$^{234}Pa^{m}$-Comments on evaluation of the decay data

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This evaluation was completed in 2009. Literature available by January 2009 was included.

1 Decay Scheme

$^{234}Pa^{m}$ disintegrates 99.85 (1) % by β^- emissions to levels in ^{234}U and also 0.15 (1) % through IT decay to ^{234}Pa. $^{234}Pa^{m}$ isomer state has $J^{\pi} = (0)^-$ (2007Br04).

Measured and recommended branching ratios for $^{234}Pa^{m}$ IT decay are listed in Table 1.

Table 1: Measured and recommended branching ratio for $^{234}Pa^{m}$ IT decay.

IT (%)	References	Comments
0.150 (25)	1938Fe02	
0.12	1945Br05	Not used
0.63	1954Zi02	Not used
0.18 (2)	1960Fo15	
0.13 (3)	1963Bj02	Deduced by comparing $I_{ce's}$, $I_{\gamma's}$, and β- disintegration rates from $^{234}Pa^{g}$ following $^{234}Pa^{m}$ decay
0.15 (5)	1973Go40	
0.19 (6)		
0.19 (5)	1978Ch06	Deduced from measured I_{γ}(73.9 keV)
0.157 (14)	1990Sc09	Deduced from measured P_{γ}(131 keV)
0.126 (16)	2006Al28	Deduced from measured P_{γ}(131 keV)
0.151 (8)		LWEIGHT
0.15 (1)		Adopted

Statistical processing was performed with the LWEIGHT computer program.

Our recommended IT decay branching ratio is I_{IT} = 0.15 (1) % which taken from LWEIGHT result. Thus, I_{β^-} = 99.85 (1) %.

The $^{234}Pa^{m}$ β^- decay scheme was built based mainly on measurement results from 1963Bj02, 1967Wa09 and 1975Ar23. 16 γ-rays were not placed in the current decay scheme. The total photon intensity of these γ transitions is about 0.018 %.

The adopted Q(β^-) value of 2269(4) + x keV has been obtained from Q(β^-) = 2195 (4) keV for ^{234}Pa β^- decay (2003Au03), the energy of γ-ray transition 73.92 keV and the estimate of isomeric transition energy x < 10 keV deduced from the limit on experimental detection (1973Go40) in ^{234}Th β^- decay. The adopted Q(β^-) is in certain agreement with the effective Q(β^-) value of 2259.7 (24) keV, calculated by the evaluators from average radiation energies using the RADLST computer program. This agreement supports the completeness and correctness of the decay scheme.

2 Nuclear Data

The Q(β^-) value is from the mass adjustment in 2003Au03 and the energies of γ-ray transitions in $^{234}Pa^{m}$ IT decay (see above).

Level energies, have been obtained from a least-squares fit to γ-ray energies (GTOL computer code). Spin and parities are from 2007Br04.

The measured and recommended $^{234}Pa^{m}$ half-life values are listed in Table 2.

Table 2: Measured half-life values of $^{234}Pa^{m}$ and recommended value

$T_{1/2}$ (min)	References	Comments
1.175 (3)	1951Ba83	
1.25 (10)	1956On07	
1.14 (1)	1963Bj02	
1.183 (37)	1969SaZR	
1.175	1969DeZX	Not used
1.159 (16)	2004Wo02	Evaluated value
1.187 (23)		Unweighted mean
1.159 (11)		LWEIGHT weighted mean,χ^2=2.54
1.159 (11)		Recommended value

The weighted average of 1.15946 for this data set of the 4 values is dominated by the accurate value of 1951Ba83. The LWEIGHT computer program, which uses a Limitation of Relative Statistical Weights (LRSW method), has increased the 1951Ba83 uncertainty from 0.003 to 0.0096 and used a weighted mean and an external uncertainty for recommended average.

Thus, the adopted value of the $^{234}Pa^{m}$ half-life is 1.159 (11) minute.

2.1 β^- transitions

The maximum energies of the β^- transitions in the decay of $^{234}Pa^{m}$ have been deduced from the Q(β-) value (2003Au03), and the level energies which given in Tables 3 and 4.

Table 3: ^{234}Pa levels populated in $^{234}Pa^{m}$ IT decay

Level energy (keV)	Spin & parity	Half-life
0.0	4+	6.70 (5) h
73.92 (2)	(3+)	
73.92+x	(0-)	1.159 (11) min

Table 4: ^{234}U levels populated in $^{234}Pa^{m}$ β^- decay

Level energy (keV)	Spin & parity	Half-life	β^- transition probabilities (%)
0.0	0+	2.455 (6)×10^5 a	97.599 (24)
43.428 (14)	2+	0.252 (7) ns	
143.279 (24)	4+		
786.243 (14)	1-		0.049 (3)
809.786 (23)	0+	< 0.1 ns	0.945 (12)
849.18 (7)	3-		
851.56 (4)	2+	> 1.74 ps	
926.659 (20)	2+	1.38 (17) ps	
989.359 (19)	2-	0.76 (4) ns	
1044.469 (15)	0+		1.006 (13)
1085.04 (4)	2+		

Level energy (keV)	Spin & parity	Half-life	β^- transition probabilities (%)
1126.32 (4)	2+		
1174.2 (4)	(1,2+)		0.004 6 (3)
1237.23 (3)	1-		0.012 1 (11)
1435.05 (5)	1-		0.009 2 (11)
1457.40 (8)	(2-)		
1500.8 (3)	(1)		0.013 1 (6)
1553.62 (6)	(1)		0.032 0 (6)
1570.53 (4)	1+		0.002 31 (19)
1591.64 (7)	(1)		0.024 9 (5)
1601.68 (4)	1+		0.001 27 (23)
1666.77 (5)	(1-)		0.006 1 (3)
1693.7? (6)	(1-)		0.002 4 (3)
1781.19 (8)	(0+,1)		0.035 7 (18)
1796.4 (6)	(1)		0.002 1 (3)
1808.97 (7)	(1-)		0.014 6 (7)
1863.11 (7)	(1)		0.003 11 (19)
1874.86 (8)	(1)		0.025 8 (3)
1911.04 (5)	(1-)		0.045 2 (8)
1936.68 (7)	(1)		0.010 8 (3)
1970.0 (5)	(1-)		0.003 89 (22)

The adopted β^- transition probabilities and the associated uncertainties were deduced from the γ transition probability balance at each level of the decay scheme.

The values of *logft* and average β^- energies have been calculated with the program LOGFT.

2.2 γ Transitions

The γ-ray transition probabilities were deduced using the γ-ray emission intensities and the relevant internal conversion coefficients.

Multipolarities and mixing ratios of γ-ray transitions are from 1963Bj02 and 2007Br04.

The internal conversion coefficient (ICC) (and its associated uncertainty) for γ-ray transitions have been interpolated from theoretical values based on the "Frozen Orbital" approximation (2002Ba85) using the BrIcc computer program (2008Ki07).

3. Atomic data

Atomic fluorescence yields (ω_K,ϖ_L, ϖ_M, η_{KL} and η_{LM}) are from Schönfeld (1996Sc06).

The X-ray and Auger electron emission probabilities have been deduced from γ-ray and conversion electron data by using the computer code RADLST.

The deduced total KX-ray emission probability of 0.67 ± 0.01 %, is in agreement with the measured value of 0.72 (1963Bj02), thus confirming the completeness of the decay scheme.

4. Electron Emissions.

The conversion electron emission probabilities have been deduced from γ-ray transition data using theoretical internal conversion coefficients.

5. Photon Emissions

5.1 γ-ray energies

Measured results for the energies of γ-rays from $^{234}Pa^{m}$ decay are listed in Table 5. The recommended values were obtained mainly from measurements of 2004Br43, 2000Ni13, 1975Ar23, 1972Sa06 and 1967Wa09 using the LWEIGHT computer program, except as noted in the table.

Table 5: Measured and recommended γ-ray energy values from $^{234}Pa^{m}$ decay

1963Bj02	1967Wa09	1972Sa06	1975Ar23	2000Ni13	2004Br43	LWEIGHT	Recommended
							< 10[#]
							41.82[a]
43.5							43.49 (2)[b]
							62.70 (1)[a]
							73.92 (2)[#]
							99.86 (2)[ab]
							135.32 (8)[a]
							137.23 (5)[a]
			140.1 (10)				140.1 (10)
							166.5 (1)[a]
	185.2 (5)		184.7 (5)			185.0 (4)	185.0 (4)
			193.4 (8)				193.4 (8)
							197.91 (15)[a]
			199.9 (10)				199.9 (10)
			203.3 (8)				203.3 (8)
			209.9 (4)				209.9 (4)
							233.6 (2)[a]
							235.9 (3)[ab]
236 (1)							236 (1)
			243.5 (8)				243.5 (8)[×]
			247.7 (8)				247.7 (8)
255 (5)	258.0 (5)		258.26 (3)	258.227 (3)		258.227 (3)	258.227 (3)
			275.5 (8)				275.5 (8)
			299.0 (10)				299.0 (10)
			311.0 (10)				311.0 (10)
							316.7 (1)[a]
			338.1 (8)				338.1 (8)
							340.2 (1)[a]
			357.5 (10)				357.5 (10)
			362.8 (10)				362.8 (10)
			387.6 (8)				387.6 (8)
							427.4 (2)[a]
							445.91 (10)[a]
	451.4 (6)		450.97 (10)			450.98 (10)	450.98 (10)
			453.58 (10)				453.58 (10)
			456.7 (10)				456.7 (10)
			468.43 (10)				468.43 (10)
			475.74 (10)				475.74 (10)

1963Bj02	1967Wa09	1972Sa06	1975Ar23	2000Ni13	2004Br43	LWEIGHT	Recommended
							485.44 (7)[a]
			507.5 (10)				507.5 (10)
			509.2 (8)				509.2 (8)
							516.60 (6)[a]
							526.02 (10)[a]
			543.98 (10)				543.98 (10)
							557.24 (6)[a]
			557.3 (10)				557.3 (10)[x]
			572.0 (10)				572.0 (10)
							581.19 (10)[a]
			624.6 (10)				624.6 (10)
			647.7 (8)				647.7 (8)[x]
			649.0 (10)				649.0 (10)
			655.3 (10)				655.3 (10)
			670.8 (10)				670.8 (10)
			673.9 (10)				673.9 (10)
			683.4 (10)				683.4 (10)
			691.0 (3)				691.0 (3)
			695.5 (10)				695.5 (10)
			699.02 (10)				699.02 (10)
			702.0 (1)				702.0 (1)
			705.94 (12)				705.94 (12)
			708.2 (10)				708.2 (10)
							719.01 (7)[a]
			732.5 (10)				732.5 (10)
			740.10 (8)				740.10 (8)
746 (5)	742.7 (6)	742.814 (22)	742.77 (8)	742.813 (5)		742.813 (5)	742.813 (5)
							750.12 (6)[a]
			760.3 (10)				760.3 (10)[x]
							760.53 (15)[a]
765	766.5 (6)	766.358 (20)	766.42 (10)			766.361 (20)	766.361 (20)
			781.75 (10)				781.75 (10)
							783.4 (1)[a]
	786.3 (8)	786.272 (22)	786.28 (10)			786.272 (22)	786.272 (22)
790 (5)							791.94 (5)[b]
806			805.75 (10)				805.75 (10)
			808.2 (1)				808.2 (1)
811							810.0 (7)[b]
			818.2 (5)				818.2 (5)
	825.5 (2)		825.6 (5)			825.5 (2)	825.5 (2)
			844.1 (8)				844.1 (8)
	852.1 (12)		851.58 (10)			851.6 (1)	851.6 (1)
			866.8 (10)				866.8 (10)
		880.514 (36)	880.9 (5)			880.52 (4)	880.52 (4)
		883.237 (33)	883.22 (10)			883.24 (3)	883.24 (3)

1963Bj02	1967Wa09	1972Sa06	1975Ar23	2000Ni13	2004Br43	LWEIGHT	Recommended
			887.29 (10)				887.29 (10)[x]
			921.72 (10)				921.72 (10)
			926.61 (10)				926.61 (10)
			936.3 (10)				936.3 (10)
			941.96 (10)				941.96 (10)
		946.002 (28)	945.94 (2)			945.961 (16)	945.961 (16)
			960.0 (10)				960.0 (10)
			996.1 (20)				996.1 (20)
1001	1001.3 (5)	1001.025 (22)	1000.99 (10)		1001.03 (3)	1001.026 (18)	1001.026 (18)
1045			1041.70 (10)				1041.70 (10)
			1059.4 (8)				1059.4 (8)
			1061.86 (10)				1061.86 (10)
			1081.9 (10)				1081.9 (10)
			1084.25 (10)				1084.25 (10)
			1120.6 (8)				1120.6 (8)
	1125.2 (8)		1124.93 (10)			1124.93 (10)	1124.93 (10)
1160			1174.2 (10)				1174.2 (10)
	1194.2 (6)	1193.767 (30)	1193.73 (12)			1193.77 (3)	1193.77 (3)
			1220.37 (10)				1220.37 (10)[x]
	1238.0 (7)		1237.26 (10)			1237.28 (10)	1237.28 (10)
			1353.0 (15)				1353.0 (15)[x]
	1392 (2)		1392.7 (10)			1392.6 (9)	1392.6 (9)
	1414.7 (10)		1413.88 (10)			1413.89 (10)	1413.89 (10)
1440	1435.5 (8)		1434.14 (10)			1434.16 (10)	1434.16 (10)
			1458.5 (15)				1458.5 (15)
			1501 (2)				1501 (2)
	1510.9 (7)		1510.21 (10)			1510.22 (10)	1510.22 (10)
	1528.2 (12)		1527.27 (10)			1527.28 (10)	1527.28 (10)
			1550.0 (10)				1550.0 (10)
	1554.7 (8)		1553.75 (10)			1553.77 (10)	1553.77 (10)
			1558.4 (10)				1558.4 (10)
	1570.6 (12)		1570.67 (10)			1570.67 (10)	1570.67 (10)
	1593.4 (7)		1593.8 (10)			1593.5 (6)	1593.5 (6)
			1601.8 (15)				1601.8 (15)
			1667.6 (10)				1667.6 (10)
			1694.1 (10)				1694.1 (10)
			1720.5 (15)				1720.5 (15)[x]
			1732.2 (15)				1732.2 (15)[x]
	1738.5 (7)		1737.75 (10)			1737.77 (10)	1737.77 (10)
1750	1759 (2)		1759.81 (10)			1759.81 (10)	1759.81 (10)
	1765.5 (6)		1765.44 (10)			1765.44 (10)	1765.44 (10)
	1796.5 (20)		1796.2 (10)			1796.3 (9)	1796.3 (9)
	1809.4 (7)		1809.04 (10)			1809.05 (10)	1809.05 (10)
			1819.69 (10)				1819.69 (10)
	1831.9 (10)		1831.36 (10)			1831.37 (10)	1831.37 (10)

1963Bj02	1967Wa09	1972Sa06	1975Ar23	2000Ni13	2004Br43	LWEIGHT	Recommended
			1863.09 (10)				1863.09 (10)
	1868.6 (8)		1867.69 (10)			1867.7 (1)	1867.7 (1)
	1876.3 (8)		1874.88 (10)			1874.9 (1)	1874.9 (1)
	1893.5 (8)		1893.51 (11)			1893.51 (11)	1893.51 (11)
	1911.5 (7)		1911.19 (11)			1911.20 (11)	1911.20 (11)
			1926.5 (10)				1926.5 (10)
	1937.5 (7)		1937.04 (13)			1937.01 (13)	1937.01 (13)
	1970.4 (10)		1970.0 (15)			1970.3 (8)	1970.3 (8)
					2022.24 (12)		2022.24 (12)×
					2041.23 (13)		2041.23 (13)×
					2065.80 (13)		2065.80 (13)×
					2093.19 (38)		2093.19 (38)×
					2102.14 (15)		2102.14 (15)×
					2136.69 (14)		2136.69 (14)×

#: IT decay, energy from 1973Go40.

a: Expected but as yet unobserved, energy from adopted gammas.

b: Energy from ^{238}Pu α decay.

×: Not placed in level scheme.

5.2 Relative values of the γ-ray intensities

Measurements of the relative γ-ray intensities from $^{234}Pa^{m}$ are listed in table 6. The recommended values have been obtained with the LWEIGHT computer program using measurement results from 2006Al28, 2004Br43, 2000Ni13, 1992Si17, 1990Sc09, 1986Mo09, 1975Ar23 1971GuZQ and 1967Wa09.

As the measured results of 1990Sc09 and 1971GuZQ contained the contributions from $^{234}Pa^{g}$ β^- decay, these contributions had to be estimated and removed from the values cited in 2007Br04. Also the measurement results of 1963Bj02 have been rejected and not listed in table as the associated uncertainties are not given.

Table 6: Measured and recommended relative γ-ray intensities from $^{234}Pa^{m}$ decay

E_γ/keV	I_γ										
	1967Wa09	1971GuZQ	1975Ar23	1986Mo09	1990Sc09	1992Si17	2000Ni13	2004Br43!	2006Al28!	LWEIGHT	Recommended
< 10											17.7 (12)#
41.82[a]											1.61 (8)[b]
43.49											166.8 (4)[b]
62.70[a]											0.15 (4)[d]
73.92											1.53 (12)#
99.86[a]											0.96 (7)[b]
135.32[a]											0.000 50 (6)[d]
137.23[a]											0.0057 (21)[d]
140.1			< 0.15								< 0.15
166.5[a]											0.000 028 (6)[d]
185.0	0.2 (1)		0.203 (17)							0.203 (17)	0.203 (17)
193.4			0.085 (17)								0.085 (17)
197.91[a]											0.003 2 (7)[d]

E_γ/keV	I_γ										
	1967Wa09	1971GuZQ	1975Ar23	1986Mo09	1990Sc09	1992Si17	2000Ni13	2004Br43!	2006Al28!	LWEIGHT	Recommended
199.9			0.068 (14)								0.068 (14)
203.3			0.122 (24)		0.145 (12)[c]					0.14 (1)	0.14 (1)
209.9			0.156 (17)								0.156 (17)
233.6[a]			0.059 (12)								≈ 0.1[e]
235.9[a]											0.010 (4)[d]
236											8.7 (9)[f]
243.5[×]			0.059 (10)								0.059 (10)
247.7			0.114 (26)								0.114 (26)
258.227	6.7 (17)	8.82 (24)	9.66 (39)		8.70 (4)	8.6 (6)	9.08 (24)		8.46 (33)	8.72 (4)	8.72 (4)
275.5			0.037 (7)								0.037 (7)
299.0			0.076 (15)								0.076 (15)
311.0			0.061 (12)								0.061 (12)
316.7[a]											0.022 (5)[d]
338.1			0.134 (27)								0.134 (27)
340.2[a]											0.008 5 (25)[d]
357.5			0.095 (20)								0.095 (20)
362.8			0.081 (17)								0.081 (17)
387.6[&]			0.170 (17)								0.115 (17)
387.6[&]											0.056 (4)[d]
427.4[a]											0.002 4 (6)d
445.91[a]											0.003 6 (8)[d]
450.98	0.42 (10)	0.42 (5)	0.356 (34)		0.358 (19)	0.39 (8)				0.366 (15)	0.366 (15)
453.58		0.254 (24)	0.288 (34)		0.23 (2)	0.31 (6)				0.251 (14)	0.251 (14)
456.7			0.085 (17)								0.085 (17)
468.43		0.204 (41)[c]	0.280 (27)		0.237 (16)[c]				0.19 (10)c	0.243 (13)	0.243 (13)
475.74		0.209 (42)	0.339 (34)		0.274 (18)	0.34 (9)				0.280 (15)	0.280 (15)
485.44[a]											0.002 2 (2)[d]
507.5			0.187 (17)								0.187 (17)
509.2			0.254 (34)								0.254 (34)
516.60[a]											0.001 44 (19)[d]
526.02[a]											0.001 06 (14)[d]
543.98		0.40 (8)[c]	0.441 (51)		0.404 (19)[c]	0.46 (6)			0.32 (21)c	0.412 (17)	0.412 (17)
557.24[a]											0.000 98 (13)[d]
557.3[×]			0.085 (19)								0.085 (19)
572.0			0.103 (20)								0.103 (20)
581.19[a]											0.009 4 (11)[d]
624.6			0.170 (17)								0.013 7 (14)[d]
647.7[×]			0.187 (17)								0.187 (17)
649.0[&]			0.127 (25)								0.007 (1)
649.0[&]											0.12 (3)
655.3			0.164 (17)								0.164 (17)
670.8			0.044 (10)								0.044 (10)
673.9			0.076 (15)								0.076 (15)
683.4			0.068 (14)								0.068 (14)

E_γ/keV	I_γ										
	1967Wa09	1971GuZQ	1975Ar23	1986Mo09	1990Sc09	1992Si17	2000Ni13	2004Br43!	2006Al28!	LWEIGHT	Recommended
691.0		1.09 (6)	0.932 (85)		1.073 (23)	0.92 (10)				1.06 (2)	1.06 (2)
695.5			0.187 (17)			0.28 (6)				0.194 (16)	0.194 (16)
699.02		0.70 (7)	0.095 (19)		0.68 (3)					0.68 (3)	0.68 (3)
702.0		0.85 (8)	0.915 (85)		0.846 (20)	0.93 (10)			0.67 (34)	0.852 (17)	0.852 (17)
705.94		0.72 (7)[c]	0.481 (51)		0.656 (16)[c]	0.47 (12)				0.61 (6)	0.61 (6)
708.2			< 0.085								< 0.085
719.01[a]											0.003 02 (24)[d]
732.5			0.154 (17)								0.154 (17)
740.10		1.33 (12)	1.20 (12)		1.41 (3)	1.26 (12)				1.39 (3)	1.39 (3)
742.813	13.3 (17)	11.12 (24)[c]	9.59 (39)	11.3 (7)	10.93 (8)[c]	10.4 (5)	12.27 (23)c			11.13 (28)	11.13 (28)
750.12[a]											0.002 02 (27)[d]
760.3[x]			0.187 (17)								0.187 (17)
760.53[a]											0.000 5 (1)[d]
766.361	36.7 (67)	37.8 (4)[c]	35.1 (14)	39.91 (84)	38.36 (25)[c]	37.6 (11)			35.7 (16)	38.2 (2)	38.2 (2)
781.75		0.845 (85)	0.898 (85)		0.93 (2)	0.86 (12)				0.923 (19)	0.923 (19)
783.4[a]											0.004 6 (8)[d]
786.272	5 (1)	6.41 (12)[c]	5.80 (22)	6.36 (46)	6.37 (6)[c]	5.97 (33)				6.33 (5)	6.33 (5)
791.94											0.001 17 (15)[d]
805.75		0.718 (38)[c]	0.509 (51)		0.820 (15)[c]	0.49 (15)				0.73 (9)	0.73 (9)
808.2		0.34 (4)[c]	0.356 (34)		0.303 (30)[c]	0.39 (10)				0.332 (19)	0.332 (19)
810.0											85[g]
818.2			0.119 (34)								0.119 (34)
825.5	0.42 (25)	0.489 (25)[c]	0.168 (34)		0.547 (14)[c]					0.46 (9)	0.17 (4)
844.1			0.129 (27)								0.129 (27)
851.6	0.67 (25)	0.879 (48)[c]	0.746 (68)		0.820 (17)[c]	0.83 (9)				0.822 (16)	0.822 (16)
866.8		0.145 (24)	0.127 (26)							0.137 (18)	0.137 (18)
880.52		0.438 (9)[c]	0.458 (51)		0.468 (4)[c]	0.52 (16)				0.463 (4)	0.463 (4)
883.24		0.428 (13)[c]	0.424 (34)		0.453 (4)[c]	0.50 (16)			0.38 (10)	0.450 (4)	0.450 (4)
887.29[x]		0.761 (36)	0.882 (85)		0.846 (15)	0.90 (12)				0.836 (14)	0.836 (14)
921.72		1.51 (7)	1.41 (14)		1.51 (2)	1.40 (15)			1.34 (45)	1.506 (19)	1.506 (19)
926.61		0.215 (11)[c]	0.148 (15)		0.213 (3)[c]					0.202 (18)	0.148 (15)
936.3		0.091 (23)	0.22 (5)							0.12 (2)	0.12 (2)
941.96		0.282 (24)[c]	0.356 (34)		0.289 (12)[c]	0.33 (6)				0.295 (10)	0.295 (10)
945.961		1.33 (3)[c]	1.19 (12)	1.27 (15)	1.242 (11)[c]	1.25 (37)			1.18 (31)	1.252 (10)	1.252 (10)
960.0			0.102 (34)								0.102 (34)
996.1		0.90 (5)	0.492 (85)			0.51 (10)				0.7 (2)	0.7 (2)
1001.026	100	100	100	100	100	100	100	100	100		100
1041.70		0.111 (22)	0.170 (17)		0.137 (11)					0.141 (9)	0.141 (9)
1059.4			0.131 (26)								0.131 (26)
1061.86		0.290 (24)	0.237 (17)		0.274 (15)	0.25 (10)				0.264 (10)	0.264 (10)
1081.9			0.107 (22)								0.107 (22)
1084.25			0.058 (10)		0.136 (11)[c]					0.10 (4)	0.10 (4)
1120.6			0.204 (17)								0.204 (17)
1124.93[&]	0.50 (17)	0.495 (21)[c]	0.475 (51)		0.436 (14)[c]	0.48 (8)				0.456 (11)	0.046 (1)

E_γ/keV	I_γ										
	1967Wa09	1971GuZQ	1975Ar23	1986Mo09	1990Sc09	1992Si17	2000Ni13	2004Br43!	2006Al28!	LWEIGHT	Recommended
1124.93[&]											0.41 (1)
1174.2			0.227 (22)								0.227 (22)
1193.77	1.33 (33)	1.615 (36)[c]	1.525 (85)		1.606 (16)[c]	1.58 (14)			1.67 (78)	1.605 (15)	1.605 (15)
1220.37[x]		0.106 (23)	0.119 (34)		0.107 (11)					0.108 (10)	0.108 (10)
1237.28	0.50 (17)	0.592 (24)	0.610 (68)		0.632 (12)	0.58 (13)				0.623 (11)	0.623 (11)
1353.0[x]		0.271 (27)	0.075 (15)		0.226 (10)					0.18 (6)	0.18 (6)
1392.6	0.50 (25)	0.447 (48)	0.187 (17)		0.465 (5)					0.34 (12)	0.34 (12)
1413.89	0.2 (1)	0.279 (17)	0.254 (17)		0.274 (12)					0.270 (9)	0.270 (9)
1434.16	1.17 (33)	1.09 (6)	0.99 (10)		1.156 (15)	1.12 (17)				1.149 (15)	1.149 (15)
1458.5			0.220 (51)								0.22 (5)
1501			0.153								0.153
1510.22	1.83 (33)	1.57 (4)	1.54 (10)		1.538 (19)	1.59 (15)				1.545 (17)	1.545 (17)
1527.28	0.33 (10)	0.263 (16)	0.254 (34)		0.286 (11)					0.277 (9)	0.277 (9)
1550.0		0.153 (11)[c]	0.220 (17)		0.151 (9)[c]					0.162 (17)	0.162 (17)
1553.77	1.0 (2)	0.990 (24)	1.068 (85)		0.966 (16)	1.07 (18)				0.976 (13)	0.976 (13)
1558.4		0.085 (12)	0.090 (19)							0.086 (10)	0.086 (10)
1570.67	0.10 (4)	0.127 (19)	0.146 (34)		0.131 (11)					0.130 (9)	0.130 (9)
1593.5	1.33 (33)	0.284 (3)[c]	0.458 (51)		0.253 (9)[c]	0.45 (19)				0.278 (13)	0.278 (13)
1601.8			0.056 (25)								0.056 (25)
1667.6		0.145 (12)	0.098 (21)		0.143 (9)					0.139 (7)	0.139 (7)
1694.1		0.044 (4)[c]	0.054 (10)		0.044 (3)[c]					0.0445 (23)	0.0445 (23)
1720.5[x]			0.039 (17)								0.039 (17)
1732.2[x]			0.220 (34)								0.220 (34)
1737.77	3.0 (4)	2.545 (24)[c]	2.41 (10)		2.51 (3)[c]	2.45 (25)				2.528 (18)	2.528 (18)
1759.81[x]	0.33 (17)	0.174 (7)	0.271 (34)		0.167 (7)					0.173 (5)	0.173 (5)
1765.44	1.17 (33)	0.918 (24)	1.04 (10)		1.037 (15)	1.01 (25)				0.99 (6)	0.99 (6)
1796.3	0.10 (7)	0.036 (6)[c]	0.037 (7)							0.037 (5)	0.037 (5)
1809.05	0.4 (1)	0.447 (12)	0.508 (51)		0.441 (9)	0.46 (9)				0.444 (7)	0.444 (7)
1819.69		0.103 (7)[c]	0.141 (31)		0.106 (8)					0.105 (5)	0.105 (5)
1831.37	2.33 (33)	2.114 (24)	1.90 (7)		2.05 (3)	2.09 (21)				2.077 (18)	2.077 (18)
1863.09		0.139 (11)	0.144 (29)		0.143 (6)					0.142 (5)	0.142 (5)
1867.7	1.33 (33)	1.105 (11)	0.90 (9)		1.097 (16)	1.15 (17)				1.101 (9)	1.101 (9)
1874.9	1.17 (33)	0.942 (24)	0.932 (85)		0.977 (15)	0.97 (14)				0.967 (13)	0.967 (13)
1893.51	0.33 (10)	0.256 (11)[c]	0.254 (17)		0.260 (8)[c]	0.26 (7)				0.258 (6)	0.258 (6)
1911.20	0.83 (17)	0.737 (12)	0.627 (68)		0.751 (12)	0.74 (11)				0.742 (8)	0.742 (8)
1926.5		0.057 (5)[c]	0.053 (10)		0.049 (5)[c]					0.053 (4)	0.053 (4)
1937.0	0.4 (1)	0.336 (7)[c]	0.356 (34)		0.335 (8)[c]	0.38 (9)				0.336 (5)	0.336 (5)
1970.3	0.033 (33)	0.0483 (36)	0.066 (14)							0.049 (4)	0.049 (4)
2022.24[x]								0.022 (2)			0.022 (2)
2041.23[x]								0.013 (1)			0.013 (1)
2065.80[x]								0.008 4 (12)			0.008 4 (12)
2093.19[x]								0.002 4 (7)			0.002 4 (7)
2102.14[x]								0.007 2 (10)			0.007 2 (10)
2136.69[x]								0.008 4 (5)			0.008 4 (5)

#: I(γ+ce), from IT decay.

a: Expected but as yet unobserved.

b: From γ-ray transition intensity balance.

c: Removed the contributions from $^{234}Pa^{g}$ β^- decay.

d: Deduced from adopted γ branching in 2007Br04.

e: I(γ+ce), from I(γ+ce)(γ234)/ I(γ1042) ≈ 0.7 in ^{234}Np ε decay.

f: I(γ+ce), from measured I_{ce}(K) = 70.

g: I(γ+ce), from I_{ce}(810)/ I(γ1001) = 0.51 / 0.6 in 1963Bj02.

&: Multiply placed, intensity suitably divided.

×: Not placed in level scheme.

5.3 Absolute values of the γ-ray emission probabilities

Measurements of the absolute γ-ray emission probability of 1001.026 keV per 100 disintegrations of $^{234}Pa^{m}$ β^--decay and three weighted average results are listed in Table 7.

It should be noted that the uncertainties quoted in 1990Sc09, 1986Mo09, and 1971GuZQ are questionable (perhaps, only statistical errors were included) when compared with the data of 1992Si17 who used a purified $^{234}Pa^{m}$ source. Thus 2 % systematic uncertainty was added by the evaluators to those measurement results.

Table 7: Measured and recommended absolute emission probability of the 1001.026 keV γ-ray per 100 disintegrations of $^{234}Pa^{m}$ β^- decay

P_γ(1001.026 keV) (%)	References	Comments
0.59 (10)	1963Bj02	scintillation spectrometers
0.828 (18)	1971GuZQ	
0.92	1982Mo30	Not used
0.834 (21)	1986Mo09	Ge(Li)
0.839 (20)	1990Sc09	HPGe
0.818 (30)	1992Ja17	
0.788 (43)	1992Li05	
0.845 (21)	1992Si17	HPGe, 0.844 104 with another method
0.910 (25)	1993Su37	
0.924 (17)	1999An40	HPGe
0.861 (15)	2003Yu06	n-type Ge detector
0.923 (30)	2006Al28	HPGe, from extended sample
0.835 (11)	1998Ad08	Evaluation
0.835 (4)	1999Nz01	Evaluation
0.862 (13)		Average of all measurements with LWEIGHT program,χ^2 = 3.7
0.856 (12)		Average of all measurements with Normalised residuals method
0.848 (8)		Average of all measurements with Rajput and MacMahon method
0.848 (8)		**Recommended value**

The recommended value of the absolute γ-ray emission probability of the 1001.026 keV γ-ray is obtained with the method of averaging discrepant data of Rajput and MacMahon (1992Ra08) and adopted as the normalization factor N, with N = 0.008 48 (8) × 0.998 5 (1).

Thus, the recommended absolute γ-ray emission probabilities are the relative values recommended in Table 6 multiplied by 0.008 47 (8).

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