^{37}Ar - Comments on evaluation of decay data by V.P. Chechev

Evaluated in March 2012 with a literature cut-off by the same date.

1. Decay Scheme and Decay Energy

^{37}Ar disintegrates by 100 % electron capture (EC) transition to the ground state of the stable nuclide ^{37}Cl. The decay scheme is complete as there are no excited levels of ^{37}Cl below the EC decay energy Q^+ (1998En04).
Q^+ value has been taken from atomic mass adjustment (2003Au03, 2011AuZZ) based on the precise spectrometric measurement of the Q-value for (p, n) reaction on ^{37}Cl (1998Bo30).

2. Half-Life

The following values of the ^{37}Ar half-life presented in Table 1 were considered.

Table 1. Results of ^{37}Ar half-life measurements (in days)

Reference	Author(s)	Value	Comments
1944We**	Weimer et al.	34.1 (3)	Omitted; ^{39}K (d,α), ^{37}Cl (d,2n) and ^{37}Cl (p,n), ionization chamber, t = 7 half-lives, possible source impurities, uncertainty strongly underestimated in an unknown amount
1952Mi**	Miskel and Perlman	35.0 (4)	Omitted; ^{40}Ca (n,α), proportional counter, no details, possible source impurities
1959Ki41	Kiser and Johnston	34.30 (14)	Omitted; ^{40}Ca (n,α), K Auger peak decay, proportional counter, t = 2 half-lives, possible source impurities, uncertainty strongly underestimated in an unknown amount
1965St09	Stoenner et al.	35.1 (1)	^{40}Ca (n,α), 5 proportional counters, t = 5 half-lives, declared uncertainty includes possible systematic errors
1973Co26	Colomer and Gauvain	35.06 (9)	^{37}Cl (p,n), 2 proportional counters, t = 5 and 3 half-lives; the authors reported the uncertainty of 0.18 d for 95% confidence level
1975Ki10	Kishore et al.	35.02 (2)	^{37}Cl (p,n), several proportional counters, numerous decay curves (over 1 to 3 half-lives), 28 measurements
2001Re01	Renne and Norman	34.95 (4)	^{40}Ca (n,α) and ^{40}Ca (n,nα), ^{37}Ar/^{36}Ar mass spectrometry; the authors reported the uncertainty of 0.08 d for 95% confidence level

The four input values (from 1965St09, 1973Co26, 1975Ki10, and 2001Re01) have been adopted for the statistical processing. The weighted average for this data set is 35.011 with an internal uncertainty of 0.017 and external uncertainty of 0.019 (χ^2/ν = 1.21). The smallest experimental uncertainty reported is 0.02.
The recommended value of the ^{37}Ar half-life is **35.01 (2) days**.

3. Electron Capture

The energy of the electron-capture transition 3/2+ → 3/2+ in the decay of ^{37}Ar → ^{37}Cl is equal to the adopted Q^+ value.
K, L, M-electron capture probabilities P_K, P_L, P_M were deduced using the EC-CAPTURE computer program (1998Sc28). It should be noted that according to theory L- and M-electron captures occur basically on L1 and M1 subshells (1972Dz09). Log ft value was calculated for the allowed electron-capture transition using the LOGFT computer code (NNDC Tools and Publications, Web programming: M. Emeric and A. Sonzogni, NNDC, Brookhaven National Laboratory).

4. Atomic Data, X-Ray and Auger Electron Emissions

Atomic values, ω_K, ϖ_L and n_{KL} are from Schönfeld and Janβen (1996Sc06).
The X-ray and Auger electron emission probabilities were calculated using the program EMISSION (2000Sc47). The calculation results including average energies per disintegration are given in Tables 2, 3.

Table 2. KX- and LX- rays in decay of ^{37}Ar

	Energy, keV	Number of photons per disintegration	Energy per disintegration, keV
X Kα$_2$	2.6208	0.0276 (7)	0.0723 (18)
X Kα$_1$	2.6224	0.0546 (14)	0.143 (4)
X Kβ	2.8156	0.0071 (4)	0.020 (1)
X Lβ	0.240	0.0020 (4)	0.00048 (10)
		Total	**0.236 (5)**

Table 3. Auger electrons in decay of ^{37}Ar

	Energy, keV	Number of electrons per disintegration	Energy per disintegration, keV
L-Auger	0.17-0.26	1.665 (8)	0.38 (4)
K-LL	2.31 (7)	0.689 (6)	1.59 (5)
K-LM	2.57 (4)	0.119 (6)	0.306 (5)
K-MM	2.8	0.0051 (5)	0.014 (2)
		Total	**2.29 (6)**

5. Internal Bremsstrahlung

The characteristics of the internal bremsstrahlung in the ^{37}Ar decay were calculated in 1986BrZQ (Table 4). The results of that calculation were taken for the evaluation of the average energy E_{IB} of internal bremsstrahlung per disintegration of ^{37}Ar: E_{IB} = 0.139 (14) keV (2011Ch65). The relative uncertainty of E_{IB} was set as 10 % based on that the theoretical estimation of the internal bremsstrahlung intensity for allowed electron capture transitions (1972Dz09) agrees with experimental data within less than 15 %.

Table 4. Internal bremsstrahlung in decay of ^{37}Ar

Energy (keV)	Number of photons per disintegration	Energy (keV) per disintegration
10-20	$1.31 \cdot 10^{-6}$	$2.0 \cdot 10^{-5}$
20-40	$3.8 \cdot 10^{-6}$	$1.17 \cdot 10^{-4}$
40-100	$2.4 \cdot 10^{-5}$	$1.8 \cdot 10^{-3}$
100-300	$1.63 \cdot 10^{-4}$	0.034
300-600	$2.0 \cdot 10^{-4}$	0.087
600-814	$2.5 \cdot 10^{-5}$	0.0164
Total		**0.139 (14)**

6. Total energy of non-neutrino radiation per disintegration

Decay of ^{37}Ar is accompanied by emissions of *X*-rays, internal bremsstrahlung, Auger electrons and monochromatic neutrinos with energies of 811.05 (20), 813.60 (20), and 813.85 (20) keV. The neutrino energies were deduced from the value of decay energy Q^+ = 813.87 (20) keV (see Section 1) and the values of *K*, *L*, *M*-electron binding energies (Cl, *Z* = 17) (1977La19).

The total energy of non-neutrino radiation per disintegration releasing in the form of (*X* + Auger) emissions and internal bremsstrahlung is obtained from Tables 2–4 of 2.67 (7) keV. This value was specified using the calculation of (*X* + Auger) - energy releasing in each act of ^{37}Ar electron capture by the relation of $E = W_K P_K + W_L P_L + W_M P_M$, where W_J - binding energy of electron in J-shell, P_J - probability of electron capture in J-shell, J = K, L, M. The more accurate value of the energy of non-neutrino radiation per disintegration is 2.709 (16) keV per disintegration (2011Ch65).

7. References

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