^{40}K ε decay (1.248×10^9 y) 1999BeZQ,1999BeZS

Type	Author	History Citation	Literature Cutoff Date
Full Evaluation	Jun Chen	NDS 140, 1 (2017)	30-Sep-2015

Parent: ^{40}K: E=0; $J^\pi=4^-$; $T_{1/2}=1.248\times10^9$ y *3*; Q(ε)=1504.40 *6*; %ε+%β^+ decay=10.72 *11*

^{40}K-J^π: From unique 3rd forbidden β^- spectral shape for decay to 0^+ level and L transfer in charge-particle reactions.

^{40}K-$T_{1/2}$: From 2004Ko09 and 2002Gr01; the same value from measurements of specific activity of natural potassium salts using liquid-scintillation counting (LSC) technique. (2002Gr01 reported a value of 1.248×10^9 y *2*, later adjusted to 1.248×10^9 y *3* by 2004Ko09 to correct the quoted uncertainty on measured isotopic abundance of ^{40}K). Both papers used natural abundance of ^{40}K as 0.01167% 2 (1975Ga24). The natural abundance of ^{40}K=0.0117% 1 (as recommended in the International Union of Pure and Applied Chemistry 70, 217 (1998), based on the measured value of 1975Ga24) would give about four times larger uncertainty on $T_{1/2}$. The earlier values of 1.265×10^9 y *13* (1999BeZS,1999BeZQ) based on recomputation of 1.277×10^9 y *8* (evaluation by 1973EnVA); and 1.26×10^9 y *1* (evaluation by 1990Ho28 from 14 different measurements out of a total of 34 measurements listed) are in good agreement. Variation of $T_{1/2}$ due to environmental conditions has been studied by 2001No10, where No significant effect has been reported. Earlier (pre-1977) measurements of partial (β^- and ce) and/or total $T_{1/2}$ of ^{40}K: 1977Ce04, 1972Go21, 1966Fe09, 1965Le15, 1965Br25, 1962Fl05, 1961Gl07, 1960Sa31, 1960Eg01, 1959Ke26, 1957We43, 1956Mc20, 1955Ba25, 1955Ko21, 1955Su38, 1953Bu58, 1950Sa52, 1947Gl07. Another 16 references (from 1931 to 1971) are listed by 1990Ho28 and in the 1978 Table of Isotopes (1978LeZA); but are not present in the NSR database.

^{40}K-$T_{1/2}$: @B@0@0@@@@ @B@0@1@@@@@1 $T_{1/2}=3.992\times10^{16}$ s *40* or 1.265×10^9 y *13*.

^{40}K-Q(ε): From 2012Wa38.

^{40}K-%ε+%β^+ decay: deduced by the present evaluator based on Iγ(1460γ)/Iβ^-=0.1195 *14*, which is equal to I(ε to 1461 level)/Iβ^-, and I(β^+)/I(β^-)=1.12×10^{-5} *14* from evaluation of 1973EnVA, and ε/β^+(^{40}K to ^{40}Ar g.s.)=45.2 *14* (3U theory), with all β^+ decay proceeding to ^{40}Ar ground state. Previously evaluated value by 1999BeZQ,1999BeZS is 0.1086 *13* based on the estimation of ε/β^+=200 *100* for the unique 3rd forbidden branch to the ^{40}Ar ground state.

Additional information 2.

1999BeZQ, 1999BeZS: evaluations of ^{40}K decay.

Measurements: 2014Be25, 2013Be06, 2004Ko09, 2002Gr01, 2001No10, 1977Ce04, 1972Go21, 1967Mc10, 1966Fe09, 1965Le15, 1965Br25, 1962Fl05, 1962En01, 1961Gl07, 1960Sa31, 1960Eg01, 1959Ke26, 1957We43, 1956Mc20, 1955Ba25, 1955Ko21, 1955Su38, 1953Bu58, 1952Fe16, 1951Go29, 1951De34, 1950Sa52, 1949Ov01,1948Ev09, 1947Gl07. This list is not complete, see 1978LeZA for several other references that are not present in NSR database.

The decay scheme, which includes the β^- decay to the ground state of ^{40}Ca and two levels in ^{40}Ar, is complete since these are the only levels in the daughter nuclides below the respective decay energies.

In principle, the 1460-keV γ ray could be used for energy calibration. However, in a Ge semiconductor detector the apparent γ-ray energy depends on the source-detector configuration and ^{40}K sources usually consist of a large volume of material, so this Eγ is usually not useful. This also means that in most cases the uncertainty in the observed energy is much larger than that given here.

^{40}Ar Levels

E(level)	J^π	$T_{1/2}$	Comments
0	0^+	stable	
1460.851 *6*	2^+		J^π: from Adopted Levels.

ε,β^+ radiations

E(decay)	E(level)	Iβ^+ †	Iε†	Log *ft*	I($\varepsilon+\beta^+$)†	Comments
(43.55 *6*)	1460.851		10.67 *11*	11.53[1u] *1*	10.67 *11*	εK=0.7609 *4*; εL=0.2114 *3*; εM+=0.02771 *4*
(1504.40 *6*)	0	0.00100 *13*	0.045 *6*	21.4[3u]	0.046 *6*	av Eβ=197.325 *25*; εK=0.5059 *1*; εL=0.04906 *1*; εM+=0.007191 *2* Iε: from Iβ^+(to ^{40}Ar g.s.)/Iβ^-=1.12×10^{-5} *14* in evaluation of 1973EnVA and adopted %Iβ^-=89.28 *11*, with ε/β^+(^{40}K to ^{40}Ar g.s.)=45.2 *14* (3U

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ϵ,β^+ radiations (continued)

E(decay)	E(level)	Comments
		theory). Log *ft*: from private communication from R. B. Firestone; see also 1970Wa11. Additional information 3.

† Absolute intensity per 100 decays.

$\gamma(^{40}Ar)$

Iγ normalization: Iγ(1460 γ) is from the measured γ/β^- ratio (evaluated in 1973EnVA), which can be obtained from I(ε,1460)/(1+α+IPFC). $\alpha(1460)=2.5\times10^{-5}$ and IPFC=7.3×10^{-5} *5*, so the correction for these is 0.01% and is completely negligible compared to the 1% uncertainty in I(ε,1460).

E_γ	I_γ†	E_i(level)	J^π_i	E_f	J^π_f	Mult.	α‡	Comments
1460.820 *5*	10.66 *13*	1460.851	2^+	0	0^+	E2	2.95×10^{-5} *9*	E_γ: the evaluator has re-scaled the original values in 1979He13 using the new calibration standards in 2000He14. Others: 1460.75 *6* (1967Ki10), 1460.95 *7* (1970Ja15). I_γ: Iγ(1460)=I(ε,1460)/(1+α+IPFC)=10.67 *11*/1.000102 *5*. Additional information 4.

† Absolute intensity per 100 decays.
‡ Total theoretical internal conversion coefficients, calculated using the BrIcc code (2008Ki07) with Frozen orbital approximation based on γ-ray energies, assigned multipolarities, and mixing ratios, unless otherwise specified.

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Decay Scheme

Intensities: $I_{(\gamma+ce)}$ per 100 parent decays