^{243}Am - Comments on evaluation of decay data
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This evaluation was completed in September 2004 and reviewed in 2009. The literature available by April 2009 was included. Half-life and conversion coefficients have been updated.

Several measurements of the α emission intensities were carried out and, their results are in good agreement. However, the available experimental γ-ray emission intensities are mostly imprecise and in poor agreement with each other.
The decay scheme overall consistency is supported by the agreement between Q(eff)=5439.6 (40) keV, deduced from average radiation energies and intensities, and Q(β^-)=5438.8 (10) keV, from the atomic mass adjustment (2003Au03).

Evaluation Procedures

The *Limitation of Relative Statistical Weight* (LWM) [1985ZiZY] method, used for averaging numbers throughout this evaluation, provided a uniform approach for the analysis of discrepant data. The uncertainty assigned in this evaluation to the recommended value is always greater than or equal to the smallest uncertainty in any of the experimental values used in the calculation.

1 Decay Scheme

^{243}Am decays 100 % by emission of α particles, with a minute branch of 3.8 (7) $\times 10^{-9}$ % (2002Sa53) by spontaneous fission. Other value: 3.7 (9) $\times 10^{-9}$ % (1966Gv01). The α-particle intensities (in percent) to individual levels presented in the decay scheme are experimental values from α-spectroscopic measurements. α-hindrance factors given in the decay scheme have been calculated by using a radius parameter r_0 (^{239}Np) = 1.505, average of r_0 (^{238}U) = 1.5143 (9), r_0 (^{240}U) = 1.5062 (10), r_0 (^{238}Pu) = 1.5013 (10), and r_0 (^{240}Pu) = 1.4979 (7) (1998Ak04). The level energies, spins, parities, as well as γ-ray multipolarities shown in the decay scheme are recommended values from the evaluation 2003Br12.

Levels at 71- and 122 keV are based on α-γ coincidence experiments with γ rays (169-, 50.6-, and 195 keV) that feed such levels. The de-excitations of these two levels, however, have not been observed. The expected γ rays may have been masked by more intense ones, which de-excite other levels.

2 Nuclear Data

The recommended half-life of ^{243}Am is 7367 *a*, a weighted average of the values given in Table 1, the most accurate value (from 2007Ag02) contributes 54 % to the statistical weight. The calculated internal uncertainty is 17 *a*. However, the recommended uncertainty is the smallest uncertainty in the input values, i.e., 23 *a*. This half-life compares well with other recommended values such as 7370 (40) *a* (1992Ak06), 7366 (20) *a* (1991BaZS), and 7370 (15) *a* (1986LoZT).

Q_α= 5438.8 (10) keV is from the atomic mass adjustment 2003Au03.

Table 1. ^{243}Am measured half-life values

Reference	Method	$T_{1/2}(^{243}Am)/T_{1/2}(^{241}Am)$	$T_{1/2}(^{243}Am)$ (*a*)	u_c	Remarks
1959Ba22	Relative activity	16.85 (35)	7289.3 *	151.7	
1960Be10	Relative activity	16.70 (10)	7224.4 *	100.0	An uncertainty of 1.4% (100 *a*) from 1960Be10 is mostly systematic. Thus, dividing this value by the square root of the number of measurements (5) is questionable and was not done in the evaluation of 1986LOZT. Omitted from analysis.
1968Br22	Relative activity	16.96 (13)	7336.9 *	57.2	
	Specific activity		7390	50	
1974Po17			7380	34	This value is the weighted mean result from specific $T_{1/2}(^{243}Am)$ determination and from measurements relative to $T_{1/2}(^{241}Am)$
1980Ag05	Relative activity	17.010 (95)	7359 *	42	Superseded by 2007Ag02
2007Ag02	Relative activity	17.022 (27)	7363.7 *	23	
	LWM		7367	17	χ^2 /n-1 = 0.2 , χ^2 crit = 3.3, int. uc = 17
		Recommended value	7367 (23)		Weighted average. Some results depend on the $T_{1/2}(^{241}Am)$ and then are not independent so the uncertainty is the minimum value from input.

* Relative to $T_{1/2}(^{241}Am)$=432.6 (6) *a* (Chechev in 2004BeZQ).

3 Atomic Data

X-ray and Auger (relative and absolute) electron emission probabilities given in Sections 3 and 5, respectively, have been calculated by means of the computer code EMISSION (version 3,01, Nov. 3, 1999) [1], which makes use of the atomic data from 1996Sc06, from reference [2], and from the evaluated γ-ray data given in Sections 2.1 and 4.2. In addition, internal conversion electron energies and absolute emission probabilities for the strongest lines are presented in Section 5. Electron energies have been calculated using electron binding energies from 1977La19, and γ-ray energies from Section 2.1. Absolute electron emission probabilities have been calculated using absolute γ-ray emission probabilities given in Section 4.2 and conversion coefficients from Section 2.1.

4 Alpha Particles

a-Particle Energies

Most of the recommended α-particle energies in this evaluation are weighted averages (*Limited Relative Statistical Weight* method, LWM) of values from 1964Ba26 and 1968Ba25 (magnetic spectrograph), and from 1996Sa24 and 2002Da21 (semiconductor detectors). Values reported by 2002Da21 are from the analysis of an α-particle spectrum measured by 1992Ga01.

A. Rytz (1991Ry01) has critically evaluated the α-particle groups at 5233, 5275, and 5379 keV. His energies, also recommended in this evaluation, are virtually the same as the weighted average energies given in Table 2. This table shows the results of various measurements as well as the values recommended in this evaluation.

Table 2. ^{243}Am Alpha-Particle Energies

1964Ba26	1968Ba25	1996Sa24	2002Da21$^{\&}$	W. Average	Rec. Values
4695 (3)			[4697]#		4695 (3)
4919 (3)					4919 (3)
4930 (3)			[4936]#		4930 (3)
4946 (3)			[4951]#		4946 (3)
4997 (3)			[5001]#		4997 (3)
5008 (3)		5002(5)	5012 (5)	5008 (3)	5008 (3)
5029 (3)		5030 (5)		5029 (3)	5029 (3)
5035 (3)			5037 (5)	5035 (3)	5035 (3)
5088 (3)		5083 (5)	5091 (5)	5088 (5)	5088 (5)
5113 (1)		5109 (5)	5113 (5)	5113 (1)	5113 (1)
5181 (1)		5177 (5)	5178 (5)	5181 (1)	5181 (1)
5234 (1)	5232.9 (10)	5232 (5)	5233 (5)	5233.4 (10)	5233.3 (10)*
5276 (1)	5274.8 (10)	5275 (5)	5275 (5)	5275.3 (10)	5275.3 (10)*
5321 (1)		5319 (5)	5318 (5)	5321 (1)	5321 (1)
5350 (1)		5350 (5)	5349 (5)	5350 (1)	5349.4 (23)*

2002Da21 did not measure the alpha spectrum of 243Am. The alpha spectrum used was from 1992Ga01, who had not identified these very weak peaks. 2002Da21 reported for these peaks, intensities ranging from 2 to 13 times those given by 1964Ba26. Evaluators have interpreted this discrepancy as possibly caused by *spurious peaks* produced in the spectral peak-shape analysis of 2002Da21. Thus, they did not use these α-particle energies in the averaging process.

* From 1991Ry01.

& Rounded values. Uncertainties assigned by evaluators are typical values for spectra measured with semiconductor detectors.

α-Particle Emission Intensities

Table 3 shows the emission intensities measured by various authors. The uncertainties given by all of them (except one, 1996Sa24) are statistical values deduced from spectral peak-shape analysis. Such uncertainties do not include a constraint imposed by normalizing the sum of the emission probabilities to 100, that is, to absolute emission intensities (p_i(%)) per 100 α-particle disintegrations of the parent nuclide. The following formula (1988Br07) may be used to convert uncertainties (dI_i) in relative α-particle emission intensities (I_i) to values in the absolute emission intensities (dp_i(%)):

$$dp_i(\%)/p_i(\%) = [\ (dI_i/I_i)^2\,(1 - 2\ I_i/\Sigma I_k) + \Sigma dI_k^{\,2}/(\Sigma I_k)^2\ ]^{1/2} \qquad (1)$$

The uncertainties given by 1996Sa24 (see Table 3) are those in the absolute α-emission intensities (dp_i(%)), whereas the other authors give uncertainties only in the relative α-emission intensities (dI_i). This situation significantly affects only the two most intense α-particle groups for which 1996Sa24 give the same uncertainty of 0.03.

The energies and absolute emission intensities recommended in this evaluation are given in Section 2.2. The following description shows the procedure used here for determining these recommended absolute emission intensities:

1. Changing the uncertainty in the 5275-keV α-particle group before averaging from its absolute value of dp (%) = 0.03 (1996Sa24) to a relative value (estimated by evaluators) of dI = 0.06.

2. Averaging (i.e., weighted averages, LWM) the relative emission intensities given by various authors (1955St98, 1956Hu96, 1964Ba26, 1966Le13, 1992Ga01, 1996Sa24, 2002Da21) and depicted in Table 3. Relative emission probabilities from 1998Ya17 (also shown in Table 3) are in disagreement with those from these authors, thus significantly increasing χ^2/ν for most averages. Their uncertainties include a "non-statistical component." Unfortunately, 1998Ya17 give neither their values for these components nor the criteria used for estimating them. Therefore, data from 1998Ya17 have not been used for averaging.

3. Converting uncertainties in the recommended emission intensities (Table 3, column 9) to uncertainties in the absolute α-particle emission intensities by using formula (1). It should be noticed that only the uncertainties in the two most intense α-particle groups have been affected by this procedure.

Table 3. ^{243}Am Alpha particle emission intensities

Eα(keV)	1955St98	1956Hu96	1964Ba26	1966Le13	1992Ga01	1998Ya17	1996Sa24##	2002Da21$	Iα(avg)&&	χ^2/ν	Rec. Iα &&&
4695			0.0006	0.0017 (5)***				0.0038 (4)^^			0.0017 (5)
4919			0.000085								0.000085
4930			0.00018					0.0026 (3)^^			0.00018
4946			0.00034					0.0028 (3)^^			0.00034
4997			0.0016#		0.0016 (5)#		0.0020 (4)#	0.0031 (4)^^	0.0018 (3)	0.39	0.0018 (4)#
5008								0.0052 (4)^^			
5029			0.0022^		0.0033 (5)^		0.0044 (5)^	0.0082 (5)^^	0.0039 (4)	2.4	0.0039 (6)^
5035											
5088			0.004		0.0056 (7)		0.0055 (6)	0.0112 (6)^^	0.0055 (5)	0.01	0.0055 (6)
5113			0.0054		0.010 (1)		0.0101 (10)	0.019 (1)^^	0.0100 (7)	0	0.010 (1)
5181	1.1 (3)&	1.3 (2)	1.1		1.36 (1)	0.98 (2)	1.388 (8)	1.391 (7)	1.383 (5)	2.0	1.383 (7)
5233	11.5 (3)*	11.5 (3)	10.6 (2)**		11.46 (3)	11.04 (7)	11.37 (3)	11.52 (2)	11.46 (6)	7.1	11.46 (5)$$
5275	87.1 (4)*	86.9 (4)	87.9 (3)**		86.74 (6)	87.42 (8)	86.79 (3)	86.60 (7)	86.74 (4)	4.1	86.74 (5)$$
5321	0.16	0.16	0.12		0.190 (7)	0.270 (6)	0.194 (3)	0.190 (3)	0.192 (2)	0.48	0.192 (3)
5349	0.17	0.17	0.16		0.230 (7)	0.298 (8)	0.243 (3)	0.240 (3)	0.240 (2)	1.5	0.240 (3)

$ 2002Da21 analyzed an α spectrum of 1992Ga01.

& Uncertainty assumed by evaluator.

* From 1955St98, quoted in 1991Ry01; uncertainties are from 1991Ry01.

4997α + 5008α

^ 5029α + 5035α

** From 1964Ba26, quoted in 1991Ry01; uncertainties are from 1991Ry01.

Uncertainties include the effect of covariances when normalizing ΣIα = 100.

^^ α-particle intensities are at least about twice those found by other authors, which suggest a possible systematic bias in the analysis of the spectrum. These values were not used for averaging.

*** Agrees well with Iα=0.00148 3% from γ-ray transition intensity balance.

&& Weighted average using the Limitation of Relative Statistical Weights method. Data from 1998Ya17 have not been included. See text.

$$ Normalization of Iα to ΣIa=100 requires same values for these uncertainties. See text.

&&& Uncertainty is always greater than or equal to the smallest uncertainty in any of the experimental values used in the calculation

5 Gamma Rays

Energies

The recommended γ-ray energies given in Sections 2.1 and 4.2 are weighted averages (LWM) of values given in 1982Ah04 and 1975Pa04, complemented with values from 1996Sa23, 1969En02, and 1968Va09 (See table 4).

Table 4. ^{243}Am Gamma-ray Energies							
E_g (keV)	**E_g (keV)**	**E_g (keV)**	**E_g (keV)**	**E_g (keV)**	**E_g (keV)**		**E_g (keV)**
1996Sa23	1982Ah04	1975Pa04	1969En02	1968Va09	**W. Avg.***	c**2/**n	**Rec. E**g
31.13	31.14 (3)	31.10 (15)		31.2	31.14 (3)	0.068	31.14 (3)
		43.1	43.1				43.1#
43.53	43.53 (2)	43.53 (15)		43.6	43.53 (2)		43.53 (2)
50.6				50.6			50.6&$
55.18			55.4	55.4			55.18&
74.66	74.66 (2)	74.67 (15)	74.7	74.8	74.66 (2)	0.004	74.66 (2)
86.71	86.71 (2)	86.79 (15)	86.7	86.7	86.71 (2)	0.27	86.71 (2)
98.5			98.5				98.5^
117.84		117.60 (15)	117.8	117.8			117.60 (15)#
141.89	141.89 (3)	142.18 (15)	142	142	141.90 (3)	3.6	141.90 (6)
169				169			169$
195				195			195$
* Weighted average of values in 1982Ah04 and 1975Pa04.							
# From 1975Pa04							
& From 1996Sa23							
$ From 1968Va09							
^ From 1969En02							

The recommended absolute γ-ray emission (photons) and transition (photons + electrons) intensities given in Sections 4.2 and 2.2, respectively, are weighted averages (LWM) of values in 1996Sa23, 1996Wo05, 1984Va41, 1982Ah04, 1979Po20, 1977St35, 1975Pa04, 1972Ah02, 1969Al14 and 1960As02 (see Table 5).

The conversion coefficients used for deducing absolute transition probabilities (see section 2.2) are theoretical values interpolated from the Band's tables (2002Ba85) by using the computer code BrIcc (2008Ki07) with the so called "Frozen orbital" approximation.

The M1/E2 mixing ratio for $\gamma_{3,0}$ (31,1 keV) $\delta = 0{,}17$ was deduced from probability balance in ^{243}Am α- decay and in ^{239}U β^- -decay

The M1/E2 mixing ratios for $\gamma_{4,3}$ (43,1 keV) $\delta = 0{,}38\ (4)$ and $\gamma_{6,4}$ (55,2 keV) $\delta = 0{,}75\ (10)$ have been taken from Engelkemeir (1969En02).
The remaining M1/E2 mixing ratios are from 2003Br12 based on measurements of 1957Ho07, 1964Bl11, 1969En02.

Table 5. ^{243}Am γ-ray Absolute Emission Probabilities

E_γ (keV) Rec. Value*	I_γ 1960As02	I_γ@ 1968Va09	I_γ 1969Al14	I_γ 1972Ah02	I_γ 1975Pa04	I_γ 1977St35	I_γ 1979Po20	I_γ 1982Ah04	I_γ 1984Va41	I_γ 1996Wo05	I_γ 1996Sa23	W. Avg.	χ^2/n	I_γ [a] Rec. Value
31.14 (3)								0.069 (7)			0.0477 (13)	0.0484 (13)	9	0.048 (4)
43.1		0.03												0.065^
43.53 (2)	4 (1)	5.3	5 (1)	5.5 (3)			5.3 (12)	6.20 (30)	6.04 (13)	5.93 (10)	5.72 (17)	5.89 (7)	1.4	5.89 (10)
50.6		0.0027									0.0062 (10)			0.0062 (10)#
55.18		0.0094									0.0168 (11)			0.0168 (11)#
74.66 (2)	69 (3)	61		66 (3)		59.1 (40)	60 (4)	68.0 (20)	68.5 (15)	66.7 (12)	68.4 (13)	67.2 (7)	1.4	67.2 (12)
86.71 (2)		0.37						0.340 (15)	0.35 (1)	0.342 (15)	0.344 (9)	0.346 (6)	0.2	0.346 (9)
98.5											0.0151 (21)			0.0151 (21)#
117.60 (15)		0.75			0.56 (8)						0.57 (5)			0.57 (5)#
141.90 (6)		0.13						0.128 (6)	0.13 (1)	0.117 (5)	0.1068 (26)	0.115 (2)	3.8	0.115 (8)
169		0.0012												0.0012&
195		0.00085												0.00085&

a Recommended absolute emission probabilities are weighted averages (LWM) of experimental values, unless otherwise noted.
Uncertainty is always greater than or equal to the smallest uncertainty in any of the experimental values used in the calculation.

***** From Table 4

From 1996Sa23

& From 1968Va09

^ Estimated by 2003Br12 from α_M (43.1γ, exp.) = 31, I_M (ce, 43.1γ) / Iγ(117) = 3.56 (1969En02), and Iγ(117) = 0.57.

@ Uncertainties are at least 10%.

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