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

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

$^{35}$K-$J^\pi$,$T_{1/2}$: From 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($\varepsilon+\beta^+$): 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 $\gamma$-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−$\mu$m thick silicon detector. Protons were detected using a 20−$\mu$m-700−$\mu$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 $^{35}$K $T_{1/2}$, and coeffcients 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 1979HaZY, 1979HaZT.

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−$\mu$m DSSD sandwiched between a 140−$\mu$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 $^{35}$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. $\gamma$ 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 $^{35}$K beam was produced via the fragmentation of 500-MeV/nucleon $^{40}$Ca impinging on a $^9$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 $^{35}$K ground state from $\beta$-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 $\beta$-NMR.

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

### $^{35}$Ar Levels

| E(level)† | $J^\pi$‡ | 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* | | $E(p0)_{c.m.}$=452 keV *11* (2019ChZU). |
| 7053 *11* | | $E(p0)_{c.m.}$=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* reported by 2019ChZU with $E(p3)_{c.m.}$=965 *11*. The former two E(level) were deduced from $E(p0)_{c.m.}$=1601 *20* (1980Ew02) and $E(p1)_{c.m.}$=1467 *20* (1980Ew02), respectively, with the corresponding |

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

### $^{35}$Ar Levels (continued)

| E(level)† | Jπ‡ | Comments |
|---|---|---|
| | | E(level)($^{34}$Cl) (2012Ni10) and S(p)($^{35}$Ar)=5896.2 *7* (2021Wa16). |
| 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 $\gamma$-ray energies in 1980Ew02 for levels connected with $\gamma$ transitions.
‡ From the Adopted Levels.

### $\varepsilon,\beta^+$ 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* | |
| (4356 *11*) | 7518 | >0.09 | 2.53×10$^{-4}$ | <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$^{-6}$ *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.

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

I$\gamma$ normalization: From Σ%I$\gamma$($\gamma$ 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($\varepsilon+\beta^+$)(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.

$\varepsilon+\beta^+$ 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 $^{35}$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 $\gamma$ intensity from $^{35}$K decay should be missed for that reason.

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

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

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

| $E_\gamma$ [†] | $I_\gamma$ [†‡] | $E_i$(level) | $J_i^\pi$ | $E_f$ | $J_f^\pi$ | Comments |
|---|---|---|---|---|---|---|
| 2589.8 *1* | 52 *2* | 5572.66 | $3/2^+$ | 2982.79 | $3/2^+,5/2^+$ | %Iγ=26.3 *18* |
| 2638.0 *4* | 5.5 *7* | 2637.99 | $3/2^+,5/2^+$ | 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). |
| 2934.5 *5* | 3.5 *6* | 5572.66 | $3/2^+$ | 2637.99 | $3/2^+,5/2^+$ | %Iγ=1.8 *4* |
| 2982.68 *13* | 100 *4* | 2982.79 | $3/2^+,5/2^+$ | 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 | $1/2^+$ | 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*<br>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: $I_\gamma$ per 100 parent decays