^{35}K $\varepsilon+\beta^+$ decay (175 ms) 1980Ew02

Parent: ^{35}K: E=0; $J^\pi=3/2^+$; $T_{1/2}$=175 ms *2*; Q(ε)=11874.4 *9*; %ε+%β^+ decay=100.0
^{35}K-J^π,$T_{1/2}$: From the Adopted Levels of ^{35}K.
^{35}K-$T_{1/2}$: Weighted average of 175 ms *2* (2018Sa54), 178 ms *8* (1998Sc19), and 190 ms *30* (1980Ew02).
^{35}K-Q(ε): From 2021Wa16.
^{35}K-%($\varepsilon+\beta^+$)p=0.37 *15* for E(p)>0.9 MeV (1980Ew02). E(p)<0.9 MeV has also been observed (2018Sa54,2019ChZU).

1980Ew02,1979Ca15: A 600-MeV proton beam was produced from the synchrocyclotron at CERN-ISOLDE and bombard a ScC_2 target. The ^{45}Sc(p,8n3p) spallation reaction products diffused out of the target and reached a tungsten surface ionization source where potassium isotopes were selectively ionized. The beam was extracted from the ion source, separated by the ISOLDE analyzing magnet, and collected by a mylar foil for γ-ray measurements and then a carbon foil for proton measurements. γ rays were detected using a Ge(Li) detector. Time for positron activities were determined using a 700−μm thick silicon detector. Protons were detected using a 20−μm-700−μm thick ΔE-E telescope of silicon surface barrier detectors with FWHM=50 keV. Measured Eγ(<5 MeV), Iγ, E_p(>0.9 MeV), I_p. Deduced levels, J, π, decay branching ratios, log *ft*, parent ^{35}K $T_{1/2}$, and coefficients of the isobaric multiplet mass equation for A=36, T=2 quartets. Comparisons with shell-model calculations and the mirror nucleus ^{35}Cl. Also see abstracts 1978HaYH, 1979HaZY, 1979HaZT, and 1979AnZZ.

2018Sa54: A 36-MeV/nucleon ^{36}Ar primary beam was produced from the K500 cyclotron at Texas A&M University. The secondary ^{35}K beam was produced via the ^{1}H(^{36}Ar,^{35}K)2n reaction of ^{36}Ar bombarding a LN_2-cooled hydrogen gas target, separated by MARS, and implanted into a 45−μm DSSD sandwiched between a 140−μm SSSD and a 1-mm Si-pad detector in a pulsed-beam mode. $\varepsilon+\beta^+$-delayed protons were detected by the implantation detector. γ rays were detected by two HPGe detectors. Measured E_p(>300 keV), I_p, Eγ, Iγ, pγ-coin, $\gamma\gamma$-coin. Deduced parent ^{35}K $T_{1/2}$.

2019ChZU: Same beam production as 2018Sa54. ^{35}K was implanted into the AstroBox2 detector filled with 800-Torr P5 gas. $\varepsilon+\beta^+$-delayed protons were detected by the implantation detector. γ rays were detected by 4 Clover Ge detectors. Measured E_p(>100 keV), I_p, Eγ, Iγ, pγ-coin, $\gamma\gamma$-coin.

1998Sc19: A polarized ^{35}K beam was produced via the fragmentation of 500-MeV/nucleon ^{40}Ca impinging on a ^{9}Be target at GSI, separated using ΔE-tof by FRS, momentum-selected by slits, and implanted into a KBr single crystal placed in the central region of a magnet. Positrons were detected using plastic scintillators. γ rays were detected using a Ge detector. Measured β-decay asymmetry and $\beta\gamma$-coin. Deduced polarization and *g*-factor of ^{35}K ground state from β-NMR and ^{35}K $T_{1/2}$ from $\beta\gamma$-decay time spectra.

2006Me04: A polarized ^{35}K beam was produced via the proton-pickup reaction ^{36}Ar(^{9}Be,^{10}Li)^{35}K, separated by NSCL-A1900, and implanted into a KBr crystal. Positrons were detected using plastic scintillators. Deduced the magnetic dipole moment and *g*-factor of ^{35}K ground state from β-NMR.

Theoretical studies involving ^{35}K decay: shell model (1985Br29, 2003Sm02).

^{35}Ar Levels

E(level)[†]	J^π[‡]	$T_{1/2}$	Comments
0	$3/2^+$	1.7756 s *14*	
1184.01 *25*	$1/2^+$		
1750.72 *25*	$(5/2)^+$		
2637.99 *26*	$3/2^+$		
2982.79 *12*	$5/2^+$		
4065.0? *4*	$(1/2^+,3/2^+,5/2^+)$		
4528.2 *4*	$(1/2^+,3/2^+,5/2^+)$		
4725.9 *6*	$1/2^+$		
4785.8 *11*	$1/2^+,3/2^+,5/2^+$		
5572.66 *15*	$3/2^+$		T=3/2
6348 *11*	(1/2,3/2,5/2)		$E(p0)_{c.m.}$=452 keV *11* (2019ChZU).
7053 *11*	$3/2^+,5/2^+$		$E(p0)_{c.m.}$=1157 keV *11* (2019ChZU).
7255 *11*			$E(p3)_{c.m.}$=693 keV *11* (2019ChZU).
7283 *11*			$E(p0)_{c.m.}$=1387 keV *11* (2019ChZU).
7431 *11*			$E(p3)_{c.m.}$=869 keV *11* (2019ChZU).
7518 *11*	$1/2^+,3/2^+,5/2^+$		E(level): weighted average of E(level) of 7497 *20*, 7510 *20*, and 7527 *11*. The former two E(level) are deduced from $E(p0)_{c.m.}$=1601 *20* (1980Ew02) and $E(p1)_{c.m.}$=1467 *20* (1980Ew02), respectively, with the corresponding E(level)(^{34}Cl) (2012Ni10) and S(p)(^{35}Ar)=5896.2 *7* (2021Wa16). The 7527 *11*

Continued on next page (footnotes at end of table)

^{35}K ε+β^+ decay (175 ms) 1980Ew02 (continued)

^{35}Ar Levels (continued)

E(level)†	J$^\pi$‡	Comments
		is from 2019ChZU with E(p3)$_{c.m.}$=965 *11*.
8393? *20*	1/2$^+$,3/2$^+$,5/2$^+$	E(level): weighted average of E(level) of 8392 *20*, 8392 *20*, and 8395 *20*, deduced from E(p0)$_{c.m.}$=2496 *20* (1980Ew02), E(p1)$_{c.m.}$=2349 *20* (1980Ew02), and E(p2)$_{c.m.}$=2038 *20* (1980Ew02), respectively, with the corresponding E(level)(^{34}Cl) (2012Ni10) and S(p)(^{35}Ar)=5896.2 *7* (2021Wa16).

† From a least-squares fit to γ-ray energies in 1980Ew02 for levels connected with γ transitions.
‡ From the Adopted Levels.

ε,β^+ radiations

E(decay)	E(level)	Iβ^+ †	Iε†	Log *ft*	I($\varepsilon+\beta^+$)†	Comments
(3481 *20*)	8393?	0.062 *26*	4.3×10^{-4} *18*	4.6 *+3−2*	0.062 *26*	I($\varepsilon+\beta^+$): 0.062 *26* I(p0+p1+p2) from Table 3 of 1980Ew02.
(4356 *11*)	7518	>0.090	>3×10^{-4}	5.0	>0.09	I($\varepsilon+\beta^+$): 0.15 *6* I(p0+p1) from Table 3 of 1980Ew02. Evaluators adopted a lower limit due to unreported I(p3) (2019ChZU).
(5526 *11*)	6348	0.0025 *5*	2.9×10^{-6} *6*	7.2 *1*	2.5×10^{-3} *5*	
(6301.7 *14*)	5572.66	36.3 *24*	0.0265 *18*	3.31 *4*	36.3 *24*	
(7088.6 *18*)	4785.8	1.0 *4*	5×10^{-4} *2*	5.2 *2*	1.0 *4*	
(7148.5 *15*)	4725.9	2.1 *4*	0.0010 *2*	4.9 *1*	2.1 *4*	
(7346.2 *14*)	4528.2	0.7 *4*	3×10^{-4} *2*	5.4 *+4−2*	0.7 *4*	
(7809.4 *14*)	4065.0?	0.56 *33*	2.0×10^{-4} *12*	5.6 *+4−2*	0.56 *33*	
(8891.6 *14*)	2982.79	26.0 *22*	0.0060 *5*	4.27 *4*	26.0 *22*	
(9236.4 *14*)	2637.99	≤0.4		≥6.2	≤0.4	
(10123.7 *14*)	1750.72	11.9 *9*	0.00181 *14*	4.91 *4*	11.9 *9*	
(10690.4 *14*)	1184.01	2.2 *7*	2.8×10^{-4} *9*	5.8 *+2−1*	2.2 *7*	
(11874.4 *17*)	0	19 *4*	0.0018 *4*	5.1 *1*	19 *4*	I($\varepsilon+\beta^+$): From 1980Ew02 assuming mirror log *ft* with a small asymmetry correction.

† Absolute intensity per 100 decays.

γ(^{35}Ar)

Iγ normalization: From Σ%Iγ(γ to g.s.)=80.6 *40*, deduced from 100−Σ%I$_p$-%I($\varepsilon+\beta^+$)(g.s.), where Σ%I$_p$=0.37 *15* (1980Ew02) and %I(ε+β^+)(g.s.)=19 *4* (1980Ew02), corresponding to log *ft*=5.07 *5*, which was deduced from the ^{35}S (g.s.)->^{35}Cl (g.s.) mirror log *ft*=5.01 *2* with a small asymmetry correction.

ε+β^+ feeding is obtained from γ intensity balance at each state, except for proton-emitting states. 1980Ew02 states that in complex decay schemes of heavy nuclides this method is known to be suspect since there is significant γ intensity that is unobserved because it lies in a multitude of very weak γ-ray peaks. In a nucleus as light as ^{35}K the problem is less acute. They have generated a pandemonium test in the same spirit as in 1977Ha51 and find that less than one percent of the γ intensity from ^{35}K decay should be missed for that reason.

E$_\gamma$†	I$_\gamma$†‡	E$_i$(level)	J$^\pi_i$	E$_f$	J$^\pi_f$	Comments
886.8 *5*	0.9 *3*	2637.99	3/2$^+$	1750.72	(5/2)$^+$	%Iγ=0.46 *+19−17*
1044.4 *4*	1.3 *4*	5572.66	3/2$^+$	4528.2	(1/2$^+$,3/2$^+$,5/2$^+$)	%Iγ=0.66 *+25−23*
1184.0 *3*	14.3 *7*	1184.01	1/2$^+$	0	3/2$^+$	%Iγ=7.2 *5*

Continued on next page (footnotes at end of table)

^{35}K $\varepsilon+\beta^+$ decay (175 ms) 1980Ew02 (continued)

$\gamma(^{35}Ar)$ (continued)

E_γ †	I_γ †‡	E_i(level)	J_i^π	E_f	J_f^π	Comments
1426.8 *4*	3.0 *5*	4065.0?	$(1/2^+,3/2^+,5/2^+)$	2637.99	$3/2^+$	%Iγ=1.5 *+4−3*
1507.4 *5*	1.9 *4*	5572.66	$3/2^+$	4065.0?	$(1/2^+,3/2^+,5/2^+)$	%Iγ=0.96 *+27−25*
1750.5 *3*	28 *1*	1750.72	$(5/2)^+$	0	$3/2^+$	%Iγ=14.1 *9*
1798.9 *5*	3.5 *6*	2982.79	$5/2^+$	1184.01	$1/2^+$	%Iγ=1.8 *4*
2589.8 *1*	52 *2*	5572.66	$3/2^+$	2982.79	$5/2^+$	%Iγ=26.3 *18*
2638.0 *4*	5.5 *7*	2637.99	$3/2^+$	0	$3/2^+$	%Iγ=2.8 *5*
^{x}2697.7 *6*						Unplaced γ ray, accounting for no more than 1.2% $\varepsilon+\beta^+$-feeding (1980Ew02). No ^{35}Ar γ rays at this energy were observed in other reaction studies.
2934.5 *5*	3.5 *6*	5572.66	$3/2^+$	2637.99	$3/2^+$	%Iγ=1.8 *4*
2982.68 *13*	100 *4*	2982.79	$5/2^+$	0	$3/2^+$	%Iγ=50.5 *27*
3542.0 *6*	2.9 *6*	4725.9	$1/2^+$	1184.01	$1/2^+$	%Iγ=1.5 *4*
3821.7 *7*	3.5 *7*	5572.66	$3/2^+$	1750.72	$(5/2)^+$	%Iγ=1.8 *5*
4387.2 *9*	3.5 *8*	5572.66	$3/2^+$	1184.01	$1/2^+$	%Iγ=1.8 *5*
4527.9 *7*	2.6 *7*	4528.2	$(1/2^+,3/2^+,5/2^+)$	0	$3/2^+$	%Iγ=1.3 *4*
4724.5 *11*	1.2 *5*	4725.9	$1/2^+$	0	$3/2^+$	%Iγ=0.61 *+30−27*
4785.4 *11*	1.9 *7*	4785.8	$1/2^+,3/2^+,5/2^+$	0	$3/2^+$	%Iγ=1.0 *4*
5572.3 *10*	6.1 *16*	5572.66	$3/2^+$	0	$3/2^+$	%Iγ=3.1 *+10−9* 1980Ew02 observed the double escape peak at 4550 keV of this γ ray. 2018Sa54 observed the photopeak at 5572 keV.

† From 1980Ew02.
‡ For absolute intensity per 100 decays, multiply by 0.505 *29*.
^{x} γ ray not placed in level scheme.

^{35}K $\varepsilon+\beta^+$ decay (175 ms) 1980Ew02

Decay Scheme

Intensities: I_γ per 100 parent decays