^{135}Nd ε decay (12.4 min) 1975Wi11

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}Nd: E=0.0; J$^\pi$=9/2$^{(-)}$; $T_{1/2}$=12.4 min *6*; Q(ε)=4722 *23*; %ε+%β^+ decay=100.0

1975Wi11: measured Eγ, Iγ, γγ, ce.

Others: 1968BrZX, 1970Ab07, 1972Ar02.

Total decay energy of 4576 keV *195* calculated (by RADLIST code) from level scheme agrees with the expected value of 4722 keV *23*.

^{135}Pr Levels

E(level)[†]	J$^\pi$[‡]	$T_{1/2}$	Comments
0.0	3/2$^{(+)}$		
41.47 *5*	5/2$^{(+)}$		
206.17 *7*	7/2$^{(+)}$		
245.53 *7*	7/2$^{(+)}$		
358.15 *8*	(11/2$^-$)	105 μs *10*	%IT=100 $T_{1/2}$: from 'Adopted Levels'.
493.37 *17*	7/2$^{(+)}$		
517.35 *15*	9/2$^{(+)}$		
543.20 *11*	7/2$^{(-)}$		
688.6 *4*	(9/2$^+$)		
730.95 *21*	(15/2$^-$)		Apparent ε, β^+ feeding deduced from an intensity balance of 1.0% 4 must be due to unobserved γ transitions feeding this level, since no β feeding is expected for ΔJ=(3), Δπ=(no).
777.4 *3*	(11/2$^+$)		
799.25 *16*	9/2$^{(-)}$		
951.78 *25*	(13/2$^-$)		Apparent ε, β^+ feeding deduced from an intensity balance of 2.0% 7 must be due to unobserved γ transitions feeding this level, since β feeding is expected as <0.003% for ΔJ=(2), Δπ=(no).
984.4 *4*	(9/2$^+$)		
1159.7? *4*	(9/2$^-$)		
1185.16 *23*	(9/2$^-$,11/2$^-$)		
1214.2 *3*	(7/2$^-$,9/2$^-$,11/2$^-$)		
1289.5 *3*	(11/2$^-$)		
1303.2 *4*	(11/2$^-$)		
1765.9? *8*	(7/2$^-$,9/2$^-$,11/2$^-$)		
1998.0 *7*	(7/2,9/2,11/2$^+$)		
2129.2? *7*	(7/2,9/2,11/2$^-$)		

† From least-squares fit to Eγ′s.
‡ From 'Adopted Levels'.

ε,β^+ radiations

From γ-ray intensity balance, the levels at 731 and 952 have apparent but improbable ε+β^+ feedings of 1.0% 4 and 2.2% 7, respectively. Almost no feedings are expected from log *ft* limits for J$^\pi$′s involved.

Continued on next page (footnotes at end of table)

^{135}Nd ε decay (12.4 min) 1975Wi11 (continued)

ε,β^+ radiations (continued)

E(decay)	E(level)	Iβ^+ †	Iε†	Log *ft*	I(ε+β^+)†	Comments
(2593 *23*)	2129.2?	0.16 *5*	0.59 *20*	6.69 *15*	0.75 *25*	av Eβ=707 *11*; εK=0.668 *7*; εL=0.0940 *10*; εM+=0.0266 *3*
(2724 *23*)	1998.0	0.8 *3*	2.3 *9*	6.15 *17*	3.1 *12*	av Eβ=766 *11*; εK=0.629 *7*; εL=0.0884 *10*; εM+=0.0250 *3*
(2956 *23*)	1765.9?	0.9 *3*	1.7 *5*	6.35 *14*	2.6 *8*	av Eβ=871 *11*; εK=0.558 *8*; εL=0.0782 *11*; εM+=0.0222 *3*
(3419 *23*)	1303.2	0.75 *15*	0.75 *15*	6.84 *9*	1.5 *3*	av Eβ=1081 *11*; εK=0.422 *7*; εL=0.0590 *9*; εM+=0.0167 *3*
(3433 *23*)	1289.5	0.81 *20*	0.79 *20*	6.82 *12*	1.6 *4*	av Eβ=1088 *11*; εK=0.418 *7*; εL=0.0585 *9*; εM+=0.01655 *25*
(3508 *23*)	1214.2	0.85 *16*	0.75 *14*	6.86 *9*	1.6 *3*	av Eβ=1122 *11*; εK=0.398 *6*; εL=0.0556 *9*; εM+=0.01576 *24*
(3537 *23*)	1185.16	1.6 *2*	1.3 *1*	6.61 *6*	2.9 *3*	av Eβ=1135 *11*; εK=0.391 *6*; εL=0.0546 *9*; εM+=0.01546 *24*
(3562 *23*)	1159.7?	1.0 *2*	0.86 *18*	6.81 *10*	1.9 *4*	av Eβ=1147 *11*; εK=0.384 *6*; εL=0.0537 *9*; εM+=0.01520 *24*
(3738 *23*)	984.4	0.83 *24*	0.57 *16*	7.03 *13*	1.4 *4*	av Eβ=1228 *11*; εK=0.343 *6*; εL=0.0478 *8*; εM+=0.01353 *21*
(3923 *23*)	799.25	7.3 *10*	4.1 *5*	6.22 *7*	11.4 *15*	av Eβ=1313 *11*; εK=0.303 *5*; εL=0.0422 *7*; εM+=0.01195 *19*
(3945 *23*)	777.4	1.8 *5*	0.95 *25*	6.86 *12*	2.7 *7*	av Eβ=1323 *11*; εK=0.298 *5*; εL=0.0416 *7*; εM+=0.01177 *19*
(4033 *23*)	688.6	1.8 *5*	0.90 *23*	6.90 *12*	2.7 *7*	av Eβ=1364 *11*; εK=0.281 *5*; εL=0.0392 *6*; εM+=0.01110 *18*
(4179 *23*)	543.20	4.4 *7*	1.9 *3*	6.61 *8*	6.3 *10*	av Eβ=1432 *11*; εK=0.256 *4*; εL=0.0356 *6*; εM+=0.01007 *16*
(4205 *23*)	517.35	6.3 *7*	2.7 *3*	6.46 *6*	9.0 *10*	av Eβ=1444 *11*; εK=0.251 *4*; εL=0.0350 *6*; εM+=0.00990 *16*
(4229 *23*)	493.37	4.3 *3*	1.7 *1*	6.65 *4*	6.0 *4*	av Eβ=1455 *11*; εK=0.247 *4*; εL=0.0344 *6*; εM+=0.00974 *15*
(4364 *23*)	358.15	14 *4*	5.1 *13*	6.22 *12*	19 *5*	av Eβ=1518 *11*; εK=0.226 *4*; εL=0.0315 *5*; εM+=0.00891 *14*
(4476 *23*)	245.53	9 *4*	3.0 *12*	6.47 *19*	12 *5*	av Eβ=1570 *11*; εK=0.210 *4*; εL=0.0293 *5*; εM+=0.00828 *13*
(4516 *23*)	206.17	4.9 *5*	1.6 *2*	6.76 *6*	6.5 *7*	av Eβ=1589 *11*; εK=0.205 *3*; εL=0.0285 *5*; εM+=0.00807 *13*
(4681‡ *23*)	41.47	<4	<2	>8.5^{1u}	<6	av Eβ=1655 *11*; εK=0.347 *5*; εL=0.0490 *6*; εM+=0.01391 *17* I(ε+β^+): from log $f^{1u}t$>8.5. Intensity balance gives 6 ±30.

† Absolute intensity per 100 decays.

‡ Existence of this branch is questionable.

γ(^{135}Pr)

Iγ normalization: from Ti(206.0γ+245.4γ+493.4γ+ γ′s to 41.5 level)=100. Direct ε,β^+ feeding to 41.5 level is assumed as <6% corresponding to log $f^{1u}t$>8.5.
No direct ε, β^+ feeding to g.s. is expected.

E_γ	I_γ #	E_i(level)	J_i^π	E_f	J_f^π	Mult.†	δ‡	α@	Comments
41.48 *5*	45 *10*	41.47	$5/2^{(+)}$	0.0	$3/2^{(+)}$	M1(+E2)	<0.15	3.1 *6*	α(L)=2.5 *5*; α(M)=0.53 *11*; α(N+..)=0.14 *3* α(N)=0.116 *24*; α(O)=0.018 *4*; α(P)=0.001085 *18* α(L)exp=2.0 *10*.
112.62 *5*	9.0 *10*	358.15	$(11/2^-)$	245.53	$7/2^{(+)}$	M2		8.26	α(K)=6.46 *10*; α(L)=1.408 *20*; α(M)=0.312 *5*; α(N+..)=0.0817 *12* α(N)=0.0699 *10*; α(O)=0.01101 *16*; α(P)=0.000707 *10* α(K)exp=6.7 *15*, K/L=4.1 *11*. δ(E3/M2)<0.2.
164.70 *5*	8.0 *6*	206.17	$7/2^{(+)}$	41.47	$5/2^{(+)}$	M1+E2	+0.45 *20*	0.326 *8*	α(K)=0.269 *4*; α(L)=0.045 *6*; α(M)=0.0096 *14*; α(N+..)=0.0025 *4* α(N)=0.0021 *3*; α(O)=0.00033 *4*; α(P)=1.98×10^{-5} *8* Mult.,δ: α(K)exp=0.35 *6* gives M1,E2; δ: 0.94 *13* from K/L=4.6 *17*, +0.45 *20* from γ(θ) in (p,2nγ).
185.07 *8*	5.5 *6*	543.20	$7/2^{(-)}$	358.15	$(11/2^-)$	(E2)		0.247	α(K)=0.182 *3*; α(L)=0.0509 *8*; α(M)=0.01124 *16*; α(N+..)=0.00282 *4* α(N)=0.00245 *4*; α(O)=0.000356 *5*; α(P)=1.084×10^{-5} *16* Mult.: α(K)exp=0.20 *4* gives M1,E2; K/L=2.7 *6* is slightly lower than K/L(E2)(theory).
204.09 *5*	100	245.53	$7/2^{(+)}$	41.47	$5/2^{(+)}$	M1		0.1762	α(K)=0.1503 *21*; α(L)=0.0205 *3*; α(M)=0.00431 *6*; α(N+..)=0.001130 *16* α(N)=0.000964 *14*; α(O)=0.0001553 *22*; α(P)=1.149×10^{-5} *17* α(K)exp=0.18 *2*, K/L=8.7 *12*.
206.0 *3*	6.0 *5*	206.17	$7/2^{(+)}$	0.0	$3/2^{(+)}$	E2		0.172	α(K)=0.1296 *20*; α(L)=0.0332 *5*; α(M)=0.00730 *11*; α(N+..)=0.00184 *3* α(N)=0.001594 *25*; α(O)=0.000233 *4*; α(P)=7.90×10^{-6} *12* Mult.: α(K)exp=0.16 *5* gives M1,E2; adopted ΔJ forbids L=1.
221.0 *5*	1.4 *5*	951.78	$(13/2^-)$	730.95	$(15/2^-)$	M1,E2		0.139 *4*	α(K)=0.112 *9*; α(L)=0.021 *5*; α(M)=0.0045 *11*; α(N+..)=0.00115 *25* α(N)=0.00099 *22*; α(O)=0.00015 *3*; α(P)=7.8×10^{-6} *15* α(K)exp=0.09 *4*.
233.4 *3*	2.5 *3*	1185.16	$(9/2^-,11/2^-)$	951.78	$(13/2^-)$	M1,E2		0.118 *5*	α(K)=0.096 *9*; α(L)=0.017 *4*; α(M)=0.0037 *8*; α(N+..)=0.00096 *18* α(N)=0.00082 *16*; α(O)=0.000126 *19*; α(P)=6.7×10^{-6} *13* α(K)exp=0.10 *2*.
245.4 *2*	6.8 *5*	245.53	$7/2^{(+)}$	0.0	$3/2^{(+)}$	(E2)		0.0963	α(K)=0.0748 *11*; α(L)=0.01686 *25*; α(M)=0.00369 *6*; α(N+..)=0.000932 *14* α(N)=0.000807 *12*; α(O)=0.0001198 *18*; α(P)=4.71×10^{-6} *7* Mult.: α(K)exp=0.065 *13* gives M1+E2 with δ<0.5; K/L=7.2 *38* gives δ>2. Adopted ΔJ forbids L=1.

γ(^{135}Pr) (continued)

E_γ	I_γ[#]	E_i(level)	J^π_i	E_f	J^π_f	Mult.[†]	δ[‡]	α[@]	Comments
247.5 *10*	0.4 *2*	493.37	7/2$^{(+)}$	245.53	7/2$^{(+)}$				
256.1 *2*	5.3 *6*	799.25	9/2$^{(-)}$	543.20	7/2$^{(-)}$	M1(+E2)	<0.35	0.0949 *15*	α(K)=0.0807 *15*; α(L)=0.01121 *25*; α(M)=0.00237 *6*; α(N+..)=0.000619 *14* α(N)=0.000528 *12*; α(O)=8.47×10^{-5} *16*; α(P)=6.10×10^{-6} *15* α(K)exp=0.097 *16*.
259.8[&] *3*	1.5 *5*	777.4	(11/2$^+$)	517.35	9/2$^{(+)}$				This γ may be contributed by an impurity, since expected Iγ=0.3 *1* (from adopted gammas); and α(K)exp<0.01 gives E1 but ΔJ^π requires M1,E2.
271.9 *2*	4.9 *6*	517.35	9/2$^{(+)}$	245.53	7/2$^{(+)}$	M1+E2	+0.25 *5*	0.0807	α(K)=0.0686 *11*; α(L)=0.00951 *15*; α(M)=0.00201 *4*; α(N+..)=0.000525 *8* α(N)=0.000448 *7*; α(O)=7.19×10^{-5} *11*; α(P)=5.19×10^{-6} *9* α(K)exp=0.100 *15*, K/L=6.9 *29*. α(K)exp is higher by≈20% than α(K)(M1). δ: <0.8 (from K/L=6.9 *29*), +0.25 *5* from (p,2nγ).
316.7 *3*	2.2 *4*	358.15	(11/2$^-$)	41.47	5/2$^{(+)}$	E3		0.1601	α(K)=0.1081 *16*; α(L)=0.0405 *6*; α(M)=0.00914 *14*; α(N+..)=0.00229 *4* α(N)=0.00200 *3*; α(O)=0.000288 *5*; α(P)=7.31×10^{-6} *11* α(K)exp=0.070 *13*, K/L=2.1 *7*. α(K)exp is lower by≈30% than α(K)(E3).
^{x}322.6 *10*	1.2 *4*					E1(+M2)	<0.3	0.019 *9*	α(K)=0.016 *7*; α(L)=0.0023 *12*; α(M)=0.00050 *25*; α(N+..)=0.00013 *7* α(N)=0.00011 *6*; α(O)=1.8×10^{-5} *9*; α(P)=1.2×10^{-6} *7* α(K)exp=0.015 *8*.
351.6 *5*	2.0 *4*	1303.2	(11/2$^-$)	951.78	(13/2$^-$)				
372.8 *2*	4.5 *4*	730.95	(15/2$^-$)	358.15	(11/2$^-$)	E2		0.0260	α(K)=0.0212 *3*; α(L)=0.00380 *6*; α(M)=0.000818 *12*; α(N+..)=0.000209 *3* α(N)=0.000180 *3*; α(O)=2.76×10^{-5} *4*; α(P)=1.426×10^{-6} *20* Mult.: α(K)exp=0.020 *5* gives δ(E2/M1)>1.2; $\gamma(\theta)$ in (α,8nγ) (1975Wi11) gives ΔJ=2.
385.9 *2*	2.9 *4*	1185.16	(9/2$^-$,11/2$^-$)	799.25	9/2$^{(-)}$	(E2)		0.0235	α(K)=0.0192 *3*; α(L)=0.00339 *5*; α(M)=0.000729 *11*; α(N+..)=0.000187 *3* α(N)=0.0001608 *23*; α(O)=2.46×10^{-5} *4*; α(P)=1.297×10^{-6} *19* Mult.: α(K)exp=0.013 *6* gives E1 or E2.
415.0 *3*	2.2 *3*	1214.2	(7/2$^-$,9/2$^-$,11/2$^-$)	799.25	9/2$^{(-)}$	M1,E2		0.023 *4*	α(K)=0.019 *4*; α(L)=0.00288 *21*; α(M)=0.00061 *4*; α(N+..)=0.000159 *12* α(N)=0.000136 *10*; α(O)=2.14×10^{-5} *20*; α(P)=1.4×10^{-6} *4* α(K)exp=0.022 *8*.

γ(^{135}Pr) (continued)

E_γ	I_γ#	E_i(level)	J^π_i	E_f	J^π_f	Mult.†	δ‡	α@	Comments
441.1 2	28.8 20	799.25	9/2$^{(-)}$	358.15	(11/2$^-$)	M1,E2		0.020 4	α(K)=0.016 4; α(L)=0.00242 22; α(M)=0.00051 5; α(N+..)=0.000133 12 α(N)=0.000114 10; α(O)=1.80×10^{-5} 20; α(P)=1.2×10^{-6} 3 α(K)exp=0.017 3.
442.7 7	2.0 10	688.6	(9/2$^+$)	245.53	7/2$^{(+)}$				
451.9 2	8.5 5	493.37	7/2$^{(+)}$	41.47	5/2$^{(+)}$	M1+E2	+0.4 1	0.0208 6	α(K)=0.0178 5; α(L)=0.00241 5; α(M)=0.000508 9; α(N+..)=0.0001331 24 α(N)=0.0001136 20; α(O)=1.82×10^{-5} 4; α(P)=1.33×10^{-6} 4 Mult.: α(K)exp=0.014 3 gives M1,E2; δ from (p,2nγ).
475.8 2	16.5 10	517.35	9/2$^{(+)}$	41.47	5/2$^{(+)}$	E2		0.01291	α(K)=0.01070 15; α(L)=0.001742 25; α(M)=0.000373 6; α(N+..)=9.60×10^{-5} 14 α(N)=8.25×10^{-5} 12; α(O)=1.278×10^{-5} 18; α(P)=7.41×10^{-7} 11 α(K)exp=0.0090 20 gives δ(E2/M1)>4.
482.6 4	3.4 7	688.6	(9/2$^+$)	206.17	7/2$^{(+)}$	M1(+E2)	<1.5	0.0164 21	α(K)=0.0139 20; α(L)=0.00195 15; α(M)=0.00041 3; α(N+..)=0.000107 9 α(N)=9.2×10^{-5} 7; α(O)=1.46×10^{-5} 13; α(P)=1.03×10^{-6} 17 α(K)exp=0.022 10.
490.3 3	1.7 3	1289.5	(11/2$^-$)	799.25	9/2$^{(-)}$	M1+E2	−1.5 10	0.014 3	α(K)=0.012 3; α(L)=0.00172 21; α(M)=0.00037 4; α(N+..)=9.5×10^{-5} 12 α(N)=8.1×10^{-5} 10; α(O)=1.28×10^{-5} 18; α(P)=8.3×10^{-7} 23 Mult.: α(K)exp=0.014 5 gives M1,E2; δ from (p,2nγ).
493.4 3	2.9 3	493.37	7/2$^{(+)}$	0.0	3/2$^{(+)}$	E2		0.01169	α(K)=0.00971 14; α(L)=0.001561 22; α(M)=0.000333 5; α(N+..)=8.60×10^{-5} 13 α(N)=7.38×10^{-5} 11; α(O)=1.147×10^{-5} 17; α(P)=6.74×10^{-7} 10 α(K)exp=0.0093 31. Mult.: α(K)exp=0.0093 31 gives δ(E2/M1)>1; but adopted ΔJ forbids L=1.
501.6 2	19.4 12	543.20	7/2$^{(-)}$	41.47	5/2$^{(+)}$	E1		0.00373	α(K)=0.00321 5; α(L)=0.000414 6; α(M)=8.66×10^{-5} 13; α(N+..)=2.26×10^{-5} 4 α(N)=1.93×10^{-5} 3; α(O)=3.09×10^{-6} 5; α(P)=2.22×10^{-7} 4 α(K)exp=0.0023 8.
531.9 3	3.9 10	777.4	(11/2$^+$)	245.53	7/2$^{(+)}$	(E2)		0.00955	α(K)=0.00796 12; α(L)=0.001249 18; α(M)=0.000266 4; α(N+..)=6.88×10^{-5} 10 α(N)=5.90×10^{-5} 9; α(O)=9.21×10^{-6} 13; α(P)=5.57×10^{-7} 8 Mult.: α(K)exp=0.0073 34 gives δ(E2/M1)>0.8, but ΔJ$^\pi$ requires E2.
572.0 5	1.1 4	1303.2	(11/2$^-$)	730.95	(15/2$^-$)				
593.7 4	7.6 10	951.78	(13/2$^-$)	358.15	(11/2$^-$)	M1+E2	−1.5 10	0.0084 19	α(K)=0.0071 17; α(L)=0.00101 17; α(M)=0.00021 4; α(N+..)=5.6×10^{-5} 9 α(N)=4.8×10^{-5} 8; α(O)=7.6×10^{-6} 14; α(P)=5.1×10^{-7} 14 Mult.: α(K)exp=0.0110 25 gives M1+E2, δ<0.65. From (p,2nγ), δ=−1.5 10.

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

E_γ	I_γ[#]	E_i(level)	J_i^π	E_f	J_f^π	Mult.[†]	δ[‡]	α[@]	Comments
616.5 *3*	3.8 *6*	1159.7?	$(9/2^-)$	543.20	$7/2^{(-)}$				
670.6 *7*	1.0 *4*	1214.2	$(7/2^-,9/2^-,11/2^-)$	543.20	$7/2^{(-)}$				
[x]708.4 *5*	1.6 *3*					M2,E3		0.016 *5*	α(K)=0.013 *4*; α(L)=0.0020 *4*; α(M)=0.00043 *8*; α(N+..)=0.000113 *21* α(N)=9.7×10^{-5} *18*; α(O)=1.5×10^{-5} *3*; α(P)=1.0×10^{-6} *4* α(K)exp=0.012 *6*.
739.4 *5*	1.6 *3*	984.4	$(9/2^+)$	245.53	$7/2^{(+)}$	M1+E2	−2.0 *15*	0.0046 *14*	α(K)=0.0039 *12*; α(L)=0.00055 *13*; α(M)=0.00012 *3*; α(N+..)=3.0×10^{-5} *7* α(N)=2.6×10^{-5} *6*; α(O)=4.1×10^{-6} *11*; α(P)=2.8×10^{-7} *10* Mult.,δ: from (p,2nγ).
746.1 *5*	1.5 *5*	1289.5	$(11/2^-)$	543.20	$7/2^{(-)}$				
777.7 *5*	1.2 *6*	984.4	$(9/2^+)$	206.17	$7/2^{(+)}$				
966.6 *7*	5.2 *15*	1765.9?	$(7/2^-,9/2^-,11/2^-)$	799.25	$9/2^{(-)}$				
1172.1[&] *7*	2.2 *7*	1214.2	$(7/2^-,9/2^-,11/2^-)$	41.47	$5/2^{(+)}$				
1480.7 *7*	2.3 *7*	1998.0	$(7/2,9/2,11/2^+)$	517.35	$9/2^{(+)}$				
1586.0 *7*	1.5 *5*	2129.2?	$(7/2,9/2,11/2^-)$	543.20	$7/2^{(-)}$				
1752.0 *15*	4.0 *20*	1998.0	$(7/2,9/2,11/2^+)$	245.53	$7/2^{(+)}$				

† From α(K)exp and K/L.

‡ Estimated (by evaluators) from α(K)exp and/or K/L.

For absolute intensity per 100 decays, multiply by 0.496 *16*.

@ 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.

& Placement of transition in the level scheme is uncertain.

x γ ray not placed in level scheme.

$^{135}_{59}Pr_{76}$-6

^{135}Nd ε decay (12.4 min) 1975Wi11