≈1.4[@]									
1347.8 *10*	0.45 *25*	2136.5	4$^+$	788.69	2$^+$	E2		1.12×10^{-3}		α(K)=0.000937 *14*; α(L)=0.0001213 *17*; α(M)=2.53×10^{-5} *4* α(N)=5.59×10^{-6} *8*; α(O)=9.05×10^{-7} *13*; α(P)=6.82×10^{-8} *10*; α(IPF)=3.17×10^{-5} *5*
^{x}1358.9 *6*	1.5 *3*									
1426.9 *7*	0.50 *25*	2903.16	(1,2$^+$)	1476.88	0$^+$					
^{x}1430.8 *2*	3.9 *5*									Additional information 5.
^{x}1432.6[@] *5*	2.0[@] *4*									
1447.8 *2*	5.4 *7*	2236.51	2$^+$	788.69	2$^+$	M1+E2	0.18 *+5−4*	1.30×10^{-3}		α(K)=0.001069 *16*; α(L)=0.0001354 *20*; α(M)=2.81×10^{-5} *5*

γ(^{138}Ce) (continued)

E_γ[‡]	I_γ[‡a]	E_i(level)	J_i^π	E_f	J_f^π	Mult.[&]	α[†]	$I_{(\gamma+ce)}$[a]	Comments
									α(N)=6.25×10^{-6} *10*; α(O)=1.018×10^{-6} *15*; α(P)=7.98×10^{-8} *12*; α(IPF)=6.11×10^{-5} *9* Additional information 13.
1476.9 *2*		1476.88	0$^+$	0.0	0$^+$	E0		1.05 *7*	Additional information 10. I(ce 1477γ)/I(3415β$^+$)=0.00035 *5* (1966Gr15), K/(L+M)=4.9 *8* (1971Af05). $I_{(\gamma+ce)}$: from I(ce)/I(ce(K) 789γ)=3.61 *22* (1971Af05), I(789γ)=100, α(K)(789γ)=0.00291.
1510.2 *2*	3.6 *5*	1510.45	2$^+$	0.0	0$^+$	E2	9.54×10^{-4}		α(K)=0.000752 *11*; α(L)=9.63×10^{-5} *14*; α(M)=2.00×10^{-5} *3* α(N)=4.44×10^{-6} *7*; α(O)=7.19×10^{-7} *10*; α(P)=5.47×10^{-8} *8*; α(IPF)=8.09×10^{-5} *12* Additional information 12.
1551.1 *1*	17.5 *19*	2339.80	0$^+$	788.69	2$^+$	E2	9.25×10^{-4}		α(K)=0.000714 *10*; α(L)=9.13×10^{-5} *13*; α(M)=1.90×10^{-5} *3* α(N)=4.21×10^{-6} *6*; α(O)=6.82×10^{-7} *10*; α(P)=5.20×10^{-8} *8*; α(IPF)=9.56×10^{-5} *14* Additional information 15. Mult.: α(K)exp=0.00010 *4* (1971Af05).
[x]1619.9 *9*	0.40 *15*								
[x]1631.1 *7*	0.8 *2*								
1682.1 *2*	1.5 *3*	2470.96	(1,2$^+$)	788.69	2$^+$				
[x]1804.2 *3*	1.4 *3*								Additional information 6.
1853.7 *3*	1.0 *2*	2642.3	2$^+$	788.69	2$^+$				
[x]1893.2 *2*	2.2 *4*								Additional information 7.
2114.4 *2*	1.6 *3*	2903.16	(1,2$^+$)	788.69	2$^+$				Additional information 18.
[x]2223.3[b] *9*	0.15 *8*								
2236.5 *2*	3.3 *5*	2236.51	2$^+$	0.0	0$^+$	E2	8.27×10^{-4}		α(K)=0.000363 *5*; α(L)=4.54×10^{-5} *7*; α(M)=9.41×10^{-6} *14* α(N)=2.09×10^{-6} *3*; α(O)=3.39×10^{-7} *5*; α(P)=2.64×10^{-8} *4*; α(IPF)=0.000407 *6* Additional information 14.
[x]2298.1 *9*	0.25 *15*								
2471.1 *2*	2.2 *4*	2470.96	(1,2$^+$)	0.0	0$^+$				Additional information 16.
2642.0 *7*	0.35 *15*	2642.3	2$^+$	0.0	0$^+$				Additional information 17.
[x]2922.6 *8*	0.35 *15*								
3177.4 *7*	0.37 *17*	3177.4?		0.0	0$^+$				

† Additional information 19.
‡ From 1974Bu03, unless otherwise noted. Others: 1971Ju01, 1971Af05, 1970Ho28.
\# These γ rays may belong to ^{138}Nd (1974Bu03).
@ From 1971Af05 only.

γ(^{138}Ce) (continued)

[&] From Adopted Gammas. Arguments for mult from this experiment are ce data given as comments.
[a] For absolute intensity per 100 decays, multiply by 0.025 *4*.
[b] Placement of transition in the level scheme is uncertain.
[x] γ ray not placed in level scheme.

$^{138}_{58}Ce_{80}$-5

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Decay Scheme

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