

²³⁴Pa-Comments on evaluation of decay data

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Brief update in 2021: atomic emissions have been corrected based on this evaluation as they were erroneous. This evaluation was completed in 2009. Literature available by January 2009 was included.

1 Decay Scheme

²³⁴Pa disintegrates 100% by β^- emissions to levels in ²³⁴U. ²³⁴Pa ground state has $J^\pi = 4^+$ (2007Br04).

The β^- decay scheme of ²³⁴Pa is based on the measurement results of 1986Ar05. 28 observed γ -rays were not placed in the current decay scheme. These gamma rays carry about 3.2% of the total intensity of all the gamma rays placed in the decay scheme.

The $Q(\beta^-)$ value of 2195 (4) keV adopted from 2003Au03 is not in good agreement with the effective $Q(\beta^-)$ value of 2336 (70) keV, calculated by the evaluators from average radiation energies using the RADLST computer program. The total intensity $\Sigma I(\beta^-)$ deduced by the evaluators from intensity balance at each level is about 110%.

These results suggest that the γ -ray intensity balance for some levels may be incomplete and the decay scheme has some inconsistency. Further measurements are strongly needed to determine the γ transitions and the decay scheme with greater precision.

2 Nuclear Data

The $Q(\beta^-)$ value is from the mass adjustment in 2003Au03.

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 ²³⁴Pa half-life values are listed in Table 1.

Table 1: Measured half-life values of ²³⁴Pa and recommended value

$T_{1/2}$ (h)	References	Comments
6.7	1931Cu01	Not used
6.658 (12)	1954Zi02	
6.75 (3)	1962Bj01	
6.704 (46)		Unweighted mean
6.671 (11)		Weighted mean
6.704 (46)		LWEIGHT weighted mean, $\chi^2 = 4.7$
6.70 (5)		Recommended value

The weighted average for this data set of the 2 discrepant experimental values is dominated by the accurate value of 1954Zi02. The LWEIGHT computer program, which uses a Limitation of Relative Statistical Weights (LRSW method), has increased the 1954Zi02 uncertainty from 0.012 to 0.030 and used a weighted mean and an external uncertainty for recommended average.

Thus, the adopted value of the ²³⁴Pa half-life is 6.70 (5) hours.

2.1 β^- transitions

The maximum energies of the β^- transitions in the decay of ²³⁴Pa have been deduced from the $Q(\beta^-)$ value (2003Au03) and the ²³⁴U level energies (Table 2), obtained from a least-squares fit to recommended γ -ray energies (GTOL computer code).

Table 2: ²³⁴U levels populated in ²³⁴Pa β⁻ decay

Level energy (keV)	Spin & parity	Half-life	β ⁻ transition probabilities (%)
0.0	0+	2.455 (6) × 10 ⁵ a	
43.481 (15)	2+	0.252 (7) ns	
143.375 (21)	4+		< 5
296.075 (24)	6+		
497.05 (4)	8+		
786.295 (15)	1-		
809.92 (8)	0+	< 0.1 ns	
849.265 (23)	3-		< 0.8
851.73 (5)	2+	> 1.74 ps	
926.744 (21)	2+	1.38 (17) ps	
947.59 (5)	4+		< 0.8
962.55 (3)	5-		< 0.4
968.45 (3)	3+		< 2.5
989.444 (20)	2-	0.76 (4) ns	< 3.1
1023.795 (24)	3-		< 5
1023.92 (3)	4+		1.5 (13)
1069.297 (22)	4-		< 8
1085.07 (10)	2+		
1090.89 (4)	5+		0.69 (20)
1096.12 (9)	6+		
1125.29 (5)	7-		
1126.65 (3)	2+		
1127.535 (25)	5-		1.9 (10)
1165.41 (4)	3+		
1172.03 (3)	6+		
1194.761 (23)	6-		< 1.5
1214.70 (5)	4+		0.30 (12)
1237.24 (3)	1-		
1261.77 (3)	7+		
1274.32 (9)	(5+)		
1277.45 (3)	7-		
1312.20 (9)	3-		0.109 (18)
1341.33 (8)	(6+)		
1421.252 (24)	6-	33.5 (20) μs	
1447.89 (10)	5-		0.11 (3)
1456.54 (7)	(2-)		
1486.17 (12)	(3-)		0.117 (25)
1496.14 (3)	3+		< 2.7
1502.38 (8)	3,4+		0.25 (4)
1533.37 (5)	(4-)		0.21 (4)
1537.25 (3)	4+		< 0.9
1543.71 (5)	4+		0.10 (9)
1548.10 (8)	(5)		0.078 (20)
1552.554 (24)	5+	2.20 (25) ns	19.6 (18)
1581.67 (10)	(5-)		0.05 (3)
1588.84 (3)	5+		< 0.7
1619.46 (9)	(6+)		0.035 (20)
1649.99 (12)	(6-)		0.18 (4)
1653.35 (7)	(3+)		0.95 (13)

Level energy (keV)	Spin & parity	Half-life	β^- transition probabilities (%)
1693.42 (3)	5-		6.9 (8)
1722.89 (4)	3-		8.4 (9)
1723.424 (24)	4+		36 (5)
1737.42 (7)	3+		1.16 (14)
1738.18 (6)	(3+)		0.78 (19)
1761.86 (6)	(4-)		2.8 (4)
1770.79 (9)	(3+)		0.129 (17)
1782.58 (3)	5+		8 (3)
1784.19 (13)	4+		0.061 (11)
1793.05 (6)	4+		0.41 (8)
1811.62 (6)	4+		1.43 (15)
1843.88 (17)	3,4,5-		0.17 (3)
1863.08 (15)	(5+)		0.029 (7)
1881.75 (7)	4+		0.25 (3)
1916.28 (9)	3,4+		0.21 (3)
1927.51 (7)	4+		0.22 (4)
1940.52 (9)	4+		0.35 (5)
1958.75 (4)	3-		0.44 (19)
1968.84 (10)	4+,5		0.044 (12)
1981.22 (7)	4+		0.59 (8)
2000.45 (13)	(4+)		0.122 (16)
2019.82 (13)	4+		0.112 (16)
2033.54 (5)	3+,4+		0.90 (15)
2037.06 (17)	4+,5		0.055 (8)
2066.24 (10)			0.140 (24)
2068.82 (11)	3,4,5+		0.40 (7)
2101.42 (9)	5+		0.064 (11)
2115.71 (11)	4+		0.21 (3)
2144.04 (9)	3+,4+		0.42 (5)

Table 3: Measured and evaluated β^- energies (keV) and probabilities (%) in the ²³⁴Pa decay

1956On07		1959De30		1968Bj06		Evaluated	
E β^-	P β^-	E β^-	P β^-	E β^-	P β^-	E β^-	P β^-
155	28	141 (10)	35.5			158 (4)	0.055 (8)
		274 (10)	21.4	280 (70)	12	279 (4)	0.21 (3)
320 (20)	32					313 (4)	0.25 (3)
		363 (10)	10.3			383 (4)	1.43 (15)
		477 (10)	16.0			472 (4)	36 (5)
530 (20)	27			550 (100)	63	545 (4)	0.18 (4)
		576 (10)	13.2			576 (4)	0.035 (20)
				790 (100)	19	747 (4)	0.11 (3)
		1042 (20)	3.6			1067 (4)	1.9 (10)
1130 (50)	13					1126 (4)	< 8
				1190 (100)	5	1171 (4)	< 5
				1510 (200)	≤ 1	1346 (4)	< 0.8

The adopted β^- transition probabilities and the associated uncertainties were deduced from the γ transition probability balance at each ²³⁴U level.

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

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 1967Wa26, 1968Bj06 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 ($\omega_K, \omega_L, \omega_M, \eta_{KL}$ 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 EMISSION computer code.

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 ²³⁴Pa are listed in Table 4. The recommended values are taken from the precise measurements of 2000Ni13, 1986Ar05 and 1972Sa06, except as noted in the table.

Table 4: Measured and recommended γ -ray energy values from ²³⁴Pa β^- decay

1968Bj06	1968Go20	1972Sa06	1975Ar24	1986Ar05	2000Ni13	Recommended
34.30 (4)						34.30 (4)
						41.82 (11) ^a
43.40 (5)				43.49 (2)		43.49 (2)
45.19 (5)				45.45 (5)		45.45 (5)
				54.96 (10)		54.96 (10)
				55.45 (5)		55.45 (5)
58.20 (6)				58.2 (1)		58.20 (6)
				59.19 (5)		59.19 (5)
63.40 (7)			63.0 (5)	62.70 (1)		62.70 (1)
67.10 (7)				67.25 (10)		67.25 (10)
69.90 (7)				69.46 (5)		69.46 (5)
				75.0 (3) ^a		75.0 (3) ^a
79.69 (8)			80.5 (5)	79.84 (2)		79.84 (2)
				97.17 (10)		97.17 (10)
99.67 (10)				99.86 (2)		99.86 (2)
				100.89 (2)		100.89 (2)
103.41 (11)				103.77 (2)		103.77 (2)
				106.68 (5)		106.68 (5)
125.20 (13)			125.3 (2)	125.46 (1)		125.46 (1)
131.00 (13)			131.28 (10)	131.30 (1)		131.30 (1)

1968Bj06	1968Go20	1972Sa06	1975Ar24	1986Ar05	2000Ni13	Recommended
134.37 (14)				134.61 (2)		134.61 (2)
			137.7 (5)	137.23 (5)		137.23 (5)
139.97 (14)			140.3 (2)	140.15 (2)		140.15 (2)
				140.91 (3)		140.91 (3)
144.35 (15)			143.6 (5)	143.78 (2)		143.78 (2)
~ 150.2				149.88 (3)		149.88 (3)
152.46 (16)			153.0 (2)	152.71 (2)		152.71 (2)
159.10 (16)			159.2 (3)	159.48 (2)		159.48 (2)
				164.94 (5)		164.94 (5)
			166.3 (10)	165.61 (5)		165.61 (5)
170.77 (18)			170.6 (3)	170.85 (2)		170.85 (2)
			174.6 (8)	174.55 (3)		174.55 (3)
				179.80 (8)		179.80 (8)
185.95 (19)			186.2 (5)	186.15 (2)		186.15 (2)
193.4 (2)			193.5 (5)	193.73 (3)		193.73 (3)
196.4 (2)			196.5 (10)	196.80 (5)		196.80 (5)
199.7 (2)				199.95 (5)		199.95 (5)
200.6 (2)			200.9 (3)	200.97 (3)		200.97 (3)
202.9 (2)			202.9 (3)	203.12 (3)		203.12 (3)
219.60 (22)			220.8 (5)	220.00 (8)		220.00 (8)
				221.15 (10)		221.15 (10)
				221.83 (10)		221.83 (10)
226.15 (23)			226.87 (10)	226.50 (3)		226.50 (3)
227.00 (23)				227.25 (3)		227.25 (3)
				232.21 (3)		232.21 (3)
						233.6 (2) ^b
				235.11 (3)		235.11 (3)
						235.9 (3) ^b
				240.2 (1)		240.2 (1)
245.00 (25)			245.2 (3)	245.37 (2)		245.37 (2)
						247.79 (7) ^b
248.80 (25)			249.1 (3)	249.22 (1)		249.22 (1)
				257.2 (1)		257.2 (1)
			267.1 (8)	267.12 (5)		267.12 (5)
271.85 (27)			272.1 (3)	272.28 (5)		272.28 (5)
				275.04 (10)		275.04 (10)
			277.9 (8)	278.3 (1)		278.3 (1)
293.5 (3)			293.7 (2)	293.79 (5)		293.79 (5)
				295.91 (8)		295.91 (8)
				298.7 (2)		298.7 (2)
			309.6 (8)	308.6 (2)		308.6 (2)
				310.2 (1)		310.2 (1)
						310.52 (10) ^b
312.5 (3)				313.5 (1)		313.5 (1)
316.8 (3)			316.3 (8)	316.7 (1)		316.7 (1)
			320.7 (8)	320.4 (1)		320.4 (1)
328.3 (3)			330.3 (5)	330.40 (5)		330.40 (5)
330.6 (3)				331.4 (1)		331.4 (1)
				340.2 (1)		340.2 (1)
				343.8 (2)		343.8 (2)

1968Bj06	1968Go20	1972Sa06	1975Ar24	1986Ar05	2000Ni13	Recommended
351.6 (4)			351.8 (3)	351.9 (1)		351.9 (1)
				357.9 (1)		357.9 (1)
				360.6 (3)		360.6 (3)
				365.0 (3)		365.0 (3)
369.3 (4)			369.6 (3)	369.50 (5)		369.50 (5)
371.8 (4)			372.2 (3)	372.0 (1)		372.0 (1)
				379.1 (1)		379.1 (1)
				385.4 (1)		385.4 (1)
						387.94 (6) ^b
				394.1 (1)		394.1 (1)
				397.7 (3)		397.7 (3)
				401.8 (2)		401.8 (2)
			409.8 (5)	409.8 (1)		409.8 (1)
				416.1 (1)		416.1 (1)
				425.3 (2)		425.3 (2)
427.0 (4)			426.8 (5)	426.95 (5)		426.95 (5)
						427.4 (4) ^b
			432.6 (5)	433.1 (1)		433.1 (1)
			446.9 (5)	446.6 (1)		446.6 (1)
						450.93 (4) ^b
				452.4 (3)		452.4 (3)
458.6 (5)			458.6 (3)	458.68 (5)		458.68 (5)
			461.8 (10)	461.5 (1)		461.5 (1)
				464.2 (1)		464.2 (1)
468.0 (5)			467.5 (10)	468.0 (1)		468.0 (1)
			472.1 (10)	472.3 (1)		472.3 (1)
474.0 (5)			473.5 (10)	474.2 (2)		474.2 (2)
			478.7 (10)	478.6 (1)		478.6 (1)
			480.5 (8)	481.0 (1)		481.0 (1)
			498.9 (10)	498.0 (1)		498.0 (1)
				502.0 (1)		502.0 (1)
506.0 (5)			506.8 (5)	506.75 (5)		506.75 (5)
513.6 (5)			513.7 (5)	513.4 (1)		513.4 (1)
			520.2 (5)	519.6 (1)		519.6 (1)
521.0 (5)			521.0 (5)	521.4 (1)		521.4 (1)
527.6 (5)			528.0 (5)	527.9 (1)		527.9 (1)
				529.1 (3)		529.1 (3)
			533.2 (10)	534.1 (1)		534.1 (1)
			537.1 (10)	537.2 (1)		537.2 (1)
				543.8 (1)		543.8 (1)
				553.7 (1)		553.7 (1)
			557 (1)	558.0 (2)		558.0 (2)
				559.2 (2)		559.2 (2)
				562.8 (3)		562.8 (3)
565.1 (6)			566.3 (10)	565.2 (1)		565.2 (1)
568.7 (6)				568.9 (2)		568.9 (2)
569.5 (6)			569.26 (10)	569.5 (1)		569.5 (1)
574.0 (6)				575.5 (1)		575.5 (1)
				584.1 (1)		584.1 (1)
			586.1 (8)	586.3 (1)		586.3 (1)

1968Bj06	1968Go20	1972Sa06	1975Ar24	1986Ar05	2000Ni13	Recommended
				590.3 (10)		590.3 (10)
				595.4 (2)		595.4 (2)
			596.5 (5)	596.9 (1)		596.9 (1)
			602.7 (5)	602.6 (1)		602.6 (1)
				604.6 (3)		604.6 (3)
612.0 (6)			611.4 (10)	612.0 (1)		612.0 (1)
			616.2 (5)	617.0 (2)		617.0 (2)
				619.0 (2)		619.0 (2)
623.8 (6)			623.6 (5)	624.2 (1)		624.2 (1)
629.1 (6)			627.5 (5)	628.1 (1)		628.1 (1)
			630.6 (10)	629.4 (1)		629.4 (1)
				632.6 (2)		632.6 (2)
			634.5 (10)	634.3 (2)		634.3 (2)
			643.2 (10)	643.2 (2)		643.2 (2) ^x
646.0 (7)			646.2 (10)	646.5 (1)		646.5 (1)
653.7 (7)			653.2 (8)	653.7 (1)		653.7 (1)
			655.0 (8)	655.2 (2)		655.2 (2)
657.0 (7)			658.0 (5)	657.4 (1)		657.4 (1)
			660.6 (10)	659.8 (1)		659.8 (1) ^x
			664.6 (10)	663.9 (1)		663.9 (1)
667.0 (7)			666.7 (6)	666.5 (1)		666.5 (1)
			669.8 (5)	669.7 (1)		669.7 (1)
				675.1 (1)		675.1 (1)
			683.3 (8)	683.9 (2)		683.9 (2)
687.0 (7)			685.5 (10)	685.1 (2)		685.1 (2)
692.8 (7)			692.5 (5)	692.6 (1)		692.6 (1)
699.0 (7)			699.1 (3)	699.03 (5)		699.03 (5)
706.8 (7)			706.0 (2)	705.9 (1)		705.9 (1)
						708.3 (2) ^b
			711.2 (8)	711.5 (1)		711.5 (1) ^x
				713.7 (1)		713.7 (1)
				716.5 (2)		716.5 (2)
				727.8 (2)		727.8 (2)
				730.9 (2)		730.9 (2)
732.9 (7)			733.0 (2)	733.39 (5)		733.39 (5)
737.5 (7)			738.4 (5)	738.0 (1)		738.0 (1)
~ 743.4	742.8 (6)	742.814 (22)	742.67 (20)	742.81 (3)	742.813 (5)	742.813 (5)
			746.5 (15)	745.9 (1)		745.9 (1)
				748.1 (3)		748.1 (3)
756.6 (8)			754.8 (6)	755.0 (1)		755.0 (1)
				758.9 (1)		758.9 (1)
			760 (1)	761.0 (2)		761.0 (2)
				764.8 (2)		764.8 (2)
767.0 (8)	765.0 (7)	766.358 (20)	865.7 (8)	766.4 (2)		766.4 (2)
			768.7 (10)	769.1 (1)		769.1 (1)
				772.4 (2)		772.4 (2)
			777.9 (10)	778.6 (2)		778.6 (2) ^x
~ 780.9			780.5 (6)	780.4 (2)		780.4 (2)
			783.1 (10)	783.4 (1)		783.4 (1)
~ 787.0	786.3 (5)	786.272 (22)	786.2 (6)	786.27 (3)		786.27 (3)

1968Bj06	1968Go20	1972Sa06	1975Ar24	1986Ar05	2000Ni13	Recommended
			793.6 (10)	792.8 (3)		792.8 (3)
				794.9 (2)		794.9 (2)
797.2 (8)			796.2 (5)	796.1 (1)		796.1 (1)
						799.7 (2) ^b
				802.3 (2)		802.3 (2)
804.2 (8)			804.5 (10)	804.1 (1)		804.1 (1)
806.8 (8)			805.5 (5)	805.8 (5)		805.8 (5)
808.0 (8)				808.4 (3)		808.4 (3)
810.0 (8)				810.0 (7)		810.0 (7)
			812.5 (15)	811.5 (1)		811.5 (1)
				814.2 (1)		814.2 (1)
~ 820.2			819.4 (5)	819.2 (1)		819.2 (1)
824.0 (8)			824.7 (5)	824.2 (2)		824.2 (2) ^x
826.3 (8)				825.1 (2)		825.1 (2)
				829.3 (2)		829.3 (2)
832.4 (24)			831.1 (5)	831.5 (1)		831.5 (1)
			841.9 (10)	839.5 (1)		839.5 (1)
~ 845.4			844.1 (10)	844.1 (1)		844.1 (1)
				846.1 (2)		846.1 (2) ^x
				848.9 (2)		848.9 (2)
				851.8 (1)		851.8 (1)
				857.7 (2)		857.7 (2)
				863.2 (2)		863.2 (2)
				869.7 (1)		869.7 (1)
872.0 (26)			872.9 (10)	874.0 (3)		874.0 (3)
876.4 (26)			876.7 (7)	876.0 (1)		876.0 (1)
880.2 (27)	880.0 (7)	880.514 (36)	880.6 (5)	880.5 (1)		880.5 (1)
883.0 (27)	883.0 (6)	883.237 (33)	883.5 (5)	883.24 (4)		883.24 (4)
				890.1 (4)		890.1 (4)
899.3 (27)			898.6 (5)	898.67 (5)		898.67 (5)
905.2 (28)			904.2 (10)	904.2 (1)		904.2 (1)
				916.5 (2)		916.5 (2)
				918.4 (1)		918.4 (1)
				920.5 (2)		920.5 (2) ^x
926 (3)			924.6 (10)	925.0 (1)		925.0 (1)
						926.0 (2) ^a
927.1 (28)			926.7 (5)	926.7 (1)		926.7 (1)
				935.8 (2)		935.8 (2)
				942.0 (3)		942.0 (3)
946.3 (28)	945.8 (3)	946.002 (28)	945.78 (10)	946.00 (3)		946.00 (3)
949.6 (28)				947.7 (2)		947.7 (2)
				952.7 (1)		952.7 (1)
			959 (1)	960.0 (1)		960.0 (1)
966.4 (29)			965.9 (10)	965.8 (1)		965.8 (1)
				975.1 (1)		975.1 (1)
			978.8 (10)	978.2 (3)		978.2 (3)
980.8 (29)			980.5 (5)	980.3 (1)		980.3 (1)
				981.6 (3)		981.6 (3)
984.5 (29)			983.4 (10)	984.2 (1)		984.2 (1)
				989.5 (1)		989.5 (1)

1968Bj06	1968Go20	1972Sa06	1975Ar24	1986Ar05	2000Ni13	Recommended
				992.0 (2)		992.0 (2) [×]
				994.6 (3)		994.6 (3)
				997.7 (3)		997.7 (3)
				1009.9 (3)		1009.9 (3)
				1019.5 (4)		1019.5 (4)
				1021.8 (2)		1021.8 (2)
1023.1 (30)			1022.7 (8)	1023.6 (2)		1023.6 (2) [×]
				1025.3 (2)		1025.3 (2) [×]
1028.6 (30)			1028.1 (8)	1028.7 (1)		1028.7 (1)
				1032.8 (2)		1032.8 (2)
				1035.9 (2)		1035.9 (2) [×]
				1037.9 (2)		1037.9 (2)
				1041.1 (2)		1041.1 (2)
1044.9 (31)				1044.4 (2)		1044.4 (2)
				1051.4 (2)		1051.4 (2)
				1057.8 (3)		1057.8 (3)
				1065.1 (1)		1065.1 (1)
1073 (3)			1074.4 (10)	1073.6 (2)		1073.6 (2)
1084 (3)			1082.5 (6)	1083.2 (1)		1083.2 (1)
				1085.3 (3)		1085.3 (3)
			1108.5 (6)	1106.9 (2)		1106.9 (2)
				1110.6 (1)		1110.6 (1)
1121.9 (33)			1122.3 (6)	1121.7 (1)		1121.7 (1)
				1125.2 (1)		1125.2 (1)
1126.8 (33)			1126.0 (6)	1126.8 (1)		1126.8 (1)
				1151.4 (3)		1151.4 (3)
			1153.1 (6)	1153.5 (3)		1153.5 (3)
			1171.3 (8)	1171.3 (1)		1171.3 (1)
				1173.1 (1)		1173.1 (1)
				1182.1 (2)		1182.1 (2)
		1193.767 (30)		1194.0 (2)		1194.0 (2)
1217 (4)			1217.5 (8)	1217.3 (1)		1217.3 (1)
				1220.4 (2)		1220.4 (2) [×]
1239 (4)				1237.3 (3)		1237.3 (3)
			1240.9 (8)	1241.2 (1)		1241.2 (1)
				1247.8 (2)		1247.8 (2)
				1252.6 (2)		1252.6 (2)
				1256.5 (1)		1256.5 (1)
			1277.1 (8)	1277.7 (2)		1277.7 (2)
1292 (4)			1292.8 (8)	1292.8 (1)		1292.8 (1)
				1296.4 (2)		1296.4 (2) [×]
				1301.2 (2)		1301.2 (2) [×]
				1327.0 (2)		1327.0 (2) [×]
				1342.9 (2)		1342.9 (2)
			1353.0 (6)	1352.9 (1)		1352.9 (1)
1354 (4)				1354.6 (2)		1354.6 (2)
			1358.4 (10)	1359.0 (1)		1359.0 (1)
				1389.6 (2)		1389.6 (2)
1394 (4)			1394.1 (5)	1393.9 (1)		1393.9 (1)
			1399.7 (10)	1397.5 (2)		1397.5 (2)

1968Bj06	1968Go20	1972Sa06	1975Ar24	1986Ar05	2000Ni13	Recommended
				1400.3 (1)		1400.3 (1)
				1409.1 (2)		1409.1 (2)
				1414.4 (2)		1414.4 (2)
			1427 (1)	1426.9 (1)		1426.9 (1)
				1442.8 (2)		1442.8 (2)
1446 (4)			1446.1 (8)	1445.4 (1)		1445.4 (1)
1453 (4)			1452.6 (15)	1452.7 (1)		1452.7 (1)
				1458.9 (1)		1458.9 (1)
				1475.8 (2)		1475.8 (2)
				1485.4 (2)		1485.4 (2)
				1488.0 (2)		1488.0 (2)
1493 (4)			1493.7 (10)	1493.6 (1)		1493.6 (1)
				1496.0 (2)		1496.0 (2)
				1500.0 (2)		1500.0 (2)
				1507.3 (2)		1507.3 (2) ^x
				1510.1 (2)		1510.1 (2)
1516 (5)				1515.6 (2)		1515.6 (2)
				1520.7 (2)		1520.7 (2) ^x
				1538.8 (2)		1538.8 (2) ^x
~1552			1549.2 (10)	1550.1 (1)		1550.1 (1)
				1567.0 (2)		1567.0 (2)
			1580.1 (10)	1579.9 (1)		1579.9 (1)
			1585.4 (10)	1585.9 (1)		1585.9 (1)
1595 (5)			1593.8 (8)	1594.0 (1)		1594.0 (1)
				1618.3 (2)		1618.3 (2)
			1628 (1)	1627.3 (1)		1627.3 (1)
			1638.2 (10)	1638.1 (1)		1638.1 (1)
1640 (5)				1640.5 (3)		1640.5 (3)
				1644.9 (2)		1644.9 (2)
1653 (5)				1650.2 (2)		1650.2 (2)
				1655.7 (1)		1655.7 (1) ^x
				1664.8 (3)		1664.8 (3) ^x
			1668.5 (8)	1668.4 (1)		1668.4 (1)
1671 (5)				1672.8 (1)		1672.8 (1)
				1679.5 (1)		1679.5 (1)
1688 (5)			1686.3 (10)	1685.7 (1)		1685.7 (1)
			1694.0 (8)	1693.8 (2)		1693.8 (2)
1695 (5)				1695.0 (3)		1695.0 (3)
				1700.5 (2)		1700.5 (2)
				1719.7 (2)		1719.7 (2)
				1723.2 (2)		1723.2 (2)
				1727.8 (2)		1727.8 (2)
1736 (5)			1737.9 (10)	1737.7 (2)		1737.7 (2)
				1741.1 (2)		1741.1 (2)
				1743.2 (2)		1743.2 (2) ^x
				1750.0 (1)		1750.0 (1)
1756 (5)				1757.5 (1)		1757.5 (1) ^x
			1768.4 (15)	1768.0 (3)		1768.0 (3)
				1770.8 (2)		1770.8 (2)
1775 (5)			1772.2 (15)	1773.0 (2)		1773.0 (2)

1968Bj06	1968Go20	1972Sa06	1975Ar24	1986Ar05	2000Ni13	Recommended
				1783.7 (2)		1783.7 (2)
			1796.9 (10)	1797.1 (1)		1797.1 (1)
1802 (5)				1805.8 (3)		1805.8 (3)
				1815.3 (3)		1815.3 (3)
				1819.8 (3)		1819.8 (3)
				1825.1 (3)		1825.1 (3)
1828 (5)				1830.8 (3)		1830.8 (3) [×]
			1838.20 (8)	1838.0 (2)		1838.0 (2)
1849 (6)			1850 (1)	1849.8 (2)		1849.8 (2) [×]
			1872.8 (10)	1872.8 (2)		1872.8 (2)
				1884.1 (3)		1884.1 (3)
			1891.1 (10)	1890.1 (2)		1890.1 (2)
				1893.4 (3)		1893.4 (3)
			1897.5 (10)	1896.7 (2)		1896.7 (2)
1905 (6)				1915.5 (3)		1915.5 (3)
			1926.5 (6)	1925.4 (2)		1925.4 (2)
				1927.9 (4)		1927.9 (4) [×]
				1935.2 (4)		1935.2 (4) [×]
1940 (6)			1937.8 (10)	1937.7 (3)		1937.7 (3)
				1958.0 (4)		1958.0 (4)
				1971.2 (4)		1971.2 (4)
				1977.4 (4)		1977.4 (4)
				1989.6 (4)		1989.6 (4)
				2072.2 (4)		2072.2 (4)

a: Expected but as yet unobserved, energy from level scheme.

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

×: Not placed in level scheme.

5.2 Relative values of the γ -ray intensities

Measured results for the relative γ -ray intensities from ²³⁴Pa are listed in table 5. The recommended values are from the measurements of 1986Ar05, except as noted in the footnotes of the table.

The values from 1975Ar24 were superseded by the same group in 1986Ar05. The uncertainties of 1968Bj06 are large (~ 20-30%), and not listed in table. Some γ -ray intensities from 1990Sc09 are also not listed in table because these intensities contain the contributions from ²³⁴Pa^m decay.

Table 5: Measured and recommended relative γ -ray intensities in decay of ²³⁴Pa

E_γ/keV	I_γ							
	1967Wa09	1968Bj06 ¹	1975Ar24	1986Ar05	1990Sc09 ¹	2006Al28 ¹	LWEIGHT	Recommended
34.30								0.0036 ^f
41.82 ^a								0.27 (7) ^d
43.49		0.123		0.12 (3)				0.12 (3)
45.45		0.009		0.026 (8)				0.026 (8)
54.96 ^b				~ 0.009				~ 0.009
54.96 ^b								~ 0.009
55.45				0.026 (8)				0.026 (8)
58.20		0.0026		< 0.009				0.0026 (8)
59.19				0.031 (10)				0.031 (10)
62.70	3.2	2.45	3.6	1.5 (4)				1.5 (4)
67.25				0.035 (10)				0.035 (10)

E_γ/keV	I_γ							
	1967Wa09	1968Bj06 ¹	1975Ar24	1986Ar05	1990Sc09 ¹	2006Al28 ¹	LWEIGHT	Recommended
69.46				0.017 (7)				0.017 (7)
75.0 ^a								0.030 (6) ^d
79.84		0.11		0.06 (2)				0.06 (2)
97.17				0.23 (8)				0.23 (8)
99.86		4.64		3.1 (5)				3.1 (5)
100.89				0.12 (2)				0.12 (2)
103.77		0.114		0.23 (3)				0.23 (3)
106.68				0.035 (10)				0.035 (10)
125.46	1.2	0.79	0.61	0.76 (9)				0.76 (9)
131.30	18	17.5	17.5	17.5	17.5	17.5		17.5
134.61		0.13		0.11 (2)				0.11 (2)
137.23				0.026 (8)				0.026 (8)
140.15	0.9			0.49 (5)				0.49 (5)
140.91				0.30 (3)				0.30 (3)
143.78	0.2		0.32	0.31 (3)				0.31 (3)
149.88				0.07 (2)				0.07 (2)
152.71	6	5.25	5.78	5.8 (4)	5.08 (19)		5.2 (2)	5.8 (4)
159.48	0.6	0.44	0.61	0.63 (7)				0.63 (7)
164.94				0.05 (2)				0.05 (2)
165.61				0.07 (2)				0.07 (2)
170.85	0.4	0.44	0.55	0.49 (5)				0.49 (5)
174.55			0.21	0.16 (2)				0.16 (2)
179.80				0.043 (15)				0.043 (15)
186.15	1.8	1.5	2.02	1.71 (10)				1.71 (10)
193.73	0.5	0.6	0.51	0.48 (6)				0.48 (6)
196.80		< 0.44	0.06	0.07 (2)				0.07 (2)
199.95				0.07 (2)				0.07 (2)
200.97		0.9	0.96	0.87 (9)				0.87 (9)
203.12	2.1		1.14	1.19 (10)				1.19 (10)
220.00	0.4		0.1	0.14 (2)				0.14 (2)
221.15				0.05 (2)				0.05 (2)
221.83				0.07 (2)				0.07 (2)
226.50	10	5.6	10.1	4.1 (3)	10.25 (15)			4.7 (3) [#]
227.25		5.25		5.6 (3)				5.6 (3)
232.21				0.17 (2)				0.17 (2)
233.6 ^a								~ 0.018 ^d
235.11				0.11 (2)				0.11 (2)
235.9 ^a								0.0044 (25) ^c
240.2				0.05 (2)				0.05 (2)
245.37	0.8	0.9	0.66	0.73 (8)				0.73 (8)
247.79 ^a								3.6 (3)E-4 ^c
249.22	2.5	2.19	2.45	2.4 (3)	2.14 (10)		2.2 (1)	2.4 (3)
257.2				0.05 (2)				0.05 (2)
267.12			0.15	0.17 (2)				0.17 (2)
272.28	1	0.9	0.88	1.05 (10)	1.1 (1)		1.08 (7)	1.05 (10)
275.04				0.09 (2)				0.09 (2)
278.3			0.06	0.04 (1)				0.04 (1)
293.79	3.7		3.4	2.9 (2)	3.0 (1)		2.98 (9)	2.9 (2)

E_γ/keV	I_γ							
	1967Wa09	1968Bj06 ¹	1975Ar24	1986Ar05	1990Sc09 ¹	2006Al28 ¹	LWEIGHT	Recommended
295.91				0.14 (2)				0.14 (2)
298.7				0.013 (5)				0.013 (5)
308.6				0.020 (5)				0.020 (5)
310.2				0.07 (1)				0.07 (1)
310.52 ^a								1.30 (14)E-4 ^c
313.5				0.10 (1)				0.10 (1)
316.7			0.11	0.10 (1)				0.10 (1)
320.4				0.050 (6)				0.050 (6)
330.4 ^b	1.1		0.75	0.75 (5)				0.75 (5)
330.4 ^b								
331.4				0.07 (1)				0.07 (1)
340.2				0.039 (8)				0.039 (8)
343.8				0.033 (7)				0.033 (7)
351.9	0.5	0.6	0.53	0.40 (3)				0.40 (3)
357.9				0.035 (10)				0.035 (10)
360.6				0.017 (6)				0.017 (6)
365.0 ^b				0.017 (6)				0.017 (6)
365.0 ^b								
369.50	3.5	2.63	2.49	2.40 (15)	2.69 (10)		2.60 (8)	2.40 (15)
372.0	1	0.96	1.23	1.18 (8)	1.41 (10)		1.27 (6)	1.18 (8)
379.1				0.04 (1)				0.04 (1)
385.4				0.04 (1)				0.04 (1)
387.94 ^a								6.9 (4)E-4 ^c
394.1				0.09 (1)				0.09 (1)
397.7				0.026 (6)				0.026 (6)
401.8 ^x				0.035 (10)				0.035 (10)
409.8	0.4		0.48	0.33 (3)				0.33 (3)
416.1	0.1			0.035 (10)				0.035 (10)
425.3 ^x				0.035 (10)				0.035 (10)
426.95	0.8		0.47	0.44 (3)				0.44 (3)
427.4 ^a								3.0 (8)E-5 ^c
433.1			0.05	0.09 (1)				0.09 (1)
446.6 ^b			0.11	0.11 (1)				0.11 (1)
446.6 ^b								
450.93 ^a								3.8 (18)E-3 ^c
452.4				0.026 (8)				0.026 (8)
458.68	1.3		1.26	1.10 (6)	1.22 (10)		1.13 (5)	1.10 (6)
461.5 ^b				0.033 (10)				0.033 (10)
461.5 ^b								
464.2				0.03 (1)				0.03 (1)
468.0				0.21 (2)				0.21 (2)
472.3			0.21	0.35 (2)				0.35 (2)
474.2				0.035 (10)				0.035 (10)
478.6 ^b			0.26	0.12 (1)				0.12 (1)
478.6 ^b								
481.0	0.4		0.42	0.30 (2)				0.30 (2)
498.0 ^b			0.09	0.06 (1)				0.06 (1)
498.0 ^b								
502.0				0.026 (8)				0.026 (8)

E_γ/keV	I_γ							
	1967Wa09	1968Bj06 ¹	1975Ar24	1986Ar05	1990Sc09 ¹	2006Al28 ¹	LWEIGHT	Recommended
506.75	1.5		1.4	1.25 (8)	2.14 (12)		1.7 (5)	1.25 (8)
513.4 ^c	1.3		1.3	1.10 (7)				~ 0.73
513.4 ^c								~ 0.37
519.6				0.38 (3)				0.38 (3)
521.4	1.1	0.9	0.81	0.72 (5)				0.72 (5)
527.9		0.6	0.61	0.38 (3)				0.38 (3)
529.1 ^b	0.3			0.09 (3)				0.09 (3)
529.1 ^b								
534.1				0.08 (1)				0.08 (1)
537.2			0.14	0.08 (1)				0.08 (1)
543.8				0.13 (2)				0.13 (2)
553.7				0.043 (15)				0.043 (15)
558.0 ^b				0.09 (2)				0.09 (2)
558.0 ^b								
559.2				0.07 (2)				0.07 (2)
562.8				0.035 (10)				0.035 (10)
565.2 ^b		0.9		1.00 (6)				1.00 (6)
565.2 ^b								
568.9		2.63		3.5 (4)				3.5 (4)
569.5	14.5	8.75	12.1	8.0 (8)	12.42 (16)	12.9 (38)		8.9 (8)~
575.5				0.026 (8)				0.026 (8)
584.1				0.17 (2)				0.17 (2)
586.3			0.09	0.07 (1)				0.07 (1)
590.3				0.035 (10)				0.035 (10)
595.4				0.09 (2)				0.09 (2)
596.9 ^b			0.31	0.19 (2)				0.19 (2)
596.9 ^b								
602.6	0.4		0.76	0.52 (3)				0.52 (3)
604.6				0.05 (2)				0.05 (2)
612.0		0.6	0.61	0.37 (3)				0.37 (3)
617.0 ^b				0.05 (2)				0.05 (2)
617.0 ^b								
619.0				0.035 (10)				0.035 (10)
624.2		0.35	0.54	0.34 (3)				0.34 (3)
628.1				0.23 (4)				0.23 (4)
629.4		0.35		0.34 (5)				0.34 (5)
632.6				0.035 (10)				0.035 (10)
634.3 ^b				0.13 (2)				0.13 (2)
634.3 ^b								
643.2 ^x				0.026 (8)				0.026 (8)
646.5		0.9	0.19	0.11 (1)				0.11 (1)
653.7 ^b		0.44	0.58	0.45 (6)				0.45 (6)
653.7 ^b								
655.2	0.7			0.13 (2)				0.13 (2)
657.4	0.7	0.9		0.38 (3)				0.38 (3)
659.8 ^x				0.26 (2)				0.26 (2)
663.9			0.9	0.52 (7)				0.52 (7)
666.5	2.2		1.49	1.13 (7)	0.92 (9)		1.05 (6)	1.13 (7)
669.7 ^c	2.0		1.14	0.96 (5)	1.04 (10)		0.98 (5)	0.96 (5)

E_γ/keV	I_γ							
	1967Wa09	1968Bj06 ¹	1975Ar24	1986Ar05	1990Sc09 ¹	2006Al28 ¹	LWEIGHT	Recommended
669.7 ^c								< 0.0005
675.1				0.097 (10)				0.097 (10)
683.9				0.15 (3)				0.15 (3)
685.1 ^b			0.24	0.14 (3)				0.14 (3)
685.1 ^b								
692.6	1.3	1.5	1.4	1.20 (7)				1.20 (7)
699.03 ^b	4.1	3.5	4.16	3.5 (2)	3.61 (10)		3.59 (9)	3.5 (2)
699.03 ^b								
705.9	2.9	3.1	2.14	2.2 (1)				2.2 (1)
708.3 ^a								0.022 (8) ^c
711.5 [×]			0.18	0.15 (2)				0.15 (2)
713.7 ^b				0.14 (2)				0.14 (2)
713.7 ^b								
716.5				0.030 (8)				0.030 (8)
727.8				0.11 (1)				0.11 (1)
730.9				0.61 (8)				0.61 (8)
733.39	9.2	7	7.5	6.7 (4)	7.04 (11)		7.02 (11)	6.7 (4)
738.0		1.75	1.14	1.12 (7)	1.29 (11)		1.17 (6)	1.12 (7)
742.813	2.5		2.0	2.0 (1)				2.0 (1)
745.9			0.11	0.31 (3)				0.31 (3)
748.1				0.10 (2)				0.10 (2)
755.0 ^b	0.6		1.4	1.18 (6)	1.29 (11)		1.21 (5)	1.18 (6)
755.0 ^b								
758.9				0.24 (2)				0.24 (2)
761.0				0.07 (2)				0.07 (2)
764.8				0.19 (4)				0.19 (4)
766.4	0.4	0.26		0.25 (4)				0.25 (4)
769.1				0.18 (1)				0.18 (1)
772.4				0.07 (2)				0.07 (2)
778.6 [×]				0.044 (8)				0.044 (8)
780.4	0.7		0.88	0.87 (4)				0.87 (4)
783.4			0.44	0.29 (3)				0.29 (3)
786.272	1		1.4	1.16 (6)				1.16 (6)
792.8				0.043 (10)				0.043 (10)
794.9				0.65 (8)				0.65 (8)
796.1	3.8		2.9	2.5 (2)	3.31 (15)		2.9 (4)	2.5 (2)
799.7 ^a								
802.3				0.030 (8)				0.030 (8)
804.1			0.35	0.6 (2)				0.6 (2)
805.8	3	2.9	2.71	2.45 (15)				2.45 (15)
808.4				0.035 (10)				0.035 (10)
810.0								0.19 (6) ^f
811.5				0.12 (1)				0.12 (1)
814.2				0.30 (2)				0.30 (2)
819.2	2.8		2.01	1.83 (10)	2.26 (9)		2.05 (22)	1.83 (10)
824.2 [×]			3.23	1.2 (1)				1.2 (1)
825.1	4.3			1.83 (10)	4.16 (11)			1.83 (10)
829.3				0.35 (10)				0.35 (10)
831.5	5.3		4.46	4.0 (2)	4.77 (9)	3.8 (23)	4.38 (28)	4.0 (2)

E_γ/keV	I_γ							
	1967Wa09	1968Bj06 ¹	1975Ar24	1986Ar05	1990Sc09 ¹	2006Al28 ¹	LWEIGHT	Recommended
839.5				0.030 (7)				0.030 (7)
844.1	0.4		0.44	0.41 (3)				0.41 (3)
846.1 [×]				0.05 (1)				0.05 (1)
848.9				0.026 (7)				0.026 (7)
851.8				0.07 (2)				0.07 (2)
857.7				0.035 (7)				0.035 (7)
863.2				0.07 (2)				0.07 (2)
869.7				0.19 (2)				0.19 (2)
874.0				0.035 (7)				0.035 (7)
876.0	7		3.19	2.45 (2)	2.57 (8)		2.46 (2)	2.45 (2)
880.52 ^c	18		11.64	10.1 (6)	12.97 (12)		11.6 (15)	4.1 (4)
880.52 ^c								6.0 (5)
883.24	4		10.85	9.3 (6)				9.3 (6)
890.1				0.026 (7)				0.026 (7)
898.67	4.3	3.6	3.15	3.15 (20)	3.61 (8)		3.55 (8)	3.15 (20)
904.2	0.5		0.41	0.33 (2)				0.33 (2)
916.5				0.023 (6)				0.023 (6)
918.4				0.096 (10)				0.096 (10)
920.5 [×]				0.028 (7)				0.028 (7)
925.0		8.8		7.6 (5)	8.69 (11)		8.64 (11)	7.6 (5)
926.0 ^a								1.7 (12) ^g
926.7	22	8.75	14.7	8.7 (5)				7.0 (9) ^g
935.8				0.064 (7)				0.064 (7)
942.0				0.044 (7)				0.044 (7)
946.00	19	13.1	16.1	13.0 (8)				13.0 (8)
947.7				1.57 (15)	1.90 (9)		1.81 (8)	1.57 (15)
952.7				0.08 (1)				0.08 (1)
960.0	0.2		0.09	0.07 (1)				0.07 (1)
965.8	0.4	0.7	0.09	0.46 (3)				0.46 (3)
975.1				0.026 (7)				0.026 (7)
978.2				0.087 (20)				0.087 (20)
980.3 ^c	3.8		~ 2.6	1.92 (10)	2.75 (9)			~ 2.6 ^h
980.3 ^c			~ 1.7					~ 1.7 ^h
981.6				0.7 (2)				0.7 (2)
984.2	1.5		1.49	1.57 (15)	1.84 (8)		1.78 (7)	1.57 (15)
989.5				0.10 (1)				0.10 (1)
992.0 [×]				0.08 (2)				0.08 (2)
994.6				0.06 (2)				0.06 (2)
997.7				0.044 (10)				0.044 (10)
1009.9 ^b				0.064 (10)				0.064 (10)
1009.9 ^b								
1019.5				0.026 (7)				0.026 (7)
1021.8	0.4			0.14 (3)				0.14 (3)
1023.6 [×]				0.06 (2)				0.06 (2)
1025.3 [×]				0.05 (2)				0.05 (2)
1028.7	0.8	0.8	0.44	0.55 (3)				0.55 (3)
1032.8				0.017 (4)				0.017 (4)
1035.9 [×]				0.025 (9)				0.025 (9)
1037.9				0.017 (6)				0.017 (6)

E_γ/keV	I_γ							LWEIGHT	Recommended
	1967Wa09	1968Bj06 ¹	1975Ar24	1986Ar05	1990Sc09 ¹	2006Al28 ¹			
1041.1				0.031 (10)					0.031 (10)
1044.4		0.44		~ 0.030					~ 0.030
1051.4				0.06 (1)					0.06 (1)
1057.8				~ 0.017					~ 0.017
1065.1				0.026 (7)					0.026 (7)
1073.6		0.21	0.17	0.10 (1)					0.10 (1)
1083.2	0.6	0.7		0.49 (3)					0.49 (3)
1085.3				0.026 (7)					0.026 (7)
1106.9				0.08 (1)					0.08 (1)
1110.6				0.06 (1)					0.06 (1)
1121.7	0.4		0.44	0.24 (3)					0.24 (3)
1125.2	0.8			0.35 (7)					0.35 (7)
1126.8				0.29 (3)					0.29 (3)
1151.4 ^b				0.031 (9)					0.031 (9)
1151.4 ^b									
1153.5				0.044 (7)					0.044 (7)
1171.3				0.087 (10)					0.087 (10)
1173.1				0.044 (7)					0.044 (7)
1182.1				~ 0.009					~ 0.009
1193.77				0.020 (5)					0.020 (5)
1217.3		0.9	0.32	0.21 (2)					0.21 (2)
1220.4 ^x				0.06 (1)					0.06 (1)
1237.3				< 0.009					< 0.009
1241.2				0.22 (2)					0.22 (2)
1247.8				0.021 (5)					0.021 (5)
1252.6				0.017 (7)					0.017 (7)
1256.5				0.057 (6)					0.057 (6)
1277.7			0.24	0.043 (7)					0.043 (7)
1292.8	0.6	0.7	0.45	0.45 (3)	0.55 (6)		0.47 (3)		0.45 (3)
1296.4 ^x				0.028 (6)					0.028 (6)
1301.2 ^x				0.017 (4)					0.017 (4)
1327.0 ^x				0.017 (4)					0.017 (4)
1342.9				0.012 (4)					0.012 (4)
1352.9	1.7	1.84	1.10	1.12 (5)	1.17 (5)		1.15 (4)		1.12 (5)
1354.6				0.13 (3)					0.13 (3)
1359.0			0.11	0.15 (2)					0.15 (2)
1389.6				0.07 (2)					0.07 (2)
1393.9	2.8	2.2	2.1	2.0 (1)	2.39 (6)		2.2 (2)		2.0 (1)
1397.5				0.08 (2)					0.08 (2)
1400.3				0.17 (2)					0.17 (2)
1409.1				0.043 (8)					0.043 (8)
1414.4				< 0.0026					< 0.0026
1426.9			0.17	0.16 (2)					0.16 (2)
1442.8				0.030 (6)					0.030 (6)
1445.4	0.3			0.31 (3)					0.31 (3)
1452.7	0.9	1	0.7	0.78 (5)	0.74 (6)		0.76 (4)		0.78 (5)
1458.9				0.09 (2)					0.09 (2)
1475.8				0.008 (3)					0.008 (3)
1485.4				0.029 (6)					0.029 (6)

E_γ/keV	I_γ							
	1967Wa09	1968Bj06 ¹	1975Ar24	1986Ar05	1990Sc09 ¹	2006Al28 ¹	LWEIGHT	Recommended
1488.0				0.013 (5)				0.013 (5)
1493.6		0.26	0.17	0.10 (1)				0.10 (1)
1496.0				0.035 (8)				0.035 (8)
1500.0				0.011 (3)				0.011 (3)
1507.3 [×]				0.019 (4)				0.019 (4)
1510.1				< 0.009				< 0.009
1515.6		0.35		0.07 (1)				0.07 (1)
1520.7 [×]				~ 0.009				~ 0.009
1538.8 [×]				0.013 (3)				0.013 (3)
1550.1			0.09	0.07 (1)				0.07 (1)
1567.0				0.011 (2)				0.011 (2)
1579.9			0.15	0.07 (2)				0.07 (2)
1585.9	0.3		0.26	0.14 (1)				0.14 (1)
1594.0	0.8	0.6	0.46	0.30 (2)				0.30 (2)
1618.3				0.009 (3)				0.009 (3)
1627.3			0.09	0.073 (8)				0.073 (8)
1638.1	0.3		0.19	0.20 (1)				0.20 (1)
1640.5		0.6		0.010 (3)				0.010 (3)
1644.9				0.010 (3)				0.010 (3)
1650.2				< 0.005				< 0.005
1655.7 [×]				0.025 (3)				0.025 (3)
1664.8 [×]				0.017 (6)				0.017 (6)
1668.41	1		0.33	0.74 (5)	0.74 (5)			0.74 (5)
1672.8				0.033 (10)				0.033 (10)
1679.5				0.074 (16)				0.074 (16)
1685.7				0.30 (2)				0.30 (2)
1693.8			0.80	0.67 (7)				0.67 (7)
1695.0	1.1	1.4		0.26 (6)				0.26 (6)
1700.5				0.10 (1)				0.10 (1)
1719.7				0.017 (5)				0.017 (5)
1723.2				0.015 (3)				0.015 (3)
1727.8				0.019 (4)				0.019 (4)
1737.7		0.19	0.07	0.072 (8)				0.072 (8)
1741.1				0.047 (6)				0.047 (6)
1743.2 [×]				0.032 (7)				0.032 (7)
1750.0				0.062 (7)				0.062 (7)
1757.5 [×]				0.023 (5)				0.023 (5)
1768.0	0.2		0.05	0.019 (4)				0.019 (4)
1770.8				0.065 (15)				0.065 (15)
1773.0				0.065 (15)				0.065 (15)
1783.7				0.024 (6)				0.024 (6)
1797.1	0.3		0.19	0.23 (2)				0.23 (2)
1805.8				0.005 (2)				0.005 (2)
1815.3				0.009 (3)				0.009 (3)
1819.8				0.004 (1)				0.004 (1)
1825.1				0.009 (3)				0.009 (3)
1830.8 [×]				0.004 (1)				0.004 (1)
1838.0 ^b			0.08	0.040 (9)				0.040 (9)
1838.0 ^b								

E_γ/keV	I_γ							
	1967Wa09	1968Bj06 [!]	1975Ar24	1986Ar05	1990Sc09 [!]	2006Al28 [!]	LWEIGHT	Recommended
1849.8 [×]		0.044		0.027 (6)				0.027 (6)
1872.8				0.034 (8)				0.034 (8)
1884.1				0.015 (4)				0.015 (4)
1890.1	0.4			0.14 (1)				0.14 (1)
1893.4				~ 0.006				~ 0.006
1896.7				0.10 (2)				0.10 (2)
1915.5				0.019 (4)				0.019 (4)
1925.4	0.6		0.28	0.29 (4)	0.31 (3)		0.30 (2)	0.29 (4)
1927.9 [×]				0.052 (10)				0.052 (10)
1935.2 [×]				~ 0.009				~ 0.009
1937.7			0.04	0.04 (1)				0.04 (1)
1958.0				0.0096 (25)				0.0096 (25)
1971.2				~ 0.0026				~ 0.0026
1977.4				0.016 (4)				0.016 (4)
1989.6				0.007 (3)				0.007 (3)
2072.2				0.004 (2)				0.004 (2)

!: Normalized to $I(\gamma_{131.3}) = 17.5$.

#: From $I(\gamma_{227.25}) = 5.6$ (3) in 1986Ar05 and $I(\gamma_{226.5} + \gamma_{227.25}) = 10.25$ (15) in 1990Sc09.

~: From $I(\gamma_{568.9}) = 3.5$ (4) in 1986Ar05 and $I(\gamma_{569.5} + \gamma_{568.9}) = 12.42$ (16) in 1990Sc09.

a: Expected but as unobserved yet.

b: Multiply placed, intensity not divided.

c: Multiply placed, intensity suitably divided.

d: $I(\gamma + \text{ce})$, from γ -ray transition intensity balance.

e: From adopted γ branching.

f: From $I(\gamma + \text{ce})$, from ce measurements(1968Bj06).

g: From $I_\gamma(926 + 926.7) = 8.7$ (5) and $I_\gamma(926.7)/I_\gamma(883.2) = 0.75$ (8) in ²³⁸Pu α decay.

h: From $\gamma\gamma$ coincidence measurements(1968Bj06).

×: Not placed in level scheme.

5.3 Absolute values of the γ -ray emission probabilities

There is no measured absolute γ -ray emission probability in the ²³⁴Pa β^- decay. The normalization factor N for translation of the relative intensities to the absolute emission probabilities has been obtained from the relation of $\Sigma I(\gamma + \text{ce})(\text{g.s.}) + \Sigma I(\gamma + \text{ce})(43.5\text{keV level}) = 100\%$, excluding the 43.5-keV transition and supposing no β^- feeding to the above-mentioned two states. $N = 1.04$ (9).

The recommended absolute γ -ray emission probabilities (photons per 100 disintegrations) are the relative values recommended in table 5 multiplied by 1.04 (9).

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