^{215}Po -Comments on evaluation of decay data
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This evaluation was done in November 2010 with a literature cut-off by the same date.

1. DECAY SCHEME

^{215}Po decays 100 % to levels of ^{211}Pb by emission of α particles and 2.3 (2) × 10^{-4} % to ^{215}At by emission of β^- particles. The structure of the adopted scheme of ^{215}Po decay is based on the experiment of 1998Li53 and the evaluation by E. Browne (2004Br45). The existence of the alpha-particle group with energy of 6950 keV, reported in 1962Wa18, 1971Gr17, was not confirmed in 1998Li53 and the relevant ^{211}Pb level of 447 keV was omitted in this evaluation. Similarly, the questionable ^{211}Pb level of 762 keV, determined by the alpha-particle group with energy of 6636 keV and intensity of ~ 3 × 10^{-4} %, has not been adopted.

The decay scheme of ^{215}Po is not completed as only approximate information is available for weak gamma transitions following α decay, their gamma-ray emission probabilities and multipolarities have not been determined, and, in fact, the ^{211}Pb levels were deduced only from measurements of alpha-particle groups. In respect of ^{215}Po β^- decay, the β^- - spectrum has not been measured and a fine structure of β^- decay is unknown.

The current evaluated data are supported by the agreement between Q(calculated) = 7526.2 (22) keV, deduced from the calculated average energies of all emissions, and Q(α) = 7526.3 (8) keV, adopted from 2003Au03. Percentage deviation of Q(calculated) from the Q(α) of Audi *et al*. (2003Au03) is (0.0 ± 0.3) %.

2. NUCLEAR DATA

Q(α) and Q(β^-) values are from Audi et al. (2003Au03).

The ^{215}Po half-life is based on the experimental results given in Table 1.

Table 1. Experimental values of ^{215}Po half-life

Reference	Author(s)	Half-life (ms)	Method
1942Wa04	Ward	1.83 (4)	Observations with a single Geiger counter
1961Vo06	Volkov et al.	1.778 (5)	Measurements with ionization alpha-spectrometer equipped by time analyzer
1971Er02	Erlik et al.	1.785 (10)	Time interval analyzer method
1971Er02	Erlik et al.	1.784 (8)	Multichannel delay coincidence method

The set of the four experimental values is consistent. The weighted average for this data set is 1.781 with the internal uncertainty of 0.0039 and an external uncertainty of 0.0033 ($\chi^2/\nu = 0.72$).

The recommended value of the **^{215}Po half-life** is **1.781 (4) ms**.

β^- branching of 2.3 (2) × 10^{-4} % was adopted from the measurement of 1950Av61. With this value the α branching is obtained to be 99.999 77 (2) %.

2.1. Alpha Transitions

The alpha transition energies have been obtained from the Q(α) value and ^{211}Pb level energies given in Table 2 from 2004Br45. The uncertainties in the energies of levels 2 - 7 have been adopted ± 3 keV taking into account the average discrepancy of experimental and calculated alpha-particle energies (Table 3) and as provided by uncertainties of gamma ray energies from 1998Li53 ≥ 1.0 keV for all γ rays, except for γ438.9 keV.

Table 2. ^{211}Pb levels populated in ^{215}Po α-decay

Level	Energy (keV)	Spin and parity	Half-life	Probability of α- transition (%)
0	0.0	9/2+	36.1(4) min	99.934 (20)
1	438.9 (2)	(7/2)+		0.06 (2)
2	584 (3)			4 (2) × 10^{-4}
3	598 (3)	(5/2+)		1.6 (5) × 10^{-3}
4	643 (3)	11/2+		8 (3) × 10^{-4}
5	733 (3)	(13/2+)		8 (3) × 10^{-4}
6	815 (3)	(9/2+)		2.0 (6) × 10^{-3}
7	894 (3)	(11/2+)		3 × 10^{-4}

The alpha transitions in ^{215}Po decay were observed in a number of works by study of an ^{223}Ra alpha emitting source (1962Wa18, 1965Va10, 1970Da09, 1998Li53). In 1962Wa18 the ^{215}Po alpha spectrum was measured with magnetic spectrometer. In 1965Va10 the coincidence of $\gamma_{1,0}$ (438.9 keV)-gamma ray with $\alpha_{0,1}$ (6.95 MeV) was observed. In 1970Da09 the alpha transition probability (P(α)) was measured for $\alpha_{0,1}$ (6.95 MeV)-transition. Most accurate and detailed data were obtained by 1998Li53 with use of α–γ coincidences. These measurement results have been adopted for the recommended P(α) and compared in Table 3 with other available poor experimental data.

Table 3. Experimental ^{215}Po alpha transition probability values (P(α))

α-particle energy (keV)	1962Wa18	1970Da09	1998Li53
7386	100		99.93
6955	≈ 0.056	≈ 0.1	0.06 (2)
6813			4 (2) × 10^{-4}
6799			1.6 (5) × 10^{-3}
6755			8 (3) × 10^{-4}
6667			8 (3) × 10^{-4}
6586			2.0 (6) × 10^{-3}
6509			~ 3 × 10^{-4}

The accurate $P(\alpha_{0,0})$ value has been deduced from $\Sigma P(\alpha_{0,i}) = 99.999\ 77\ (2)$ %, (i = 0, 1,...7) and, the individual adopted $P(\alpha_{0,i})$, (i = 1 – 7).

The α decay hindrance factors were calculated using the ALPHAD computer program from the ENSDF evaluation package with r_0 (^{211}Pb) = 1.5393 fm (2004Br45).

2.2. Gamma Transitions and Internal Conversion Coefficients

Information on the gamma-ray transition probabilities and the gamma-ray multipolarities is not available, except for γ438.9 keV (1968Br17, 1970Da09, 1998Li53, see §6.2.2). The gamma-ray transition probability $P_{\gamma+ce}$ ($\gamma_{1,0}$ - 438.9 keV) was then deduced from the probability balance: $P(\alpha_{0,1}) = P_{\gamma+ce}$ ($\gamma_{1,0}$ - 438.9 keV). The multipolarity of this gamma-ray transition has been adopted as being E2. In 1998Li53 a multipolarity higher than a pure E2 was reported from the relative intensity $P(KX) / P_\gamma$ (438.9 keV) = 0.034 (10), then it was noted that a small amount of M1 cannot be ruled out.

ICCs have been interpolated using the BrIcc computer program, version v2.2a, data set BriccFO (2008Ki07).

3. ATOMIC DATA

The fluorescence yields, X-ray energies and relative probabilities, and Auger electrons energies and relative probabilities are from the SAISINUC software.

4. ALPHA EMISSIONS

The energy of the alpha-particle group $\alpha_{0,0}$ that populates the ^{211}Pb ground state is the absolute measurement result from 1971Gr17 adjusted in 1991Ry01 for change in calibration standards: $E(\alpha_{0,0}) = 7386.1\ (8)$ keV. Latter coincides with the value deduced by the evaluator from the adopted Q(α) taking into account the recoil energy for ^{211}Pb.

The energy of alpha-particle group $\alpha_{0,1}$ of 6955.4 (8) keV has been deduced from the Q(α) value taking into account the level energy of 439.8 (2) keV and the recoil energy for ^{211}Pb. The above value of $E(\alpha_{0,1})$ can be compared to the measured $E(\alpha_{0,1})$ of 6956.7 keV (without uncertainty) by 1962Wa18, 1971Gr17 and of 6954 (3) keV by 1998Li53 with adjustement adopted in 2004Br45.

The energies of remaining alpha-particle groups have been deduced from Q(α) and the relevant ^{211}Pb level energies. In Table 4 the deduced (recommended) E(α) are compared with the experimental values from the measurements of 1998Li53 adjusted in 2004Br45 to the adopted $E(\alpha_{0,0})$= 7386.1 (8) keV.

Table 4. Experimental and deduced (recommended) ^{215}Po alpha-particle energies (E(α))

Level	Level energy (keV)	α-transition energy	Experimental E(α) (1998Li53) [a]	Deduced E(α) (recommended)
0	0.0	7526.3 (8)	7386.1 (8)	7386.1 (8)
1	438.9 (2)	7087.4 (10)	6954 (3)	6955.4 (8)
2	584 (3)	6942 (3)	6819 (15)	6813 (3)
3	598 (3)	6928 (3)	6803 (8)	6799 (3)
4	643 (3)	6883 (3)	6754 (10)	6755 (3)

Level	Level energy (keV)	α-transition energy	Experimental E(α) (1998Li53) [a]	Deduced E(α) (recommended)
5	733 (3)	6793 (3)	6671 (10)	6667 (3)
6	815 (3)	6711 (3)	6589 (8)	6586 (3)
7	894 (3)	6632 (3)	6519 (20)	6509 (3)

[a] E(α) have been adjusted to the adopted $E(\alpha_{0,0})$ = 7386.1 (8) keV.

5. ELECTRON EMISSIONS

The energies of the conversion electrons for the γ438.9 keV transition have been obtained from the gamma-ray transition energy and the atomic electron binding energies.

The emission probabilities of the conversion electrons have been deduced using the P_γ and ICC values.

The absolute emission probabilities of K and L Auger electrons have been calculated using the EMISSION computer program.

6. PHOTON EMISSIONS

6.1 X - Ray emissions

The absolute emission probabilities of Pb KX- and LX-rays were calculated using the EMISSION computer program. The total emission probability of Pb KX-rays in decay of ^{215}Po was determined relatively to $P_\gamma(\gamma_{1,0}$ - 438.9 keV) (1998Li53). The experimental $P(KX)/P_\gamma(\gamma_{1,0}$ - 438.9 keV) = 0.034 (10) agrees with the value of 0.029 (14) calculated with the EMISSION code.

The agreement between measured and calculated KX-ray emission probabilities supports the recommended γ-ray emission probability and assigned multipolarity for $\gamma_{1,0}$ - 438.9 keV.

6.2. Gamma emissions

6.2.1. Gamma ray energies

The gamma-ray energies (E_γ) have been taken from the measurements of 1998Li53. The uncertainties on the gamma-ray energies higher than 500 keV have been assumed being ± 3 keV (see section **2.1**). Other measurements of E ($\gamma_{1,0}$ - 438.9 keV) are reported in 1968Br17 (438.7 (3) keV) and in 1970Da09 (438.9 keV – without uncertainty).

6.2.2. Gamma ray emission probabilities

There is no available information on the gamma-ray emission probabilities, except for P(γ438.9 keV): 0.048 (5) % (1968Br17) and 0.064 (2) % (1970Da09). These discrepant values do not conflict with the recommended value of P(γ438.9 keV) = 0.058 (19) % deduced by the evaluator from the alpha transition probability $P(\alpha_{0,1})$ = 0.06 (2) % and total internal conversion coefficient α_T = 0.0405 (6) under the assumption of E2 multipolarity.

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