$^{109}_{46}$Pd $_{63}$

1 Decay Scheme

Pd-109 decays predominantly by beta- emission to the metastable state of Ag-109 which undergoes 100% IT decay (first excited state; half-life of 39.7(2) s). A full decay scheme has been proposed that encompasses Ag-109m decay to the ground state of Ag-109.
Le palladium 109 se désintègre par émissions bêta moins principalement vers le niveau excité de 39,7 s de période de l'argent 109.

2 Nuclear Data

$T_{1/2}(^{109}Pd)$	:	13,58	(12)	h
$T_{1/2}(^{109}Ag^{m})$	:	39,7	(2)	s
$Q^{-}(^{109}Pd)$	:	1116,1	(20)	keV

2.1 β^- Transitions

	Energy keV	Probability × 100	Nature	lg ft
$\beta^-_{0,23}$	17,6 (20)	0,00018 (3)	(allowed)	6,22
$\beta^-_{0,20}$	204,0 (22)	0,000074 (14)	1st forbidden non-unique	9,87
$\beta^-_{0,19}$	205,1 (20)	0,00166 (17)	allowed	8,53
$\beta^-_{0,16}$	246,6 (20)	0,0194 (9)	allowed	7,72
$\beta^-_{0,15}$	253,3 (20)	0,00167 (10)	1st forbidden non-unique	8,82
$\beta^-_{0,14}$	304,1 (21)	0,000108 (24)	(allowed)	10,3
$\beta^-_{0,11}$	380,8 (20)	0,0334 (15)	allowed	8,096
$\beta^-_{0,10}$	391,8 (20)	0,0204 (9)	(allowed)	8,351
$\beta^-_{0,9}$	409,1 (20)	0,00178 (12)	(allowed)	9,47
$\beta^-_{0,7}$	414,2 (20)	0,00460 (21)	1st forbidden non-unique	9,08
$\beta^-_{0,6}$	418,3 (20)	0,00016 (7)	(allowed)	10,55
$\beta^-_{0,4}$	700,9 (20)	0,0063 (2)	1st forbidden non-unique	9,73
$\beta^-_{0,3}$	804,7 (20)	0,0191 (22)	1st forbidden non-unique	9,46
$\beta^-_{0,1}$	1028,1 (20)	99,891 (3)	allowed	6,134

2.2 Gamma Transitions and Internal Conversion Coefficients

	Energy keV	$P_{\gamma+ce}$ × 100	Multipolarity	α_K	α_L	α_M	α_T
$\gamma_{2,1}$(Ag)	44,7 (1)	0,0121 (15)	M1+E2	5,69 (9)	2,69 (5)	0,533 (10)	9,00 (15)
$\gamma_{1,0}$(Ag)	88,03360 (103)	99,951 (4)	E3	11,41 (16)	12,06 (17)	2,47 (4)	26,33 (40)
$\gamma_{4,3}$(Ag)	103,8 (2)	0,00097 (15)	M1+E2	0,329 (6)	0,0411 (7)	0,00783 (13)	0,379 (7)
$\gamma_{14,6}$(Ag)	114,2 (9)	0,000063 (21)	(M1+E2)				
$\gamma_{16,11}$(Ag)	134,2 (2)	0,00132 (12)	M1+E2	0,1658 (25)	0,0212 (4)	0,00404 (6)	0,192 (3)
$\gamma_{16,10}$(Ag)	145,1 (2)	0,00096 (8)	(M1+E2)	0,1326 (20)	0,01670 (25)	0,00318 (5)	0,153 (2)
$\gamma_{7,4}$(Ag)	286,7 (3)	0,000180 (16)	M1+E2	0,0216 (3)	0,00264 (4)	0,000501 (8)	0,0248 (4)
$\gamma_{10,4}$(Ag)	309,1 (3)	0,00416 (23)	(E1)	0,00591 (9)	0,000697 (10)	0,0001317 (19)	0,00677 (10)
$\gamma_{3,0}$(Ag)	311,4 (1)	0,0320 (21)	M1+E2	0,01749 (25)	0,00213 (3)	0,000405 (6)	0,0201 (3)
$\gamma_{4,1}$(Ag)	327,2 (2)	0,000132 (15)	E1	0,00509 (8)	0,000599 (9)	0,0001133 (17)	0,00582 (9)
$\gamma_{7,3}$(Ag)	390,5 (2)	0,00094 (7)	M1+E2	0,00980 (14)	0,001178 (17)	0,000224 (4)	0,01124 (16)
$\gamma_{9,3}$(Ag)	395,6 (3)	0,000068 (13)	(E1)	0,00312 (5)	0,000366 (6)	0,0000692 (10)	0,00357 (5)
$\gamma_{23,6}$(Ag)	400,7 (6)	0,000063 (23)	(M1+E2)				
$\gamma_{10,3}$(Ag)	413,0 (2)	0,0068 (7)	(E1+(M2))	0,00366 (7)	0,000442 (8)	0,0000839 (16)	0,00420 (8)
$\gamma_{4,0}$(Ag)	415,2 (2)	0,0110 (6)	E2	0,00944 (14)	0,001257 (18)	0,000240 (4)	0,01098 (16)
$\gamma_{11,3}$(Ag)	423,9 (2)	0,00093 (7)	E1(+M2)	0,00436 (7)	0,000536 (9)	0,0001020 (16)	0,00502 (8)
$\gamma_{15,4}$(Ag)	447,6 (4)	0,00087 (7)	M1+E2	0,00698 (10)	0,000833 (12)	0,0001580 (23)	0,00800 (12)
$\gamma_{16,4}$(Ag)	454,3 (3)	0,00050 (4)	E1	0,00222 (4)	0,000259 (4)	0,0000490 (7)	0,00253 (4)
$\gamma_{20,4}$(Ag)	496,9 (10)	0,000073 (14)	M1+E2	0,00541 (8)	0,000644 (10)	0,0001222 (18)	0,0062 (1)
$\gamma_{14,3}$(Ag)	500,6 (6)	0,000045 (11)	(E1)	0,001756 (25)	0,000205 (3)	0,0000387 (6)	0,00201 (3)
$\gamma_{15,3}$(Ag)	551,4 (3)	0,00065 (7)	M1+E2	0,00420 (6)	0,000500 (7)	0,0000948 (14)	0,00482 (7)
$\gamma_{16,3}$(Ag)	558,1 (2)	0,00250 (17)	E1(+M2)	0,00207 (4)	0,000249 (4)	0,0000473 (8)	0,00238 (4)
$\gamma_{6,2}$(Ag)	565,1 (5)	0,000108 (14)	(E2)	0,00386 (6)	0,000489 (7)	0,0000931 (14)	0,00446 (7)
$\gamma_{11,2}$(Ag)	602,6 (2)	0,0086 (6)	E2	0,00324 (5)	0,000407 (6)	0,0000774 (11)	0,00374 (6)
$\gamma_{6,1}$(Ag)	609,8 (4)	0,00018 (6)	(M1+E2)				
$\gamma_{10,1}$(Ag)	636,3 (1)	0,0101 (6)	(E2)	0,00281 (4)	0,000350 (5)	0,0000665 (10)	0,00323 (5)
$\gamma_{11,1}$(Ag)	647,3 (1)	0,0252 (14)	M1+E2				
$\gamma_{7,0}$(Ag)	701,9 (2)	0,00348 (20)	M1+E2	0,00239 (4)	0,000280 (4)	0,0000531 (8)	0,00273 (4)
$\gamma_{9,0}$(Ag)	707,0 (2)	0,00171 (12)	(E1)	0,000807 (12)	0,0000933 (13)	0,00001762 (25)	0,000921 (13)
$\gamma_{10,0}$(Ag)	724,4 (1)	0,00025 (3)	(E1)	0,000766 (11)	0,0000885 (13)	0,00001672 (24)	0,000874 (13)
$\gamma_{16,2}$(Ag)	736,7 (2)	0,00181 (13)	E2	0,00193 (3)	0,000236 (4)	0,0000448 (7)	0,00221 (4)
$\gamma_{19,2}$(Ag)	778,3 (5)	0,00148 (17)	M1+E2				
$\gamma_{16,1}$(Ag)	781,4 (1)	0,0123 (9)	M1+E2				
$\gamma_{23,3}$(Ag)	787,1 (3)	0,0000216 (18)	(E1)	0,000644 (9)	0,0000743 (11)	0,00001403 (20)	0,000735 (11)
$\gamma_{19,1}$(Ag)	823,0 (4)	0,000181 (18)	M1+E2				
$\gamma_{15,0}$(Ag)	862,8 (2)	0,000148 (20)	E2	0,001313 (19)	0,0001583 (23)	0,0000300 (5)	0,00151 (2)
$\gamma_{16,0}$(Ag)	869,5 (1)	0,000053 (16)	M2(+E3)	0,00372 (6)	0,000453 (7)	0,0000862 (13)	0,00427 (6)
$\gamma_{23,2}$(Ag)	965,8 (3)	0,000068 (11)					
$\gamma_{23,1}$(Ag)	1010,5 (2)	0,000030 (6)					

3 Atomic Data

3.1 Ag

ω_K	:	0,831	(4)
$\bar{\omega}_L$	:	0,0583	(14)
n_{KL}	:	0,964	(4)

3.1.1 X Radiations

		Energy keV		Relative probability
X_K				
	$K\alpha_2$	21,9906		53
	$K\alpha_1$	22,16317		100
	$K\beta_3$	24,9118	}	
	$K\beta_1$	24,9427	}	
	$K\beta_5''$	25,146	}	27,7
	$K\beta_2$	25,4567	}	
	$K\beta_4$	25,512	}	4,8
X_L				
	$L\ell$	2,634		
	$L\alpha$	2,978 – 2,984		
	$L\eta$	2,806		
	$L\beta$	3,151 – 3,348		
	$L\gamma$	3,52 – 3,75		

3.1.2 Auger Electrons

	Energy keV	Relative probability
Auger K		
KLL	17,79 – 18,69	100
KLX	20,945 – 22,160	42,5
KXY	24,079 – 25,507	4,52
Auger L	1,9 – 3,8	1656

4 Electron Emissions

		Energy keV		Electrons per 100 disint.
e_{AL}	(Ag)	1,9 - 3,8		79,5 (5)
e_{AK}	(Ag)			7,06 (23)
	KLL	17,79 - 18,69	}	
	KLX	20,945 - 22,160	}	
	KXY	24,079 - 25,507	}	
$ec_{1,0}$ T	(Ag)	62,52 - 88,03		96,29 (6)
$ec_{1,0}$ K	(Ag)	62,520 (1)		41,7 (4)
$ec_{1,0}$ L	(Ag)	84,2278 - 84,6825		44,1 (4)
$\beta^-_{0,23}$	max:	17,6 (20)		0,00018 (3)
$\beta^-_{0,23}$	avg:	4,5 (5)		
$\beta^-_{0,20}$	max:	204,0 (22)		0,000074 (14)
$\beta^-_{0,20}$	avg:	56,3 (7)		
$\beta^-_{0,19}$	max:	205,1 (20)		0,00166 (17)
$\beta^-_{0,19}$	avg:	56,7 (6)		
$\beta^-_{0,16}$	max:	246,6 (20)		0,0194 (9)
$\beta^-_{0,16}$	avg:	69,4 (6)		
$\beta^-_{0,15}$	max:	253,3 (20)		0,00167 (10)
$\beta^-_{0,15}$	avg:	71,5 (6)		
$\beta^-_{0,14}$	max:	304,1 (21)		0,000108 (24)
$\beta^-_{0,14}$	avg:	87,7 (7)		
$\beta^-_{0,11}$	max:	380,8 (20)		0,0334 (15)
$\beta^-_{0,11}$	avg:	113,1 (7)		
$\beta^-_{0,10}$	max:	391,8 (20)		0,0204 (9)
$\beta^-_{0,10}$	avg:	116,8 (7)		
$\beta^-_{0,9}$	max:	409,1 (20)		0,00178 (12)
$\beta^-_{0,9}$	avg:	122,8 (7)		
$\beta^-_{0,7}$	max:	414,2 (20)		0,00460 (21)
$\beta^-_{0,7}$	avg:	124,5 (7)		
$\beta^-_{0,6}$	max:	418,3 (20)		0,00016 (7)
$\beta^-_{0,6}$	avg:	125,9 (7)		
$\beta^-_{0,4}$	max:	700,9 (20)		0,0063 (2)
$\beta^-_{0,4}$	avg:	229,7 (8)		
$\beta^-_{0,3}$	max:	804,7 (20)		0,0191 (22)
$\beta^-_{0,3}$	avg:	270,3 (8)		
$\beta^-_{0,1}$	max:	1028,1 (20)		99,891 (3)
$\beta^-_{0,1}$	avg:	361,0 (8)		

5 Photon Emissions

5.1 X-Ray Emissions

		Energy keV		Photons per 100 disint.	
XL	(Ag)	2,634 — 3,75		4,92 (13)	
$XK\alpha_2$	(Ag)	21,9906		9,92 (23)	} $K\alpha$
$XK\alpha_1$	(Ag)	22,16317		18,7 (5)	}
$XK\beta_3$	(Ag)	24,9118	}		
$XK\beta_1$	(Ag)	24,9427	}	5,18 (13)	$K'\beta_1$
$XK\beta_5''$	(Ag)	25,146	}		
$XK\beta_2$	(Ag)	25,4567	}		
$XK\beta_4$	(Ag)	25,512	}	0,90 (4)	$K'\beta_2$

5.2 Gamma Emissions

	Energy keV	Photons per 100 disint.
$\gamma_{2,1}$(Ag)	44,7 (1)	0,00121 (15)
$\gamma_{1,0}$(Ag)	88,03360 (103)	3,66 (6)
$\gamma_{4,3}$(Ag)	103,8 (2)	0,00070 (11)
$\gamma_{14,6}$(Ag)	114,2 (9)	0,000063 (21)
$\gamma_{16,11}$(Ag)	134,2 (2)	0,00111 (10)
$\gamma_{16,10}$(Ag)	145,1 (2)	0,00083 (7)
$\gamma_{7,4}$(Ag)	286,7 (3)	0,000176 (16)
$\gamma_{10,4}$(Ag)	309,1 (3)	0,00413 (23)
$\gamma_{3,0}$(Ag)	311,4 (1)	0,0314 (21)
$\gamma_{4,1}$(Ag)	327,2 (2)	0,000131 (15)
$\gamma_{7,3}$(Ag)	390,5 (2)	0,00093 (7)
$\gamma_{9,3}$(Ag)	395,6 (3)	0,000068 (13)
$\gamma_{23,6}$(Ag)	400,7 (6)	0,000063 (23)
$\gamma_{10,3}$(Ag)	413,0 (2)	0,0068 (7)
$\gamma_{4,0}$(Ag)	415,2 (2)	0,0109 (6)
$\gamma_{11,3}$(Ag)	423,9 (2)	0,00093 (7)
$\gamma_{15,4}$(Ag)	447,6 (4)	0,00086 (7)
$\gamma_{16,4}$(Ag)	454,3 (3)	0,00050 (4)
$\gamma_{20,4}$(Ag)	496,9 (10)	0,000073 (14)
$\gamma_{14,3}$(Ag)	500,6 (6)	0,000045 (11)
$\gamma_{15,3}$(Ag)	551,4 (3)	0,00065 (7)
$\gamma_{16,3}$(Ag)	558,1 (2)	0,00249 (17)
$\gamma_{6,2}$(Ag)	565,1 (5)	0,000108 (14)
$\gamma_{11,2}$(Ag)	602,6 (2)	0,0086 (6)
$\gamma_{6,1}$(Ag)	609,8 (4)	0,00018 (6)
$\gamma_{10,1}$(Ag)	636,3 (1)	0,0101 (6)

	Energy keV	Photons per 100 disint.
$\gamma_{11,1}$(Ag)	647,3 (1)	0,0252 (14)
$\gamma_{7,0}$(Ag)	701,9 (2)	0,00347 (20)
$\gamma_{9,0}$(Ag)	707,0 (2)	0,00171 (12)
$\gamma_{10,0}$(Ag)	724,4 (1)	0,00025 (3)
$\gamma_{16,2}$(Ag)	736,7 (2)	0,00181 (13)
$\gamma_{19,2}$(Ag)	778,3 (5)	0,00148 (17)
$\gamma_{16,1}$(Ag)	781,4 (1)	0,0123 (9)
$\gamma_{23,3}$(Ag)	787,1 (3)	0,0000216 (18)
$\gamma_{19,1}$(Ag)	823,0 (4)	0,000181 (18)
$\gamma_{15,0}$(Ag)	862,8 (2)	0,000148 (20)
$\gamma_{16,0}$(Ag)	869,5 (1)	0,000053 (16)
$\gamma_{23,2}$(Ag)	965,8 (3)	0,000068 (11)
$\gamma_{23,1}$(Ag)	1010,5 (2)	0,000030 (6)

6 Main Production Modes

Pd – 108(n,γ)Pd – 109

Pd – 108(d,p)Pd – 109

Pd – 110(n,2n)Pd – 109

U – 238(n,f)Pd – 109

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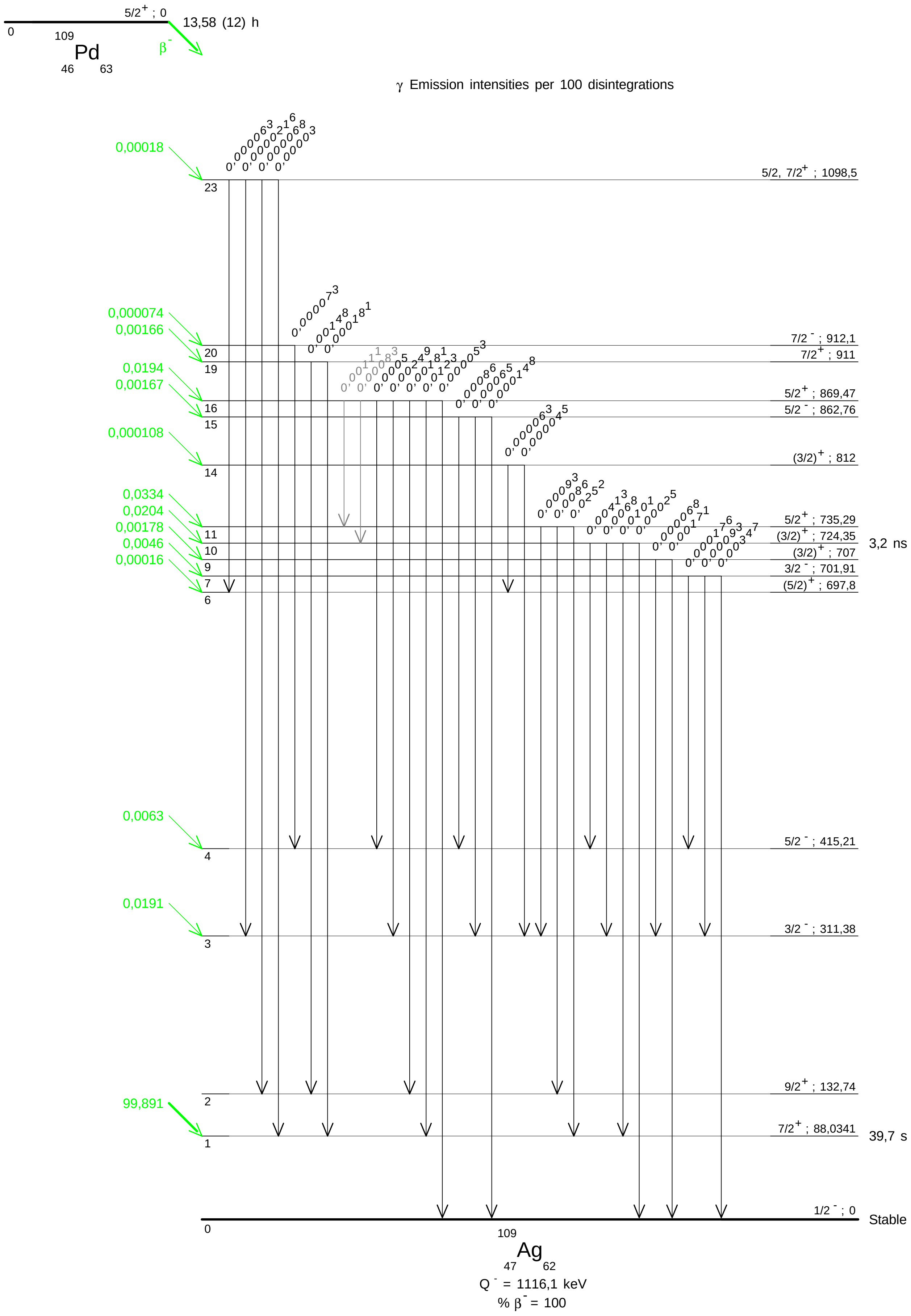
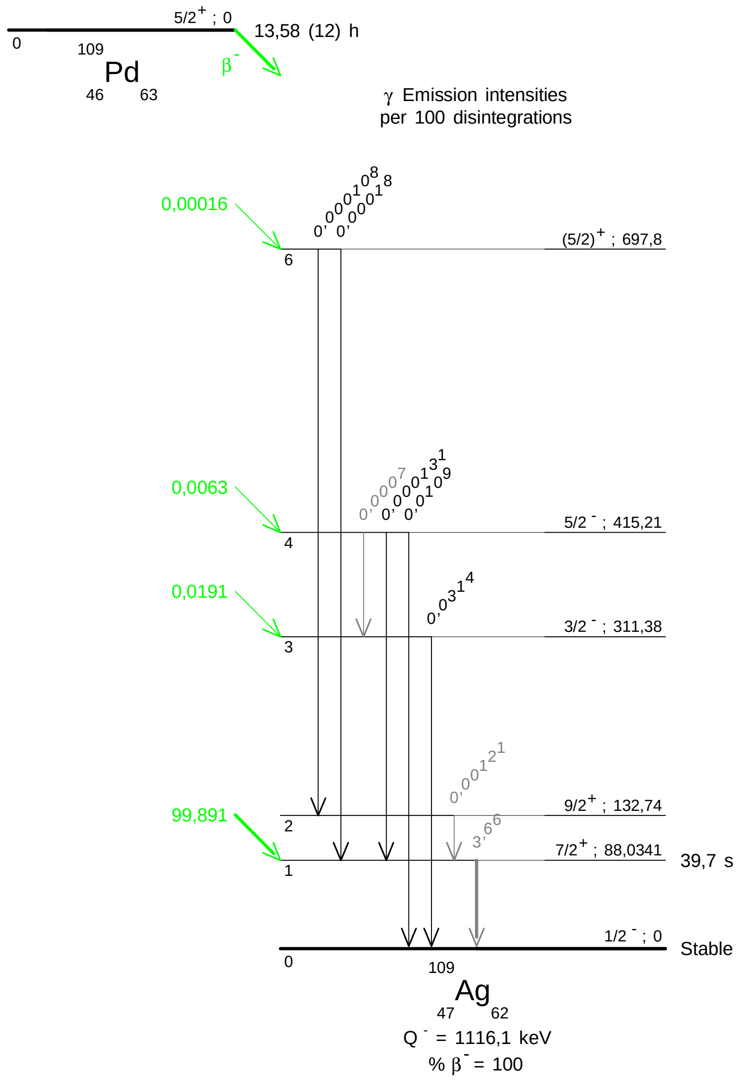

5/2+ ; 0
13,58 (12) h
β-
109 Pd 46 63
γ Emission intensities per 100 disintegrations
0,00018
0,000074
0,00166
0,0194
0,00167
0,000108
0,0334
0,0204
0,00178
0,0046
0,00016
0,0063
0,0191
99,891
5/2, 7/2+ ; 1098,5
7/2 - ; 912,1
7/2+ ; 911
5/2+ ; 869,47
5/2 - ; 862,76
(3/2)+ ; 812
5/2+ ; 735,29
(3/2)+ ; 724,35
(3/2)+ ; 707
3/2 - ; 701,91
(5/2)+ ; 697,8
3,2 ns
5/2 - ; 415,21
3/2 - ; 311,38
9/2+ ; 132,74
7/2+ ; 88,0341
39,7 s
1/2 - ; 0
Stable
109 Ag 47 62
Q - = 1116,1 keV
% β- = 100


5/2+ ; 0
13,58 (12) h
0
109
Pd
46
63
β-
γ Emission intensities
per 100 disintegrations
0,00016
0,0063
0,0191
99,891
(5/2)+ ; 697,8
5/2 - ; 415,21
3/2 - ; 311,38
9/2+ ; 132,74
7/2+ ; 88,0341
39,7 s
1/2 - ; 0
Stable
109
Ag
47
62
Q- = 1116,1 keV
% β- = 100