

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

Parent:  $^{35}\text{K}$ :  $E=0$ ;  $J^\pi=3/2^+$ ;  $T_{1/2}=175$  ms 2;  $Q(\varepsilon)=11874.4$  9;  $\% \varepsilon + \% \beta^+$  decay=100

$^{35}\text{K}$ - $J^\pi$ ,  $T_{1/2}$ : From Adopted Levels of  $^{35}\text{K}$ .

$^{35}\text{K}$ - $T_{1/2}$ : Weighted average of 175 ms 2 (2018Sa54), 178 ms 8 (1998Sc19), and 190 ms 30 (1980Ew02).

$^{35}\text{K}$ - $Q(\varepsilon+\beta^+)$ : From 2021Wa16.

$^{35}\text{K}$ - $\%(\varepsilon+\beta^+)$ :  $p=0.37$  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  $\text{ScC}_2$  target. The  $^{45}\text{Sc}(p, 8n3p)$  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  $\gamma$ -ray measurements and then a carbon foil for proton measurements.  $\gamma$  rays were detected using a Ge(Li) detector. Time for positron activities were determined using a 700- $\mu\text{m}$  thick silicon detector. Protons were detected using a 20- $\mu\text{m}$ -700- $\mu\text{m}$  thick  $\Delta E$ -E telescope of silicon surface barrier detectors with FWHM=50 keV. Measured  $E_\gamma(<5$  MeV),  $I_\gamma$ ,  $E_p(>0.9$  MeV),  $I_p$ . Deduced Deduced levels,  $J$ ,  $\pi$ , decay branching ratios,  $\log ft$ , parent  $^{35}\text{K}$   $T_{1/2}$ , and coefficients of the isobaric multiplet mass equation for  $A=36$ ,  $T=2$  quartets. Comparisons with shell-model calculations and the mirror nucleus  $^{35}\text{Cl}$ . Also see abstracts 1978HaYH, 1979HaZY, 1979HaZT, and 1979AnZZ.

2018Sa54: A 36-MeV/nucleon  $^{36}\text{Ar}$  primary beam was produced from the K500 cyclotron at Texas A&M University. The secondary  $^{35}\text{K}$  beam was produced via the  $^1\text{H}(^{36}\text{Ar}, ^{35}\text{K})2n$  reaction of  $^{36}\text{Ar}$  bombarding a  $\text{LN}_2$ -cooled hydrogen gas target, separated by MARS, and implanted into a 45- $\mu\text{m}$  DSSD sandwiched between a 140- $\mu\text{m}$  SSSD and a 1-mm Si-pad detector in a pulsed-beam mode.  $\varepsilon+\beta^+$ -delayed protons were detected by the implantation detector.  $\gamma$  rays were detected by two HPGe detectors. Measured  $E_p(>300$  keV),  $I_p$ ,  $E_\gamma$ ,  $I_\gamma$ ,  $p\gamma$ -coin,  $\gamma\gamma$ -coin. Deduced parent  $^{35}\text{K}$   $T_{1/2}$ .

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

1998Sc19: A polarized  $^{35}\text{K}$  beam was produced via the fragmentation of 500-MeV/nucleon  $^{40}\text{Ca}$  impinging on a  $^9\text{Be}$  target at GSI, separated using  $\Delta E$ -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.  $\gamma$  rays were detected using a Ge detector. Measured  $\beta$ -decay asymmetry and  $\beta\gamma$ -coin. Deduced polarization and  $g$ -factor of  $^{35}\text{K}$  ground state from  $\beta$ -NMR and  $^{35}\text{K}$   $T_{1/2}$  from  $\beta\gamma$ -decay time spectra.

2006Me04: A polarized  $^{35}\text{K}$  beam was produced via the proton-pickup reaction  $^{36}\text{Ar}(^9\text{Be}, ^{10}\text{Li})^{35}\text{K}$ , 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  $^{35}\text{K}$  ground state from  $\beta$ -NMR.

Theoretical studies involving  $^{35}\text{K}$  decay: shell model (1985Br29, 2003Sm02, Surender et al., Annals of Physics 470, 169772 (2024)).

 $^{35}\text{Ar}$  Levels

$E(\text{level})^\dagger$	$J^\pi^\ddagger$	Comments
0	$3/2^+$	
1184.01 25	$1/2^+$	
1750.72 25	$(5/2)^+$	
2637.99 26	$3/2^+, 5/2^+$	
2982.79 12	$3/2^+, 5/2^+$	
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	$1/2^+$	
5572.66 15	$3/2^+$	$T=3/2$
6348 11	$1/2, 3/2, 5/2$	$E(p0)_{\text{c.m.}}=452$ keV 11 (2019ChZU).
7053 11		$E(p0)_{\text{c.m.}}=1157$ keV 11 (2019ChZU).
7255 11		$E(p3)_{\text{c.m.}}=693$ keV 11 (2019ChZU).
7283 11		$E(p0)_{\text{c.m.}}=1387$ keV 11 (2019ChZU).
7431 11		$E(p3)_{\text{c.m.}}=869$ keV 11 (2019ChZU).
7518 11	$1/2^+, 3/2^+, 5/2^+$	$E(\text{level})$ : weighted average of $E(\text{level})$ of 7497 20, 7510 20, and 7527 11. The former two $E(\text{level})$ are deduced from $E(p0)_{\text{c.m.}}=1601$ 20 (1980Ew02) and $E(p1)_{\text{c.m.}}=1467$ 20 (1980Ew02), respectively, with the corresponding $E(\text{level})(^{34}\text{Cl})$ (2012Ni10) and $S(p)(^{35}\text{Ar})=5896.2$ 7

Continued on next page (footnotes at end of table)

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

E(level) <sup>†</sup>	J <sup>π</sup> <sup>‡</sup>	Comments
8393? 20	1/2 <sup>+</sup> , 3/2 <sup>+</sup> , 5/2 <sup>+</sup>	(2021Wa16). The 7527 11 is from 2019ChZU with E(p3) <sub>c.m.</sub> =965 11. E(level): weighted average of E(level) of 8392 20, 8392 20, and 8395 20, deduced from E(p0) <sub>c.m.</sub> =2496 20 (1980Ew02), E(p1) <sub>c.m.</sub> =2349 20 (1980Ew02), and E(p2) <sub>c.m.</sub> =2038 20 (1980Ew02), respectively, with the corresponding E(level)( <sup>34</sup> Cl) (2012Ni10) and S(p)( <sup>35</sup> Ar)=5896.2 7 (2021Wa16).

<sup>†</sup> From a least-squares fit to  $\gamma$ -ray energies in 1980Ew02 for levels connected with  $\gamma$  transitions.

<sup>‡</sup> From the Adopted Levels.

 $\varepsilon, \beta^+$  radiations

E(decay)	E(level)	I $\beta^+$ <sup>†</sup>	I $\varepsilon$ <sup>†</sup>	Log <i>ft</i>	I( $\varepsilon+\beta^+$ ) <sup>†</sup>	Comments
(3481 20)	8393?	0.062 26	4.3×10 <sup>-4</sup> 18	4.6 +3-2	0.062 26	
(4356 11)	7518	>0.090	>3×10 <sup>-4</sup>	5.0	>0.09	I( $\varepsilon+\beta^+$ ): 0.15 6 I(p0+p1) (1980Ew02). Evaluators adopted a lower limit due to unreported I(p3) (2019ChZU).
(5526 11)	6348	0.0025 5	2.9×10 <sup>-6</sup> 6	7.2 1	2.5×10 <sup>-3</sup> 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 <sup>-4</sup> 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 <sup>-4</sup> 2	5.4 +4-2	0.7 4	
(7809.4 14)	4065.0?	0.56 33	2.0×10 <sup>-4</sup> 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 <sup>-4</sup> 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 <i>ft</i> with a small asymmetry correction.

<sup>†</sup> Absolute intensity per 100 decays.

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

I $\gamma$  normalization: From  $\Sigma\%I\gamma(\gamma \text{ to g.s.})=80.6 \ 40$ , deduced from  $100-\Sigma\%I_p-\%I(\varepsilon+\beta^+)(\text{g.s.})$ , where  $\Sigma\%I_p=0.37 \ 15$  (1980Ew02) and  $\%I(\varepsilon+\beta^+)(\text{g.s.})=19 \ 4$  (1980Ew02), corresponding to log *ft*=5.07 5, which was deduced from the <sup>35</sup>S (g.s.)→<sup>35</sup>Cl (g.s.) mirror log *ft*=5.01 2 with a small asymmetry correction.

$\varepsilon+\beta^+$  feeding is obtained from  $\gamma$  intensity balance at each level. 1980Ew02 states that in complex decay schemes of heavy nuclides this method is known to be suspect since there is significant  $\gamma$  intensity that is unobserved because it lies in a multitude of very weak  $\gamma$ -ray peaks. In a nucleus as light as <sup>35</sup>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  $\gamma$  intensity from <sup>35</sup>K decay should be missed for that reason.

E $\gamma$ <sup>†</sup>	I $\gamma$ <sup>‡</sup>	E <sub>i</sub> (level)	J <sub>i</sub> <sup>π</sup>	E <sub>f</sub>	J <sub>f</sub> <sup>π</sup>	Comments
886.8 5	0.9 3	2637.99	3/2 <sup>+</sup> , 5/2 <sup>+</sup>	1750.72	(5/2) <sup>+</sup>	%I $\gamma$ =0.46 +19-17
1044.4 4	1.3 4	5572.66	3/2 <sup>+</sup>	4528.2	1/2 <sup>+</sup> , 3/2 <sup>+</sup> , 5/2 <sup>+</sup>	%I $\gamma$ =0.66 +25-23
1184.0 3	14.3 7	1184.01	1/2 <sup>+</sup>	0	3/2 <sup>+</sup>	%I $\gamma$ =7.2 5
1426.8 4	3.0 5	4065.0?	1/2 <sup>+</sup> , 3/2 <sup>+</sup> , 5/2 <sup>+</sup>	2637.99	3/2 <sup>+</sup> , 5/2 <sup>+</sup>	%I $\gamma$ =1.5 +4-3
1507.4 5	1.9 4	5572.66	3/2 <sup>+</sup>	4065.0?	1/2 <sup>+</sup> , 3/2 <sup>+</sup> , 5/2 <sup>+</sup>	%I $\gamma$ =0.96 +27-25
1750.5 3	28 1	1750.72	(5/2) <sup>+</sup>	0	3/2 <sup>+</sup>	%I $\gamma$ =14.1 9
1798.9 5	3.5 6	2982.79	3/2 <sup>+</sup> , 5/2 <sup>+</sup>	1184.01	1/2 <sup>+</sup>	%I $\gamma$ =1.8 4

Continued on next page (footnotes at end of table)

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

$E_\gamma$ <sup>†</sup>	$I_\gamma$ <sup>†‡</sup>	$E_i(\text{level})$	$J_i^\pi$	$E_f$	$J_f^\pi$	Comments
2589.8 1	52 2	5572.66	$3/2^+$	2982.79	$3/2^+, 5/2^+$	%I $\gamma$ =26.3 18
2638.0 4	5.5 7	2637.99	$3/2^+, 5/2^+$	0	$3/2^+$	%I $\gamma$ =2.8 5
<sup>x</sup> 2697.7 6						Unplaced $\gamma$ ray, accounting for no more than 1.2% $\varepsilon+\beta^+$ -feeding ( <b>1980Ew02</b> ).
2934.5 5	3.5 6	5572.66	$3/2^+$	2637.99	$3/2^+, 5/2^+$	%I $\gamma$ =1.8 4
2982.68 13	100 4	2982.79	$3/2^+, 5/2^+$	0	$3/2^+$	%I $\gamma$ =50.5 27
3542.0 6	2.9 6	4725.9	$1/2^+$	1184.01	$1/2^+$	%I $\gamma$ =1.5 4
3821.7 7	3.5 7	5572.66	$3/2^+$	1750.72	$(5/2)^+$	%I $\gamma$ =1.8 5
4387.2 9	3.5 8	5572.66	$3/2^+$	1184.01	$1/2^+$	%I $\gamma$ =1.8 5
4527.9 7	2.6 7	4528.2	$1/2^+, 3/2^+, 5/2^+$	0	$3/2^+$	%I $\gamma$ =1.3 4
4724.5 11	1.2 5	4725.9	$1/2^+$	0	$3/2^+$	%I $\gamma$ =0.61 +30-27
4785.4 11	1.9 7	4785.8	$1/2^+$	0	$3/2^+$	%I $\gamma$ =1.0 4
5572.3 10	6.1 16	5572.66	$3/2^+$	0	$3/2^+$	%I $\gamma$ =3.1 +10-9
						<b>1980Ew02</b> observed the double escape peak at 4550 keV of this $\gamma$ ray. <b>2018Sa54</b> observed the photopeak at 5572 keV.

<sup>†</sup> From **1980Ew02**.<sup>‡</sup> For absolute intensity per 100 decays, multiply by 0.505 29.<sup>x</sup>  $\gamma$  ray not placed in level scheme.

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

## Decay Scheme

Legend

Intensities:  $I_\gamma$  per 100 parent decays

- $\longrightarrow$   $I_\gamma < 2\% \times I_\gamma^{\max}$   
 $\longrightarrow$   $I_\gamma < 10\% \times I_\gamma^{\max}$   
 $\longrightarrow$   $I_\gamma > 10\% \times I_\gamma^{\max}$

$\xrightarrow{\quad} \begin{array}{c} 3/2^+ \\ 0 \\ Q_\varepsilon = 11874.4 \text{ 9} \end{array} \begin{array}{c} 175 \text{ ms } 2 \\ \\ \\ \end{array}$   
 $^{35}_{19}\text{K}_{16}$

