^{109}Pd - Comments on evaluation of decay data by A. L. Nichols

Evaluated: January 2007/March 2009

A.1. Evaluation Procedure

Limitation of Relative Statistical Weight Method (LWM) was applied to average the measured decay data when appropriate (see below).

Decay Scheme

A reasonably comprehensive decay scheme was constructed from the gamma-ray studies of 1968Gr02, 1968Be22, 1969Sc12, 1970Bo37, 1975El10 and 1978Pr08. Other earlier studies involved the use of low-resolution NaI(Tl) detectors, and these data have been set aside from consideration in this particular evaluation [1962Br15, 1962Ec02]. The gamma-ray emission probabilities were expressed in terms of the emission probability of the 647.3-keV gamma ray (100 %), and weighted mean data were derived as appropriate.

Most of the beta decay goes directly to the 88.034-keV metastable state of ^{109}Ag (half-life of 39.7 s). Hence, the resulting 88.03360-keV gamma ray dominates the decay scheme.

A.2. Nuclear Data

^{109}Pd undergoes beta decay to ^{109}Ag, including population of the 88.034-keV nuclear level (^{109}Ag^{m}, half-life of 39.7 s) that undergoes 100 % gamma decay to the stable ground state of ^{109}Ag.

Half-life (^{109}Pd)

The recommended half-life has been determined from the measurements of Gueben and Govaerts (1958Gu09), Starner (1959St28), Brandhorst and Cobble (1962Br15), Bormann *et al.* (1970Bo22), Gindler and Glendenin (1977Gi11), Chatterjee and Baliga (1983Ch42) and Abzouzi *et al*. (1990Ab06). A value of 13.58 (12) hours was derived in terms of LWM, with the uncertainty extended to include the most precise measurement of 13.7012 hours.

Half-life measurements (^{109}Pd)

Reference	Half-life (*h*)
1958Gu09	13.99 ± 0.16 13.20 ± 1.66
1959St28	13.45 ± 0.01
1962Br15	13.47 ± 0.01
1970Bo22	13.67 ± 0.07
1977Gi11	13.427 ± 0.014
1983Ch42	13.85 ± 0.17
1990Ab06	13.7012 ± 0.0024
Recommended value	13.58 ± 0.12

Half-life (^{109}Ag^{m})

The recommended half-life has been determined from the measurements of Helmholz (1941He03), Wiedenbeck (1945Wi11), Bradt *et al.* (1945Br06, 1946Bro7, 1947Br05), Wolicki *et al.* (1951Wo15), Middelboe (1967Mi11), Abrams and Pelekis (1967Ab07), and Cottrell (1973Co10). A value of 39.7 (2) seconds was derived in terms of LWM.

Half-life measurements (^{109}Ag^{m})

Reference	Half-life (*s*)
1941He03	40 ± 3
1945Wi11	40.4 ± 0.2
1947Br05	39.2 ± 0.2
1951Wo15	40 ± 1
1967Mi11	39.80 ± 0.18
1967Ab07	39.3 ± 0.3
1973Co10	35 ± 5
Recommended value	39.7 ± 0.2

Gamma Rays

Energies

Gamma-ray transition energies were calculated from the structural details of the proposed decay scheme. The nuclear level energies of 2006Bl02 were adopted, and used to determine the energies of the gamma-ray transitions between the populated-depopulated levels, apart from the 88.03360-keV gamma ray which was adopted from 2000He14.

Emission Probabilities

Specific features of the earlier decay data studies of ^{109}Pd were considered and adopted to varying degrees during the course of assembling a reasonably consistent decay scheme (1953Av25, 1953Nu04, 1954Mo38, 1957Ma16, 1957Wa05, 1962Ec02, 1967Bl08, 1968BaZY and 1970Fo01). Relative emission probabilities and their uncertainties were determined from the measurements of 1968Gr02, 1968Be22, 1969Sc12, 1970Bo37, 1975El10, 1978Pr08 and 1983Ch42 normalized to the 647.3-keV gamma ray (100 %). These seven data sets were in reasonably good agreement with each other, although some difficulties occurred as noted below.

The 44.7-keV gamma ray has only been observed and quantified by 1968Gr02, 1968Be22 and 1970Bo37. Equivalent relative emission probabilities for the high-intensity 88.0336-keV gamma ray varied by as much as 25 %, and all of these measurements possess rather large uncertainties of ± 9 % to 10 % - not a particularly satisfactory situation for such an important gamma transition. A few gamma-ray emissions of questionable origin were noted by 1975El10 (in particular), 1978Pr08 and 1983Ch42. Thus, the 114.2-, 400.7-, 500.6-, 565.1- and 787.1-keV gamma rays have only been observed by 1975El10. The 327.2-, 395.6-, 609.8- and 869.5-keV gamma rays are also of doubtful origin.

Gamma-ray emission probabilities as measured and reported.

transition	E_γ (keV)	P_γ^{rel}								
		1962Ec02[#]	1968BaZY	1968Be22	1968Gr02	1969Sc12	1970Bo37	1975El10	1978Pr08	1983Ch42
$\gamma_{2,1}$ (Ag)	44.7 (1)	-	-	4.5 (14)	3.6 (11)	-	4.8 (5)	-	-	-
$\gamma_{1,0}$ (Ag)	88.03360 (103)	4.35 (90)	-	11600 (1160)	8900 (800)	3850 (350)	11700 (1150)	11568 (995)	14600 (1300)	16252 (2194)
$\gamma_{4,3}$ (Ag)	103.8 (2)	-	-	1.0 (3)	2.2 (7)	1.0 (2)	1.9 (2)	2.2 (4)	2.8 (5)	1.59
$\gamma_{14,6}$ (Ag)	114.2 (9) ?	-	-	-	-	-	-	0.20 (6)	-	-
$\gamma_{16,11}$ (Ag)	134.2 (2)	-	3.2	3.7 (11)	3.2 (10)	1.4 (3)	4.0 (4)	3.8 (4)	6.1 (9)	8.0 (13)
$\gamma_{16,10}$ (Ag)	145.1 (2)	-	2.5	2.5 (8)	2.7 (8)	1.2 (2)	3.1 (3)	2.8 (3)	3.8 (8)	4.3 (18)
$\gamma_{7,4}$ (Ag)	286.7 (3)	-	-	-	-	0.15 (4)	-	0.660 (72)	0.5 (1)	0.84 (11)
$\gamma_{10,4}$ (Ag)	309.1 (3)	-	-	9 (1)	-	5.0 (15)	11.0 (9)	13.30 (14)	20 (6)	29.8 (36)
$\gamma_{3,0}$ (Ag)	311.4 (1)	0.046 (9)	100	85 (9)	100	34 (3)	91 (8)	100	124 (6)	140.4 (152)
$\gamma_{4,1}$ (Ag)	327.2 (2) ?	-	-	-	-	-	-	-	-	0.52 (5)
$\gamma_{7,3}$ (Ag)	390.5 (2)	0.010 ?	2.3	3.0 (9)	2.5 (5)	1.0 (2)	3.2 (3)	3.2 (4)	3.6 (3)	3.6 (4)
$\gamma_{9,3}$ (Ag)	395.6 (3)	-	-	-	-	0.07 (3)	-	0.60 (19)	0.27 (5)	0.46 (13)
$\gamma_{23,6}$ (Ag)	400.7 (6) ?	-	-	-	-	-	-	0.20 (7)	-	-
$\gamma_{10,3}$ (Ag)	413.0 (2)	0.016 (3)	47 (complex)	22 (2)	26 (8)	7 (1)	23 (2)	23.50 (23)	29 (2)	32.9 (37)
$\gamma_{4,0}$ (Ag)	415.2 (2)	-		45 (5)	23 (7)	11.3 (10)	45.0 (42)	35.2 (3)	42 (3)	46.0 (50)
$\gamma_{11,3}$ (Ag)	423.9 (2)	-	1.7	3.8 (11)	1.8 (4)	1.0 (2)	3.9 (3)	3.1 (3)	3.5 (3)	3.8 (4)
$\gamma_{15,4}$ (Ag)	447.6 (4)	0.005	1.8	3.3 (10)	2.6 (6)	0.88 (20)	3.3 (3)	2.46 (30)	3.5 (3)	3.6 (4)
$\gamma_{16,4}$ (Ag)	454.3 (3)	-	0.9	2.5 (8)	-	0.56 (25)	2.3 (2)	1.80 (23)	1.7 (2)	1.7 (2)
$\gamma_{20,4}$ (Ag)	496.9 (10)	-	-	0.2 (1)	-	-	0.15 (3)	-	0.31 (6)	0.33 (9)
$\gamma_{14,3}$ (Ag)	500.6 (6) ?	-	-	-	-	-	-	0.15 (3)	-	-
$\gamma_{15,3}$ (Ag)	551.4 (3)	0.006 (1) ?	1.9	2.6 (8)	1.5 (5)	0.65 (15)	2.5 (3)	2.1 (3)	2.7 (2)	2.6 (3)
$\gamma_{16,3}$ (Ag)	558.1 (2)	-	6.4	9.8 (10)	6.2 (8)	2.6 (3)	9.6 (9)	8.70 (95)	9.9 (7)	9.7 (10)
$\gamma_{6,2}$ (Ag)	565.1 (5) ?	-	-	-	-	-	-	0.35 (4)	-	-
$\gamma_{11,2}$ (Ag)	602.6 (2)	0.003	21	34 (3)	21.5 (20)	8.5 (5)	34 (3)	28.1 (20)	35 (2)	33.2 (37)
$\gamma_{6,1}$ (Ag)	609.8 (4) ?	-	-	-	-	0.15 (7)	-	0.60 (15)	-	-
$\gamma_{10,1}$ (Ag)	636.3 (1)	-	31	41 (4)	27 (3)	10.6 (5)	41.0 (38)	32.5 (3)	42 (3)	41.5 (45)
$\gamma_{11,1}$ (Ag)	647.3 (1)	0.031 (6)	64	100	65 (5)	26 (2)	100	81.2 (80)	100	100
$\gamma_{7,0}$ (Ag)	701.9 (2)	0.004 (1)	9.2	15 (2)	9.2 (10)	3.3 (3)	14.7 (12)	11.20 (12)	13.5 (18)	12.6 (14)

transition	E_γ (keV)	P_γ^{rel}								
		1962Ec02#	1968BaZY	1968Be22	1968Gr02	1969Sc12	1970Bo37	1975El10	1978Pr08	1983Ch42
$\gamma_{9,0}$ (Ag)	707.0 (2)	-	3.8	6.9 (7)	4.5 (5)	1.7 (2)	7.1 (7)	5.8 (6)	6.3 (9)	5.6 (7)
$\gamma_{10,0}$ (Ag)	724.4 (1)	-	-	1.2 (4)	-	0.20 (5)	1.1 (1)	0.8 (2)	0.4 (1)	0.27 (7)
$\gamma_{16,2}$ (Ag)	736.7 (2)	-	4.4	7.8 (8)	5.0 (6)	1.8 (2)	7.7 (7)	6.1 (7)	6.8 (9)	6.4 (7)
$\gamma_{19,2}$ (Ag)	778.3 (5)	-	-	4 (1)	-	1.6 (5)	4.0 (4)	4.7 (6)	7.3 (25)	9.6 (13)
$\gamma_{16,1}$ (Ag)	781.4 (1)	0.010 (2)	34	49 (5)	33 (3)	11.7 (12)	50 (4)	40.0 (35)	48 (3)	50.5 (56)
$\gamma_{23,3}$ (Ag)	787.1 (3) ?	-	-	-	-	-	-	0.070 (4)	-	-
$\gamma_{19,1}$ (Ag)	823.0 (4)	-	0.5	0.8 (2)	-	0.20 (3)	0.5 (1)	1.2 (3)	0.77 (11)	0.66 (8)
$\gamma_{15,0}$ (Ag)	862.8 (2)	-	0.4	0.6 (2)	< 0.5	0.14 (3)	0.3 (1)	0.40 (15)	0.66 (11)	0.68
$\gamma_{16,0}$ (Ag)	869.5 (1) ?	-	-	-	-	-	-	-	0.21 (6) ?	-
$\gamma_{23,2}$ (Ag)	965.8 (3)	-	-	0.10 (3)	-	-	< 0.1	0.3 (1)	0.25 (4)	0.28
$\gamma_{23,1}$ (Ag)	1010.5 (2)	-	-	0.10 (3)	-	-	< 0.1	0.200 (66)	0.11 (4)	0.12 (4)

NaI(Tl) detectors were used with a lack of spectral resolution – this data set was discarded.

Relative gamma-ray emission probabilities – re-normalised for weighted mean analysis.

E_γ (keV)	P_γ^{rel}								
	1968BaZY§	1968Gr02	1968Be 22	1969Sc12	1970Bo37	1975El10	1978Pr08	1983Ch42	Recommended
44.7 (1)	-	5.5 (17)	4.5 (14)	-	4.8 (5)	-	-	-	4.8 (5)
88.03360 (103)	-	13690 (1230)*	11600 (1160)*	14810 (1350)	11700 (1150)*	14250 (1230)	14600 (1300)	16252 (2194)*	14540 (750)
103.8 (2)	-	3.4 (11)*	1.0 (3)*	3.8 (8)*	1.9 (2)*	2.7 (5)	2.8 (5)	1.5*	2.8 (4)
114.2 (9) ?	-	-	-	-	-	0.25 (8)	-	-	0.25 (8)
134.2 (2)	5	4.9 (15)	3.7 (11)*	5.4 (12)	4.0 (4)	4.7 (5)	6.1 (9)*	8.0 (13)*	4.4 (3)
145.1 (2)	3.9	4.2 (12)	2.5 (8)	4.6 (8)	3.1 (3)	3.4 (4)	3.8 (8)	4.3 (18)	3.3 (2)
286.7 (3)	-	-	-	0.58 (15)	-	0.81 (9)	0.5 (1)	0.84 (11)	0.70 (5)
309.1 (3)	-	-	9 (1)*	19 (6)	11.0 (9)*	16.4 (2)	20 (6)	29.8 (36)*	16.4 (2)
311.4 (1)	156	154 (12)*	85 (9)*	131 (12)	91 (8)*	123 (12)	124 (6)	140.4 (152)*	125 (5)
327.2 (2) ?	-	-	-	-	-	-	-	0.52 (5)	0.52 (5)
390.5 (2)	3.6	3.8 (8)	3.0 (9)*	3.8 (8)	3.2 (3)*	3.9 (5)	3.6 (3)	3.6 (4)	3.7 (2)
395.6 (3)	-	-	-	0.27 (12)	-	0.74 (23)*	0.27 (5)	0.46 (13)*	0.27 (5)

E_γ (keV)	P_γ^{rel}								
	1968BaZY[§]	1968Gr02	1968Be22	1969Sc12	1970Bo37	1975El10	1978Pr08	1983Ch42	Recommended
400.7 (6) ?	-	-	-	-	-	0.25 (9)	-	-	0.25 (9)
413.0 (2)	73(complex)	40 (12)*	22 (2)	27 (4)	23 (2)	28.94 (28)	29 (2)	32.9 (37)	27 (2)
415.2 (2)		35 (11)	45 (5)	43 (4)	45.0 (42)	43.3 (4)	42 (3)	46.0 (50)	43.3 (4)
423.9 (2)	2.7	2.8 (6)*	3.8 (11)	3.8 (8)	3.9 (3)	3.8 (4)	3.5 (3)	3.8 (4)	3.7 (2)
447.6 (4)	2.8	4.0 (9)	3.3 (10)	3.4 (8)	3.3 (3)	3.03 (37)	3.5 (3)	3.6 (4)	3.4 (2)
454.3 (3)	1.4	-	2.5 (8)	2.2 (10)	2.3 (2)	2.22 (28)	1.7 (2)	1.7 (2)	2.0 (1)
496.9 (10)	-	-	0.2 (1)	-	0.15 (3)*	-	0.31 (6)	0.33 (9)	0.29 (5)
500.6 (6) ?	-	-	-	-	-	0.18 (4)	-	-	0.18 (4)
551.4 (3)	3.0	2.3 (8)	2.6 (8)	2.5 (6)	2.5 (3)	2.6 (4)	2.7 (2)	2.6 (3)	2.6 (2)
558.1 (2)	10	9.5 (12)	9.8 (10)	10 (1)	9.6 (9)	10.7 (12)	9.9 (7)	9.7 (10)	9.9 (4)
565.1 (1) ?	-	-	-	-	-	0.43 (5)	-	-	0.43 (5)
602.6 (2)	33	33.0 (31)	34 (3)	33 (2)	34 (3)	34.6 (25)	35 (2)	33.2 (37)	34 (1)
609.8 (4) ?	-	-	-	0.6 (3)	-	0.74 (19)	-	-	0.7 (2)
636.3 (1)	48	42 (5)	41 (4)	41 (2)	41.0 (38)	40.0 (4)	42 (3)	41.5 (45)	40.1 (4)
647.3 (1)	100	100	100	100	100	100	100	100	100
701.9 (2)	14.4	14.2 (15)	15 (2)	12.7 (12)	14.7 (12)	13.79 (14)	13.5 (18)	12.6 (14)	13.8 (2)
707.0 (2)	5.9	6.9 (8)	6.9 (7)	6.5 (8)	7.1 (7)	7.1 (7)	6.3 (9)	5.6 (7)*	6.8 (3)
724.4 (1)	-	-	1.2 (4)	0.8 (2)	1.1 (1)	1.0 (3)	0.4 (1)*	0.27 (7)*	1.0 (1)
736.7 (2)	6.9	7.7 (9)	7.8 (8)	6.9 (8)	7.7 (7)	7.5 (9)	6.8 (9)	6.4 (7)	7.2 (3)
778.3 (5)	-	-	4 (1)*	6.2 (19)	4.0 (4)*	5.8 (7)	7.3 (25)	9.6 (13)*	5.9 (6)
781.4 (1)	53	51 (5)	49 (5)	45 (5)	50 (4)	49 (4)	48 (3)	50.5 (56)	49 (2)
787.1 (3) ?	-	-	-	-	-	0.086 (5)	-	-	0.086 (5)
823.0 (4)	0.8	-	0.8 (2)	0.77 (12)	0.5 (1)*	1.5 (4)*	0.77 (11)	0.66 (8)	0.72 (6)
862.8 (2)	0.6	< 0.8	0.6 (2)	0.54 (12)	0.3 (1)*	0.49 (18)	0.66 (11)	0.68*	0.59 (7)
869.5 (1) ?	-	-	-	-	-	-	0.21 (6) ?	-	0.21 (6)
965.8 (3)	-	-	0.10 (3)*	-	< 0.1	0.4 (1)	0.25 (4)	0.28*	0.27 (4)
1010.5 (2)	-	-	0.10 (3)	-	< 0.1	0.25 (8)	0.11 (4)	0.12 (4)	0.12 (2)

§ Uncertainties were not assigned to the intensity measurements – this data set was discarded.

* Data were not used in the weighted mean analysis process (LWM) – some of these data lack quantified uncertainties, while other data deviate considerably from the majority of equivalent data from other sources.

Gamma-ray emissions: recommended energies, relative emission probabilities, multipolarities and theoretical internal conversion coefficients (frozen orbital approximation).

E_γ (keV)	P_γ^{rel}	Multipolarity	α_K	α_L	α_{M+}	α_{tot}
44.7 (1)	4.8 (5)	M1 + E2 δ = 0.533	5.69 (9)	2.69 (5)	0.62 (2)	9.00 (15)
88.033 60 (103)	14 540 (750)	E3	11.41 (16)	12.06 (17)	2.86 (4)	26.33 (40)
103.8 (2)	2.8 (4)	M1 + E2 δ = – 0.045	0.329 (6)	0.041 (1)	0.009	0.379 (7)
114.2 (9) ?	0.25 (8)	(M1 + E2)	-	-	-	-
134.2 (2)	4.4 (3)	M1 + E2 (δ = 0.15)	0.165 8 (25)	0.021 2 (4)	0.005 (1)	0.192 (3)
145.1 (2)	3.3 (2)	(M1 + E2) δ = 0.132	0.132 6 (20)	0.016 70 (25)	0.003 7	0.153 (2)
286.7 (3)	0.70 (5)	M1 + E2 (δ = 0.199)	0.021 6 (3)	0.002 64 (4)	0.000 56	0.024 8 (4)
309.1 (3)	16.4 (2)	(E1)	0.005 91 (9)	0.000 697 (10)	0.000 163	0.006 77 (10)
311.4 (1)	125 (5)	M1 + E2 δ = – 0.22	0.017 49 (25)	0.002 13 (3)	0.000 48	0.020 1 (3)
327.2 (2) ?	0.52 (5)	E1	0.005 09 (8)	0.000 599 (9)	0.000 131	0.005 82 (9)
390.5 (2)	3.7 (2)	M1 + E2 δ = 0.19	0.009 80 (14)	0.001 178 (17)	0.000 262	0.011 24 (16)
395.6 (3)	0.27 (5)	(E1)	0.003 12 (5)	0.000 366 (6)	0.000 084	0.003 57 (5)
400.7 (6) ?	0.25 (9)	(M1 + E2)	-	-	-	-
413.0 (2)	27 (2)	(E1 (+ M2)) δ = 0.18	0.003 66 (7)	0.000 442 (8)	0.000 098	0.004 20 (8)
415.2 (2)	43.3 (4)	E2	0.009 44 (14)	0.001 257 (18)	0.000 283	0.010 98 (16)
423.9 (2)	3.7 (2)	E1 (+ M2) δ = – 0.27	0.004 36 (7)	0.000 536 (9)	0.000 124	0.005 02 (8)
447.6 (4)	3.4 (2)	M1 + E2 δ = – 0.16	0.006 98 (10)	0.000 833 (12)	0.000 187	0.008 00 (12)
454.3 (3)	2.0 (1)	E1	0.002 22 (4)	0.000 259 (4)	0.000 051	0.002 53 (4)
496.9 (10)	0.29 (5)	M1 + E2 (δ = 0.20)	0.005 41 (8)	0.000 644 (10)	0.000 146	0.006 2 (1)
500.6 (6) ?	0.18 (4)	(E1)	0.001 756 (25)	0.000 205 (3)	0.000 049	0.002 01 (3)
551.4 (3)	2.6 (2)	M1 + E2 δ = – 0.28	0.004 20 (6)	0.000 500 (7)	0.000 12	0.004 82 (7)
558.1 (2)	9.9 (4)	E1 (+ M2) δ = – 0.26	0.002 07 (4)	0.000 249 (4)	0.000 061	0.002 38 (4)
565.1 (5) ?	0.43 (5)	(E2)	0.003 86 (6)	0.000 489 (7)	0.000 111	0.004 46 (7)
602.6 (2)	34 (1)	E2	0.003 24 (5)	0.000 407 (6)	0.000 093	0.003 74 (6)
609.8 (4) ?	0.7 (2)	(M1 + E2)	-	-	-	-
636.3 (1)	40.1 (4)	(E2)	0.002 81 (4)	0.000 350 (5)	0.000 07	0.003 23 (5)
647.3 (1)	100	M1 + E2	-	-	-	-
701.9 (2)	13.8 (2)	M1 + E2 δ = 0.029	0.002 39 (4)	0.000 280 (4)	0.000 06	0.002 73 (4)
707.0 (2)	6.8 (3)	(E1)	0.000 807 (12)	0.000 093 3 (13)	0.000 020 7	0.000 921 (13)
724.4 (1)	1.0 (1)	(E1)	0.000 766 (11)	0.000 088 5 (13)	0.000 019 5	0.000 874 (13)
736.7 (2)	7.2 (3)	E2	0.001 93 (3)	0.000 236 (4)	0.000 044	0.002 21 (4)
778.3 (5)	5.9 (6)	M1 + E2	-	-	-	-
781.4 (1)	49 (2)	M1 + E2	-	-	-	-
787.1 (3) ?	0.086 (5)	(E1)	0.000 644 (9)	0.000 074 3 (11)	0.000 016 7	0.000 735 (11)
823.0 (4)	0.72 (6)	M1 + E2	-	-	-	-
862.8 (2)	0.59 (7)	E2	0.001 313 (19)	0.000 158 3 (23)	0.000 038 7	0.001 51 (2)
869.5 (1) ?	0.21 (6)	M2 (+ E3)	0.003 72 (6)	0.000 453 (7)	0.000 097	0.004 27 (6)
965.8 (3)	0.27 (4)	-	-	-	-	-
1010.5 (2)	0.12 (2)	-	-	-	-	-

Much of the lower-energy gamma-ray data of 1968Gr02, 1968Be22, 1970Bo37 and 1983Ch42 deviated significantly from the studies of 1969Sc12, 1975El10 and 1978Pr08 (particularly below 400 keV) and after careful consideration of the individual data sets, some of these measurements were set aside and not included in the eventual weighted mean analyses. Despite these problems, every effort has been made to incorporate all of the gamma-ray data within a reasonably comprehensive decay scheme. One result of this effort is the introduction of two relatively poorly defined nuclear levels at 697.8 (5/2+) and 812.0 (3/2+) keV, primarily to accommodate the 114.2-, 500.6-, 565.1- and 609.8-keV gamma rays. Additional low-intensity gamma transitions were also incorporated into the proposed decay scheme, including the 327.2-, 400.7-, 787.1- and 869.5-keV gamma rays.

Multipolarities and Internal Conversion Coefficients

The nuclear level scheme specified by Blachot (2006Bl02) has been used to define the multipolarities of the gamma transitions on the basis of known spins and parities. Somewhat disparate mixing ratios were obtained by 1970Ro14, 1975El10, 1977Bo04 and 1978Pro8 based on angular correlation measurements, and these data were used to determine the assignments and internal conversion coefficients of the 103.8-, 145.1-, 311.4-, 390.5-, 413.0-, 423.9-, 447.6-, 551.4-, 558.1- and 701.9-keV-keV gamma rays. Recommended internal conversion coefficients were determined from the theoretical tabulations of Band *et al.* (2002Ba85, 2002Ra45) by means of the methodology of Kibedi *et al.* (2008Ki07) in which the frozen orbital approximation was adopted. Finally, the theoretical internal conversion coefficients and mixing ratio of the 44.7-keV (M1 + E2) gamma transition were derived from the population-depopulation balance of the 132.74-keV nuclear level (with no populating beta transition).

A normalization factor of 0.000 252 (14) was calculated from the internal conversion coefficients and relative emission probabilities of the gamma-ray transitions populating the ^{109}Ag ground state directly, assuming that there is no direct beta feeding as implied from the spins and parities derived for the ^{109}Pd ($5/2^+$) and ^{109}Ag ($1/2^-$) ground states:

$$\sum P_{\gamma+ce}^{rel} = 100\%$$

$$397\,572\ (21\,307)\ F = 100$$

$$F = 0.000\,251\,53 \pm 0.000\,013\,51 \quad [= 0.000\,252 \pm 0.000\,014]$$

Beta-particle Emissions

Energies and emission probabilities

The beta-particle energies were calculated from the structural detail of the proposed decay scheme. Nuclear level energies adopted from Blachot (2006Bl02) and a Q_{β^-} value of 1116.1 ± 2.0 keV from Audi *et al.* (2003Au03) were used to determine the energies and uncertainties of the beta-particle transitions. Beta-particle emission probabilities were calculated from the relative gamma-ray emission probabilities, the associated normalization factor and the theoretical internal conversion coefficients derived from Kibedi *et al.* (2008Ki07). Direct beta population of the 132.74-keV nuclear level and ground state of ^{109}Ag were assumed to be zero on the basis of spin and parity considerations ($5/2^+$ to $9/2^+$ (2nd forbidden non-unique), and $5/2^+$ to $1/2^-$ (1st forbidden unique), respectively).

Beta-particle Emission Probability per 100 Disintegrations of ^{109}Pd.

Transition	E_β (keV)	P_β	Transition type	log*ft*
$\beta^-_{0,23}$	17.6 ± 2.0	0.000 18 ± 0.000 03	(allowed)	6.22
$\beta^-_{0,20}$	204.0 ± 2.2	0.000 074 ± 0.000 014	1st forbidden non-unique	9.87
$\beta^-_{0,19}$	205.1 ± 2.0	0.001 66 ± 0.000 17	allowed	8.53
$\beta^-_{0,16}$	246.6 ± 2.0	0.019 4 ± 0.000 9	allowed	7.72
$\beta^-_{0,15}$	253.3 ± 2.0	0.001 67 ± 0.000 10	1st forbidden non-unique	8.82
$\beta^-_{0,14}$	304.1 ± 2.1	0.000 108 ± 0.000 024	(allowed)	10.3
$\beta^-_{0,11}$	380.8 ± 2.0	0.033 4 ± 0.001 5	allowed	8.096
$\beta^-_{0,10}$	391.8 ± 2.0	0.020 4 ± 0.000 9	(allowed)	8.351
$\beta^-_{0,9}$	409.1 ± 2.0	0.001 78 ± 0.000 12	(allowed)	9.47
$\beta^-_{0,7}$	414.2 ± 2.0	0.004 60 ± 0.000 21	1st forbidden non-unique	9.08
$\beta^-_{0,6}$	418.3 ± 2.0	0.000 16 ± 0.000 07	(allowed)	10.55
$\beta^-_{0,4}$	700.9 ± 2.0	0.006 3 ± 0.000 2	1st forbidden non-unique	9.73
$\beta^-_{0,3}$	804.7 ± 2.0	0.019 1 ± 0.002 2	1st forbidden non-unique	9.46
$\beta^-_{0,1}$	1028.1 ± 2.0	99.891 ± 0.003	allowed	6.134 (5)

Σ 99.999 832

A.3. Atomic Data

The X-ray and Auger electron data have been calculated using the evaluated gamma-ray data, and the atomic data from 1996Sc06, 1998ScZM and 1999ScZX.

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