

²²⁵Ac - Comments on evaluation of the decay data

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This evaluation was completed in 2008. Literature available by December 2008 was included.

1 Decay Scheme

²²⁵Ac disintegrates 100 % by α emission to levels in ²²¹Fr. ²²⁵Ac ground state has $J^\pi=(3/2^-)$ (1990Ak03).

The ²²⁵Ac α decay scheme was built from the experimental conversion-electron data of 1971DzZP, 1972Dz14 and 2000Ar23, the α - γ coincidence data of 2003Ku44, the γ - γ coincidence data of 1990Ko14, and the experimental singles γ -rays data of 2000Ar23 and 2003Ku44.

The recommended $Q(\alpha)$ value of 5935.1 (14) keV in Audi (2003Au03) agrees with the $Q(\alpha)$ value of 5932.5 (16) keV, calculated by the evaluator (using program RADLST) from average radiation energies. This agreement supports the completeness and correctness of the decay scheme.

2 Nuclear Data

The Q 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 1990Ak03, 2000Ar23 and 2003Ku44.

The measured and recommended ²²⁵Ac half-life values are listed in Table 1.

Table 1 Measured half-life values of ²²⁵Ac and recommended value, in days

$T_{1/2}$ (d)	References	Measurement method
10	1947En03	
10.0 (1)	1950Ha52	Alpha pulse analyzer, 10 $T_{1/2}$
10.0 (1)	Recommended value	From 1950Ha52

The recommended value is taken from the measurement of 1950Ha52. Further measurements are merited to determine this value with greater confidence.

2.1 γ Transitions

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

Multipolarities and mixing ratios of γ -ray transitions are from 1971DzZP, 1972Dz14, 1977Vy02, 1990ArZZ and 2003Ku44. The multipolarity marked in square brackets for other γ transition are from the level scheme (they are not measured).

The internal conversion coefficients (ICC) and their associated uncertainties for γ -ray transitions have been obtained using the BrIcc computer program, which uses the "Frozen Orbital" approximation (2002Ba85). Experimental and theoretical conversion coefficients are compared in Table 2.

Table 2 Comparison of theoretical and measured conversion coefficients

E _γ (keV)	Multipolarity	α(theory)	α(exp.)
			2003Ku44
78.8	M1	α _T = 5.63, α _L = 4.27	α _T = 5.1 (11)
87.41	M1	α _T = 4.16, α _L = 3.16	α _T = 2.8 (6)
114	M1	α _T = 9.86, α _L = 7.93	α _T = 13.0 (17)
139.6	M1+E2	α _T = 3.9, α _K = 2.4	α _T = 3.2 (5)
145.16	(E1)	α _T = 0.191	α _T ≤ 0.1
153.92	E1	α _T = 0.166	α _T ≤ 0.35
197.5	E1	α _T = 0.0908	α _T ≤ 0.04

2.2 α Transitions

The level energies of ²²¹Fr are determined from the least-squares fit to the recommended γ-ray energies. The level energies of ²²¹Fr and Q-values (2003Au03) were used to determine the energies and uncertainties of the alpha particle transitions to the various levels.

The recommended energies of alpha particles were calculated from the proposed decay scheme and listed in table 3. The recommended values are in good agreement with the measurements of 1967Dz02. Other measurements are 1964Gr11, 1967Ba51, and 1972Go29.

Table 3 Measured and recommended value of α-particle energy for ²²⁵Ac (keV)

1964Gr11	1967Ba51 ^a	1967Dz02 ^b	1972Go29	1991Ry01	Recommended
5829 (5)	5829 (2)	5829 (2)		5829.6 (14)	5829.6 (14)
	5804 (2)				5804.2 (14)
5792 (5)	5793 (3)	5792 (3)	5792.5 (22)	5793.1 (21)	5793.1 (21)
	5791 (4)		5790.6 (22)		5791.7 (14)
5732 (5)	5731 (2)	5731 (3)		5731.9 (17)	5731.9 (17)
					5731.6 (14)
					5730.5 (14)
5724 (5)	5722.6 (25)	5723 (3)			5723.1 (14)
					5686.4 (14)
5683 (5)	5681 (2)	5681 (3)			5682.2 (14)
5638 (5)	5636.2 (20)	5637 (3)			5637.3 (14)
5610 (5)	5607.6 (30)	5608 (3)			5609.0 (14)
	5597.5 (40)				5599.3 (14)
5581 (5)	5579.1 (30)	5577 (3)			5580.5 (14)
	5561.6 (40)				5563.3 (14)
	5552.6 (40)				5555.3 (14)
	5544.1 (40)				5546.5 (14)
	5538.5 (40)	5540 (5)			5540.1 (14)
	5521.5 (70)	5526 (5)			5523.7 (14)
	5514.5 (7)	(5519)			5515.2 (14)
5494 (10)		5497 (4)			5497.4 (14)
		5489 (4)			5487.4 (14)
		(5468)			5468.4 (14)
5448 (10)	5441.1 (40)	5444 (3)			5443.3 (14)
	5433.5 (40)	5437 (4)			5435.8 (14)

1964Gr11	1967Ba51 ^a	1967Dz02 ^b	1972Go29	1991Ry01	Recommended
					5430.1 (14)
	5419 (7)	5427 (4)			5428.3 (14)
		5411 (4)			5414.5 (14)
5398		5391 (4)			5391.2 (14)
5367		(5377)			5379.0 (14)
		(5355)			5356.2 (14)
		(5342)			5341.9 (14)
5328 (10)	5318 (4)	5322 (3)			5321.2 (14)
5295 (10)	5285 (4)	5286 (3)			5287.6 (14)
	5266.5 (40)	5271 (4)			5269.1 (14)
	5229 (7)	5238 (4)			5239.3 (14)
5225	5209.3 (50)	5211 (3)			5210.2 (14)
	5205.5 (50)	5201 (5)			5203.3 (14)
		(5192)			5195.1 (14)
		5160 (5)			5162.1 (14)
		5130 (5)			5129.0 (14)
		5091 (4)			5094.1 (14)
					5076.8 (14)
		5066 (5)			5064.1 (14)
		(5030)			5035.5 (14)
					5025.5 (14)
		(5020)			5019.3 (14)
					4992.7 (14)
		4901 (5)			4903.6 (14)

a: Original energies should be increased by 1 keV due to changes in calibration energies (recommended by 1979Ry03).

b: Original energies should be decreased by 0.3 keV due to changes in calibration energies (recommended by 1979Ry03)

The evaluated alpha particle emission probabilities were deduced from the transition intensity balance and listed in table 4. These calculated results are in good agreement with the measured emission probabilities of the main alpha transitions. The measurements are from 1964Gr11, 1967Ba51, 1967Dz02, 1972Go29, and 2003Ku4.

Table 4 Measured and recommended α -particle emission probabilities for ²²⁵Ac

E_α (keV)	P_α					Evaluation
	1964Gr11	1967Ba51	1967Dz02	1972Go29	2003Ku44	
5829.6 (14)	52 (3)	50.65 (15)	51.6 (15)			52.4 (24)
5804.2 (14)		0.3				0.3
5793.1 (21)	28 (3)	24.3 (1)	26.7 (10)	18.1 (20)	20.2 (11)	18.9 (20)
5791.7 (14)		2.50 (1)			8.4 (5)	6.2 (9)
5731.9 (17)	12 (2)	10.10 (3)	10.0 (1)	8.6 (9)	8.5 (4)	9.0 (5)
5731.6 (14)					1.6 (2)	1.24 (10)
5730.5 (14)					1.05 (8)	1.6 (3)
5723.1 (14)		3.40 (1)	2.9 (5)		3.77 (19)	2.03 (23)

E_{α} (keV)	P_{α}					
	1964Gr11	1967Ba51	1967Dz02	1972Go29	2003Ku44	Evaluation
5686.4 (14)					0.095 (4)	0.021 (14)
5682.2 (14)	1.3 (3)	1.250 (4)	1.4 (2)		1.08 (5)	1.31 (4)
5637.3 (14)	4.2 (3)	4.350 (13)	4.5 (3)		3.7 (1)	4.16 (23)
5609.0 (14)	1.0 (3)	1.20 (1)	1.1 (1)		0.86 (3)	1.09 (5)
5599.3 (14)		0.0410 (1)			0.099 (4)	0.114 (7)
5580.5 (14)	1.0 (3)	1.20 (4)	1.2 (1)		0.89 (3)	0.95 (4)
5563.3 (14)		0.0340 (1)			0.0034 (5)	0.017 (7)
5555.3 (14)		0.1000 (3)			0.089 (4)	0.084 (10)
5546.5 (14)		0.0310 (1)			0.075 (3)	0.055 (12)
5540.1 (14)		0.0150 (5)	0.04 (1)		0.0070 (7)	0.0072 (8)
5523.7 (14)		~ 0.005	0.010 (2)			0.013 (6)
5515.2 (14)		~ 0.005	≤ 0.02			0.0052 (19)
5497.4 (14)	~ 0.02		0.003 (1)			0.0022 (7)
5487.4 (14)			0.0020 (7)			0.0020 (3)
5468.4 (14)			≤ 0.001			0.00052 (18)
5443.3 (14)	0.15 (5)	0.150 (1)	0.13 (1)		0.086 (4)	0.098 (19)
5435.8 (14)		0.0710 (2)	0.07 (2)		0.029 (2)	0.0083 (6)
5430.1 (14)						0.0028 (8)
5428.3 (14)			0.008 (3)		0.0010 (1)	0.0023 (3)
5414.5 (14)		~ 0.003	0.0020 (5)			0.0030 (4)
5391.2 (14)	~ 0.01		0.0010 (5)			0.0006 (4)
5379.0 (14)	~ 0.01		≤ 0.001			0.0020 (5)
5356.2 (14)			≤ 0.001			9.7E-5 (2)
5341.9 (14)			≤ 0.001		0.0009 (3)	0.0027 (8)
5321.2 (14)	0.07 (3)	0.080 (2)	0.068 (8)		0.054 (2)	0.007 (7)
5287.6 (14)	0.2 (1)	0.300 (1)	0.23 (1)		0.17 (1)	0.214 (10)
5269.1 (14)		0.0180 (5)	0.009 (2)		0.0086 (8)	0.048 (19)
5239.3 (14)			0.0030 (8)		0.00019 (8)	0.0026 (5)
5210.2 (14)	~ 0.02	0.0250 (1)	0.003 (3)		0.022 (2)	0.022 (1)
5203.3 (14)		0.0130 (1)	0.0020 (5)		0.0044 (6)	0.0101 (10)
5195.1 (14)			≤ 0.002			0.00015 (5)
5162.1 (14)			0.0020 (8)			0.00066 (12)
5129.0 (14)			0.0020 (8)		0.0013 (3)	0.0058 (8)
5094.1 (14)			0.006 (1)		0.0054 (15)	0.015 (7)
5076.8 (14)						0.0038 (19)
5064.1 (14)			0.003 (1)		0.0014 (2)	0.00114 (18)
5035.5 (14)			≤ 0.001			0.0021 (3)
5025.5 (14)						0.00083 (21)
5019.3 (14)			≤ 0.001		~ 0.00004	0.00015 (5)
4992.7 (14)						0.0013 (3)
4903.6 (14)			0.0020 (5)			0.0011 (4)

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 computer code RADLST. Measured and calculated X-ray emission probabilities are compared in Table 5.

Table 5 Comparison of the calculated and measured X-ray emission probabilities

	1972Dz14	Adopted (deduced)
$K_{\alpha 1}$	1.5 (2)	1.64 (12)
$K_{\alpha 2}$	1.0 (1)	1.00 (8)

The deduced KX-ray emission probabilities agree with the measured value of 1972Dz14, thus confirming the completeness of the decay scheme.

4. Electron Emissions.

The conversion electron emission probabilities have been deduced from γ -ray transition data.

5. Photon Emissions

5.1 γ -ray energy values

There are many measured γ -ray energies of ²²⁵Ac. The present evaluated values are taken from the LWM average value of 1972Dz14, 2000Ar23 and 2003Ku44. The measurements of 1990ArZZ were replaced by 2000Ar23. The experimental and our recommended γ -ray energies from ²²⁵Ac α decay are listed in table 6.

Table 6 Measured and recommended value of γ -ray energy for ²²⁵Ac (keV)

1972Dz14	1990ArZZ	2000Ar23	2003Ku44	LWM	Evaluation
		10.6	10.6		10.6
26.0 (1)	26.05 (10)	26.0 (1)	26.0	26.0 (1)	26.0 (1)
36.6 (1)	36.65 (3)	36.70 (3)	36.7 (1)	36.69 (3)	36.69 (3)
38.5 (1)	38.53 (3)	38.60 (4)	38.5 (1)	38.58 (4)	38.58 (4)
	46.24 (5)	46.24 (5)	46.2 (2)	46.24 (5)	46.24 (5)
49.0 (2)	49.09 (5)	49.13 (4)	49.1 (2)	49.12 (4)	49.12 (4)
		50.2			50.2
53.8 (1)		53.01 (5)		53.4 (4)	53.4 (4)
57.8 (1)	57.75 (5)	57.69 (4)	57.8 (2)	57.71 (4)	57.71 (4)
		62.6 (3)			62.6 (3)
62.90 (5)	62.95 (3)	62.96 (3)	62.9 (1)	62.94 (3)	62.94 (3)
		63.5 (3)			63.5 (3)
64.1 (1)	64.28 (5)	64.28 (3)	64.3 (1)	64.27 (3)	64.27 (3)
69.8 (1)	69.8 (2)	69.87 (5)		69.86 (5)	69.86 (5)
71.7 (1)	71.74 (3)	71.72 (4)	71.4 (3)	71.71 (4)	71.71 (4)
73.6 (1)	73.5 (1)	73.36 (20)	73.5	73.55 (9)	73.55 (9)
73.83 (5)	73.86 (2)	73.85 (4)	73.9 (1)	73.85 (3)	73.85 (3)
74.9 (2)	74.9 (2)	74.82 (5)	74.6 (4)	74.82 (5)	74.82 (5)
			78.8		78.8
					82.6 ^{ab}
87.38 (5)	87.41 (3)	87.42 (3)	87.4 (1)	87.41 (3)	87.41 (3)

1972Dz14	1990ArZZ	2000Ar23	2003Ku44	LWM	Evaluation
94.9 (2)	94.90 (5)	94.90 (3)	94.9 (1)	94.90 (2)	94.90 (2)
96.3 (2)	96.15 (5)	96.15 (5)	96.7 (5)	96.16 (5)	96.16 (5)
99.55 (10)	99.63 (5)	99.71 (6)	99.6	99.67 (5)	99.67 (5)
99.8 (1)	99.91 (5)	100.07 (10)	99.8 (1)	99.89 (6)	99.89 (6)
100.8 (1)	100.96 (5)	100.87 (4)	100.8 (2)	100.86 (4)	100.86 (4)
	103.46 (10)	103.44 (12)	103.6 (2)	103.48 (10)	103.48 (10)
108.4 (1)	108.41 (3)	108.38 (3)	108.4 (1)	108.38 (3)	108.38 (3)
111.5 (1)	111.54 (3)	111.52 (3)	111.5 (1)	111.52 (3)	111.52 (3)
	112.8 (2)	112.8 (2)	112.8	112.8 (2)	112.8 (2)
			114		114
		119.09 (6)			119.09 (6) ^b
119.9 (1)	119.87 (5)	119.84 (3)	119.9 (1)	119.85 (3)	119.85 (3)
		121.06 (7)			121.06 (7)
123.8 (1)	123.75 (5)	123.73 (4)	123.8 (1)	123.75 (4)	123.75 (4)
124.8 (1)	124.82 (5)	124.81 (3)	124.8 (1)	124.81 (3)	124.81 (3)
	126.15 (10)	126.09 (5)	126.2 (2)	126.10 (5)	126.10 (5)
	129.2 (2)	129.22 (7)	129.2 (2)	129.22 (7)	129.22 (7)
	133.64 (5)	133.60 (4)	133.6 (1)	133.60 (3)	133.60 (3)
134.8 (1)	134.86 (5)	134.85 (3)	134.9 (1)	134.85 (3)	134.85 (3)
		137.40 (10)	137.6		137.40 (10)
					138.2 ^{ab}
			139.6		139.6
		144.7 (2)	144.7		144.7 (2)
145.0 (2)	145.17 (5)	145.15 (3)	145.2 (1)	145.15 (3)	145.15 (3)
150.09 (5)	150.04 (2)	150.02 (4)	150.1 (1)	150.05 (3)	150.05 (3)
	152.63 (5)	152.64 (3)	152.6 (2)	152.64 (3)	152.64 (3)
154.0 (1)	153.92 (5)	153.91 (3)	153.9 (1)	153.92 (3)	153.92 (3)
157.25 (5)	157.26 (2)	157.24 (3)	157.3 (2)	157.25 (3)	157.25 (3)
		161.35 (7)			161.35 (7)
	169.1 (2)	169.18 (4)	169.1	169.18 (4)	169.18 (4)
			169.9		169.9
170.6 (1)	170.7 (2)	170.83 (6)	170.7 (2)	170.77 (5)	170.77 (5)
			173.4		173.4
	178.4 (1)	178.29 (3)	178.3 (2)	178.29 (3)	178.29 (3)
	179.8 (2)	179.78 (4)	179.8 (3)	179.78 (4)	179.78 (4)
			183		183
			186.1		186.1
186.1 (1)	186.2 (1)	186.31 (3)	186.3	186.29 (3)	186.29 (3)
			187.2		187.2
188.0 (1)	188.00 (5)	187.95 (3)	188.0 (1)	187.96 (3)	187.96 (3)
			193.2		193.2
195.69 (7)	195.78 (5)	195.74 (3)	195.8 (2)	195.74 (3)	195.74 (3)
		197.50 (3)	197.4		197.50 (3)
	197.7 (1)		197.9		197.7 (1)
198.70 (7)	198.7 (1)	198.23 (8)	198.4 (3)	198.47 (23)	198.47 (23)

Comments on evaluation

1972Dz14	1990ArZZ	2000Ar23	2003Ku44	LWM	Evaluation
		205.12 (11)	204.7 (3)	205.07 (11)	205.07 (11)
	216.90 (5)	216.89 (3)	216.9 (2)	216.89 (3)	216.89 (3)
		220.43 (8)			220.43 (8)
224.56 (7)	224.64 (5)	224.58 (3)	224.7 (1)	224.59 (3)	224.59 (3)
			228.2 (4)		228.2 (4)
	231.3 (2)	231.14 (7)	231.3 (2)	231.16 (7)	231.16 (7)
			236.0 (6)		236.0 (6)
		238.64 (8)			238.64 (8)
	240.8 (1)	240.68 (3)	240.7 (2)	240.68 (3)	240.68 (3)
	243.2 (1)	243.11 (5)	243.2 (2)	243.12 (5)	243.12 (5)
	249.5 (2)	249.60 (3)	249.6 (2)	249.60 (3)	249.60 (3)
253.50 (7)	253.54 (5)	253.45 (3)	253.5 (1)	253.46 (3)	253.46 (3)
		256.0 (2)	256		256.0 (2)
	279.25 (10)	279.18 (3)	279.3 (3)	279.18 (3)	279.18 (3)
	282.1 (2)				282.1 (2)
	284.8 (1)	284.75 (3)	284.8 (3)	284.75 (3)	284.75 (3)
		298.32 (5)	298.6 (3)	298.33 (5)	298.33 (5)
		317.23 (18)	317.4		317.23 (18)
		321.77 (4)	321.8 (4)	321.77 (4)	321.77 (4)
	348.5 (1)	348.33 (4)	348.2 (4)	348.33 (4)	348.33 (4)
	354.8 (2)	354.54 (6)	354.9 (3)	354.56 (6)	354.56 (6)
			356.6		356.6
	362.5 (1)	362.38 (3)	362.2 (4)	362.38 (3)	362.38 (3)
		367.72 (12)	368.3 (6)	367.74 (12)	367.74 (12)
	375.2 (1)	374.98 (5)	375.0 (7)	374.98 (5)	374.98 (5)
		388.07 (7)			388.07 (7)
	403.1 (1)	403.1 (1)	403.4 (3)	403.13 (10)	403.13 (10)
	406.1 (1)	405.95 (3)	406.2 (3)	405.95 (3)	405.95 (3)
	418.1 (1)	417.90 (3)	417.9 (3)	417.90 (2)	417.90 (2)
		429.80 (18)			429.80 (18)
		434.81 (5)	435.0 (3)	434.82 (5)	434.82 (5)
		442.16 (8)			442.16 (8)
		443.43 (10)			443.43 (10)
		446.31 (10)			446.31 (10)
		451.04 (5)	450.1 (7)	451.04 (5)	451.04 (5)
452.4 (1)	452.4 (1)	452.21 (3)	452.4 (2)	452.23 (3)	452.23 (3)
	458.8 (2)	458.79 (8)	458.8 (4)	458.79 (8)	458.79 (8)
	462.4 (4)	462.43 (13)	462.4 (6)	462.43 (13)	462.43 (13)
	469.5 (3)	469.48 (5)	469.5 (3)	469.48 (5)	469.48 (5)
	481.05 (5)	480.84 (3)	481.1 (2)	480.85 (3)	480.85 (3)
		491.42 (10)	492.6 (6)	491.45 (10)	491.45 (10)
	496.9 (3)				496.9 (3)
			498.6 (6)		498.6 (6)
			512.5 (7)		512.5 (7)
	515.40 (5)	515.12 (3)	515.3 (2)	515.13 (3)	515.13 (3)

1972Dz14	1990ArZZ	2000Ar23	2003Ku44	LWM	Evaluation
	517.78 (5)	517.50 (3)	517.9 (2)	517.51 (3)	517.51 (3)
	522.3 (1)	522.14 (4)	522.1 (2)	522.14 (4)	522.14 (4)
	526.09 (5)	525.77 (3)	526.1 (1)	525.94 (17)	525.94 (17)
		527.29 (5)			527.29 (5) ^b
	529.9 (1)	529.59 (3)	529.7 (3)	529.59 (3)	529.59 (3)
	531.3 (1)	530.86 (4)	531.2 (3)	530.87 (4)	530.87 (4)
		532.11 (9)			532.11 (9)
	538.1 (1)				538.1 (1)
			545.8 (6)		545.8 (6)
	552.0 (1)	551.78 (3)	552.0 (2)	551.79 (3)	551.79 (3)
		564.31 (11)	565.6 (7)	564.34 (11)	564.34 (11)
		567.47 (5)	568.3 (6)	567.48 (5)	567.48 (5)
	571.0 (1)	570.68 (3)	571.0 (2)	570.69 (3)	570.69 (3)
		590.41 (5)	591.4 (7)	590.42 (5)	590.42 (5)
	594.2 (1)	593.86 (4)	594.6 (3)	593.87 (4)	593.87 (4)
	601.1 (1)	600.92 (3)	601.0 (3)	600.92 (3)	600.92 (3)
	603.3 (1)	603.09 (4)	603.5 (5)	603.09 (4)	603.09 (4)
		628.93 (10)	629.9 (7)	628.95 (10)	628.95 (10)
			637.1 (7)		637.1 (7)
		645.87 (13)	646.3 (3)	645.94 (12)	645.94 (12)
	649.2 (1)	649.01 (4)	649.5 (2)	649.03 (4)	649.03 (4)
			653.5 (4)		653.5 (4) ^b
		656.18 (11)			656.18 (11)
		657.88 (5)			657.88 (5)
		667.10 (8)	668.1 (4)	667.14 (8)	667.14 (8)
		675.51 (18)	674.3 (4)	674.9 (3)	674.9 (3)
	679.7 (1)	679.35 (6)	680.4 (6)	679.36 (6)	679.36 (6)
		697.54 (13)	698.4 (4)	697.62 (12)	697.62 (12) ^b
		702.00 (14)			702.00 (14)
	747.0 (1)	747.0 (1)	747	747.0 (1)	747.0 (1)
		752.46 (12)			752.46 (12)
	753.7 (3)	754.04 (13)	753.7	754.04 (13)	754.04 (13)
	758.7 (1)				758.7 (1) ^b
		767.6 (4)	768.4 (5)	767.9 (3)	767.9 (3)
			780.6 (6)		780.6 (6)
		808.48 (10)			808.48 (10)
			824.2 (7)		824.2 (7)

a: from 1969Le09. b: not placed in level scheme.

5.2 Relative values of the γ -ray intensities

The results of measurements of the relative γ -ray intensities of ²²⁵Ac are listed in table 7. The recommended values are taken from the LWM average of the measured values of 2000Ar23 and 2003Ku44. The measurements of 1990ArZZ were replaced by 2000Ar23; measurements of 1994Gr20 were replaced by 2003Ku44.

Table 7 Measured and recommended relative γ -ray intensities for ²²⁵Ac

E_γ (keV)	I_γ							Evaluation
	1967Le23	1972Dz14	1990ArZZ	1994Gr20	2000Ar23	2003Ku44	LWM	
10.6								2.17 (28)*
26.0 (1)		~ 0.21	< 1.4		0.23 (3)	0.25 (8)	0.23 (3)	0.23 (3)
36.69 (3)	~ 4.1	~ 2.1	2.19 (27)	2.63 (36)	2.65 (33)	2.58 (27)	2.61 (21)	2.61 (21)
38.58 (4)		1.4	1.64 (14)	1.84 (50)	1.48 (23)	1.57 (16)	1.54 (13)	1.54 (13)
46.24 (5)			0.55 (27)		0.82 (17)	0.65 (11)	0.70 (9)	0.70 (9)
49.12 (4)		0.7	0.96 (27)	1.07 (36)	1.3 (2)	1.10 (13)	1.16 (11)	1.16 (11)
50.2					~ 0.09			~ 0.09
53.4 (4)		2.68 (56)			< 0.58			< 0.58
57.71 (4)		0.7	0.55 (27)	0.71 (36)	0.88 (19)	0.65 (14)	0.73 (11)	0.73 (11)
62.6 (3)					0.77 (17)			0.77 (17)
62.94 (3)	58 (7)	77.5 (70)	56.2 (27)	69.1 (52)	69.5 (87)	71.7 (49)	71.2 (42)	71 (4)
63.5 (3)					3.0 (4)			3.0 (4)
64.27 (3)		8.5 (28)	4.1 (4)	5.4 (5)	6.8 (7)	6.83 (75)	6.8 (5)	6.8 (5)
69.86 (5)		0.7	0.68 (27)	0.89 (36)	0.68 (17)		0.68 (17)	0.68 (17)
71.71 (4)		1.4	1.78 (14)	1.96 (48)	1.87 (20)	2.10 (43)	1.91 (18)	1.91 (18)
73.55 (9)		2.8	1.23 (27)		2.17 (72)	4.2 (12)	2.7 (6)	2.7 (6)
73.85 (3)	55 (10)	45.1 (42)	39.6 (18)	43.0 (34)	46.3 (58)	44.0 (36)	44.6 (31)	44.6 (31)
74.82 (5)		5.6	2.19 (27)		1.88 (43)	3.7 (12)	2.1 (4)	2.1 (4)
78.8				3.0 (13)		1.78 (27)		1.78 (27)
82.6 ^x	21 (5)							21 (5)
87.41 (3)	< 6.8	40.8 (42)	31.9 (15)	40.5 (29)	44.9 (58)	37.7 (29)	39.1 (26)	39.1 (26)
94.90 (2)		22.5 (85)	11.9 (11)	12.5 (14)	18.8 (27)	14.0 (15)	15.1 (13)	15.1 (13)
96.16 (5)	4 (1)	4.2 (14)	3.84 (41)		< 4.3	4.7 (9)		4.7 (9)
99.67 (5)	301 (55)	95.8 (99)	78.1 (41)	243 (2)	197 (27)	117 (12)	110 (7)	110 (7)
99.89 (6)		239 (28)	127.4 (68)		38 (14)	167 (20)	156 (11)	156 (11)
100.86 (4)		7.0	8.8 (14)	10.9 (27)	17.5 (19)	12.5 (12)	13.9 (10)	13.9 (10)
103.48 (10)	~ 1.4		0.55 (27)		0.94 (27)	0.38 (9)	0.44 (9)	0.44 (9)
108.38 (3)	38 (7)	39.4 (42)	31.5 (14)	37.9 (27)	39.1 (43)	36.0 (26)	36.8 (22)	36.8 (22)
111.52 (3)	44 (7)	45.1 (42)	39.9 (18)	48.0 (36)	49.2 (58)	44.0 (32)	45.2 (28)	45.2 (28)
112.8 (2)			0.27 (13)		< 0.43	0.30 (4)		0.30 (4)
114						0.125 (18)		0.125 (18)
119.09 (6) ^x					2.6 (4)			2.6 (4)
119.85 (3)	9.6 (27)	8.5 (14)	9.3 (8)	12.1 (13)	14.0 (14)	11.0 (7)	11.6 (6)	11.6 (6)
121.06 (7)					2.5 (7)			2.5 (7)
123.75 (4)		26.8 (28)	9.0 (8)	10.9 (14)	14.2 (14)	12.0 (9)	12.6 (8)	12.6 (8)
124.81 (3)	29 (7)	7.0 (14)	3.3 (3)	4.6 (9)	4.6 (4)	4.0 (3)	4.22 (24)	4.22 (24)

E_γ (keV)	I_γ							
	1967Le23	1972Dz14	1990ArZZ	1994Gr20	2000Ar23	2003Ku44	LWM	Evaluation
126.10 (5)			0.96 (27)		1.06 (20)	1.17 (12)	1.14 (10)	1.14 (10)
129.22 (7)			0.41 (14)		0.48 (16)	0.37 (7)	0.39 (7)	0.39 (7)
133.60 (3)			1.78 (27)	2.7 (4)	13.9 (27)	2.83 (22)		2.83 (22)
134.85 (3)	5.5 (27)	5.6 (14)	3.84 (41)	5.0 (5)	4.8 (7)	4.5 (4)	4.6 (4)	4.6 (4)
137.40 (10)					0.43 (19)	0.32 (4)	0.33 (4)	0.33 (4)
138.2 ^x	2.7 (14)							2.7 (14)
139.6						0.20 (3)		0.20 (3)
144.7 (2)	21 (4)				~ 0.07	0.067 (17)		0.067 (17)
145.15 (3)		18.3 (42)	18.4 (8)	21.8 (18)	21.4 (22)	21.0 (15)	21.1 (12)	21.1 (12)
150.05 (3)	100	100	100	100	100	100	100	100
152.64 (3)			2.2 (3)	2.7 (4)	2.39 (27)	3.17 (23)	2.84 (18)	2.84 (18)
153.92 (3)	23 (4)	26.8 (70)	23.6 (11)	27.7 (30)	28.2 (29)	30.3 (21)	29.6 (17)	29.6 (17)
157.25 (3)	51 (10)	43.7 (42)	45.2 (27)	55.4 (5)	50.7 (58)	53.3 (43)	52.4 (35)	52.4 (35)
161.35 (7)					0.52 (13)			0.52 (13)
169.18 (4)			2.33 (27)	2.86 (36)	2.29 (27)	1.17 (18)	1.7 (6)	1.7 (6)
169.9						2.0 (2)		2.0 (2)
170.77 (5)	5.5 (28)	1.4	0.96 (41)		1.06 (19)	2.83 (22)	1.9 (9)	1.9 (9)
173.4 ^x						1.67 (19)		1.67 (19)
178.29 (3)	2.7 (14)		1.78 (14)		2.32 (26)	2.33 (20)	2.33 (16)	2.33 (16)
179.78 (4)			0.96 (27)	1.25 (36)	1.53 (19)	1.57 (13)	1.56 (11)	1.56 (11)
183 ^x						1.22 (19)		1.22 (19)
186.1						1.83 (19)		1.83 (19)
186.29 (3)		2.8	2.47 (55)		2.74 (30)	0.60 (6)		0.60 (6) ^b
187.2						1.48 (9)		1.48 (9)
187.96 (3)	81 (8)	64.8 (70)	67.8 (34)	78.6 (5)	78.1 (87)	75 (5)	75.8 (44)	76 (4)
193.2 ^x						0.28 (5)		0.28 (5)
195.74 (3)	19 (4)	19.7 (28)	20.5 (14)	25.2 (13)	23.4 (23)	20.5 (14)	21.3 (12)	21.3 (12)
197.50 (3)				3.6 (7)		3.83 (39)		3.8 (4) ^b
197.7 (1)			7.53 (68)	4.1 (9)	7.8 (10)	5.5 (6)		5.5 (6) ^b
198.47 (23)	4.1 (12)	2.8	3.01 (68)	3.8 (9)	2.55 (26)	2.83 (22)	2.71 (17)	2.71 (17)
205.07 (11)					0.27 (10)	0.18 (7)	0.21 (6)	0.21 (6)
216.89 (3)	47 (14)		39.7 (82)	53 (10)	47.8 (43)	45.2 (33)	46.2 (27)	46.2 (27)
220.43 (8)					0.87 (26)			0.87 (26)
224.59 (3)	15 (4)	11.3 (14)	12.1 (12)	14.8 (14)	15.6 (17)	16.3 (12)	16.1 (10)	16.1 (10)
228.2 (4)						0.67 (17)		0.67 (17)
231.16 (7)			0.27 (13)		0.30 (7)	1.10 (12)	0.7 (4)	0.7 (4)
236.0 (6)						0.25 (4)		0.25 (4)
238.64 (8)					0.14 (4)			0.14 (4)
240.68 (3)	2.7 (13)		0.96 (27)		1.71 (19)	1.67 (19)	1.69 (14)	1.69 (14)
243.12 (5)			0.16 (7)		0.39 (7)	0.50 (6)	0.45 (5)	0.45 (5)
249.60 (3)	2.7 (13)		1.51 (68)		1.9 (2)	2.0 (2)	1.95 (14)	1.95 (14)
253.46 (3)	21 (5)	14.1 (14)	15.5 (7)	18.4 (9)	18.5 (19)	19.3 (14)	19.0 (11)	19.0 (11)
256.0 (2)					0.05 (1)	0.100 (34)	0.054 (10)	0.054 (10)
279.18 (3)	4.1 (12)		2.33 (27)		4.63 (43)	4.17 (39)	4.4 (3)	4.4 (3)

E_γ (keV)	I_γ							Evaluation
	1967Le23	1972Dz14	1990ArZZ	1994Gr20	2000Ar23	2003Ku44	LWM	
282.1 (2)			0.55 (27)					0.079 (6)*
284.75 (3)	~ 1.4		0.55 (27)	0.71 (36)	1.09 (13)	1.05 (10)	1.07 (8)	1.07 (8)
298.33 (5)					0.29 (4)	0.30 (9)	0.29 (4)	0.29 (4) ^c
317.23 (18)					0.06 (3)	> 0.018		0.06 (3) ^c
321.77 (4)					0.46 (7)	0.50 (7)	0.48 (5)	0.48 (5) ^c
348.33 (4)			0.41 (14)		0.46 (7)	0.42 (5)	0.43 (4)	0.43 (4)
354.56 (6)			0.21 (5)	0.25 (7)	0.19 (3)	0.38 (5)	0.29 (10)	0.29 (10)
356.6						0.037 (15)		0.037 (15)
362.38 (3)			0.82 (27)		0.9 (1)	0.70 (8)	0.78 (6)	0.78 (6)
367.74 (12)					0.05 (3)	0.10 (3)	0.075 (25)	0.075 (25)
374.98 (5)			0.41 (14)		0.027 (4)	0.28 (7)		0.28 (7)
388.07 (7)					0.18 (3)			0.18 (3)
403.13 (10)			0.18 (5)		< 0.29	0.027 (23)		0.027 (23)
405.95 (3)			0.96 (27)		1.14 (13)	1.12 (9)	1.13 (7)	1.13 (7)
417.90 (2)			0.68 (14)		0.82 (10)	0.80 (8)	0.81 (6)	0.81 (6)
429.80 (18)					0.055 (27)			0.055 (27)
434.82 (5)					0.46 (7)	0.40 (5)	0.42 (4)	0.42 (4)
442.16 (8)					0.65 (10)			0.65 (10)
443.43 (10)					~ 0.014			~ 0.014 ^d
443.43 (10)					0.20 (7)			0.20 (7) ^d
446.31 (10)					0.09 (5)			0.09 (5)
451.04 (5)					0.41 (7)	0.53 (14)	0.43 (6)	0.43 (6)
452.23 (3)	15 (5)	15.5 (14)	14.8 (12)		17.1 (19)	14.8 (11)	15.4 (10)	15.4 (10)
458.79 (8)			0.68 (27)		0.07 (2)	0.097 (37)	0.076 (18)	0.076 (18)
462.43 (13)			2.2 (11)		0.055 (16)	0.125 (45)	0.063 (15)	0.063 (15)
469.48 (5)			0.55 (14)		0.26 (10)	0.47 (6)	0.41 (5)	0.41 (5)
480.85 (3)	4.1 (12)		4.1 (4)		4.9 (6)	4.83 (41)	4.85 (34)	4.9 (3)
491.45 (10)					0.06 (2)	0.037 (23)	0.05 (2)	0.05 (2)
496.9 (3)			0.21 (10)					0.21 (10)
498.6 (6)						0.12 (3)		0.12 (3)
512.5 (7)						0.08 (3)		0.08 (3)
515.13 (3)	~ 1.4		2.47 (27)		2.95 (30)	3.17 (23)	3.09 (18)	3.09 (18)
517.51 (3)			1.78 (27)		2.1 (2)	2.5 (2)	2.30 (14)	2.30 (14)
522.14 (4)			0.21 (5)		0.30 (3)	0.30 (5)	0.30 (2)	0.30 (2)
525.94 (17)	~ 1.4		3.97 (41)		4.63 (43)	5.50 (43)	5.1 (3)	5.1 (3)
527.29 (5) ^x					0.27 (4)			0.27 (4)
529.59 (3)			0.82 (41)		1.01 (12)	1.18 (13)	1.09 (9)	1.09 (9)
530.87 (4)			0.55 (14)		0.68 (9)	0.67 (9)	0.68 (6)	0.68 (6)
532.11 (9)					0.11 (3)			0.11 (3)
538.1 (1)			0.55 (14)					0.55 (14)
545.8 (6)						0.077 (20)		0.077 (20)
551.79 (3)			0.55 (14)		0.56 (7)	0.93 (8)	0.75 (19)	0.75 (19)
564.34 (11)					~ 0.014	0.032 (13)		0.032 (13)
567.48 (5)					0.13 (2)	0.22 (5)	0.18 (5)	0.18 (5)

E_γ (keV)	I_γ							
	1967Le23	1972Dz14	1990ArZZ	1994Gr20	2000Ar23	2003Ku44	LWM	Evaluation
570.69 (3)			0.55 (14)		0.59 (7)	0.53 (9)	0.57 (6)	0.57 (6)
590.42 (5)					0.12 (2)	0.12 (3)	0.12 (2)	0.12 (2)
593.87 (4)			0.22 (11)		0.41 (4)	0.47 (10)	0.42 (4)	0.42 (4)
600.92 (3)			0.47 (14)		0.35 (6)	0.62 (15)		0.35 (6) ^{ad}
600.92 (3)					~ 0.87			~ 0.87 ^{ad}
603.09 (4)			0.27 (13)		0.25 (3)	0.27 (7)	0.25 (3)	0.25 (3)
628.95 (10)					0.049 (13)	0.043 (14)	0.046 (10)	0.046 (10)
637.1 (7)						~ 0.017		~ 0.017
645.94 (12)					0.032 (10)	0.017 (7)	0.022 (6)	0.022 (6)
649.03 (4)			0.18 (5)		0.27 (3)	0.20 (5)	0.25 (3)	0.25 (3)
653.5 (4) ^x						0.025 (7)		0.025 (7)
656.18 (11)					0.07 (3)			0.07 (3)
657.88 (5)					0.20 (4)			0.20 (4)
667.14 (8)					0.56 (13)	0.040 (12)	0.30 (26)	0.30 (26)
674.9 (3)					0.019 (9)	0.012 (7)	0.015 (6)	0.015 (6)
679.36 (6)			0.11 (3)		0.09 (2)	0.102 (26)	0.095 (16)	0.095 (16) ^c
697.62 (12) ^x					0.035 (13)	0.028 (8)	0.030 (7)	0.030 (7)
702.00 (14)					0.023 (10)			0.023 (10)
747.0 (1)			0.16 (5)		< 0.29	< 0.017		0.16 (5)
752.46 (12)					0.038 (10)			0.038 (10)
754.04 (13)			0.11 (3)		0.033 (10)	< 0.017		0.033 (10)
758.7 (1) ^x			0.68 (14)					0.68 (14)
767.9 (3)					0.049 (13)	0.040 (12)	0.044 (9)	0.044 (9)
780.6 (6)						0.008 (2)		0.008 (2)
808.48 (10)					0.30 (4)			0.30 (4)
824.2 (7)						~ 0.007		~ 0.007

a: From 2000Ar23.

b: From 2003Ku44.

c: Multiply placed, intensity not divided.

d: Multiply placed, intensity suitable divided.

*: From intensity balance.

x: Not placed in level scheme.

5.3 Absolute values of the γ -ray emission probabilities

Measured absolute γ -ray emission probabilities for the 150.04 keV line for ²²⁵Ac are compiled and listed in Table 8.

2000Ar23 gives the value 0.691 (16) %, which was obtained from correction of the intensity of 1986He06 using the measured value 0.053 (6) % (2000Ga52) for the 149.89 keV transition in ²²⁹Th α -decay and the measured value 0.051 (10) % (1995Sh01) for the 150.14 keV transition in ²²¹Fr α -decay.

Conversely, to correct the measured intensity of 1986He06, if using the measured value 0.053 (6) % (2000Ga52) for the 149.89 keV transition in ²²⁹Th α -decay and the evaluated value 0.0478 (23) % (1990Ak05) for the 150.14 keV transition in ²²¹Fr α decay, the value would be then 0.695 (13) %. These corrected values are in good agreement with the measured value in 1995Ch74.

The recommended absolute γ -ray emission probability of the 150.04 keV γ -ray is from the measurement of 1995Ch74 and adopted as the normalization factor N, with $N = 0.00693$ (12). The recommended absolute γ -ray emission probabilities are the relative values evaluated in table 7 multiplied by 0.00693 (12).

Table 8 Measured and recommended absolute γ -ray emission probability of 150.04 keV for ^{225}Ac

P_γ (150.04 keV) (%)	References	measurement method
0.981 (3)	1981Di14	Ge(Li)
0.796 (11)	1986He06	Ge(Li), Au-Si surface barrier, in equilibrium with ^{229}Th
0.693 (12)	1995Ch74	Ge(Li), $\alpha\gamma$ -coincidence
0.691 (16)	2000Ar23	From 1986He06 corrected by 2000Ga52 and 1995Sh01
0.693 (12)		Recommended value from 1995Ch74

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