

$^{39}\text{K}(p,p'\gamma)$ 1974Du01,1986St02,1968Lo03

Type	Author	History Citation	Literature Cutoff Date
Full Evaluation	Jun Chen	NDS 149, 1 (2018)	1-Jan-2018

- 1974Du01** (also **1972Du08**): Two separate experiments were carried out for $p\gamma$ -coincidence measurement and lifetime (DSAM) measurement, respectively. The first measurement: $E=10, 11$ and 12 MeV proton beams were produced from the EN-tandem Van de Graaff of the Max-Planck-Institut für Kernphysik. Targets were $350 \mu\text{g}/\text{cm}^2$ ^{39}KI on Au foils. γ rays were detected with a Ge(Li) detector and protons were detected with two ion-implanted surface-barrier detectors. Measured $E\gamma$, $I\gamma$, $p\gamma$ -coin. Deduced levels, γ -ray branching ratios. The second measurement: $E=6.0, 6.8, 8.2$ MeV protons were from the EN-tandem Van de Graaff of the University of Liverpool. γ rays were detected with a Ge(Li)-NaI(Tl) escape-suppressed and pair-escape spectrometer. Measured $E\gamma$, $I\gamma$, Doppler-shift attenuation. Deduced levels, J , π , branching ratios, lifetimes. Comparisons with shell-model calculations.
- 1986St02**: Proton beams $E=6.2$ MeV (for level scheme) and $E=5.97$ MeV (for DSAM) were produced from the 6-MV Van de Graaff of the National Accelerator Centre at Faure, Cape. Targets were $124 \mu\text{g}/\text{cm}^2$ natural KI on a $20 \mu\text{g}/\text{cm}^2$ carbon backing and $356 \mu\text{g}/\text{cm}^2$ KI (>99% enriched) on a $45 \mu\text{g}/\text{cm}^2$ carbon backing, respectively. γ rays were detected a Ge(Li) detector and scattered protons were detected with a surface-barrier detector. Measured $E\gamma$, $I\gamma$, $p\gamma$ -coin, Doppler-shift attenuation. Deduced levels, lifetimes, γ -ray branching ratios. Report data for 10 levels up to 4127. **1986St02** also report σ data of (p,p') and $\gamma(\theta)$ data of $(\alpha,p\gamma)$.
- 1968Lo03**: $E=7.12-8.51$ MeV proton beams were produced from the Oxford University tandem generator. Target was a layer of about $150 \mu\text{g}/\text{cm}^2$ KI (99.7% in ^{39}K). Scattered protons were detected with a surface-barrier silicon counter and γ rays were detected with two NaI(Tl) crystals. Measured $E\gamma$, $I\gamma$, $\gamma(\theta)$, $p\gamma$ -coin. Deduced levels, J , π , γ -ray branching ratios and mixing ratios. Report data for 3600 to 4740 levels. **1968Lo03** also report γ -ray data for 2530, 2830 and 3020 levels from $^{42}\text{Ca}(p,\alpha\gamma)$ and 13 proton groups from 2530-4740 in $^{39}\text{K}(p,p')$.

Others:

- 1974Hu09**: $E=5.65$ MeV; measured lifetimes of 2814 and 3598 levels by direct timing using a pulsed beam.
- 1971Ta10**: $E=6.47-6.67$ MeV; measured lifetimes of nine levels up to 4120 by DSAM.
- 1970Ho26**: $E=5.9$ MeV; measured $p\gamma(t)$ and lifetime of 2814 level.
- 1969Go04**: $E=5.6$ MeV; measured $p\gamma(t)$ and lifetime of 2814 level.
- 1969Ro15**: $E=8.175$ MeV; measured lifetime of first three excited states by DSAM.
- 1965Ne09**: $E=141$ MeV. Measured $E\gamma$, σ . Excited states seen at 2522, 2814, 3597, 4100 (4082+4095 doublet) and 6396.
- [Additional information 1.](#)

 ^{39}K Levels

<u>E(level)[†]</u>	<u>$J^{\pi\ddagger}$</u>	<u>$T_{1/2}$[@]</u>	<u>Comments</u>
0	$3/2^+$		
2522.1 5	$1/2^+$	57 fs 12	E(level): weighted average of 2521.9 5 (1974Du01), 2522.2 6 (1986St02), 2522.3 6 (1969Ro15). $T_{1/2}$: weighted average of 53 fs 12 (1986St02), 49 fs 13 (1974Du01), 61 fs 12 (1971Ta10), 73 fs 22 (1969Ro15).
2813.9 [#] 4	$7/2^-$	49.2 ps 35	E(level): weighted average of 2813.9 7 (1986St02) and 2813.9 4 (1969Ro15). $T_{1/2}$: from 1974Hu09 . Others: >4.2 ps (1969Ro15), ≤ 78 ps (1969Go04), <55 ps (1970Ho26), >0.7 ps (1971Ta10).
3019.1 5	$3/2^-$	17 fs 6	E(level): weighted average of 3018.6 5 (1974Du01), 3019.3 7 (1986St02), and 3019.5 5 (1969Ro15). $T_{1/2}$: weighted average of 35 fs 14 (1986St02), 12 fs 6 (1974Du01), 28 fs 15 (1971Ta10). Other: <37 fs (1969Ro15).
3597.0 [#] 8	$9/2^-$	63 ps 19	E(level): from 1986St02 . $T_{1/2}$: from 1974Hu09 . Other: >0.7 ps (1971Ta10).
3883.3 5	$5/2^-$	15 fs 8	E(level): weighted average of 3883.1 5 (1974Du01) and 3882.8 8 (1986St02). $T_{1/2}$: weighted average of 13 fs 8 (1986St02) and 19 fs 14 (1971Ta10). Other: <21 fs (1974Du01).
3938.9 5	$3/2^+$	66 fs 14	E(level): weighted average of 3938.9 5 (1974Du01) and 3939.0 8 (1986St02). $T_{1/2}$: weighted average of 66 fs 19 (1986St02), 62 fs 14 (1974Du01), 71 fs 21 (1971Ta10).
3942.6 5	$11/2^-$	0.83 ps 29	E(level): weighted average of 3942.7 5 (1974Du01) and 3942.4 9 (1986St02).

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$^{39}\text{K}(\text{p},\text{p}'\gamma)$ **1974Du01,1986St02,1968Lo03** (continued) ^{39}K Levels (continued)

E(level) [†]	J^{π} [‡]	$T_{1/2}$ [@]	Comments
4082.6 5	3/2 ⁻	35 fs 10	J^{π} : 1968Lo03 propose 5/2,7/2 for a single level near 3940. E(level): weighted average of 4082.5 5 (1974Du01) and 4082.8 8 (1986St02). $T_{1/2}$: weighted average of 37 fs 14 (1986St02), 30 fs 10 (1974Du01), 54 fs 26 (1971Ta10).
4095.0 5	1/2 ⁺	55 fs 10	E(level): other: 4095.2 11 (1986St02). $T_{1/2}$: others: 76 fs +45-36 (1971Ta10), 0.35 ps 14 (1986St02).
4126.0 5	7/2 ⁻	37 fs 10	E(level): weighted average of 4125.8 5 (1974Du01) and 4126.7 9 (1986St02). $T_{1/2}$: weighted average of 40 fs 21 (1986St02) and 31 fs 10 (1974Du01). Other: 69 fs +29-26 (1971Ta10).
4475.2 5	1/2 ⁻ ,3/2 ⁻	0.15 ps 6	
4514.1 10	5/2 ⁺	28 fs 14	
4520.5 7	9/2 ⁻	0.12 ps 3	
4679.1 5	7/2 ⁻	76 fs 21	
4737.7 4	5/2 ⁻ ,7/2 ⁻ ,9/2 ⁻		E(level): from Adopted Levels.
4738.9 7	5/2 ⁺	24 fs 7	
4929.4 10	3/2 ⁺	64 fs 17	J^{π} : 1/2,3/2 ⁻ from 1974Du01.
5008.7 5	7/2 ⁻	0.42 ps +17-10	
5009.0 10	(3/2,5/2 ⁻ ,7/2 ⁻)	<35 fs	
5157 2			
5163.0 10	9/2 ⁻	>1.4 ps	
5173.2 10	(1/2,3/2,5/2)	15 fs 6	
5261.7 10	5/2 ⁺	14 fs 7	
5316.8 10	3/2 ⁺	<28 fs	
5354.4 5	11/2 ⁻	113 fs 35	
5501.3 10	7/2 ⁻	0.31 ps 13	
5596.3 10	5/2 ⁺	<14 fs	
5644.1 5	7/2 ⁻	0.67 ps +42-21	
5710.6 10	3/2 ⁺	49 fs 31	
5787.6 10	(5/2,7/2) ⁺	28 fs 14	
5803.4 7	7/2 ⁻	>0.52 ps	
5825.6 10	1/2 ⁻ ,3/2 ⁻	<14 fs	
5891 2	(5/2,7/2) ⁻		
5936.9 10	5/2 ⁺	<14 fs	
6041.0 10		42 fs 21	
6093 2	5/2 ⁻ ,7/2 ⁻		
6110.5 10	1/2 ⁻ ,3/2 ⁻	76 fs 28	
6186 2			
6192 2	(7/2 ⁻)		
6244.0 10		21 fs 14	
6330.7 10	3/2 ⁺	<55 fs	
6356 2	5/2 ⁺		
6396 2			
6465 2			
6502 2	(3/2,5/2) ⁺		
6527 2			
6546 2	7/2 ⁻		
6653 2	3/2 ⁺ ,5/2 ⁺		
6740 2	(3/2 ⁺ ,5/2 ⁺)		
6828 2			
6916 2	3/2 ⁺ ,5/2 ⁺		
6943 2			
7021 2			
7051 2	(3/2,5/2) ⁻		
7170 2			
7200 2			
7260 2	(3/2 ⁺)		

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$^{39}\text{K}(\text{p,p}'\gamma)$ **1974Du01,1986St02,1968Lo03** (continued) ^{39}K Levels (continued)

† From 1974Du01, unless otherwise stated. 1974Du01 give level energies from measured γ -ray energies but without giving values of the latter with uncertainties.

‡ From Adopted Levels.

The value in 1974Du01 is given to nearest keV.

@ From DSAM in 1974Du01, unless otherwise noted.

$E_i(\text{level})$	J_i^π	E_γ^\dagger	$I_\gamma^\#$	E_f	J_f^π	$\gamma(^{39}\text{K})$ Mult.‡	δ^\ddagger	Comments
2522.1	1/2 ⁺	2522.0	100	0	3/2 ⁺			
2813.9	7/2 ⁻	2813.8	100	0	3/2 ⁺	Q+O	+0.18 9	δ : from +0.09< δ <+0.27 for J=9/2 (1968Lo03). $A_2=+0.28$ 3, $A_4=-0.11$ 8 (1968Lo03).
3019.1	3/2 ⁻	3019.0	100	0	3/2 ⁺			
3597.0	9/2 ⁻	783.1	44.6 10	2813.9	7/2 ⁻	D+Q	+0.85 35	I_γ : other: 50 3 (1974Du01), 39 7 (1968Lo03). δ : from +0.5< δ <+1.2 for J=9/2 (1968Lo03). $A_2=+0.60$ 3, $A_4=+0.03$ 5 (1968Lo03). I_γ : <4 (1968Lo03). I_γ : other: 50 3 (1974Du01), 61 7 (1968Lo03). $\delta(\text{M4/E3})=0.00$ 5 (1986St02), <0.36 or >2.7 (1968Lo03). $A_2=+0.64$ 3, $A_4=-0.04$ 5 (1968Lo03).
		1074.9@ ^b		2522.1	1/2 ⁺			
		3596.8	55.4 11	0	3/2 ⁺	E3		
3883.3	5/2 ⁻	286.3@ ^b	<2@	3597.0	9/2 ⁻			
		864.2@ ^b	<2@	3019.1	3/2 ⁻			
		1069.4@ ^b	<2@	2813.9	7/2 ⁻			
		1361.2@ ^b	<2@	2522.1	1/2 ⁺			
		3883.1	100	0	3/2 ⁺	D		$A_2=+0.25$ 3, $A_4=0.00$ 5 (1968Lo03). I_γ : other: 10 3 (1974Du01). I_γ : other: 90 3 (1974Du01). $A_2=-0.02$ 5, $A_4=+0.01$ 7 (1968Lo03). I_γ : other: 53 3 (1974Du01). I_γ : other: 47 3 (1974Du01). I_γ : other: 11 3 (1974Du01). I_γ : other: 27 3 (1974Du01). I_γ : other: 62 3 (1974Du01). I_γ : other: 9 2 (1974Du01). I_γ : other: 91 2 (1974Du01).
3938.9	3/2 ⁺	1416.8	8 1	2522.1	1/2 ⁺			
		3938.7	92 1	0	3/2 ⁺			
3942.6	11/2 ⁻	345.6	34 3	3597.0	9/2 ⁻			
		1128.7	66 3	2813.9	7/2 ⁻			
4082.6	3/2 ⁻	1063.5	17 2	3019.1	3/2 ⁻			
		1560.5	22 2	2522.1	1/2 ⁺			
		4082.4	61 3	0	3/2 ⁺			
4095.0	1/2 ⁺	1075.9	14 2	3019.1	3/2 ⁻			
		1572.9	86 4	2522.1	1/2 ⁺			
4126.0	7/2 ⁻	1312.1	100	2813.9	7/2 ⁻			
4475.2	1/2 ⁻ , 3/2 ⁻	591.9@ ^b		3883.3	5/2 ⁻			I_γ : <5 (1968Lo03).
		878.2@ ^b		3597.0	9/2 ⁻			I_γ : <7 (1968Lo03).
		1456.1	16 5	3019.1	3/2 ⁻			I_γ : other: 10 6 (1968Lo03).
		1661.3@ ^b		2813.9	7/2 ⁻			I_γ : <5 (1968Lo03).
		1953.0	47 5	2522.1	1/2 ⁺			I_γ : other: 29 15 (1968Lo03).
		4474.9	37 5	0	3/2 ⁺			I_γ : other: 61 21 (1968Lo03).
4514.1	5/2 ⁺	4513.8	100	0	3/2 ⁺			
4520.5	9/2 ⁻	578.9	22 5	3942.6	11/2 ⁻			
		923.5	78 5	3597.0	9/2 ⁻			
4679.1	7/2 ⁻	553.1	18 5	4126.0	7/2 ⁻			
		795.8@ ^b		3883.3	5/2 ⁻			I_γ : <10 (1968Lo03).
		1082.1@ ^b		3597.0	9/2 ⁻			I_γ : <10 (1968Lo03).

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$^{39}\text{K}(\text{p,p}'\gamma)$ **1974Du01,1986St02,1968Lo03** (continued) $\gamma(^{39}\text{K})$ (continued)

$E_i(\text{level})$	J_i^π	E_γ^\dagger	$I_\gamma^\#$	E_f	J_f^π	Comments		
4679.1	$7/2^-$	1660.0 ^{@b}		3019.1	$3/2^-$	I _γ : <10 (1968Lo03). I _γ : other: 100 (1968Lo03). I _γ : <10 (1968Lo03). I _γ : <5 (1968Lo03).		
		1865.2	82 5	2813.9	$7/2^-$			
		2156.9 ^{@b}		2522.1	$1/2^+$			
		4678.8 ^{@b}		0	$3/2^+$			
4737.7	$5/2^-, 7/2^-, 9/2^-$	1923.5 ^{&}		2813.9	$7/2^-$			
4738.9	$5/2^+$	4738.6 ^a		0	$3/2^+$			
4929.4	$3/2^+$	846.8	58 7	4082.6	$3/2^-$			
		2407.2	10 5	2522.1	$1/2^+$			
		4929.1	32 5	0	$3/2^+$			
5008.7	$7/2^-$	882.7	77 5	4126.0	$7/2^-$			
		1411.7	23 5	3597.0	$9/2^-$			
5009.0	$(3/2, 5/2^-, 7/2^-)$	1125.7	64 5	3883.3	$5/2^-$			
		1989.8	36 5	3019.1	$3/2^-$			
5157		2343	100	2813.9	$7/2^-$			
5163.0	$9/2^-$	642.5	53 10	4520.5	$9/2^-$			
		1037.0	10 5	4126.0	$7/2^-$			
		1220.4	37 10	3942.6	$11/2^-$			
5173.2	$(1/2, 3/2, 5/2)$	5172.8	100	0	$3/2^+$			
5261.7	$5/2^+$	5261.3	100	0	$3/2^+$			
5316.8	$3/2^+$	5316.4	100	0	$3/2^+$			
5354.4	$11/2^-$	1411.8	100	3942.6	$11/2^-$			
5501.3	$7/2^-$	822.2	37 5	4679.1	$7/2^-$			
		980.8	6 3	4520.5	$9/2^-$			
		1904.2	23 5	3597.0	$9/2^-$			
		2687.3	34 5	2813.9	$7/2^-$			
		5596.3	$5/2^+$	1470.3	7 3	4126.0	$7/2^-$	
		2782.3		23 5	2813.9	$7/2^-$		
5644.1	$7/2^-$	5595.9	70 7	0	$3/2^+$			
		906.6	39 5	4737.7	$5/2^-, 7/2^-, 9/2^-$			
		965.0	21 5	4679.1	$7/2^-$			
		1518.1	40 5	4126.0	$7/2^-$			
5710.6	$3/2^+$	5710.2	100	0	$3/2^+$			
5787.6	$(5/2, 7/2)^+$	5787.1	100	0	$3/2^+$			
5803.4	$7/2^-$	1282.9	36 5	4520.5	$9/2^-$			
		1677.4	24 5	4126.0	$7/2^-$			
		2989.4	40 5	2813.9	$7/2^-$			
5825.6	$1/2^-, 3/2^-$	5825.1	100	0	$3/2^+$			
5891	$(5/2, 7/2)^-$	728	3 2	5163.0	$9/2^-$			
		1371	14 5	4520.5	$9/2^-$			
		1765	12 5	4126.0	$7/2^-$			
		3077	71 7	2813.9	$7/2^-$			
		5936.9	$5/2^+$	5936.4	100	0	$3/2^+$	
6041.0		6040.5	100	0	$3/2^+$			
6093	$5/2^-, 7/2^-$	3279	100	2813.9	$7/2^-$			
6110.5	$1/2^-, 3/2^-$	3588.2	78 5	2522.1	$1/2^+$			
		6110.0	22 5	0	$3/2^+$			
6186		924	61 5	5261.7	$5/2^+$			
		6186	39 5	0	$3/2^+$			
6192	$(7/2^-)$	1672	79 5	4520.5	$9/2^-$			
		2249	21 5	3942.6	$11/2^-$			
6244.0		1564.9	35 5	4679.1	$7/2^-$			
		3429.9	65 5	2813.9	$7/2^-$			
6330.7	$3/2^+$	6330.1	100	0	$3/2^+$			
6356	$5/2^+$	2473		3883.3	$5/2^-$			
		6355		0	$3/2^+$			

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${}^{39}\text{K}(\text{p},\text{p}'\gamma)$ **1974Du01,1986St02,1968Lo03** (continued) $\gamma({}^{39}\text{K})$ (continued)

$E_i(\text{level})$	J_i^π	E_γ^\dagger	$I_\gamma^\#$	E_f	J_f^π	$E_i(\text{level})$	J_i^π	E_γ^\dagger	$I_\gamma^\#$	E_f	J_f^π
6396		2270		4126.0	$7/2^-$	6740	$(3/2^+, 5/2^+)$	6739		0	$3/2^+$
		3582		2813.9	$7/2^-$	6828		1899		4929.4	$3/2^+$
6465		754		5710.6	$3/2^+$			6827		0	$3/2^+$
		6464		0	$3/2^+$	6916	$3/2^+, 5/2^+$	6915	100	0	$3/2^+$
6502	$(3/2, 5/2)^+$	2619		3883.3	$5/2^-$	6943		6942	100	0	$3/2^+$
		6501		0	$3/2^+$	7021		7020	100	0	$3/2^+$
6527		6526	100	0	$3/2^+$	7051	$(3/2, 5/2)^-$	4237		2813.9	$7/2^-$
6546	$7/2^-$	3732	100	2813.9	$7/2^-$			7050		0	$3/2^+$
6653	$3/2^+, 5/2^+$	2178		4475.2	$1/2^-, 3/2^-$	7170		7169	100	0	$3/2^+$
		6652		0	$3/2^+$	7200		4386		2813.9	$7/2^-$
6740	$(3/2^+, 5/2^+)$	1567		5173.2	$(1/2, 3/2, 5/2)$			7199		0	$3/2^+$
		2001		4738.9	$5/2^+$	7260	$(3/2^+)$	4446		2813.9	$7/2^-$
		2857		3883.3	$5/2^-$			7259		0	$3/2^+$

[†] From level-energy differences with recoil correction removed. **1974Du01** give level energies from measured γ -ray energies but without giving values of the latter with uncertainties.

[‡] From $\gamma(\theta)$ data of **1968Lo03**.

[#] From **1986St02** for levels below 4200 and from **1974Du01** for levels above 4200.

[@] Observed in **1968Lo03**.

[&] **1974Du01** defined only one level near 4738.9 and placed 1923γ and 4739γ from this level with $I_\gamma(1925)/I_\gamma(4739)=29/3/71/3$.

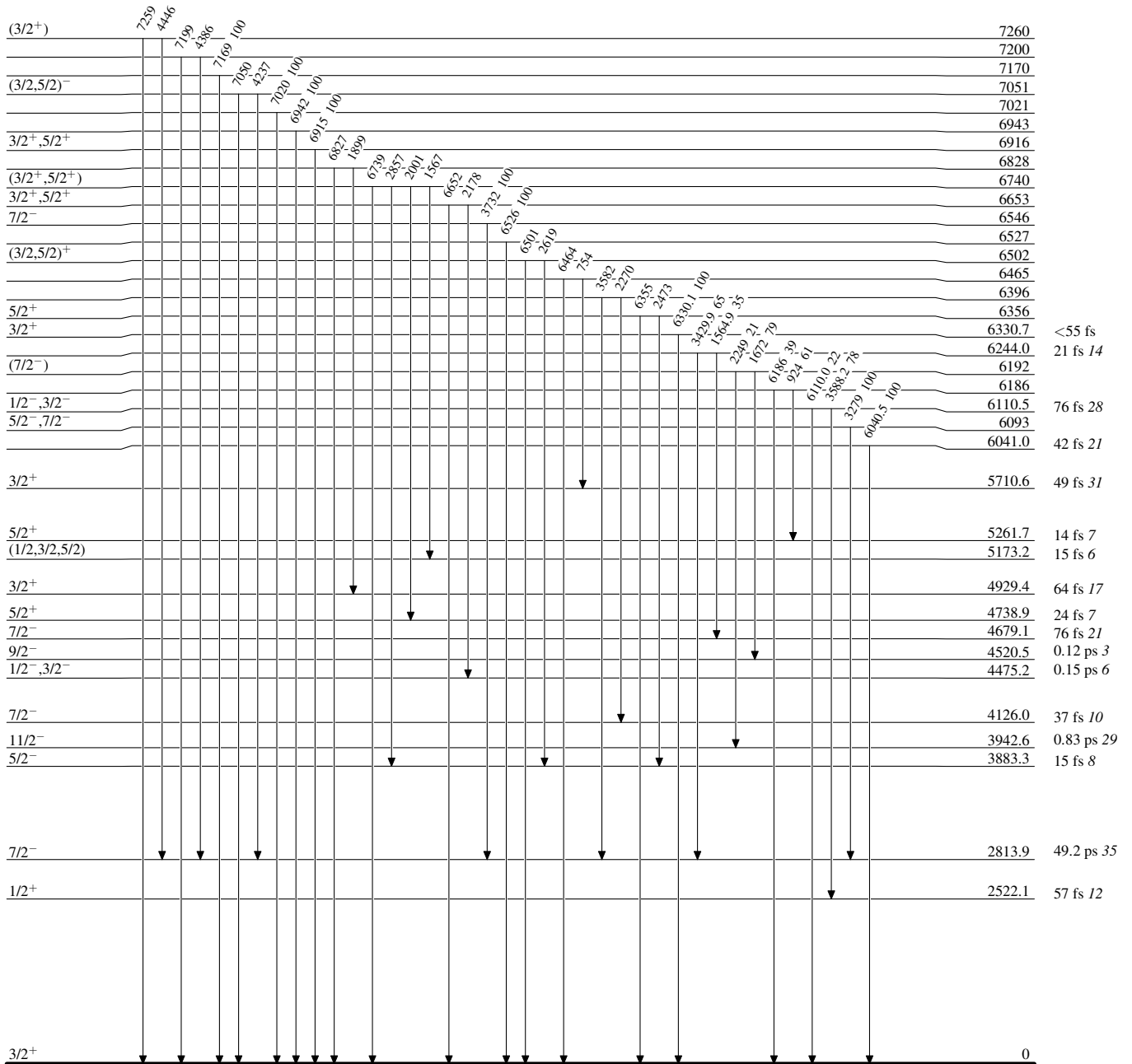
^a See comment for 1923γ .

^b Placement of transition in the level scheme is uncertain.

$^{39}\text{K}(p,p'\gamma)$ 1974Du01,1986St02,1968Lo03

Level Scheme

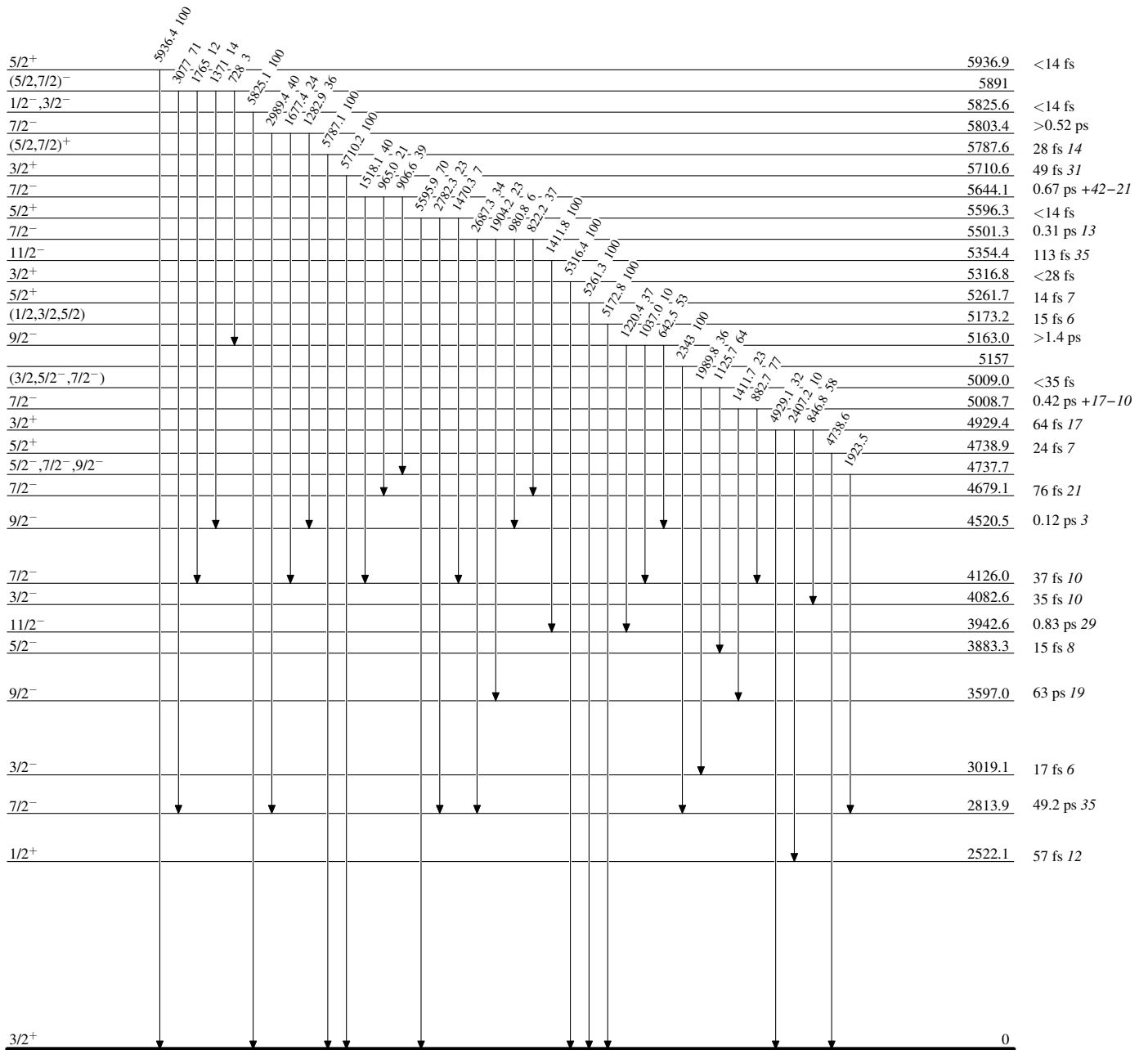
Intensities: % photon branching from each level



$^{39}\text{K}(\text{p},\text{p}'\gamma)$ 1974Du01,1986St02,1968Lo03

Level Scheme (continued)

Intensities: % photon branching from each level

 $^{39}\text{K}_{20}$

$^{39}\text{K}(\text{p},\text{p}'\gamma)$ 1974Du01,1986St02,1968Lo03

Legend

Level Scheme (continued)

Intensities: % photon branching from each level

-----► γ Decay (Uncertain)