^{41}K(α,nγ),(α,n) 1973Ar14,1973Dr08,1976Co26

History

Type	Author	Citation	Literature Cutoff Date
Full Evaluation	Jun Chen and Balraj Singh	NDS 190,1 (2023)	20-Jun-2023

1973Ar14: (α,nγ) E=10, 12, 14 MeV alpha particles were produced from the 80 cm cyclotron at the Research Institute for Physics in Stockholm. Target was K_2CO_3 (enriched to 99.18% in ^{41}K) on lead backings. γ-rays were detected with Ge(Li) detectors. Measured Eγ, Iγ, $\gamma\gamma$-coin. Deduced levels, J, π, γ-ray branching ratios.

1973Dr08: (α,nγ) E=6.5, 7.5 MeV alpha beam produced from the Manchester HILAC. Target of gold backed 400 μg/cm^2 KI (enriched to 96% in ^{41}K). Two Ge(Li) detectors for detecting γ-rays. Measured Eγ, Iγ, $\gamma\gamma$-coin. Deduced levels, branchings, half-lives using Doppler Shift Attenuation Method (DSAM).

1976Co26: (α,nγ) E=4.5, 7.5, 10.0 MeV alpha beams were produced from the 5.5 MV Van de Graaff accelerator of Strasbourg. Target was 150 μg/cm^2 KI (enriched to 95% in ^{41}K). γ rays were detected with two Ge(Li) detectors and neutrons were detected with a NE213 liquid scintillator. Measured Eγ, nγ-coin, $\gamma\gamma$-coin, Doppler-shift attenuation. Deduced $T_{1/2}$ for levels at 1648, 1651, 1680, and 1767.

Others:

1961Sm05: (α,n) E=8.29 MeV alpha beam produced from the Yale cyclotron. Target of 0.4 mg/cm^2 potassium chloride enriched to 82% in ^{41}K on a tantalum backing. Reaction neutrons detected by their proton recoils in Ilford C-2 emulsions. Measured neutron groups.

1961Ba13: (α,n) E=10 and 43 MeV at the Lawrence Radiation Laboratory. Measured isomeric ratio.

1961Ma06: (α,n) E=23-40 MeV from the 60-inch cyclotron at BNL. Measured isomeric ratio.

1964Ri08: (α,n) E=8-19 MeV from the Florida State University Tandem van de Graaff accelerator. Measured isomeric ratio.

1966Ke03: (α,nγ) E=6-13 MeV alpha beam produced from the Argonne tandem Van de Graaff accelerator. Target of natural KCl onto aluminum backing. NaI(Tl) detectors for detecting γ-rays. Measured $\sigma(E_\alpha)$ for pairs of isomeric states.

1989Ma46: (α,n) E=15-31.5 MeV. Measured residuals ground state, isomer production $\sigma(E_\alpha)$ ratio.

1991Sc07: (α,n) E=3-8 MeV from the University of Melbourne 5U Pelletron accelerator. Measured neutron yields with a 4π neutron detector. Deduced $\sigma(E_\alpha)$.

Additional information 1.

^{44}Sc Levels

E(level)[†]	J$^\pi$[‡]	$T_{1/2}$[#]	Comments
0.0	2$^+$		
67.44 *26*	1$^-$		
146.04 *35*	0$^-$		
234.71 *27*	2$^-$	>3.8 ps	
270.9 *4*	6$^+$	58.61 h *10*	$T_{1/2}$: from the Adopted Levels.
349.74 *31*	4$^+$	>5.5 ps	
424.52 *29*	3$^-$	>5.5 ps	
531.69 *30*	3	>3.8 ps	
630.79 *34*	4$^-$	>3.8 ps	
640.9 *9*			E(level): 1973Dr08 prove that the 642 level deexcited by a single 496γ in (p,γ) by 1971PoZP is erroneous due to non-observation of the 496γ, which is not observed in 1973Ar14 either. But this 641 level proposed by 1973Ar14 is based on a 573.4γ to the 68 level. This level is considered different from the 642 level in 1971PoZP and kept by the evaluators, even though the 573.4γ from 1973Ar14 is not reported in 1973Dr08.
666.6 *8*	1$^+$	49 fs *+16−19*	
763.5 *5*	3$^+$	215 fs *56*	
828.2 *6*			
966.9 *11*			
985.5 *9*		1.39 ps *+71−59*	
1006.0 *5*		≥5.5 ps	
1012.0? *20*			E(level): this level is listed in Table II of 1973Ar14, but not adopted in their proposed level scheme and it is not reported in 1973Dr08 and other studies. It is therefore considered questionable and not included in the Adopted dataset by the evaluators.

Continued on next page (footnotes at end of table)

^{41}K(α,nγ),(α,n) 1973Ar14,1973Dr08,1976Co26 (continued)

^{44}Sc Levels (continued)

E(level)[†]	Jπ[‡]	$T_{1/2}$[#]
1052.3 *6*		170 fs *+69−59*
1102.9 *7*		
1185.6 *5*	3^+	39 fs *15*
1197.5 *6*		>2 ps
1326.0 *7*	3^+	125 fs *34*
1425.9 *5*	$(1,2)^-$	
1506.6 *10*		
1531.6 *10*		
1569.5 *21*		
1592.0 *20*		
1647.9 *6*		122[@] fs *19*
1651.6 *5*		107[@] fs *24*
1680.0 *6*		97[@] fs *23*
1766.4 *4*		55[@] fs *12*
2100.8? *20*		
2175.6? *20*		
2425? *4*		
2606.5? *21*		
2630.2 *21*		
2665.0? *23*		
2693 *5*		
2718.0 *23*		

[†] From a least-squares fit to Eγ data, assuming ΔEγ=0.5 keV for Eγ quoted to nearest tenth keV and 1 keV for Eγ quoted to nearest keV where no uncertainty is quoted. Neutron groups corresponding to levels at 1930, 2340, 2610, 2930 and 3340 are not given here.

[‡] From 1973Dr08 based on γ(θ) from their (p,nγ) measurement. See (p,nγ) dataset for details.

[#] From DSAM in 1973Dr08, unless otherwise noted. A systematic uncertainty of 25% due to uncertainties in the stopping power theory as stated in 1973Dr08 has been added in quadrature by the evaluators.

[@] From DSAM in 1976Co26. A 20% uncertainty assumed for stopping power has been taken into account (1976Co26).

γ(^{44}Sc)

E_i(level)	J_i^π	E_γ[†]	I_γ[‡]	E_f	J_f^π	Mult.	Comments
67.44	1^-	67.9	100	0.0	2^+		I(rel)=50.
146.04	0^-	78.4	100	67.44	1^-		I(rel)=5.
		146.3	5	0.0	2^+		I(rel)=0.3.
234.71	2^-	88.7 *10*	<3	146.04	0^-		I(rel)=0.8.
		166.9 *5*	45 *3*	67.44	1^-		I(rel)=15.
		234.6 *5*	100 *3*	0.0	2^+		I(rel)=44.2.
270.9	6^+	270.6 *5*	100[a]	0.0	2^+	E4	Mult.: from the Adopted Gammas. I(rel)=6.5.
349.74	4^+	349.5 *5*	100	0.0	2^+		I(rel)=100.
424.52	3^-	189.8 *5*	45 *3*	234.71	2^-		I(rel)=5.3.
		356.5 *5*	100 *3*	67.44	1^-		I(rel)=17.5.
		424.5 *5*	28 *3*	0.0	2^+		I(rel)=5.6.
531.69	3	181.6[d] *10*	4 *2*	349.74	4^+		I(rel)=0.8.
		296.3 *5*	100 *4*	234.71	2^-		I(rel)=10.
		464.8 *5*	20 *4*	67.44	1^-		I(rel)=2.2.
		531.7 *5*	80 *4*	0.0	2^+		I(rel)=7.3. Eγ: 1973Ar14 also place this γ from 1197 level, but this placement is not adopted in their final level scheme.

Continued on next page (footnotes at end of table)

^{41}K(α,nγ),(α,n) 1973Ar14,1973Dr08,1976Co26 (continued)

γ(^{44}Sc) (continued)

E_i(level)	J_i^π	E_γ[†]	I_γ[‡]	E_f	J_f^π	Comments
630.79	4⁻	206.1 *5*	18 *2*	424.52	3⁻	I(rel)=5.4.
		281.0 *5*	100 *4*	349.74	4⁺	I(rel)=22.5.
		361.6[d] *20*	2	270.9	6⁺	I(rel)=0.4.
		396.0 *5*	86 *4*	234.71	2⁻	I(rel)=21.7.
640.9		573.4 *10*	100[a]	67.44	1⁻	E_γ: from 1973Ar14 only; not reported in 1973Dr08. I(rel)=1.3.
666.6	1⁺	667[#]	100	0.0	2⁺	I(rel)=5.3 for probable doublet. E_γ: other: 665 *2* in 1973Ar14 for a possible doublet.
763.5	3⁺	412.6 *10*	7.5 *20*	349.74	4⁺	I(rel)=1.3.
		761.9 *10*	100 *2*	0.0	2⁺	I(rel)=18.3. E_γ: seen in coincidence with 745γ in 1973Dr08, which excludes another placement of this γ from 1507 level deexcited by 745γ in 1973Ar14.
828.2		403.6[&d] *5*	<170[a]	424.52	3⁻	I(rel)=3.9.
		829 *2*	100[a]	0.0	2⁺	I(rel)=2.3.
966.9		696.0 *10*	100[a]	270.9	6⁺	I(rel)=19.2.
985.5		915[d] *2*	37[a]	67.44	1⁻	I(rel)=1.6. E_γ: report only in 1973Ar14; this γ is not seen in 1973Dr08 and other studies which only report a single 986γ from this level. Besides, with Iγ(915) in 1973Ar14 and $T_{1/2}$ in 1973Ar14, it would require a B(M2)(W.u.)=750 for this transition that is greatly larger than RUL=3. Therefore, this transition is considered questionable and not included in the Adopted dataset by the evaluators.
		986.2[c] *10*	100[a]	0.0	2⁺	I(rel)=4.3 for a probable doublet.
1006.0		375[#]	88 *20*	630.79	4⁻	I(rel)=5.8. E_γ: a Eγ=375.1 *10* is assigned to ^{44}Ca in 1973Ar14.
		581.5 *10*	100 *15*	424.52	3⁻	I(rel)=5.
		656.4 *10*	56 *24*	349.74	4⁺	I(rel)=1.6.
		771.7[c&d] *10*	53 *18*	234.71	2⁻	I(rel)=10 for a probable doublet.
1012.0?		1012[&d] *2*	100[a]	0.0	2⁺	I(rel)=7.6 for 1012γ+1016γ(^{44}ca).
1052.3		701.4 *10*	100[a]	349.74	4⁺	I(rel)=15.8.
		986.2[cd] *10*	<27[a]	67.44	1⁻	I(rel)=4.3 for a probable doublet.
		1052.0[&d] *10*	36[a]	0.0	2⁺	E_γ: 1973Dr08 report that 1052γ is probably in coincidence with 235γ, 281γ, 350γ and 396γ, which make this placement of 1052γ to g.s. by 1973Ar14 questionable. Note that a 1052.3γ is placed from the 1683 level by 2005La19 in (^{18}O,p3nγ). I(rel)=5.7.
1102.9		436.7 *10*	60[a]	666.6	1⁺	I(rel)=1.5.
		569.9 *10*	100[a]	531.69	3	I(rel)=2.5.
		869.1[d] *10*	<160[a]	234.71	2⁻	I(rel)=4.0.
		1034.0 *10*	100[a]	67.44	1⁻	I(rel)=4.3.
1185.6	3⁺	835.1 *10*	100 *10*	349.74	4⁺	I(rel)=3.5.
		1185.8[#]	67 *10*	0.0	2⁺	I(rel)=5.8 for a probable doublet of 1184.4+1185.8.
1197.5		566.4 *10*	100 *12*	630.79	4⁻	I(rel)=5.8.
		771.7[c&] *10*	64 *19*	424.52	3⁻	I(rel)=10 for a probable doublet.
		849.8 *10*	72[a]	349.74	4⁺	I(rel)=4.2.
		926.0 *10*	74 *12*	270.9	6⁺	I(rel)=6.7.
1326.0	3⁺	322[d] *2*	12[a]	1006.0		I(rel)=1.4.
		693[d] *3*	20[a]	630.79	4⁻	I(rel)=2.3.
		976[#]	100 *9*	349.74	4⁺	E_γ: a Eγ=975.7 *20* with I(rel)=11.3 is assigned to ^{45}Sc in 1973Ar14.

Continued on next page (footnotes at end of table)

^{41}K(α,nγ),(α,n) 1973Ar14,1973Dr08,1976Co26 (continued)

γ(^{44}Sc) (continued)

E_i(level)	J_i^π	E_γ [†]	I_γ [‡]	E_f	J_f^π	Comments
1326.0	3^+	1326[#]	79 *9*	0.0	2^+	Eγ=1325 *2* with I(rel)=4.5 for a probable doublet.
1425.9	$(1,2)^-$	665[d] *2*		763.5	3^+	I(rel)=5.3 for probable doublet. E_γ: placed by 1973Ar14; not confirmed in other studies. This γ is also placed from 667 level by 1973Ar14.
		1001[#]	56 *9*	424.52	3^-	I(rel)=25 for a doublet.
		1191[#]	37 *9*	234.71	2^-	
		1280[#]	<23	146.04	0^-	
		1358[#]	40 *5*	67.44	1^-	
		1426[&] *2*	100 *7*	0.0	2^+	I(rel)=1.4.
1506.6		745 *2*	30	763.5	3^+	I(rel)=2.5. E_γ: 1973Ar14 also place this γ from a 745 level, which however is excluded by observed coincidence of this γ with the 762γ to g.s. in 1973Dr08.
		1235.2[c] *10*	100	270.9	6^+	I(rel)=8.2 for a probable doublet.
1531.6		1184.4[&d] *20*	<109	349.74	4^+	I(rel)=5.8 for a probable doublet of 1184.4+1185.8.
		1260.0[&] *10*	100	270.9	6^+	I(rel)=5.3.
1569.5		806 *2*	100	763.5	3^+	I(rel)=3.5.
1592.0		1524.5 *20*	100	67.44	1^-	I(rel)=4.8.
1647.9		1580.4[@] *5*	100	67.44	1^-	
1651.6		1651.6[@] *5*	100	0.0	2^+	
1680.0		1612.7[@] *5*	100	67.44	1^-	
		1677 *2*	<15[b]	0.0	2^+	I(rel)=10.8.
1766.4		1001.9[&d]	<250	763.5	3^+	I(rel)=25 for a doublet.
		1235.2[cd] *10*	<82	531.69	3	I(rel)=8.2 for a probable doublet.
		1699.7[@] *5*	<28	67.44	1^-	I(rel)=2.8 for a probable doublet.
		1767 *2*	100	0.0	2^+	I(rel)=10.
2100.8?		1751[cd] *2*	100	349.74	4^+	I(rel)=2.5 for probable triplet (1973Ar14).
2175.6?		1751[cd] *2*	100	424.52	3^-	I(rel)=2.5 for probable triplet (1973Ar14).
2425?		2154[&d] *4*	100	270.9	6^+	I(rel)=4.2.
2606.5?		1409[d] *2*	100	1197.5		I(rel)=1.5.
2630.2		1802 *2*	100	828.2		I(rel)=3.4.
2665.0?		1698[d] *2*	100	966.9		I(rel)=2.8 for a probable doublet.
2693		1929 *5*	100	763.5	3^+	I(rel)=1.3.
2718.0		1751[c] *2*	100	966.9		I(rel)=2.5 for probable triplet (1973Ar14).

[†] From 1973Ar14, unless otherwise stated. For those unplaced transitions from 1973Ar14, it is not unknown whether they belong to ^{44}Sc.

[‡] From 1973Dr08 up to 1426 level and above that level values are deduced from relative intensities I(rel) in 1973Ar14 as given under comments, unless otherwise stated. Quoted values of I(rel) given under comments are the original values from 1973Ar14 re-normalized to Iγ(349.5γ)=100 (from original 120 in 1973Ar14) by the evaluators.

[#] From 1973Dr08.

[@] From 1976Co26.

[&] Contaminated by similar transitions in ^{44}Ca (1973Ar14).

[a] From I(rel) in 1973Ar14.

[b] From I(1681)/I(1613)<0.15 in 1976Co26.

[c] Multiply placed.

[d] Placement of transition in the level scheme is uncertain.

[x] γ ray not placed in level scheme.

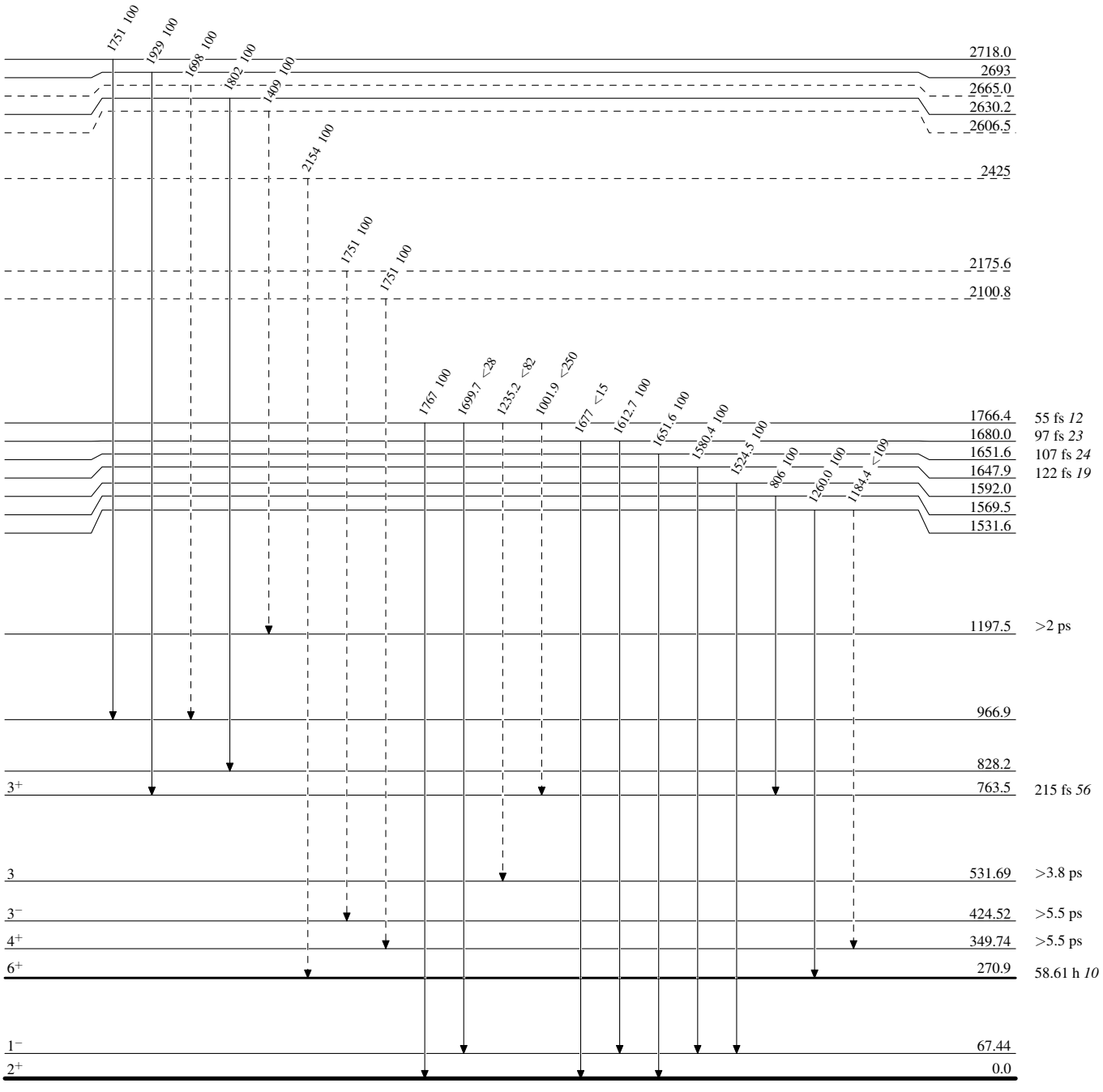
^{41}K(α,nγ),(α,n) 1973Ar14,1973Dr08,1976Co26

Legend

Level Scheme

Intensities: Relative photon branching from each level

γ Decay (Uncertain)



$^{44}_{21}Sc_{23}$

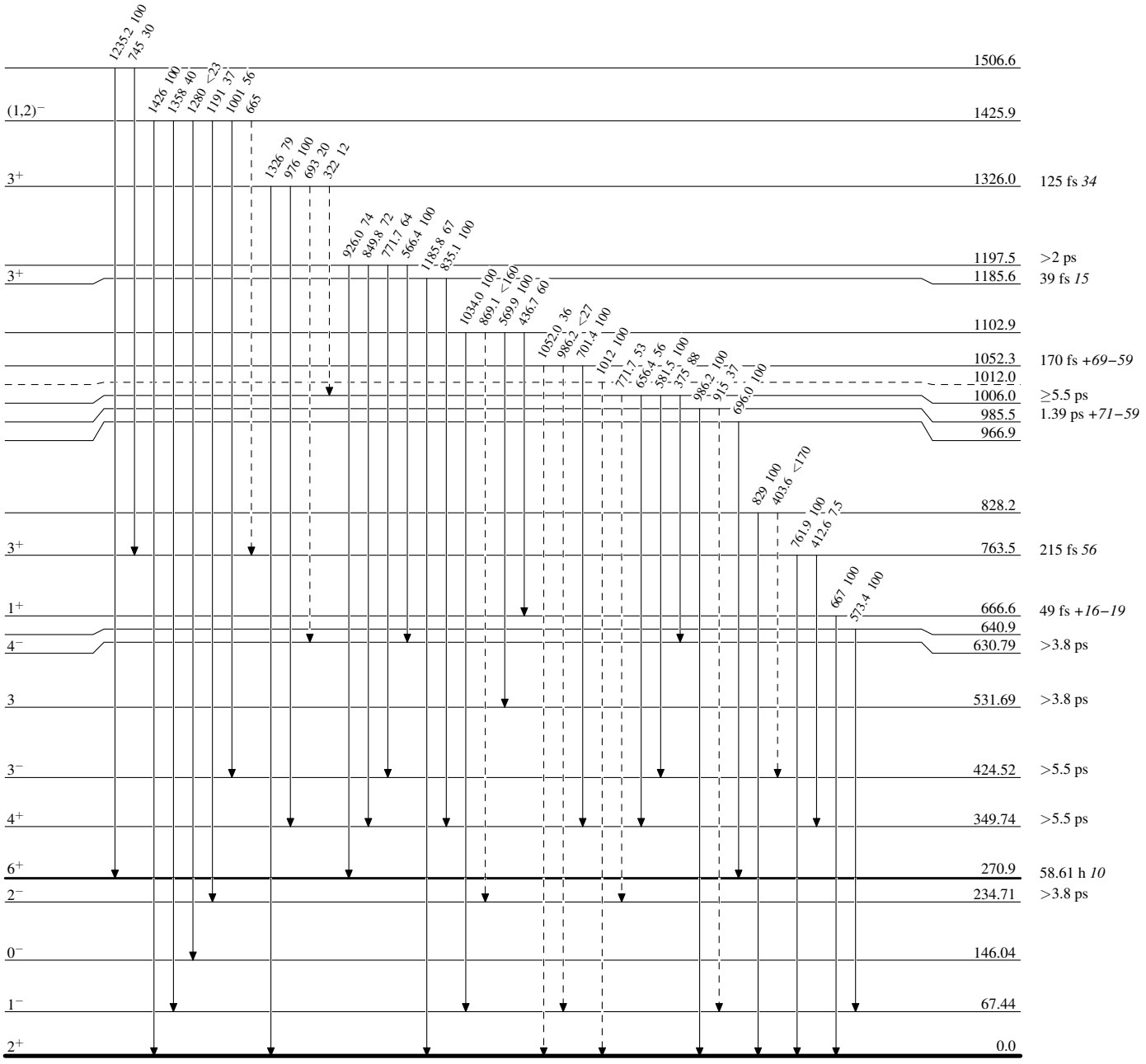
^{41}K(α,nγ),(α,n) 1973Ar14,1973Dr08,1976Co26

Legend

Level Scheme (continued)

Intensities: Relative photon branching from each level

γ Decay (Uncertain)



$^{44}_{21}Sc_{23}$

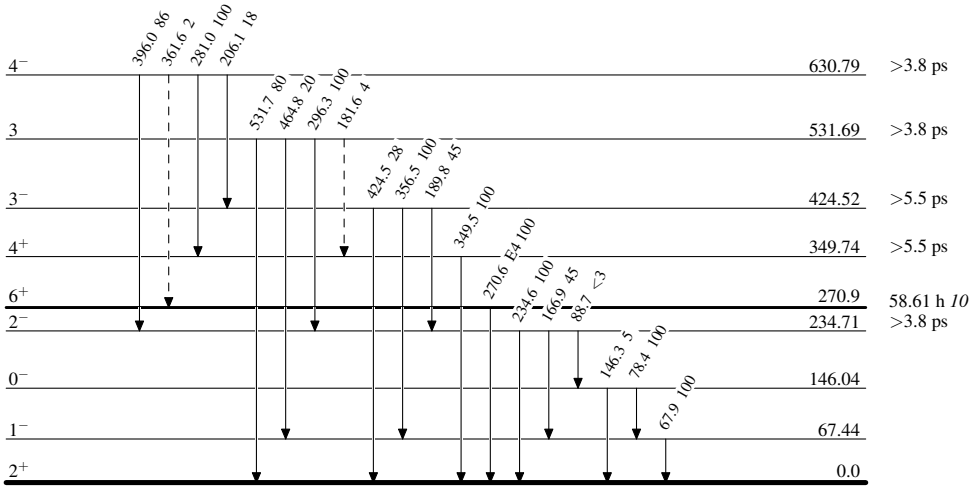
^{41}K(α,nγ),(α,n) 1973Ar14,1973Dr08,1976Co26

Legend

Level Scheme (continued)

Intensities: Relative photon branching from each level

γ Decay (Uncertain)



$^{44}_{21}Sc_{23}$