Nuclear Data Sheets for A=40*

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Abstract: The experimental nuclear structure data and decay data are evaluated for the known nuclides of mass 40 (Mg, Al, Si, P, S, Cl, Ar, K, Ca, Sc, Ti). Detailed evaluated nuclear structure information is presented with the best values recommended for level energies, half-lives, γ -ray energies and intensities, decay properties (energies, intensities and placement of radiations), and other spectroscopic data. The ^{40}Ca and ^{40}K nuclides remain as the most extensively studied from many different reactions and decays; no excited states are known in ^{40}Mg , ^{40}Al , ^{40}P and ^{40}Ti . This work supersedes the earlier full evaluation of A=40 by J. Cameron and B. Singh (2004Ca38).

Cutoff Date: Literature available up to September 30, 2015 has been included. The main bibliographic source was the NSR database (2011Pr03) at the Brookhaven laboratory webpage: www.nndc.bnl.gov/nsr/.

General Policies and Organization of Material: See the January issue of the *Nuclear Data Sheets* or <http://www.nndc.bnl.gov/nds/NDSPolicies.pdf>.

General Comments: The statistical analysis of γ -ray data and deduced level schemes is carried out through computer codes available at NNDC, BNL website: www.nndc.bnl.gov. The direct feedings to excited states in β^- and ϵ decays have generally been computed from $I(\gamma+\text{ce})$ intensity balances at each level; the associated $\log ft$ values are calculated using the $\log ft$ code. The Q values and particle-separation energies have been adopted from 2012Wa38 (AME-12). In cases where weighted averaging procedures have been used, the assigned uncertainty is generally not lower than the lowest uncertainty given in a measurement. Nuclear charge radii have been adopted from 2013An02 evaluation. Moments are from 2014StZZ and 2013StZZ whenever possible. Theoretical total conversion coefficients are from the BrIcc code (2008Ki07) for frozen-orbit option with an implicit uncertainty of 1.4% when not stated.

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Skeleton Scheme for A=40

Skeleton Scheme for A=40 (continued)

3/2+ 0.0
80.4 ms 9
41Ti19

(3/2+) 0.0
21.2 ms 7
43Cr19

0.0
111 ms 7
44V21

Ground-State and Isomeric-Level Properties				
Nuclide	Level	J π	T _{1/2}	Decay Mode
40Mg	0.0	0+	>170 ns	% β^- =100 ; % β^- n=? ; % β^- 2n=?
40Al	0.0		>260 ns	% β^- =100 ; % β^- n=? ; % β^- 2n=?
40Si	0.0	0+	33.0 ms 10	% β^- =100 ; % β^- n=? ; % β^- 2n=?
40P	0.0	(2-,3-)	150 ms 8	% β^- =100 ; % β^- n=15.8 21 ; % β^- 2n=?
40S	0.0	0+	8.8 s 22	% β^- =100
40Cl	0.0	2-	1.35 min 3	% β^- =100
40Ar	0.0	0+	stable	
40K	0.0	4-	1.248 $\times 10^9$ y 3	% β^- =89.28 11 ; % ϵ +% β^+ =10.72 11
40Ca	0.0	0+	stable	
40Sc	0.0	4-	182.3 ms 7	% ϵ +% β^+ =100 ; % ϵ p=0.44 7 ; % ϵ α =0.017 5
40Ti	0.0	0+	52.4 ms 3	% ϵ +% β^+ =100 ; % ϵ p=100
41P	0.0		101 ms 5	% β^- n=30 10
41Ti	0.0	3/2+	80.4 ms 9	% ϵ p $\approx$ 100
43Cr	0.0	(3/2+)	21.2 ms 7	% β^+ 3p=0.18 13
44V	0.0		111 ms 7	% ϵ α =?

S(n) 19120 SY

Adopted Levels

$Q(\beta^-)=20630$ SY; $S(n)=1740$ SY; $S(p)=30650$ CA; $Q(\alpha)=-25790$ CA [2012Wa38,1997Mo25](#)

$\Delta Q(\beta^-)=780$, $\Delta S(n)=790$ (syst,[2012Wa38](#)).

$Q(\beta^-)$ and $S(n)$ are from [2012Wa38](#); $S(p)$ and $Q(\alpha)$ are from [1997Mo25](#).

$S(2n)=1610$ 780, $Q(\beta^-n)=19540$ 780 (syst,[2012Wa38](#)). $S(2p)=54010$ (theory,[1997Mo25](#)).

First identification of ^{40}Mg nuclide as particle stable by [2007Ba71](#).

[2014Cr02](#): $C(^{42}\text{Si},X)$ One- and two-proton knockout reactions from ^{42}Si were carried out at Radioactive Isotope Beam Factory (RIBF) at RIKEN. A primary beam of ^{48}Ca , at an energy of 345 MeV/nucleon, with an average intensity of approximately 70 pnA, was fragmented in a thick (15-mm) rotating Be production target to produce a cocktail of projectile-like fragments and was selected through the BigRIPS fragment separator. Secondary beam fragments were identified event by event through a combination of energy loss and time-of-flight and bombarded a 4.02 g/cm^2 thick carbon target at the focal point of the ZeroDegree spectrometer (ZDS). Reaction products were identified by ZDS. Deduced inclusive cross section for 2p knockout from ^{42}Si . Shell model calculation considering the SDPFU-Si and SDPF- μ interactions. A prolate deformation for the ^{40}Mg g.s. has been suggested. A total of 5 events of ^{40}Mg were observed for 9.65×10^5 incident ^{42}Si nuclei.

[2007Ba71](#): $W(^{48}\text{Ca},X\gamma)$ $E=141$ MeV/nucleon beam from the National Superconducting Cyclotron Laboratory (NSCL). The fragments were separated with the A1900 fragment separator. Isotopic identification by multiple ΔE signals, magnetic rigidity, total energy and time of flight analysis. Detectors: plastic scintillators, parallel-plate avalanche counters (PPACs) and silicon PIN diodes. A total of three events were assigned to ^{40}Mg . This establishes stability of ^{40}Mg against particle emission.

[2002Lu19](#) and [2002No11](#) (also [2003Pe31](#)) searched for evidence for the formation of ^{40}Mg nuclide in fragmentation of ^{48}Ca beam at 59, 64 MeV/nucleon bombarding a ^{181}Ta target at RIKEN-RIPS facility. With a predicted cross section of 0.01 pb, only one event was expected; but none was observed. Thus the identification and particle stability of ^{40}Mg remained uncertain in this work.

Structure calculations:

[2014Ca21](#) (energy and $B(E2)$ of first 2^+ state).

[2014Eb02](#) (electric dipole strengths of PDR).

[2014Ch02](#) (levels, rms radii, occupation probabilities).

[2014Wa14](#) (binding energies, $J\pi$, deformation).

[2013Do17](#) (levels, $J\pi$, bands, g factor, $B(E2)$).

[2006Yo07](#) (transition strengths, QRPA).

[2006Zh19](#) (binding energies, deformation parameters, $B(E2)$).

[2004Ca34](#) (level energies, Q_2 , $B(E2)$, deformation).

[2002Ro32](#) (levels, moments, potential energy surface).

[1999Si13](#) ($BE(2)$, electric quadrupole and magnetic moments).

[1999La18](#) ($B(E2)$, radii, deformation).

 ^{40}Mg Levels

E(level)	J^π	$T_{1/2}$	Comments
0	0^+	>170 ns	<p>$\% \beta^- = 100$; $\% \beta^-n = ?$; $\% \beta^-2n = ?$</p> <p>Theoretical $\% \beta^-n = 44.4$, $\% \beta^-2n = 17.8$ (2003Mo09).</p> <p>2014Cr02 measured inclusive cross section $= 40\text{ }\mu\text{b} + 27 - 17$ for 2p knockout from ^{42}Si, in better agreement with the calculated (SDPF-μ) total value of $67\text{ }\mu\text{b}$ for 0^+ g.s. and first 2^+ state ($51\text{ }\mu\text{b}$ for g.s. and $16\text{ }\mu\text{b}$ for first 2^+), presumably indicates that only one of the two predicted 0^+ states is bound in ^{40}Mg, considering recommended $S_n(^{40}\text{Mg}) = 1740$ keV 790 (syst,2012Wa38) and predicted second 0^+ state at 1683 keV from SDPF-μ calculations.</p> <p>$T_{1/2}$: limiting value estimated from time-of-flight of ≈ 170 ns (figure 3 in 2007Ba71) at NSCL facility. The actual half-life is expected to be much longer as suggested by 10 ms from systematics (2012Au07), 12.5 ms from calculations by 2003Mo09, 2.4 ms from calculations by 2013Li39.</p>

Adopted Levels

$Q(\beta^-)=22540$ SY; $S(n)=1090$ SY; $S(p)=21590$ SY; $Q(\alpha)=-20360$ SY [2012Wa38](#)

$\Delta(Q(\beta^-))=550$, $\Delta(S(n))=710$, $\Delta(S(p))=720$, $\Delta(Q(\alpha))=780$ (syst,[2012Wa38](#)).

$S(2n)=4380$ 560, $Q(\beta^-n)=17580$ 510 (syst,[2012Wa38](#)).

First identification of ^{40}Al nuclide by [1997Sa14](#).

^{40}Al isotope identified in $^{181}\text{Ta}(^{48}\text{Ca},X)$ reaction at $E=70$ MeV/nucleon ([1997Sa14](#)). A total of 34 events were observed in this study. In [1996Sa34](#) (from the same group as [1997Sa14](#)) only one event was tentatively assigned to ^{40}Al .

Structure calculations: [2013Li39](#) (levels, $T_{1/2}$, β -delayed emission probabilities, $\log ft$, branching ratios), [2013Sh05](#) (binding energy, charge radii, deformation parameter).

 ^{40}Al Levels

E(level)	$T_{1/2}$	Comments
0.0	>260 ns	$\% \beta^- = 100$; $\% \beta^- n = ?$; $\% \beta^- 2n = ?$ Theoretical $\% \beta^- n = 15.6$, $\% \beta^- 2n = 73.8$, $\% \beta^- 3n = 8.5$ (2003Mo09). $T_{1/2}$: estimated from TOF of the experimental arrangement (1997Sa14). Calculated $T_{1/2}(\beta^- \text{ decay}) = 3.7$ ms (2003Mo09), 9.8 ms to 13.0 ms for different $J\pi$ values (2013Li39).

Adopted Levels, Gammas

$Q(\beta^-)=13.50\times 10^3$ 26; $S(n)=4.96\times 10^3$ 25; $S(p)=22860$ SY; $Q(\alpha)=-17.38\times 10^3$ 51 2012Wa38

$\Delta(S(n))=550$ (syst, 2012Wa38).

$S(2n)=6543$ 240, $S(2p)=43220$ 550 (syst), $Q(\beta^-n)=10190$ 250, (2012Wa38).

First identification of ^{40}Si nuclide by 1989Gu03.

1989Gu03: ^{40}Si produced and identified in $^{181}\text{Ta}(^{48}\text{Ca},X)$ reaction at 55 MeV/nucleon.

2004Gr20 (also 2004Gr28, 2003Gr22): ^{40}Si produced by fragmentation of ^{48}Ca beam at 60 MeV/nucleon with a ^9Be target followed by separation of fragments by LISE3 spectrometer; measured β , γ , $T_{1/2}$.

2006Kh08: $\text{Si}(^{40}\text{Si},X)$ $E=30\text{--}65$ MeV. Measured cross section, deduced radius and isospin dependence. Measured $\langle r_0^2 \rangle = 1.21 \text{ fm}^2$ 6.

Mass measurement: 2007Ju03, 2000Sa21 (also 2001Sa72).

Structure calculations: 2014Ca21 (energies and $B(E2)$ of first 2^+ state), 2014Eb02 (low-lying electric dipole strengths of PDR, deformation), 2013Ha27 (deformation, binding energy), 2013Xu01 (binding energy, $S(2n)$, $S(2p)$, rms charge, moment).

 ^{40}Si LevelsCross Reference (XREF) Flags

A $^1\text{H}(^{40}\text{Si}, p'\gamma), ^1\text{H}(^{42}\text{P}, X\gamma)$
B $\text{C}(^{44}\text{S}, ^{40}\text{Si}\alpha\gamma)$

E(level)	J^π	$T_{1/2}$	XREF	Comments
0	0^+	33.0 ms 10	AB	$\% \beta^- = 100$; $\% \beta^- n = ?$; $\% \beta^- 2n = ?$ $\% \beta^- n = 53$ 12 (preliminary value from 1999YoZW). Theoretical $\% \beta^- n = 48.7$, $\% \beta^- 2n = 0.04$ (2003Mo09). $T_{1/2}$: from 2004Gr20 (also 2003Gr22, 2004Gr28). Calculated $T_{1/2}(\beta^- \text{ decay}) = 30.6$ ms (2003Mo09).
986 5	(2^+)		AB	J^π : systematics of even-even nuclides; also predicted by shell-model calculations (2012Ta20).
1624? 7	$(0^+, 2^+, 4^+)^{\dagger}$		AB	E(level): 1614 14 from 2012Ta20 in $\text{C}(^{44}\text{S}, ^{40}\text{Si}\alpha\gamma)$. J^π : predicted by shell-model calculations (2012Ta20).
1831? 8			A	
2524? 19	$(4^+)^{\dagger}$		B	E(level): this level is tentatively assigned by 2012Ta20 in $\text{C}(^{44}\text{S}, ^{40}\text{Si}\alpha\gamma)$ based on $\gamma\gamma$ -coin as the first 4^+ state predicted by shell-model calculations. The resulting energy ratio between the first 4^+ and 2^+ states is $R_{4/2} = 2.56$ 5. Another possible candidate for the first 4^+ state is 1614 keV from the $629\gamma \rightarrow 985\gamma$ cascade (2012Ta20).

† From shell-model calculations 2012Ta20 suggest that the 2524 level is the first 4^+ state and that the 1624 level has $J^\pi = 0$ or 2^+ . They do not rule out the possibility that the 1624 level is the 4^+ state; however, they argue that the systematics of $E(4^+)/E(2^+)$ ratio of neighbouring nuclei favors the first alternative.

 $\gamma(^{40}\text{Si})$

$E_\gamma^{\dagger}$	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Comments
638 ‡ 5	1624?	$(0^+, 2^+, 4^+)$	986	(2^+)	E_γ : 629 8 from 2012Ta20 in $\text{C}(^{44}\text{S}, ^{40}\text{Si}\alpha\gamma)$.
845 ‡ 6	1831?		986	(2^+)	
986 5	986	(2^+)	0	0^+	E_γ : 985 11 from 2012Ta20 in $\text{C}(^{44}\text{S}, ^{40}\text{Si}\alpha\gamma)$.
1539 16	2524?	(4^+)	986	(2^+)	E_γ : from 2012Ta20 in $\text{C}(^{44}\text{S}, ^{40}\text{Si}\alpha\gamma)$.

† From 2006Ca26 in $^1\text{H}(^{40}\text{Si}, p'\gamma), ^1\text{H}(^{42}\text{P}, X\gamma)$, unless otherwise noted.

‡ Weak γ seen only in the pn removal reaction from ^{42}P (2006Ca26).

§ Placement of transition in the level scheme is uncertain.

$^1\text{H}(^{40}\text{Si},\text{p}'\gamma), ^1\text{H}(^{42}\text{P},\text{X}\gamma)$ 2006Ca26,2007Ca35

2007Ca35: Primary beam of ^{48}Ca at 140 MeV/nucleon was provided by the Coupled Cyclotron Facility. ^9Be target used. ^{40}Si secondary beam isolated using A1900 fragment separator. Si particles directed onto the RIKEN LH_2 target. The γ -ray measuring array around the LH_2 target consisted of 16 SeGA detectors at angles of 37° and 90° . Deformation parameter deduced from measured excitation cross section.

2006Ca26: Beams= ^{40}Si and ^{42}P , target=liquid hydrogen (LH_2). Beams of ^{40}Si and ^{42}P were obtained from fragmentation of primary beam of ^{48}Ca at 140 MeV/nucleon impinging upon a ^9Be target. The secondary target was liquid hydrogen (LH_2). The fragments were separated by A1900 fragment separator $\text{B}\rho$ - ΔE - $\text{B}\rho$ method at NSCL, Michigan facility. Prompt γ rays were detected by SeGA γ -detector array of 32-fold segmented HPGe detectors. FWHM $\approx 3\%$ at 1 MeV.

 ^{40}Si Levels

E(level)	J^π	Comments
0	0^+	
986 5	2^+	feeding-corrected excitation cross-section=20.2 mb $+2I-47$ (2007Ca35). $\beta_2(\text{p},\text{p}')=0.37 +2-5$ (Vibrational), $0.35 +2-4$ (prolate), $0.39 +2-5$ (oblate). Sign of β_2 is not given (2007Ca35).
1624? [†] 7		
1831? [†] 8		

[†] 2006Ca26 suggest that one of 638γ and 845γ feeds the 2^+ state, giving a level at 1624 or 1831.

 $\gamma(^{40}\text{Si})$

E_γ [†]	I_γ [†]	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Comments
638 ^{‡§} 5	≈ 50	1624?		986	2^+	
845 ^{‡§} 6	≈ 50	1831?		986	2^+	
986 5	100	986	2^+	0	0^+	E_γ : most intense γ seen in both reactions.

[†] From 2006Ca26.

[‡] Weak γ seen only in pn removal reaction from ^{42}P .

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

$\text{C}(^{44}\text{S}, ^{40}\text{Si}\alpha\gamma)$ **2012Ta20**

2012Ta20: E=385 MeV/nucleon ^{48}Ca primary beam with an average intensity of 70 pnA was produced at the RIBF facility at RIKEN and incident on a 15-mm-thick rotating beryllium target. A secondary ^{44}S beam was analyzed by the BigRIPS fragment separator and accelerated to E=210 MeV/nucleon with an intensity of 4×10^4 pps. The secondary target was a 2.54 g/cm² carbon foil. Reaction products were analyzed by the ZeroDegree spectrometer and identified using the energy loss (ionization chamber), magnetic rigidity and time-of-flight (plastic scintillators); γ rays were detected by the DALI2 array of 186 NaI(Tl) detectors surrounding the reaction target (20% efficiency, FWHM=10% at E γ =1 MeV). Measured E γ , I γ , particle- γ -coin. Deduced levels, J π , rapid deformation development of Si isotopes. Comparison with shell-model calculations.

 ^{40}Si Levels

E(level) [†]	J π [‡]	Comments
0	0 ⁺	
985 11	2 ⁺	
1614? 14	(0 ⁺ , 2 ⁺ , 4 ⁺) [#]	
2524? 19	(4 ⁺) [#]	E(level): this level is tentatively assigned by authors based on $\gamma\gamma$ -coin as the first 4 ⁺ state predicted by shell-model calculations. Resulting energy ratio between the first 4 ⁺ and 2 ⁺ states is R _{4/2} =2.56 5. Another possible candidate for the first 4 ⁺ state is 1614 keV from the 629 γ -> 985 γ cascade (2012Ta20).

[†] From E γ data.

[‡] Predicted by shell-model calculations.

[#] From shell-model calculations 2012Ta20 suggest that the 2524 level is the first 4⁺ state and that the 1624 level has J π =0 or 2⁺. They do not rule out the possibility that the 1624 level is the 4⁺ state; however, they argue that the systematics of E(4⁺)/E(2⁺) ratio of neighbouring nuclei favors the first alternative.

 $\gamma(^{40}\text{Si})$

E γ	E _i (level)	J π _i	E _f	J π _f
629 8	1614?	(0 ⁺ , 2 ⁺ , 4 ⁺)	985	2 ⁺
985 11	985	2 ⁺	0	0 ⁺
1539 16	2524?	(4 ⁺)	985	2 ⁺

Adopted Levels

$Q(\beta^-)=14.76\times 10^3$ 11; $S(n)=3.32\times 10^3$ 14; $S(p)=17.68\times 10^3$ 14; $Q(\alpha)=-16.45\times 10^3$ 15 2012Wa38

$S(2n)=9550$ 140, $S(2p)=38860$ 270, $Q(\beta^-n)=7020$ 120 (2012Wa38).

First identification of ^{40}P nuclide by 1979Au03.

Mass measurement: 2007Ju03, 2001Sa21 (also 2001Sa72), 1991Zh24.

2003Gr22: ^{40}P produced by fragmentation of ^{48}Ca beam at 60 MeV/ nucleon with a ^9Be target followed by separation of fragments by LISE3 spectrometer; measured β , γ , $T_{1/2}$. See also 2004Gr28, 2004Gr20.

2001Wi21: ^{40}P was produced in the fragmentation of ^{48}Ca beam at $E=70$ MeV/nucleon with a Be target followed by analysis using using A1200 fragment separator.

Others:.

1989Le16: ^{40}P formed and identified in $^{181}\text{Ta}(^{48}\text{Ca},X)$. Measured $T_{1/2}$ and $\%\beta^-n$.

1979We10: ^{40}P produced in $^9\text{Be}(^{48}\text{Ca},X)$ at 212 MeV/nucleon.

1979Au03: ^{40}P produced in $^{238}\text{U}(\text{Ar},X)$ at 263 MeV. Measured fractional-charge parameter versus A. Deduced evidence for ^{37}Si , ^{40}P , $^{41,42}\text{S}$.

1999YoZW, in a preliminary result, suggested that ^{41}Si decays dominantly ($>50\%$) by β^-n decay to ^{40}P , but final details of this study are not yet available.

 ^{40}P Levels

E(level)	J^π	$T_{1/2}$	Comments
0	$(2^-, 3^-)$	150 ms 8	$\%\beta^-=100$; $\%\beta^-n=15.8$ 21 (2001Wi21); $\%\beta^-2n=?$ Theoretical $T_{1/2}=210$ ms, $\%\beta^-n=10.8$, $\%\beta^-2n=0.26$ (2003Mo09). J^π : probable feeding ($\log ft=6.1$) of 2^+ state. Possible coupling of $\pi 1/2[211]$ and $\nu 5/2[312]$ (see discussion in 2001Wi21). $T_{1/2}$: weighted average of 153 ms 8 (2001Wi21) and 125 ms 25 (2003Gr22). Other: 260 ms +100-60 (1989Le16). $\%\beta^-n$ from 2001Wi21. Other: 30 10 (1989Le16).

Adopted Levels, Gammas

$Q(\beta^-)=4720\ 30$; $S(n)=7750\ 50$; $S(p)=17300\ 90$; $Q(\alpha)=-12870\ 70$ [2012Wa38](#)

$S(2n)=12119\ 8$, $S(2p)=33250\ 70$ ([2012Wa38](#)).

First identification of ^{40}S nuclei by [1971Ar32](#) in $^{232}\text{Th}(^{40}\text{Ar},X)$ at $E=290\ \text{MeV}$.

Mass measurements: [2009Ri12](#), [2007Ju03](#), [2000Sa21](#) (also [2001Sa72](#)).

Other reactions:..

[2011FuZZ](#): $^9\text{Be}(^{48}\text{Ca},X)$ $E=345\ \text{MeV/nucleon}$. Measured thick target fragmentation. Deduced σ .

[2006Kh08](#): $\text{Si}(^{40}\text{S},X)$ $E=30\text{--}65\ \text{MeV/nucleon}$. Measured energy-integrated reaction. Deduced radii ($r_0^2=1.282\ \text{fm}^2\ 25$, isospin dependence.

[2006Ro34](#): $^2\text{H}(^{42}\text{S},X)$ $E=99.8\ \text{MeV/nucleon}$. Measured production σ .

[1999Ai02](#): $\text{Si}(^{40}\text{S},X)$ $E=38\text{--}80\ \text{MeV/nucleon}$. Measured mean energy-integrated cross sections, deduced strong absorption radii, $r_0^2=1.29\ \text{fm}^2\ 8$.

[1997Fo01](#): $^{208}\text{Pb}(^{37}\text{Cl},X)$ $E=230\ \text{MeV}$. Measured yield.

[1991Zh24](#): $\text{Th}(p,X)$ $E=800\ \text{MeV}$. Measured fragment mass, charge ratio. Deduced mass excess.

[1986Du07](#): $^9\text{Be}(^{40}\text{Ar},X)$ $E=60\ \text{MeV/nucleon}$. Measured $\beta\gamma(t)$. Deduced $T_{1/2}$, evidence for residuals production.

 ^{40}S LevelsCross Reference (XREF) Flags

A	$^{40}\text{P}\ \beta^-$ decay (150 ms)	E	$^{208}\text{Pb}(^{36}\text{S},X\gamma)$
B	$^{41}\text{P}\ \beta^-n$ decay (101 ms)	F	Coulomb excitation
C	$^1\text{H}(^{40}\text{S},^{40}\text{S}')$		
D	$^9\text{Be}(^{48}\text{Ca},X\gamma)$		

E(level) [†]	J^π	$T_{1/2}$	XREF	Comments
0	0^+	8.8 s 22	ABCDEF	$\%\beta^-=100$ $T_{1/2}$: from 1986Du07 .
903.69 7	2^+	14.1 ps +17–14	ABCDEF	$B(E2)\uparrow=0.0334\ 36$ (1996Sc31) $\mu=-0.02\ 12$ (2006Da08,2014StZZ) μ : from measured g-factor=-0.01 6 using transient field technique in Coulomb excitation (2006Da08). J^π : Coulomb excited from 0^+ . $T_{1/2}$: deduced by evaluator from measured $B(E2)$ by 1996Sc31 in Coulomb excitation and adopted $E\gamma=903.68\ 9$. $\beta_2(p,p')=0.35\ 5$ (1999Ma63), $\beta_2(\text{Coul. ex.})=0.284\ 16$ (1996Sc31).
1916.84 21	(4^+)		A	J^π : 1013.17 γ to 2^+ ; probable member of 2-phonon triplet. $J^\pi=0^+$ is not excluded but similarity with ^{42}Ar states suggests 4^+ is more likely.
2254.79 12	(4^+)		A DE	J^π : (2^+) assigned by 2001Wi21 in $^{40}\text{P}\ \beta^-$ decay based on probable member of 2-phonon triplet, but $J=(4^+)$ from γ -ray anisotropy in $^9\text{Be}(^{48}\text{Ca},X\gamma)$ (2002So14) and from yrast band structure in $^{208}\text{Pb}(^{36}\text{S},X\gamma)$ (2010Wa12).
3236.1 3			A	
3489.46 18	(1^-)		A	J^π : 3489.6 γ to 0^+ ; log $ft=5.5$ from $(2^-,3^-)$ parent.
3828	(6^+)		E	E(level): from $^{208}\text{Pb}(^{36}\text{S},X\gamma)$ (2010Wa12). J^π : 2010Wa12 proposed $J^\pi=(6^+)$ for this level with $J^\pi=(4^+)$ for 2255 level based on band structure. However, 2001Wi21 in $^{40}\text{P}\ \beta^-$ decay propose $J^\pi=(2^+)$ for the 2255 level.
3947.0 3			A	
4138.30 20	$(1^-,2^-,3^-)$		A	J^π : 3234.7 γ to 2^+ ; probable allowed β feeding from $(2^-,3^-)$.
4724.61 23			A	J^π : suggested by 2001Wi21 in $^{40}\text{P}\ \beta^-$ decay as possible member of 3-phonon triplet since the level decays to members of 2-phonon triplet.
5009.4 4	$(1^-,2^-,3^-)$		A	J^π : 4105.7 γ to 2^+ ; probable allowed β feeding from $(2^-,3^-)$.

[†] From a least-squares fit to γ -ray energies.

Adopted Levels, Gammas (continued)

$\gamma(^{40}\text{S})$							Comments
$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\dagger$	E_f	J_f^π	Mult.	
903.69	2^+	903.68 9	100	0	0^+	E2	B(E2)(W.u.)=8.2 9 Mult.: from Coulomb excitation.
1916.84	(4^+)	1013.17 20	100	903.69	2^+		
2254.79	(4^+)	1351.10 14	100 7	903.69	2^+		Mult.: $\gamma(\theta)$ in $^9\text{Be}(^{48}\text{Ca}, X\gamma)$ allows $\Delta J=2$, Q or $\Delta J=0$, D+Q.
		2254.5 ‡ 9	<4	0	0^+		
3236.1		981.2 4	100	2254.79	(4^+)		
3489.46	(1^-)	2585.6 4	12.9 24	903.69	2^+		
		3489.6 4	100 10	0	0^+		
3828	(6^+)	1572		2254.79	(4^+)		E_γ : from $^{208}\text{Pb}(^{36}\text{S}, X\gamma)$ (2010Wa12).
3947.0		1692.6 9	25 9	2254.79	(4^+)		
		3043.2 4	100 12	903.69	2^+		
4138.30	$(1^-, 2^-, 3^-)$	648.82 15	13.7 12	3489.46	(1^-)		
		3234.7 4	100 7	903.69	2^+		
4724.61		2469.79 20	100 14	2254.79	(4^+)		
		2808.2 9	86 24	1916.84	(4^+)		
5009.4	$(1^-, 2^-, 3^-)$	1773.2 ‡ 7	8.5 24	3236.1			
		4105.7 4	100 14	903.69	2^+		

 † From ^{40}P β^- decay, except where noted. ‡ Placement of transition in the level scheme is uncertain.

^{40}P β^- decay (150 ms) 2001Wi21

Parent: ^{40}P : $E=0.0$; $J\pi=(2^-, 3^-)$; $T_{1/2}=150$ ms 8; $Q(\beta^-)=14.76 \times 10^3$ 11; % β^- decay=100

^{40}P - $J\pi, T_{1/2}$: From Adopted Levels of ^{40}P .

^{40}P - $Q(\beta^-)$: From 2012Wa38.

^{40}P -% β^- decay: % β^- -n=15.8 21, deduced by 2001Wi21 by comparing the intensities of γ rays in the $A=39$ and $A=40$ mass chains produced in the measurement since ^{40}P is the only member of the $A=40$ mass chain and no members of the $A=39$ or lighter mass chains were present in the separated beam.

2001Wi21: ^{40}P was produced in the fragmentation of ^{48}Ca beam at $E=70$ MeV/nucleon on a Be target followed by analysis using A1200 fragment separator. The decays of the implanted ions were studied by two Ge detectors and one thin plastic scintillator. Measured $E\gamma$, $I\gamma$, $\gamma\gamma$, $\beta\gamma$ -coin, $\beta\gamma\gamma$ -coin, decay curve. Deduced levels, J , π , parent $T_{1/2}$, γ -ray and β -decay branching ratios. Comparison with Geometrical Collective Model (GCM) calculations.

Others: 2003Gr22, 1989Le16.

 ^{40}S Levels

E(level)	$J\pi^\dagger$	Comments
0.0	0^+	
903.69 7	2^+	
1916.84 21	(4^+)	
2254.79 12	(4^+)	$J\pi$: (2^+) assigned by 2001Wi21 in ^{40}P β^- decay based on probable member of 2-phonon triplet.
3236.1 3		
3489.46 18	(1^-)	
3947.0 3		
4138.30 20	$(1^-, 2^-, 3^-)^\ddagger$	
4724.61 23		$J\pi$: suggested by 2001Wi21 as possible member of 3-phonon triplet since the level decays to members of 2-phonon triplet.
5009.4 4	$(1^-, 2^-, 3^-)^\ddagger$	
S(n)+x		S(n)(^{40}S)=7750 50, $x < 7010$.

† From Adopted Levels.

‡ 2001Wi21 suggest $J\pi$ not 1^- , since no g.s. transition observed.

^{40}P β^- decay (150 ms) **2001Wi21** (continued) β^- radiations

E(decay)	E(level)	$I\beta^-$ ^{†‡}	Log f [†]	Comments
($4. \times 10^3$ @ 4)	S(n)+x	15.8 21		$I\beta^-$: % β^- -n=15.8 21 (from ^{40}P Adopted Levels).
(9.75×10^3 11)	5009.4	11.3 16	5.3	
(1.004×10^4 11)	4724.61	7.5 12	5.6	
(1.062×10^4 11)	4138.30	29.8 26	5.1	
(1.081×10^4 11)	3947.0	3.4 5	6.1	
(1.127×10^4 11)	3489.46	14.1 18	5.5	
(1.152×10^4 11)	3236.1	0.7 3	6.9	
(1.251×10^4 11)	2254.79	1.6 9	6.7	
(1.386×10^4 11)	903.69	9.6 27	6.1	

[†] Deduced by **2001Wi21** from γ -ray intensity imbalance at each level, with all γ -ray intensities normalized to measured absolute $I(903.7\gamma)=63\%$ 3. It is found that 6% 5 feeding remains unaccounted for. Since $J(^{40}\text{P g.s.})=2,3$ does not allow significant feeding to ^{40}S ground state (<3% for the first forbidden unique decay of 2^- to 0^+), this feeding may go to higher unobserved levels, although, no escape peaks are observed by **2001Wi21** for γ rays above 4.2 MeV. All β^- feedings should be considered as upper limits due to a large energy window available between the reported level at 5009 and Q value of 14510.

[‡] These values should be considered as lower limits since some of the decay strength may be shifted to higher (unobserved) states due to a large energy gap between the Q-value and the highest observed level in **2001Wi21**.

Absolute intensity per 100 decays.

@ Estimated for a range of levels.

 $\gamma(^{40}\text{S})$

The following γ rays are assigned to ^{39}S from β -n decay of ^{40}P : 339.88 11 (4.6 5), 398.61 14 (6.1 9), 465.45 19 (4.5 9) (**2001Wi21**).

$I\gamma$ normalization: From measured absolute intensity of 903.7 γ based on the known decay branches for ^{40}Cl (**2001Wi21**).

E_γ	I_γ [†]	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Comments
648.82 15	5.7 5	4138.30	($1^-, 2^-, 3^-$)	3489.46	(1^-)	
^x 834.90 8	5.7 17					
903.68 9	100 2	903.69	2^+	0.0	0^+	
981.2 4	2.5 4	3236.1		2254.79	(4^+)	
1013.17 20	5.2 12	1916.84	(4^+)	903.69	2^+	
1351.10 14	12.5 9	2254.79	(4^+)	903.69	2^+	
1692.6 9	1.1 4	3947.0		2254.79	(4^+)	
1773.2 [‡] 7	1.4 4	5009.4	($1^-, 2^-, 3^-$)	3236.1		
2254.5 [‡] 9	<0.5	2254.79	(4^+)	0.0	0^+	
2469.79 20	6.4 9	4724.61		2254.79	(4^+)	
^x 2550.4 5	1.7 4					in coin with 903 γ .
2585.6 4	3.2 6	3489.46	(1^-)	903.69	2^+	
^x 2614.8 3	2.6 9					
2808.2 9	5.5 15	4724.61		1916.84	(4^+)	
3043.2 4	4.4 5	3947.0		903.69	2^+	
3234.7 4	41.5 29	4138.30	($1^-, 2^-, 3^-$)	903.69	2^+	
3489.6 4	24.9 24	3489.46	(1^-)	0.0	0^+	
4105.7 4	16.5 23	5009.4	($1^-, 2^-, 3^-$)	903.69	2^+	

[†] For absolute intensity per 100 decays, multiply by 0.63 3.

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

^x γ ray not placed in level scheme.

$^{40}\text{P} \beta^-$ decay (150 ms) 2001Wi21

^{41}P $\beta^{-}\text{n}$ decay (101 ms) [1989Le16,1998WiZV](#)

Parent: ^{41}P : $E=0$; $T_{1/2}=101$ ms 5; $Q(\beta^{-}\text{n})=9790$ 80; $\%\beta^{-}\text{n}$ decay=30 10

^{41}P - $J\pi$: $1/2^{+}$ proposed from both systematics ([2012Au07](#)) and shell model calculations ([2007Ba47](#)), $3/2^{+}$ from relativistic mean field model ([2014Wa34](#)).

^{41}P - $T_{1/2}$: From Adopted Levels of ^{41}P in ENSDF database.

^{41}P - $Q(\beta^{-}\text{n})$: From [2012Wa38](#).

^{41}P - $\%\beta^{-}\text{n}$ decay: From [1999YoZW](#).

$\%\beta^{-}\text{n}=30$ 10 ([1999YoZW](#)).

No details are available about the level scheme.

$^1\text{H}(^{40}\text{S}, ^{40}\text{S}')$ [1999Ma63](#)

Beam= ^{40}S from fragmentation of ^{48}Ca beam with a Be target. Target= CH_2 .

[1999Ma63](#) (also [1999Su05,2000B125](#)): E=30 MeV/nucleon ^{40}S secondary beam was produced by fragmentation of a primary 60 MeV/nucleon ^{48}Ca beam provided by the K1200 cyclotron at NSCL on a 285 mg/cm² Be target. Fragments were separated using the A1200 fragment separator. The secondary target was a 2 mg/cm² (CH₂)_n foil. Incident beam and scattered fragments were detected by a $\Delta\text{E-E}$ phoswich scintillator at 0° after the target and recoiling protons were detected with an array of eight telescopes of a 300 μm Si strip detector backed by a 500 μm Si detector covering angles from 56° to 89°. Measured $\sigma(\text{Ep},\theta)$. Deduced levels, quadrupole deformation parameter from DWBA analysis.

 ^{40}S Levels

<u>E(level)</u>	<u>Jπ</u>	<u>Comments</u>
0	0 ⁺	
860 90	2 ⁺	$\beta_2=0.35$ 5 (1999Ma63) E(level),J π : from 1999Ma63 .

$^9\text{Be}(^{48}\text{Ca},\text{X}\gamma)$ 2002So14

2002So14 (also 2002Az02,2002Az01,2002Gu08,2000So17,2000Az03): E=60.3 MeV/nucleon ^{48}Ca beam with an intensity of 15 enA was produced from the accelerator complex at GANIL. Target was 2.76 mg/cm² ^9Be . Fragments were detected and identified at the focal plane of the SPEG spectrometer according to information of energy measured by a plastic scintillator and ionization chambers, and time-of-flight between the timing signal of the scintillator and the cyclotron frequency. γ rays were detected with an array of 74 BaF₂ crystals and 3 segmented Ge clover detectors. Measured E γ , I γ , $\gamma\gamma$ -coin, $\gamma(\theta)$. Deduced levels, J, π , multipolarities. A level at 3265 decaying by 2360 γ (I γ =20) was listed in conference papers (2002Az01,2002Gu08), but it is not included in 2002So14.

 ^{40}S Levels

E(level) [†]	J π [‡]	Comments
0	0 ⁺	
909 5	2 ⁺	
2265 11	(4 ⁺)	J π : 1356 $\gamma(\theta)$ allows 0 ⁺ , 2 ⁺ and 4 ⁺ ; but 0 ⁺ is ruled out by γ to 0 ⁺ in Adopted Gammas; fragmentation reaction used by 2002So14 favors yrast states.

[†] From γ -ray energies.

[‡] As proposed in 2002So14.

 $\gamma(^{40}\text{S})$

E γ [†]	I γ [†]	E _i (level)	J π _i	E _f	J π _f	Mult. [‡]	Comments
909 5	100	909	2 ⁺	0	0 ⁺	Q	
1356 6	40	2265	(4 ⁺)	909	2 ⁺	(Q)	Mult.: $\gamma(\theta)$ allows $\Delta J=2$, Q or $\Delta J=0$, D+Q.

[†] From 2002So14.

[‡] From measured $\gamma\gamma(\theta)$ (2002So14).

Coulomb excitation **1996Sc31,2006Da08**

- 1996Sc31:** $^{197}\text{Au}(^{40}\text{S}, ^{40}\text{S}'\gamma)$ $E=39.5$ MeV/nucleon ^{40}S beam was produced by fragmentation of ^{48}Ca primary beams with energy up to 80 MeV/nucleon and intensity as high as 5pnA provided from the K1200 cyclotron at NSCL on a 379 mg/cm^2 ^9Be primary target. The secondary target was a 184.1 mg/cm^2 gold. γ rays were detected by an array of 42 position-sensitive NaI(Tl) detectors. Measured $E\gamma$, γ yield, $\gamma(\text{particle})$ -coin. Deduced level energy, B(E2), deformation parameter. Comparison with shell-model calculations.
- 2006Da08** (also **2006St21**): $^{197}\text{Au}(^{40}\text{S}, ^{40}\text{S}'\gamma)$ $E\approx 40$ MeV/nucleon ^{40}S beam was produced by fragmentation of 140 MeV/nucleon primary beam provided from the Cyclotron Facility of NSCL on a 1 g/cm^2 ^9Be target. Fragments were separated by the A1900 fragment separator. The secondary target was 355 mg/cm^2 gold. Projectiles were detected with a plastic scintillator and γ rays were detected with 14 HPGe detectors of the SeGA array. Measured $E\gamma$, $I\gamma(\theta, H, t)$, (particle) γ -coin. Deduced g-factor using transient field technique. Comparison with shell-model calculations.

 ^{40}S Levels

E(level)	J^π	$T_{1/2}$	Comments
0	0^+		
891 13	2^+	14.1 ps +17-14	B(E2) $\uparrow=0.0334$ 36 (1996Sc31) $\mu=-0.02$ 12 (2006Da08) E(level): from $E\gamma$ (1996Sc31). J^π : Coulomb excited from 0^+ . $T_{1/2}$: deduced by evaluator from measured B(E2) in 1996Sc31 and adopted $E\gamma=903.68$ 9 in Adopted Gammas. g-factor=-0.01 6 (2006Da08). μ : from measured g-factor=-0.01 6 using transient field technique (2006Da08).

 $\gamma(^{40}\text{S})$

E_γ	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult.	Comments
891 13	891	2^+	0	0^+	E2	E_γ : from 1996Sc31 .

Coulomb excitation **1996Sc31,2006Da08**Level Scheme

$^{208}\text{Pb}(^{36}\text{S},\text{X}\gamma)$ 2010Wa12

2010Wa12: E=215 MeV ^{36}S beam was produced from the XTU-Tandem Van de Graaff-ALPI superconducting linear accelerator complex at the INFN Legnaro National Laboratory, Italy. Target was a thin 99.7% enriched ^{208}Pb of $300\text{ }\mu\text{g}/\text{cm}^2$ thickness on a $20\text{ }\mu\text{g}/\text{cm}^2$ carbon backing. Reaction products were analyzed with the PRISMA magnetic spectrometer and detected by a position sensitive microchannel plate (MCP) detector and a multiwire parallel-plate avalanche counter (MWPPAC) for position and time information, and by an ionization chamber for energy. γ rays were detected with the CLARA array of 25 escape-suppressed Ge clover detectors. Measured $E\gamma$, $I\gamma$, $\gamma\gamma$ -coin. Deduced levels, J, π . Comparison with shell-model calculations.

 ^{40}S Levels

<u>E(level)</u>	<u>Jπ[†]</u>
0 [‡]	0 ⁺
904 [‡]	2 ⁺
2256 [‡]	(4 ⁺)
3828 [‡]	(6 ⁺)

[†] As given by 2010Wa12 based on band structure.

[‡] (A): Yrast sequence. Configurations $\pi(2s_{1/2}^1, 1d_{3/2}^1)$ and $\pi(2s_{1/2}^0, 1d_{3/2}^2)$ are important for the yrast structure.

 $\gamma(^{40}\text{S})$

<u>E_γ</u>	<u>$E_i(\text{level})$</u>	<u>Jπ_i</u>	<u>E_f</u>	<u>Jπ_f</u>
904	904	2 ⁺	0	0 ⁺
1352	2256	(4 ⁺)	904	2 ⁺
1572	3828	(6 ⁺)	2256	(4 ⁺)

Adopted Levels, Gammas

$Q(\beta^-)=7480\ 30$; $S(n)=5830\ 30$; $S(p)=11680\ 60$; $Q(\alpha)=-9730\ 30$ [2012Wa38](#)

$S(2n)=13900\ 30$, $S(2p)=27470\ 90$ ([2012Wa38](#)).

First identification of ^{40}Cl nuclide by [1956Mo39](#) via $^{40}\text{Ar}(n,p)$.

^{40}Cl produced in $^{40}\text{Ar}(n,p)$: [1956Mo39](#), [1965Gr03](#), [1970Ke12](#). Others: Thesis (Masters) by E.L. Robinson (Purdue

University, 1958), [1968Hu07](#), [1968Hu15](#), [1970Lu10](#), [1972KI06](#), [1973KI02](#).

A 0.10 s β^- activity in ^{40}Cl reported by [1968FI10](#) (also [1968FI11](#)) is not convincing and has not been confirmed in any other study.

Mass measurements: [1989Mi03](#), [1984Fi02](#).

Other reactions:.

[2012Bh09](#): $^{40}\text{Ar}(n,p)$ E=9-15 MeV. Measured E_γ , I_γ , $\sigma(E)$, activation method.

[2012Zh06](#): $^9\text{Be}(^{40}\text{Ar},X)$ and $^{181}\text{Ta}(^{40}\text{Ar},X)$ E=57 MeV/nucleon. Measured fragment yields.

[2008KI02](#): $^{40}\text{Ar}(\mu^-, \nu)$. Measured isotopic yields.

[2007Na31](#): $^{136}\text{Xe}(p,X)$ E=1 GeV. Measured isotopic σ .

[2006Ro34](#): $^2\text{H}(^{48}\text{Ca},X)$ E=102 MeV/nucleon. Measured production σ .

[1999Ai02](#): $\text{Si}(^{40}\text{Cl},X)$ E=38-80 MeV. Measured mean-energy integrated cross section, deduced strong absorption radii, $r_0^2=1.28$

fm^2 7, 1.21 fm^2 8.

[1997Fo01](#): $^{208}\text{Pb}(^{37}\text{Cl},X)$ E=230 MeV: measured yield.

[1988Ma53](#): $^{40}\text{Ar}(n,p)$: analyzed one-nucleon transfer σ data, deduced g.s. occupation numbers for ^{40}Ar .

[1971Ar32](#): $^{232}\text{Th}(^{40}\text{Ar},X)$: yield for ^{40}Cl production.

 ^{40}Cl LevelsCross Reference (XREF) Flags

- A** ^{40}S β^- decay (8.8 s)
B $^9\text{Be}(^{36}\text{S}, \alpha p \gamma)$
C $^{40}\text{Ar}(^7\text{Li}, ^7\text{Be}), (^{11}\text{B}, ^{11}\text{C})$
D $^{208}\text{Pb}(^{40}\text{Ar}, X \gamma)$

E(level) [†]	J π [#]	T _{1/2} [‡]	XREF	Comments
0 [@]	2 ⁻	1.35 min 3	ABCD	$\% \beta^- = 100$ J^π : $\log ft = 4.9$ for β^- decay to 1 ⁻ level at E=5880 in ^{40}Ar , $\log ft = 5.9$ to 3 ⁻ level at E=4083 in ^{40}Ar . T _{1/2} : weighted average of 1.32 min 2 (1972KI06), 1.44 min 8 (1970Ke12), 1.38 min 2 (thesis (masters) by E.L. Robinson, Purdue University, 1958). Other: 1.4 min (1956Mo39).
211.62 13	(1 ⁻)		ABcD	
244.03 [@] 8	(3 ⁻)	<10 ns	BcD	
367.1 4	(2)		B D	
431.8 3	(1 to 3 ⁺)		AB D	J^π : 431.58 γ (D) to 2 ⁻ ; 457.8 γ and 1875.6 γ from 1 ⁺ .
601.28 [@] 14	(4 ⁻)	<7 ns	BcD	
680.95 17	(4 ⁻)		BcD	
839.16 [@] 15	(5 ⁻)		BCD	
889.5 4	1 ⁺		A D	J^π : $\log ft = 4.7$ from 0 ⁺ in ^{40}S .
1160 40	(4 ⁻)		CD	J^π : tentatively assigned by 1984Fi02 in $^{40}\text{Ar}(^7\text{Li}, ^7\text{Be})$.
1293.3 5	(0 ⁻ , 1, 2)		A	J^π : 1292.87 γ to 2 ⁻ , 403.70 γ to 1 ⁺ and 1081.33 γ to (1 ⁻).
1580 40			C	
1740 40			C	
2014.7 [@] 4	(6 ⁻)	≤ 3.5 ps	BCD	
2194.2 3	(5)		B	
2307.2 7	1 ⁺		A C	XREF: C(2290). J^π : $\log ft = 3.7$ from 0 ⁺ in ^{40}S .

Continued on next page (footnotes at end of table)

Adopted Levels, Gammas (continued) ^{40}Cl Levels (continued)

<u>E(level)[†]</u>	<u>J^π</u>	<u>T_{1/2}[‡]</u>	<u>XREF</u>
2413.7 4	(6)		B
2620.4 @ 5	(7 ⁻)	≤3.5 ps	B
4087.1? @ 8	(8 ⁻)		B

[†] From a least-squares fit to γ -ray energies.

[‡] From ($^{36}\text{S}, \alpha p \gamma$) for excited states.

When no J π arguments are given, the assignments are based on $\gamma(\theta)$ data in ($^{36}\text{S}, \alpha p \gamma$) and comparison of experimental level structure with shell-model calculations (particularly of 1989Wa09 and 1989Ji01).

@ (A): Yrast negative-parity structure. A multiplet (2⁻ to 5⁻) is expected from weak coupling of 3/2⁺ g.s. of ^{37}Cl and 7/2⁻ g.s. of ^{43}Ca .

 $\gamma(^{40}\text{Cl})$

<u>E_i(level)</u>	<u>J_i^π</u>	<u>E_γ</u>	<u>I_γ[†]</u>	<u>E_f</u>	<u>J_f^π</u>	<u>Mult.[§]</u>	<u>Comments</u>
211.62	(1 ⁻)	211.59 11	100	0	2 ⁻	(D)	E _γ : weighted average of 211.59 11 from ^{40}S β^- decay, 211.60 13 from ($^{36}\text{S}, \alpha p \gamma$), and 211.6 4 from ($^{40}\text{Ar}, X\gamma$).
244.03	(3 ⁻)	244.02 8	100	0	2 ⁻	(D)	E _γ : weighted average of 244.04 8 from $^9\text{Be}(^{36}\text{S}, \alpha p \gamma)$ and 244.0 1 from $^{208}\text{Pb}(^{40}\text{Ar}, X\gamma)$.
367.1	(2)	155.5 3	100	211.62	(1 ⁻)		E _γ : weighted average of 155.5 3 from $^9\text{Be}(^{36}\text{S}, \alpha p \gamma)$ and 156 1 from $^{208}\text{Pb}(^{40}\text{Ar}, X\gamma)$.
431.8	(1 to 3 ⁺)	431.58 7	100	0	2 ⁻	(D)	E _γ : weighted average of 431.57 7 from ^{40}S β^- decay, 431.63 21 from $^9\text{Be}(^{36}\text{S}, \alpha p \gamma)$, and 431.8 4 from $^{208}\text{Pb}(^{40}\text{Ar}, X\gamma)$.
601.28	(4 ⁻)	357.37 14	100 5	244.03	(3 ⁻)	(D)	E _γ : weighted average of 357.36 14 from $^9\text{Be}(^{36}\text{S}, \alpha p \gamma)$ and 357.4 2 from $^{208}\text{Pb}(^{40}\text{Ar}, X\gamma)$.
		601.1 1	9.1 12	0	2 ⁻		E _γ : weighted average of 601.1 3 from $^9\text{Be}(^{36}\text{S}, \alpha p \gamma)$ and 601.1 1 from $^{208}\text{Pb}(^{40}\text{Ar}, X\gamma)$.
							I _γ : weighted average of 8.6 14 from $^9\text{Be}(^{36}\text{S}, \alpha p \gamma)$ and 10 2 from $^{208}\text{Pb}(^{40}\text{Ar}, X\gamma)$.
680.95	(4 ⁻)	436.90 10	100	244.03	(3 ⁻)	(D)	E _γ : weighted average of 436.86 17 from $^9\text{Be}(^{36}\text{S}, \alpha p \gamma)$ and 436.9 1 from $^{208}\text{Pb}(^{40}\text{Ar}, X\gamma)$.
839.16	(5 ⁻)	157.8 3	9.7 7	680.95	(4 ⁻)	(D)	E _γ : from $^9\text{Be}(^{36}\text{S}, \alpha p \gamma)$ only.
		237.92 9	100 3	601.28	(4 ⁻)	(D)	E _γ : weighted average of 237.93 9 from $^9\text{Be}(^{36}\text{S}, \alpha p \gamma)$ and 237.9 1 from $^{208}\text{Pb}(^{40}\text{Ar}, X\gamma)$.
							E _γ : from $^9\text{Be}(^{36}\text{S}, \alpha p \gamma)$ only.
889.5	1 ⁺	594.9 4	7.4 16	244.03	(3 ⁻)		
		457.4 ‡ 6	15 ‡ 4	431.8	(1 to 3 ⁺)		
		677.41 ‡ 12	100 ‡ 14	211.62	(1 ⁻)		
		889.06 17	40 ‡ 6	0	2 ⁻		
							E _γ : weighted average of 889.04 17 from ^{40}S β^- decay and 889.2 5 from $^{208}\text{Pb}(^{40}\text{Ar}, X\gamma)$.
1160	(4 ⁻)	563.3 4	100	601.28	(4 ⁻)		E _γ : from $^{208}\text{Pb}(^{40}\text{Ar}, X\gamma)$ only.
1293.3	(0 ⁻ , 1, 2)	403.70 ‡ 12	33 ‡ 4	889.5	1 ⁺		

Continued on next page (footnotes at end of table)

Adopted Levels, Gammas (continued)

$\gamma(^{40}\text{Cl})$ (continued)							Comments
$E_i(\text{level})$	J_i^π	E_γ	$I_\gamma^\dagger$	E_f	J_f^π	Mult. §	
1293.3	(0 ⁻ ,1,2)	1081.33 [‡] 18	100 [‡] 13	211.62	(1 ⁻)		
		1292.87 [‡] 21	43 [‡] 6	0	2 ⁻		
2014.7	(6 ⁻)	1175.4 3	100	839.16	(5 ⁻)		
2194.2	(5)	1513.6 4	100 33	680.95	(4 ⁻)	(D)	
		1592.5 4	42 8	601.28	(4 ⁻)		
2307.2	1 ⁺	1013.57 [‡] 13	100 [‡] 6	1293.3	(0 ⁻ ,1,2)		
		1874.41 [‡] 19	89 [‡] 11	431.8	(1 to 3 ⁺)		
2413.7	(6)	219.52 13	100	2194.2	(5)	(D)	
2620.4	(7 ⁻)	605.4 6	100 30	2014.7	(6 ⁻)		I_γ : $I_\gamma(605.4\gamma)/I_\gamma(1781.4\gamma)=60$ 16/100 40 in $(^{40}\text{Ar},\text{X}\gamma)$.
		1781.4 5	42 15	839.16	(5 ⁻)		
4087.1?	(8 ⁻)	1466.7 ^{&} 6	100	2620.4	(7 ⁻)		

[†] From $(^{36}\text{S},\alpha\gamma)$, unless otherwise noted.

[‡] From ^{40}S β^- decay.

§ From $(^{36}\text{S},\alpha\gamma)$ based on measured $\gamma(\theta)$ consistent with $\Delta J=1$, dipole (1993Ba62).

$^\&$ Placement of transition in the level scheme is uncertain.

Adopted Levels, Gammas

$^{40}_{17}\text{Cl}_{23}$

^{40}S β^- decay (8.8 s) 2006Wi10

Parent: ^{40}S : $E=0$; $J\pi=0^+$; $T_{1/2}=8.8$ s 22; $Q(\beta^-)=4720$ 30; % β^- decay=100

^{40}S - $T_{1/2}$: From Adopted Levels of ^{40}S , taken from 1986Du07.

^{40}S - $Q(\beta^-)$: From 2012Wa38.

2006Wi10 (also 1998WiZX,1998WiZV): ^{40}S isotope was obtained from the decay of ^{40}P isotope produced by fragmentation of a ^{48}Ca beam at 70 MeV/nucleon bombarding a 254 mg/cm² ^9Be target at NSCL, Michigan facility. The fragments were separated by A1200 fragment separator and identified using energy loss (ΔE) versus time-of-flight (TOF) measured by a 500- μm Si PIN diode (ΔE) and a thin plastic scintillator (TOF), and implanted into 17-mil targets on a rotatable wheel. β particles were detected with a 1-mm-thick plastic scintillator directly downstream of the Al targets and γ rays were detected by two Ge detectors (FWHM=2.5 and 2.9 keV at 1332 keV). Measured $E\gamma$, $I\gamma$, $E\beta$, $I\beta$, $\gamma\gamma$ -coin, $\beta\gamma$ -coin. Deduced levels, J , π , β -decay branching ratios, $\log ft$. Comparisons with shell-model calculations.

1986Du07: ^{40}S ions were produced by fragmentation of a 60 MeV/nucleon ^{40}Ar beam on a 190 mg/cm² Be target at GANIL. Fragments were separated by the LISE spectrometer. β particles were detected with a 1-mm-thick plastic scintillator and γ rays were detected with a 174 cm³ intrinsic Ge detector. Measured $E\gamma$, $I\gamma$, decay curves. Deduced $T_{1/2}$, γ -ray branching ratios. Reported four γ rays at 211.6, 431.9, 677.5 and 888.6.

 ^{40}Cl Levels

<u>E(level)[†]</u>	<u>$J\pi^{\ddagger}$</u>
0	2^-
211.56 9	1^-
431.61 7	$(1^-, 2)$
889.02 10	1^+
1292.75 11	(1^+)
1998.02 21	(1^+)
2306.23 13	1^+

[†] From a least-squares fit to γ -ray energies.

[‡] From Adopted Levels.

 β^- radiations

<u>E(decay)</u>	<u>E(level)</u>	<u>$I\beta^-^{\ddagger}$</u>	<u>$\log ft$</u>	<u>Comments</u>
$(2.41 \times 10^3$ 3)	2306.23	46 4	3.7 2	$I\beta^-$: 2006Wi10 give 47 4.
$(2.72 \times 10^3$ 3)	1998.02	10 2	4.6 2	
$(3.43 \times 10^3$ 3)	1292.75	5 4	5.4 4	$I\beta^-$: 2006Wi10 give 6 3.
$(3.83 \times 10^3$ 3)	889.02	35 5	4.7 2	$I\beta^-$: 2006Wi10 give 36 4.
$(4.72 \times 10^3^{\#}$ 3)	0	<0.5	>8.8	$I\beta^-$: from 2006Wi10, shell-model prediction; intensity balance gives 3 7 (or <10).

[†] Deduced by evaluator based on γ -ray intensity imbalance at each level with a normalization of 0.52 3 from 2006Wi10, unless otherwise noted.

[‡] Absolute intensity per 100 decays.

[#] Existence of this branch is questionable.

^{40}S β^- decay (8.8 s) 2006Wi10 (continued) $\gamma(^{40}\text{Cl})$

I_γ normalization: Deduced by 2006Wi10 from relative intensities of strong γ rays from ^{40}Cl β^- decay observed in the saturation spectra. The value is 0.54 2 deduced by evaluator assuming $\Sigma(I_\gamma \text{ to g.s.})=100$.

$E_\gamma^\dagger$	$I_\gamma^{\dagger\dagger}$	$E_i(\text{level})$	J_i^π	E_f	J_f^π
211.59 11	100 3	211.56	1^-	0	2^-
403.70 12	12.6 15	1292.75	(1^+)	889.02	1^+
431.57 7	49 5	431.61	$(1^-, 2)$	0	2^-
457.4 6	7.7 19	889.02	1^+	431.61	$(1^-, 2)$
677.41 12	52 7	889.02	1^+	211.56	1^-
705.20 23	9.5 20	1998.02	(1^+)	1292.75	(1^+)
889.04 17	21 3	889.02	1^+	0	2^-
1013.57 13	47 3	2306.23	1^+	1292.75	(1^+)
1081.33 18	38 5	1292.75	(1^+)	211.56	1^-
1292.87 21	16.4 24	1292.75	(1^+)	0	2^-
1786.6 3	9.6 21	1998.02	(1^+)	211.56	1^-
1874.41 19	42 5	2306.23	1^+	431.61	$(1^-, 2)$

† From 2006Wi10.

†† For absolute intensity per 100 decays, multiply by 0.52 3.

$^{40}\text{S} \beta^-$ decay (8.8 s) 2006Wi10

Decay Scheme

Intensities: $I_{(\gamma+ce)}$ per 100 parent decays

Legend

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

$^9\text{Be}(^{36}\text{S}, \alpha p \gamma)$ 1993Ba62, 1988Ko05

1993Ba62: E=105 MeV ^{36}S beam with an intensity up to 500 nA was produced from the University of Pennsylvania FN tandem Van de Graaff accelerator. Target was a film of Be metal of thickness 500-750 mg/cm² evaporated onto a 32 mg/cm² Au backing. Charged particles were detected with the Penn 4 π array of 24 phoswich scintillators and γ rays were detected with Ge detectors. Measured E γ , I γ , $\gamma\gamma$ -coin, $\alpha p \gamma$ -coin, $\gamma\gamma(\theta)$. Deduced levels, J, π , γ -multipolarities.

1988Ko05: E=100 MeV ^{36}S beam was produced from the Argonne Tandem-Linac Accelerator System (ATLAS). Target was a 2.34 mg/cm² rolled Be foil on a 10 mg/cm² Pb backing. Charged particles were detected with two E-E Si surface barrier detector telescopes and γ rays were detected with 8 Compton-suppressed Ge detectors in the Argonne-Notre Dame γ -ray facility. Measured E γ , I γ , $\gamma(\theta)$, $\gamma\gamma$ -coin, $\alpha p \gamma$ -coin. Deduced levels, J, π .

 ^{40}Cl Levels

A level at 900 proposed by 1988Ko05 has been omitted due to the revised placement of 219.52 γ by 1993Ba62.

E(level) [†]	J π [‡]	T _{1/2}	E(level) [†]	J π [‡]	T _{1/2}	E(level) [†]	J π [‡]	T _{1/2}
0 ^{&}	2 ⁻		601.28 ^{&} 14	(4 ⁻)	<7 [#] ns	2413.7 4	(6)	
211.60 13	(1 ⁻)		680.95 17	(4 ⁻)		2620.4 ^{&} 5	(7 ⁻)	$\leq 3.5^@$ ps
244.03 ^{&} 8	(3 ⁻)	<10 [#] ns	839.16 ^{&} 15	(5 ⁻)		4087.17 ^{&} 8	(8 ⁻)	
367.1 4	(2)		2014.7 ^{&} 4	(6 ⁻)	$\leq 3.5^@$ ps			
431.63? 21			2194.2 3	(5)				

[†] From a least-squares fit to γ -ray energies.

[‡] For excited states, the assignments are based on $\gamma(\theta)$ data and comparison of experimental level structure with shell-model calculations (particularly of 1989Wa09 and 1989Ji01). All assignments are given here under parentheses, although, some were quoted without parentheses by 1993Ba62. Assignment for g.s. is from Adopted Levels.

[#] From electronic timing (1993Ba62).

[@] From estimate of Doppler shift attenuation (1993Ba62).

[&] (A): Yrast negative-parity structure. A multiplet (2⁻ to 5⁻) is expected from weak coupling of 3/2⁺ g.s. of ^{37}Cl and 7/2⁻ g.s. of ^{43}Ca .

 $\gamma(^{40}\text{Cl})$

Asymmetry ratio R=yield at 135°/yield at 90° (1993Ba62).

E γ [†]	I γ [†]	E _i (level)	J π _i	E _f	J π _f	Mult.	Comments
155.5 3	0.4 2	367.1	(2)	211.60	(1 ⁻)		
157.8 3	3.0 2	839.16	(5 ⁻)	680.95	(4 ⁻)	(D) [‡]	Mult.: R(135°/90°)=0.84 17 (1993Ba62).
211.60 13	11.2 7	211.60	(1 ⁻)	0	2 ⁻	(D) [‡]	E γ : weighted average of 211.55 13 from 1988Ko05 and 211.7 2 from 1993Ba62. I γ : weighted average of 14 2 from 1988Ko05 and 11.0 5 from 1993Ba62. Mult.: R(135°/90°)=0.99 8 (1993Ba62).
219.53 13	9.1 5	2413.7	(6)	2194.2	(5)	(D) [‡]	Mult.: R(135°/90°)=0.67 6 (1993Ba62). E γ : weighted average of 219.50 13 from 1988Ko05 and 219.6 2 from 1993Ba62. This γ was placed from a 900 level by 1988Ko05. I γ : weighted average of 11 2 from 1988Ko05 and 9.0 5 from 1993Ba62.
237.93 9	31 1	839.16	(5 ⁻)	601.28	(4 ⁻)	(D) [‡]	E γ : weighted average of 237.93 9 from 1988Ko05 and 237.9 2 from 1993Ba62. I γ : weighted average of 34 3 from 1988Ko05 and 31 1 from

Continued on next page (footnotes at end of table)

$^9\text{Be}(^{36}\text{S}, \alpha p \gamma)$ **1993Ba62, 1988Ko05 (continued)** $\gamma(^{40}\text{Cl})$ (continued)

$E_\gamma^\dagger$	$I_\gamma^\dagger$	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult.	Comments
							1993Ba62.
244.03 8	100 2	244.03	(3 ⁻)	0	2 ⁻	(D) [‡]	Mult.: $R(135^\circ/90^\circ)=0.83\ 5$ (1993Ba62). E_γ : weighted average of 244.04 8 from 1988Ko05 and 244.0 2 from 1993Ba62 . I_γ : other: 100 7 from 1988Ko05 . Mult.: $R(135^\circ/90^\circ)=0.96\ 3$ (1993Ba62). In coin with 244 γ , 437 γ and 220 γ .
^x 347 357.36 14	44 2	601.28	(4 ⁻)	244.03	(3 ⁻)	(D) [‡]	E_γ : weighted average of 357.29 14 from 1988Ko05 and 357.5 2 from 1993Ba62 . I_γ : weighted average of 47 4 from 1988Ko05 and 43 2 from 1993Ba62 . Mult.: $R(135^\circ/90^\circ)=0.94\ 3$ (1993Ba62).
431.63 § 21	8 3	431.63?		0	2 ⁻	(D)	E_γ : weighted average of 431.54 21 from 1988Ko05 and 431.8 3 from 1993Ba62 . Placement proposed (by the evaluators) based on ^{40}S β^- decay. Unplaced in 1988Ko05 and 1993Ba62 . I_γ : unweighted average of 5 2 from 1988Ko05 and 10 1 from 1993Ba62 . Mult.: $R(135^\circ/90^\circ)=0.99\ 10$ (1993Ba62).
436.86 17	27 2	680.95	(4 ⁻)	244.03	(3 ⁻)	(D) [‡]	E_γ : weighted average of 436.76 17 from 1988Ko05 and 437.0 2 from 1993Ba62 . I_γ : weighted average of 31 4 from 1988Ko05 and 26 2 from 1993Ba62 . Mult.: $R(135^\circ/90^\circ)=0.87\ 10$ (1993Ba62).
594.9 4 601.1 3	2.3 5 3.8 6	839.16 601.28	(5 ⁻) (4 ⁻)	244.03 0	(3 ⁻) 2 ⁻		E_γ : weighted average of 601.30 28 from 1988Ko05 and 600.9 3 from 1993Ba62 . I_γ : weighted average of 6 2 from 1988Ko05 and 3.7 5 from 1993Ba62 .
605.4 6 ^x 676.7 3	3.3 10 3.2 5	2620.4	(7 ⁻)	2014.7	(6 ⁻)		$R(135^\circ/90^\circ)=0.96\ 30$. A 677.9 γ is placed from an 888, 1 ⁺ level in β^- decay, but it seems unlikely that a 1 ⁺ level would be populated in ($^{36}\text{S}, \alpha p \gamma$). Moreover a strong 889 transition from the same level seen in β^- decay is not reported in this reaction.
1175.4 3 1466.7 § 6 1513.6 4 1592.5 4 1781.4 5 ^x 2075	7.1 20 1.0 7 6.0 20 2.5 5 1.4 5 <0.6	2014.7 4087.1? 2194.2 2194.2 2620.4	(6 ⁻) (8 ⁻) (5) (5) (7 ⁻)	839.16 2620.4 680.95 601.28 839.16	(5 ⁻) (7 ⁻) (4 ⁻) (4 ⁻) (5 ⁻)	(D) [‡]	Mult.: $R(135^\circ/90^\circ)=0.7\ 3$ (1993Ba62).

[†] From from **1993Ba62**, unless otherwise stated.[‡] $\gamma(\theta)$ data consistent with $\Delta J=1$, dipole (**1993Ba62**).

§ Placement of transition in the level scheme is uncertain.

^x γ ray not placed in level scheme.

$^{40}\text{Ar}(^7\text{Li}, ^7\text{Be}), (^{11}\text{B}, ^{11}\text{C})$ 1984Fi02

1984Fi02: $E(^7\text{Li})=52, 54$ and $E(^{11}\text{B})=81$ MeV beams were produced from the Australian National University 14 UD pelletron accelerator. Target was ^{40}Ar gas in a stainless steel gas cell. Reaction products were momentum analyzed by an Enge split-pole spectrometer (FWHM=180 keV for ^7Be spectra) and detected by a multi-element gas-filled detector at the focal plane. Measured $\sigma(E)$. Deduced mass excess, levels.

 ^{40}Cl Levels

<u>E(level)[†]</u>	<u>$J\pi^{\ddagger}$</u>	<u>Comments</u>
0	2^-	
230 40		
640 30	(4^-)	J^π : 5^- from 1984Fi02.
840 30	(5^-)	J^π : 3^- from 1984Fi02.
1160 40	(4^-)	J^π : suggested by 1984Fi02.
1580 40		
1740 40		
2020 40		
2290 40		

[†] From 1984Fi02.

[‡] From Adopted Levels, unless otherwise noted. 1984Fi02 suggest that low-lying levels of $J\pi=2^-$ to 5^- may arise from weak coupling of $3/2^+$ ^{37}Cl g.s. to levels in ^{43}Ca , as in ^{38}Cl . The assignments from 1984Fi02 are considered as tentative by the evaluator.

$^{208}\text{Pb}(^{40}\text{Ar}, \text{X}\gamma)$ 2013Sz02

Transfer channel: 1p removal, 1n addition 2013Sz02: E=255 MeV ^{40}Ar beam was provided by the ECR ion source and accelerated by the superconducting ALPI-Linac accelerator of the Laboratori Nazionali di Legnaro. Target was $300 \mu\text{g}/\text{cm}^2$ ^{208}Pb .

Projectile-like fragments were separated and identified with the large solid angle magnetic spectrometer Prisma with TOF information provided by a position-sensitive microchannel plate detector at the entrance of the Prisma and ΔE -E information by an array of transverse field multiparametric ionization chamber at the end of Prisma. γ rays were detected with the Clara array of 24 HPGe clover detectors. Measured fragments, $E\gamma$, $I\gamma$, time-of-flight, energy loss, $\gamma\gamma$ -coin, (fragment) γ -coin. Deduced levels, J, π .

Comparison with large-scale shell-model calculations.

All data are from 2013Sz02, unless otherwise noted.

 ^{40}Cl Levels

E(level) [†]	J π [‡]	Comments
0.0	2 ⁻	
211.6 4	(1 ⁻)	
243.95 10	(3 ⁻)	
367.6 11	(2)	
431.8 4	(0 ⁻ to 3 ⁺)	J π : (3 ⁻) from figure 9 in 2013Sz02, based on shell-model prediction; (0 ⁻) listed in authors' table II.
601.15 10	(4 ⁻)	
680.85 14	(4 ⁻)	
839.06 14	(5 ⁻)	
889.2 5	1 ⁺	
1164.5 5		
2014.2 10	(6 ⁻)	
2619.9 10	(7 ⁻)	

[†] From a least-squares fit to γ -ray energies.

[‡] From Adopted Levels, unless otherwise noted.

 $\gamma(^{40}\text{Cl})$

E_γ	I_γ [†]	$E_i(\text{level})$	J π_i	E_f	J π_f
156 1	10.0 20	367.6	(2)	211.6	(1 ⁻)
211.6 4	8.0 20	211.6	(1 ⁻)	0.0	2 ⁻
^x 219.0 4	9.0 20				
237.9 1	31.0 30	839.06	(5 ⁻)	601.15	(4 ⁻)
244.0 1	78 4	243.95	(3 ⁻)	0.0	2 ⁻
357.4 2	38 6	601.15	(4 ⁻)	243.95	(3 ⁻)
431.8 4	13 5	431.8	(0 ⁻ to 3 ⁺)	0.0	2 ⁻
436.9 1	29 5	680.85	(4 ⁻)	243.95	(3 ⁻)
458 [‡]		889.2	1 ⁺	431.8	(0 ⁻ to 3 ⁺)
563.3 4	17.0 20	1164.5		601.15	(4 ⁻)
601.1 1	3.8 9	601.15	(4 ⁻)	0.0	2 ⁻
605 2	3.0 8	2619.9	(7 ⁻)	2014.2	(6 ⁻)
678 [‡]		889.2	1 ⁺	211.6	(1 ⁻)
889.2 5	4.0 20	889.2	1 ⁺	0.0	2 ⁻
1175 1	11.0 30	2014.2	(6 ⁻)	839.06	(5 ⁻)
^x 1360 1	6.5 20				
1781 1	5.0 20	2619.9	(7 ⁻)	839.06	(5 ⁻)

[†] Effective number of counts after taking into account detector efficiency. $I\gamma$ from 2013Sz02 divided by 10.

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

^x γ ray not placed in level scheme.

Adopted Levels, Gammas

$Q(\beta^-) = -1504.40$ 6; $S(n) = 9869$ 5; $S(p) = 12528.7$ 17; $Q(\alpha) = -6800.69$ 19 [2012Wa38](#)

$S(2n) = 16467.71$ 19, $S(2p) = 22757$ 7 ([2012Wa38](#)).

First identification of ^{40}Ar nuclide by [1919As01](#) (later in [1921As01](#)) in a mass spectrometer ([2012Th10](#)).

Other reactions:..

[2012Zh06](#): $^9\text{Be}(^{40}\text{Ar}, X)$, $^{181}\text{Ta}(^{40}\text{Ar}, X)$ $E = 57$ MeV/nucleon. Measured fragment yields.

[2006LiZX](#): $^9\text{Be}(^{38}\text{S}, X)$ $E = 5.45$ MeV/nucleon. Measured E_γ , I_γ .

[1999Ma14](#): $^{40}\text{Ar}(\mu^-, X)$ $E = 125$ MeV. Measured capture rates.

[1996Ri19](#), [1996Ri09](#): $^{40}\text{Ar}(^{16}\text{O}, ^{16}\text{O}')$ $E = 250$ MeV/nucleon. Deduced structure near isovector dipole and isoscalar quadrupole giant resonances.

[1994An39](#): $^{36}\text{S}(\alpha, \alpha)$. Resonances were observed at $E\alpha = 13320$ ($J\pi = 7^-$) and $E\alpha = 14120$ ($J\pi = 8^+$).

[1992Wa11](#), [1991Mo05](#): $^{40}\text{Ca}(\pi^-, \pi^+)$ $E = 295$ MeV. Deduced double isovector giant-dipole resonance at 31.1 MeV with a width of 90 MeV.

[1990Va11](#): $^{40}\text{Ar}(X, X)$ $E = 5.9$ keV. Measured $E(x\text{-ray})$.

[1989Al15](#): $^{40}\text{Ar}(^{32}\text{S}, ^{32}\text{S})$ $E = 100$ MeV. Measured $\sigma(\theta)$. [1989Gr06](#): $E = 180, 240$ MeV; [1979Da16](#): $E = 290$ MeV.

[1986Ge01](#), [1985Ge04](#): $^{40}\text{Ar}(\pi, \pi)$ $E = 180$ MeV. Measured $\sigma(\theta)$.

[1985Sh06](#): $^{40}\text{Ar}(^{16}\text{O}, ^{16}\text{O})$ $E = 100$ MeV. Measured $\sigma(\theta)$.

[1983To18](#): $^{40}\text{Ca}(E, \pi^+)$ $E = 400$ MeV.

[1980KoZI](#): $^{48}\text{Ca}(^3\text{He}, ^{11}\text{Be})$. Deduced 8-particle transfer and isospin=4 isotopic multiplet.

Muonic x ray: $2p_{3/2}$ to $1s_{1/2}$: 643.674 keV 20 ([1981Fr25](#), [1992Fr01](#)), 643.94 keV 11 ([1971Bb11](#), [1976Pf01](#)).

Hyperfine structure and isotope shift measurements: [2008BeZH](#), [2005BI33](#), [2003Sa20](#), [1996KI04](#), [1988Mo30](#), [1986Mu06](#), [1982Ei01](#).

Mass measurement: [2005Go36](#), [2003Fr08](#), [2002Bf02](#), [2001Wa50](#), [1998Ca53](#), [1997Br44](#), [1995Ya15](#), [1995Di08](#), [1968Sc01](#), [1968Fu11](#).

 ^{40}Ar LevelsCross Reference (XREF) Flags

A	$^{40}\text{Cl} \beta^-$ decay (1.35 min)	J	$^{40}\text{Ar}(\gamma, \gamma')$, (pol γ, γ')	S	$^{40}\text{Ca}(^{14}\text{C}, ^{14}\text{O})$
B	$^{40}\text{K} \varepsilon$ decay (1.248×10^9 y)	K	$^{40}\text{Ar}(e, e')$, (e, e)	T	$^{41}\text{K}(d, ^3\text{He})$
C	$^{12}\text{C}(^{36}\text{S}, 2\alpha\gamma)$	L	$^{40}\text{Ar}(n, n'\gamma)$, (n, n)	U	$^{42}\text{Ca}(^{14}\text{C}, ^{16}\text{O})$
D	$^{26}\text{Mg}(^{16}\text{O}, 2p\gamma)$, $^{27}\text{Al}(^{18}\text{O}, p\alpha\gamma)$	M	$^{40}\text{Ar}(p, p'\gamma)$	V	$^{44}\text{Ca}(^3\text{He}, ^7\text{Be})$
E	$^{26}\text{Mg}(^{18}\text{O}, 2p2n\gamma)$	N	$^{40}\text{Ar}(p, p')$, (pol p, p')	W	$^{44}\text{Ca}(\alpha, 2\alpha)$
F	$^{36}\text{S}(\alpha, \gamma)$: resonances	O	$^{40}\text{Ar}(\text{pol } d, d')$, (d, d')	X	$^{208}\text{Pb}(^{40}\text{Ar}, X\gamma)$
G	$^{37}\text{Cl}(\alpha, p\gamma)$	P	$^{40}\text{Ar}(^3\text{He}, ^3\text{He}')$, ($^3\text{He}, ^3\text{He}$)		
H	$^{38}\text{Ar}(t, p)$	Q	$^{40}\text{Ar}(\alpha, \alpha')$, (α, α)		
I	$^{38}\text{Ar}(\alpha, ^2\text{He})$	R	Coulomb excitation		

$E(\text{level})^\dagger$	J^π	$T_{1/2}$ or $\Gamma^@$	XREF	Comments
0^C	0^+	stable	ABCDEFGHIJKLMNQRSTUUVWX	J^π : Optical spectroscopy measurements: 1937Ko03 , 1953Me73 ; no hyperfine structure seen. Evaluated rms charge radius = 3.4274 fm 26 (2013An02). $\Delta\langle r^2 \rangle(^{38}\text{Ar}, ^{40}\text{Ar}) = 0.169 \text{ fm}^2$ 33 (1996KI04), 0.17 fm ² (1986Mu06). charge radius $\langle r^2 \rangle_{1/2} = 3.415 \text{ fm}$ 5 (1976Pf01), 3.429 fm 6 (1971Bb11) from Muonic x-ray data; 3.393 fm 15(stat) (1976Fi12), 3.41 fm 4, (1971Sc09), 3.47 fm 5 (1971Gr27 , 1975GrYY), 3.48 fm 4 (1974We02) from $^{40}\text{Ar}(e, e')$ data. $\mu = -0.04$ 6 (2008Sp04 , 2014StZZ) $Q = +0.01$ 4 (1970Na05 , 2013StZZ) J^π : $L(\alpha, \alpha') = L(t, p) = L(\text{pol } d, d') = L(\text{pol } p, p') = L(d, ^3\text{He}) = 2$. $T_{1/2}$ or Γ : weighted average of 1.09 ps 28 from $^{37}\text{Cl}(\alpha, p\gamma)$, 1.11 ps 4 from $^{40}\text{Ar}(e, e')$, 1.35 ps 10 from $^{40}\text{Ar}(p, p'\gamma)$ and
1460.849 ^C	5 2^+	1.15 ps 5	ABCDEFGHIJKLMNQRSTUUVWX	

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Adopted Levels, Gammas (continued) ^{40}Ar Levels (continued)

E(level) [†]	J ^π #	T _{1/2} or Γ [@]	XREF			Comments
						1.25 ps 14 from $^{12}\text{C}(^{36}\text{S}, 2\alpha\gamma)$. μ: using transient-field technique (2008Sp04). Others: -2 2 (1992Cu04), -0.03 8 (2005St22). Q: from reorientation in Coulomb Excitation (1970Na05).
2120.91 ^f 17	0 ⁺	104 ps 14	A C EFGH	LMNO Q	UVWX	J ^π : L(α,α')=L(p,p')=0; 680γ(θ) is isotropic from (n,n'γ). T _{1/2} or Γ: from pγ(t) in (p,p'γ).
2524.09 ^f 11	2 ⁺	0.23 ps 4	A C EFGH	KLMNO Q	T V X	J ^π : L(α,α')=L(pol d,d')=L(pol p,p')=2. T _{1/2} or Γ: weighted average of 0.24 ps 4 from (α,pγ), 0.194 ps 35 from (e,e') and 0.34 ps 6 from (p,p'γ). Others: 0.50 ps 8 from $^{36}\text{S}(\alpha,\gamma)$:resonances, 0.47 ps 7 from $^{12}\text{C}(^{36}\text{S}, 2\alpha\gamma)$.
2892.65 ^c 9	4 ⁺	1.95 ps 28	A CDEFGHI	LMNO Q	V X	J ^π : L(α,α')=L(pol d,d')=L(pol p,p')=4. T _{1/2} or Γ: weighted average of 2.9 ps 14 from $^{26}\text{Mg}(^{16}\text{O}, 2p\gamma)$, 2.3 ps 6 from (α,pγ), 1.80 ps 28 from $^{12}\text{C}(^{36}\text{S}, 2\alpha\gamma)$, and 3.0 ps +18-9 from (p,p'γ).
3207.93 13	2 ⁺	34 fs 7	A C FGH	KLMNO Q	TUV X	J ^π : L(t,p)=L(pol p,p')=2. T _{1/2} or Γ: weighted average of 28 fs 14 from (α,pγ) and 35 fs 7 from (e,e'). Others: 62 fs 12 from (α,γ):resonances, <24 fs from (p,p'γ).
3464.56 ^c 12	6 ⁺	0.680 ns 21	DE GHI	Q	X	J ^π : 571.88γ E2 to 4 ⁺ , L(t,p)=(6). T _{1/2} or Γ: from (α,pγ).
3511.54 20	2 ⁺	59 fs 12	A FGH	K MNO q	T V X	J ^π : L(pol d,d')=L(d, ³ He)=2. T _{1/2} or Γ: weighted average of 62 fs 12 from (α,γ):resonances, 49 fs 14 from (α,pγ) and 83 fs 31 from (p,p'γ).
3515 ^f 1	4 ⁺	0.139 ps 28	E G	q		J ^π : from γ(θ) in (α,pγ) and γ(DCO) and band assignment in $^{26}\text{Mg}(^{18}\text{O}, 2p2n\gamma)$.
3680.60 12	3 ⁻	0.132 ps 28	A C FGH	K MNO Q	V X	J ^π : L(α,α')=L(pol d,d')=L(pol p,p')=3. T _{1/2} or Γ: from (α,pγ). Other: 0.10 ps +6-5 from (p,p'γ).
3918.85 12	2 ⁺	0.29 ps 3	A FGH	K MNo q		J ^π : 3918.6γ E2 to 0 ⁺ , L(t,p)=L(pol p,p')=2. T _{1/2} or Γ: weighted average of 0.28 ps 3 from (α,pγ) and 0.30 ps 4 from (p,p'γ).
3941.9? 2			A	o q	w	XREF: A(?). J ^π : (1,2 ⁺) from possible 3941.7γ to 0 ⁺ g.s.
4042 2	NATURAL		FGH	MN Q	w	XREF: N(4053). E(level): from (P,P'G). J ^π : 0 ⁺ , 1 ⁻ , 2 ⁺ , 3 ⁻ , 4 ⁺ from γ to 2 ⁺ and π=natural in (α,α').
4082.63 16	3 ⁻	40 fs 14	A FGH	MN Q	w	J ^π : based on γ(θ,pol) in (α,pγ) and pγ(θ) in (p,p'γ), log ft=5.9 from 2 ⁻ in ^{40}Cl β ⁻ decay.
4178.9? 3			A			XREF: A(?).
4230 2	4 ⁽⁻⁾	>2.8 ps	C G	m		J ^π : based on γ(θ,pol) in (α,pγ).
4232 2	(1 ⁺ , 2 ⁻ , 3 ⁺)	0.166 ps 28	G	mN Q		XREF: N(4240). J ^π : possible unnatural parity from (α,α'); 1705γ and 2768γ to 2 ⁺ .
4301.08 23	(3) ⁻	58 fs 14	A FGh	MN Q	u	J ^π : log ft=5.1 from 2 ⁻ in ^{40}Cl β ⁻ decay; possible natural parity in (α,α'); L(p,p')=(2,3).
4324.5 3	2 ⁺	16 fs 6	A FGh	Q	Tu	XREF: T(4360).

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Adopted Levels, Gammas (continued)

⁴⁰ Ar Levels (continued)									
E(level) [†]	J ^π #	T _{1/2} or Γ [@]	XREF				Comments		
4358.0 3			A		N	Q	u	J ^π : L(d, ³ He)=0, L(t,p)=2. T _{1/2} or Γ: weighted average of 15 fs 6 from ³⁶ S(α,γ):resonances and 18 fs 7 from (α,pγ). XREF: A(?)N(?).	
4420 1	(2 ⁺ ,3 ⁻)			G	MNO		q	J ^π : π=(natural) from (α,α'), (1,2 ⁺) from possible 4357.6γ to 0 ⁺ g.s. XREF: N(4430).	
4427 1	(4 ⁺)	0.125 ps 21		GH			q	J ^π : 2959γ, 1896γ and 1212γ to 2 ⁺ gives (0+:4 ⁺); natural parity in (α,α') for 4420 and/or 4427 levels gives 1 ⁻ ,2 ⁺ ,3 ⁻ ,4 ⁺ ; L(pol d,d')=(2) gives (2 ⁺); L(pol p,p')=3 gives 3 ⁻ .	
4473 1	1&	0.070 eV 13		FG	J	N		J ^π : L(t,p)=3,4; γ(θ,pol) in (α,pγ) gives 3 ⁺ ,4,5 ⁺ ; 4 ⁻ ,5 ⁺ is ruled out by RUL for 2966γ to 2 ⁺ . XREF: N(4484).	
4481.0 3	1 ⁻	<0.07 ps	A			M	Q	J ^π : from γ(θ) in (α,γ):resoances, (γ,γ') and (α,pγ). T _{1/2} or Γ: from (2J+1)Γ ₀ ² /Γ=0.21 eV 4 with Γ ₀ /Γ=1 in (γ,γ'). XREF: A(?).	
4494 ^d 1	5 ⁻	0.50 ps 7		C E	GH			J ^π : from γ(θ) in (p,p'γ); natural parity in (α,α'). T _{1/2} or Γ: from (p,p'γ).	
4562.36 16	(1,3) ⁻		A		G		Q	T	J ^π : 1601γ E1(+M2) to 4 ⁺ , 1029γ d(+Q) to 6 ⁺ . T _{1/2} or Γ: from (α,pγ). XREF: T(4530).
4578 1	3 ⁽⁻⁾	37 fs 14	A		G		N	Q	J ^π : log ft=5.4 from 2 ⁻ in ⁴⁰ Cl β ⁻ decay; possible natural parity in (α,α'). XREF: A(?).
4602 1		53 fs 20		FG		N	Q		J ^π : 2 ⁺ ,3 is given by 1983Bi08 in (α,pγ) based on γ(θ), but Jπ=2 ⁺ should be ruled out since it results in ΔJ=2 for the 1685γ to 4 ⁺ , which expects positive A ₂ value while the measured A ₂ by 1983Bi08 is negative. Natural parity in (α,α') gives π=- for J=3.
4674 1	(1 ⁺ ,2 ⁻ ,3 ⁺)	66 fs 17		GH		N	Q	u	J ^π : 2078γ and 3141γ to 2 ⁺ ; possible natural parity in (α,α'). T _{1/2} or Γ: unweighted average of 73 fs 12 from (α,γ):resonances and 33 fs 14 from (α,pγ). XREF: N(4683).
4737.8? 4			A				Q	u	J ^π : 3213γ to 2 ⁺ ; possible π=unnatural in (α,α'). XREF: A(?).
4769.0 3	1 ⁻	0.82 eV 6	A		G	J	N	Q	J ^π : (1,2 ⁺) from possible 4737.5γ to 0 ⁺ g.s. J ^π : based on γ(θ,pol) in (pol γ,γ') and γ(θ) in (α,pγ); possible π=natural in (α,α').
4794 1	4 ⁺	52 fs 14		GH		N	Q		T _{1/2} or Γ: from (2J+1)Γ ₀ ² /Γ=2.46 eV 17 with Γ ₀ /Γ=1 in (γ,γ'). XREF: N(4808).
4858 1	5 ⁻	37 fs 10		G					J ^π : 1901γ M1+E2 to 4 ⁺ , L(t,p)=3,4.
4870 10	3 ⁻			H		NO	Q		J ^π : 1965γ E1(+M2) to 4 ⁺ , 1394γ to 6 ⁺ . E(level): from (t,p).
4901? 3					J				J ^π : L(pol d,d')=3; L(t,p)=3,4.
4929 1	(1 ⁻ to 4 ⁺)			G		N			J ^π : (1,2 ⁺) from possible 4901γ to 0 ⁺ g.s. XREF: N(4941).
4942.6? 4			A				q		J ^π : 2405γ and 3468γ to 2 ⁺ and 1248γ to 3 ⁻ . XREF: A(?).

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Adopted Levels, Gammas (continued) ^{40}Ar Levels (continued)

E(level) [†]	J ^π #	T _{1/2} or Γ [@]	XREF		Comments
4959 ^f 1	6 ⁺	0.10 ps 4	E Gh	q	J ^π : 1444γ and 2066γ E2 to 4 ⁺ ; γ(DCO) and band assignment in $^{26}\text{Mg}(^{18}\text{O}, 2\text{p}2\text{n}\gamma)$.
4972 1	(2 ⁺ , 3, 4 ⁺)		Gh		J ^π : 2079γ to 4 ⁺ and 3511γ to 2 ⁺ .
4991 1	4 ⁽⁻⁾	2.1 ps 7	G	N Q	XREF: N(5004).
					J ^π : based on γ(θ, pol) of 765γ in (α, pγ), which implies a parity conserving transition to 4 ⁽⁻⁾ . But the parity is inconsistent with possible natural parity in (α, α'), which is π=+ for J=4.
5110? 3			J		J ^π : (1, 2 ⁺) from possible 5110γ to 0 ⁺ .
5115 2	(5 ⁻)		GH		J ^π : L(t, p)=(5).
5143 2	(5)	<10 fs	G		J ^π : 1628γ to 4 ⁺ and 1678γ to 6 ⁺ gives (4 ⁺ , 5, 6 ⁺); T _{1/2} disfavors E2 for either transition.
5165.6 8	(2) ⁺		A G	Q t	J ^π : 1650γ to 4 ⁺ and 3704.6γ to 2 ⁺ ; natural parity in (α, α') favors (2, 4) ⁺ ; L(d, ^3He)=0 from 3/2 ⁺ for a level at 5200 gives 1 ⁺ , 2 ⁺ ; (1, 2 ⁺) from possible 5165.5γ to 0 ⁺ .
5191 15			H	t	E(level): from (t, p).
					J ^π : L(d, ^3He)=0 from 3/2 ⁺ for a level at 5200 gives 1 ⁺ , 2 ⁺ .
5245 2	(0 ⁺ to 4 ⁺)		G		J ^π : 3784γ to 2 ⁺ .
5269.6 3	(1 ⁻ , 3 ⁻)		A G	n Q u	J ^π : 1186.7γ and 1589.0γ to 3 ⁻ and 2063.0γ to 2 ⁺ ; possible natural parity in (α, α'); log ft=5.9 from 2 ⁻ in ^{40}Cl β ⁻ decay.
5293 2	(2 ⁺)		Gh	n u	J ^π : 3832γ to 2 ⁺ ; L=2 for a level at 5298 15 in (t, p).
5310 2	(2 ⁺)		A Gh	n Q u	XREF: A(?).
					J ^π : possible natural parity from (α, α'); 1228γ and 1629γ to 3 ⁻ ; L=2 for a level at 5298 15 in (t, p).
5350 2			G	u	J ^π : 2457γ to 4 ⁺ .
5378 2	(4 ⁺ , 5, 6 ⁺)		G		J ^π : 1863γ and 2485γ to 4 ⁺ and 1913γ to 6 ⁺ .
5400.5 8	1 ⁻	0.030 eV 7	A H J	N Q	XREF: N(?).
					J ^π : spin from γ(θ) in (γ, γ'); natural parity in (α, α'). L(p, p')=(5) for a level at 5410 is inconsistent and it might imply that it is a different level.
					T _{1/2} or Γ: from (2J+1)Γ ₀ ² /Γ=0.09 eV 2 in (γ, γ') assuming Γ ₀ /Γ=1.
5454 15	3 ⁻ , 4 ⁺		H	N Q	E(level): from (t, p).
					J ^π : L(t, p)=3, 4.
5508 2	NATURAL		GH	Q	J ^π : natural parity from (α, α'); 1993γ to 4 ⁺ .
5544 2	(0 ⁺ to 4 ⁺)		G		J ^π : 4083γ to 2 ⁺ .
5559 2	(4 ⁺ , 5 ⁻ , 6 ⁺)		G	Q	J ^π : 2044γ and 2666γ to 4 ⁺ and 2094γ to 6 ⁺ ; natural parity in (α, α').
5608.8 10	(1, 2, 3)		A G	q	J ^π : 4147.8γ to 2 ⁺ ; log ft=6.3 from 2 ⁻ in ^{40}Cl β ⁻ decay; possible natural parity in (α, α') for a group near 5608.
5611 2			G	q	J ^π : 2147γ to 6 ⁺ .
5630 1			A G	q	XREF: A(?).
					J ^π : 1203γ to (4 ⁺); possible natural parity from (α, α') for a doublet.
5654 2			G		J ^π : 3130γ to 2 ⁺ .
5662 2			G	n	J ^π : 2769γ to 4 ⁺ .
5675 2	(3 ⁻ , 4 ⁺)		GH	n Q	J ^π : L(t, p)=3, 4; possible natural parity in (α, α').
5717.8? 10			A	n Q	
5766 2			G	w	J ^π : 2558γ to 2 ⁺ .

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Adopted Levels, Gammas (continued) ^{40}Ar Levels (continued)

E(level) [†]	J ^π [#]	T _{1/2} or Γ [@]	XREF				Comments
5818 2	(3 ⁻ ,4 ⁺)		GH	T	w		XREF: H(5835). J ^π : L(t,p)=3,4.
5880.3 4	1 ⁻	0.117 eV 13	A	J	o	q	J ^π : log ft=4.9 from 2 ⁻ in ^{40}Cl β ⁻ decay; spin=1 from γ(θ) in (γ,γ'). T _{1/2} or Γ: from (2J+1)Γ ₀ ² /Γ=0.35 eV 4 in (γ,γ') assuming Γ ₀ /Γ=1.
5885 2	3 ⁻		GH	No	q		XREF: N(5900). J ^π : L(pol p,p')=3; L(pol d,d')=(3). But L(t,p)=2 for a level at 5883 15 is inconsistent.
5906.0 7	(1 ⁻)		A		q		J ^π : 3784.9γ to 0 ⁺ ; log ft=5.8 from 2 ⁻ in ^{40}Cl β ⁻ decay; possible natural parity in (α,α').
5912 3	1 ^{&}	0.050 eV 17		J	q		E(level): a level at the same energy is also observed in (α,pγ) but with completely different decay mode and it is considered by evaluator as a separate level. T _{1/2} or Γ: from (2J+1)Γ ₀ ² /Γ=0.15 eV 5 in (γ,γ') assuming Γ ₀ /Γ=1.
5912 2	(1 ⁻ to 4 ⁺)		G		q		J ^π : 1830γ to 3 ⁻ and 2704γ to 2 ⁺ .
5931 2	(2 ⁺ ,3,4 ⁺)		G				J ^π : 3038γ to 4 ⁺ and 4470γ to 2 ⁺ .
5950.5 10	(1,2)		A				J ^π : 5950.0γ to 0 ⁺ ; log ft=6.9 from 2 ⁻ in ^{40}Cl β ⁻ decay.
5973 ^e 2	(6 ⁻)		E	G			J ^π : from (α,pγ) based on analog in ^{42}Ca , and from γ(DCO) in $^{26}\text{Mg}(^{18}\text{O},2\text{p}2\text{n}\gamma)$.
6013 ^d 2	(7 ⁻)		E	G			J ^π : from (α,pγ) based on analog in ^{42}Ca , and from γ(DCO) and band assignment in $^{26}\text{Mg}(^{18}\text{O},2\text{p}2\text{n}\gamma)$.
6053.6 8	1 ⁽⁻⁾	0.41 eV 6	A	J	q		J ^π : spin from γ(θ) in (γ,γ'); log ft=5.9 from 2 ⁻ in ^{40}Cl β ⁻ decay. T _{1/2} or Γ: from (2J+1)Γ ₀ ² /Γ=1.24 eV 19 in (γ,γ') assuming Γ ₀ /Γ=1.
6054	4 ⁺				0	q	E(level): as quoted in 1976Se09 in (pol d,d'), a level at the same energy is also observed in ^{40}Cl β ⁻ decay and (γ,γ') but with J ^π =1 ⁽⁻⁾ . Therefore it is considered as a separate level. J ^π : L(pol d,d')=4.
6100 2	(1,2 ⁺)		G	J			J ^π : based on γγ(θ) in (γ,γ') and 6100γ to 0 ⁺ . Γ ₀ =0.22 eV 6 for J(6100)=1 and 0.13 eV 4 for J(6100)=2 from (2J+1)Γ ₀ ² /Γ=0.17 eV 5 in (γ,γ') with Γ ₀ /Γ=0.26.
6104 2			G				J ^π : 3211γ to 4 ⁺ .
6138 2			A	GH	N	Q	XREF: A(?). J ^π : 2674γ to 6 ⁺ , but L=(2,3) in (p,p') and L(t,p)=(5) are inconsistent.
6158 2	(4 ⁺ ,5,6 ⁺)		G				J ^π : 2693γ to 6 ⁺ and 3265γ to 4 ⁺ .
6185 2			G				J ^π : 1691γ to 5 ⁻ .
6203 2			G		q	T	XREF: T(6230). J ^π : 3310γ to 4 ⁺ ; natural parity in (α,α').
6208.5 8	(1,2)		A		q		J ^π : 6208γ to 0 ⁺ ; log ft=6.6 from 2 ⁻ in ^{40}Cl β ⁻ decay.
6270 2			G		n		J ^π : 2806γ to 6 ⁺ .
6276.0? 9	1 ⁻ ,2 ⁻ ,3 ⁻		A		n		XREF: A(?). J ^π : log ft=5.6 from 2 ⁻ in ^{40}Cl β ⁻ decay.
6305 2	(4 ⁺ ,5,6 ⁺)		GH		n		J ^π : 2790γ to 4 ⁺ and 2840γ to 6 ⁺ .
6338.7 11	1 ⁻	0.29 eV 3	A	J			J ^π : spin from γγ(θ) in (γ,γ'); log ft=5.6 from 2 ⁻ in ^{40}Cl β ⁻ decay.

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Adopted Levels, Gammas (continued) ^{40}Ar Levels (continued)

<u>E(level)[†]</u>	<u>J^π#</u>	<u>T_{1/2} or Γ[@]</u>	<u>XREF</u>				<u>Comments</u>
							T _{1/2} or Γ: from (2J+1)Γ ₀ ² /Γ=0.87 eV 10 in (γ,γ') with Γ ₀ /Γ=1. J ^π : 1498γ to 5 ⁻ and 2891γ to 6 ⁺ .
6356 2	(4 ⁺ to 7 ⁻)			G			
6421 [‡]	(8 ⁻) ^b			E			
6450? 3					J		
6476.0 8	1 ⁻	0.43 eV 5	A	H	J	N	J ^π : spin from γγ(θ) in (γ,γ'); log ft=5.6 from 2 ⁻ in ^{40}Cl β ⁻ decay. L(t,p)=(2) is inconsistent. T _{1/2} or Γ: from (2J+1)Γ ₀ ² /Γ=1.29 eV 16 in (γ,γ') with Γ ₀ /Γ=1. XREF: A(?)N(6650).
6651.7 8			A	H		N	
6703 3	1 ^{&}				J		
6760 15	3 ⁻ ,4 ⁺			H			E(level): from (t,p). J ^π : L(t,p)=3,4.
6806 ^f	(8 ⁺)			E	G		E(level): from (α,pγ). Other: 6801 from $^{26}\text{Mg}(^{18}\text{O},2\text{p}2\text{n}\gamma)$. J ^π : from γ(DCO) and band assignment in $^{26}\text{Mg}(^{18}\text{O},2\text{p}2\text{n}\gamma)$; possible analog state of ^{42}Ca (1983Bi08) from (α,pγ).
6835 15	3 ⁻ ,4 ⁺			H			E(level): from (t,p). J ^π : L(t,p)=3,4.
6979 ^e	(8 ⁻)			E	G		J ^π : from γ(DCO) and band assignment in $^{26}\text{Mg}(^{18}\text{O},2\text{p}2\text{n}\gamma)$; possible analog state of ^{42}Ca (1983Bi08) from (α,pγ).
7070 15				H			E(level): from (t,p).
7168 3	1 ^{&}			H	J		
7246 3	1 ^{&}				J		
7281 3	1 ^{&}			H	J	N	XREF: H(7300)N(7300).
7519 3	1 ^{&}			H	J		XREF: H(7495).
7626 3	1 ^{&}				J		
7640 15	2 ⁺			H			E(level): from (t,p). J ^π : L(t,p)=2.
7688 ^{‡d}	(9 ⁻) ^b			E			
7708 3	1 ⁻ &				J		
7730 3				H			E(level): from (t,p).
7918 2	1 ⁻ &			H	J		XREF: H(7890).
7993 3	1 ⁻ &			E	H	J	XREF: H(7980).
7999 ^{‡e}	(10 ⁻) ^b			E			
8032 3	1 ⁻ &				J		
8163 2	1 ⁻ &				J		
8191 3	1 ⁻ &				J		
8303 3	1 ⁻ &				J		
8552 3	1 ⁻ &				J		
8585 3	1 ⁻ &				J		
8644 3	1 ⁻ &				J		
8676 3	1,2 ⁺ &				J		
8834 4	1 ⁻ &				J		
8884 3	1 ⁻ &				J		
8918 3	1 ⁻ &	0.34 eV 14	F	I	J		T _{1/2} or Γ: from (γ,γ').

Continued on next page (footnotes at end of table)

Adopted Levels, Gammas (continued) ^{40}Ar Levels (continued)

E(level) [†]	J ^π #	T _{1/2} or Γ [@]	XREF	Comments
8946 ^{‡d}	(11 ⁻) ^b		E	
9070 ^{‡f}	(10 ⁺) ^b		E	
9127 3	1 ⁻ &	0.71 eV 14	F iJ	T _{1/2} or Γ: from (γ,γ'). 0.72 eV 16 from ³⁶ S(α,γ):resonances.
9138 6	(1 ⁻ ,2 ⁺) ^a		F	
9147 5	1 ⁻ ^a		F	
9178 3	1 ⁻ ^a		F	
9197 6	(1 ⁻ ,2 ⁺) ^a		F	
9216 4	1 ⁻ ^a		F	
9234 4	1 ⁻ ^a		F	
9240 6	1 ⁻ ^a		F	
9264 4	(1 ⁻ ,2 ⁺) ^a		F	
9273 6	1 ⁻ ^a		F	
9287 4			F	
9296 5	(1 ⁻ ,2 ⁺) ^a		F	
9314 4	1 ⁻ &a		F J	
9330 4	1 ⁻ ^a		F	
9337 3	1 ⁻ ^a		F J	
9355 3	1 ⁻ &a	1.0 eV 3	F J	T _{1/2} or Γ: from (γ,γ'). 1.1 eV 3 from (α,γ):resonances.
9373 4			F	
9416 3	1 ⁻ &a	3.4 eV 18	F J	E(level): doublet: 9408+9417 in (α,γ) with same J ^π for both; the second component seems to correspond to 9416 in (γ,γ'). T _{1/2} or Γ: from (γ,γ'). 4.0 eV 20 from ³⁶ S(α,γ):resonances.
9425 5	(1 ⁻ ,2 ⁺) ^a		F	
9433 5	(1 ⁻ ,2 ⁺) ^a		F	
9450 3	1 ⁻ ^a		F	
9472 4	(1 ⁻ ,2 ⁺) ^a		F	
9485 5	1 ⁻ ^a		F	
9491?			F	
9504.2 14	1 ⁻ &a	7.9 eV 13	F J	T _{1/2} or Γ: from (γ,γ'). 8.2 eV 18 from ³⁶ S(α,γ):resonances.
9527 4			F	
9565 4	1 ⁻ ^a		F	
9583 3	1 ⁻ &a	7.3 eV 21	F J	E(level): doublet:9581+9586 in (α,γ), 9580+9585 in (γ,γ'); the second component has J ^π =(1 ⁻ ,2 ⁺) in (α,γ). T _{1/2} or Γ: from (γ,γ').
9596 4			F	
9608 5			F	
9617 3	1 ⁻ &a		F J	
9656 4	1 ⁻ ^a		F	
9669 4	1 ⁻ ^a		F	
9690 5	(1 ⁻ ,2 ⁺) ^a		F	E(level),J ^π : doublet:9687+9694 with the same J ^π for both.
9736 3	1 ⁻ ^a		F	
9757 3	1 ⁺ &	0.56 eV 22	F J	J ^π : (1 ⁻ ,2 ⁺) from γ(θ) and natural parity in (α,γ):resonances. T _{1/2} or Γ: from (γ,γ').

Continued on next page (footnotes at end of table)

Adopted Levels, Gammas (continued) ^{40}Ar Levels (continued)

E(level) [†]	J ^π [#]	T _{1/2} or Γ [@]	XREF		Comments
9769 4	(1 ⁻ ,2 ⁺) ^a		F		
9787 4	1 ^{-a}		F		
9813 3	1 ^{-a}		F		
9825 3	1 ^{-a}		F		
9840 3	1 ^{-&}			J	
9851 2	1 ^{-&a}	21 eV 4	F	J	E(level): doublet: 9849+9852 in (α,γ). T _{1/2} or Γ: from (γ,γ'). 22 eV 6 from ³⁶ S(α,γ):resonances.
9866 4			F		
9881 4	1 ^{-a}		F		
9893 4	1 ^{-a}		F		
9912 5	(1 ⁻ ,2 ⁺) ^a		F		
9944 3	1 ^{-a}		F		
9952 3	1 ^{-&}	10 eV 3	F	J	E(level): weighted average of 9954 3 from (α,γ), 9950 3 from (γ,γ'). T _{1/2} or Γ: from (γ,γ'). ≥9.6 eV from ³⁶ S(α,γ):resonances.
10090 3	1 ^{-&}			J	
10151 3	1 ^{-&}			J	
10179 2	1 ^{-&}			J	
10362 3	1,2 ⁺ &			J	
10745 3	1 ^{-&}			J	
10857 3	1 ^{-&}			J	
11769 ^{‡f}	(12 ⁺) ^b		E		
17.7×10 ³ 2	2 ⁺			Q	E(level),J ^π : isoscalar giant-quadrupole resonance with L(α,α')=2.

[†] From a least-squares fit to γ-ray energies if values with uncertainties are available, otherwise, from (α,pγ) up to 6979 level and from (α,γ):resonances after 8919 level if available, unless otherwise noted.

[‡] From ²⁶Mg(¹⁸O,2p2nγ).

[#] In (d,³He) reaction, ⁴¹K target Jπ(g.s.)=3/2⁺.

[@] Values of half-lives are from (α,pγ), unless otherwise noted; widths are from (γ,γ') and/or (α,γ). Some half-lives are also available from (p,p'γ) and (α,γ) and weighted averages are taken when values are from more than one reactions. In addition to the width values from (γ,γ') given here for levels with known γ-decay branching ratios, width data for other levels (mostly α-unbound) with unknown γ-decay branching ratios are also available in that dataset.

& From (γ,γ'), based on γ(θ) in (γ,γ'), parity from polarization asymmetry if available.

^a From (α,γ):resonances, based on γ(θ) and natural parity.

^b From ²⁶Mg(¹⁸O,2p2nγ) based on γ(DCO) and band assignment.

^c (A): Member of f_{7/2}² yrast sequence.

^d (B): Band based on 5⁻, α=1.

^e (C): Band based on (6⁻), α=0.

^f (D): SD band. Q(transition)=1.45 +49-31(stat) 15(syst) (2010Id02) from ²⁶Mg(¹⁸O,2p2nγ). Possible configuration=π[(d5/2)^{-1.2}(s_{1/2}d_{3/2})^{-3.8}(fp)^{2.5}(g_{9/2})^{0.5}]⊗ν[(d5/2)^{-0.7}(s_{1/2}d_{3/2})^{-2.4}(fp)^{4.5}(g_{9/2})^{0.5}].

Adopted Levels, Gammas (continued)

$\gamma(^{40}\text{Ar})$								
$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\S$	E_f	J_f^π	Mult.&	$\delta^\&$	Comments
1460.849	2 ⁺	1460.820 5	100	0	0 ⁺	E2		B(E2)(W.u.)=9.0 4 E _γ : from ⁴⁰ K ε decay. Other: 1460.73 5 from ⁴⁰ Cl β ⁻ decay. Mult.: from γ(θ,pol) in ²⁶ Mg(¹⁶ O,2pγ), γ(θ) in ⁴⁰ Ar(p,p'γ) and ce data in ⁴⁰ K ε decay.
2120.91	0 ⁺	660.1 4	100	1460.849	2 ⁺	[E2]		B(E2)(W.u.)=5.3 8 E _γ : from ⁴⁰ Cl β ⁻ decay.
2524.09	2 ⁺	403 @ 1063.1 2	<1.7 100 2	2120.91 1460.849	0 ⁺ 2 ⁺	M1+E2	-0.41 +6-13	E _γ , I _γ : from ⁴⁰ Ar(p,p'γ). B(M1)(W.u.)=0.037 6; B(E2)(W.u.)=18 5 I _γ : from ³⁷ Cl(α,pγ). Others: 100 10 from ⁴⁰ Cl β ⁻ decay, and 100 3 from ⁴⁰ Ar(p,p'γ). Mult., δ: from (p,p'γ). B(E2)(W.u.)=1.19 18 I _γ : weighted average of 86 10 from ⁴⁰ Cl β ⁻ decay, 75.4 18 from ³⁷ Cl(α,pγ), and 69 3 from ⁴⁰ Ar(p,p'γ). Mult.: Q from (p,p'γ); M2 is ruled out by RUL.
		2524.1 2	74 2	0	0 ⁺	E2		B(E2)(W.u.)=5.9 9 E _γ : weighted average of 1432.1 4 from ⁴⁰ Cl β ⁻ decay and 1431.80 10 from ³⁷ Cl(α,pγ). Mult.: from γ(θ,pol) in ²⁶ Mg(¹⁶ O,2pγ), γ(θ) in (p,p'γ); M2 is ruled out by RUL.
2892.65	4 ⁺	369.0 6 1431.82 10	1.0 5 100 10	2524.09 1460.849	2 ⁺ 2 ⁺	[E2] E2		B(E2)(W.u.)=5.1E+3 21 is much higher than allowed by RUL. B(E2)(W.u.)=35 19 B(M1)(W.u.)=0.104 22; B(E2)(W.u.)=1.3 +17-13 I _γ : from ³⁷ Cl(α,pγ). Others: 100 9 from ⁴⁰ Cl β ⁻ decay and 100 3 from ⁴⁰ Ar(p,p'γ). Mult., δ: D+Q from γ(θ) in (p,p'γ), polarity from no level-parity change determined from other evidence.
3207.93	2 ⁺	315.0 5 1087.6 4 1746.5 2	0.9 3 3.0 15 100 1	2892.65 2120.91 1460.849	4 ⁺ 0 ⁺ 2 ⁺	[E2] [E2] M1+E2	+0.11 7	B(E2)(W.u.)=0.61 16 I _γ : weighted average of 18 3 from ⁴⁰ Cl β ⁻ decay, 11.1 11 from ³⁷ Cl(α,pγ), and 10 3 from ⁴⁰ Ar(p,p'γ). B(E2)(W.u.)=1.67 6 E _γ : from (α,pγ). Mult.: from γ(θ,pol) in ²⁶ Mg(¹⁶ O,2pγ), γ(θ) in (α,pγ); M2 is ruled out by RUL.
		3208.2 3	11.7 16	0	0 ⁺	[E2]		I _γ : weighted average of 5 3 from ⁴⁰ Cl β ⁻ decay and 2.2 23 from ⁴⁰ Ar(p,p'γ). B(E2)(W.u.)=2.0×10 ² +21-20 I _γ : from (α,pγ). I _γ : from (α,pγ).
3464.56	6 ⁺	571.91 8	100	2892.65	4 ⁺	E2		
3511.54	2 ⁺	303.0 6 621.1 6 987	3.2 18 2 2 6.2 12	3207.93 2892.65 2524.09	2 ⁺ 4 ⁺ 2 ⁺	 [E2] 		

Adopted Levels, Gammas (continued)

$\gamma(^{40}\text{Ar})$ (continued)								
$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\S$	E_f	J_f^π	Mult.&	$\delta\&$	Comments
3511.54	2 ⁺	2050.5 4	100 2	1460.849	2 ⁺	M1(+E2)	-0.05 11	B(M1)(W.u.)=0.034 7 I _γ : from ⁴⁰ Ar(p,p'γ). Others: 100 15 from ⁴⁰ Cl β ⁻ decay, 100 4 from ³⁷ Cl(α,pγ). Mult.,δ: D(+Q) from γ(θ) in (p,p'γ), polarity from no level-parity change determined from other evidence. B(E2)(W.u.)=0.26 6 I _γ : weighted average of 15 6 from ⁴⁰ Cl β ⁻ decay, 17.3 25 from ³⁷ Cl(α,pγ), and 12.4 23 from ⁴⁰ Ar(p,p'γ).
		3511.0 5	14.7 17	0	0 ⁺	[E2]		B(M1)(W.u.)=0.20 5 Mult.,δ: D(+Q) from γ(θ) in (α,pγ); E1(+M2) ruled out by RUL. B(E2)(W.u.)=5×10 ¹ 3 B(E2)(W.u.)=8.2 18
3515	4 ⁺	622	52 3	2892.65	4 ⁺	M1(+E2)	-0.07 10	E _γ ,I _γ : from (p,p'γ). B(E1)(W.u.)=0.0012 5 B(E1)(W.u.)=0.00086 21 I _γ : weighted average of 11.6 12 from ⁴⁰ Cl β ⁻ decay, 11.6 12 from ³⁷ Cl(α,pγ), and 18 4 from ⁴⁰ Ar(p,p'γ). B(E1)(W.u.)=0.00012 3 I _γ : weighted average of 7.0 12 from ⁴⁰ Cl β ⁻ decay, 4.7 6 from ³⁷ Cl(α,pγ), and 7 4 from ⁴⁰ Ar(p,p'γ). B(E1)(W.u.)=0.00032 7 I _γ : from ³⁷ Cl(α,pγ). Others: 100 14 from ⁴⁰ Cl β ⁻ decay, and 100 4 from ⁴⁰ Ar(p,p'γ). Mult.,δ: D(+Q) from pγ(θ) in (p,p'γ), polarity from level-parity change determined from other evidence.
		991	15 8	2524.09	2 ⁺	[E2]		B(E3)(W.u.)<3×10 ² B(E1)(W.u.)=0.0012 7 E _γ : from ⁴⁰ Cl β ⁻ decay, observed in (p,p'γ) but not in (α,pγ). I _γ : scaled from Iγ(2457.7)=30 3 from (α,pγ) by the factor of Iγ(239.0)/Iγ(2457.7)=4.8 23/100 17 from ⁴⁰ Cl β ⁻ decay. I _γ : from (α,pγ). Others: 13.6 17 from (p,p'γ), 26 4 from ⁴⁰ Cl β ⁻ decay. B(E2)(W.u.)=1.1 3 I _γ : from (α,pγ). Others: 20 3 from (p,p'γ), 47 7 from ⁴⁰ Cl β ⁻ decay. I _γ : from (α,pγ). Others: 36 5 from (p,p'γ), 100 17 from ⁴⁰ Cl β ⁻ decay. Mult.: D+Q from γ(θ) in (p,p'γ), polarity from no level-parity change determined from other evidence. δ: <-0.3 or >+6 from (p,p'γ). B(E2)(W.u.)=0.154 21 I _γ : from (α,pγ). Others: 100 5 from (p,p'γ), 83 9 from ⁴⁰ Cl β ⁻ decay. It is seen from the gamma spectrum in 1972KI06 in ⁴⁰ Cl β ⁻ decay that the 3919
		2054	100 3	1460.849	2 ⁺	[E2]		
3680.60	3 ⁻	170 @	<8	3511.54	2 ⁺			
		472.0 4	3.5 12	3207.93	2 ⁺	[E1]		
		788.1 3	11.9 12	2892.65	4 ⁺	[E1]		
		1156.2 4	5.2 7	2524.09	2 ⁺	[E1]		
		2220.0 2	100 2	1460.849	2 ⁺	E1(+M2)	-0.07 +5-11	
3918.85	2 ⁺	3681 @	<6	0	0 ⁺	[E3]		
		239.0 3	1.4 8	3680.60	3 ⁻	[E1]		
		1394.7 3	22 3	2524.09	2 ⁺			
		1797.8 2	15 3	2120.91	0 ⁺	[E2]		
		2457.7 4	30 3	1460.849	2 ⁺	M1+E2		
		3918.6 2	100 7	0	0 ⁺	E2		

Adopted Levels, Gammas (continued)

$\gamma(^{40}\text{Ar})$ (continued)								
$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\S$	E_f	J_f^π	Mult.&	$\delta\&$	Comments
								single-escape-peak+full-energy-peak is much stronger than the 2458 peak. It is possible that the intensity of 3919 single-escape peak is not taken into account for the total intensity of the 3919 gamma-ray by 1972KI06.
3941.9?		3941.7@ 2	100	0	0 ⁺			Mult.: Q from $\gamma(\theta)$ in (p,p' γ); M2 is ruled out by RUL.
4042	NATURAL	1518 2	100 16	2524.09	2 ⁺			E_γ : from (p,p' γ). I_γ : from $^{36}\text{S}(\alpha,\gamma)$:resonances. Other: 100 22 from $^{40}\text{Ar}(\text{p,p}'\gamma)$. I_γ : weighted average of 59 16 from $^{36}\text{S}(\alpha,\gamma)$:resonances and 67 22 from $^{40}\text{Ar}(\text{p,p}'\gamma)$.
		2581	62 16	1460.849	2 ⁺			B(E1)(W.u.)=0.00012 5 B(E1)(W.u.)=0.0008 3 B(E3)(W.u.)= 2.7×10^2 11
4082.63	3 ⁻	1558.7 4	3.3 4	2524.09	2 ⁺	[E1]		
		2621.7 2	100 9	1460.849	2 ⁺	[E1]		
		4082.1 8	1.7 3	0	0 ⁺	[E3]		
4178.9?		4178.7@ 3	100	0	0 ⁺			
4230	4 ⁽⁻⁾	547 2	89 4	3680.60	3 ⁻	D+Q	-10 +3-9	E_γ : from (p,p' γ). Mult., δ : based on $\gamma(\theta,\text{pol})$ in ($\alpha,\text{p}\gamma$).
		1338 2	100 4	2892.65	4 ⁺	D(+Q)	+0.6 +4-8	Mult., δ : based on $\gamma(\theta)$ in ($\alpha,\text{p}\gamma$). E_γ : from (p,p' γ). E_γ : from (p,p' γ).
4232	(1 ⁺ ,2 ⁻ ,3 ⁺)	1708 2	100 4	2524.09	2 ⁺			
		2771	30 4	1460.849	2 ⁺			
4301.08	(3) ⁻	621.1 6	<0.9	3680.60	3 ⁻			
		1092.9 8	1.0 2	3207.93	2 ⁺	[E1]		B(E1)(W.u.)= 8×10^{-5} 3
		1776.9 8	0.06 1	2524.09	2 ⁺	[E1]		B(E1)(W.u.)= 1.1×10^{-6} 4
		2840.1 3	100 15	1460.849	2 ⁺	[E1]		B(E1)(W.u.)=0.00043 14
4324.5	2 ⁺	2864	43 9	1460.849	2 ⁺			I_γ : from from $^{36}\text{S}(\alpha,\gamma)$:resonances. Not seen in $^{40}\text{Cl} \beta^-$ decay. Other: 100 7 from ($\alpha,\text{p}\gamma$). B(E2)(W.u.)=0.8 4 I_γ : from $^{36}\text{S}(\alpha,\gamma)$:resonances. Other: 41 7from ($\alpha,\text{p}\gamma$).
		4324.2 3	100 9	0	0 ⁺	[E2]		
4358.0		4357.6@ 3	100	0	0 ⁺			
4420	(2 ⁺ ,3 ⁻)	1212	11 2	3207.93	2 ⁺			
		1896	10 2	2524.09	2 ⁺			
		2959	100 5	1460.849	2 ⁺			
4427	(4 ⁺)	1534	75 9	2892.65	4 ⁺	D+Q		E_γ : 2958 3 from (p,p' γ). Mult.: from ($\alpha,\text{p}\gamma$) based on $\gamma(\theta)$. δ : -0.2 to +1.0 from ($\alpha,\text{p}\gamma$) based on $\gamma(\theta)$. B(E2)(W.u.)=1.4 3
		2966	100 9	1460.849	2 ⁺	[E2]		
4473	1	4473 3	100	0	0 ⁺			
4481.0	1 ⁻	4480.7 3	100	0	0 ⁺	D		Mult.: based on $\gamma(\theta)$ in (p,p' γ).
4494	5 ⁻	264	3.0 5	4230	4 ⁽⁻⁾			I_γ : from ($\alpha,\text{p}\gamma$). B(E1)(W.u.)=0.000113 23 I_γ : from ($\alpha,\text{p}\gamma$).
		979	15 2	3515	4 ⁺	[E1]		

Adopted Levels, Gammas (continued)

$\gamma(^{40}\text{Ar})$ (continued)								
$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\S$	E_f	J_f^π	Mult. &	$\delta^\&$	Comments
4494	5 ⁻	1029	46 3	3464.56	6 ⁺	D(+Q)	+0.06 +7-10	I _γ : from (α,pγ). Mult.,δ: from (α,pγ), based on γ(θ). B(E1)(W.u.)=0.00017 3
		1601	100 5	2892.65	4 ⁺	E1(+M2)	0.00 +6-9	I _γ : from (α,pγ). Mult.,δ: from (α,pγ), based on γ(θ,pol).
4562.36	(1,3) ⁻	261.2 7	7.1 7	4301.08	(3) ⁻			I _γ : other: 18.4 21 from (α,pγ). I _γ : other: 86 8 from (α,pγ).
		479.9 4	7.9 14	4082.63	3 ⁻			
		643.6 3	59 4	3918.85	2 ⁺			
		881.3 3	22.9 22	3680.60	3 ⁻			
		1051.1 5	4.3 7	3511.54	2 ⁺			
		1353.7 5	1.8 7	3207.93	2 ⁺			
		3101.7 4	100 14	1460.849	2 ⁺			I _γ : other: 100 8 from (α,pγ).
4578	3 ⁽⁻⁾	222.5 @ 5		4358.0				E _γ : observed only in ⁴⁰ Cl β ⁻ decay.
		1067	90 10	3511.54	2 ⁺			
		1370	38 5	3207.93	2 ⁺			
		1685	100 10	2892.65	4 ⁺	D+Q		Mult.: based on γ(θ) in (α,pγ). δ: -0.05 to +0.72 for J=3 based on γ(θ) in (α,pγ).
		3117	28 5	1460.849	2 ⁺			
		4580.1 @ 5		0	0 ⁺	[E3]		E _γ : observed only in ⁴⁰ Cl β ⁻ decay.
4602		2078	100 2	2524.09	2 ⁺			
		3141	11 2	1460.849	2 ⁺			
4674	(1 ⁺ , 2 ⁻ , 3 ⁺)	3213	100	1460.849	2 ⁺			
4737.8?		4737.5 @ 4	100	0	0 ⁺			
4769.0	1 ⁻	4768.7 3	100	0	0 ⁺			
4794	4 ⁺	1901	100 10	2892.65	4 ⁺	M1+E2		Mult.,δ: based on γ(θ,pol) in (α,pγ) with δ(E2/M1)=0.22 +13-5 or +1.60 15.
		3333	100 10	1460.849	2 ⁺	[E2]		B(E2)(W.u.)=1.6 5
4858	5 ⁻	364	15 8	4494	5 ⁻			
		1394	36 2	3464.56	6 ⁺	[E1]		B(E1)(W.u.)=0.0014 4
		1965	100 3	2892.65	4 ⁺	E1(+M2)	-0.09 +8-12	B(E1)(W.u.)=0.0014 4 Mult.,δ: based on γ(θ,pol) in (α,pγ).
4901?		4901 @ 3		0	0 ⁺			
4929	(1 ⁻ to 4 ⁺)	1248	100 8	3680.60	3 ⁻			
		2405	44 6	2524.09	2 ⁺			
		3468	56 6	1460.849	2 ⁺			
4942.6?		361.3 @ 5	90 20	4578	3 ⁽⁻⁾			
		381.0 @ 5	100 40	4562.36	(1,3) ⁻			
4959	6 ⁺	1444	100 5	3515	4 ⁺	E2		B(E2)(W.u.)=7×10 ¹ 3 Mult.: based on γ(θ) in (α,pγ); RUL rules out M2.
		2066	56 5	2892.65	4 ⁺	E2		B(E2)(W.u.)=7 3 Mult.: based on γ(θ) in (α,pγ); RUL rules out M2.

Adopted Levels, Gammas (continued)

$\gamma(^{40}\text{Ar})$ (continued)

$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\S$	E_f	J_f^π	Mult. &	Comments
4972	(2 ⁺ ,3,4 ⁺)	2079	100 7	2892.65	4 ⁺		
		3511	69 7	1460.849	2 ⁺		
4991	4 ⁽⁻⁾	761	100 2	4230	4 ⁽⁻⁾	(M1+E2)	Mult., δ : from $\gamma(\theta,\text{pol})$ in $(\alpha,\text{p}\gamma)$, with $\delta(\text{Q/D})=-0.13$ to $+0.77$ or -0.72 to -1.5 .
		909	11 1	4082.63	3 ⁻		
		1310	10 1	3680.60	3 ⁻		
5110?		5110 @ 3		0	0 ⁺		
5115	(5 ⁻)	1651	100	3464.56	6 ⁺		
5143	(5)	1628	20 2	3515	4 ⁺		
		1678	100 2	3464.56	6 ⁺		
5165.6	(2) ⁺	1650	100 4	3515	4 ⁺		E_γ, I_γ : observed in $(\alpha,\text{p}\gamma)$ only. This strong transition is not seen in ⁴⁰ Cl β^- decay. It could suggest that it may be misplaced.
		3704.6 8	43 4	1460.849	2 ⁺		I_γ : from $(\alpha,\text{p}\gamma)$. Other: 100 10 from ⁴⁰ Cl β^- decay.
		5165.5 @ 10	4 2	0	0 ⁺		E_γ : observed in ⁴⁰ Cl β^- decay only.
							I_γ : normalized to $I(3704.6\gamma)=43$ 4 from $(\alpha,\text{p}\gamma)$ by the factor of $I(5165.5\gamma)/I(3704.6\gamma)=10$ 5/100 10 from ⁴⁰ Cl β^- decay.
5245	(0 ⁺ to 4 ⁺)	3784	100	1460.849	2 ⁺		
5269.6	(1 ⁻ ,3 ⁻)	1186.7 4	75 8	4082.63	3 ⁻		
		1589.0 3	100 17	3680.60	3 ⁻		
		2063.0 10	42 17	3207.93	2 ⁺		
5293	(2 ⁺)	3832	100	1460.849	2 ⁺		
5310	(2 ⁺)	748	23 2	4562.36	(1,3) ⁻		
		1228	85 6	4082.63	3 ⁻		
		1629	100 6	3680.60	3 ⁻		
		5309.6 @ 10		0	0 ⁺		E_γ : only transition observed from a level at 5310 in ⁴⁰ Cl β^- decay, not observed in other studies. The evaluator has considered this transition as questionable.
5350		2457	100	2892.65	4 ⁺		
5378	(4 ⁺ ,5,6 ⁺)	1863	42 4	3515	4 ⁺		
		1913	55 4	3464.56	6 ⁺		
		2485	100 8	2892.65	4 ⁺		
5400.5	1 ⁻	5400.1 8	100	0	0 ⁺		
5508	NATURAL	1993	100	3515	4 ⁺		
5544	(0 ⁺ to 4 ⁺)	4083	100	1460.849	2 ⁺		
5559	(4 ⁺ ,5 ⁻ ,6 ⁺)	2044	46 4	3515	4 ⁺		
		2094	61 4	3464.56	6 ⁺		
		2666	100 7	2892.65	4 ⁺		
5608.8	(1,2,3)	4147.7 10	100	1460.849	2 ⁺		
5611		2147	100	3464.56	6 ⁺		
5630		1203	100	4427	(4 ⁺)		
		5629.0 @ 10		0	0 ⁺		E_γ : only transition observed from a level at 5630 in ⁴⁰ Cl β^- decay, not observed in other studies. The evaluator has considered this transition as questionable.
5654		3130	100	2524.09	2 ⁺		

Adopted Levels, Gammas (continued)

$\gamma(^{40}\text{Ar})$ (continued)

$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\S$	E_f	J_f^π	Comments
5662		2769	100	2892.65	4 ⁺	
5675	(3 ⁻ ,4 ⁺)	1994	100	3680.60	3 ⁻	
5717.8?		3193.7 @ 10	100	2524.09	2 ⁺	
5766		2558	100	3207.93	2 ⁺	
5818	(3 ⁻ ,4 ⁺)	2925	100	2892.65	4 ⁺	
5880.3	1 ⁻	1317.2 5	10 1	4562.36	(1,3) ⁻	
		1579.9 8	8 2	4301.08	(3) ⁻	
		3356.6 8	8 3	2524.09	2 ⁺	
		3759.9 10	2.6 13	2120.91	0 ⁺	
		5879.6 12	100 5	0	0 ⁺	
5885	3 ⁻	2992	100 7	2892.65	4 ⁺	
		4424	87 7	1460.849	2 ⁺	
5906.0	(1 ⁻)	3784.9 6	100	2120.91	0 ⁺	
5912	1	5912 3	100	0	0 ⁺	
		1830	100 10	4082.63	3 ⁻	
		2704	100 10	3207.93	2 ⁺	
5931	(2 ⁺ ,3,4 ⁺)	3038	100 6	2892.65	4 ⁺	
		4470	39 6	1460.849	2 ⁺	
5950.5	(1,2)	5950.0 10	100	0	0 ⁺	
5973	(6 ⁻)	2508	100	3464.56	6 ⁺	
6013	(7 ⁻)	1519	100 6	4494	5 ⁻	E_γ : 1522 from ²⁶ Mg(¹⁸ O,2p2n γ).
		2548	100 6	3464.56	6 ⁺	E_γ : 2553 from ²⁶ Mg(¹⁸ O,2p2n γ).
6053.6	1(-)	6053.1 8	100	0	0 ⁺	
6100	(1,2 ⁺)	4638 3	100 7	1460.849	2 ⁺	E_γ : from (γ,γ').
		6100	33 7	0	0 ⁺	
6104		3211	100	2892.65	4 ⁺	
6138		2674	100	3464.56	6 ⁺	
6158	(4 ⁺ ,5,6 ⁺)	2693	100 2	3464.56	6 ⁺	
		3265	15 2	2892.65	4 ⁺	
6185		1691	100	4494	5 ⁻	
6203		3310	100	2892.65	4 ⁺	
6208.5	(1,2)	6208.0 8	100	0	0 ⁺	
6270		2805	100	3464.56	6 ⁺	
6276.0?	1 ⁻ ,2 ⁻ ,3 ⁻	1333.4 @ 8	100	4942.6?		
6305	(4 ⁺ ,5,6 ⁺)	2790	100 8	3515	4 ⁺	
		2840	67 8	3464.56	6 ⁺	
6338.7	1 ⁻	6338.2 11	100	0	0 ⁺	
6356	(4 ⁺ to 7 ⁻)	1498	100 8	4858	5 ⁻	
		2891	49 8	3464.56	6 ⁺	
6421	(8 ⁻)	2956 [†]		3464.56	6 ⁺	
6450?		6450 @ 3		0	0 ⁺	

Adopted Levels, Gammas (continued)

<u>$\gamma(^{40}\text{Ar})$ (continued)</u>							Comments
<u>E_i(level)</u>	<u>J_i^{π}</u>	<u>E_{γ}^{$\dagger$}</u>	<u>I_{γ}^{$\S$}</u>	<u>E_f</u>	<u>J_f^{π}</u>	<u>Mult.^{$\&$}</u>	
6476.0	1 ⁻	6475.5 8	100	0	0 ⁺		
6651.7		1042.3 @ 3	100	5608.8	(1,2,3)		
6703	1	6703 3	100	0	0 ⁺		
6806	(8 ⁺)	1847	100	4959	6 ⁺		E _{γ} : from (α ,p γ). Other: 1841 from (¹⁸ O,2p2n γ).
6979	(8 ⁻)	1006	100	5973	(6 ⁻)		
7168	1	7168 3	100	0	0 ⁺		
7246	1	7246 3	100	0	0 ⁺		
7281	1	7281 3	100	0	0 ⁺		
7519	1	7519 3	100	0	0 ⁺		
7626	1	6168 @ 3		1460.849	2 ⁺		
		7626 3	100	0	0 ⁺		
7688	(9 ⁻)	709 [‡]		6979	(8 ⁻)		
		1671 [‡]		6013	(7 ⁻)		
7708	1 ⁻	7708 3	100	0	0 ⁺	E1	
7918	1 ⁻	7918 2	100	0	0 ⁺	E1	
7993	1 ⁻	7993 3	100	0	0 ⁺	E1	
7999	(10 ⁻)	311 [‡]		7688	(9 ⁻)		
		1020 [‡]		6979	(8 ⁻)		
		1578 [‡]		6421	(8 ⁻)		
8032	1 ⁻	6570 @ 3		1460.849	2 ⁺		
		8032 3	100	0	0 ⁺	E1	
8163	1 ⁻	6703 @ 2		1460.849	2 ⁺		
		8163 2	100	0	0 ⁺	E1	
8191	1 ⁻	8191 3	100	0	0 ⁺	E1	
8303	1 ⁻	8303 3	100	0	0 ⁺	E1	
8552	1 ⁻	8552 3	100	0	0 ⁺	E1	
8585	1 ⁻	8585 3	100	0	0 ⁺	E1	
8644	1 ⁻	8644 3	100	0	0 ⁺	E1	
8676	1,2 ⁺	8676 3	100	0	0 ⁺		
8834	1 ⁻	8834 4	100	0	0 ⁺		
8884	1 ⁻	8884 3	100	0	0 ⁺	E1	
8918	1 ⁻	8917 3	100	0	0 ⁺	E1	B(E1)(W.u.)=0.0006 3
8946	(11 ⁻)	947 [‡]		7999	(10 ⁻)		
		1258 [‡]		7688	(9 ⁻)		
9070	(10 ⁺)	2269 [‡]		6806	(8 ⁺)		
9127	1 ⁻	9128 3	100	0	0 ⁺	E1	B(E1)(W.u.)=0.00118 24
9314	1 ⁻	9313		0	0 ⁺		
9337	1 ⁻	9337 3	100	0	0 ⁺		
9355	1 ⁻	5054	7	4301.08	(3) ⁻		

Adopted Levels, Gammas (continued)

<u>$\gamma(^{40}\text{Ar})$ (continued)</u>						
<u>$E_i(\text{level})$</u>	<u>J_i^π</u>	<u>$E_\gamma^\dagger$</u>	<u>$I_\gamma^\S$</u>	<u>E_f</u>	<u>J_f^π</u>	<u>Mult.&</u>
9355	1^-	5436	8	3918.85	2^+	
		9356 3	100	0	0^+	E1
9416	1^-	5333	54	4082.63	3^-	
		5497	40	3918.85	2^+	
		5904	51	3511.54	2^+	
		6891	9	2524.09	2^+	
		7954	31	1460.849	2^+	
		9416 3	100	0	0^+	E1
		5938	23	3511.54	2^+	
9450	1^-	6242	23	3207.93	2^+	
		6557	11	2892.65	4^+	[E3]
		6925	37	2524.09	2^+	
		7328	34	2120.91	0^+	
		7988	100	1460.849	2^+	
		9449	69	0	0^+	
		5585	3	3918.85	2^+	
9504.2	1^-	7383	2	2120.91	0^+	
		8043	7	1460.849	2^+	
		9503	100	0	0^+	E1
9583	1^-	5664	12	3918.85	2^+	
		6690	12	2892.65	4^+	[E3]
		7058	27	2524.09	2^+	
		7461	61	2120.91	0^+	
		8121	44	1460.849	2^+	
		9582 3	100	0	0^+	(E1)
9617	1^-	5698	11	3918.85	2^+	
		5936	4	3680.60	3^-	
		6105	4	3511.54	2^+	
		6409	9	3207.93	2^+	
		6724	7	2892.65	4^+	[E3]
		7092	15	2524.09	2^+	
		7495	7	2120.91	0^+	
		8155	100	1460.849	2^+	
		9616	67	0	0^+	
		5088	26	4602		
9690	$(1^-, 2^+)$	5365	15	4324.5	2^+	
		5771	11	3918.85	2^+	
		6178	11	3511.54	2^+	
		6482	9	3207.93	2^+	
		7165	100	2524.09	2^+	
		8228	7	1460.849	2^+	
		9689	6	0	0^+	

Adopted Levels, Gammas (continued)

							$\gamma(^{40}\text{Ar})$ (continued)
$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\S$	E_f	J_f^π	Mult. $\&$	Comments
9736	1^-	5134	10	4602			
		5817	27	3918.85	2^+		
		6528	23	3207.93	2^+		
		7211	10	2524.09	2^+		
		7614	15	2120.91	0^+		
		8274	23	1460.849	2^+		
		9735	100	0	0^+		
9757	1^+	9757 3	100	0	0^+	M1	B(M1)(W.u.)=0.029 12
9825	1^-	5906	40	3918.85	2^+		
		6144	36	3680.60	3^-		
		6313	8	3511.54	2^+		
		6617	52	3207.93	2^+		
		7300	68	2524.09	2^+		
		7703	28	2120.91	0^+		
		8363	100	1460.849	2^+		
		9824	68	0	0^+		
9840	1^-	9840 3	100	0	0^+		
9851	1^-	6958 @	19	2892.65	4^+	[E3]	
		7326	60	2524.09	2^+		
		8389	53	1460.849	2^+		
		9850 2	100	0	0^+	E1	
9944	1^-	6025	13	3918.85	2^+		
		7419	61	2524.09	2^+		
		7822	24	2120.91	0^+		
		8482	66	1460.849	2^+		
		9943	100	0	0^+		
9952	1^-	5627	6	4324.5	2^+		
		5910	3	4042	NATURAL		
		6033	3	3918.85	2^+		
		7427	13	2524.09	2^+		
		8490	17	1460.849	2^+		
		9950 3	100	0	0^+	E1	
10090	1^-	10090 3	100	0	0^+	E1	
10151	1^-	10151 3	100	0	0^+	E1	
10179	1^-	10179 2	100	0	0^+	E1	
10362	$1,2^+$	10362 3	100	0	0^+		
10745	1^-	10745 3	100	0	0^+	E1	
10857	1^-	10857 3	100	0	0^+	E1	
11769	(12 ⁺)	2699 ‡		9070	(10 ⁺)		

† Values with uncertainties are from ⁴⁰Cl β⁻ decay if available, otherwise from (γ,γ'), and those without uncertainties are for transitions reported in (α,pγ) up to 6979 level (ΔEγ=1-2 keV) and in (α,γ):resonances after 8919 level (ΔEγ=3-5 keV) and are taken from level-energy differences by evaluator, unless otherwise

Adopted Levels, Gammas (continued)

$\gamma(^{40}\text{Ar})$ (continued)

noted.
‡ Observed in ²⁶Mg(¹⁸O,2p2n γ) only.
§ From ⁴⁰Cl β^- decay if available, otherwise from (α ,p γ) up to 6979 level and from (α , γ):resonances after 8919 level, unless otherwise noted.
& From (α ,p γ) based on measured $\gamma(\theta)$ and $\gamma(\text{lin pol})$ up to 6979 level, and from (γ , γ') based on polarization asymmetry after that, unless otherwise noted.
@ Placement of transition in the level scheme is uncertain.

Adopted Levels, Gammas

^{40}Cl β^- decay (1.35 min) 1972K106,1970Ke12

Parent: ^{40}Cl : $E=0$; $J\pi=2^-$; $T_{1/2}=1.35$ min 3; $Q(\beta^-)=7482$ 32; % β^- decay=100

^{40}Cl - $J\pi$, $T_{1/2}$: From Adopted Levels of ^{40}Cl .

^{40}Cl - $Q(\beta^-)$: From 2012Wa38.

1972K106 (also 1973K102,1981HuZT): ^{40}Cl ions were produced via $^{40}\text{Ar}(n,p)$ reaction with $E=14$ MeV neutron beam on pure natural argon target. γ rays were detected with a Ge(Li) detector (FWHM=4 keV at 1.33 MeV) and a NaI(Tl) detector. Measured $E\gamma$, $I\gamma$, $\gamma\gamma$ -coin. Deduced levels, J , π , γ -ray branching ratios.

1970Ke12: ^{40}Cl sources were prepared via the $^{40}\text{Ar}(n,p)$ reaction with $E=14.9$ MeV neutron produced from the University of Kentucky neutron generator. γ rays were detected with Ge(Li) detectors and NaI(Tl) detectors. Measured $E\gamma$, $I\gamma$, $\gamma\gamma$ -coin, decay curve. Deduced levels, J , π , γ -ray branching ratios, parent $T_{1/2}$.

Others:.

1989Mi03: Measured $E\beta$, $\beta\gamma$ -coin. Deduced mass excess.

1968Hu07, 1965Gr03, 1956Mo39: Measured $E\gamma$, $I\gamma$. Deduced levels.

Thesis (M.S.) by E.L. Robinson (Purdue, 1958). $E\gamma$, $I\gamma$ data and level scheme from this work are quoted by 1970Ke12. This thesis was not available to the present evaluator.

 ^{40}Ar Levels

<u>E(level)[†]</u>	<u>$J\pi$</u>	<u>$T_{1/2}$</u>
0	0^+	stable
1460.78 5	2^+	
2120.82 19	0^+	
2524.03 12	2^+	
2892.70 22	4^+	
3207.89 14	2^+	
3511.18 25	2^+	
3680.53 14	3^-	
3918.82 13	2^+	
3941.91? $\dagger$ 20		
4082.60 17	3^-	
4178.9? $\dagger$ 3		
4301.01 23	$(3)^-$	
4324.5 3	2^+	
4359.5? $\dagger$ 9		
4481.0? $\dagger$ 3	1^-	
4562.28 17	$(1,3)^-$	
4582.0? $\dagger$ 8	(3^-)	
4737.8? $\dagger$ 4		
4769.0 3	1^-	
4943.3? $\dagger$ 6		
5165.7 7	$(2)^+$	
5269.6 3	$(1^-, 3^-)$	
5310.0? $\#$ 10	(2^+)	
5400.5 8	1^-	
5609.4 8	$(1,2,3)$	
5629.4? $\#$ 10		
5717.8 10		
5880.1 4	1^-	
5905.9 7	(1^-)	
5950.5 10	$(1,2)$	
6053.6 8	$1^{(-)}$	
6133.5? $@$ 10		
6208.5 8	$(1,2)$	

Continued on next page (footnotes at end of table)

^{40}Cl β^- decay (1.35 min) [1972Kl06](#), [1970Ke12](#) (continued) ^{40}Ar Levels (continued)

E(level) [†]	J π &	Comments
6276.7? 10	(1 ⁻ , 2 ⁻ , 3 ⁻)	E(level): this level is constructed by 1972Kl06 only based on a 1333-keV transition to a level at 4943 which is considered as improbable by 1983Bi08 in (α ,p γ). Therefore, the evaluator has considered this level as questionable as well.
6338.7 11	1(-)	
6476.1 8	1(-)	
6651.7? 8		

[†] From a least-squares fit to γ -ray energies.[‡] Level considered as improbable based on results of (α ,p γ) study of [1983Bi08](#).# Level considered as improbable since the decay mode is very different from that in (α ,p γ) ([1983Bi08](#)) from a level near the same energy.@ From [1981HuZT](#) only.

& From Adopted Levels.

 β^- radiations

E(decay)	E(level)	$I\beta^-$ ^{†‡}	Log f_t	Comments
(8.3×10^2 # 3)	6651.7?	0.49 17	4.8 2	
(1.01×10^3 3)	6476.1	0.16 3	5.6 1	
(1.14×10^3 3)	6338.7	0.26 8	5.6 2	
(1.21×10^3 # 3)	6276.7?	0.32 6	5.6 1	
(1.27×10^3 3)	6208.5	0.041 25	6.6 3	
(1.35×10^3 3)	6133.5?	≈ 0.04	≈ 6.7	$I\beta^-$: from 1981HuZT .
(1.43×10^3 3)	6053.6	0.32 6	5.9 1	
(1.53×10^3 3)	5950.5	0.041 25	6.9 3	
(1.58×10^3 3)	5905.9	0.65 9	5.8 1	
(1.60×10^3 3)	5880.1	5.2 5	4.9 1	
(1.76×10^3 3)	5717.8	0.08 4	6.9 2	
(1.85×10^3 # 3)	5629.4?	0.08 4	7.0 2	
(1.87×10^3 3)	5609.4	0.41 19	6.3 2	
(2.08×10^3 3)	5400.5	0.16 7	6.9 2	
(2.17×10^3 # 3)	5310.0?	0.16 9	7.0 3	
(2.21×10^3 3)	5269.6	2.1 3	5.9 1	
(2.32×10^3 3)	5165.7	0.9 1	6.3 1	
(2.71×10^3 3)	4769.0	0.49 9	6.9 1	
(2.74×10^3 # 3)	4737.8?	0.41 9	7.0 1	
(2.90×10^3 # 3)	4582.0?	0.17 7	7.5 2	
(2.92×10^3 3)	4562.28	22.6 21	5.4 1	$E\beta^-$: 2729 145 (1989Mi03) from β (3101 γ).
(3.00×10^3 # 3)	4481.0?	0.24 6	7.4 1	
(3.12×10^3 # 3)	4359.5?	0.24 8	7.5 2	
(3.16×10^3 3)	4324.5	0.16 5	7.7 2	
(3.18×10^3 3)	4301.01	27 5	5.5 1	$E\beta^-$: 3086 75 (1989Mi03) from β (2840 γ).
(3.30×10^3 # 3)	4178.9?	0.24 6	7.6 1	
(3.40×10^3 3)	4082.60	13.8 15	5.9 1	$E\beta^-$: 3070 100 (1989Mi03) from β (2622 γ).
(3.54×10^3 # 3)	3941.91?	0.16 5	7.9 2	
(3.56×10^3 3)	3918.82	5.5 12	6.4 1	
(3.80×10^3 3)	3680.53	4.6 11	6.6 1	
(3.97×10^3 3)	3511.18	0.9 2	7.4 1	
(4.27×10^3 3)	3207.89	2.1 4	7.2 1	

Continued on next page (footnotes at end of table)

^{40}Cl β^- decay (1.35 min) **1972Kl06,1970Ke12** (continued) β^- radiations (continued)

E(decay)	E(level)	$I\beta^-$ ^{†‡}	Log ft	Comments
$(4.59 \times 10^3 \text{ } ^3)$	2892.70	0.7 2	9.5 1	
$(4.96 \times 10^3 \text{ } ^3)$	2524.03	1.7 5	7.5 1	
$(6.02 \times 10^3 \text{ } ^{\#} \text{ } ^3)$	1460.78	4 4	>7.2	
$(7.48 \times 10^3 \text{ } ^3)$	0	<9	>9.8	<p>$E\beta^-$: 7390 118 (1989Mi03).</p> <p>$I\beta^-$: The only available experimental value is 9% from E.L. Robinson (M.S. thesis, Purdue, 1958). This value has been quoted in several papers (1989Mi03,1981HuZT,1972Kl06,1970Ke12) and in Endt's compilations. 1970Ke12 quoted $I\beta^-$=9-18%, again based on Robinson's data, suggesting equal feedings to the ground state and the first excited state. The singles β spectrum of 1989Mi03 does show that there is a direct feeding to the ground state, but in the opinion of the evaluator, precise feeding is not known. $\log f^{du}_t > 8.5$ expected for first-forbidden unique transition allows up to 100% feeding.</p>

[†] Deduced by evaluator from imbalance of γ -ray intensities at each level using the GTOL program.

[‡] Absolute intensity per 100 decays.

[#] Existence of this branch is questionable.

⁴⁰Cl β⁻ decay (1.35 min) 1972Kl06,1970Ke12 (continued)

γ(⁴⁰Ar)

Iγ normalization: From Σ(Iγ to g.s.)=95.5 45, obtained by assuming β⁻ feeding to g.s. is <9% (see comments for g.s. β⁻ branching ratio) which is equivalent to 4.5% 45. Singles β⁻ spectrum of 1989Mi03 shows some g.s feeding. But its precise value is unknown.

E _γ [†]	I _γ ^{†a}	E _i (level)	J _i ^π	E _f	J _f ^π	Mult.	δ	α	Comments
222.5 ^c 5	0.20 6	4582.0?	(3 ⁻)	4359.5?					
239.0 ^s 3	0.28 ^s 13	3918.82	2 ⁺	3680.53	3 ⁻	[E1]		1.13×10 ⁻³	
261.2 ^s 7	1.0 ^s 1	4562.28	(1,3) ⁻	4301.01	(3) ⁻				
270 [‡]		5880.1	1 ⁻	5609.4	(1,2,3)				
303.0 6	0.07 4	3511.18	2 ⁺	3207.89	2 ⁺				
315.0 5	0.03 1	3207.89	2 ⁺	2892.70	4 ⁺	[E2]		0.00249	
361.3 ^c 5	0.09 2	4943.3?		4582.0?	(3 ⁻)				
369.0 6	0.02 1	2892.70	4 ⁺	2524.03	2 ⁺	[E2]		1.41×10 ⁻³	
381.0 ^c 5	0.10 4	4943.3?		4562.28	(1,3) ⁻				
472.0 4	0.3 1	3680.53	3 ⁻	3207.89	2 ⁺	[E1]		1.64×10 ⁻⁴	
479.9 ^s 4	1.1 ^s 3	4562.28	(1,3) ⁻	4082.60	3 ⁻				
621.1 ^b 6	<0.3 ^b	3511.18	2 ⁺	2892.70	4 ⁺	[E2]		2.51×10 ⁻⁴	
621.1 ^b 6	<0.3 ^b	4301.01	(3) ⁻	3680.53	3 ⁻				
643.6 ^s 3	8.3 ^s 6	4562.28	(1,3) ⁻	3918.82	2 ⁺				
660.1 ^s 4	3.1 ^s 3	2120.82	0 ⁺	1460.78	2 ⁺	[E2]		2.09×10 ⁻⁴	
788.1 ^s 3	1.0 ^s 1	3680.53	3 ⁻	2892.70	4 ⁺	[E1]			
881.3 ^s 3	3.2 ^s 3	4562.28	(1,3) ⁻	3680.53	3 ⁻				
1042.3 ^c 3	0.6 2	6651.7?		5609.4	(1,2,3)				
1051.1 5	0.6 2	4562.28	(1,3) ⁻	3511.18	2 ⁺				
1063.1 ^s 2	2.9 ^s 3	2524.03	2 ⁺	1460.78	2 ⁺	M1+E2	-0.41 +6-13		
1087.6 4	0.10 5	3207.89	2 ⁺	2120.82	0 ⁺	[E2]			
1092.9 ^s 8	0.33 ^s 7	4301.01	(3) ⁻	3207.89	2 ⁺	[E1]			
1156.2 4	0.6 1	3680.53	3 ⁻	2524.03	2 ⁺	[E1]		5.43×10 ⁻⁵ 8	
1186.7 4	0.9 1	5269.6	(1 ⁻ ,3 ⁻)	4082.60	3 ⁻				
1317.2 5	0.50 6	5880.1	1 ⁻	4562.28	(1,3) ⁻				
1333.4 ^c 8	0.40 7	6276.7?	(1 ⁻ ,2 ⁻ ,3 ⁻)	4943.3?					E _γ : this transition connects to a level at 4943 which is considered as improbable by 1983Bi08 in (α,pγ). Therefore, the evaluator has considered it as questionable as well.
1353.7 5	0.25 10	4562.28	(1,3) ⁻	3207.89	2 ⁺				
1394.7 3	1.5 2	3918.82	2 ⁺	2524.03	2 ⁺				
1432.1 ^s 4	2.0 ^s 2	2892.70	4 ⁺	1460.78	2 ⁺	E2		9.45×10 ⁻⁵ 14	
1460.73 ^s 5	100 ^s	1460.78	2 ⁺	0	0 ⁺	E2		1.03×10 ⁻⁴	

⁴⁰Cl β⁻ decay (1.35 min) [1972K106](#),[1970Ke12](#) (continued)

γ(⁴⁰Ar) (continued)

E _γ [†]	I _γ ^{†a}	E _i (level)	J _i ^π	E _f	J _f ^π	Mult.	δ	α	Comments
1558.7 4	0.60 7	4082.60	3 ⁻	2524.03	2 ⁺	[E1]		3.25×10 ⁻⁴	
1579.9 8	0.4 1	5880.1	1 ⁻	4301.01	(3) ⁻				
1589.0 § 3	1.2 § 2	5269.6	(1 ⁻ ,3 ⁻)	3680.53	3 ⁻				
1746.5 § 2	3.3 § 3	3207.89	2 ⁺	1460.78	2 ⁺	M1+E2	+0.11 7	1.65×10 ⁻⁴ 3	
1776.9 8	0.020 3	4301.01	(3) ⁻	2524.03	2 ⁺	[E1]		4.91×10 ⁻⁴	
1797.8 § 2	2.7 § 4	3918.82	2 ⁺	2120.82	0 ⁺	[E2]		2.36×10 ⁻⁴	
2050.5 4	1.3 2	3511.18	2 ⁺	1460.78	2 ⁺	M1(+E2)	-0.05 11	2.82×10 ⁻⁴ 5	
2063.0 10	0.5 2	5269.6	(1 ⁻ ,3 ⁻)	3207.89	2 ⁺				
2220.0 § 2	8.6 § 12	3680.53	3 ⁻	1460.78	2 ⁺	E1(+M2)	-0.07 +5-11	7.97×10 ⁻⁴ 19	
2457.7 § 4	5.8 § 10	3918.82	2 ⁺	1460.78	2 ⁺	M1+E2		0.00050 5	δ: <-0.3 or>+6 from (p,p'γ).
2524.1 § 2	2.5 § 3	2524.03	2 ⁺	0	0 ⁺	E2		5.79×10 ⁻⁴	
2621.7 § 2	18.1 § 16	4082.60	3 ⁻	1460.78	2 ⁺	[E1]		1.04×10 ⁻³	
2840.1 § 3	34 § 5	4301.01	(3) ⁻	1460.78	2 ⁺	[E1]		1.17×10 ⁻³	
3101.7 § 4	14.0 @ 20	4562.28	(1,3) ⁻	1460.78	2 ⁺				
3193.7 10	0.10 5	5717.8		2524.03	2 ⁺				
3208.2 3	0.6 1	3207.89	2 ⁺	0	0 ⁺	[E2]		8.79×10 ⁻⁴	
3356.6 8	0.4 1	5880.1	1 ⁻	2524.03	2 ⁺				
3511.0 5	0.20 8	3511.18	2 ⁺	0	0 ⁺	[E2]		1.00×10 ⁻³	
3704.6 8	1.0 1	5165.7	(2) ⁺	1460.78	2 ⁺				
3759.9 10	0.10 3	5880.1	1 ⁻	2120.82	0 ⁺				
3784.9 6	0.8 1	5905.9	(1 ⁻)	2120.82	0 ⁺				
3918.6 § 2	4.8 § 5	3918.82	2 ⁺	0	0 ⁺	E2		1.15×10 ⁻³	It is seen from the gamma spectrum in 1972K106 that the 3919 single-escape peak+full-energy peak is much stronger than the 2458 peak. It is possible that the intensity of 3919 single-escape peak is not taken into account for the total intensity of the 3919 gamma-ray by 1972K106 .
3941.7 &c 2	0.20 5	3941.91?		0	0 ⁺				
4082.1 8	0.30 6	4082.60	3 ⁻	0	0 ⁺	[E3]		9.21×10 ⁻⁴	
4147.7 10	1.1 1	5609.4	(1,2,3)	1460.78	2 ⁺				
4178.7 &c 3	0.30 7	4178.9?		0	0 ⁺				
4324.2 3	0.20 5	4324.5	2 ⁺	0	0 ⁺	[E2]		1.29×10 ⁻³	
4357.6 &c 3	0.50 7	4359.5?		0	0 ⁺				
4480.7 &c 3	0.30 7	4481.0?	1 ⁻	0	0 ⁺	D			
4580.1 &c 5	0.10 4	4582.0?	(3) ⁻	0	0 ⁺	[E3]		1.07×10 ⁻³	
4737.5 &c 4	0.5 1	4737.8?		0	0 ⁺				
4768.7 3	0.6 1	4769.0	1 ⁻	0	0 ⁺				
5165.5 10	0.10 5	5165.7	(2) ⁺	0	0 ⁺				

⁴⁰Cl β⁻ decay (1.35 min) 1972Kl06,1970Ke12 (continued)

γ(⁴⁰Ar) (continued)

<u>E_γ[†]</u>	<u>I_γ^{†a}</u>	<u>E_i(level)</u>	<u>J_i^π</u>	<u>E_f</u>	<u>J_f^π</u>
5309.6 ^c 10	0.2 1	5310.0?	(2 ⁺)	0	0 ⁺
5400.1 8	0.20 8	5400.5	1 ⁻	0	0 ⁺
5629.0 ^c 10	0.10 5	5629.4?		0	0 ⁺
5879.6 [§] 12	5.0 [§] 5	5880.1	1 ⁻	0	0 ⁺
5950.0 10	0.05 3	5950.5	(1,2)	0	0 ⁺
6053.1 8	0.40 6	6053.6	1 ⁽⁻⁾	0	0 ⁺
6133 ^{‡c}	≈0.05 [#]	6133.5?		0	0 ⁺
6208.0 8	0.05 3	6208.5	(1,2)	0	0 ⁺
6338.2 [§] 11	0.32 [§] 9	6338.7	1 ⁽⁻⁾	0	0 ⁺
6475.5 8	0.20 3	6476.1	1 ⁽⁻⁾	0	0 ⁺

[†] From 1972Kl06, unless otherwise noted.

[‡] From 1981HuZT only, intensity is not available.

[§] Weighted average from 1972Kl06 and 1970Ke12.

& Placement questioned by 1983Bi08 based on their (α,pγ) study.

@ From 1972Kl06, obtained in indirect method. Other: 5 3 in 1970Ke12.

From β feeding quoted by 1981HuZT.

^a For absolute intensity per 100 decays, multiply by 0.81 4.

^b Multiply placed with undivided intensity.

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

$^{40}_{17}\text{Cl}_{23}^-$ decay (1.35 min) 1972K106,1970Ke12

Decay Scheme

Intensities: I_γ per 100 parent decays

Legend

- $\longrightarrow$ $I_\gamma < 2\% \times I_\gamma^{\max}$
 $\longrightarrow$ $I_\gamma < 10\% \times I_\gamma^{\max}$
 $\longrightarrow$ $I_\gamma > 10\% \times I_\gamma^{\max}$
 $\cdots\cdots\cdots\longrightarrow$ γ Decay (Uncertain)

2^- 0 1.35 min 3
 $Q^- = 7482.32$ $\% \beta^- = 100$
 $^{40}_{17}\text{Cl}_{23}$

^{40}Cl β^- decay (1.35 min) 1972Kl06,1970Ke12

Decay Scheme (continued)

Intensities: I_γ per 100 parent decays
& Multiply placed: undivided intensity given

Legend

- $\longrightarrow$ $I_\gamma < 2\% \times I_\gamma^{\max}$
 $\longrightarrow$ $I_\gamma < 10\% \times I_\gamma^{\max}$
 $\longrightarrow$ $I_\gamma > 10\% \times I_\gamma^{\max}$
 $\cdots\cdots\cdots$ γ Decay (Uncertain)

^{40}Cl β^- decay (1.35 min) 1972Kl06,1970Ke12

Decay Scheme (continued)

Intensities: I_γ per 100 parent decays
& Multiply placed: undivided intensity given

Legend

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

^{40}K ε decay (1.248×10^9 y) [1999BeZQ](#), [1999BeZS](#)

Parent: ^{40}K : $E=0$; $J\pi=4^-$; $T_{1/2}=1.248 \times 10^9$ y 3; $Q(\varepsilon)=1504.40$ 6; $\% \varepsilon + \% \beta^+$ decay = 10.72 11

^{40}K - $J\pi$: From unique 3rd forbidden β^- spectral shape for decay to 0^+ level and L transfer in charge-particle reactions.

^{40}K - $T_{1/2}$: From [2004Ko09](#) and [2002Gr01](#); the same value from measurements of specific activity of natural potassium salts using liquid-scintillation counting (LSC) technique. ([2002Gr01](#) reported a value of 1.248×10^9 y 2, later adjusted to 1.248×10^9 y 3 by [2004Ko09](#) to correct the quoted uncertainty on measured isotopic abundance of ^{40}K). Both papers used natural abundance of ^{40}K as 0.01167% 2 ([1975Ga24](#)). The natural abundance of $^{40}\text{K}=0.0117\%$ 1 (as recommended in the International Union of Pure and Applied Chemistry 70, 217 (1998), based on the measured value of [1975Ga24](#)) would give about four times larger uncertainty on $T_{1/2}$. The earlier values of 1.265×10^9 y 13 ([1999BeZS](#), [1999BeZQ](#)) based on recomputation of 1.277×10^9 y 8 (evaluation by [1973EnVA](#)); and 1.26×10^9 y 1 (evaluation by [1990Ho28](#) from 14 different measurements out of a total of 34 measurements listed) are in good agreement. Variation of $T_{1/2}$ due to environmental conditions has been studied by [2001No10](#), where no significant effect has been reported. Earlier (pre-1977) measurements of partial (β^- and ce) and/or total $T_{1/2}$ of ^{40}K : [1977Ce04](#), [1972Go21](#), [1966Fe09](#), [1965Le15](#), [1965Br25](#), [1962Fl05](#), [1961Gl07](#), [1960Sa31](#), [1960Eg01](#), [1959Ke26](#), [1957We43](#), [1956Mc20](#), [1955Ba25](#), [1955Ko21](#), [1955Su38](#), [1953Bu58](#), [1950Sa52](#), [1947Gl07](#). Another 16 references (from 1931 to 1971) are listed by [1990Ho28](#) and in the 1978 Table of Isotopes ([1978LeZA](#)); but are not present in the NSR database.

^{40}K - $Q(\varepsilon)$: From [2012Wa38](#).

^{40}K - $\% \varepsilon + \% \beta^+$ decay: deduced by the present evaluator based on $I\gamma(1460\gamma)/I\beta^-=0.1195$ 14, which is equal to $I(\varepsilon$ to 1461 level)/ $I\beta^-$, and $I(\beta^+)/I(\beta^-)=1.12 \times 10^{-5}$ 14 from evaluation of [1973EnVA](#), and $\varepsilon/\beta^+ (^{40}\text{K}$ to ^{40}Ar g.s.) = 45.2 14 (3U theory), with all β^+ decay proceeding to ^{40}Ar ground state. Previously evaluated value by [1999BeZQ](#), [1999BeZS](#) is 0.1086 13 based on the estimation of $\varepsilon/\beta^+=200$ 100 for the unique 3rd forbidden branch to the ^{40}Ar ground state.

[1999BeZQ](#), [1999BeZS](#): evaluations of ^{40}K decay.

Measurements: [2014Be25](#), [2013Be06](#), [2004Ko09](#), [2002Gr01](#), [2001No10](#), [1977Ce04](#), [1972Go21](#), [1967Mc10](#), [1966Fe09](#), [1965Le15](#), [1965Br25](#), [1962Fl05](#), [1962En01](#), [1961Gl07](#), [1960Sa31](#), [1960Eg01](#), [1959Ke26](#), [1957We43](#), [1956Mc20](#), [1955Ba25](#), [1955Ko21](#), [1955Su38](#), [1953Bu58](#), [1952Fe16](#), [1951Go29](#), [1951De34](#), [1950Sa52](#), [1949Ov01](#), [1948Ev09](#), [1947Gl07](#). This list is not complete, see [1978LeZA](#) for several other references that are not present in NSR database.

The decay scheme, which includes the β^- decay to the ground state of ^{40}Ca and two levels in ^{40}Ar , is complete since these are the only levels in the daughter nuclides below the respective decay energies.

In principle, the 1460-keV γ ray could be used for energy calibration. However, in a Ge semiconductor detector the apparent γ -ray energy depends on the source-detector configuration and ^{40}K sources usually consist of a large volume of material, so this $E\gamma$ is usually not useful. This also means that in most cases the uncertainty in the observed energy is much larger than that given here.

 ^{40}Ar Levels

E(level)	$J\pi$	$T_{1/2}$	Comments
0	0^+	stable	
1460.851 6	2^+		$J\pi$: from Adopted Levels.

 ε, β^+ radiations

E(decay)	E(level)	$I\beta^+{}^\dagger$	$I\varepsilon{}^\dagger$	Log ft	$I(\varepsilon + \beta^+){}^\dagger$	Comments
(43.55 6)	1460.851		10.67 11	11.53 1	10.67 11	
(1504.40 6)	0	0.00100 13	0.045 6	21.4	0.046 6	$I\varepsilon$: from $I\beta^+$ (to ^{40}Ar g.s.)/ $I\beta^-=1.12 \times 10^{-5}$ 14 in evaluation of 1973EnVA and adopted $\%I\beta^-=89.28$ 11, with $\varepsilon/\beta^+ (^{40}\text{K}$ to ^{40}Ar g.s.) = 45.2 14 (3U theory). Log ft : from private communication from R. B. Firestone; see also 1970Wa11 .

† Absolute intensity per 100 decays.

⁴⁰K ε decay (1.248×10⁹ y) **1999BeZQ,1999BeZS (continued)**

γ(⁴⁰Ar)

I_γ normalization: I_γ(1460 γ) is from the measured γ/β[−] ratio (evaluated in [1973EnVA](#)), which can be obtained from I(ε,1460)/(1+α+IPFC). α(1460)=2.5×10^{−5} and IPFC=7.3×10^{−5} 5, so the correction for these is 0.01% and is completely negligible compared to the 1% uncertainty in I(ε,1460).

<u>E_γ</u>	<u>I_γ[†]</u>	<u>E_i(level)</u>	<u>J_i^π</u>	<u>E_f</u>	<u>J_f^π</u>	<u>Mult.</u>	<u>α</u>	<u>Comments</u>
1460.820 5	10.66 13	1460.851	2 ⁺	0	0 ⁺	E2	2.95×10 ^{−5} 9	E _γ : the evaluator has re-scaled the original values in 1979He13 using the new calibration standards in 2000He14 . Others: 1460.75 6 (1967Ki10), 1460.95 7 (1970Ja15). I _γ : I _γ (1460)=I(ε,1460)/(1+α+IPFC)=10.67 11/1.000102 5.

[†] Absolute intensity per 100 decays.

⁴⁰K ε decay (1.248×10⁹ y) **1999BeZQ,1999BeZS**

Decay Scheme

Intensities: I_(γ+ce) per 100 parent decays

$^{12}\text{C}(^{36}\text{S}, 2\alpha\gamma)$ 2008Sp04

2008Sp04, 2008Sp01: E=70 MeV ^{36}S beam was produced from the Cologne tandem accelerator. Target was natural C of 0.19 mg/cm² thickness on 3.03 mg/cm² Gd deposited on 1.0 mg/cm² Ta backed by 2.0 mg/cm² Cu. γ -rays were detected with four NaI(Tl) detectors and a Ge detector and α -particles were detected with a Si counter. Measured $E\gamma$, $I\gamma$, $E\alpha$, $\gamma\gamma$ -coin, $\alpha\gamma$ -coin, Doppler-shift attenuation. Deduced levels, J, π , B(E2), $T_{1/2}$, g-factor by transient field technique in inverse kinematics reaction. All data are from 2008Sp04 unless otherwise noted.

 ^{40}Ar Levels

E(level) [†]	J π [†]	$T_{1/2}$ [‡]	Comments
0	0 ⁺		
1461	2 ⁺	1.25 ps 14	g=-0.02 3 (2008Sp04)
2121	0 ⁺		
2524	2 ⁺	0.47 ps 7	$T_{1/2}$: from weighted average of τ =0.7 ps 1 and 0.6 ps 2 in 2008Sp01.
2893	4 ⁺	1.80 ps 28	
3208	2 ⁺		
3681	3 ⁻		
4226	4 ⁽⁻⁾		
4494	5 ⁻		

[†] From Adopted Levels. Energies are rounded values.

[‡] From 2008Sp04 and 2008Sp01 by DSAM.

 $\gamma(^{40}\text{Ar})$

E_γ	$E_i(\text{level})$	J π_i	E_f	J π_f
660	2121	0 ⁺	1461	2 ⁺
1063	2524	2 ⁺	1461	2 ⁺
1333	4226	4 ⁽⁻⁾	2893	4 ⁺
1432	2893	4 ⁺	1461	2 ⁺
1461	1461	2 ⁺	0	0 ⁺
1601	4494	5 ⁻	2893	4 ⁺
1747	3208	2 ⁺	1461	2 ⁺
2220	3681	3 ⁻	1461	2 ⁺
2524	2524	2 ⁺	0	0 ⁺

$^{26}\text{Mg}(^{16}\text{O},2\text{p}\gamma), ^{27}\text{Al}(^{18}\text{O},\text{p}\alpha\gamma)$ 1977Eg01,1975Wa23

1977Eg01: $^{26}\text{Mg}(^{16}\text{O},2\text{p}\gamma)$ E=34 MV ^{16}O beams of 40-200 nA were produced from the Utrecht EN tandem accelerator. Targets were about $400 \mu\text{g}/\text{cm}^2$ ^{26}Mg (99.42 enriched) on $30 \mu\text{m}$ Au backings. γ rays were detected with a large volume Ge(Li)-NaI(Tl) Compton-suppression spectrometer (CSS) and large Ge(Li) detectors. Measured $E\gamma$, $I\gamma$, $\gamma\gamma$ -coin, $\gamma(\theta)$, $\gamma(\text{lin pol})$. Deduced levels, J, π , γ -ray multipolarities. Comparison with shell-model calculations.

1975Wa23: $^{27}\text{Al}(^{18}\text{O},\text{p}\alpha\gamma)$ E=35 MeV. Measured recoil distance. Deduced lifetime for the 4^+ level at E=2893 keV using the Recoil Distance Method (RDM).

 ^{40}Ar Levels

E(level)	$J\pi^\dagger$	$T_{1/2}$	Comments
0	0^+		
1461	2^+		
2893	4^+	2.9 ps 14	$T_{1/2}$: from 1975Wa23 by RDM.
3465	6^+		

† From Adopted Levels.

 $\gamma(^{40}\text{Ar})$

$E_\gamma^\ddagger$	$I_\gamma^\ddagger$	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult. ‡	Comments
572	41 2	3465	6^+	2893	4^+	E2	$A_2=+0.40$ 3, $A_4=-0.10$ 3, POL=+0.40 20 (1977Eg01).
1432	70 2	2893	4^+	1461	2^+	E2	$A_2=+0.290$ 20, $A_4=-0.13$ 3, POL=+0.40 11 (1977Eg01).
1461	108 2	1461	2^+	0	0^+	E2	$A_2=+0.230$ 20, $A_4=-0.100$ 20, POL=+0.30 11 (1977Eg01).

† From 1977Eg01.

‡ Deduced from measured $\gamma(\theta)$ and $\gamma(\text{pol lin})$ in 1977Eg01.

§ From $E\gamma$.

$^{26}\text{Mg}(^{18}\text{O}, 2\text{p}2\text{n}\gamma)$ 2010Id02

2010Id02: E=70 MeV ^{18}O beam was provided by the tandem accelerator at JAEA. Targets were two stacked self-supporting foils of enriched ^{26}Mg isotopes with thickness of 0.47 and 0.43 mg/cm². γ rays were detected with GEMINI-II array of 16 HPGe detectors with BGO Compton suppressors and charged particles were detected with a 4π array of ΔE Si detectors. Measured $E\gamma$, $I\gamma$, $\gamma\gamma$, (particle) γ coin, $\gamma\gamma(\theta)$ (DCO), Doppler-shift attenuation. Deduced levels, J, π , quadrupole moment, band structure. Comparisons with cranked Hartree-Fock-Bogoliubov (HFB) calculations.

 ^{40}Ar Levels

$E(\text{level})^\dagger$	$J^\pi^\ddagger$	$E(\text{level})^\dagger$	$J^\pi^\ddagger$	$E(\text{level})^\dagger$	$J^\pi^\ddagger$
0 [#]	0 ⁺	4494 [@]	5 ⁻	7688 [@]	9 ⁻
1461 [#]	2 ⁺	4960 ^a	6 ⁺	7999 ^{&}	10 ⁻
2121 ^a	0 ⁺	5973 ^{&}	(6 ⁻)	8946 [@]	11 ⁻
2522 ^a	2 ⁺	6016 [@]	7 ⁻	9070 ^a	10 ⁺
2892 [#]	4 ⁺	6421	(8 ⁻)	11769 ^a	(12 ⁺)
3463 [#]	6 ⁺	6801 ^a	8 ⁺		
3515 ^a	4 ⁺	6979 ^{&}	8 ⁻		

[†] From least-squares fit to γ -ray energies, assuming the same uncertainty for each γ ray.

[‡] As given in 2010Id02, based on measured DCO ratios and band structure.

[#] (A): Member of $f_{7/2}^2$ yrast sequence.

[@] (B): Band based on 5⁻, $\alpha=1$.

[&] (b): Band based on (6⁻), $\alpha=0$.

^a (C): SD band. $Q(\text{transition})=1.45 +49-3I(\text{stat}) 15(\text{syst})$ (2010Id02) from lifetime measurements for 993, 1445, 1841 and 2269 transitions in the SD band. Possible configuration= $\pi[(d5/2)^{-1.2}(s_{1/2}d_{3/2})^{-3.8}(\text{fp})^{2.5}(g_{9/2})^{0.5}]\otimes\nu[(d5/2)^{-0.7}(s_{1/2}d_{3/2})^{-2.4}(\text{fp})^{4.5}(g_{9/2})^{0.5}]$.

 $\gamma(^{40}\text{Ar})$

$E_\gamma^\dagger$	$E_i(\text{level})$	J_i^π	E_f	J_f^π	$E_\gamma^\dagger$	$E_i(\text{level})$	J_i^π	E_f	J_f^π	$E_\gamma^\dagger$	$E_i(\text{level})$	J_i^π	E_f	J_f^π
311	7999	10 ⁻	7688	9 ⁻	1061	2522	2 ⁺	1461	2 ⁺	2054	3515	4 ⁺	1461	2 ⁺
571	3463	6 ⁺	2892	4 ⁺	1258	8946	11 ⁻	7688	9 ⁻	2068	4960	6 ⁺	2892	4 ⁺
623	3515	4 ⁺	2892	4 ⁺	1431	2892	4 ⁺	1461	2 ⁺	2269	9070	10 ⁺	6801	8 ⁺
709	7688	9 ⁻	6979	8 ⁻	1445	4960	6 ⁺	3515	4 ⁺	2510	5973	(6 ⁻)	3463	6 ⁺
947	8946	11 ⁻	7999	10 ⁻	1461	1461	2 ⁺	0	0 ⁺	2522	2522	2 ⁺	0	0 ⁺
963	6979	8 ⁻	6016	7 ⁻	1522	6016	7 ⁻	4494	5 ⁻	2553	6016	7 ⁻	3463	6 ⁺
993	3515	4 ⁺	2522	2 ⁺	1578	7999	10 ⁻	6421	(8 ⁻)	2699	11769	(12 ⁺)	9070	10 ⁺
1005	6979	8 ⁻	5973	(6 ⁻)	1602	4494	5 ⁻	2892	4 ⁺	2958	6421	(8 ⁻)	3463	6 ⁺
1020	7999	10 ⁻	6979	8 ⁻	1671	7688	9 ⁻	6016	7 ⁻					
1031	4494	5 ⁻	3463	6 ⁺	1841	6801	8 ⁺	4960	6 ⁺					

[†] From 2010Id02. Uncertainties are not given and the evaluator has assumed the same uncertainty for each γ ray in the level fitting procedure.

$^{36}\text{S}(\alpha,\gamma)$:resonances **1988Cs02,1986Jo09**

Includes $^{36}\text{S}(\alpha,\alpha)$: Resonances from **1994An39**.

1988Cs02, 1986Jo09: E=2.35-3.50 MeV alpha beams were produced from the 5 MV Van de Graaff accelerator of the Institute of Nuclear Research in Debrecen. Target was prepared by implanting a $15\text{ }\mu\text{g}/\text{cm}^2$ or a $32\text{ }\mu\text{g}/\text{cm}^2$ ^{36}S ions into a 0.4 mm thick Ta backing. γ rays were detected with a HARSHAW 105 cm^3 Ge(Li) detector (FWHM=4.5 keV at 2.61 MeV). Measured $\sigma(E\alpha)$, γ yields, $\gamma(\theta)$ Doppler-shift attenuation. Deduced levels, J, π , $T_{1/2}$.

1994An39: $^{36}\text{S}(\alpha,\alpha)$ E=12.56-15 MeV. Measured $\sigma(\theta)$. Deduced resonances in ^{40}Ar at $E\alpha=13320$ ($J\pi=7^-$) and $E\alpha=14120$ ($J\pi=8^+$).

All data are from **1988Cs02** and also **1986Jo09**.

 ^{40}Ar Levels

E(level) [†]	$J\pi^{\ddagger}$	$T_{1/2}$ or $\Gamma^{\#}$	$E\alpha(\text{Lab})^{\&}$	$(2J+1)\Gamma_{\alpha}\Gamma_{\gamma}/\Gamma$ (eV) [@]	Comments
0	0^+				
1461	2^+				
2121	0^+				
2524	2^+	0.50 ps 8			
2893	4^+				
3208	2^+	62 fs 12			
3511	2^+	62 fs 12			
3681	3^-				
3919	2^+				
4041					
4082	3^-				
4301	$(1,3)^-$				
4324	2^+	15 fs 6			
4473	1				
4602		73 fs 12			
8919 3	1^-		2353	0.10 5	$\Gamma_{\alpha}/\Gamma_{\gamma}\leq 0.11$, $\Gamma_{\gamma}\geq 0.33$ eV (1988Cs02).
9127 3	1^-	0.72 eV 16	2584	0.18 3	
					$\Gamma_{\alpha}/\Gamma_{\gamma}=0.10$ 2, $\Gamma_{\alpha}=0.07$ eV 2, $\Gamma_{\gamma}=0.65$ eV 16, $\Gamma_{\gamma 0}=0.65$ eV 17 (1988Cs02).
9138 6	$(1^-, 2^+)$		2597	0.2 1	
9147 5	1^-		2607	0.2 1	
9178 3	1^-		2641	0.2 1	
9197 6	$(1^-, 2^+)$		2662	0.2 1	
9216 4	1^-		2683	0.030 15	
9234 4	1^-		2703	0.30 15	
9240 6	1^-		2710	0.10 5	
9264 4	$(1^-, 2^+)$		2737	0.10 5	
9273 6	1^-		2747	0.030 15	
9287 4			2762	0.30 15	
9296 5	$(1^-, 2^+)$		2772	0.30 15	
9314 4	$(1^-, 2^+)$		2792	0.10 5	
9330 4	1^-		2810	0.10 5	
9339 4	1^-		2820	0.30 15	
9355 3	1^-	1.1 eV 3	2838	0.8 1	$\Gamma_{\alpha}/\Gamma_{\gamma}=0.63$ 17, $\Gamma_{\alpha}=0.43$ eV 21, $\Gamma_{\gamma}=0.69$ eV 23, $\Gamma_{\gamma 0}=0.60$ eV 21 (1988Cs02).
9373 4			2858	0.30 15	
9413 5	1^-	4.0 eV 20			E(level): for unresolved 9408+9417 doublet, with $E\alpha=2897$ 4 and 2907 4, and $(2J+1)\Gamma_{\alpha}\Gamma_{\gamma}/\Gamma=0.5$ eV 1 and 0.8 eV 1, respectively. $\Gamma_{\alpha}/\Gamma_{\gamma}=0.07$ 3, $\Gamma_{\alpha}=0.10$ eV 5, $\Gamma_{\gamma}=3.9$ eV 20, $\Gamma_{\gamma 0}=1.4$ eV 7 (1988Cs02).
9425 5	$(1^-, 2^+)$		2916	0.10 5	
9433 5	$(1^-, 2^+)$		2925	0.4 2	
9450 3	1^-		2943	0.9 2	

Continued on next page (footnotes at end of table)

$^{36}\text{S}(\alpha,\gamma)$:resonances **1988Cs02,1986Jo09** (continued) ^{40}Ar Levels (continued)

E(level) [†]	J ^π [‡]	T _{1/2} or Γ [#]	Eα(Lab) ^{&}	(2J+1)Γ _α Γ _γ /Γ (eV) [@]	Comments
9472 4	(1 ⁻ ,2 ⁺)		2968	0.10 5	
9485 5	1 ⁻		2982	0.2 1	
9491?			2989		
9504.2 14	1 ⁻	8.2 eV 18	3004.4	3.3 4	Γ _α /Γ _γ =0.19 4, Γ _α =1.3 eV 5, Γ _γ =6.9 eV 17, Γ _{γ0} =6.2 eV 16 (1988Cs02).
9527 4			3029	0.7 3	
9565 4	1 ⁻		3071	0.30 15	
9582 3					E(level): for unresolved 9581+9586 doublet, with Eα=3089 3 and 3095 7, and (2J+1)Γ _α Γ _γ /Γ=4.6 eV 7 and 0.9 eV 4, respectively. J ^π : 1 ⁻ for Eα=3089 component and (1 ⁻ ,2 ⁺) for Eα=3095 component.
9596 4			3106	0.6 3	
9608 5			3119	0.6 3	
9618 3	1 ⁻		3130	2.5 4	
9656 4	1 ⁻		3172	0.30 15	
9669 4	1 ⁻		3187	0.6 3	
9689 3	(1 ⁻ ,2 ⁺)				E(level): for unresolved 9687+9694 doublet, with Eα=3207 3 and 3215 5, and (2J+1)Γ _α Γ _γ /Γ=2.4 eV 7 and 1.5 eV 8, respectively.
9736 3	1 ⁻		3262	1.3 2	
9759 4	(1 ⁻ ,2 ⁺)		3287	0.10 5	Γ _α /Γ _γ ≤0.07, Γ _γ ≥0.53 eV.
9769 4	(1 ⁻ ,2 ⁺)		3298	0.10 5	
9787 4	1 ⁻		3318	0.8 4	
9813 3	1 ⁻		3347	1.5 8	
9825 3	1 ⁻		3360	1.9 2	
9850 3	1 ⁻	22 eV 6			E(level): for unresolved 9849+9852 doublet, with Eα=3387 3 and 3391 5, and (2J+1)Γ _α Γ _γ /Γ=1.9 eV 2 and 0.7 eV 3, respectively. Γ _α /Γ _γ =0.03 1, Γ _α =0.65 eV 29, Γ _γ =22 eV 6, Γ _{γ0} =10 eV 3 (1988Cs02).
9866 4			3406	0.2 1	
9881 4	1 ⁻		3423	0.10 5	
9893 4	1 ⁻		3436	0.2 1	
9912 5	(1 ⁻ ,2 ⁺)		3457	0.2 1	
9944 3	1 ⁻		3493	2.8 4	
9954 3	1 ⁻	≥9.6 eV	3503	5.5 7	Γ _α /Γ _γ =2.9 10, Γ _α ≥7.1 eV, Γ _γ ≥2.5 eV, Γ _{γ0} ≥1.7 eV (1988Cs02).

[†] Rounded values from Adopted Levels up to 4602. The excitation energies of resonances (levels above E=4602) are deduced from Eα(lab). Excitation energy=Eα(c.m.)+S(α)(^{40}Ar), with S(α)=6800.69 19 (2012Wa38).

[‡] Assignments above 8 MeV are based on measured γ(θ) and natural parity for resonant levels excited by (α,γ) (1988Cs02); below this energy the assignments are from Adopted Levels.

[#] From 1988Cs02. Half-life was measured by DSAM.

[@] From 1986Jo09 (also in 1988Cs02).

[&] From 1986Jo09 (also in 1988Cs02), uncertainty is the same as given for the excitation energy.

$^{36}\text{S}(\alpha,\gamma)$:resonances **1988Cs02,1986Jo09** (continued)

						$\gamma(^{40}\text{Ar})$					
$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\ddagger$	E_f	J_f^π	$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\ddagger$	E_f	J_f^π
1461	2 ⁺	1461		0	0 ⁺	9618	1 ⁻	6107	2	3511	2 ⁺
2121	0 ⁺	660		1461	2 ⁺			6409	4	3208	2 ⁺
2524	2 ⁺	1063		1461	2 ⁺			6724 ^c	3	2893	4 ⁺
		2524		0	0 ⁺			7093	7	2524	2 ⁺
2893	4 ⁺	1432		1461	2 ⁺			7496	3	2121	0 ⁺
3208	2 ⁺	1747		1461	2 ⁺			8156	46	1461	2 ⁺
3511	2 ⁺	2051		1461	2 ⁺			9617	31	0	0 ⁺
3681	3 ⁻	2220		1461	2 ⁺	9689	(1 ⁻ ,2 ⁺)	5087 ^{&}	14 ^{&}	4602	
3919	2 ⁺	3919		0	0 ⁺			5365 ^{&}	8 ^{&}	4324	2 ⁺
4041		1517	63 ^a 10	2524	2 ⁺			5770 ^{&}	6 ^{&}	3919	2 ⁺
		2580	37 ^a 10	1461	2 ⁺			6178 ^{&}	6 ^{&}	3511	2 ⁺
4082	3 ⁻	2622		1461	2 ⁺			6480 ^{&}	5 ^{&}	3208	2 ⁺
4301	(1,3) ⁻	2840		1461	2 ⁺			7164 ^{&}	54 ^{&}	2524	2 ⁺
4324	2 ⁺	2864	30 6	1461	2 ⁺			8227 ^{&}	4 ^{&}	1461	2 ⁺
		4324	70 6	0	0 ⁺			9688 ^{&}	3 ^{&}	0	0 ⁺
4473	1	4473		0	0 ⁺	9736	1 ⁻	5134	5	4602	
4602		2078		2524	2 ⁺			5817	13	3919	2 ⁺
9127	1 ⁻	9127	100	0	0 ⁺			6527	11	3208	2 ⁺
9355	1 ⁻	4882 ^{bc}		4473	1			7211	5	2524	2 ⁺
		5054	6	4301	(1,3) ⁻			7614	7	2121	0 ⁺
		5436	7	3919	2 ⁺			8274	11	1461	2 ⁺
		9354	87	0	0 ⁺			9735	48	0	0 ⁺
9413	1 ⁻	5331 [#]	19 [#]	4082	3 ⁻	9825	1 ⁻	5906	10	3919	2 ⁺
		5494 [#]	14 [#]	3919	2 ⁺			6144	9	3681	3 ⁻
		5902 [#]	18 [#]	3511	2 ⁺			6314	2	3511	2 ⁺
		6888 [#]	3 [#]	2524	2 ⁺			6616	13	3208	2 ⁺
		7951 [#]	11 [#]	1461	2 ⁺			7300	17	2524	2 ⁺
		9412 [#]	35 [#]	0	0 ⁺			7703	7	2121	0 ⁺
9450	1 ⁻	5939	8	3511	2 ⁺			8363	25	1461	2 ⁺
		6242	8	3208	2 ⁺			9824	17	0	0 ⁺
		6556 ^c	4	2893	4 ⁺	9850	1 ⁻	6956 ^{sc}	9 ^s	2893	4 ⁺
		6925	13	2524	2 ⁺			7325 ^s	28 ^s	2524	2 ⁺
		7328	12	2121	0 ⁺			8388 ^s	25 ^s	1461	2 ⁺
		7988	35	1461	2 ⁺			9849 ^s	47 ^s	0	0 ⁺
		9449	24	0	0 ⁺	9944	1 ⁻	5471 ^c	4	4473	1
9504.2	1 ⁻	5585	3	3919	2 ⁺			6025	5	3919	2 ⁺
		7383	2	2121	0 ⁺			7419	23	2524	2 ⁺
		8042	6	1461	2 ⁺			7822	9	2121	0 ⁺
		9503	89	0	0 ⁺			8482	25	1461	2 ⁺
9582		5663 [@]	5 [@]	3919	2 ⁺			9943	38	0	0 ⁺
		6688 ^{@c}	5 [@]	2893	4 ⁺	9954	1 ⁻	5630	4	4324	2 ⁺
		7057 [@]	11 [@]	2524	2 ⁺			5913	2	4041	
		7460 [@]	25 [@]	2121	0 ⁺			6035	2	3919	2 ⁺
		8120 [@]	18 [@]	1461	2 ⁺			7429	9	2524	2 ⁺
		9581 [@]	41 [@]	0	0 ⁺			8492	12	1461	2 ⁺
9618	1 ⁻	5699	5	3919	2 ⁺			9953	71	0	0 ⁺
		5937	2	3681	3 ⁻						

[†] Values are not given in **1988Cs02** and **1986Jo09**. The evaluator has taken level-energy differences based on decay scheme in **1986Jo09**. For levels below 4602, energies are rounded values from Adopted Gammas.

[‡] Quoted values are % branching from each level from **1986Jo09**.

Continued on next page (footnotes at end of table)

$^{36}\text{S}(\alpha,\gamma)\text{:resonances}$ **1988Cs02,1986Jo09 (continued)**

$\gamma(^{40}\text{Ar})$ (continued)

§ γ decays from 9849 and 9852 are unresolved. Quoted $E\gamma$ corresponds to the average deduced from the decay of two levels.

& γ decays from 9687 and 9694 are unresolved. Quoted $E\gamma$ corresponds to the average deduced from the decay of two levels.

@ γ decays from 9581 and 9586 are unresolved. Quoted $E\gamma$ corresponds to the average deduced from the decay of two levels.

γ decays from 9408 and 9417 are unresolved. Quoted $E\gamma$ corresponds to the average deduced from the decay of two levels.

^a Measured at 3503 resonance.

^b Weak γ ray. **1986Jo09** state that it could be a transition to the 4473 or 4481 levels.

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

$^{37}\text{Cl}(\alpha, p\gamma)$ 1983Bi08

Includes $^{27}\text{Al}(^{18}\text{O}, p\alpha\gamma)$ at E=35 MeV and $^{25}\text{Mg}(^{18}\text{O}, n2p\gamma)$ at E=40 MeV from 1975Wa23.

1983Bi08: E=12, 13 MeV alpha beams were produced from the 7 MV Van de Graaff accelerator of the University of Freiburg.

Targets were prepared by evaporating $120 \mu\text{g}/\text{cm}^2$ AgCl (98% enriched in ^{37}Cl) onto a $15 \mu\text{g}/\text{cm}^2$ carbon foil or a $1500 \mu\text{g}/\text{cm}^2$ gold foil for lifetime measurements. Protons were detected with an annular ΔE -E telescope of two surface barrier detectors at 180° and γ rays were detected by a 120 cm^3 Ge(Li) detector at 55° . Measured $E\gamma$, $I\gamma$, $p\gamma$ -coin, $p\gamma(\theta)$, $\gamma(\text{lin pol})$, Doppler-shift attenuation. Deduced levels, J, π , $T_{1/2}$, γ -ray branching ratios and mixing ratios, multipolarities, transition strengths.

Others:.

1975Wa23: E=12 MeV. Measured $E\gamma$, $I\gamma$, recoil distance. Deduced lifetimes by recoil-distance method for 1461, 2893 and 3464 levels.

1975Po13: E=10.6 MeV. Measured $E\gamma$, $p\gamma(t)$. Deduced lifetime of 3464 level.

1971Ja15: E=6.25, 7.00, 8.00 MeV. Measured $E\gamma$, $I\gamma$, $\gamma\gamma$ -coin, $\gamma(\theta)$, Doppler-shift attenuation. Deduced levels, J, π , $T_{1/2}$ for 1461, 2121, 2525, 2893, 3208 and 3515 levels.

1970Cu02: E=8.40 MeV. Measured $E\gamma$, Doppler-shift attenuation. Deduced $T_{1/2}$ for 1461 level.

All data are from 1983Bi08, unless otherwise noted.

 ^{40}Ar Levels

E(level) [†]	J π [#]	$T_{1/2}$ ^{&}	Comments
0 ^a	0 ⁺		
1460.849 ^{‡a} 5	2 ⁺	1.09 ps 28	$T_{1/2}$: weighted average of 1.39 ps 28 (1983Bi08) and 0.83 ps 26 (1971Ja15). Other: 1.7 ps +125-9 (1970Cu02).
2121 ^b 1	0 ⁺	>2.8 ps	$T_{1/2}$: other: 6.2 ps +90-28 (1971Ja15).
2524 ^b 1	2 ⁺	0.24 ps 4	$T_{1/2}$: weighted average of 0.27 ps 4 (1983Bi08) and 0.19 ps 5 (1971Ja15).
2892.68 ^{‡a} 10	4 ⁺	2.3 ps 6	$T_{1/2}$: weighted average of 2.2 ps 6 (1983Bi08) and 2.9 ps 14 (1975Wa23). Other: 2.8 ps +56-14 (1971Ja15).
3208 1	2 ⁺	28 fs 14	
3464.59 ^{‡a} 13	6 ⁺	0.680 ns 21	$T_{1/2}$: weighted average of 0.693 ns 21 from direct timing $p\gamma(t)$ (1975Po13) and 0.645 ns 35 from recoil-distance method (1975Wa23). Others: >2.8 ps (1983Bi08).
3511 1	1,2 ⁺	49 fs 14	
3515 ^b 1	4 ⁺	0.139 ps 28	
3681 1	3 ⁻	0.132 ps 28	
3919 1	2 ⁺	0.28 ps 3	
4041 1			
4082 1	2 ⁻ , 3 ⁻	40 fs 14	
4226 1	4 ⁽⁻⁾	>2.8 ps	
4229 1		0.166 ps 28	
4300 1	1 ⁻ , 2 ⁻ , 3 ⁻	58 fs 14	
4328 1	1,2 ⁺	18 fs 7	
4420 1			
4427 1	(3 ⁺ , 4 ⁺)	125 fs 21	J π : 3 ⁺ , 4, 5 ⁺ is given in 1983Bi08, but 4 ⁻ and 5 ⁺ should be ruled out by RUL for 2966 γ to 2 ⁺ .
4473 1	1		
4494 1	5 ⁻	0.50 ps 7	
4562 1	1 ⁻ , 2 ⁻ , 3 ⁻		
4578 1	3	37 fs 14	J π : 2 ⁺ , 3 is given in 1983Bi08, but J π =2 ⁺ results in $\Delta J=2$ for the 1685 γ to 4 ⁺ , which expects positive A_2 value while the measured A_2 by 1983Bi08 is negative.
4602 1		33 fs 14	
4674 1		66 fs 17	
4769 1	1,2		
4794 1	3 ⁺ , 4 ⁺	52 fs 14	
4858 1	5 ⁻	37 fs 10	
4929 1			
4959 ^b 1	6 ⁺ , (5 ⁺ , 4)	0.10 ps 4	
4972 1			

Continued on next page (footnotes at end of table)

$^{37}\text{Cl}(\alpha, p\gamma)$ **1983Bi08 (continued)** ^{40}Ar Levels (continued)

E(level) [†]	J π [#]	T _{1/2} ^{&}	E(level) [†]	J π [#]	E(level) [†]	J π [#]
4991 1	4 ⁽⁻⁾	2.1 ps 7	5608 2		6099 2	
5115 2			5611 2		6104 2	
5143 2		<10 fs	5630 2		6138 2	
5166 2			5654 2		6158 2	
5245 2			5662 2		6185 2	
5269 2			5675 2		6203 2	
5293 2			5766 2		6270 2	
5310 2			5818 2		6305 2	
5350 2			5885 2		6356 2	
5378 2			5912 2		6806 ^b 2	(8 ⁺) [@]
5508 2			5931 2		6979 2	(8 ⁻) [@]
5544 2			5973 2	(6 ⁻) [@]		
5559 2			6013 2	(7 ⁻) [@]		

[†] From **1983Bi08**, uncertainty is 1 keV for levels below 5 MeV and 2 keV for other levels, unless otherwise noted.

[‡] Original values are from **1975Wa23** are based on $E\gamma(1461\gamma)=1460.81$ 4. Quoted values are deduced by the evaluator based on the Adopted $E\gamma(1461\gamma)=1460.820$ 5.

[#] From **1983Bi08** based on measured $\gamma(\theta)$ and $\gamma(\text{lin pol})$; the assignment for low-lying levels below E=2893 are from Adopted Levels, unless otherwise noted.

[@] From analog in ^{42}Ca (**1983Bi08**).

[&] From **1983Bi08** using DSAM, unless otherwise noted.

^a (A): Member of $f_{7/2}^2$ yrast sequence.

^b (B): 0⁺ deformed band.

 $\gamma(^{40}\text{Ar})$

E _i (level)	J π _i	E γ [†]	I γ [§]	E _f	J π _f	Mult. ^{&}	δ ^{&}	Comments
1460.849	2 ⁺	1460.820 [‡] 5	100	0	0 ⁺			
2121	0 ⁺	660	100	1460.849	2 ⁺			
2524	2 ⁺	1063	57 1	1460.849	2 ⁺			
		2524	43 1	0	0 ⁺			I γ : I γ (2524)/I γ (1063)=38/62.
2892.68	4 ⁺	1430.80 [‡] 10	100	1460.849	2 ⁺			
3208	2 ⁺	1747	90 1	1460.849	2 ⁺			
		3208	10 1	0	0 ⁺			
3464.59	6 ⁺	571.91 [‡] 8	100	2892.68	4 ⁺			A ₂ =+0.30 2, A ₄ =-0.09 2 from $^{25}\text{Mg}(^{18}\text{O}, n2p\gamma)$ in 1975Wa23 .
3511	1,2 ⁺	987	5 1	2524	2 ⁺			
		2050	81 3	1460.849	2 ⁺			
		3511	14 2	0	0 ⁺			
3515	4 ⁺	622	31 2	2892.68	4 ⁺	M1(+E2)	-0.07 10	A ₂ =+0.45 3, A ₄ =-0.04 4. Mult.: D(+Q) from $\gamma(\theta)$; E1(+M2) ruled out by RUL. δ : other: -0.4 to -1.3 for J=3.
		991	9 5	2524	2 ⁺			
		2054	60 2	1460.849	2 ⁺			
3681	3 ⁻	788	10 1	2892.68	4 ⁺			
		1157	4.0 5	2524	2 ⁺			
		2220	86 2	1460.849	2 ⁺			
3919	2 ⁺	1395	13 2	2524	2 ⁺			
		1798	9 2	2121	0 ⁺			

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$^{37}\text{Cl}(\alpha, \text{p}\gamma)$ **1983Bi08 (continued)** $\gamma(^{40}\text{Ar})$ (continued)

$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\S$	E_f	J_f^π	Mult. &	$\delta^\&$	Comments
3919	2^+	2458	18 2	1460.849	2^+			
		3919	60 4	0	0^+			
4041		1517	100	2524	2^+			
4082	$2^-, 3^-$	2621	100	1460.849	2^+			
4226	$4^{(-)}$	545	47 2	3681	3^-	D+Q	-10 +3-9	$A_2=-0.10$ 3, $A_4=-0.09$ 3. POL=-0.03 11.
		1333	53 2	2892.68	4^+	D(+Q)	+0.6 +4-8	$A_2=+0.34$ 4, $A_4=+0.08$ 4. δ : other: -1.7 +13-4 for J=3.
4229		1705	77 3	2524	2^+			
		2768	23 3	1460.849	2^+			
4300	$1^-, 2^-, 3^-$	2839	100	1460.849	2^+			
4328	$1, 2^+$	2867	71 5	1460.849	2^+			
		4328	29 5	0	0^+			
4420		1212	9 2	3208	2^+			
		1896	8 2	2524	2^+			
		2959	83 4	1460.849	2^+			
4427	$(3^+, 4^+)$	1534	43 5	2892.68	4^+	D+Q		$A_2=+0.41$ 4, $A_4=+0.03$ 4. δ : -0.34 to -1.8 for J=3; -0.2 to +1.0 for J=4; +0.32 to +0.77 for J=5.
		2966	57 5	1460.849	2^+			
4473	1	4473	100	0	0^+			
4494	5^-	268	1.8 3	4226	$4^{(-)}$			
		979	9 1	3515	4^+			
		1029	28 2	3464.59	6^+	D(+Q)	+0.06 +7-10	$A_2=-0.17$ 4, $A_4=-0.03$ 4.
		1601	61 3	2892.68	4^+	E1(+M2)	0.00 +6-9	$A_2=-0.24$ 3, $A_4=-0.03$ 3. POL=+0.58 15.
4562	$1^-, 2^-, 3^-$	480	9 1	4082	$2^-, 3^-$			
		643	42 4	3919	2^+			
		3101	49 4	1460.849	2^+			
4578	3	1067	35 4	3511	$1, 2^+$			
		1370	15 2	3208	2^+			
		1685	39 4	2892.68	4^+	D+Q		based on $\gamma(\theta)$, $A_2=-0.21$ 6, $A_4=+0.08$ 6, $\Delta J=2$ is ruled out since positive A_2 is expected. δ : -0.05 to +0.72 for J=3.
4602		3117	11 2	1460.849	2^+			
		274@		4328	$1, 2^+$			1983Bi08 indicate that this transition could have escaped detection due to low energy.
		2078	90 2	2524	2^+			
		3141	10 2	1460.849	2^+			
4674		3213	100	1460.849	2^+			
4769	1, 2	4769	100	0	0^+			
4794	$3^+, 4^+$	1901	50 5	2892.68	4^+	M1+E2		$A_2=+0.32$ 4, $A_4=-0.07$ 5. δ : 0.22 +13-5 or +1.60 15 for J=4; -1.0 6 for J=3.
		3333	50 5	1460.849	2^+			
4858	5^-	364	10.0 5	4494	5^-			
		1393	24 1	3464.59	6^+			
		1965	66 2	2892.68	4^+	E1(+M2)	-0.09 +8-12	$A_2=-0.43$ 4, $A_4=-0.04$ 3, POL=+0.71 26.
4929		1248	50 4	3681	3^-			
		2405	22 3	2524	2^+			
		3468	28 3	1460.849	2^+			
4959	$6^+, (5^+, 4)$	1444	64 3	3515	4^+	E2		$A_2=+0.30$ 3, $A_4=-0.07$ 4.
		2066	36 3	2892.68	4^+	E2		$A_2=+0.29$ 5, $A_4=-0.07$ 6.
4972		2079	59 4	2892.68	4^+			

Continued on next page (footnotes at end of table)

$^{37}\text{Cl}(\alpha, \text{p}\gamma)$ **1983Bi08 (continued)** $\gamma(^{40}\text{Ar})$ (continued)

$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\S$	E_f	J_f^π	Mult. &	Comments
4972		3511	41 4	1460.849	2 ⁺		
4991	4 ⁽⁻⁾	765	83 2	4226	4 ⁽⁻⁾	D+Q	$A_2=+0.40$ 3, $A_4=+0.04$ 5, $\text{POL}>+0.65$. $\delta(Q/D)=-0.13$ to $+0.77$ or -0.72 to -1.5 .
		909	9 1	4082	2 ⁻ , 3 ⁻		
		1310	8 1	3681	3 ⁻		
5115		1650	100	3464.59	6 ⁺		
5143		1628	17 2	3515	4 ⁺		
		1678	83 2	3464.59	6 ⁺		
5166		1651	70 3	3515	4 ⁺		
		3705	30 3	1460.849	2 ⁺		
5245		3784	100	1460.849	2 ⁺		
5269		1588	100	3681	3 ⁻		
5293		3832	100	1460.849	2 ⁺		
5310		816	11 1	4494	5 ⁻		
		1228	41 3	4082	2 ⁻ , 3 ⁻		
		1629	48 3	3681	3 ⁻		
5350		2457	100	2892.68	4 ⁺		
5378		1863	21 2	3515	4 ⁺		
		1913	28 2	3464.59	6 ⁺		
		2485	51 4	2892.68	4 ⁺		
5508		1993	100	3515	4 ⁺		
5544		4083	100	1460.849	2 ⁺		
5559		2044	26 2	3515	4 ⁺		
		2094	28 2	3464.59	6 ⁺		
		2666	46 4	2892.68	4 ⁺		
5608		4147	100	1460.849	2 ⁺		
5611		2146	100	3464.59	6 ⁺		
5630		1203	100	4427	(3 ⁺ , 4 ⁺)		
5654		3130	100	2524	2 ⁺		
5662		2769	100	2892.68	4 ⁺		
5675		1994	100	3681	3 ⁻		
5766		2558	100	3208	2 ⁺		
5818		2925	100	2892.68	4 ⁺		
5885		2992	53 4	2892.68	4 ⁺		
		4424	47 4	1460.849	2 ⁺		
5912		1830	50 5	4082	2 ⁻ , 3 ⁻		
		2704	50 5	3208	2 ⁺		
5931		3038	72 4	2892.68	4 ⁺		
		4470	28 4	1460.849	2 ⁺		
5973	(6 ⁻)	2508	100	3464.59	6 ⁺		
6013	(7 ⁻)	1519	50 3	4494	5 ⁻		
		2548	50 3	3464.59	6 ⁺		
6099		4638	75 5	1460.849	2 ⁺		
		6099	25 5	0	0 ⁺		
6104		3211	100	2892.68	4 ⁺		
6138		2673	100	3464.59	6 ⁺		
6158		2693	87 2	3464.59	6 ⁺		
		3265	13 2	2892.68	4 ⁺		
6185		1691	100	4494	5 ⁻		
6203		3310	100	2892.68	4 ⁺		
6270		2805	100	3464.59	6 ⁺		
6305		2790	60 5	3515	4 ⁺		
		2840	40 5	3464.59	6 ⁺		
6356		1498	67 5	4858	5 ⁻		

Continued on next page (footnotes at end of table)

$^{37}\text{Cl}(\alpha, \text{p}\gamma)$ **1983Bi08** (continued) $\gamma(^{40}\text{Ar})$ (continued)

$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\S$	E_f	J_f^π
6356		2891	33 5	3464.59	6^+
6806	(8^+)	1847	100	4959	$6^+, (5^+, 4)$
6979	(8^-)	1006	100	5973	(6^-)

[†] Values are not given in **1983Bi08** and taken by the evaluator from level-energy differences, unless otherwise noted.

[‡] Original values from **1975Wa23** are relative to $E\gamma(1461\gamma)=1460.81\ 4$ for 1431γ and $E\gamma(^{207}\text{Bi } 570\gamma)=569.67\ 2$ for 571γ .

Quoted values are deduced by the evaluator based on the Adopted $E\gamma(1461\gamma)=1460.820\ 5$ and $E\gamma(^{207}\text{Bi } 570\gamma)=569.698\ 2$.

[§] Quoted values are % branchings from each level.

[&] From **1983Bi08** based on $\gamma(\theta)$, $\gamma(\text{lin pol})$ and RUL where applicable.

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

$^{38}\text{Ar}(\text{t,p})$ 1975F108

Target ^{38}Ar $J\pi(\text{g.s.})=0^+$.

1975F108,1973Ca13: E=20 MeV triton beam was produced from the Los Alamos three-stage Van de Graaff facility with a typical current of 300 nA. Target was enriched argon gas (95% in ^{38}Ar) with an effective thickness of $\approx 60 \mu\text{g}/\text{cm}^2$. Reaction products were momentum analyzed with a broad-range spectrograph (FWHM ≈ 35 keV) and detected in nuclear emulsions. Measured $\sigma(E_p, \theta)$. Deduced levels, J, π , enhancement factors, L-transfer from DWBA analysis.

All data are from 1975F108, unless otherwise noted.

Measured absolute cross sections (uncertainty=15%) (1975F108)

Level mb/sr	$d\sigma/d\Omega$ (max)	θ	Level mb/sr	$d\sigma/d\Omega$ (max)	θ
0	0.28	20.0	5298	0.086	12.5
1461	0.54	12.5	5393	0.040	35.0
2121	0.014	12.5	5454	0.074	12.5
2524	0.006	12.5	5500	0.040	20.0
2892	0.33	20.0	5671	0.056	20.0
3207	0.32	12.5	5835	0.18	20.0
3468	0.068	42.5	5883	0.42	12.5
3507	0.077	12.5	6140	0.032	27.5
3681	0.18	12.5	6305	0.092	12.5
3926	0.18	12.5	6470	0.10	12.5
4053	0.015	27.5	6670	0.018	35.0
4092	weak		6760	0.20	20.0
4310	0.17	12.5	6835	0.077	12.5
4430	0.39	20.0	7070	0.015	35.0
4495	0.021	20.0	7160	0.061	12.5
4665	0.015	27.5	7300	0.089	12.5
4798	0.071	12.5	7495	0.17	12.5
4870	0.024	20.0	7640	0.13	12.5
4968	0.012	27.5	7730	0.12	12.5
5117	0.022	20.0	7890	0.088	12.5
5191	0.024	20.0	7980	0.085	12.5

$^{38}\text{Ar}(\text{t,p})$ **1975FI08 (continued)** ^{40}Ar Levels

E(level)	L&	$\varepsilon_{@ \&}$	E(level)	L&	$\varepsilon_{@ \&}$	E(level)	L&	$\varepsilon_{@ \&}$
0 [†]	0	3.5	4495 10	(5)	0.02	6140 15	(5)	0.03
1461 5	2	2	4665 10			6305 15		
2121 [†] 5		$\approx 0.1^c$	4798 10	3,4		6470 15	(2)	
2524 5	(2)	0.03	4870 10	3,4	0.2 ^b	6670 15		
2892 5	(3,4)	1.5 ^a	4968 10			6760 15	3,4	
3207 5	2	1	5117 15	(5)	0.02	6835 15	3,4	
3468 5	(6)	0.4	5191 15			7070 15		
3507 5	(2)	0.05	5298 15	2	0.4	7160 15		
3681 5	3,4	0.9 ^b	5393 15			7300 15		
3926 5	2	0.8	5454 15	3,4	0.05 ^b	7495 15		
4053 5		0.06 ^a	5500 15	3,4	0.04 ^b	7640 15	2	
4092 [#] 10			5671 15	3,4	0.2 ^a	7730 15		
4310 10	2	0.7	5835 15	3,4	1.3,0.6	7890 15		
4430 5	3,4	3,1.5	5883 15	2	2	7980 15		

[†] Summed absolute cross section=0.02 mb/sr (1973Ca13).

[‡] Summed absolute cross section=0.73 mb/sr (1973Ca13).

[#] Weak group (1975FI08).

@ Enhancement factor (ε) is defined by $\varepsilon=(d\sigma/d\Omega)\exp/218\sigma_{\text{DWUCK}}$. Form factors used were $f_{7/2}^2$ for most of the levels and $f_{7/2} d_{3/2}$ for levels with L=3 or L=5 transfer.

& From comparisons of measured differential cross sections with DWBA predictions (1975FI08).

^a For L=4.

^b For L=3.

^c For L=0. $\sigma(\theta)$ is uncharacteristic of L=0 distribution (1975FI08).

$^{38}\text{Ar}(\alpha, ^2\text{He})$ **1978Ja10**

1978Ja10 (also **1978Ja22** and thesis by **1980SiZO**): E=65 MeV alpha beam was produced from the Lawrence Berkeley Laboratory 88-inch cyclotron. Target was ^{38}Ar gas in a 6-cm diameter cylindrical gas cell. Reaction products were detected by two telescopes of a 380- μm phosphorus diffused Si ΔE detector and a 5-mm Si(Li) E counter and a 5-mm Si(Li) veto counter (FWHM=300-600 keV). Measured pp-coin, $\sigma(\theta)$, TOF. Deduced levels, J, π .

 ^{40}Ar Levels

<u>E(level)[†]</u>	<u>Jπ[#]</u>
0	0 ⁺
1460 70	2 ⁺
2890 70	4 ⁺
3470 70	6 ⁺
8.2×10^3 $\ddagger$ 8	
9.0×10^3 1	

[†] From **1978Ja10**.

[‡] Broad peak, probably complex structure of many states.

[#] As given **1978Ja10**, member of $(f_{7/2})^2$ multiplet.

$^{40}\text{Ar}(\gamma, \gamma'), (\text{pol } \gamma, \gamma')$ 1988Mo12, 2006Li23, 1986Wi08

1988Mo12: (γ, γ') E=8.5, 10.3, 11.8 MeV bremsstrahlung electron beams were produced from the MUSL-2 accelerator of the University of Illinois. Target was natural liquid argon. γ rays were detected with two Ge(Li) detectors. Measured $E\gamma$, $I\gamma$, $\gamma\gamma$ -coin, γ -ray intensity ratios. Deduced levels, J, π , widths. Comparisons with theoretical calculations.

2006Li23: (pol γ, γ') E=7.8-10.8 MeV linearly-polarized photon beams were produced from HIγS facility at the Duke FEL. Target was natural argon gas with an effective thickness of 6.64 g/cm². γ rays were detected with four HPGe detectors. Measured $E\gamma$, $I\gamma$, γ (pol asymmetry). Deduced levels, J, π , transition strengths. Comparisons with shell-model calculations.

1986Wi08: (pol γ, γ') E=17 MeV bremsstrahlung was produced from the linearly-polarized bremsstrahlung beam facility at the University of Giessen electron linear accelerator. Target was argon gas. γ rays were detected with Ge(Li) detectors. Measured $E\gamma$, $I\gamma$, γ (pol asymmetry). Deduced levels, J, π .

 ^{40}Ar Levels

Transition strengths are deduced by 2006Li23 based on ground state decay widths Γ_0 from 1988Mo12.

E(level) [†]	J π [#]	Γ^b	(2J+1) Γ_0^2/Γ (eV) ^d	Comments
0	0 ⁺			
1461	2 ⁺			
4473 3	1		0.21 ^e 4	
4768 [‡] 1	1 ⁻ &		2.46 ^e 17	
4901? 3			0.05 2	
5110? 3	(1,2 ⁺)		0.07 2	
5393 3	1		0.09 2	
5880 3	1		0.35 4	
5912 3	1		0.15 5	
6056 [‡] 2	1 [@]		1.24 19	
6102 3	1,2 ⁺		0.17 5	
6339 [‡] 2	1 [@]		0.87 ^e 10	
6450? 3			0.17 4	
6477 [‡] 3	1 [@]		1.29 ^e 16	
6703 3	1		0.38 6	
7168 3	1		0.24 7	
7246 3	1		0.37 7	
7281 3	1		0.48 10	
7519 3	1		0.46 10	
7626 3	1		0.33 8	
7708 [‡] 3	1 ⁻ @a		2.2 3	
7918 [‡] 2	1 ⁻ @a		1.84 24	
7993 [‡] 3	1 ⁻ @a		0.78 14	
8032 3	1 ⁻		1.13 20	J π : from 2006Li23. J π =1,2 ⁺ from 1988Mo12.
8163 [‡] 2	1 ⁻ &a		5.7 10	
8191 [‡] 3	1 ⁻ @a		2.2 3	
8303 3	1 ⁻ a		1.14 19	
8552 3	1 ⁻ a		1.66 18	
8585 [‡] 3	1 ⁻ @a		2.6 4	
8644 3	1 ⁻ a		0.80 21	
8676 3	1,2 ⁺		1.8 7	
8834 4	1 ⁻			E(level): observed only in 2006Li23. J π : from polarization asymmetry in 2006Li23.
8884 [‡] 3	1 ⁻ @a		2.5 4	
8918 3	1 ⁻ a	0.34 ^c eV 14	0.81 21	
9128 3	1 ⁻ a	0.71 eV 14	1.8 3	

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$^{40}\text{Ar}(\gamma, \gamma'), (\text{pol } \gamma, \gamma')$ **1988Mo12, 2006Li23, 1986Wi08 (continued)** ^{40}Ar Levels (continued)

E(level) [†]	J π [#]	Γ ^b	(2J+1) Γ_0^2/Γ (eV) ^d	Comments
9314	1 ⁻			E(level): observed only in 2006Li23 . J π : from polarization asymmetry in 2006Li23 .
9337 3	1,2 ⁺		0.76 18	
9356 3	1 ^{-a}	1.0 eV 3	0.96 24	
9416 3	1 ^{-a}	3.4 eV 18	1.2 6	
9502 [‡] 2	1 ^{-&a}	7.9 eV 13	13.8 12	
9582 3	1 ^{(-)-a}	7.3 eV 21	0.99 25	E(level), Γ : doublet: 9580+9585.
9617	1 ⁻			E(level): observed only in 2006Li23 . J π : from polarization asymmetry in 2006Li23 .
9757 3	1 ^{+a}	0.56 ^c eV 22	1.5 3	
9840 3	1		4.0 10	
9850 [‡] 2	1 ^{-&a}	21 eV 4	13.4 20	E(level), Γ : doublet: 9848+9851.
9950 3	1 ^{-a}	10 eV 3	0.95 26	
10090 3	1 ^{-a}		1.4 3	
10151 3	1 ^{-a}		3.4 5	
10179 [‡] 2	1 ^{-@a}		4.5 6	
10362 3	1,2 ⁺		1.5 4	
10745 3	1 ^{-a}		1.6 3	
10857 3	1 ^{-a}		1.7 4	

[†] From [1988Mo12](#), unless otherwise noted.[‡] Weighted average of values from [1988Mo12](#) and [1986Wi08](#).[#] From [1988Mo12](#) based on measured γ -ray intensity ratio $R=I\gamma(90^\circ)/I\gamma(127^\circ)$, unless otherwise noted. For most levels, the intensity ratios agree with those expected for 0-1-0 cascade.@ [1986Wi08](#) give 1,2⁺.& Parity from polarization asymmetry in [1986Wi08](#).^a Parity from polarization asymmetry in [2006Li23](#).^b Deduced by [1988Mo12](#) from their $(2J+1)\Gamma_0^2/\Gamma$ values, and $S(\alpha, \gamma)=(2J+1)\Gamma_\alpha\Gamma_\gamma/\Gamma$ and Γ_0/Γ_γ from [1986Jo09](#).^c Lower limit using $\Gamma_0/\Gamma_\gamma=1$.^d From [1988Mo12](#), J=spin of excited state.^e For $\Gamma_0/\Gamma_\gamma=1$. $\gamma(^{40}\text{Ar})$

E_γ [†]	$E_i(\text{level})$	J π_i	E_f	J π_f
1461	1461	2 ⁺	0	0 ⁺
4473 3	4473	1	0	0 ⁺
4641@ 3	6102	1,2 ⁺	1461	2 ⁺
4768 1	4768	1 ⁻	0	0 ⁺
4901@ 3	4901?		0	0 ⁺
5110@ 3	5110?	(1,2 ⁺)	0	0 ⁺
5393 3	5393	1	0	0 ⁺
5880 3	5880	1	0	0 ⁺
5912 3	5912	1	0	0 ⁺
6056 2	6056	1	0	0 ⁺
6102 3	6102	1,2 ⁺	0	0 ⁺
6165@ 3	7626	1	1461	2 ⁺

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$^{40}\text{Ar}(\gamma, \gamma'), (\text{pol } \gamma, \gamma')$ **1988Mo12, 2006Li23, 1986Wi08** (continued) $\gamma(^{40}\text{Ar})$ (continued)

$E_\gamma^\dagger$	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult. [§]	Comments
6339 2	6339	1	0	0 ⁺		
6449 @ 3	6450?		0	0 ⁺		
6476 3	6477	1	0	0 ⁺		
6570 @ 3	8032	1 ⁻	1461	2 ⁺		
6701 & † @ 2	8163	1 ⁻	1461	2 ⁺		
6702 & † 3	6703	1	0	0 ⁺		
7167 3	7168	1	0	0 ⁺		
7245 3	7246	1	0	0 ⁺		
7280 3	7281	1	0	0 ⁺		
7518 3	7519	1	0	0 ⁺		
7625 3	7626	1	0	0 ⁺		
7707 3	7708	1 ⁻	0	0 ⁺	E1	POL=-0.58 10.
7917 2	7918	1 ⁻	0	0 ⁺	E1	POL=-0.72 12.
7992 3	7993	1 ⁻	0	0 ⁺	E1	POL=-0.49 15.
8031 3	8032	1 ⁻	0	0 ⁺	E1	POL=-0.55 12.
8162 2	8163	1 ⁻	0	0 ⁺	E1	POL=-0.65 8.
8190 3	8191	1 ⁻	0	0 ⁺	E1	POL=-0.59 11.
8302 3	8303	1 ⁻	0	0 ⁺	E1	POL=-0.47 19.
8551 3	8552	1 ⁻	0	0 ⁺	E1	POL=-0.70 9.
8584 3	8585	1 ⁻	0	0 ⁺	E1	POL=-0.49 11.
8643 3	8644	1 ⁻	0	0 ⁺	E1	POL=-0.57 13.
8675 3	8676	1,2 ⁺	0	0 ⁺		
8833 4	8834	1 ⁻	0	0 ⁺		POL<-0.33.
8883 3	8884	1 ⁻	0	0 ⁺	E1	POL<-0.50.
8917 3	8918	1 ⁻	0	0 ⁺	E1	POL<-0.33.
9127 3	9128	1 ⁻	0	0 ⁺	E1	POL<-0.10 (2006Li23).
9314	9314	1 ⁻	0	0 ⁺		POL<-0.44.
9336 3	9337	1,2 ⁺	0	0 ⁺		
9355 3	9356	1 ⁻	0	0 ⁺	E1	POL=-0.43 13.
9415 3	9416	1 ⁻	0	0 ⁺	E1	POL=-0.28 13.
9501 2	9502	1 ⁻	0	0 ⁺	E1	POL=-0.44 13.
9581 3	9582	1 ⁽⁻⁾	0	0 ⁺	(E1)	
9617	9617	1 ⁻	0	0 ⁺		POL<-0.16 26.
9756 3	9757	1 ⁺	0	0 ⁺	M1	POL=+0.48 14.
9839 3	9840	1	0	0 ⁺		
9849 2	9850	1 ⁻	0	0 ⁺	E1	POL=-0.53 15.
9949 3	9950	1 ⁻	0	0 ⁺	E1	POL<-0.08.
10089 3	10090	1 ⁻	0	0 ⁺	E1	POL<-0.16.
10150 3	10151	1 ⁻	0	0 ⁺	E1	POL=-0.74 13.
10178 2	10179	1 ⁻	0	0 ⁺	E1	POL=-0.56 14.
10361 3	10362	1,2 ⁺	0	0 ⁺		
10743 3	10745	1 ⁻	0	0 ⁺	E1	POL<-0.20.
10855 3	10857	1 ⁻	0	0 ⁺	E1	POL<-0.06.

† 1988Mo12 and 1986Wi08 only give excitation energies from measured γ -ray energies which are not given in the papers. The evaluator has therefore taken the γ -ray energies from excitation energies.

‡ In Table I of 1988Mo12 6703 γ is shown to deexcite only the 8162 level, but in authors' Table II, 6703 level is also given.

§ From 2006Li23 based on polarization asymmetry.

& Multiply placed.

@ Placement of transition in the level scheme is uncertain.

$^{40}\text{Ar}(e,e'),(e,e)$ 1977Fi09,1975GrYY,1956He83

1977Fi09, 1976Fi12 (also thesis by 1976FiZW): (e,e') E=65-115 MeV electron beam was produced from the high-resolution electron scattering facilities of the National Bureau of Standards (NBS). Target was natural argon gas (99.6% ^{40}Ar). Scattered electrons were momentum analyzed with a magnetic-angle spectrometer and detected by an array of 48 lithium-drifted silicon detectors. Measured $\sigma(E,\theta)$. Deduced levels, J, π , form factors, transition strengths, lifetimes, partial γ -decay widths and rms radius from DWBA analysis using the Tassie model. Comparisons with available data.

1975GrYY: (e,e') . Measured σ . Deduced level, form factor.

1956He83: (e,e') E=187 MeV. Measured $\sigma(E,\theta)$. Deduced levels, J, π , transition strengths, lifetimes.

Others:

1982Ot01: (e,e) E=116, 249 MeV. Measured $\sigma(\theta)$. Deduced rms radius.

1975Ch41: (e,e') E=150-165 MeV. Measured $\sigma(E)$. Deduced giant resonance structure.

1974We02: (e,e) E=248 MeV. Measured $\sigma(\theta)$. Deduced rms radius.

1971Sc09: (e,e) E=40-57 MeV. Measured $\sigma(\theta)$. Deduced rms radius.

1971Gr27: (e,e) E=78-120 MeV. Measured $\sigma(\theta)$. Deduced rms radius, form factors.

1963Go04: (e,e) E=41.5 MeV. Measured σ .

1963Ba19: (e,e') E=41.5 MeV. Measured σ .

 ^{40}Ar Levels

Transition strengths are those extracted by 1977Fi09 from comparisons of measured differential cross sections with DWBA calculations using the Tassie model. 1977Fi09 also given values from the PWBA analysis using the Helm model.

E(level) [†]	J π [#]	T _{1/2} [@]	Comments
0	0 ⁺		$\langle r^2 \rangle^{1/2} = 3.393$ fm 15(stat) (1976Fi12), 3.41 fm 4 (1971Sc09), 3.47 fm 5 (1971Gr27, 1975GrYY), 3.48 fm 4 (1974We02). Others from Muonic x-ray data: 3.423 6 (1971Bb11, 1974Da05), 3.415 fm 5 (1976Pf01).
1460	2 ⁺	1.11 ps 4	B(E2) $\uparrow$ =0.0382 13 (1977Fi09)
2520	2 ⁺	194 fs 35	B(E2) $\uparrow$ =0.0063 12 (1977Fi09) T _{1/2} : other: 0.23 ps 4 from β_2 in 1956He83. β_2 =0.025 5 (1956He83).
3210	2 ⁺	35 fs 7	B(E2) $\uparrow$ =0.0029 4 (1977Fi09) J π : 2 ⁺ is supported by $\sigma(\theta)$ data of 1977Fi09.
3510 [‡]			
3680	3 ⁻		B(E3) $\uparrow$ =0.0088 10 (1977Fi09)
3920 [‡]			

[†] From 1977Fi09, unless otherwise noted.

[‡] From 1975GrYY only.

[#] From Adopted Levels.

[@] Deduced by the evaluator from B(EL) $\uparrow$ from 1977Fi09 and adopted branching ratios.

$^{40}\text{Ar}(\text{n},\text{n}'\gamma),(\text{n},\text{n})$ 1965Ma41,2012Ma23

1965Ma41 (also **1966Ma10**): E=3-4.5 MeV neutron beam was produced from the Texas Nuclear Corporation's 2 MeV Van de Graaff accelerator via the D(d,n) reaction. Target was liquid argon in cylindrical polyethylene containers 2.54 cm in diam. and 5.1 cm in length. γ rays were detected with a two-crystal total-absorption gamma-ray spectrometer. Measured $E\gamma$, $\gamma(\theta)$. Deduced levels, J, π .

2012Ma23: E=1-30 MeV neutron beams were produced via spallation on a natural W target by an 800-MeV proton linear accelerator beam at the Los Alamos Neutron Science Center (LANSCE). Target was argon gas. γ rays were detected with the GEANIE array of 20 HPGe detectors with bismuth germanate escape suppression shields. Measured $\sigma(E_n)$ for six γ -ray transitions. Comparisons with calculations by the TALYS and COH₃ reaction codes.

2013Ma39: (n,n) E=6.0 MeV. Measured elastic scattering cross section.

 ^{40}Ar Levels

$E(\text{level})^\dagger$	$J\pi^\#$	Comments
0	0^+	
1461	(2^+)	
2121	0^+	J^π : 680 $\gamma(\theta)$ is isotropic (1965Ma41).
2524	(2^+)	
2893 ‡	$4^+ @$	
3208	(4^+)	J^π : inconsistent with 2^+ from Adopted Levels.
3465 ‡	$6^+ @$	
3512 ‡	$2^+ @$	
3681 ‡	$3^- @$	
4230 ‡	$4^{(-)} @$	

† Rounded values from Adopted Levels.

‡ Reported in **2012Ma23** only.

$^\#$ Assignments for excited states are from **1965Ma41** based on deduced γ -ray multiplicities (parentheses added by evaluator), unless otherwise noted.

$@$ From Adopted Levels.

 $\gamma(^{40}\text{Ar})$

$E_\gamma^\dagger$	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult. §
547 ‡	4230	$4^{(-)}$	3681	3^-	
572 ‡	3465	6^+	2893	4^+	
660	2121	0^+	1461	(2^+)	
1063	2524	(2^+)	1461	(2^+)	(E2)
1432 ‡	2893	4^+	1461	(2^+)	
1461	1461	(2^+)	0	0^+	(E2)
1747	3208	(4^+)	1461	(2^+)	(E2)
2051 ‡	3512	2^+	1461	(2^+)	
2220 ‡	3681	3^-	1461	(2^+)	
2524	2524	(2^+)	0	0^+	(E2)

† Rounded values from Adopted Gammas.

‡ Observed in **2012Ma23** only.

§ Deduced by **1965Ma41** based on measured $\gamma(\theta)$ (parentheses added by evaluator).

$^{40}\text{Ar}(\text{p,p}'), (\text{pol p,p}') \quad \text{1988Bi04, 1985De03, 1961Ka26}$

Includes (p,p), (pol p,p).

1988Bi04: (p,p') E=0.8 GeV proton beams was produced from the Los Alamos Clinton P. Anderson Meson Physics Facility (LAMPF). Target was natural argon gas. Scattered ions were analyzed with the high-resolution spectrometer (HRS) (FWHM=140 keV). Measured $\sigma(\theta)$. Deduced levels, J, π , L-transfer, deformation parameters from DWBA analysis.

1985De03: (p,p') E=29.6, 35.1 MeV proton beams were produced from the Milan AVF cyclotron. Target was gaseous argon. Scattered particles were detected with three telescopes of surface-barrier silicon detectors (FWHM=80-120 keV). Measured $\sigma(\theta)$. Deduced levels, J, π , L-transfer, deformation parameters, transition strengths from coupled-channel analysis and DWBA analysis.

1961Ka26: (p,p') E=8 MeV. 23 levels reported with precise energies.

1968Jo14: (p,p') E=24.85 MeV. Measured $\sigma(\theta)$. Deduced levels, J, π , deformation parameters from DWBA analysis.

1965Gr11: (p,p') E=14.1, 16.9 MeV. Measured $\sigma(\theta)$. Deduced levels, J, π , deformation parameters from DWBA analysis.

1961Be32: (p,p') E=7.3, 9.4 MeV. 21 levels reported.

Others.

2007Ok01: (p,p') E=25.1, 32.5, 40.7 MeV. Measured $\sigma(\theta)$, analyzing powers.

1992Go18: (p,p) E=1.875-1.879 MeV. Measured yield.

1983Ba01: (p,p') E=1 GeV. Measured total σ .

1983Ok01: (pol p,p) E=25.1, 32.5, 40.7 MeV. Measured analyzing powers.

1982Sa19, 1982Sa37, 1979Sa38, 1978Sa33: (pol p,p) E=65 MeV. Measured analyzing powers.

1980Fa06, 1980Fa07: (p,p) E=20.9-44.1 MeV. Measured $\sigma(\theta)$.

1977Bi09: (p,p) E=1.093, 0.992 MeV. Measured σ .

1973Be41: (pol p,p) E=40 MeV. Measured analyzing powers.

1971Ru04: (pol p,p') E=49.4 MeV. Measured $\sigma(\theta)$, analyzing powers. 5 levels at 1460, 2530, 2910, 3230 and 3710 studied.

1969Ba23: (pol p,p) E=21 MeV. Measured $\sigma(\theta)$, analyzing powers.

1966Hu05, 1966Hu12: (p,p') E=4.1, 7.3 MeV. Measured $\sigma(\theta)$.

1964Bo27: (pol p,p) E=14.5 MeV. Measured $\sigma(\theta)$.

1962Ta05: (p,p') E=6.14 MeV. Measured $\sigma(\theta)$ for three levels.

1962An04: (p,p') E=14.8 MeV.

1961Ba29: (p,p') E=0.8-3.5 MeV. Measured $\sigma(\theta)$.

1961Ro13, 1961Ro05: (pol p,p) E=8, 10 MeV. Measured $\sigma(\theta)$.

1961Co29: (p,p) E=1-2 MeV.

1960Od01: (p,p') E=7.6-14.2 MeV. Measured $\sigma(\theta)$ for gs and 1460 peak. Two other peaks seen at 3700 and 4800.

1958Ty47: (p,p') E=185 MeV. Measured $\sigma(\theta)$.

1957Gi14: (p,p') E=9.5 MeV.

1956Ei15: (p,p') E=8.5, 9.0, 9.8 MeV. Measured $\sigma(\theta)$.

1956Va28: (p,p').

1956Bu95: (p,p) E=9.5 MeV.

1956Ki54: (p,p) E=14.5, 20, 31.5 MeV. Measured $\sigma(\theta)$.

1954Fr43: (p,p') E=9.5 MeV. Measured $\sigma(\theta)$.

1947He02: (p,p') E=9.2 MeV, levels reported at 1500 and 2400.

 ^{40}Ar Levels

B(EL) values from **1985De03** correspond to different nuclear models (rotational or vibrational) and to different choice of low-lying levels in coupled-channel (CC) calculations. Known γ -ray branching ratios and lifetimes were used in the analysis. The negative sign for some of these values is that of the corresponding matrix element. See full details in **1985De03**.

Multiple values of deformation parameters and transition probabilities B(EL) arise from choice of different nuclear models and to selection of low-lying levels used in the analysis.

E(level) [†]	L [@]	β_{LR} (fm) ^{&}	Comments
0	0		
1462 2	2	0.95	$\beta_2=0.242$ 5 or 0.220 4 (1985De03), 0.24 2 or 0.26 2 (1971Ru04), 0.21 (1968Jo14). B(E2)(from g.s.)=0.046 8, 0.0459 19, 0.0448 20, 0.0430 10, 0.0441 10, 0.0447 10 (1985De03).
2125 3	0		L: from 1985De03 . Other: ≤ 2 (1965Gr11), 1 (1968Jo14).

Continued on next page (footnotes at end of table)

$^{40}\text{Ar}(\text{p,p}'), (\text{pol p,p}') \quad \text{1988B104, 1985De03, 1961Ka26 (continued)}$ ^{40}Ar Levels (continued)

E(level) [†]	L [@]	β_{LR} (fm) ^{&}	Comments
2529 3	2	0.28	$\beta_1=0.05$ for L=1 (1968Jo14). $\beta_0=0.032$ 8 or -0.029 8 (1985De03). B(E2)(from 1460,2 ⁺)= 0.0046 17, 0.00078 14, 0.00014 4 (1985De03). L: other: (0),1 (1965Gr11). $\beta_2=0.33$ 3 (1985De03), 0.05 (1968Jo14). B(E2)(from g.s.)= 0.0039 7, 0.00350 2, 0.0024 2 (1985De03). B(E2)(from 1460,2 ⁺)= 0.0011 2, 0.00013 11, 0.00006 14 (1985De03). B(E4)(from 1460,2 ⁺)= 0.0000048 12, 0.000079 8, 0.000047 41 (1985De03). B(E2)(from 2120,0 ⁺)= 0.097 9, 0.23 4 (1985De03).
2897 5	4	0.32	$\beta_4=0.107$ 12 or 0.078 7 (1985De03), 0.11 (1968Jo14). B(E4)(from g.s.)= 0.00113 6, 0.00077 11, 0.00080 5 (1985De03). B(E2)(from 1460,2 ⁺)= 0.024 4, 0.0040 1, 0.0054 22, 0.014 4 (1985De03). B(E4)(from 1460,2 ⁺)= 0.000294 13, 0, 0.00063 37, 0.00005 9 (1985De03).
3213 5	2	0.22	$\beta_2=0.07$ (1968Jo14). B(E2)(from g.s.)= 0.0010 3 (1985De03). B(E2)(from 1460,2 ⁺)= 0.0014 5 (1985De03). B(E4)(from 1460,2 ⁺)= 0.00040 34 (1985De03).
3518 5	(2)	0.17	$\beta_3=0.07$ for L=3 (1968Jo14). E(level),L, β_{LR} (fm): complex structure (1988B104), known levels at 3512, 4 ⁺ and 3464, 6 ⁺ may be included in the peak at 3510. The angular distribution (in 1988B104) for 3510 does not agree with that expected for L=2.
3688 5	3	1.00	$\beta_3=0.26$ 3 (1985De03, 1968Jo14), 0.29 2 or 0.31 2 (1971Ru04). B(E3)(from g.s.)= 0.0150 5 (DWBA), 0.0165 3 (CC) (1985De03). B(E2)(from 1460,2 ⁺)= 0.0038 10 (1985De03).
3926 6	2	0.22	B(E5)(from 1460,2 ⁺)= 0.000035 17 (1985De03). $\beta_2=0.07$ (1968Jo14). B(E2)(from g.s.)= 0.0024 2 (1985De03). B(E2)(from 1460,2 ⁺)= 0.0065 29 (1985De03). B(E4)(from 1460,2 ⁺)= 0.00105 17 (1985De03).
4053 7			
4092 7			
4240 7			
4310 7	(2,3)		L: from 1968Jo14. $\beta_2=0.07$, $\beta_3=0.08$ (1968Jo14).
4348 11			
4430 7	3	0.44	L: other: (2) (1965Gr11). $\beta_4=0.19$ for J=4 (1968Jo14).
4484 8			
4581 7			
4612 9			
4683? 10			
4775? 10			
4808 10			
4880 9	(4)		L: from 1965Gr11. Other: (2,3,4) from 1968Jo14.
4941 10			
5004 12			
5280 [‡] 20			
5410	(5)	0.24	L, β_{LR} (fm): 0.22 for L=4 (1988B104). J ^π : 1 ⁻ in Adopted Levels for the 5400.5 level.
5460 [‡] 20			
5695 [#] 33			
5900 [‡] 20	3	0.32	$\beta_4=0.10$ for J=4 (1968Jo14).

Continued on next page (footnotes at end of table)

$^{40}\text{Ar}(\text{p,p}'),(\text{pol p,p}') \quad \text{1988B104,1985De03,1961Ka26 (continued)}$ ^{40}Ar Levels (continued)

<u>E(level)[†]</u>	<u>L[@]</u>	<u>β_{LR} (fm)^{&}</u>	<u>Comments</u>
6130 [‡] 20	(2)	0.22	$\beta_2=0.08$ (1968Jo14). J^π : no assignment in Adopted Levels. L, β_{LR} (fm): 0.25 for L=3 (1988B104).
6270 [#] 33			
6475 [#] 42			
6650 [#] 24			
7300 [‡] 20			

[†] From 1961Ka26, unless otherwise noted. Most values seem to be systematically higher by 4-10 keV than the precisely known values in Adopted Levels adopted from other measurements and they are not considered in Adopted Levels unless there are no other data available.

[‡] From 1968Jo14.

[#] From 1961Be32.

[@] From 1988B104, unless otherwise noted. Same values are also from 1985De03, 1968Jo14 and 1965Gr11 for some of the levels.

[&] Deformation length from 1988B104, with $R=r_0A^{1/3}$.

$^{40}\text{Ar}(\text{p},\text{p}'\gamma)$ 1976So05,1976So03

1976So05,1976So03: E=6.75 MeV proton beam was produced from the Auckland University folded tandem accelerator. Target was gaseous argon in a gas cell. Charged particles were detected by an annular silicon surface barrier detector and γ rays were detected by a NaI(Tl) crystal and a Ge(Li) detector. Measured $E\gamma$, $I\gamma$, $\text{p}\gamma$ -coin, $\text{p}\gamma(\theta)$, Doppler-shift attenuation (DSA). Deduced levels, J , $T_{1/2}$, γ -ray branching ratios and mixing ratios, transition strengths. Comparisons with shell-model calculations.

1979Be41: E=5.75 MeV proton beam was produced from the Auckland tandem Van de Graaff accelerator. Gaseous argon target. γ -rays were detected by a Ge(Li) detector (FWHM=3 keV at 1.33 MeV). Measured $E\gamma$, $I\gamma$, DSA, $\gamma(\theta)$. Deduced levels for ^{40}K , $T_{1/2}$ of 1461, 2524 and 3209 levels in ^{40}Ar .

Others:.

2014Ka35: E=1.0-3.0 MeV. Measured excitation function.

1974Be62: E=3.74 MeV. Measured $\sigma(\theta)$, $\text{p}\gamma(\theta)$.

1972He04 (also thesis by **1971HeZQ**): E=5.3 MeV. Measured $T_{1/2}$ of 2121 level.

1971PI04: E=4.7-5.8 MeV. Measured $\gamma\gamma(\theta)$, $\text{p}\gamma(\theta)$.

1966Hu05,1966Hu12: E=4.1, 7.3 MeV. Measured $\text{p}\gamma(\theta)$.

1962Wa26: E=5.1 MeV. Measured $E\gamma$, $I\gamma$, $\gamma\gamma(\theta)$. Levels reported at 1450, 2130, 2530, 2900, 4300 and 4590.

1961Ba29: E=0.8-3.5 MeV. Measured $E\gamma$, $I\gamma$.

1959Ho96: E=4 MeV. Three γ rays reported in ^{40}Ar .

A 4590 Level with γ rays to 2530 and 2900 levels reported by **1962Wa26** has not been included here due to lack of confirmation in more recent studies.

 ^{40}Ar Levels

E(level) [†]	$J\pi^{\ddagger}$	$T_{1/2}^{\#}$	Comments
0	0^+		
1461	2^+	1.35 ps <i>10</i>	$T_{1/2}$: other: 0.72 ps +80-3 (1979Be41).
2121	0^+	104 ps <i>14</i>	J^π : from $\gamma\gamma(\theta)$ in 1962Wa26 .
			$T_{1/2}$: from $\text{p}\gamma(\theta)$ in 1972He04 . Other: >17 ps (1976So03).
2524	2^+	0.34 ps <i>6</i>	$T_{1/2}$: weighted average of 0.37 ps <i>4</i> (1976So03) and 0.24 ps <i>7</i> (1979Be41).
2893	4^+	3.0 ps +18-9	
3208	2^+	<24 fs	$T_{1/2}$: other: <21 fs (1979Be41).
3511	$(1,2)^+$	83 fs <i>31</i>	
3681	$(2,3)^-$	0.10 ps +6-5	
3919	$(1,2)^+$	0.30 ps <i>4</i>	
4042 2			
4084 2	3^-		
4230 2			E(level): Two separate levels near this energy in Adopted Levels: one deexcited by 545 and 1333 γ rays, and the other by 1705 and 2768 γ rays.
4301 2	(1 to 4)		
4419 3			
4484 8	1	<0.07 ps	

[†] From **1976So05**. Values without uncertainties are rounded values taken from Adopted Levels by evaluator.

[‡] From **1976So05** based on measured $\text{p}\gamma(\theta)$, unless otherwise noted.

[#] From **1976So03** by DSAM.

 $\gamma(^{40}\text{Ar})$

A_2 and A_4 are from **1976So05**.

$E_i(\text{level})$	J_i^π	$E_\gamma^{\dagger}$	$I_\gamma^{\ddagger}$	E_f	J_f^π	Mult. [§]	Comments
1461	2^+	1461	100	0	0^+	E2	$A_2=+0.40$ 2, $A_4=-0.42$ 3.
2121	0^+	660	100	1461	2^+		$A_2=-0.03$ 3, $A_4=-0.04$ 4.

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$^{40}\text{Ar}(\text{p},\text{p}'\gamma)$ **1976So05,1976So03** (continued)

$\gamma(^{40}\text{Ar})$ (continued)								
$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\ddagger$	E_f	J_f^π	Mult. [§]	$\delta^\S$	Comments
2121	0^+	2121 &	<3	0	0^+			E_γ : this transition is from 0^+ to 0^+ and can not be observed as γ -ray transition.
2524	2^+	403 & 1063	<1 59 2	2121 0^+ 1461 2^+		M1+E2	$-0.41 +6-13$	I_γ : other: 55 5 (1971PI04). $A_2=-0.09$ 4, $A_4=-0.04$ 5. δ : other: -0.24 (1971PI04). I_γ : other: 45 5 (1971PI04). $A_2=+0.53$ 5, $A_4=-0.43$ 8.
		2524	41 2	0 0^+		E2		I_γ : from 1971PI04. Other: <1 (1976So05). E_γ : this transition is unlikely, since it would feed 0^+ level with multipolarity=E4.
2893	4^+	369 & 772 &	2 2 <2	2524 2^+ 2121 0^+				I_γ : from 1971PI04. Other: 100 (1976So05). $\delta(\text{O/Q})=-0.08$ 7 from $A_2=+0.37$ 3, $A_4=-0.19$ 5.
		1432	98 3	1461 2^+		E2		E_γ : this transition is unlikely, since it would feed 0^+ level with multipolarity=E4.
		2893 &	<2	0 0^+				I_γ : from 1971PI04. Other: <1 (1976So05).
3208	2^+	315 & 684 & 1087 & 1747	2 2 <2 2 2 91 3	2893 4^+ 2524 2^+ 2121 0^+ 1461 2^+		M1+E2	$+0.11$ 7	I_γ : from 1971PI04. Other: <2 (1976So05). I_γ : other: 84 2 (1971PI04). $A_2=+0.47$ 2, $A_4=-0.06$ 4. δ : other: $+0.20$ for $J=2$, 0 for $J=1$ (1971PI04). I_γ : Other: 12 5 (1971PI04).
3511	$(1,2)^+$	3208 303 & 618 & 987 & 1390 & 2050	9 3 2 2 2 2 <5 <5 89 2	0 0^+ 3208 2^+ 2893 4^+ 2524 2^+ 2121 0^+ 1461 2^+		M1(+E2)	-0.05 11	I_γ : from 1971PI04. Other: <3 (1976So05). I_γ : from 1971PI04. Other: <5 (1976So05). I_γ : other: 84 2 (1971PI04). $A_2=+0.34$ 7, $A_4=+0.04$ 8. δ : for $J=2$ (1976So05). I_γ : other: 12 5 (1971PI04).
3681	$(2,3)^-$	3511 170 & 473 & 788 1157 1560 & 2220	11 2 <7 <10 15 3 6 3 <5 85 3	0 0^+ 3511 $(1,2)^+$ 3208 2^+ 2893 4^+ 2524 2^+ 2121 0^+ 1461 2^+		E1(+M2)	$-0.07 +5-11$	I_γ : other: 24 6 (1971PI04). I_γ : from 1971PI04. Other: <6 (1976So05). I_γ : other: 70 3 (1971PI04). $A_2=-0.43$ 8, $A_4=+0.08$ 10. δ : for $J=3$ (1976So05).
3919	$(1,2)^+$	3681 & 238 & 408 & 711 & 1026 & 1395 1798 2458	<5 <2 <2 <2 <2 8 1 12 2 21 3	0 0^+ 3681 $(2,3)^-$ 3511 $(1,2)^+$ 3208 2^+ 2893 4^+ 2524 2^+ 2121 0^+ 1461 2^+		M1+E2		$A_2=-0.18$ 9, $A_4=+0.02$ 13. δ : <-0.3 or $>+6$.
		3919	59 3	0 0^+		E2		$A_2=+0.47$ 8, $A_4=-0.27$ 13.
4042		1149 & 1518 2	<10 60 13	2893 4^+ 2524 2^+				

Continued on next page (footnotes at end of table)

$^{40}\text{Ar}(\text{p}, \text{p}'\gamma)$ **1976So05, 1976So03** (continued) $\gamma(^{40}\text{Ar})$ (continued)

$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\ddagger$	E_f	J_f^π	Mult. [§]	Comments
4042		1921 &	<10	2121	0 ⁺		
		2581	40 13	1461	2 ⁺		
		4042 &	<10	0	0 ⁺		
4084	3 ⁻	1191 &	<10	2893	4 ⁺		
		2623 2	100	1461	2 ⁺		
		4084 &	<10	0	0 ⁺		
4230		547 2	31 5	3681	(2,3) ⁻		
		719 &	<10	3511	(1,2) ⁺		
		1022 &	<10	3208	2 ⁺		
		1338 2	32 5	2893	4 ⁺		$A_2=+0.63$ 14, $A_4=+0.17$ 19.
		1708 2	37 5	2524	2 ⁺		$A_2=+0.50$ 15, $A_4=+0.23$ 19.
		2109 &	<15	2121	0 ⁺		
		2769 &	<10	1461	2 ⁺		
		4230 &	<10	0	0 ⁺		
4301	(1 to 4)	2840 2	100	1461	2 ⁺		$A_2=+0.24$ 9, $A_4=-0.15$ 13.
4419		1895	20 10	2524	2 ⁺		
		2298 &	<15	2121	0 ⁺		
		2958 3	80 10	1461	2 ⁺		
4484	1	2363 &	<10	2121	0 ⁺		
		3023 &	<10	1461	2 ⁺		
		4484	100	0	0 ⁺	D	$A_2=-0.29$ 5, $A_4=-0.10$ 7.

[†] From **1976So05**. Values without uncertainties are taken by the evaluator from level-energy differences by evaluator.

[‡] From **1976So05**, unless otherwise noted. Values from **1971PI04** are given under comments. Quoted values are % branching from each level.

[§] From **1976So05** based on measured $p\gamma(\theta)$.

& Placement of transition in the level scheme is uncertain.

$^{40}\text{Ar}(\text{pol d,d'}),(\text{d,d'})$ 1976Se09

1976Se09: (pol d,d') E=14.83 MeV polarized deuteron beam was produced from the University of Norte Dame polarized ion source.

Target was natural argon gas in a gas cell with stainless-steel foil. Scattered particles were detected with ΔE -E solid-state counter telescopes (FWHM $\approx$ 100 keV). Measured $\sigma(E,\theta)$, vector analyzing power. Deduced levels, J, π , L-transfer, deformation parameters from DWBA and coupled-channel analysis (CCBA).

Others:.

1987Nu01: (pol d,d') E=52 MeV. Measured vector analyzing powers for g.s. and the first 2^+ state.

1980Ha14: (pol d,d) E=56 MeV. Measured $\sigma(\theta)$, vector and tensor analyzing powers.

1980Ma10: (pol d,d) E=52 MeV. Measured $\sigma(\theta)$, vector analyzing powers.

1978Bu22: (pol d,d) E=9.0, 10.75, 12.0 MeV. Measured $\sigma(\theta)$, vector analyzing powers.

1975Ca24: (d,d) E=1.5-2.3 MeV. Measured $\sigma(\theta)$.

1970Fi01: (d,d) E=11.8 MeV. Measured $\sigma(\theta)$. Deduced optical-model parameters.

1968Hi09: (d,d') E=52 MeV. Measured $\sigma(\theta)$. DWBA analysis for g.s., first 2^+ and first 3^- states.

1965Ja13: (d,d') E=10.6 MeV. Measured $\sigma(\theta)$. All states up to 3681 seen, except the 2121 level.

1961Ka26: (d,d').

All data are from 1976Se09, unless otherwise noted.

 ^{40}Ar Levels

E(level) [†]	L [‡]	BL (DWBA) [‡]	Comments
0	0		
1461	2	0.215	$\beta_2(\text{CCBA})=+0.182$ (1976Se09). $\beta_2=0.22-0.25$ (1968Hi09). $\beta_2=+0.17$ or -0.20 ; $\beta_4=+0.10$ (1987Nu01). coupling parameter $B_{02}=0.17$ (1987Nu01).
2121	(0)		$\beta_2(\text{CCBA})=-0.062$ (1976Se09).
2524	2	0.077	$\beta_2(\text{CCBA})=-0.075$ (1976Se09).
2893	4	0.110	$\beta_4(\text{CCBA})=+0.130$ (1976Se09).
3208	(2)	0.118	$\beta_2(\text{CCBA})=+0.126$ (1976Se09).
3512	2	0.076	
3681	3	0.225	$\beta_3(\text{CCBA})=+0.203$ (1976Se09). $\beta_3=0.21-0.25$ (1968Hi09).
3919 [#]	2 [#]	0.079 [#]	
3942 [#]	2 [#]	0.079 [#]	
4420?	(2)	0.153	
4876	3	0.115	
5170? [@]			
5400? [@]			
5880	(3)	0.094	
6054	4	0.095	E(level): as quoted in 1976Se09. a level at the same energy is observed in ^{40}Cl β^- decay and (γ,γ') but with $J\pi=1^{(-)}$. Therefore the evaluator have considered them as two separate levels.

[†] Rounded values from Adopted Levels, unless otherwise noted.

[‡] From comparisons of measured differential cross sections and vector analyzing powers with DWBA predictions (1976Se09).

[#] For the 3919+3942 unresolved doublet.

[@] Indicated in Fig.1 of 1976Se09.

 ${}^{40}\text{Ar}({}^3\text{He}, {}^3\text{He}'), ({}^3\text{He}, {}^3\text{He})$ **1960Ag04**

$\sigma(\theta)$ measured in all studies.

1960Ag04: (${}^3\text{He}, {}^3\text{He}'$) $E=28.5$ MeV.

1975Br26: (${}^3\text{He}, {}^3\text{He}$) $E=26.5$ MeV.

1973Mo13: (${}^3\text{He}, {}^3\text{He}$) $E=28$ MeV.

1969Zu02: (${}^3\text{He}, {}^3\text{He}$) $E=15$ MeV.

 ${}^{40}\text{Ar}$ Levels

$E(\text{level})^\dagger$

0

1460

† From **1960Ag04**.

$^{40}\text{Ar}(\alpha, \alpha'), (\alpha, \alpha)$ 1979Da12, 1970Wa17

1979Da12: (α, α') E=12-15 MeV alpha beam was produced from the University of Wisconsin EN tandem accelerator. Target was natural gas. Scattered particles were detected with an annular surface barrier detector at a back angle of 176° (FWHM=30-35 keV). Measured $\sigma(E\alpha)$. Deduced levels, J, π .

1970Wa17: (α, α') E=21.5, 22.2 MeV alpha beams were produced from Osaka University Cyclotron. Target was purified natural argon gas. Scattered particles were detected with two silicon surface barrier detectors (FWHM=140 keV) covering angles between 15° and 120° . Measured $\sigma(E\alpha, \theta)$. Deduced levels, J, π , L-transfer, β_L parameter from DWBA analysis. Comparisons with shell model calculations.

Others:

1979Di03: (α, α') E=172.5 MeV. Measured $\sigma(\theta)$, deduced GQR, DWBA analysis, $\sigma(\theta)$ for g.s. and first 2^+ also measured.

1976Yo02, 1975Mo04: (α, α') E=96 MeV. Measured $\sigma(\theta)$, deduced GQR, $\sigma(\theta)$ for g.s. and first 2^+ also measured.

1976Be31: (α, α) E=104 MeV. Deduced nuclear parameters.

1972Oe01: (α, α) E=24, 29 MeV. Measured $\sigma(\theta)$, deduced back-angle enhancement and shell structure effects.

1970Bu25 (also **1970Iv04, 1967Iv02**): (α, α') E=13-17 MeV. Measured $\sigma(\theta)$, deduced optical-model parameters.

1969Ha14: (α, α) E=104 MeV. Measured $\sigma(\theta)$, deduced optical potentials, phase shifts.

1969Ga22: (α, α) E=18-29 MeV. Measured $\sigma(\theta)$.

1966Lu02: (α, α') E=18 MeV. Deduced optical-model parameters.

1964La14: $(\alpha, \alpha' \gamma)$ E=19.6 MeV. Measured $\sigma(\theta)$.

1959Ya01: (α, α') E=40 MeV.

1958Se51: (α, α') E=18 MeV.

 ^{40}Ar Levels

E(level) [†]	J π	L ^d	BL ^d	Comments
0	0 ⁺ @	0		
1461 [‡]	2 ⁺ @c	2	0.16	$\beta_2 R=0.87$, B(E2)(W.u.)=6.7 20 (1976Yo02).
2121 [‡]	0 ⁺ @c	0	0.014	
2524 [‡]	2 ⁺ @c	2	0.05	
2893 [‡]	4 ⁺ @c	4		
3208 [‡]	(1 ⁻) @c	(1)	0.05	J π , L: L=(1) from 1970Wa17 disagrees with J π =2 ⁺ in Adopted Levels.
3464	@			
3512	(2 ⁺ , 1 ⁻) @b			E(level): 3560 from 1970Wa17 is in disagreement.
3681 [‡]	3 ⁻ @c	3	0.16	
3919 ^{‡#}	@			
3942 ^{‡#}	@			
4041	@			J π : 0 ⁺ , 1 ⁻ , 2 ⁺ , 3 ⁻ , 4 ⁺ (1979Da12).
4083	@			
4229	3 ⁺ ab			
4301 ^{‡#}	&			
4325 [#]	&			
4341 ^{‡#}	&			E(level): as given in 1979Da12 , not observed in other studies.
4358 [#]	&			
4420 [‡]	@			
4481	1 ⁻ @b			
4562 [#]	&			
4578 [#]	&			E(level): 4580 quoted by 1979Da12 .
4602 [#]	&			E(level): 4612 quoted by 1979Da12 .
4674	a			E(level): 4683 quoted by 1979Da12 .
4738 [#]	&			
4769 [#]	&			

Continued on next page (footnotes at end of table)

$^{40}\text{Ar}(\alpha, \alpha'), (\alpha, \alpha)$ **1979Da12, 1970Wa17 (continued)** ^{40}Ar Levels (continued)

E(level) [†]	J ^π	L ^d	Comments
4794 [#]	&		E(level): 4808 quoted by 1979Da12.
4876 [‡]	@		E(level): 4880 quoted by 1979Da12.
4943 [#]	&		
4991 [#]	&		E(level): 5004 quoted by 1979Da12.
5166?	(2 ⁺) ^{@b}		E(level): seen by 1979Da12 at 5205.
5270	&		
5310 [‡]	&		
5401	@		
5454			E(level): 5465 quoted by 1979Da12.
5508	@		E(level): 5515 quoted by 1979Da12.
5559	@		E(level): 5575 quoted by 1979Da12.
5609 [#]	&		
5630 ^{‡#}	&		
5675	&		E(level): 5671 quoted by 1979Da12.
5718			
5885 [#]	&		E(level): 5880 quoted by 1979Da12.
5906 ^{‡#}	&		
6054	@		E(level), J ^π : could correspond to the level at 6053.6, J ^π =1 ⁽⁻⁾ or the level at 6054 J ^π =4 ⁺ in Adopted Levels.
6138 [‡]			
6209	@		
17.7×10 ³ 2		2	E(level): isoscalar giant quadrupole resonance with FWHM=6900 600 from 1979Di03. Other: 17600 300 with FWHM=4700 300 (1976Yo02). L: from 1979Di03 and 1976Yo02. Small admixtures of L=4 and L=0 are not excluded (1979Di03).

[†] Levels are reported in 1979Da12, unless otherwise noted. 1979Da12 has taken values from a previous evaluation of 1978En02 and the quoted energies here are rounded values taken by evaluator from Adopted Levels.

[‡] Group reported by 1970Wa17 also.

[#] 3919+3942, 4301+4325+4341+4358, 4562+4578+4602, 4738+4769+4794, 4943+4991, 5608+5630 and 5885+5906 are unresolved peaks.

@ Natural parity states (1979Da12).

& Possible natural parity state (1979Da12).

^a Possible unnatural parity state (1979Da12).

^b Assignments by 1979Da12.

^c From L-value in 1970Wa17.

^d From 1970Wa17, deduced from comparisons of measured differential cross sections with DWBA calculations.

Coulomb excitation [2005St22,1998Ib01,1992Cu04](#)

[2005St22](#): $\text{C}(^{40}\text{Ar}, ^{40}\text{Ar}'\gamma)$ $E=80$ MeV ^{40}Ar beam was produced from Lawrence Berkeley National Laboratory 88-Inch Cyclotron.

Target was a multi-layer of 0.42 mg/cm^2 natural carbon evaporated on $5\text{ }\mu\text{g/cm}^2$ titanium deposited on a 3.24 mg/cm^2 gadolinium layer. Charged particles were detected by a silicon detector and γ rays were detected with four Clover Ge detectors. Measured $E\gamma$, $I\gamma(\theta, \text{H}, \text{t})$, $\gamma\gamma$ -coin, particle- γ -coin. Deduced levels, g factor using transient field technique. Comparison with shell model calculations.

[1998Ib01](#): $^{197}\text{Au}(^{40}\text{Ar}, ^{40}\text{Ar}'\gamma)$ $E=38.4$ MeV/nucleon (mid-target) was provided by the K1200 cyclotron at NSCL. Beam ions were separated and identified using the A1200 fragment separator. Target was 184 mg/cm^2 gold. Scattered beam particles were detected in a fast/slow plastic phoswich detector and γ rays were detected with an array of 39 cylindrical NaI(Tl) detectors. Measured $E\gamma$, $I\gamma$, integrated cross section. Deduced $B(E2)$.

[1992C04](#): $^{208}\text{Pb}(^{40}\text{Ar}, ^{40}\text{Ar}'\gamma)$ $E=12.5$ MeV/nucleon ^{40}Ar beam was produced from the UNILAC accelerator at Darmstadt. Targets were 13.2 mg/cm^2 highly-enriched ^{208}Pb evaporated on Gd foils. Scattered particles were detected in an annular parallel plate avalanche gas counter and γ rays were detected with four Ge detectors. Measured $E\gamma$, $I\gamma(\theta, \text{H})$, particle- γ -coin. Deduced g factor using transient field technique. Comparison with shell model calculations.

[1970Na05](#): $^{130}\text{Te}, ^{120}\text{Sn}, ^{206}\text{Pb}(^{40}\text{Ar}, ^{40}\text{Ar}'\gamma)$ $E=110\text{--}125$ MeV ^{40}Ar beams were produced from the Berkeley Hilac. Targets were ^{130}Te , ^{120}Sn , or ^{206}Pb . Scattered particles were detected with particle counters and γ rays were detected with NaI counters.

Measured $E\gamma$, $I\gamma$, $\gamma(\theta)$. Deduced quadrupole moment of the first 2^+ state by reorientation effect.

[1965Gu10](#): $^{27}\text{Al}(^{40}\text{Ar}, ^{40}\text{Ar}'\gamma)$ $E=48$ MeV. Deduced $B(E2)$ for the first 2^+ state.

Other:.

[1995Gr25](#): $^{40}\text{Ar}(^{62}\text{Ni}, ^{62}\text{Ni}'\gamma)$ $E=150$ MeV. Deduced content of ^{40}Ar in target.

 ^{40}Ar Levels

<u>E(level)</u>	<u>J^π</u>	<u>Comments</u>
0	0^+	
1461	2^+	<p>$Q=+0.01\text{ }4$ (1970Na05)</p> <p>$E(\text{level})$: rounded value from Adopted Levels. 1465 24 from 1998Ib01.</p> <p>$B(E2)=0.037\text{ }7$ (1998Ib01), $0.032\text{ }5$ (1970Na05), $0.049\text{ }10$ (1965Gu10).</p> <p>$g=-0.015\text{ }42$ (2005St22), $-0.1\text{ }1$ (1992Cu04).</p> <p>Q: using the reorientation effect (1970Na05).</p> <p>J^π: from Adopted Levels.</p>

 $\gamma(^{40}\text{Ar})$

<u>E_γ</u>	<u>$E_i(\text{level})$</u>	<u>J^π_i</u>	<u>E_f</u>	<u>J^π_f</u>	<u>Mult.</u>	<u>Comments</u>
1461	1461	2^+	0	0^+	E2	E_γ : rounded value from Adopted Gammas.

Coulomb excitation 2005St22,1998Ib01,1992Cu04

Level Scheme $^{40}_{18}\text{Ar}_{22}$

⁴⁰Ca(¹⁴C, ¹⁴O) 1980Dr09

1980Dr09: E=51 MeV ¹⁴C beam with an intensity of 200 nA was produced the Los Alamos Van de Graaff accelerator. Targets were natural Ca (about 70 μg/cm²) on carbon backings. Reaction products were momentum analyzed with a quadrupole-triple-dipole magnetic spectrometer and detected in a position-sensitive ionization chamber. Measured σ(E,θ). Deduced levels.

⁴⁰Ar Levels

E(level)
0
1460

$^{41}\text{K}(\text{d}, ^3\text{He})$ 1983Bh03

$J\pi(^{41}\text{K g.s.})=3/2^+$.

1983Bh03: E=22.8 MeV deuteron beam was produced from the Argonne National Laboratory cyclotron. Target was $160 \mu\text{g}/\text{cm}^2$

^{41}K . Charged particles were detected with a ΔE -E counter telescope (FWHM= 140 keV). Measured $\sigma(E, \theta)$. Deduced levels, J, π ,

L-transfer, spectroscopic factors from DWBA analysis.

Other: 1972ChYI (E=35 keV).

All data are from 1983Bh03.

 ^{40}Ar Levels

Spectroscopic factor is defined by $C^2S = \sigma_{\text{exp}} / \sigma_{\text{DWBA}} / N$, with normalization constant $N=2.95$ (1966Ba54).

<u>E(level)</u>	<u>$L^\dagger$</u>	<u>$C^2S^\dagger$</u>
0	2	0.43
1450 30	2	0.72
2510 30	0+2	0.02,0.11
3210 30	0+2	0.28,0.18
3520 30	2	0.66
4360 30	0	0.39
4530 30		
5200 30	0	0.35
5820 30		
6230 30		

† From comparison of measured differential cross-sections with DWBA calculations (1983Bh03).

 $^{42}\text{Ca}(^{14}\text{C}, ^{16}\text{O})$ **1980Ma40**

1980Ma40: E=78 MeV ^{14}C beam was produced from the Munich MP tandem accelerator. Target was enriched ^{48}Ca with ^{42}Ca component. Reaction products were momentum analyzed with the Q3D magnetic spectrograph and detected by a position-sensitive ionization chamber. Measured $\sigma(E)$. Deduced levels.

 ^{40}Ar LevelsE(level)[†]

0
1500
2130[‡]
3200
4300
4700
5300

[†] Values were read off by evaluator from measured ^{16}O spectrum in Fig.2 in **1980Ma40**, with uncertainty estimated as 100 keV.

[‡] Very weak.

 $^{44}\text{Ca}(^3\text{He}, ^7\text{Be})$ **1976St11**

1976St11: E=70 MeV ^3He beam was produced from the Michigan State university Cyclotron. Target was $90\text{ }\mu\text{g}/\text{cm}^2$ metallic ^{44}Ca (98.56% purity). Reaction products were momentum analyzed with an Engel split-pole spectrograph (FWHM=140 keV) and detected by a single-wire proportional counter backed by a plastic scintillator. Measured $\sigma(E, \theta)$. Deduced levels, J, π , spectroscopic factor from DWBA analysis.

 ^{40}Ar Levels

<u>E(level)</u>	<u>S[†]</u>
0	0.015
1460	
2120	
2520	
2890	
3210	
3510	
3680	

[†] From a DWBA fit to measured angular distribution (**1976St11**).

 $^{44}\text{Ca}(\alpha, 2\alpha)$ **1976Sh02**

1976Sh02: E=90 MeV alpha beam was produced from the Berkeley 88 in. cyclotron. Target was 420 $\mu\text{g}/\text{cm}^2$ ^{44}Ca (98.5% purity). Reaction products were detected by two telescopes of a 250- μm phosphorus diffused Si detector and a 3-mm Si(Li) detector (FWHM=250-300 keV). Measured $\sigma(\theta)$. Deduced levels, spectroscopic from DWIA and PWIA analysis.

 ^{40}Ar Levels

E(level)	Integrated σ (mb/sr ²)	Comments
0	0.58 12	spectroscopic factor=0.24 9 from PWIA analysis, 0.53 9 from DWIA analysis (1976Sh02).
1440 50	0.027 32	
2090 90	0.052 34	
4000 [†] 40	0.080 44	
5750 [†] 70	0.026 25	

[†] Composite of several levels.

$^{208}\text{Pb}(^{40}\text{Ar},\text{X}\gamma)$ 2011Sz02

2011Sz02,2013Sz01: E=255 MeV ^{40}Ar beam was produced from an ECR ion source accelerated by the superconducting ALPI accelerator of the Laboratory Nazionali di Legnaro. Target was $300 \mu\text{g}/\text{cm}^2$ ^{208}Pb . Projectile-like fragments were identified by spectrometer Prisma by ΔE , E and time of flight measurements. γ rays were detected by the Clara array, consisting of twenty-four HPGe clover-type detectors. Measured $E\gamma$, $I\gamma$, fragment- γ coincidence. Deduced levels, J, π . Comparison with shell model calculations.

 ^{40}Ar Levels

<u>$E(\text{level})^\dagger$</u>	<u>$J^\pi^\dagger$</u>
0.0	0^+
1461	2^+
2121	0^+
2524	2^+
2893	4^+
3208	2^+
3464	6^+
3512	2^+
3681	3^-

† From Adopted Levels. Energies are rounded values.

 $\gamma(^{40}\text{Ar})$

<u>$E_\gamma^\dagger$</u>	<u>$E_i(\text{level})$</u>	<u>J_i^π</u>	<u>E_f</u>	<u>J_f^π</u>
572 ‡	3464	6^+	2893	4^+
660	2121	0^+	1461	2^+
1063	2524	2^+	1461	2^+
1432 ‡	2893	4^+	1461	2^+
1461 ‡	1461	2^+	0.0	0^+
1747	3208	2^+	1461	2^+
2051	3512	2^+	1461	2^+
2220	3681	3^-	1461	2^+
2524	2524	2^+	0.0	0^+

† Data table for γ rays not given, γ -ray transition energies are based on those shown in figure 2 of 2011Sz02. Rounded values from Adopted Levels, Gammas are given here.

‡ Strongest transition observed, 1461 γ being very strong.

Adopted Levels, Gammas

$Q(\beta^-)=1310.89$ 6; $S(n)=7799.62$ 6; $S(p)=7582$ 5; $Q(\alpha)=-6438.39$ 7 [2012Wa38](#)

$S(2n)=20877.37$ 20, $S(2p)=18315.35$ 11 ([2012Wa38](#)).

First identification of ^{40}K nuclide by [1935Ni01](#) with a mass spectrograph ([2012Th10](#)).

$^{40}\text{K}(\alpha, \alpha')$ $E=24, 29$ MeV: [1972Oe01](#), measured $\sigma(\theta)$.

$^{41}\text{K}(^3\text{He}, \alpha)$ $E=24$ MeV: [1973DeWO](#).

$^{41}\text{K}(^3\text{He}, \alpha\gamma)$ $E=12.5$ MeV: [1977McZZ](#): measured $\alpha\gamma$ coin, deduced three levels in ^{40}K near 4384 with $T=2$, IAS.

$^{45}\text{Sc}(p, ^6\text{Li})$ $E=45$ MeV: [1970BeYK](#): measured $\sigma(\theta)$ for g.s. and some other unresolved structures which are strongly forward peaked.

Hyperfine structure, isotope-shifts, moments, etc. (measurements): [2014Pa45](#), [2014Kr04](#), [1997Si24](#), [1982Pe14](#), [1982Du19](#), [1981Le19](#), [1976Bo21](#), [1974Sa24](#), [1974Br12](#), [1972Jo09](#), [1969Jo06](#), [1968Ne05](#).

 ^{40}K Levels

See $^{39}\text{K}(n, \gamma), (n, n)$: resonances dataset for neutron resonant states in the excitation region: 7800.7 to 7987.8.

Cross Reference (XREF) Flags

A	$^{12}\text{C}(^{30}\text{Si}, n\text{p}\gamma)$	J	$^{40}\text{Ar}(^3\text{He}, t)$	S	$^{41}\text{K}(p, d)$
B	$^{26}\text{Mg}(^{16}\text{O}, n\text{p}\gamma), ^{27}\text{Al}(^{19}\text{F}, \alpha\text{pn}\gamma)$	K	$^{40}\text{K}(\gamma, \gamma)$: Mossbauer	T	$^{41}\text{K}(d, t)$
C	$^{37}\text{Cl}(\alpha, n\gamma)$	L	$^{40}\text{Ca}(\mu^-, \nu\gamma)$	U	$^{41}\text{Ca}(d, ^3\text{He})$
D	$^{38}\text{Ar}(\alpha, d)$	M	$^{40}\text{Ca}(n, p\gamma), (n, p)$	V	$^{42}\text{Ca}(p, ^3\text{He})$
E	$^{39}\text{K}(n, \gamma), (\text{pol } n, \gamma)$ $E=\text{thermal}$	N	$^{40}\text{Ca}(\text{pol } d, 2p), (d, 2p)$	W	$^{42}\text{Ca}(\text{pol } d, \alpha), (d, \alpha)$
F	$^{39}\text{K}(d, p)$	O	$^{40}\text{Ca}(t, ^3\text{He})$	X	$^{39}\text{K}(n, \gamma), (n, n)$: resonances
G	$^{39}\text{K}(d, p\gamma)$	P	$^{40}\text{Ca}(^7\text{Li}, ^7\text{Be}), (^7\text{Li}, ^7\text{Be}\gamma)$		
H	$^{40}\text{Ar}(p, n)$	Q	$^{40}\text{Ca}(^{12}\text{C}, ^{12}\text{N}), (^{13}\text{C}, ^{13}\text{N})$		
I	$^{40}\text{Ar}(p, n\gamma)$	R	$^{41}\text{K}(n, 2n), (n, 2n\gamma)$		

$E(\text{level})^\dagger$	$J^\pi^\ddagger$	$T_{1/2}^\#$	XREF	Comments
0	4^-	1.248×10^9 y 3	A B C D E F G H I J K L M N O P Q R S T U V W X	<p>$\% \beta^- = 89.28$ 11; $\% \epsilon + \% \beta^+ = 10.72$ 11 $\mu = -1.298100$ 3 (1974Sa24, 2014StZZ) $Q = -0.061$ 5 (1972Jo09, 1971St12, 2013StZZ) J^π: spin from fitting of hyperfine structure (2014Pa45, 2014Kr04); unnatural parity in (pol d, α); unique 3rd forbidden β decays to 0^+ in ^{40}Ar and ^{40}Ca; $L(d, p) = L(p, d) = L(d, t) = 3$. μ: measured using nuclear magnetic resonance method in 1974Sa24. Others: -1.2982 4 (1952Ei09), 1.291 5 (1949Da01), with atomic beam magnetic resonance method. Q: measured using quadrupole resonance/optical level crossing in 1972Jo09 and 1971St12. Others: -0.073 1 (2008Py02, 1998Ke05), -0.075 2 (1993Su36), with both re-evaluated data from 2013StZZ. See data also in 1962Bu10, 1968Ne05. $\% \beta^-$, $\% \epsilon + \% \beta^+$: deduced from γ/β^- (=I(electron capture to 1460.9 level in ^{40}Ar)/I(β^- to ^{40}Ca g.s.))=0.1195 14, and I(β^+)/I(β^-)=1.12×10^{-5} 14 from evaluation of 1973EnVA, and ϵ/β^+ (to ^{40}Ar g.s.)=45.2 14 (3U theory), with all β^+) decay proceeding to ^{40}Ar ground state. $T_{1/2}$: from 2004Ko09 and 2002Gr01 from measurements of specific activity of natural potassium salts using liquid-scintillation counting (LSC) technique. (2002Gr01 reported a value of 1.248×10^9 y 2, later adjusted to 1.248×10^9 y 3 by 2004Ko09 to correct the quoted uncertainty on measured isotopic abundance of ^{40}K). Both</p>

Continued on next page (footnotes at end of table)

Adopted Levels, Gammas (continued) ^{40}K Levels (continued)

<u>E(level)[†]</u>	<u>J^π[‡]</u>	<u>T_{1/2}[#]</u>	<u>XREF</u>	<u>Comments</u>
				papers used natural abundance of ^{40}K as 0.01167% 2 (1975Ga24). The natural abundance of ^{40}K =0.0117% 1 (as recommended in the International Union of Pure and Applied Chemistry 70, 217 (1998), based on the measured value of 1975Ga24) would give about four times larger uncertainty on T _{1/2} . The earlier recommended values of 1.265×10 ⁹ y 13 (1999BeZS, 1999BeZQ) based on recomputation of 1.277×10 ⁹ y 8 (evaluation by 1973EnVA); and 1.26×10 ⁹ y 1 (evaluation by 1990Ho28 from 14 different measurements out of a total of 34 measurements listed) are in good agreement. Variation of T _{1/2} due to environmental conditions has been studied by 2001No10, where no significant effect has been reported. Earlier (pre-1977) measurements of partial (β ⁻ and ce) and/or total T _{1/2} of ^{40}K : 1977Ce04, 1972Go21, 1966Fe09, 1965Le15, 1965Br25, 1962Fl05, 1961Gl07, 1960Sa31, 1960Eg01, 1959Ke26, 1957We43, 1956Mc20, 1955Ba25, 1955Ko21, 1955Su38, 1953Bu58, 1950Sa52, 1947Gl07. Another 16 references (from 1931 to 1971) are listed by 1990Ho28 and in the 1978 Table of Isotopes (1978LeZA); but are not present in the NSR database. Evaluated rms charge radius=3.4381 fm 28 (2013An02). $\delta\langle r^2 \rangle(^{47}\text{K}, ^{40}\text{K})=-0.066\text{ fm}^2$ 16(stat) 129(syst) (2014Kr04) for $\delta v(^{39}\text{K}, ^{40}\text{K})=+125.6\text{ MHz}$ 3 from literature. Dominant configuration= $\pi 1d_{3/2}^{-1} \otimes v(1f_{7/2}$ or $2p_{3/2})$ (2014Pa45) from comparison with shell-model calculations. $\mu=-1.29$ 9 (1974Br12, 2014StZZ) J ^π : L(t, ^3He)=L(p,d)=L(d,t)=3, L(d, ^3He)=2; π =natural in (pol d, α), γ(circ pol) in (n,γ) E=thermal. T _{1/2} : weighted average of 4.30 ns 6 from (α,nγ), 4.24 ns 9 from (n,γ) E=thermal, 4.13 ns 12 from (γ,γ) and 3.88 ns 35 from (p,nγ). μ : using TDPAD method (1974Br12). J ^π : L(d, ^3He)=2, L(d,p)=L(p,d)=L(d,t)=1+3; γ(θ,pol) in (p,nγ), γ(circ pol) in (n,γ) thermal; π =unnatural in (pol d, α). T _{1/2} : weighted average of 0.28 ps 7 from (α,nγ), 0.40 ps 8 from (d,pγ) and 0.22 ps 4 from (p,nγ). J ^π : L(α,d)=L(t, ^3He)=5, L(d,p)=L(p,d)=L(d,t)=3, L(d, ^3He)=2; γ(θ,pol) in $^{26}\text{Mg}(^{16}\text{O}, n\gamma)$. T _{1/2} : weighted average of 0.78 ps 18 from (α,nγ), 1.07 ps 23 from (d,pγ) and 0.73 ps 18 from (p,nγ). Other: 2.3 ps 10 from $^{26}\text{Mg}(^{16}\text{O}, n\gamma)$. J ^π : L(p, ^3He)=0; γ(θ) in (p,nγ); anti-analog state. T _{1/2} : weighted average of 0.340 μs 7 in (p,nγ) and 0.294 μs 23 in (n,2nγ). J ^π : L(t, ^3He)=2; γ(θ,pol) in (p,nγ). T _{1/2} : weighted average of 0.69 ps 18 from (α,nγ), 0.51 ps 8 from (p,nγ). Other: 0.42 ps +29-15 from (d,pγ). J ^π : L(d,p)=1; γ(θ,pol) in (p,nγ) and γ(circ pol) in (n,γ) E=thermal; unnatural parity in (pol d, α). T _{1/2} : weighted average of 0.37 ps 11 from (α,nγ), 0.31 ps 7 from (d,pγ) and 0.32 ps 5 from (p,nγ).
29.8299 5	3 ⁻	4.25 ns 6	BC EFG Ijklmno p q STU W	
800.1431 19	2 ⁻	0.26 ps 5	CDEFG Ij MNOPQ STU W	
891.394 19	5 ⁻	0.83 ps 18	ABCDEFGH Ij LM OpQ STU W	
1643.638 11	0 ⁺	0.336 μs 13	C EFG IJ LM O R T V	
1959.071 11	2 ⁺	0.54 ps 8	C EFG IJ LM OP T W	
2047.338 16	2 ⁻	0.32 ps 5	C EFG I M o W	

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Adopted Levels, Gammas (continued) ^{40}K Levels (continued)

E(level) [†]	J ^π [‡]	T _{1/2} [#]	XREF	Comments
2069.802 20	3 ⁻	0.43 ps 12	CDEFG I LM o U	J ^π : L(d, ³ He)=0, L(α,d)=3; γ(θ,pol) in (p,nγ) and also γ(circ pol) in (n,γ). T _{1/2} : from (α,nγ). Others: 0.26 ps +15-10 from (d,pγ), 0.73 ps +26-19 from (p,nγ). XREF: O(2091).
2103.68 3	1 ⁻	0.46 ps 9	C EFG I LM O	J ^π : L(t, ³ He)=L(d,p)=1; γ(θ) in (p,nγ) and also γγ(θ) in (n,γ) E=thermal. T _{1/2} : weighted average of 0.53 ps 14 from (α,nγ), 0.36 ps 9 from (d,pγ) and 0.58 ps 12 from (p,nγ).
2260.48 3	3 ⁺	65 fs 14	C EFG I LMnOp T W	J ^π : L(d,t)=2; π=unnatural in (pol d,α); γ(θ,pol) in (p,nγ). T _{1/2} : weighted average of 59 fs 17 from (α,nγ) and 69 fs 14 from (p,nγ). Other: 49 fs +55-29 from (d,pγ).
2289.868 11	1 ⁺	86 fs 19	C EfGHIJ LMnOp T vw	XREF: H(2333). J ^π : L(t, ³ He)=0+2; L(d,t)=2(+0); 646.223γ D to 0 ⁺ . T _{1/2} : weighted average of 76 fs 21 from (α,nγ) and 94 fs 19 from (p,nγ). Other: 0.23 ps +24-13 from (d,pγ).
2290.551 22	3 ⁻	0.15 ps 3	CDEfG I LMn p vw	J ^π : L(α,d)=3; γ(θ,pol) in (α,nγ). T _{1/2} : weighted average of 0.15 ps 3 from (α,nγ) and 0.155 ps 29 from (p,nγ). Other: 0.22 ps +14-9 from (d,pγ).
2385? 10	+			J ^π : L(d,t)=2.
2397.190 25	4 ⁻	35 fs 14	C EFG I LM O U W	J ^π : L(d, ³ He)=0; π=unnatural in (pol d,α). T _{1/2} : from (α,nγ). Other: <38 fs in (p,nγ).
2419.160 15	2 ⁻	0.55 ps +16-11	C EFG I LM O W	J ^π : L(d,p)=1; γγ(θ) in (n,γ) E=thermal; γ(θ) in (p,nγ); π=unnatural in (pol d,α). T _{1/2} : weighted average of 0.046 ps +30-18 from (α,nγ), and 0.73 ps 16 from (p,nγ), and 0.28 ps +28-11 from (d,pγ).
2423.7? 8			E	E(level): this level is proposed in 2013Fi01 in (n,γ) E=thermal only based on the placement of a 2688.1γ from the 5111.9 level. But this level was neither observed in other work nor listed in Table 3 of populated levels in 2013Fi01. The evaluator have considered this level as questionable.
2542.79 11	7 ⁺	1.09 ns 7	ABCD I O W	μ=+4.1 7 (1976Bo21,2014StZZ) J ^π : γ(θ,pol) in (α,nγ); π=unnatural in (pol d,α). T _{1/2} : weighted average of 1.10 ns 7 from (¹⁶ O,npγ) and 1.05 ns 17 from (α,nγ). μ: using IPAD method (1976Bo21). Other: +4.4 11 (recoil into gas, 1981Le19).
2558.1 10				
2575.93 3	2 ⁺	0.155 ps 26	C EFG I M o t W	J ^π : γ(θ) in (p,nγ); L(d,p)=2. T _{1/2} : from (p,nγ). Other: 0.14 ps +8-5 in (d,pγ), 0.078 ps 25 in (α,nγ).
2626.00 3	0 ⁻	0.22 ps 5	C EFG I LM O W	J ^π : analyzing power in (pol d,α); L(d,p)=1; isotropic γ(θ) in (p,nγ). T _{1/2} : from (p,nγ). Other: 0.22 ps +15-10 in (d,pγ).
2730.357 19	1	<28 fs	C E GHIJ L O w	XREF: H(2775). J ^π : spin from γ(θ) in (p,nγ); L(t, ³ He)=1 for a weak peak at 2724 indicates parity=, while probable analog of the 10319, 1 ⁺ level in ⁴⁰ Ca according to 1979Gr09 in (e,e') suggests parity=+. T _{1/2} : from (p,nγ). Others: <50 fs in (α,nγ), <83 fs in (d,pγ).

Continued on next page (footnotes at end of table)

Adopted Levels, Gammas (continued)

⁴⁰ K Levels (continued)						
E(level) [†]	J ^π [‡]	T _{1/2} [#]	XREF			Comments
2746.91 5	3 ⁻	0.128 ps 3I	C EF I		w	J ^π : L(d,p)=1 from 3/2 ⁺ ; 789γ to 2 ⁺ , 2747.00γ D+Q to 4 ⁻ ; γ(θ) in (p,nγ). T _{1/2} : weighted average of 0.19 ps 1I in (α,nγ) and 0.123 ps 3I in (p,nγ).
2756.62 3	2 ⁺	<21 fs	C E Ij M o		w	J ^π : γ(θ) in (p,nγ); J=2 ⁻ is ruled out by 1113.3γ to 0 ⁺ and RUL.
2786.645 16	3 ⁺	<38 fs	CDEfg Ij o		w	T _{1/2} : from (α,nγ). Other: <24 fs from (p,nγ). J ^π : γ(θ,pol) in (α,nγ).
2787.32 2I	3 ⁻ ,4 ⁻	55 fs 2I	C fg I o		U w	T _{1/2} : from (p,nγ). Other: <0.69 ps from (d,pγ). XREF: U(2800).
2807.88 7	(1,2) ⁻	0.14 ps 5	C EFG I LM O		W	J ^π : L(d, ³ He)=0 from 7/2 ⁻ . T _{1/2} : from (α,nγ). Other: <28 fs in (p,nγ).
2878.99 12	6 ⁺	0.27 ps 1O	ABC I O			J ^π : L(d,p)=1 from 3/2 ⁺ ; γ(θ) in (p,nγ). T _{1/2} : weighted average of 0.10 ps 7 in (α,nγ) and 0.16 ps 5 in (p,nγ).
2950.9 6		35 fs 2I	C F O			XREF: O(2865). J ^π : γ(θ,pol) in (α,nγ) and (¹⁶ O,npγ).
2985.84 3	(2 ⁻ ,3 ⁺)	69 fs 28	C EF O		W	T _{1/2} : from (α,nγ). XREF: O(2938).
3027.976 23	(2 ⁻ ,3 ⁺)	<50 fs	C EF O		W	T _{1/2} : from (α,nγ). XREF: O(3017).
3100.1 6	(4,5) ⁺	69 fs 2I	CDE j o		w	J ^π : 1027.09γ to 2 ⁺ , 2185.70γ to 2 ⁻ , 695.31γ and 2955.94γ to 3 ⁻ ; π=unnatural in (pol d,α).
3109.56 4	1 ⁺ ,2 ⁺	<97 fs	EFG j o		w	T _{1/2} : from (α,nγ). XREF: E(?).
3128.41 3	(2 ⁻ ,3 ⁺)	<21 fs	C EF O		W	J ^π : L(α,d)=4; 2208.7γ to 5 ⁻ . T _{1/2} : from (α,nγ).
3146.50 5	1 ⁽⁻⁾		C EF HI		w	J ^π : L(d,p)=0 from 3/2 ⁺ . T _{1/2} : from (d,pγ). XREF: O(3120).
3153.82 7	(2 ⁻ ,3)	<21 fs	C E		w	J ^π : 838.8γ to 1 ⁺ , 3128.06γ to 4 ⁻ ; RUL for γ to 1 ⁺ . T _{1/2} : from (α,nγ). XREF: O(3204).
3228.62 5	2 ⁻	28 fs 22	C EFG L O		u W	J ^π : γ(θ) in (p,nγ); L(d,p)=(1) from 3/2 ⁺ . J ^π : 3153.5γ to 4 ⁻ and 397.28γ to 2 ⁺ ; 1100.13γ from (1,2) ⁻ .
3293 1O	UNNATURAL			O	u W	T _{1/2} : from (α,nγ). XREF: O(3216)W(3236).
3353.46 22	(6 ⁺)		A	o		J ^π : L(t, ³ He)=1+3 from 0 ⁺ ; π=unnatural in (pol d,α)). T _{1/2} : from (d,pγ). XREF: O(3272).
3367.94 1O	(2,3) ⁻		EFG	o	W	J ^π : L(t, ³ He)=(0+2); π=unnatural, Jπ≠0 ⁻ in (pol d,α). J ^π : tentative assignment in (³⁰ Si,npγ).
3393.65 5	2 ⁻		EF	o	W	J ^π : L(d,p)=1 from 3/2 ⁺ ; 3368.0γ to 4 ⁻ .
3414.34 3	2 ⁺		EF	o	W	J ^π : L(d,p)=1 from 3/2 ⁺ ; π=unnatural, Jπ≠0 ⁻ in (pol d,α). J ^π : L(d,p)=0+2 from 3/2 ⁺ ; 3384.66γ to 3 ⁻ .

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Adopted Levels, Gammas (continued) ^{40}K Levels (continued)

E(level) [†]	J ^π [‡]	T _{1/2} [#]	XREF			Comments
3439.18 3	(2 ⁺)		E	j	o	J ^π : 1795.45γ to 0 ⁺ ; J=2 ⁺ favored by γγ(θ) and γ(circ pol) in (n,γ).
3448 10	(3,5) ⁺		D	j	o	W XREF: D(3445). E(level): from (pol d,α). Other: 3445 50 from (α,d). J ^π : L(α,d)=4 from 0 ⁺ ; π=unnatural in (pol d,α). J ^π : L(d,p)=1 from 3/2 ⁺ ; π=unnatural, Jπ≠0 ⁻ in (pol d,α). XREF: H(3503).
3486.09 4	2 ⁻		EF		o	W J ^π : L(d,p)=1 from 3/2 ⁺ ; π=unnatural, Jπ≠0 ⁻ in (pol d,α). XREF: H(3503).
3517 15			H		0	
3557.41 8	(1 ⁻ ,2 ⁺ ,3 ⁻ ,4 ⁺)		E			W XREF: W(3568). J ^π : 3526.99γ to 3 ⁻ and 981.03γ to 2 ⁺ ; Jπ=1 ⁻ ,2 ⁺ ,3 ⁻ ,4 ⁺ preferred from π=(natural) in (pol d,α).
3599.20 3	2 ⁻		EF		o	W J ^π : L(d,p)=1 from 3/2 ⁺ ; 1201.86γ to 4 ⁻ , 1308.9γ to 1 ⁺ .
3629.97 4	2 ⁻ ,3 ⁻	<69 fs	EFG		o	W J ^π : L(d,p)=1 from 3/2 ⁺ ; Jπ=0 ⁻ ,1 ⁻ ruled out by RUL for 1232.74γ and 3629.94γ to 4 ⁻ . T _{1/2} : from (d,pγ).
3663.88 4	(1 ⁻ ,2,3,4 ⁺)		EF		0	W XREF: O(3653)W(3682). J ^π : 1373.227γ and 3633.88γ to 3 ⁻ , 249.54γ and 1704.73γ to 2 ⁺ .
3712.98 9	(2) ⁻		EF	j	o	W XREF: F(3719). J ^π : L(d,p)=1 from 3/2 ⁺ ; 1452.39γ to 3 ⁺ , π=(unnatural) in (pol d,α).
3738.49 3	1 ⁺		dEF	j	o	W J ^π : 1478.01γ to 3 ⁺ , 2094.61γ to 0 ⁺ ; π=unnatural in (pol d,α). L(α,d)=4 from 0 ⁺ is inconsistent.
3768.4 3	(2) ⁻		dEF		o	W J ^π : L(d,p)=1 from 3/2 ⁺ ; Jπ=2 ⁻ preferred from π=(unnatural) in (pol d,α).
3797.48 3	1 ⁺		EF		o	W XREF: F(3791). J ^π : 2153.81γ to 0 ⁺ , 1536.84γ to 3 ⁺ ; L(d,p)=0,1 from 3/2 ⁺ ; π=unnatural in (pol d,α).
3821.45 4	2 ⁻		EF			W J ^π : L(d,p)=1 from 3/2 ⁺ ; π=unnatural in (pol d,α); 1424.229γ and 3822.17γ to 4 ⁻ .
3840.27 3	(1,2 ⁺)		EF	H J	o	XREF: H(3870). J ^π : 2196.61γ to 0 ⁺ .
3868.65 5	2 ⁻		EFG	L	o	W J ^π : L(d,p)=1 from 3/2 ⁺ ; π=unnatural in (pol d,α); 3868.3γ to 4 ⁻ , 1765.24γ to 1 ⁻ , 1578.97γ to 1 ⁺ . J ^π : tentative assignment in (³⁰ Si,npγ).
3872.33 20	(7 ⁺)	A				
3887.81 4	(1 ⁻ ,2 ⁻)		dEF	L	o	W J ^π : 1262.1γ to 0 ⁻ , 3857.97γ to 3 ⁻ .
3898 8			d F		o	W E(level): from (d,p).
3924.07 7	(2 ⁻ ,3 ⁺)		dEF	L		W J ^π : 3895.7γ to 3 ⁻ , 1634.26γ to 1 ⁺ ; π=(unnatural) in (pol d,α).
3996 10	UNNATURAL				0	W E(level): from (pol d,α). 3995 15 from t, ³ He. J ^π : π=unnatural, Jπ≠0 ⁻ in (pol d,α).
4020.39 4	(2) ⁻		EF		o	W XREF: W(4033). J ^π : L(d,p)=1 from 3/2 ⁺ ; Jπ=2 ⁻ preferred from π=(unnatural) in (pol d,α).
4080 5			F		o	W XREF: W(4071). E(level): from (d,p), 4071 10 from (pol d,α).
4104.49 4	(1 ⁻ ,2,3 ⁻)		Ef		o	W J ^π : 2001.24γ to 1 ⁻ , 1813.94γ to 3 ⁻ . Jπ=2 ⁻ preferred from π=unnatural in (pol d,α) for a level at 4118 10 if it is the same level.
4110.79 3	2		Ef			W J ^π : 2467.31γ to 0 ⁺ , 4110.39γ to 4 ⁻ . Jπ=2 ⁻ preferred from π=unnatural in (pol d,α) for a level at 4118 10 if it is the same level.
4149.04 4	(2 ⁻ ,3 ⁺)		E			W XREF: W(4154). J ^π : 1751.76γ and 4148.4γ to 4 ⁻ , 3348.91γ to 2 ⁻ ; primary 3650.34γ from 1 ⁺ ,2 ⁺ ; π=(unnatural) in (pol d,α).

Continued on next page (footnotes at end of table)

Adopted Levels, Gammas (continued) ^{40}K Levels (continued)

E(level) [†]	$J^{\pi\dagger}$	$T_{1/2}^{\#}$	XREF			Comments
4180.15 4	(3 ⁻)		E	o	W	J^{π} : 3286.4 γ to 5 ⁻ , 951.16 γ to 2 ⁻ , 2221.27 γ to 2 ⁺ .
4213.08 7	(2 ⁻ , 3 ⁺)		EF	o	W	J^{π} : 2143.37 γ to 3 ⁻ ; primary 3586.53 γ from 1 ⁺ , 2 ⁺ ; π =unnatural in (pol d, α).
4251.70 15	(1, 2 ⁻)		E	o	w	J^{π} : 1625.67 γ to 0 ⁻ . $J\pi=1^{+}, 2^{-}$ preferred from π =(unnatural) in (pol d, α) for a level at 4255 10 if it is the same level.
4253.70 4	(1, 2 ⁻)		EF	o	w	J^{π} : L(d,p)=1; 2149.93 γ to 1 ⁻ , 2183.70 γ and 4223.66 γ to 3 ⁻ ; $J\pi=(1, 2)^{-}$ from γ (circ pol) in (n, γ) E=thermal. $J\pi=2^{-}$ preferred from π =(unnatural) in (pol d, α) for a level at 4255 10 if it is the same level.
4280.42 17	2 ⁻		E	0		XREF: O(4277). J^{π} : L(t, ³ He)=1+3 from 0 ⁺ ; 4280.35 γ to 4 ⁻ , 2233.0 γ and 3480.6 γ to 2 ⁻ , 1704.70 γ to 2 ⁺ .
4313.94 11	2 ⁻		EF		W	XREF: F(4298)W(4310). J^{π} : L(d,p)=1 from 3/2 ⁺ ; π =unnatural, $J\pi\neq 0^{-}$ in (pol d, α).
4350.47 18	(2 ⁻)		EF	0	W	XREF: O(4335)W(4362). J^{π} : 2246.3 γ to 1 ⁻ , 4319.6 γ to 3 ⁻ ; π =unnatural in (pol d, α).
4365.77 18	8 ⁺	0.36 ps 14	AB			J^{π} : 1486.7 γ stretched E2 to 6 ⁺ , 1822.9 γ to 7 ⁺ . $T_{1/2}$: from (¹⁶ O,np γ). The uncertainty may be larger since the lifetime is comparable to the stopping time in the tantalum stopper (1991Ja11).
4383.7 7	0 ⁺		IJ	0	V	T=2 J^{π} : L(³ He,t)=L(p, ³ He)=0 from 0 ⁺ ; $\gamma\gamma(\theta)$ in (p,n γ). T: from (p,n γ).
4395.88 3	(2 ⁻)		EF H		W	XREF: H(4421). J^{π} : L(d,p)=1 from 3/2 ⁺ ; 657.39 γ to 1 ⁺ ; $J\pi=2^{-}$ preferred from π =(unnatural) in (pol d, α).
4419.37 7	(2 ⁻ , 3, 4 ⁺)		E			J^{π} : 2022.32 γ to 4 ⁻ , 1843.33 γ to 2 ⁺ ; primary 3380.3 γ from 1 ⁺ , 2 ⁺ .
4463.61 6	(1 ⁻ , 2, 3, 4 ⁻)		Ef	o	w	J^{π} : 2416.06 γ and 3663.32 γ to 2 ⁻ , 2393.84 γ to 3 ⁻ . $J\pi=(1^{-}, 2^{-}, 3^{-})$ preferred from L(d,p)=1 from 3/2 ⁺ for a level at 4466 5 if it is the same level.
4473.08 9	(2 ⁻ , 3, 4 ⁻)		Ef	o	w	J^{π} : 4472.80 γ to 4 ⁻ , 1079.44 γ to 2 ⁻ . $J\pi=(2^{-}, 3^{-})$ preferred from L(d,p)=1 from 3/2 ⁺ for a level at 4466 5 if it is the same level.
4508 15				0		
4537.07 4	(1 ⁻ , 2, 3)		Ef	L o	w	J^{π} : 1961.11 γ and 2577.63 γ to 2 ⁺ , 3737.01 γ to 2 ⁻ , 4506.96 γ to 3 ⁻ . $J\pi=2^{-}$ preferred from L(d,p)=1 from 3/2 ⁺ for a level at 4544 5 and π =unnatural for a level at 4535 10 in (pol d, α) if they are the same level.
4544.13 6	(0 ⁻ to 4 ⁻)		Ef	o	w	J^{π} : 1058.03 γ and 3743.2 γ to 2 ⁻ . $J\pi=2^{-}$ preferred from L(d,p)=1 from 3/2 ⁺ for a level at 4544 5 and π =unnatural for a level at 4535 10 in (pol d, α) if they are the same level.
4589 5	(2 ⁻)		F		W	E(level): from (d,p), 4590 10 from (pol d, α). J^{π} : L(d,p)=1; π =unnatural, $J\pi\neq 0^{-}$ in (pol d, α).
4662.4 3	(2 ⁻ to 6 ⁻)		Ef		w	J^{π} : 4662.1 γ to 4 ⁻ . $J\pi=2^{-}$ preferred from L(d,p)=1 from 3/2 ⁺ for a level at 4662 5 and π =unnatural for a level at 4663 10 in (pol d, α).
4666.49 6	(2 ⁻ to 5 ⁻)		Ef		w	J^{π} : 4667.0 γ to 4 ⁻ , 2375.85 γ to 3 ⁻ . $J\pi=2^{-}$ preferred from L(d,p)=1 from 3/2 ⁺ for a level at 4662 5 and π =unnatural for a level at 4663 10 in (pol d, α).

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Adopted Levels, Gammas (continued)

 ^{40}K Levels (continued)

E(level) [†]	J ^π [‡]	T _{1/2} [#]	XREF			Comments
4697 10	UNNATURAL				W	J ^π : π =unnatural in (pol d, α).
4744.14 3	(2 ⁺)		E		W	J ^π : 3100.42 γ to 0 ⁺ , 2483.8 γ to 3 ⁺ , 563.86 γ to (3 ⁻).
4765 5	(1 ⁺)		F H		W	E(level): from (d,p). Others: 4763 30 from (p,n), 4762 10 from (pol d, α).
						J ^π : L(d,p)=0 from 3/2 ⁺ ; J π =1 ⁺ preferred from π =unnatural in (pol d, α).
4788.92 10	2 ⁻		EF	0	W	J ^π : L(d,p)=1; 2162.16 γ to 0 ⁻ , 2528.44 γ to 3 ⁺ ; π =(unnatural) in (pol d, α).
4807.92 12	(0 to 3) ⁻		EF			J ^π : L(d,p)=1; 2007.41 γ to J π =1, 4008.1 γ to 2 ⁻ .
4812.01 25	(8 ⁺)	A				J ^π : tentative assignment in (^{30}Si ,np γ).
4827 10	UNNATURAL				W	J ^π : π =unnatural in (pol d, α).
4851.40 13	(2 ⁻ ,3,4 ⁺)		E		W	J ^π : 4851.16 γ to 4 ⁻ , 2892.19 γ to 2 ⁺ .
4872.56 7	(2,3) ⁻		EF		w	J ^π : L(d,p)=1; 4872.47 γ to 4 ⁻ .
4875.57 20	9 ⁺	<0.7 ps	AB		w	J ^π : γ (θ ,pol) in (^{16}O ,np γ). T _{1/2} : from (^{16}O ,np γ). J ^π : L(d,p)=1.
4909 5	(0 to 3) ⁻		F			J ^π : π =unnatural in (pol d, α).
4930 10	UNNATURAL				W	E(level): from (d,p), 4942 10 from (pol d, α).
4948 4	(2 ⁻)		F		W	J ^π : L(d,p)=1; J π =2 ⁻ preferred from π =(unnatural) in (pol d, α).
4960.36 5	(2,3 ⁻)		E			J ^π : 2857.15 γ to 1 ⁻ , 2173.67 γ to 3 ⁺ , 4929.3 γ and 2668.8 γ to 3 ⁻ .
4993.26 5	(2 ⁻)		EF		W	J ^π : 2702.60 γ , 2922.91 γ and 4962.2 γ to 3 ⁻ , 1846.72 γ to 1 ⁽⁻⁾ ; π =unnatural in (pol d, α).
5023.7 3	(2 ⁻ ,3,4 ⁻)		EF		W	J ^π : 1255.29 γ to (2 ⁻), 2627.7 γ to 4 ⁻ .
5063.37 7	(2 ⁻ ,3 ⁺)		E		w	J ^π : 2644.0 γ to 2 ⁻ , 1953.74 γ to 1 ⁺ ,2 ⁺ , 5062.9 γ to 4 ⁻ . J π =2 ⁻ ,3 ⁺ preferred from π =unnatural for a level at 5068 10 in (pol d, α) if it is the same level.
5080 5	(0 to 3) ⁻		F		w	E(level): from (d,p). J ^π : L(d,p)=1. J π =2 ⁻ preferred from π =unnatural for a level at 5068 10 in (pol d, α) if it is the same level.
5111.9 7	(2,3) ⁻		EF		w	J ^π : L(d,p)=1 from 3/2 ⁺ ; 5111.5 γ to 4 ⁻ . J π =2 ⁻ preferred from π =unnatural for a possible 5112+5132 doublet at 5111 10 in (pol d, α).
5136 5	(0 to 3) ⁻		F h		w	J ^π : L(d,p)=1. J π =2 ⁻ preferred from π =unnatural for a possible 5112+5132 doublet at 5111 10 in (pol d, α).
5158 5	(0 to 3) ⁻		F h		W	XREF: W(5169). J ^π : L(d,p)=1.
5189.89 5	(2 ⁻)		E			J ^π : 5188.8 γ to 4 ⁻ , 1393.16 γ to 1 ⁺ , 2459.48 γ to 1 ⁽⁻⁾ .
5214.23 20	2 ⁻		EF		W	J ^π : L(d,p)=1 from 3/2 ⁺ ; π =unnatural in (pol d, α); 3144.30 γ to 3 ⁻ .
5247.1 6			E			
5332.91 24	(9 ⁺)	A	F			XREF: F(?). J ^π : tentative assignment in (^{30}Si ,np γ).
5488.65 17	(2 ⁻ ,3,4 ⁻)		E			J ^π : 5488.5 γ to 4 ⁻ , 2680.4 γ to (1,2) ⁻ .
5681 32			H			
5870 20			J			
5891.90 22	(9 ⁻)	A				J ^π : tentative assignment in (^{30}Si ,np γ).
6098.22 7	(1 ⁻ ,2,3,4 ⁻)		E			J ^π : 1702.35 γ to (2 ⁻), 6067.6 γ to 3 ⁻ .
6118 30			H			
6227.01 25	(8,10) ⁻	<1.4 ps	B			J ^π : from γ (θ ,pol) in (^{16}O ,np γ). T _{1/2} : from (^{16}O ,np γ).
6790 30			H			
≈7000				P		

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Adopted Levels, Gammas (continued) ^{40}K Levels (continued)

E(level) [†]	J ^π [‡]	T _{1/2} [#]	XREF	Comments
7033.0 4	(9 ⁻)		A	J ^π : tentative assignment in ($^{30}\text{Si},\text{np}\gamma$).
7468 37			H	
7472.2 3	(9 ⁻ ,11 ⁻)		AB	J ^π : from $\gamma(\theta)$ in ($^{16}\text{O},\text{np}\gamma$).
7748.0 4	(9 ⁻ ,10 ⁻)		A	J ^π : tentative assignment in ($^{30}\text{Si},\text{np}\gamma$).
7795 33			H	
7799			E	
7800.70 6	(0 to 3) ⁻			X
7802.82 6	(0 to 3) ⁻			X
7808.77 6	1 ⁺	73 eV 8		X
7811.47 6				X
7811.93 6	3 ⁻	1.2 eV 2		X
7813.56 6	(2) ⁻			X
7815.18 6	2 ⁻	1.64 eV 24		X
7815.91 6	(3 ⁻)			X
7823.96 7				X
7824.53 7	2 ⁺	95 eV 3		X
7827.26 7				X
7830.98 7	3 ⁻	3 eV		X
7832.10 7	2 ⁻	13 eV 1		X
7836.23 8	(2 ⁻)			X
7836.33 8	(2 ⁻)			X
7841.26 7	2 ⁺	0.54 keV 3		X
7843.62 8				X
7844.45 8	2 ⁻	42 eV 2		X
7850.42 8	(2) ⁻			X
7852.62 8				X
7852.79 8	2 ⁻	17 eV 4		X
7854.04 8				X
7855.97 8	1 ⁺	1.1 keV 1		X
7856.94 8				X
7857.99 8	1 ⁻	83 eV 13		X
7860.29 8				X
7866.25 9	1	1.94 keV 24		X
7866.80 9				X
7873.43 10				X
7878.23 10				X
7878.74 10				X
7882.37 10				X
7885.12 11	1 ⁻	0.47 keV 5		X
7890.06 11				X
7890.36 11				X
7893.94 12				X
7894.47 12				X
7896.32 12	2 ⁻	0.11 keV 3		X
7899.05 21	2 ⁻	36 eV 11		X
7900.50 21				X
7901.41 21				X
7903.13 21				X
7905.46 21				X
7905.58 21	1 ⁺	2.0 keV 4		X
7906.44 21				X
7906.81 21				X
7911.78 25				X
7914.07 25				X

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Adopted Levels, Gammas (continued)

^{40}K Levels (continued)				
E(level) [†]	J^π [‡]	$T_{1/2}$ [#]	XREF	Comments
7915.41 25				X
7916.7 3				X
7919.3 3	(2) ⁻			X
7922.6 3	(2)			X
7923.5 3				X
7924.3 3				X
7925.7 3				X
7931.5 3				X
7932.2 3				X
7932.8 3				X
7940.1 3	2 ⁻	0.17 keV 4		X
7941.0 3				X
7943.1 3				X
7944.0 3				X
7947.8 4				X
7949.6 4	(3 ⁻)			X
7952 32			H	
7957.8 4				X
7972.7 4	1	1.12 keV 15		X
7983.1 5				X
7987.8 5	1 ⁺	1.0 keV 2		X
7994.1 6	(9 ⁻ to 12 ⁻)		A	J^π : tentative assignment in ($^{30}\text{Si}, n\text{p}\gamma$).
≈ 11000			PQ	
12.0×10^3 3			Q	

[†] From a least-squares fit to γ -ray energies when available. Doubly or multiply placed γ rays were not used in the least-squares procedure. Uncertainties of some γ rays were increased by a factor 2 or 4 in the fitting procedure in order to get an acceptable fit (reduced $\chi^2 < 3$). Other level-energy values are either from individual reactions or weighted averages when quoted precision is comparable. See additional levels in (n, γ) defined on the basis of two-quantum cascades (2002Va28). These levels are not listed here due to insufficient information about their decay modes and spin-parity assignments.

[‡] When L-transfer arguments are used, the target spin-parity is $J^\pi = 3/2^+$ for $^{39}\text{K}(\text{d}, \text{p})$, $^{41}\text{K}(\text{p}, \text{d})$ and $^{41}\text{K}(\text{d}, \text{t})$; $J^\pi = 7/2^-$ for $^{41}\text{Ca}(\text{d}, ^3\text{He})$; $J^\pi = 0^+$ for $^{42}\text{Ca}(\text{p}, ^3\text{He})$, $^{40}\text{Ar}(^3\text{He}, \text{t})$ and $^{38}\text{Ar}(\alpha, \text{d})$. Assignments in (n, γ), (n,n):resonances (for levels above 7800) are from fits to experimental cross sections. When assigning J^π to a level based on γ transitions from this level to a level of known J^π , evaluator consider transitions to be E1, M1 or E2.

[#] Lifetimes are available for 27 levels from ($\alpha, n\gamma$); 22 levels from (p, $n\gamma$); 17 levels from (d, $p\gamma$); and 5 levels from (HI, $xn\gamma$). Weighted averages from different reactions. For values from (d, $p\gamma$) and (p, $n\gamma$), 15% systematic uncertainty is added in quadrature. For values from other datasets, systematic uncertainty is already included. Level widths given are the sum of the neutron widths and gamma widths extracted from fits to resonance data of (n, γ), unless otherwise noted.

Adopted Levels, Gammas (continued)

<u>E_i(level)</u>	<u>J_i^π</u>	<u>γ(⁴⁰K)</u>		<u>E_f</u>	<u>J_f^π</u>	<u>Mult.[§]</u>	<u>δ[§]</u>	<u>α</u>	<u>Comments</u>
		<u>E_γ[†]</u>	<u>I_γ[†]</u>						
29.8299	3 ⁻	29.8299 5	100	0	4 ⁻	M1		0.298	B(M1)(W.u.)=0.150 3 Mult.: δ(E2/M1)≤0.07 from γγ(θ) in (n,γ) E=thermal, but RUL favors pure M1.
800.1431	2 ⁻	770.3053 18	100 9	29.8299	3 ⁻	M1(+E2)	+0.04 +3-6		B(M1)(W.u.)=0.18 +5-3 Mult.: D(+Q) from γγ(θ) in (n,γ) E=thermal; polarity from no level-parity change determined from other experimental evidence. δ: from γγ(θ) in (n,γ) E=thermal. Other: δ(Q/D)=0.00 1 in (p,nγ).
891.394	5 ⁻	800.3 3	0.147 16	0	4 ⁻	[E2]			B(E2)(W.u.)=1.2 +7-4
		862.2 & 3	<1.3 &	29.8299	3 ⁻	[E2]			B(E2)(W.u.)<3
		891.372 21	100 10	0	4 ⁻	M1+E2	+0.085 15		B(M1)(W.u.)=0.037 +11-7; B(E2)(W.u.)=1.1 +9-5
1643.638	0 ⁺	843.478 16	24.4 24	800.1431	2 ⁻	[M2]			Mult.,δ: from γ(θ,pol) in ²⁶ Mg ¹⁶ O,npγ). B(M2)(W.u.)=0.0036 +6-5
1959.071	2 ⁺	1613.84 4	100 3	29.8299	3 ⁻	[E3]			I _γ : weighted average of 25 6 from (α,nγ), 27.5 28 from (n,γ) E=thermal, 22.0 24 from (p,nγ). B(E3)(W.u.)=1.07 +8-7
		1158.901 20	100 3	800.1431	2 ⁻	E1(+M2)	0.00 5		I _γ : from (p,nγ). B(E1)(W.u.)=0.00058 +13-9
		1929.34 10	21.5 24	29.8299	3 ⁻	E1+M2	+0.11 3		I _γ : from (p,nγ). Mult.,δ: from γ(θ) and γ(pol) in (p,nγ). B(E1)(W.u.)=2.6×10 ⁻⁵ 5; B(M2)(W.u.)=0.40 +24-19
2047.338	2 ⁻	1247.173 24	100 3	800.1431	2 ⁻	M1+E2	+0.09 4		I _γ : weighted average of 22.0 24 from (α,nγ), 23 4 from (n,γ) E=thermal, 20.5 24 from (p,nγ). Other: 36 18 from (μ-,νγ) and 14.3 15 from (n,pγ). Mult.: D+Q from γ(θ) in (p,nγ), polarity from level-parity change determined from L-transfer data.
2047.338	2 ⁻								B(M1)(W.u.)=0.0142 +36-25; B(E2)(W.u.)=0.23 +37-18
		2017.53 4	74.5 25	29.8299	3 ⁻	M1+E2	+0.07 4		I _γ : from (p,nγ). Mult.: polarity from γ(circ pol) in (n,γ) E=thermal. δ: weighted average of +0.10 4 from (n,γ) E=thermal and +0.05 8 from (p,nγ).
		2047.28 4	73.6 25	0	4 ⁻	E2			B(M1)(W.u.)=0.0025 +7-5; B(E2)(W.u.)=0.010 +20-8
									I _γ : weighted average of 88 13 from (α,nγ), 67 7 from (d,pγ), 75.0 25 from (p,nγ), and 74 11 from (n,pγ). Other: 83 40 from (μ-,νγ). Mult.,δ: from γ(circ pol) in (n,γ) E=thermal. B(E2)(W.u.)=1.8 +5-3
									I _γ : weighted average of 62 13 from (α,nγ), 71 8 from (n,γ) E=thermal, 65 7 from (d,pγ), 75.0 25 from (p,nγ), 74 29 from (μ-,νγ), and 80 11 from (n,pγ). Mult.: from γ(circ pol) in (n,γ) E=thermal.

Adopted Levels, Gammas (continued)

$\gamma(^{40}\text{K})$ (continued)								
$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\dagger$	E_f	J_f^π	Mult. [§]	$\delta^\S$	Comments
2069.802	3 ⁻	1178.38 4	10 2	891.394	5 ⁻	E2		B(E2)(W.u.)=3.5 +27-15 I $_\gamma$: unweighted average of 6.4 21 from (α ,n γ), 13.3 15 from (n, γ) E=thermal, 13 4 from (d,p γ), and 6 2 from (p,n γ). Mult.: Q from $\gamma(\theta)$ in (p,n γ); M2 is ruled out by T $_{1/2}$. B(M1)(W.u.)=0.00164 +5-8; B(E2)(W.u.)=0.13 +15-10
		1269.56 5	14 2	800.1431	2 ⁻	M1+E2	-0.20 10	I $_\gamma$: weighted average of 10.6 21 from $^{37}\text{Cl}(\alpha$,n γ), 17.4 19 from (n, γ) E=thermal, 13 4 from (d,p γ), 12 4 from (p,n γ), and 25 6 from (n,p γ). Mult., δ : D+Q from $\gamma(\theta)$ in (p,n γ), polarity from no level-parity change determined from L-transfer data.
		2039.94 4	100 6	29.8299	3 ⁻	M1+E2	+0.26 10	B(M1)(W.u.)=0.00274 +12-15; B(E2)(W.u.)=0.14 +12-9 I $_\gamma$: from (α ,n γ) and (p,n γ). Mult., δ : mixing ratio is weighted average of +0.2 2 from $\gamma(\text{circ pol})$ in (n, γ) E=thermal and +0.27 10 from $\gamma(\theta)$ in (p,n γ).
		2070.08 15	82 7	0	4 ⁻	M1(+E2)	-0.07 5	B(M1)(W.u.)=0.002287 +11-22 I $_\gamma$: weighted average of 96 6 from (α ,n γ), 74 8 from (n, γ) E=thermal, 59 9 from (d,p γ), 82 10 from (p,n γ), and 77 29 from (μ^- , $\nu\gamma$). Mult., δ : mixing ratio is from $\gamma(\theta)$ in (p,n γ), +0.01 10 from $\gamma(\text{circ pol})$ in (n, γ) E=thermal.
2103.68	1 ⁻	460 [@]	<4	1643.638	0 ⁺			E $_\gamma$,I $_\gamma$: from (d,p γ). In (n, γ) E=thermal, a 460.092 γ was doubly placed from 2104 and 2397 levels by 1984Vo01 and later resolved by 2013Fi01 to be from 2397 level.
		1303.53 7	40 3	800.1431	2 ⁻	M1+E2	+0.30 6	B(M1)(W.u.)=0.00559 +18-20; B(E2)(W.u.)=0.9 4 Mult., δ : D+Q from $\gamma(\theta)$ in (p,n γ) and $\gamma\gamma(\theta)$ in (n, γ) E=thermal, polarity from no level-parity change determined from L-transfer data. I $_\gamma$: weighted average of 28 5 from (α ,n γ), 42 5 from (n, γ) E=thermal, 37 7 from (d,p γ), 42.9 29 from (p,n γ), and 39 11 from (μ^- , $\nu\gamma$).
		2073.74 10	100 3	29.8299	3 ⁻	E2		B(E2)(W.u.)=2.8 +9-6 I $_\gamma$: from (p,n γ). Mult.: Q from $\gamma(\theta)$ in (p,n γ); M2 is ruled out by T $_{1/2}$.
2260.48	3 ⁺	2230.54 5	100 3	29.8299	3 ⁻	E1(+M2)	+0.01 9	B(E1)(W.u.)=0.00063 +24-14 I $_\gamma$: from (p,n γ). δ : from $\gamma(\theta)$ in (p,n γ).
		2260.11 10	27 6	0	4 ⁻	E1(+M2)	-0.05 6	B(E1)(W.u.)=0.00016 6 I $_\gamma$: unweighted average of 18 4 from (α ,n γ), 38 4 from (n, γ) E=thermal, and 23.5 25 from (p,n γ). Mult., δ : from $\gamma(\theta)$ and $\gamma(\text{pol})$ in (p,n γ).
2289.868	1 ⁺	185.97 10 330.798 7	5.6 9 14.1 22	2103.68 1959.071	1 ⁻ 2 ⁺			E $_\gamma$: also placed from 3414 and 3924 levels in (n, γ) E=thermal. I $_\gamma$: weighted average of 14 3 from (α ,n γ), 15.7 14 from (n, γ) E=thermal, and 7 3 from (p,n γ).
		646.223 5	100 3	1643.638	0 ⁺	M1		B(M1)(W.u.)=0.51 +13-9 I $_\gamma$: from (p,n γ). Mult.: D from $\gamma(\theta)$ in (p,n γ), polarity from no level-parity change determined from L-transfer data.

Adopted Levels, Gammas (continued)

$\gamma(^{40}\text{K})$ (continued)								
$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\dagger$	E_f	J_f^π	Mult. [§]	$\delta^\S$	Comments
2289.868	1 ⁺	1489.77 5	58 5	800.1431	2 ⁻	E1(+M2)	+0.14	B(E1)(W.u.)=0.00065 +27-17 I $_\gamma$: weighted average of 56 5 from (α ,n γ), 58 6 from (n, γ) E=thermal, 60 5 from (p,n γ), and 30 22 from (μ^- , $\nu\gamma$). δ : from $\gamma(\theta)$ in (p,n γ).
2290.551	3 ⁻	1399.03 [‡] 4	19.4 18	891.394	5 ⁻	[E2]		B(E2)(W.u.)=14 +6-4 I $_\gamma$: weighted average of 23 4 from (α ,n γ), 18.9 18 from (n, γ) E=thermal, and 19.0 24 from Ar(p,n γ). B(M1)(W.u.)=0.0061 +45-21; B(E2)(W.u.)=2.3 +15-19 I $_\gamma$: from (p,n γ). Mult.: polarity from $\gamma(\text{pol})$ in (α ,n γ).
		2290.58 7	100 2	0	4 ⁻	M1+E2	-0.8 +3-5	
2397.190	4 ⁻	106.1 3 327.23 8 2367.17 5	4.3 3 10.7 14 100 3	2290.551 3 ⁻ 2069.802 3 ⁻ 29.8299 3 ⁻		M1+E2	+0.25 4	B(M1)(W.u.)=0.029 +24-10; B(E2)(W.u.)=1.0 +14-5 I $_\gamma$: from (p,n γ). Mult., δ : D+Q from $\gamma(\theta)$ in (p,n γ), polarity from no level-parity change determined from other experimental evidence.
		2397.12 6	41 3	0	4 ⁻	M1+E2	-0.32 12	B(M1)(W.u.)=0.0109 +7-9; B(E2)(W.u.)=0.6 +5-4 I $_\gamma$: weighted average of 43 6 from (α ,n γ), 39 4 from (n, γ) E=thermal, and 40.8 28 from (p,n γ). Mult., δ : D+Q from $\gamma(\theta)$ in (p,n γ), polarity from no level-parity change determined from other experimental evidence.
2419.160	2 ⁻	349.33 4 460.092 14 1619.00 4	0.85 11 2.19 24 100 3	2069.802 3 ⁻ 1959.071 2 ⁺ 800.1431 2 ⁻		M1+E2	+0.24 6	B(M1)(W.u.)=0.0059 +18-12; B(E2)(W.u.)=0.41 +38-22 I $_\gamma$: from (p,n γ). Mult., δ : D+Q from $\gamma\gamma(\theta)$ in (n, γ) E=thermal, polarity from no level-parity change determined from L-transfer data.
		2389.18 5	20.1 21	29.8299 3 ⁻		M1+E2	-0.8 5	B(M1)(W.u.)=0.00024 +12-10; B(E2)(W.u.)=0.08 +6-7 I $_\gamma$: weighted average of 19.0 25 from (α ,n γ), 21.6 21 from (n, γ) E=thermal, 19.0 25 from Ar(p,n γ). Mult., δ : D+Q from $\gamma(\theta)$ in (p,n γ), polarity from no level-parity change determined from other experimental evidence.
		2418.69 15	8.8 10	0	4 ⁻	E2		B(E2)(W.u.)=0.10 +5-4 I $_\gamma$: weighted average of 7.6 13 from (α ,n γ), 10.2 10 from (n, γ) E=thermal, and 7.6 13 from (p,n γ).
2542.79	7 ⁺	1651.31 12	100 2	891.394	5 ⁻	M2(+E3)	-0.02 3	Mult.: $\delta(\text{O/Q})$ =+0.17 28 from $\gamma(\theta)$ in (p,n γ); M2 ruled out by RUL. B(M2)(W.u.)=0.176 +14-12 E $_\gamma$: weighted average of 1651.34 24 from (^{30}Si ,np γ), 1651.29 12 from $^{26}\text{Mg}(^{16}\text{O}$,np γ), and 1651.5 5 from (α ,n γ). I $_\gamma$,Mult., δ : from $^{26}\text{Mg}(^{16}\text{O}$,np γ), with Mult. and δ from $\gamma(\theta)$ and $\gamma(\text{pol})$. Other: δ =0.00 3 from (α ,n γ).
		2542.8 3	12.7 4	0	4 ⁻	E3(+M4)	+0.10 7	B(E3)(W.u.)=1.90 +26-23

Adopted Levels, Gammas (continued)

$\gamma(^{40}\text{K})$ (continued)								
<u>E_i(level)</u>	<u>J_i^{π}</u>	<u>E_{γ}[†]</u>	<u>I_{γ}[†]</u>	<u>E_f</u>	<u>J_f^{π}</u>	<u>Mult.[§]</u>	<u>δ[§]</u>	<u>Comments</u>
								E _{γ} : weighted average of 2543.2 4 from (³⁰ Si,np γ), 2542.6 3 from (¹⁶ O,np γ), and 2542.4 10 from (α ,n γ).
								I _{γ} : weighted average of 12.6 4 from (¹⁶ O,np γ), 13.6 23 from (α ,n γ), and 13.6 23 from (p,n γ). Other: 7.4 8 from (³⁰ Si,np γ).
								Mult., δ : from $\gamma(\theta)$ and $\gamma(\text{pol})$ in (¹⁶ O,np γ).
								B(M4)(W.u.)= $3\times 10^4 + 7-3$ is too large; it is expected to be <30 from RUL and thus $\delta<0.003$.
2558.1		2558	100	0	4 ⁻			E _{γ} : from (n,p γ).
2575.93	2 ⁺	315.52 8	2.2 3	2260.48	3 ⁺			
		528.76 ^{&} 14	<0.6 ^{&}	2047.338	2 ⁻			
		2545.85 10	100	29.8299	3 ⁻	E1(+M2)		
2626.00	0 ⁻	522.319 7	100 3	2103.68	1 ⁻	M1		B(M1)(W.u.)=0.50 +12-8
		1825.77 5	44 3	800.1431	2 ⁻	E2		I _{γ} : from (p,n γ).
								B(E2)(W.u.)=4.8 +19-12
								I _{γ} : weighted average of 43 4 from (α ,n γ), 42 5 from (n, γ) E=thermal, 43 7 from (d,p γ), 44.9 29 from (p,n γ), and 37 14 from (μ^- , $\nu\gamma$).
2730.357	1	311.13 4	12.0 5	2419.160	2 ⁻			
		626.1 ^{&} 3	<0.9 ^{&}	2103.68	1 ⁻			
		1086.707 19	100 4	1643.638	0 ⁺	D		Mult.,I _{γ} : from (p,n γ).
		1930.2 3	6 4	800.1431	2 ⁻			I _{γ} : from (α ,n γ) and (p,n γ).
2746.91	3 ⁻	789 1	6.2 16	1959.071	2 ⁺			E _{γ} ,I _{γ} : from (α ,n γ).
		1946.43 17	8.0 12	800.1431	2 ⁻			
		2716.95 11	100 5	29.8299	3 ⁻	M1+E2	-0.19 14	I _{γ} : from (p,n γ).
								Mult., δ : from $\gamma(\theta)$ in (p,n γ), polarity from no level-parity change determined from other experimental evidence. Other: $\delta=-3.4 +13-29$ in (p,n γ).
		2747.00 18	51 5	0	4 ⁻	M1+E2	-0.18 +11-18	I _{γ} : weighted average of 50 5 from (α ,n γ), 52 6 from (n, γ) E=thermal, and 52 5 from (p,n γ).
								Mult., δ : from $\gamma(\theta)$ in (p,n γ), polarity from no level-parity change determined from other experimental evidence.
2756.62	2 ⁺	337.75 12	2.0 3	2419.160	2 ⁻			
		1113.3 3	1.6 3	1643.638	0 ⁺	[E2]		B(E2)(W.u.)>20
		1956.58 [‡] 5	100 3	800.1431	2 ⁻	E1(+M2)	+0.19 +19-26	B(E1)(W.u.)>0.0021?
								I _{γ} : from (p,n γ).
								Mult., δ : D+Q from $\gamma(\theta)$ in (p,n γ), polarity implied by level-parity change determined by 1113.3 γ to 0 ⁺ and RUL. Other: $\delta=-2.1 +13-7$ in (p,n γ).
		2726.62 7	52 3	29.8299	3 ⁻	E1(+M2)	0.00 12	B(E1)(W.u.)>0.00045?
								I _{γ} : from (p,n γ). Others: 86 5 from (n, γ) E=thermal, 52 5 from (α ,n γ).

Adopted Levels, Gammas (continued)

$\gamma(^{40}\text{K})$ (continued)								
$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\dagger$	E_f	J_f^π	Mult. [§]	$\delta^\S$	Comments
								Mult., δ : D+Q from $\gamma(\theta)$ in (p,n γ), polarity implied by level-parity change determined by 1113.3 γ to 0 ⁺ and RUL. Other: $-4.7 +20-144$ in (p,n γ).
2786.645	3 ⁺	496.06 4 827.552 15	2.4 3 23 3	2290.551 1959.071	3 ⁻ 2 ⁺	M1+E2	-0.09 7	B(M1)(W.u.)>0.17; B(E2)(W.u.)>0.33
		2756.81 7	100 4	29.8299	3 ⁻	E1(+M2)	-0.09 +22-5	Mult., δ : D+Q from $\gamma(\theta)$ in (p,n γ), polarity is implied by level-parity change determined from $\gamma(\theta,\text{pol})$ in ($\alpha,\text{n}\gamma$). B(E1)(W.u.)>0.00050? I γ : from ($\alpha,\text{n}\gamma$). Mult., δ : from $\gamma(\theta,\text{pol})$ in ($\alpha,\text{n}\gamma$).
2787.32	3 ⁻ ,4 ⁻	2787.0 6 496.8 5 1896.3 5 2787.10 25	7 3 98 20 46 20 100 20	0 2290.551 891.394 0	4 ⁻ 3 ⁻ 5 ⁻ 4 ⁻	M1+E2		E γ : from ($\alpha,\text{n}\gamma$). E γ : from ($\alpha,\text{n}\gamma$). E γ : from ($\alpha,\text{n}\gamma$). Mult.: D+Q from $\gamma(\theta)$ in (p,n γ), polarity from no level-parity change determined from other experimental evidence.
2807.88	(1,2) ⁻	760.6 4 848.7 3	4.8 16 4.2 8	2047.338 1959.071	2 ⁻ 2 ⁺			
2878.99	6 ⁺	2007.71 [‡] 4 336.18 6	100 12 100 3	800.1431 2542.79	2 ⁻ 7 ⁺	M1(+E2)	+0.01 2	B(M1)(W.u.)=1.4 +10-4 E γ : weighted average of 336.25 20 from (³⁰ Si,np γ), 336.18 16 from (¹⁶ O,np γ), and 336.4 4 from ($\alpha,\text{n}\gamma$). I γ : from (¹⁶ O,np γ). Mult., δ : from $\gamma(\theta,\text{pol})$ in (¹⁶ O,np γ). B(E1)(W.u.)=9.77 $\times 10^{-5}$ +4-7; B(M2)(W.u.)=0.3 +7-3 E γ : weighted average of 1988.07 35 from (³⁰ Si,np γ), 1987.8 6 from (¹⁶ O,np γ), and 1987.8 7 from ($\alpha,\text{n}\gamma$). I γ : weighted average of 46 8 from (³⁰ Si,np γ), 51 7 from (¹⁶ O,np γ), and 61 7 from ($\alpha,\text{n}\gamma$). Mult., δ : from $\gamma(\theta,\text{pol})$ in (¹⁶ O,np γ). Others: δ =-0.06 +4-5 from $\gamma(\theta,\text{pol})$ in ($\alpha,\text{n}\gamma$), -0.09 9 from $\theta(\theta)$ in (p,n γ). E γ : from ($\alpha,\text{n}\gamma$).
		1988.0 4	53 7	891.394	5 ⁻	E1(+M2)	-0.05 4	
2950.9		2950.8 6	100	0	4 ⁻			
2985.84	(2 ⁻ ,3 ⁺)	695.31 8 1027.09 24 2185.70 20 2955.94 16	8.9 13 7.7 17 100 22 88 22	2290.551 1959.071 800.1431 29.8299	3 ⁻ 2 ⁺ 2 ⁻ 3 ⁻			
3027.976	(2 ⁻ ,3 ⁺)	737.45 3	37 4	2290.551	3 ⁻			I γ : weighted average of 43 8 from ($\alpha,\text{n}\gamma$) and 36 4 from (n, γ) E=thermal.
		958.35 9 1068.87 3 3027.7 3	6.5 8 100 9 37 5	2069.802 1959.071 0	3 ⁻ 2 ⁺ 4 ⁻			I γ : from ($\alpha,\text{n}\gamma$). I γ : weighted average of 43 8 from ($\alpha,\text{n}\gamma$) and 35 5 from (n, γ) E=thermal.

Adopted Levels, Gammas (continued)

$\gamma(^{40}\text{K})$ (continued)								
$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\dagger$	E_f	J_f^π	Mult. [§]	$\delta^\S$	Comments
3100.1	(4,5) ⁺	2208.7 7	82 18	891.394	5 ⁻	[E1]		B(E1)(W.u.)=0.00035 +27-15 E _γ , I _γ : from (α,nγ). B(E1)(W.u.)=0.00015 +11-6 E _γ : from level-energy difference, reported in (α,nγ). I _γ : from (α,nγ).
		3100	100 18	0	4 ⁻	[E1]		
3109.56	1 ⁺ , 2 ⁺	534.3 & 3	<3.5 &	2575.93	2 ⁺			
		1062.20 8	20 2	2047.338	2 ⁻			
		1150.58 18	88 15	1959.071	2 ⁺			
		1466.11 ‡ 3	100 12	1643.638	0 ⁺			
3128.41	(2 ⁻ , 3 ⁺)	320.9 6	1.5 8	2807.88	(1,2) ⁻			
		371.792 10	28 3	2756.62	2 ⁺			
		838.8 5	11 3	2289.868	1 ⁺			
		3098.56 20	61 23	29.8299	3 ⁻			
		3128.06 13	100 7	0	4 ⁻			
3146.50	1 ⁽⁻⁾	727.1 & 3	<2.0 &	2419.160	2 ⁻			
		1187.45 8	9 1	1959.071	2 ⁺			
		1503.00 10	55 6	1643.638	0 ⁺	D		I _γ : weighted average of 49 8 from (α,nγ), 59 6 from (n,γ) E=thermal. Mult.: from γ(θ) in (p,nγ).
		2346.05 10	100 8	800.1431	2 ⁻	D(+Q)	+0.1 2	I _γ : from (α,nγ). Mult., δ: from γ(θ) in (p,nγ).
3153.82	(2 ⁻ , 3)	397.28 17	8 2	2756.62	2 ⁺			
		756.4 & 6	<21 &	2397.190	4 ⁻			
		1509.9 & 3	<5.8 &	1643.638	0 ⁺			Multipolarity=(M2,E3 or M3) if this transition is from this level to 0 ⁺ .
		3153.5 3	100 8	0	4 ⁻			
3228.62	2 ⁻	938.72 6	39 4	2289.868	1 ⁺	[E1]		B(E1)(W.u.)=0.004 +19-2
		2428.28 9	100 12	800.1431	2 ⁻			
		3198.6 3	58 9	29.8299	3 ⁻			
		3229.4 4	51 8	0	4 ⁻	[E2]		B(E2)(W.u.)=1.5 +70-9 E _γ , I _γ : from (³⁰ Si,npγ). E _γ , I _γ : from (³⁰ Si,npγ).
3353.46	(6 ⁺)	810.79 24	100 18	2542.79	7 ⁺			
		2461.3 11	53 10	891.394	5 ⁻			
3367.94	(2,3) ⁻	620.96 & 7	<23 &	2746.91	3 ⁻			
		1320.9 4	100 10	2047.338	2 ⁻			
		2568.8 & 4	<11 &	800.1431	2 ⁻			
		3338.2 3	80 20	29.8299	3 ⁻			
		3368.9 6	33 10	0	4 ⁻			
3393.65	2 ⁻	1434.50 6	28 3	1959.071	2 ⁺			
		2593.32 10	100 10	800.1431	2 ⁻			
3414.34	2 ⁺	627.66 3	8.2 9	2786.645	3 ⁺			
		1771.4 & 5	<2.7 &	1643.638	0 ⁺			
		2614.21 9	100 6	800.1431	2 ⁻			

Adopted Levels, Gammas (continued)

$\gamma(^{40}\text{K})$ (continued)							
$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\dagger$	E_f	J_f^π	Mult. [§]	$\delta^\S$
3414.34	2 ⁺	3384.66 24	34 4	29.8299	3 ⁻		
3439.18	(2 ⁺)	1335.48 18	2.1 4	2103.68	1 ⁻		
		1480.09 4	100 10	1959.071	2 ⁺	D(+Q)	+0.2 2
		1795.45 4	87 9	1643.638	0 ⁺		
		2638.93 11	68 5	800.1431	2 ⁻		
3486.09	2 ⁻	376.53 3	12.9 17	3109.56	1 ⁺ ,2 ⁺		
		678.13 & 20	<11.2 &	2807.88	(1,2) ⁻		
		756.4 & 6	<33 &	2730.357	1		
		1195.81 ‡ 7	23 3	2290.551	3 ⁻		
		1438.72 4	91 10	2047.338	2 ⁻		
		2685.6 3	100 21	800.1431	2 ⁻		
3557.41	(1 ⁻ ,2 ⁺ ,3 ⁻ ,4 ⁺)	528.76 & 14	<1.7 &	3027.976	(2 ⁻ ,3 ⁺)		
		981.03 ‡ 7	10.1 12	2575.93	2 ⁺		
		1267.5 & 3	<10.3 &	2289.868	1 ⁺		
		1487.42 & 9	<9.5 &	2069.802	3 ⁻		
		1509.9 & 3	<2.2 &	2047.338	2 ⁻		
		3526.99 ‡ 10	100 7	29.8299	3 ⁻		
3599.20	2 ⁻	613.384 24	21.4 24	2985.84	(2 ⁻ ,3 ⁺)		
		1023.21 4	27 3	2575.93	2 ⁺		
		1201.86 5	11.2 12	2397.190	4 ⁻		
		1308.9 4	4.5 18	2289.868	1 ⁺		
		1496.0 3	5.4 22	2103.68	1 ⁻		
		1551.77 9	10.7 13	2047.338	2 ⁻		
		2799.30 18	100 11	800.1431	2 ⁻		
		3569.30 8	47 3	29.8299	3 ⁻		
3629.97	2 ⁻ ,3 ⁻	602.26 17	10.3 18	3027.976	(2 ⁻ ,3 ⁺)		
		1232.74 3	41 4	2397.190	4 ⁻		
		1560.44 19	5.3 5	2069.802	3 ⁻		
		3599.62 20	56 6	29.8299	3 ⁻		
		3629.94 15	100 9	0	4 ⁻		
3663.88	(1 ⁻ ,2,3,4 ⁺)	249.54 16	0.93 23	3414.34	2 ⁺		
		534.3 & 3	<0.70 &	3128.41	(2 ⁻ ,3 ⁺)		
		554.741 ‡ 23	10.3 13	3109.56	1 ⁺ ,2 ⁺		
		678.13 & 20	<2.1 &	2985.84	(2 ⁻ ,3 ⁺)		
		1373.227 ‡ 21	100 10	2290.551	3 ⁻		
		1704.73 9	73 9	1959.071	2 ⁺		
		3633.88 9	49 3	29.8299	3 ⁻		
3712.98	(2) ⁻	926.24 15	19 4	2786.645	3 ⁺		
		1452.39 12	20 2	2260.48	3 ⁺		

Adopted Levels, Gammas (continued)

$\gamma(^{40}\text{K})$ (continued)						Comments
$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\dagger$	E_f	J_f^π	
3712.98	(2) ⁻	1754.72 [‡] 17	36 5	1959.071	2 ⁺	
		3683.3 5	100 30	29.8299	3 ⁻	
3738.49	1 ⁺	1478.01 6	48 8	2260.48	3 ⁺	
		1691.26 6	16.6 18	2047.338	2 ⁻	
		1779.14 8	49 3	1959.071	2 ⁺	
		2094.61 10	7.2 8	1643.638	0 ⁺	
		2938.32 9	100 6	800.1431	2 ⁻	
3768.4	(2) ⁻	620.96 ^{&} 7	<48 ^{&}	3146.50	1 ⁽⁻⁾	
		2967.8 3	100 12	800.1431	2 ⁻	
3797.48	1 ⁺	383.01 18	2.5 5	3414.34	2 ⁺	
		811.39 13	2.9 5	2985.84	(2 ⁻ ,3 ⁺)	
		1221.71 7	8.5 9	2575.93	2 ⁺	
		1536.84 5	33 4	2260.48	3 ⁺	
		1838.61 [‡] 8	56 5	1959.071	2 ⁺	
		2153.81 4	100 10	1643.638	0 ⁺	
3821.45	2 ⁻	335.44 ^{&} 14	<11.1 ^{&}	3486.09	2 ⁻	
		1034.28 ^{&} 20	<10.6 ^{&}	2787.32	3 ⁻ ,4 ⁻	
		1074.39 9	40 5	2746.91	3 ⁻	
		1090.9 3	10 3	2730.357	1	
		1424.229 23	100 11	2397.190	4 ⁻	
		1530.7 3	16 4	2290.551	3 ⁻	
		3791.9 3	50 8	29.8299	3 ⁻	
		3822.17 [‡] 13	73 5	0	4 ⁻	
3840.27	(1,2 ⁺)	730.48 15	3.9 7	3109.56	1 ⁺ ,2 ⁺	
		1771.4 ^{&} 5	<5.0 ^{&}	2069.802	3 ⁻	
		1881.20 5	81 8	1959.071	2 ⁺	
		2196.61 5	55 7	1643.638	0 ⁺	
		3040.24 13	100 7	800.1431	2 ⁻	
3868.65	2 ⁻	454.19 8	6.1 8	3414.34	2 ⁺	
		640.4 6	6.7 4	3228.62	2 ⁻	
		1121.77 7	18 2	2746.91	3 ⁻	
		1578.97 12	5.6 7	2289.868	1 ⁺	
		1765.24 15	36 4	2103.68	1 ⁻	
		3068.7 4	40 7	800.1431	2 ⁻	
		3838.50 7	100 7	29.8299	3 ⁻	
		3868.3 10	19 8	0	4 ⁻	
3872.33	(7 ⁺)	518.97 26	7.0 18	3353.46	(6 ⁺)	E_γ, I_γ : from (³⁰ Si,np γ).
		993.1 4	9.4 18	2878.99	6 ⁺	E_γ, I_γ : from (³⁰ Si,np γ).
		1329.00 26	100 18	2542.79	7 ⁺	E_γ, I_γ : from (³⁰ Si,np γ).
3887.81	(1 ⁻ ,2 ⁻)	1131.17 5	34 4	2756.62	2 ⁺	

Adopted Levels, Gammas (continued)

$\gamma(^{40}\text{K})$ (continued)

<u>E_i(level)</u>	<u>J_i^{π}</u>	<u>E_{γ}^{$\dagger$}</u>	<u>I_{γ}^{$\dagger$}</u>	<u>E_f</u>	<u>J_f^{π}</u>
3887.81	(1 ⁻ ,2 ⁻)	1262.1 3	22 4	2626.00	0 ⁻
		1597.88 4	95 10	2289.868	1 ⁺
		3088.3 5	62 13	800.1431	2 ⁻
		3857.97 11	100 7	29.8299	3 ⁻
3924.07	(2 ⁻ ,3 ⁺)	1348.06 14	12.6 15	2575.93	2 ⁺
		1634.26 8	100 8	2289.868	1 ⁺
		1964.27 23	13.4 22	1959.071	2 ⁺
		3895.7 11	76 40	29.8299	3 ⁻
4020.39	(2) ⁻	534.3 & 3	<2.8 &	3486.09	2 ⁻
		626.1 & 3	<3.1 &	3393.65	2 ⁻
		1034.28 & 20	<12 &	2985.84	(2 ⁻ ,3 ⁺)
		1213.53 ‡ 8	14.7 16	2807.88	(1,2) ⁻
		1916.51 ‡ 6	81 9	2103.68	1 ⁻
		1973.00 4	100 9	2047.338	2 ⁻
		3220.08 21	75 9	800.1431	2 ⁻
4104.49	(1 ⁻ ,2,3 ⁻)	440.77 ‡ 7	4.7 7	3663.88	(1 ⁻ ,2,3,4 ⁺)
		504.5 5	6.3 18	3599.20	2 ⁻
		1118.38 13	5.5 7	2985.84	(2 ⁻ ,3 ⁺)
		1813.94 14	7.3 9	2290.551	3 ⁻
		2001.24 20	13.8 20	2103.68	1 ⁻
		2057.07 5	14.2 16	2047.338	2 ⁻
		3304.24 11	100 7	800.1431	2 ⁻
4110.79	2	1001.05 ‡ 5	25 3	3109.56	1 ⁺ ,2 ⁺
		1082.92 7	62 7	3027.976	(2 ⁻ ,3 ⁺)
		1124.91 6	37 4	2985.84	(2 ⁻ ,3 ⁺)
		1354.12 3	50 2	2756.62	2 ⁺
		2467.31 10	21 2	1643.638	0 ⁺
		3310.9 5	37 9	800.1431	2 ⁻
		4080.69 12	100 7	29.8299	3 ⁻
		4110.39 20	98 9	0	4 ⁻
4149.04	(2 ⁻ ,3 ⁺)	756.4 & 6	<7 &	3393.65	2 ⁻
		920.12 & 18	<1.5 &	3228.62	2 ⁻
		1162.59 24	28 5	2985.84	(2 ⁻ ,3 ⁺)
		1751.76 5	20.1 21	2397.190	4 ⁻
		1858.51 5	48 5	2290.551	3 ⁻
		1888.43 8	8.8 10	2260.48	3 ⁺
		3348.91 10	100 6	800.1431	2 ⁻
		4148.4 3	12.0 16	0	4 ⁻
4180.15	(3 ⁻)	740.89 6	100 12	3439.18	(2 ⁺)
		951.16 ‡ 7	16.5 19	3228.62	2 ⁻

Adopted Levels, Gammas (continued)

$\gamma(^{40}\text{K})$ (continued)

<u>E_i(level)</u>	<u>J_i^π</u>	<u>E_γ[†]</u>	<u>I_γ[†]</u>	<u>E_f</u>	<u>J_f^π</u>	<u>Mult.[§]</u>	<u>Comments</u>
4180.15	(3 ⁻)	1761.10 & 17 1919.28 20 2109.9 3 2221.27 11 3286.4 8	<11.5 & 57 9 25 8 70 9 58 19	2419.160 2260.48 2069.802 1959.071 891.394	2 ⁻ 3 ⁺ 3 ⁻ 2 ⁺ 5 ⁻		
4213.08	(2 ⁻ ,3 ⁺)	727.1 & 3 798.8 & 3 2143.37 11 2568.8 & 4	<10.1 & <45 & 100 12 <24 &	3486.09 3414.34 2069.802 1643.638	2 ⁻ 2 ⁺ 3 ⁻ 0 ⁺		Multipolarity=(M2,E3 or M3) if this transition is from this level to 0 ⁺ .
4251.70	(1,2 ⁻)	1625.67 14	100	2626.00	0 ⁻		
4253.70	(1,2) ⁻	1100.13 18 1267.5 & 3 2149.93 5 2183.70 20 2206.35 10 3452.2 10 4223.66 7	2.5 4 <6.1 & 25.1 23 27 14 44 5 100 6 49 3	3153.82 2985.84 2103.68 2069.802 2047.338 800.1431 29.8299	(2 ⁻ ,3) (2 ⁻ ,3 ⁺) 1 ⁻ 3 ⁻ 2 ⁻ 2 ⁻ 3 ⁻		
4280.42	2 ⁻	1704.70 20 2233.0 4 3480.6 5 4249.5 4 4280.35 22	84 43 43 43 35 8 32 4 100 11	2575.93 2047.338 800.1431 29.8299 0	2 ⁺ 2 ⁻ 2 ⁻ 3 ⁻ 4 ⁻		
4313.94	2 ⁻	1204.36 10	100	3109.56	1 ⁺ ,2 ⁺		
4350.47	(2 ⁻)	1365.06 24 2246.3 3 4319.6 5	47 9 100 22 49 9	2985.84 2103.68 29.8299	(2 ⁻ ,3 ⁺) 1 ⁻ 3 ⁻		
4365.77	8 ⁺	1486.7 3	18 6	2878.99	6 ⁺	E2	B(E2)(W.u.)=4.1 +61-24 E _γ : weighted average of 1486.90 34 from (³⁰ Si,npγ) and 1486.3 5 from (¹⁶ O,npγ). I _γ : from (¹⁶ O,npγ). Mult.: from γ(θ) and RUL based on measured T _{1/2} in (¹⁶ O,npγ). E _γ : weighted average of 1822.83 21 from (³⁰ Si,npγ) and 1822.9 3 from ²⁶ Mg(¹⁶ O,npγ). I _γ : from (¹⁶ O,npγ). I _γ : from (p,nγ). I _γ : from (p,nγ).
		1822.9 2	100 21	2542.79	7 ⁺		
4383.7	0 ⁺	1653 2094	32 4 100 4	2730.357 2289.868	1 1 ⁺		
4395.88	(2) ⁻	657.39 3 1267.5 & 3 1665.43 4 1820.35 ‡ 5	29 3 <39 & 53 6 100 11	3738.49 3128.41 2730.357 2575.93	1 ⁺ (2 ⁻ ,3 ⁺) 1 2 ⁺		

Adopted Levels, Gammas (continued)

$\gamma(^{40}\text{K})$ (continued)

$E_i(\text{level})$	J_i^π	E_γ	I_γ	E_f	J_f^π
4395.88	(2) ⁻	2348.72 9	89 11	2047.338	2 ⁻
4419.37	(2 ⁻ ,3,4 ⁺)	756.4 & 6	<40 &	3663.88	(1 ⁻ ,2,3,4 ⁺)
		862.2 & 3	<6.0 &	3557.41	(1 ⁻ ,2 ⁺ ,3 ⁻ ,4 ⁺)
		1265.54 9	100 12	3153.82	(2 ⁻ ,3)
		1843.33 9	33 4	2575.93	2 ⁺
		2022.32 17	83 12	2397.190	4 ⁻
4463.61	(1 ⁻ ,2,3,4 ⁻)	2393.84 12	25 3	2069.802	3 ⁻
		2416.06 11	44 5	2047.338	2 ⁻
		3663.32 9	100 7	800.1431	2 ⁻
4473.08	(2 ⁻ ,3,4 ⁻)	1034.28 & 20	<9.5 &	3439.18	(2 ⁺)
		1079.44 13	25 3	3393.65	2 ⁻
		1487.42 & 9	<24 &	2985.84	(2 ⁻ ,3 ⁺)
		1725.68 & 17	<8.2 &	2746.91	3 ⁻
		4472.80 11	100 8	0	4 ⁻
4537.07	(1 ⁻ ,2,3)	798.8 & 3	<5.4 &	3738.49	1 ⁺
		1427.45 18	1.9 3	3109.56	1 ⁺ ,2 ⁺
		1961.11 6	13.5 14	2575.93	2 ⁺
		2577.63 10	28 3	1959.071	2 ⁺
		3737.01 10	100 6	800.1431	2 ⁻
		4506.96 7	68 4	29.8299	3 ⁻
4544.13	(0 ⁻ to 4 ⁻)	1058.03 4	53 6	3486.09	2 ⁻
		3743.2 3	100 14	800.1431	2 ⁻
4662.4	(2 ⁻ to 6 ⁻)	4662.1 3	100	0	4 ⁻
4666.49	(2 ⁻ to 5 ⁻)	1680.8 4	8.8 27	2985.84	(2 ⁻ ,3 ⁺)
		2375.85 5	100 11	2290.551	3 ⁻
		4667.0 4	97 19	0	4 ⁻
4744.14	(2 ⁺)	563.86 6	7.4 9	4180.15	(3 ⁻)
		903.878 23	15.3 15	3840.27	(1,2 ⁺)
		946.29 ‡ 8	3.8 4	3797.48	1 ⁺
		1144.7 5	8 3	3599.20	2 ⁻
		1935.7 3	12.8 23	2807.88	(1,2) ⁻
		2013.90 20	17 3	2730.357	1
		2168.16 4	18.3 19	2575.93	2 ⁺
		2454.7 3	2.6 4	2289.868	1 ⁺
		2483.8 3	3.0 8	2260.48	3 ⁺
		2784.4 4	21 5	1959.071	2 ⁺
		3100.42 20	38 14	1643.638	0 ⁺
		3943.81 6	100 5	800.1431	2 ⁻
4788.92	2 ⁻	534.3 & 3	<3.5 &	4253.70	(1,2) ⁻
		678.13 & 20	<10.4 &	4110.79	2

Adopted Levels, Gammas (continued)

$\gamma(^{40}\text{K})$ (continued)

<u>E_i(level)</u>	<u>J_i^{π}</u>	<u>E_{γ}[†]</u>	<u>I_{γ}[†]</u>	<u>E_f</u>	<u>J_f^{π}</u>	<u>Mult.[§]</u>	<u>Comments</u>
4788.92	2 ⁻	920.12 & 18	<6.5 &	3868.65	2 ⁻		
		1761.10 & 17	<11.5 &	3027.976	(2 ⁻ ,3 ⁺)		
		2031.6 3	100 15	2756.62	2 ⁺		
		2162.16 ‡ 17	15.8 19	2626.00	0 ⁻		
		2528.44 11	53 6	2260.48	3 ⁺		
		3989.07 ‡ 14	93 7	800.1431	2 ⁻		
4807.92	(0 to 3) ⁻	2077.41 13	100 9	2730.357	1		
		4008.1 3	42 5	800.1431	2 ⁻		
4812.01	(8 ⁺)	939.28 23	100 18	3872.33	(7 ⁺)		E _{γ} ,I _{γ} : from (³⁰ Si,np γ).
		2269.0 5	72 14	2542.79	7 ⁺		E _{γ} ,I _{γ} : from (³⁰ Si,np γ).
4851.40	(2 ⁻ ,3,4 ⁺)	2892.19 15	100 8	1959.071	2 ⁺		
		4851.16 25	33 4	0	4 ⁻		
4872.56	(2,3) ⁻	335.44 & 14	<16 &	4537.07	(1 ⁻ ,2,3)		
		1718.68 4	66 3	3153.82	(2 ⁻ ,3)		
		1725.68 & 17	<13 &	3146.50	1 ⁽⁻⁾		
		2115.77 14	12.3 16	2756.62	2 ⁺		
		4842.8 4	30 5	29.8299	3 ⁻		
		4872.47 14	100 8	0	4 ⁻		
4875.57	9 ⁺	509.88 20	40 7	4365.77	8 ⁺		E _{γ} : weighted average of 509.90 20 from (³⁰ Si,np γ) and 509.4 10 from (¹⁶ O,np γ).
		2332.87 22	100 11	2542.79	7 ⁺	E2	I _{γ} : weighted average of 37 7 from (³⁰ Si,np γ) and 56 17 from (¹⁶ O,np γ). B(E2)(W.u.)>1.0 I _{γ} : weighted average of 2332.89 22 from (³⁰ Si,np γ) and 2332.8 4 from (¹⁶ O,np γ). I _{γ} : from (¹⁶ O,np γ). Mult.: from $\gamma(\theta,\text{pol})$ in (¹⁶ O,np γ).
4960.36	(2,3 ⁻)	1402.73 9	37 4	3557.41	(1 ⁻ ,2 ⁺ ,3 ⁻ ,4 ⁺)		
		1566.21 ‡ 7	46 5	3393.65	2 ⁻		
		1832.01 5	34 4	3128.41	(2 ⁻ ,3 ⁺)		
		2173.67 8	28 3	2786.645	3 ⁺		
		2204.08 ‡ 10	100 12	2756.62	2 ⁺		
		2668.8 4	31 6	2290.551	3 ⁻		
		2857.15 ‡ 15	85 9	2103.68	1 ⁻		
		2912.6 3	43 6	2047.338	2 ⁻		
		4929.3 ‡ 3	54 6	29.8299	3 ⁻		
4993.26	(2 ⁻)	813.12 7	14 2	4180.15	(3 ⁻)		
		1846.72 6	32 3	3146.50	1 ⁽⁻⁾		
		2702.60 16	85 9	2290.551	3 ⁻		
		2922.91 20	100 9	2069.802	3 ⁻		

Adopted Levels, Gammas (continued)

$\gamma(^{40}\text{K})$ (continued)							
$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\dagger$	E_f	J_f^π	Mult. §	$\delta^\S$
4993.26	(2 ⁻)	3034.43 17	89 7	1959.071	2 ⁺		
		4962.2 4	32 6	29.8299	3 ⁻		
5023.7	(2 ⁻ ,3,4 ⁻)	1255.29 9	59 7	3768.4	(2) ⁻		
		2627.7 [‡] 3	100 17	2397.190	4 ⁻		
5063.37	(2 ⁻ ,3 ⁺)	1695.44 8	32 4	3367.94	(2,3) ⁻		
		1953.74 6	100 10	3109.56	1 ⁺ ,2 ⁺		
		2644.0 3	84 13	2419.160	2 ⁻		
		5062.9 4	23 3	0	4 ⁻		
5111.9	(2,3) ⁻	2688.1 [@] 4	100 26	2423.7?			
						E _γ : placed by 2013Fi01 in (n,γ) E=thermal to a level at 2324. But this level was neither observed in other work nor listed in Table 3 of populated levels in 2013Fi01. The evaluator has considered this placement as questionable.	
5189.89	(2 ⁻)	5111.5 7	43 11	0	4 ⁻		
		976.85 6	29 3	4213.08	(2 ⁻ ,3 ⁺)		
		1393.16 [‡] 8	34 4	3797.48	1 ⁺		
		2403.04 9	32 4	2786.645	3 ⁺		
		2459.48 5	52 6	2730.357	1		
		4389.32 18	100 8	800.1431	2 ⁻		
		5188.8 3	14.3 16	0	4 ⁻		
5214.23	2 ⁻	3144.30 19	100	2069.802	3 ⁻		
5247.1		5216.9 6	100	29.8299	3 ⁻		
5332.91	(9 ⁺)	2790.53 29	100	2542.79	7 ⁺		
5488.65	(2 ⁻ ,3,4 ⁻)	1931.23 20	100 9	3557.41	(1 ⁻ ,2 ⁺ ,3 ⁻ ,4 ⁺)		
		2359.8 8	11 7	3128.41	(2 ⁻ ,3 ⁺)		
		2680.4 5	23 6	2807.88	(1,2) ⁻		
		3418.5 6	25 9	2069.802	3 ⁻		
		5488.5 5	44 9	0	4 ⁻		
5891.90	(9 ⁻)	559.28 22	63 11	5332.91	(9 ⁺)		
		1016.6 4	48 9	4875.57	9 ⁺		
		1079.1 5	76 14	4812.01	(8 ⁺)		
		1525.85 27	100 20	4365.77	8 ⁺		
6098.22	(1 ⁻ ,2,3,4 ⁻)	1702.35 [‡] 3	100 9	4395.88	(2) ⁻		
		2539.87 [‡] 7	82 9	3557.41	(1 ⁻ ,2 ⁺ ,3 ⁻ ,4 ⁺)		
		6067.6 3	15.2 15	29.8299	3 ⁻		
6227.01	(8,10) ⁻	1351.51 18	100 8	4875.57	9 ⁺	E1(+M2)	-0.07 5
						B(E1)(W.u.)>0.00016; B(M2)(W.u.)>0.16	
						E _γ : weighted average of 1351.70 21 from (³⁰ Si,npγ) and 1351.37 18 from (¹⁶ O,npγ).	
						I _γ : from (¹⁶ O,npγ).	
						Mult.,δ: from γ(θ,pol) in (¹⁶ O,npγ).	
		1861.3 [@] 6	<5	4365.77	8 ⁺		
						E _γ ,I _γ : from (¹⁶ O,npγ).	

Adopted Levels, Gammas (continued)

$\gamma(^{40}\text{K})$ (continued)								
$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\dagger$	E_f	J_f^π	Mult. $\S$	$\delta^\S$	Comments
6227.01	$(8,10)^-$	3684 [@]	<2	2542.79	7^+			E_γ, I_γ : from $(^{16}\text{O}, \text{np}\gamma)$.
7033.0	(9^-)	1142.3 ⁵	59 ¹¹	5891.90	(9^-)			E_γ, I_γ : from $(^{30}\text{Si}, \text{np}\gamma)$.
		2219.7 ⁵	100 ¹⁸	4812.01	(8^+)			E_γ, I_γ : from $(^{30}\text{Si}, \text{np}\gamma)$.
7472.2	$(9^-, 11^-)$	1245.31 ²²	100 ¹⁹	6227.01	$(8,10)^-$	D+Q	+0.13 ⁷	E_γ : weighted average of 1245.10 ³¹ from $(^{30}\text{Si}, \text{np}\gamma)$ and 1245.42 ²² from $\text{Mg}(^{16}\text{O}, \text{np}\gamma)$.
								I_γ : from $(^{30}\text{Si}, \text{np}\gamma)$.
		1579.3 ⁵	37 ⁸	5891.90	(9^-)			Mult., δ : from $\gamma(\theta)$ in $(^{16}\text{O}, \text{np}\gamma)$.
7748.0	$(9^-, 10^-)$	1520.88 ³⁰	30 ⁶	6227.01	$(8,10)^-$			E_γ, I_γ : from $(^{30}\text{Si}, \text{np}\gamma)$.
		2872.9 ⁹	100 ¹⁸	4875.57	9^+			E_γ, I_γ : from $(^{30}\text{Si}, \text{np}\gamma)$.
7994.1	$(9^- \text{ to } 12^-)$	1767.1 ⁵	100	6227.01	$(8,10)^-$			E_γ : from $(^{30}\text{Si}, \text{np}\gamma)$.

- [†] From (n, γ) E=thermal, unless otherwise noted. Other values are either from individual reactions or weighted averages when quoted precision is comparable.
- ^{*} Uncertainties were increased by a factor of 2 in the least-squares fit, except for 554.741 γ , 1213.53 γ , 1393.16 γ , 1466.11 γ , 1820.35 γ , and 2539.87 γ , increased by a factor of 4. Poor fit for 554.741 γ with the fitted energy deviates by about 5 times the quoted energy uncertainty.
- [§] From $\gamma(\theta)$ data in (p,n γ), unless otherwise noted.
- [&] Multiply placed with undivided intensity.
- [@] Placement of transition in the level scheme is uncertain.

$^{12}\text{C}(^{30}\text{Si}, \text{np}\gamma)$ **2012So19**

2012So19: E=64 MeV ^{30}Si beam was provided by the tandem accelerator at Istituto Nazionale di Fisica Nucleare (INFN), Laboratori Nazionali di Legnaro (LNL) in Italy. Target was $200 \mu\text{g}/\text{cm}^2$ ^{12}C . γ rays were detected by one triple cluster detector of the AGATA array. Measured $E\gamma$, $I\gamma$, $\gamma\gamma$ -coin. Deduced levels, J^π , γ -ray branching ratios, configurations. Comparison with shell-model calculations.

All data are from **2012So19**.

 ^{40}K Levels

$E(\text{level})^\dagger$	$J^\pi^\ddagger$	$E(\text{level})^\dagger$	$J^\pi^\ddagger$	$E(\text{level})^\dagger$	$J^\pi^\ddagger$
0.0	4^-	4366.3 3	(8^+)	7033.5 5	(9^-)
891.76 20	5^-	4812.5 4	(8^+)	7472.5 4	$(9^-, 11^-)$
2543.26 24	7^+	4876.1 3	9^+	7748.6 5	$(9^-, 10^-)$
2879.6 3	6^+	5333.4 4	(9^+)	7994.8 6	$(9^- \text{ to } 12^-)$
3353.9 3	(6^+)	5892.4 3	(9^-)		
3872.8 3	(7^+)	6227.7 4	(10^-)		

† From least-squares fit to γ -ray energies.

‡ Values in parenthesis are tentative assignments in **2012So19** based on comparison of the measured branching ratios with Weisskopf estimates and others are from Adopted Levels.

 $\gamma(^{40}\text{K})$

E_γ	I_γ	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Comments
336.25 20	7.2 13	2879.6	6^+	2543.26	7^+	
509.90 20	3.8 7	4876.1	9^+	4366.3	(8^+)	
518.97 26	0.23 6	3872.8	(7^+)	3353.9	(6^+)	
559.28 22	0.57 10	5892.4	(9^-)	5333.4	(9^+)	
810.79 † 24	1.75 32	3353.9	(6^+)	2543.26	7^+	
891.74 22	100 18	891.76	5^-	0.0	4^-	
939.28 † 23	5.7 10	4812.5	(8^+)	3872.8	(7^+)	
993.1 4	0.31 6	3872.8	(7^+)	2879.6	6^+	
1016.6 4	0.44 8	5892.4	(9^-)	4876.1	9^+	
1079.1 5	0.69 13	5892.4	(9^-)	4812.5	(8^+)	
1142.3 5	0.59 11	7033.5	(9^-)	5892.4	(9^-)	
1245.10 31	1.12 21	7472.5	$(9^-, 11^-)$	6227.7	(10^-)	
1329.00 26	3.3 6	3872.8	(7^+)	2543.26	7^+	
1351.70 21	7.3 13	6227.7	(10^-)	4876.1	9^+	
1486.90 34	0.91 ‡ 17	4366.3	(8^+)	2879.6	6^+	I_γ : using $I_\gamma(1487)/I_\gamma(1823)=19 \text{ 6}/100 \text{ 6}$ from Adopted Gammas.
1520.88 30	0.42 9	7748.6	$(9^-, 10^-)$	6227.7	(10^-)	
1525.85 † 27	0.91 18	5892.4	(9^-)	4366.3	(8^+)	
1579.3 5	0.41 9	7472.5	$(9^-, 11^-)$	5892.4	(9^-)	according to e-mail reply of Jan 5, 2013 from P.A. Soderstrom, $I_\gamma(1245)/I_\gamma(1579)=21 \text{ 5}/100 \text{ 26}$ in column 4 of 2012So19 should instead be $100 \text{ 28}/36 \text{ 11}$.
1651.34 24	61 ‡ 11	2543.26	7^+	891.76	5^-	
1767.1 5	0.60 11	7994.8	$(9^- \text{ to } 12^-)$	6227.7	(10^-)	
1822.83 21	13.3 ‡ 24	4366.3	(8^+)	2543.26	7^+	
1988.07 35	3.3 6	2879.6	6^+	891.76	5^-	
2219.7 5	1.00 18	7033.5	(9^-)	4812.5	(8^+)	
2269.0 † 5	4.1 8	4812.5	(8^+)	2543.26	7^+	
2332.89 22	10.2 19	4876.1	9^+	2543.26	7^+	
2461.3 11	0.93 17	3353.9	(6^+)	891.76	5^-	I_γ : from e-mail reply of Jan 5, 2013 from P.A.

Continued on next page (footnotes at end of table)

$^{12}\text{C}(^{30}\text{Si},\text{np}\gamma)$ 2012So19 (continued)							
$\gamma(^{40}\text{K})$ (continued)							
E_γ	I_γ	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult.	Comments
2543.2 4	4.5 [†] 5	2543.26	7 ⁺	0.0	4 ⁻	[E3]	Soderstrom; 0.53 17 quoted in Table I of 2012So19 is a misprint. $I\gamma(2543)/I\gamma(1651)=12.6\ 5/100.0\ 23$ (value of 100 23 quoted in 2012So19 is a misprint, it should be 100.0 23, as in Adopted Gammas.
2790.53 29	5.4 10	5333.4	(9 ⁺)	2543.26	7 ⁺		
2872.9 9	1.42 26	7748.6	(9 ⁻ ,10 ⁻)	4876.1	9 ⁺		

[†] This γ was reported in [1977Eg01](#) in $^{26}\text{Mg}(^{16}\text{O},\text{pn}\gamma)$ but not placed.

[‡] Relative γ -ray branching ratios adopted by [2012So19](#) from Adopted Gammas. Due to strong coincidences with ^{38}Ar transitions, intensity of this γ could not be measured accurately in [2012So19](#).

$^{26}\text{Mg}(^{16}\text{O},\text{np}\gamma), ^{27}\text{Al}(^{19}\text{F},\alpha\text{pn}\gamma)$ 1977Eg01,1981He20,1991Ja11

Also include $^{27}\text{Al}(^{16}\text{O},\text{n}2\text{p}\gamma)$, $^{27}\text{Al}(^{13}\text{C},\gamma)$, $^{27}\text{Al}(^{13}\text{C},\gamma)$, $^{24}\text{Mg}(^{18}\text{O},\text{np}\gamma)$, $^{24}\text{Mg}(^{19}\text{F},\text{n}2\text{p}\gamma)$, $^{28}\text{Si}(^{14}\text{N},2\text{p}\gamma)$.

1977Eg01: $^{26}\text{Mg}(^{16}\text{O},\text{np}\gamma)$ E=34 MeV ^{16}O beam was produced from the Utrecht EN tandem accelerator. Targets were about 400 $\mu\text{g}/\text{cm}^2$ 99.42% enriched ^{26}Mg on 30 μm Au backings. γ rays were detected with a large-volume Ge(Li)-NaI(Tl) Compton-suppression spectrometer and a Ge(Li) detector. Measured $E\gamma$, $I\gamma$, $\gamma\gamma$ -coin, $\gamma(\theta)$, $\gamma(\text{lin pol})$, Doppler-shift attenuation. Deduced levels, J, π , γ -ray branching ratios, multipolarities, mixing ratios, transition strengths. Comparisons with shell-model calculations.

1981He20: $^{27}\text{Al}(^{19}\text{F},\alpha\text{pn}\gamma)$ E=47-108 MeV ^{19}F beams were produced from the MP-Tandem at the MPI in Heidelberg. Targets were 1 mg/cm^2 Al on thick Au backings. γ rays were detected with two Ge(Li) detectors (FWHM=1.9 keV and 2.1 keV) and a NaI(Tl) detector. Measured $E\gamma$, $I\gamma$, $\gamma\gamma$ -coin, $\gamma(\theta)$. Deduced levels, J, π , mixing ratios. Comparisons with shell-model calculations.

1991Ja11: $^{27}\text{Al}(^{16}\text{O},\text{n}2\text{p}\gamma)$ E=60 MeV. Measured lifetime of 892, 2543 and 4366 levels by Recoil-Distance Method (RDM).

Others:.

1990Ki04: $^{27}\text{Al}(^{13}\text{C},\gamma)$ E=39.7 MeV. Measured continuum γ , $\gamma(\theta)$; Deduced GDR parameters and strength function.

1981Le19: $^{24}\text{Mg}(^{18}\text{O},\text{np}\gamma)$ E=36 MeV. Measured $\gamma(\theta, \text{h})$ by recoil into gas. Deduced g-factor of 2543 level.

1976Bo21, 1975Bo44: $^{27}\text{Al}(^{16}\text{O},\text{n}2\text{p}\gamma)$ E=30-35 MeV; $^{28}\text{Si}(^{14}\text{N},2\text{p}\gamma)$ E=38 MeV; $^{24}\text{Mg}(^{19}\text{F},\text{n}2\text{p}\gamma)$ E=42 MeV. Measured $\gamma(\theta, \text{H})$. Deduced g-factor of 2543 level and hyperfine perturbations.

1976Ra05: $^{27}\text{Al}(^{16}\text{O},\text{n}2\text{p}\gamma)$ E=32.5 MeV. Measured $\gamma(\theta)$, recoil distance in vacuum. Deduced lifetime of 2543 level and hyperfine deorientation.

1976Ke02: $^{27}\text{Al}(^{16}\text{O},\text{n}2\text{p}\gamma)$ E=32.5-44 MeV. Measured $E\gamma$, lifetimes by Recoil-Distance Method.

1976Po03: $^{27}\text{Al}(^{19}\text{F},\alpha\text{pn}\gamma)$ E=40 MeV. This study is mainly for ^{43}Ca and ^{43}Sc .

 ^{40}K Levels

E(level) [†]	J π [‡]	T _{1/2} [#]	Comments
0.0	4 ⁻ &		
30	3 ⁻ &		
891.45 15	5 ⁻	2.3 ps 10	
2542.77 17	7 ⁺	1.10 ns 7	T _{1/2} : others: 1.10 ns 8 (1976Ke02, RDM); 1.10 ns 8, 1.06 ns 7 (apparent half-lives at 55° and 0°, respectively, 1976Ra05 using RDM). g-factor=0.63 15 (1981Le19), +0.59 10 (1976Bo21), +0.49 10 (1975Bo44).
2879.01 22	6 ⁺		
4365.6 4	8 ⁺	0.36 ps 14	T _{1/2} : the uncertainty may be larger since lifetime of the 4366 level is comparable to the stopping time in the tantalum stopper (1991Ja11). Other: <0.7 ps (1977Eg01).
4875.6 4	9 ⁺	<0.7 [@] ps	
6227.0 5	(8,10) ⁻	<1.4 [@] ps	
7472.4 5	(9 ⁻ , 11 ⁻)		E(level): from 1981He20 only.

[†] From a least-squares fit to γ -ray energies.

[‡] Based on measured $\gamma(\theta)$ and $\gamma(\text{lin pol})$ in 1977Eg01, $\gamma(\theta)$ in 1981He20, and measured half-lives combined with RUL, unless otherwise noted..

[#] From 1991Ja11 using RDM, unless otherwise noted.

[@] From 1977Eg01 using DSAM.

& From Adopted Levels.

$^{26}\text{Mg}(^{16}\text{O},\text{np}\gamma), ^{27}\text{Al}(^{19}\text{F},\alpha\text{pn}\gamma)$ **1977Eg01,1981He20,1991Ja11 (continued)**

$\gamma(^{40}\text{K})$								
$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\dagger$	E_f	J_f^π	Mult. [‡]	$\delta^\ddagger$	Comments
2879.01	6^+	336.18 16	10.5 3	2542.77	7^+	M1(+E2)	+0.01 2	δ : from 1977Eg01. Other: -0.015 20 (1981He20). $A_2=-0.19$ 3, $A_4=0$, POL= -0.22 3 (1977Eg01); $A_2=-0.21$ 3, $A_4=0$ (1981He20).
4875.6	9^+	509.4 10 ^x 810.3 3	10 3	4365.6	8^+			
891.45	5^-	861	<1	30	3^-			E_γ : Not seen. Value is from the level-energy difference.
891.45	5^-	891.46 16	100 3	0.0	4^-	M1+E2	+0.085 15	δ : unweighted average of +0.099 8 (1977Eg01) and +0.070 10 (1981He20). $A_2=-0.091$ 9, $A_4=0$, POL= -0.43 3 (1977Eg01); $A_2=-0.096$ 10, $A_4=0$ (1981He20); $A_2=-0.12$ 5 (1976Ra05).
7472.4	$(9^-, 11^-)$	^x 916.5 6 ^x 939.9 5 1245.42 22		6227.0	$(8, 10)^-$	D+Q	+0.13 7	E_γ : from 1981He20 only. δ : from 1981He20 for J=9. $A_2=-0.08$ 5, $A_4=0$ (1981He20).
6227.0	$(8, 10)^-$	^x 1329.1 14 1351.37 18	12.0 10	4875.6	9^+	E1(+M2)	-0.07 5	δ : from 1981He20 for J=10. Other: -0.01 3 for J=8 (1977Eg01). $A_2=-0.19$ 3, $A_4=0$, POL= $+0.29$ 5 (1977Eg01); $A_2=-0.20$ 3, $A_4=0$ (1981He20). $A_2=+0.9$ 5, $A_4=-0.5$ 4 (1977Eg01).
4365.6	8^+	1486.3 5 ^x 1526.9 4	3.5 11	2879.01	6^+	E2		
2542.77	7^+	1651.29 12	78.0 18	891.45	5^-	M2(+E3)	-0.02 3	δ : weighted average of -0.01 3 (1977Eg01) and -0.3 2 (1981He20). $A_2=+0.301$ 13, $A_4=-0.105$ 15, POL= -0.52 5 (1977Eg01); $A_2=+0.26$ 3, $A_4=-0.045$ 30 (1981He20).
4365.6	8^+	1822.9 3	19 4	2542.77	7^+			
6227.0	$(8, 10)^-$	1861.3 [§] 6	<0.7	4365.6	8^+			I_γ : from $I_\gamma(1861.3\gamma)/I_\gamma(1351.4\gamma)<5/100$ (1977Eg01).
2879.01	6^+	1987.8 6	5.4 7	891.45	5^-	E1(+M2)	-0.05 4	δ : from 1977Eg01. $A_2=-0.34$ 5, $A_4=0$, POL= $+0.4$ 3 (1977Eg01).
4875.6	9^+	^x 2267.9 8 2332.8 4	18.0 20	2542.77	7^+	E2		$A_2=+0.35$ 5, $A_4=-0.19$ 5, POL= $+0.51$ 7 (1977Eg01); $A_2=+0.28$ 4, $A_4=-0.05$ 4 (1981He20).
2542.77	7^+	2542.6 3	9.8 3	0.0	4^-	E3(+M4)	+0.10 7	δ : from 1981He20. Data of 1977Eg01 is consistent with pure E3. $A_2=+0.46$ 3, $A_4=0$, POL= $+0.83$ 19 (1977Eg01); $A_2=+0.50$ 4, $A_4=+0.06$ 4 (1981He20).
6227.0	$(8, 10)^-$	^x 2790.4 9 3684 [§]	<0.26	2542.77	7^+			E_γ : reported in 1977Eg01, energy value is from level-energy difference.

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$^{26}\text{Mg}(^{16}\text{O},\text{np}\gamma), ^{27}\text{Al}(^{19}\text{F},\alpha\text{pn}\gamma)$ [1977Eg01](#), [1981He20](#), [1991Ja11](#) (continued)

$\gamma(^{40}\text{K})$ (continued)

$E_i(\text{level})$

Comments

I_γ : from $I_\gamma(3684\gamma)/I_\gamma(1351.4\gamma) < 2/100$ ([1977Eg01](#)).

[†] From [1977Eg01](#), unless otherwise noted.

[‡] Based on measured $\gamma(\theta)$ and $\gamma(\text{lin pol})$ in [1977Eg01](#), $\gamma(\theta)$ in [1981He20](#), and measured half-lives combined with RUL, unless otherwise noted.

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

^x γ ray not placed in level scheme.

$^{37}\text{Cl}(\alpha, n\gamma)$ 1973Da18, 1971Ja15, 1971We09

1973Da18(also 1974Th07): E=6.90-8.00 MeV alpha beams were produced from the Liverpool University tandem accelerator.

Targets are BaCl_2 (96.5% in ^{37}Cl) on gold backings with thickness of 1-5 mg/cm^2 . γ rays were detected with a Ge(Li) detector, a NaI(Tl) detector and a Si(Li) detector. Measured $E\gamma$, $I\gamma$, $\gamma\gamma$ -coin, $\gamma\gamma(\theta)$. Deduced levels, J, π , γ -ray branching ratios.

Comparisons with shell-model calculations. $\gamma(\theta)$ and $\gamma(\text{lin pol})$ for γ rays from 2291, 2543, 2787 and 2879 levels were measured by 1974Th07.

1971Ja15: E=6.25, 7.00, 8.00 MeV alpha beams were produced at the Oliver Lodge Laboratory at the University of Liverpool.

Targets 1 mg/cm^2 PbCl_2 (66% enriched in ^{37}Cl) or BaCl_2 (95% enriched) on a gold backing. γ rays were detected by a Ge(Li) and a NaI(Tl) detector. Measured $E\gamma$, $I\gamma$, $\gamma\gamma$ -coin, Doppler-shift attenuation. Deduced levels, J, π , lifetimes, transition strengths.

Comparisons with available data and shell-model calculations.

1971We09 (also 1970Ba34): E=6.0-7.4 MeV alpha beams were produced from the Frankfurt 7 MV Van de Graaff accelerator.

Target was 400 $\mu\text{g}/\text{cm}^2$ AgCl (99% enriched in ^{37}Cl) evaporated on a tantalum backing. γ rays were detected with a Ge(Li) detector (FWHM=2.8 keV at 1.33 MeV). Measured $E\gamma$, $I\gamma$, Doppler-shift attenuation. Deduced levels, lifetimes. 1971We09 and 1970Ba34 also study ^{40}K in (p,n γ).

Others:.

1974Br12: E=5.0 MeV. Measured $\gamma(\theta, \text{H}, \text{t})$, lifetime by pulsed beam for 30-keV level.

1973Gr19: E=8.5, 9.5 MeV. Measured lifetime for 2542 level by Recoil-Distance Doppler Shift Method.

1970SkZZ: E=14 MeV. Measured $E\gamma$, $I\gamma$.

1969Ka18: E $\approx$ threshold. Measured lifetimes using DSAM. No data reported.

Level scheme is taken from 1973Da18.

 ^{40}K Levels

E(level) [†]	J π [#]	T _{1/2} ^{&}	Comments
0	4 ⁻		
29.94 23	3 ⁻	4.30 ns 6	g=-0.43 3 (1974Br12) T _{1/2} : from $\gamma(\text{t})$ in 1974Br12.
800.6 3	2 ⁻	0.28 ^a ps 7	
891.0 3	5 ⁻	0.78 ^a ps 18	
1644.5 5	0 ⁺		
1959.60 25	2 ⁺	0.69 ^a ps 18	
2047.0 [‡] 10	2 ⁻	0.37 ^a ps 11	
2069.7 5	3 ⁻	0.43 ^a ps 12	
2103.6 4	1 ⁻	0.53 ^a ps 14	
2260.6 [‡] 10	3 ⁺	59 ^a fs 17	
2290.8 5	1 ⁺	76 ^a fs 21	
2290.83 18	3 ⁻	0.15 ^a ps 3	J π : 3 ⁻ is preferred by $\gamma(\theta)$ and $\gamma(\text{lin pol})$ in 1974Th07, but 4 ⁺ is possible.
2398.04 24	4 ⁻	35 fs 14	T _{1/2} : from 1971We09. Other: <50 fs (1971Ja15).
2420.0 3	2 ⁻	0.46 ps +30-18	T _{1/2} : other: >0.7 ps (1971We09).
2542.5 5	7 ⁺ @	1.05 ns 17	T _{1/2} : from mean lifetime of 1.51 ns 25, weighted average of 1.52 ns 25 and 1.48 ns 35 measured by 1973Gr19 using Recoil-Distance method (RDM). Other: 2.1 ps to 35 ns (1971Ja15).
2576.1 3	2 ⁺	78 ^a fs 25	
2627.0 4	0 ⁻	0.21 ^a ps 7	
2731.4 8	1	<50 fs	
2747.76 23	3 ⁻	0.19 ps 11	
2756.9 3	2 ⁺	<21 fs	
2787.2 3	3 ⁺ @		
2787.29 22	3 ⁻ , 4 ⁻	55 fs 21	
2809.2 4	(1,2) ⁻	0.10 ps 7	
2878.9 6	6 ⁽⁺⁾ @	0.27 ps 10	J π : 6 ⁺ is favored by $\gamma(\text{lin pol})$ (1974Th07).
2950.9 6		35 fs 21	
2987.8 6	(2 ⁻ , 3 ⁺)	69 fs 28	

Continued on next page (footnotes at end of table)

$^{37}\text{Cl}(\alpha, n\gamma)$ **1973Da18, 1971Ja15, 1971We09** (continued) ^{40}K Levels (continued)

$E(\text{level})^\dagger$	$J^\pi^\#$	$T_{1/2}^\&$
3028.2 4	$(2^-, 3^+)$	<50 fs
3099.7 8	$(4, 5)^+$	69 fs 2I
3128.5 8	$(2^-, 3^+)$	<21 fs
3147.5 4	$1^{(-)}$	
3155.2 8	$(2^-, 3, 4^+)$	<21 fs
3229.9 6	2^-	

[†] From a least-squares fit to γ -ray energies, unless otherwise noted.[‡] From **1971Ja15**.[#] From Adopted Levels, unless otherwise noted.[@] From **1974Th07** based on $\gamma(\theta)$ and/or $\gamma(\text{lin pol})$.[&] From **1971Ja15** using DSAM, unless otherwise noted. An estimated uncertainty of about 25% due to slowing down is included.^a Weighted average of values from **1971Ja15** and **1971We09** using DSAM. An estimated uncertainty of about 30% due to slowing down is included in data from **1971We09**.

$\gamma(^{40}\text{K})$								Comments
$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\dagger$	E_f	J_f^π	Mult. [§]	$\delta^\S$	
29.94	3^-	29.9	100	0	4^-			E_γ : This transition was detected in 1973Da18 with a Si(Li) detector.
800.6	2^-	770.7	100	29.94	3^-			
891.0	5^-	891.0	100	0	4^-			
1644.5	0^+	843.9	20 [‡] 5	800.6	2^-			
		1614.5	80 [‡] 5	29.94	3^-			
1959.60	2^+	1158.9 2	82 2	800.6	2^-			
		1929.6 2	18 2	29.94	3^-			$I_\gamma(1930)/I_\gamma(1159)=22\ 5/78\ 5$ (1971Ja15).
2047.0	2^-	1246.4	40 [‡] 5	800.6	2^-			
		2017.0	35 [‡] 5	29.94	3^-			
		2046.9	25 [‡] 5	0	4^-			
2069.7	3^-	1178.4 6	3 I	891.0	5^-			$I_\gamma(1178)/I_\gamma(1269)/I_\gamma(2041)/I_\gamma(2070)=2\ 1/8\ 2/56\ 5/34\ 5$ (1971Ja15).
		1268.9 6	5 I	800.6	2^-			
		2041.0 9	47 3	29.94	3^-			
		2069.6	45 3	0	4^-			
2103.6	1^-	1303.6 5	22 4	800.6	2^-			$I_\gamma(1304)/I_\gamma(2073)=32\ 5/68\ 5$ (1971Ja15).
		2073.1 4	78 4	29.94	3^-			
2260.6	3^+	2230.6	85 [‡] 3	29.94	3^-			
		2260.5	15 [‡] 3	0	4^-			
2290.8	1^+	221.1 ^{&}	<2	2069.7	3^-			
		331.2	8 2	1959.60	2^+			
		646.2 4	59 4	1644.5	0^+			
		1490.3 5	33 3	800.6	2^-			$I_\gamma(1490)/I_\gamma(646)=38\ 5/62\ 5$ (1971Ja15).
2290.83	3^-	1400.0 4	19 3	891.0	5^-			$I_\gamma(1400)/I_\gamma(2291)=15\ 2/85\ 2$ (1971Ja15).
		2290.8 2	81 3	0	4^-	(M1+E2)	-0.9 4	δ : for $J=3^-$. $A_2=+0.40\ 1$, $A_4=-0.09\ 2$, $\text{POL}=-0.67\ 8$ (1974Th07).
2398.04	4^-	2367.9 3	70 4	29.94	3^-			
		2398.1 3	30 4	0	4^-			$I_\gamma(2398)/I_\gamma(2368)=35\ 10/65\ 10$ (1971Ja15).
2420.0	2^-	460.4 ^{&}	<2	1959.60	2^+			
		1619.6 2	79 3	800.6	2^-			

Continued on next page (footnotes at end of table)

$^{37}\text{Cl}(\alpha, n\gamma)$ **1973Da18, 1971Ja15, 1971We09** (continued) $\gamma(^{40}\text{K})$ (continued)

$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\dagger$	E_f	J_f^π	Mult. §	$\delta^{\S}$	Comments
2420.0	2^-	2389.7 3 2419.4 5	15 2 6 1	29.94 0	3^- 4^-			$I_\gamma(2390)/I_\gamma(1620)=10\ 5/90\ 5$ (1971Ja15).
2542.5	7^+	1651.5 5	88 2	891.0	5^-	M2(+E3)	0.00 3	I_γ : 100 (1971Ja15). $A_2=+0.56\ 4$, $A_4=-0.27\ 4$, POL=-0.68 8 (1974Th07).
		2542.4 10	12 2	0	4^-			
2576.1	2^+	2546.1 2	100	29.94	3^-			
2627.0	0^-	523.3 5	70 3	2103.6	1^-			
		667.4 &	<5	1959.60	2^+			
		1826.4 2	30 3	800.6	2^-			$I_\gamma(1826)/I_\gamma(523)<20/100$ (1971Ja15).
2731.4	1	440.6 &	<12	2290.8	1^+			
		1086.9 6	94 4	1644.5	0^+			I_γ : 100 (1971Ja15).
		1930.7	6 4	800.6	2^-			
2747.76	3^-	678.1 & 789 1	<3 4 1	2069.7 1959.60	3^- 2^+			$I_\gamma(789)/I_\gamma(2718)/I_\gamma(2748)=10\ 3/60\ 10/30\ 10$ (1971Ja15).
		2717.7 2	64 5	29.94	3^-			
		2747.7 3	32 3	0	4^-			
2756.9	2^+	1956.0 2	66 3	800.6	2^-			
		2727.3 3	34 3	29.94	3^-			$I_\gamma(2727)/I_\gamma(1956)=38\ 12/62\ 12$ (1971Ja15).
2787.2	3^+	827.60 25 2757.2 3	22 3 78 3	1959.60 29.94	2^+ 3^-	E1(+M2)	-0.09 +22-5	$I_\gamma(828)/I_\gamma(2757)=19\ 5/27\ 8$ (1971Ja15). $A_2=+0.35\ 2$, $A_4=-0.01\ 2$, POL=-1.02 20 (1974Th07).
2787.29	$3^-, 4^-$	496.8 5 1896.3 5	40 8 19 8	2290.83 891.0	3^- 5^-			$I_\gamma(1896)/I_\gamma(496)/I_\gamma(2787)=12\ 1/19\ 2/23\ 2$ (1971Ja15).
		2787.10 25	41 8	0	4^-			
2809.2	$(1,2)^-$	2008.5 2	100	800.6	2^-			
2878.9	$6^{(+)}$	336.4 4 1987.8 7	62 4 38 4	2542.5 891.0	7^+ 5^-	D(+Q)	-0.06 +4-5	$A_2=-0.33\ 5$, $A_4=-0.10\ 6$, POL=+0.32 26 (1974Th07). $I_\gamma(1988)/I_\gamma(336)=40\ 5/60\ 5$ (1971Ja15).
2950.9		2950.8 6	100	0	4^-			
2987.8	$(2^-, 3^+)$	2186.2 10	15 10	800.6	2^-			$I_\gamma(2186)/I_\gamma(2958)=65\ 35/35\ 35$ (1971Ja15).
		2958.1 6	85 10	29.94	3^-			
3028.2	$(2^-, 3^+)$	737.5 5	23 4	2290.83	3^-			
		1068.2 5	54 5	1959.60	2^+			
		3028.8 8	23 4	0	4^-			I_γ : 100 (1971Ja15).
3099.7	$(4,5)^+$	2208.7 7	45 10	891.0	5^-			$I_\gamma(2209)/I_\gamma(3100)=35\ 7/65\ 7$ (1971Ja15).
		3099.6	55 10	0	4^-			
3128.5	$(2^-, 3^+)$	1081.5 &	<10	2047.0	2^-			
		3098.4	53 10	29.94	3^-			
		3128.4 8	47 10	0	4^-			I_γ : 100 (1971Ja15).
3147.5	$1^{(-)}$	1503.1 4	33 5	1644.5	0^+			
		2346.8 2	67 5	800.6	2^-			
3155.2	$(2^-, 3, 4^+)$	3155.1 8	100	0	4^-			
3229.9	2^-	2428.4 10	<16	800.6	2^-			
		3201.1 10	75 6	29.94	3^-			
		3229.4 10	25 6	0	4^-			

† From 1973Da18, unless otherwise noted. Values of E_γ without uncertainties are from level-energy differences. Quoted values of I_γ are % branching from each level.

Continued on next page (footnotes at end of table)

${}^{37}\text{Cl}(\alpha, n\gamma)$ [1973Da18](#), [1971Ja15](#), [1971We09](#) (continued)

$\gamma({}^{40}\text{K})$ (continued)

[†] From [1971Ja15](#).

[§] Based on measured $\gamma(\theta)$ and $\gamma(\text{lin pol})$ in [1974Th07](#).

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

³⁸Ar(α ,d) **1976De24**

$J\pi(^{38}\text{Ar g.s.})=0^+$.
1976De24: E=34 MeV alpha beam was produced from the Princeton cyclotron. Target was 94% enriched ³⁸Ar gas. Reaction products were detected in a freon cooled ΔE -E silicon detector telescope (FWHM $\approx$ 100 keV) followed by a third detector in anticoincidence. Measured $\sigma(\theta)$. Deduced levels, J, π , L-transfer from DWBA analysis.
All data are from **1976De24**, unless otherwise noted.

⁴⁰K Levels

<u>E(level)[†]</u>	<u>L[#]</u>	<u>dσ/dΩ (vb/sr)[‡]</u>	<u>E(level)[†]</u>	<u>L[#]</u>	<u>dσ/dΩ (vb/sr)[‡]</u>	<u>E(level)[†]</u>	<u>L[#]</u>	<u>dσ/dΩ (vb/sr)[‡]</u>
0	(3)	60	2290	3	65	3445 50	4	120
800	(1)	70	2543	6	1000	3753 50	4	330
891	5	200	2787	4	700	3908 50		300
2070	3	45	3094 50	4	150			

[†] Rounded values from Adopted Levels for levels below 3000 and the rest are from **1976De24**.
[‡] At 20° (C.M. system). Absolute cross sections are accurate to 20%.
[#] Extracted from DWBA fits to measured differential cross sections.

$^{39}\text{K}(\text{n},\gamma),(\text{pol n},\gamma)$ E=thermal 1984Vo01,2013Fi01,1972Op01

1984Vo01: (n, γ) Thermal neutrons were produced from the high-flux reactor of the Institut Laue-Langevin at Grenoble. Targets were 36 mg $^{\text{nat}}\text{KCl}$ in wrapped in Al or 190 mg and 62 mg $^{\text{nat}}\text{KF}$ in a graphite container. γ rays were detected with the ILL curved-crystal spectrometers GAMS, a large-volume Ge(Li) detector and a pair spectrometer. Measured $E\gamma$, $I\gamma$. Deduced levels. A total of 427 γ rays were reported out of which 302 were placed amongst 63 levels, with 38 γ rays doubly or multiply assigned.

2013Fi01: (n, γ) Thermal neutrons were provided by the 10-MW Budapest Reactor. Target was a 0.02 g stoichiometric, high purity KCl. γ rays were detected with a Compton-suppressed HPGe detector. Measured $E\gamma$, total radiative neutron σ . Deduced levels, J, π , feedings. Monte Carlo simulations using computer code DICEBOX. Comparison with statistical model calculations, previous studies, and ENSDF evaluations. A total of 320 γ rays were reported out of which 291 γ rays were associated with 83 levels.

1972Op01: (n, γ) thermal neutrons were produced from the high-flux reactor at Petten, Netherlands. Targets were 400 mg natural K_2CO_3 or 400 mg 98.3% enriched K_2CO_3 . γ rays were detected with two Ge(Li) detectors (FWHM=3.0 and 2.6 keV at 1.33 MeV). Measured $E\gamma$, $I\gamma$, $\gamma\gamma$ -coin. Deduced levels. A total of 222 γ rays were reported out of which 187 γ rays were associated with 56 levels. $\gamma\gamma$ -coin data involved about 25 transitions.

1970Jo04: (n, γ) thermal neutrons were produced from the McMaster reactor. Target was a 35 g sample of natural potassium metal sealed in a quartz tube. γ rays were detected with Ge(Li) detectors. Measured $E\gamma$, $I\gamma$, $\gamma\gamma$ -coin. Deduced levels. A total of 252 γ rays were reported out of which 202 γ rays were associated with 56 levels. $\gamma\gamma$ -coin data involved 62 transitions.

2002Va28: (n, γ). Measured $\gamma\gamma$ -coin, two-quantum cascades. A total of 70 intermediate levels were found from 96 cascades.

Others:.

2003MoZU, 2002Re13: Compilations.

2001Ac04: (n, γ). Measured $E\gamma$, $I\gamma$. Deduced k_0 factor.

1988Se06: (n, γ). Measured $\gamma\gamma(\theta)$.

1974Op01, 1972Op02, 1969Ab03: (pol n, γ). Measured $\gamma(\text{circ pol})$ of capture γ rays to nine levels. Deduced interference in capture state.

1974IsZX: (n, γ). Measured $E\gamma$, $I\gamma$.

1972Se19: (n, γ). Measured relative intensities for six secondary γ rays and nine primary γ rays.

1972GoZN, 1971GoYN: (n, γ). Measured $E\gamma$, $I\gamma$, $\gamma\gamma$ -coin, $\gamma\gamma(\theta)$. Deduced levels, J, π , Q.

1970Ei03: (pol n, γ). Measured $\gamma(\text{circ pol})$ of capture γ rays to 30-keV level.

1969Bo04: (n, γ). Measured $\gamma\gamma(t)$ for 30-keV level.

1966Ke07: (n, γ). Measured $E\gamma$, $I\gamma$.

1965Ru06: (n, γ). Measured $E\gamma$, $I\gamma$.

1956Br42, 1956Ad49, 1952Ki32: (n, γ). Measured $E\gamma$, $I\gamma$.

The γ -ray placements and the resulting level scheme is primarily from **1984Vo01**, which is mostly based on earlier (n, γ) studies of **1972Op01** and **1970Jo04** combined with other reaction studies. However, based on a better $E\gamma$ precision achieved in the work of **1984Vo01**, placements for several γ rays are different than proposed by **1970Jo04** and/or **1972Op01**. Based on consistency with level energies, intensity balance through the level scheme and spin-parity considerations, **2013Fi01** have resolved many multiple placements of γ rays by **1984Vo01**, and have also placed many unplaced γ rays in **1984Vo01**. New levels are proposed by **2013Fi01** based on these new placements as well as new γ -ray transitions observed in their work.

 ^{40}K Levels

The following levels reported by **1972Op01** and/or **1970Jo04** have been omitted since they have not been confirmed in the high-resolution work of **1984Vo01** and **2013Fi01** (either the γ rays decaying from there levels were not observed or were placed differently based on better precision in **1984Vo01** and **2013Fi01**): 4586.8, 4665.8 from **1972Op01**; 2457.5, 2557.9, 2978.6, 3378.3, 3875.0, 4273.3, 4579.6 from **1970Jo04**; 2947.5, 3711.1, 3902.1, 4908.5 from **1972Op01** and **1970Jo04**.

E(level) [†]	J π [#]	T _{1/2}	Comments
0.0	4 ⁻		
29.8299 5	3 ⁻ @	4.26 ns 8	T _{1/2} : from $\gamma\gamma(t)$ in 1969Bo04 .
521.7? ^a 10			
800.1430 19	2 ⁻ @		
891.404 18	5 ⁻		
1084.3? ^a 10			

Continued on next page (footnotes at end of table)

$^{39}\text{K}(\text{n},\gamma),(\text{pol n},\gamma)$ E=thermal [1984Vo01,2013Fi01,1972Op01](#) (continued) ^{40}K Levels (continued)

E(level) [†]	J π [#]	Comments
1173.4? ^a 16		
1228.2? ^a 5		
1248.4? ^a 3		
1330.5? ^a 19		
1409.2? ^a 17		
1520.7? ^a 11		
1556.6? ^a 22		
1643.641 10	0 ⁺	
1877.7? ^a 8		
1959.072 10	2 ⁺	
2047.339 16	2 ⁻ @	
2069.805 20	3 ⁻ &	
2076.1? ^a 7		
2103.682 22	1 ⁻ &	J π : (1,2,3) ⁻ (1974Op01).
2260.48 3	3 ⁺	
2271.1? ^a 10		
2289.871 10	1 ⁺	
2290.531 19	3 ⁻	
2397.206 23	4 ⁻	
2419.167 14	2 ⁻ @	
2422.1? ^a 16		E(level): this level is proposed in 2013Fi01 only based on the placement of a 2688.1 γ from the 5111.9 level. But this level was neither observed in other work nor listed in Table 3 of populated levels in 2013Fi01 . The evaluator have considered this level as questionable.
2423.7? 8		
2575.946 25	2 ⁺	J π : 2 ⁺ (1984Vo01).
2618.1? ^a 12		
2626.003 22	0 ⁻	
2730.356 18	1	
2746.93 5	3 ⁻	
2756.674 23	2 ⁺	J π : 2 ⁺ , (3) (1984Vo01).
2786.646 16	3 ⁺	
2807.88 4	(1,2) ⁻	
2925.1? ^a 10		
2939.2? ^a 8		
2946.2? ^a 11		
2985.86 3	(2 ⁻ , 3 ⁺)	
3000.0? ^a 4		
3027.971 23	(2 ⁻ , 3 ⁺)	
3063.5? ^a 11		
3093.8? ^a 7		
3109.56 4	1 ⁺ , 2 ⁺	
3128.463 25	(2 ⁻ , 3 ⁺)	J π : (2 ⁻ , 3, 4 ⁺) (1984Vo01).
3140.7? ^a 2		
3146.42 4	1 ⁽⁻⁾	
3153.84 6	(2 ⁻ , 3)	J π : 3 ⁻ (1984Vo01).
3228.66 5	2 ⁻	
3305.2? ^a 12		
3326.6? ^a 6		
3367.98 8	(2,3) ⁻	

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$^{39}\text{K}(\text{n},\gamma),(\text{pol n},\gamma)$ E=thermal 1984Vo01,2013Fi01,1972Op01 (continued) ^{40}K Levels (continued)

E(level) [†]	J ^π #	Comments
3373.47 ^a 15		
3393.67 5	2 ⁻	
3414.35 3	2 ⁺	
3428.97 ^a 7		
3439.145 25	(2 ⁺) [@]	J ^π : (1,2) (1974Op01), 1 ⁻ ,2 ⁺ (1984Vo01).
3486.09 4	2 ⁻	
3517.77 ^a 11		
3528.47 ^a 9		
3557.32 7	(1 ⁻ to 4 ⁺)	
3578.37 ^a 10		
3599.223 24	2 ⁻	
3629.98 4	2 ⁻ ,3 ⁻	J ^π : (2,3) ⁻ (1984Vo01).
3655.67 ^a 3		
3663.798 24	(1 ⁻ ,2,3,4 ⁺)	J ^π : (2 ⁻ ,3,4 ⁺) (1984Vo01).
3709.57 ^a 13		
3713.09 [‡] 7	(2) ⁻	
3719.67 ^a 12		
3738.47 3	1 ⁺	J ^π : 1 ⁺ , (2 ⁻ ,3 ⁺) (1984Vo01).
3768.49 14	(2) ⁻	J ^π : (1 ⁻ ,2,3) (1984Vo01).
3797.55 3	1 ⁺	
3807.87 ^a 11		
3821.47 3	2 ⁻	
3840.254 24	(1,2 ⁺)	
3856.47 ^a 6		
3868.67 4	2 ⁻	J ^π : 3 ⁻ , (2 ⁻) (1984Vo01).
3887.83 4	(1 ⁻ ,2 ⁻)	
3924.15 7	(2 ⁻ ,3 ⁺)	
3933.07 ^a 15		
4020.36 4	(2) ⁻	
4058.37 ^a 10		
4104.47 4	(1 ⁻ ,2,3 ⁻)	
4110.82 3	2	
4149.03 3	(2 ⁻ ,3 ⁺)	
4165.47 ^a 7		
4179.99 4	(3 ⁻)	
4213.03 6	(2 ⁻ ,3 ⁺)	
4251.59 [‡] 14	(1,2 ⁻)	
4253.68 4	(1,2) ^{-&}	J ^π : (1,2) ⁻ (1974Op01).
4280.51 9	2 ⁻	
4313.94 [‡] 11	2 ⁻	
4350.69 [‡] 20	(2 ⁻)	
4395.86 3	(2) ⁻	J ^π : (≤ 3) ⁻ (1984Vo01).
4419.38 7	(2 ⁻ ,3,4 ⁺)	
4463.61 [‡] 6	(1 ⁻ ,2,3,4 ⁻)	
4473.05 7	(2 ⁻ ,3,4 ⁻)	
4537.06 4	(2 ⁻)	
4544.12 [‡] 5	(2 ⁻)	
4662.29 [‡] 24	(2 ⁻)	
4666.46 [‡] 6	(2 ⁻)	

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$^{39}\text{K}(\text{n},\gamma),(\text{pol n},\gamma)$ E=thermal 1984Vo01,2013Fi01,1972Op01 (continued) ^{40}K Levels (continued)

E(level) [†]	J π [#]	Comments
4744.134 25	(2 ⁺)	
4789.01 8	2 ⁻	J π : 1 ⁺ from 2013Fi01.
4807.76 [‡] 11	(0,1,2,3) ⁻	
4851.22 [‡] 12	(2 ⁻ ,3,4 ⁺)	
4872.58 6	(2,3) ⁻	
4906.9? ^a 13		
4960.23 [‡] 5	(2,3 ⁻)	
4993.14 5	(2 ⁻)	J π : (1 ⁻ ;4 ⁺) (1984Vo01).
5023.92 [‡] 14	(2 ⁻ ,3,4 ⁻)	
5063.38 5	(2 ⁻ ,3 ⁺)	
5111.9 [‡] 7	(2,3) ⁻	
5189.86 [‡] 4	(2 ⁻)	
5213.70 [‡] 12	2 ⁻	
5246.85 [‡] 17		
5488.76 [‡] 5	(2 ⁻ ,3,4 ⁻)	
6098.24 [‡] 4	(1 ⁻ ,2,3,4 ⁻)	
6311? ^a 3		
(7799.553 14)	1 ⁺ ,2 ⁺	E(level): S(n)=7799.62 6 (2012Wa38). J π : s-wave capture in ^{39}K (g.s. J π =3/2 ⁺). From $\gamma\gamma(\theta)$, an incoherent superposition of 1 ⁺ and 2 ⁺ is allowed, while from $\gamma(\text{circ pol})$, superposition is coherent, with either constructive or destructive interference.

[†] From a least-squares fit to γ -ray energies, unless otherwise noted. Doubly or multiply placed γ rays were not used in the least-squares procedure. Uncertainties of some γ rays were increased by a factor 2 or 4 in the fitting procedure in order to get an acceptable fit (reduced $\chi^2 < 3$).

[‡] Levels proposed by 2013Fi01.

[#] From Adopted Levels, unless otherwise noted.

@ Based on $\gamma(\text{circ pol})$ in 1974Op01 and $\gamma\gamma(\theta)$ in 1988Se06.

& Based on $\gamma(\text{circ pol})$ in 1974Op01 and arguments in Adopted Levels.

^a From 2002Va28 based on two-quantum cascades. These levels are not included in the Adopted Levels due to insufficient information about decay modes and J π values.

γ(⁴⁰K)

The following γ rays reported by 1972Op01 and/or 1970Jo04 have been omitted since they are not confirmed in the high-resolution work of 1984Vo01 and 2013Fi01: 246.9, 380.2, 1582.9, 1674.1, 2102.1, 2294.9, 3120.5, 3447.0, 4299.9, 4452.6, 4769.5, 4908.6, 5495.9 and 5840.9 from 1972Op01; 243.6, 284.6, 291.5, 297.5, 300.3, 368.3, 387.1, 421.6, 432.6, 475.9, 485.3, 608.6, 701.8, 720.7, 734.6, 1008.3, 1139.1, 1410.6, 1468.5, 1583.6, 1646.0, 1659.0, 1675.8, 1747.8, 2105.2, 2136.6, 2304.1, 2620.2, 2860.3, 2978.6, 3473.3, 3767.6, 3794.4, 3829.1, 4122.3, 4239.7, 4638.3, 4770.4, 5133.7, 5341.5, 5366.5, 5461.3, and 5841.8 from 1970Jo04.

γγ-coin information is from 1970Jo04 as shown by 1984Vo01.

γ normalization: normalized assuming Σ(Iγ to g.s.)=100 (1984Vo01). However, observed deexcitation intensity from the capture state is 89% of g.s. feeding.

σ_n=2.1 2 (1981MuZQ), 2.19 3 (2003MoZU). 2013Fi01 measured a total cross section of 2.252 b *16* observed feeding the GS and the 30-keV levels and they also deduce σ=2.28 b *4* or 2.35 b *15* using two different approaches that both combine measured data and simulations based on statistical model accounting for unobserved statistical GS feeding.

Level	γγ(θ) results (1988Se06)				
	γ ₁	(γ)	γ ₂	A ₂	A ₄
					A ₂ (if A ₄ =0)
1644	843		770	-0.04 7	+0.09 10
1959	1159		770	-0.072 22	+0.03 3
2047	1247		770	-0.09 4	+0.05 6
2104	1304		770	+0.18 6	-0.14 8
2419	1619		770	-0.09 6	+0.09 8
2626	522	(1304)	770	-0.10 15	-0.18 21
2626	522		1304	-0.03 21	+0.5 3
2626	522		2074	-0.12 15	-0.03 22
2808	2008		770	-0.09 10	+0.18 14
3439	1480		1159	+0.05 11	+0.04 16
3439	1480	(1159)	770	+0.07 11	-0.05 16
7800	4360		1480	+0.34 16	-0.16 21
7800	5173		522	+0.04 13	-0.10 18
7800	5380		1619	+0.32 5	+0.01 6
7800	5380	(1619)	770	-0.01 3	0.00 5
7800	5509		646	+0.17 7	+0.03 9
7800	5695		1304	-0.21 9	+0.14 14
7800	5695		2074	+0.09 7	0.00 9
7800	5752		1247	-0.13 7	-0.02 10
7800	5752	(1247)	770	+0.04 8	-0.11 11
7800	5752		2018	-0.1 4	+0.1 3
7800	5752		2047	-0.19 14	-0.01 20
7800	6999		770	-0.06 5	0.00 8

a: triple γ(γ)γ(θ)

γ(circ pol), γγ(θ) Results (1974Op01) For Primary Transitions						
γ ₁	Intermediate level	R	γ ₂	Final level	A ₂	F
3546	4254	+0.49 10				
4360	3439	+0.98 9				
5380	2419	0.00 3	1619	800	+0.19 2	0.96 2 d
5509	2290	+0.70 6				

5695	2104	-0.41	4	2074	30	+0.05	2		d
5695	2104			1304	800	-0.13	2		
5729	2070	-0.46	5	2070	0	+0.07	6	1	
5729	2070			2040	30	-0.20	2		
5729	2070			1178	800				
5752	2047	+0.08	3	2047	0	-0.09	2	0.02	1 d
5752	2047			2017	30	+0.08	2		
5752	2047			1247	800	-0.21	1		
6999	801	+0.63	6					0.09	4 c, 0.91 4
7769	30	-0.50	3 e					1	

\$

R: $\gamma(\text{circ pol})$ Coefficient

F: Fraction Of 2⁺ Component In ⁴⁰K Capture State

c: Constructive Interference. d: Destructive Interference

e: -0.48 16 (1970Ei03)

$E_\gamma^\dagger$	$I_\gamma^\ddagger d$	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult. §	$\delta^\S$	Comments
29.8299 5	86 7	29.8299	3 ⁻	0.0	4 ⁻	D(+Q) ^c	$\leq 0.073^c$	I_γ : from total feeding of 30-keV level using $\alpha(M1)=0.298$. $\sigma_\gamma=1.938$ b 15 (2013Fi01).
106.1 [#] 3	0.0247 [#] 17	2397.206	4 ⁻	2290.531	3 ⁻			$\sigma_\gamma=0.00058$ b 4 (2013Fi01).
185.97 10	0.118 19	2289.871	1 ⁺	2103.682	1 ⁻			$\sigma_\gamma=0.00080$ b 15 (2013Fi01).
								E_γ : also placed from 3414 and 3924 levels by 1984Vo01, resolved by 2013Fi01.
249.54 [#] 16	0.012 [#] 3	3663.798	(1 ⁻ , 2, 3, 4 ⁺)	3414.35	2 ⁺			$\sigma_\gamma=0.00029$ b 7 (2013Fi01).
284.1 ^{@f}		1084.3?		800.1430	2 ⁻			E_γ : 1970Jo04 report an unplaced γ ray at E=284.6 13, not observed in 1984Vo01 and 2013Fi01.
311.13 4	0.133 5	2730.356	1	2419.167	2 ⁻			$\sigma_\gamma=0.00286$ b 23 (2013Fi01).
315.52 8	0.062 8	2575.946	2 ⁺	2260.48	3 ⁺			$\sigma_\gamma=0.00176$ b 21 (2013Fi01).
								E_γ : also placed from 2419 and 4789 levels by 1984Vo01, resolved by 2013Fi01.
320.9 6	0.009 5	3128.463	(2 ⁻ , 3 ⁺)	2807.88	(1, 2) ⁻			
327.23 8	0.062 8	2397.206	4 ⁻	2069.805	3 ⁻			
330.798 7	0.33 3	2289.871	1 ⁺	1959.072	2 ⁺			$\sigma_\gamma=0.0069$ b 3 (2013Fi01).
335.44 ^e 14	0.040 ^e 6	3821.47	2 ⁻	3486.09	2 ⁻			
335.44 ^e 14	0.040 ^e 6	4872.58	(2, 3) ⁻	4537.06	(2 ⁻)			
337.75 12	0.036 6	2756.674	2 ⁺	2419.167	2 ⁻			
349.33 4	0.053 7	2419.167	2 ⁻	2069.805	3 ⁻			$\sigma_\gamma=0.00117$ b 20 (2013Fi01).
371.792 10	0.172 18	3128.463	(2 ⁻ , 3 ⁺)	2756.674	2 ⁺			$\sigma_\gamma=0.00404$ b 25 (2013Fi01).
								E_γ : also placed from 2419 level by 1984Vo01.
376.53 3	0.031 4	3486.09	2 ⁻	3109.56	1 ⁺ , 2 ⁺			
383.01 18	0.020 4	3797.55	1 ⁺	3414.35	2 ⁺			$\sigma_\gamma=0.00095$ b 21 (2013Fi01).
397.28 17	0.030 7	3153.84	(2 ⁻ , 3)	2756.674	2 ⁺			
440.77 7	0.047 7	4104.47	(1 ⁻ , 2, 3 ⁻)	3663.798	(1 ⁻ , 2, 3, 4 ⁺)			
^x 444.43 8	0.037 5							

³⁹K(n,γ),(pol n,γ) E=thermal 1984Vo01,2013Fi01,1972Op01 (continued)

γ(⁴⁰K) (continued)

E _γ [†]	I _γ ^{‡d}	E _i (level)	J _i ^π	E _f	J _f ^π	Comments
454.19 8	0.038 5	3868.67	2 ⁻	3414.35	2 ⁺	σ _γ =0.00069 b 18 (2013Fi01).
460.092 14	0.136 15	2419.167	2 ⁻	1959.072	2 ⁺	σ _γ =0.00412 b 23 (2013Fi01). E _γ : also placed from 2104 level by 1984Vo01.
496.06 4	0.047 5	2786.646	3 ⁺	2290.531	3 ⁻	σ _γ =0.00115 b 27 (2013Fi01).
504.5 5	0.062 18	4104.47	(1 ⁻ ,2,3 ⁻)	3599.223	2 ⁻	
521.7@f		521.7?		0.0	4 ⁻	
522.319 7	1.53 16	2626.003	0 ⁻	2103.682	1 ⁻	σ _γ =0.0391 b 8 (2013Fi01).
528.76 ^e 14	0.017 ^e 3	2575.946	2 ⁺	2047.339	2 ⁻	
528.76 ^e 14	0.017 ^e 3	3557.32	(1 ⁻ to 4 ⁺)	3027.971	(2 ⁻ ,3 ⁺)	
534.3 ^e 3	0.009 ^e 3	3109.56	1 ⁺ ,2 ⁺	2575.946	2 ⁺	
534.3 ^e 3	0.009 ^e 3	3663.798	(1 ⁻ ,2,3,4 ⁺)	3128.463	(2 ⁻ ,3 ⁺)	
534.3 ^e 3	0.009 ^e 3	4020.36	(2) ⁻	3486.09	2 ⁻	
534.3 ^e 3	0.009 ^e 3	4789.01	2 ⁻	4253.68	(1,2) ⁻	
554.741 ^{a&} 23	0.133 17	3663.798	(1 ⁻ ,2,3,4 ⁺)	3109.56	1 ⁺ ,2 ⁺	σ _γ =0.0034 b 3 (2013Fi01).
^x 558.73 10	0.044 7					
563.86 ^{&} 6	0.073 9	4744.134	(2 ⁺)	4179.99	(3 ⁻)	σ _γ =0.0010 b 3 (2013Fi01).
^x 569.98 7	0.062 8					σ _γ =0.0027 b 3 (2013Fi01).
602.26 17	0.034 6	3629.98	2 ⁻ ,3 ⁻	3027.971	(2 ⁻ ,3 ⁺)	
613.384 24	0.203 23	3599.223	2 ⁻	2985.86	(2 ⁻ ,3 ⁺)	σ _γ =0.0053 b 3 (2013Fi01).
^x 616.43 6	0.096 11					
620.96 ^e 7	0.070 ^e 8	3367.98	(2,3) ⁻	2746.93	3 ⁻	
620.96 ^e 7	0.070 ^e 8	3768.49	(2) ⁻	3146.42	1 ⁽⁻⁾	
626.1 ^e 3	0.010 ^e 3	2730.356	1	2103.682	1 ⁻	
626.1 ^e 3	0.010 ^e 3	4020.36	(2) ⁻	3393.67	2 ⁻	
627.66 3	0.095 10	3414.35	2 ⁺	2786.646	3 ⁺	σ _γ =0.00250 b 28 (2013Fi01).
640.4 6	0.044 22	3868.67	2 ⁻	3228.66	2 ⁻	σ _γ =0.0018 b 3 (2013Fi01). E _γ : also placed from 3768, 4744 and 4789 levels by 1984Vo01, resolved by 2013Fi01.
646.223 5	2.10 12	2289.871	1 ⁺	1643.641	0 ⁺	σ _γ =0.0508 b 9 (2013Fi01).
657.39 3	0.078 8	4395.86	(2) ⁻	3738.47	1 ⁺	σ _γ =0.00137 b 23 (2013Fi01).
666.91 ^a 5	0.057 6	2626.003	0 ⁻	1959.072	2 ⁺	σ _γ =0.00198 b 24 (2013Fi01).
678.13 ^e 20	0.027 ^e 5	3486.09	2 ⁻	2807.88	(1,2) ⁻	
678.13 ^e 20	0.027 ^e 5	3663.798	(1 ⁻ ,2,3,4 ⁺)	2985.86	(2 ⁻ ,3 ⁺)	
678.13 ^e 20	0.027 ^e 5	4789.01	2 ⁻	4110.82	2	
695.31 8	0.042 6	2985.86	(2 ⁻ ,3 ⁺)	2290.531	3 ⁻	σ _γ =0.00125 b 23 (2013Fi01). E _γ : also placed from 3924 level by 1984Vo01, resolved by 2013Fi01.
720.5@f		1520.7?		800.1430	2 ⁻	E _γ : 1970Jo04 report an unplaced γ ray at E=720.7 10, not observed in 1984Vo01 and 2013Fi01.

³⁹K(n,γ),(pol n,γ) E=thermal 1984Vo01,2013Fi01,1972Op01 (continued)γ(⁴⁰K) (continued)

$E_\gamma^\dagger$	$I_\gamma^\ddagger d$	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult. [§]	$\delta^\S$	Comments
727.1 ^e 3	0.014 ^e 3	3146.42	1 ⁽⁻⁾	2419.167	2 ⁻			
727.1 ^e 3	0.014 ^e 3	4213.03	(2 ⁻ ,3 ⁺)	3486.09	2 ⁻			
730.48 15	0.024 4	3840.254	(1,2 ⁺)	3109.56	1 ⁺ ,2 ⁺			
737.45 3	0.146 15	3027.971	(2 ⁻ ,3 ⁺)	2290.531	3 ⁻			$\sigma_\gamma=0.0036$ b 3 (2013Fi01).
740.89 6	0.26 3	4179.99	(3 ⁻)	3439.145	(2 ⁺)			$\sigma_\gamma=0.0064$ b 3 (2013Fi01).
756.4 ^{@f}		1556.6?		800.1430	2 ⁻			
756.4 ^e 6	0.08 ^e 4	3153.84	(2 ⁻ ,3)	2397.206	4 ⁻			
756.4 ^e 6	0.08 ^e 4	3486.09	2 ⁻	2730.356	1			
756.4 ^e 6	0.08 ^e 4	4149.03	(2 ⁻ ,3 ⁺)	3393.67	2 ⁻			
756.4 ^e 6	0.08 ^e 4	4419.38	(2 ⁻ ,3,4 ⁺)	3663.798	(1 ⁻ ,2,3,4 ⁺)			
760.6 4	0.12 4	2807.88	(1,2) ⁻	2047.339	2 ⁻			
770.3053 18	43 4	800.1430	2 ⁻	29.8299	3 ⁻	D(+Q) ^c	+0.04 ^c +3-6	$\sigma_\gamma=1.017$ b 14 (2013Fi01).
^x 783.82 4	0.103 11							
^x 791.06 4	0.50 5							$\sigma_\gamma=0.0117$ b 5 (2013Fi01).
798.8 ^e 3	0.062 ^e 7	4213.03	(2 ⁻ ,3 ⁺)	3414.35	2 ⁺			
798.8 ^e 3	0.062 ^e 7	4537.06	(2 ⁻)	3738.47	1 ⁺			
800.3 3	0.063 7	800.1430	2 ⁻	0.0	4 ⁻			$\sigma_\gamma=0.0029$ b 3 (2013Fi01). E _γ : also placed from 3557 level by 1984Vo01.
811.39 13	0.023 4	3797.55	1 ⁺	2985.86	(2 ⁻ ,3 ⁺)			
813.12 7	0.046 6	4993.14	(2 ⁻)	4179.99	(3 ⁻)			$\sigma_\gamma=0.0013$ b 3 (2013Fi01). E _γ : also placed from 3439 level by 1984Vo01, resolved by 2013Fi01.
827.552 15	0.45 5	2786.646	3 ⁺	1959.072	2 ⁺			$\sigma_\gamma=0.0109$ b 5 (2013Fi01).
838.8 5	0.066 17	3128.463	(2 ⁻ ,3 ⁺)	2289.871	1 ⁺			$\sigma_\gamma=0.00107$ b 23 (2013Fi01).
843.478 16	1.57 16	1643.641	0 ⁺	800.1430	2 ⁻			$\sigma_\gamma=0.0222$ b 6 (2013Fi01).
848.7 3	0.104 19	2807.88	(1,2) ⁻	1959.072	2 ⁺			$\sigma_\gamma=0.00218$ b 25 (2013Fi01). E _γ : also placed from 3110 level by 1984Vo01.
862.2 ^e 3	0.012 ^e 3	891.404	5 ⁻	29.8299	3 ⁻			
862.2 ^e 3	0.012 ^e 3	4419.38	(2 ⁻ ,3,4 ⁺)	3557.32	(1 ⁻ to 4 ⁺)			
^x 869.97 4	0.143 15							$\sigma_\gamma=0.0036$ b 3 (2013Fi01).
891.372 21	0.90 9	891.404	5 ⁻	0.0	4 ⁻			$\sigma_\gamma=0.0213$ b 7 (2013Fi01).
903.878 23	0.150 15	4744.134	(2 ⁺)	3840.254	(1,2 ⁺)			$\sigma_\gamma=0.0034$ b 3 (2013Fi01).
^x 915.38 16	0.017 3							
920.12 ^e 18	0.017 ^e 3	4149.03	(2 ⁻ ,3 ⁺)	3228.66	2 ⁻			
920.12 ^e 18	0.017 ^e 3	4789.01	2 ⁻	3868.67	2 ⁻			
926.24 ^a 15	0.019 4	3713.09	(2) ⁻	2786.646	3 ⁺			
938.72 6	0.098 11	3228.66	2 ⁻	2289.871	1 ⁺			
946.29 ^{&} 8	0.037 4	4744.134	(2 ⁺)	3797.55	1 ⁺			
951.16 7	0.043 5	4179.99	(3 ⁻)	3228.66	2 ⁻			

³⁹K(n,γ),(pol n,γ) E=thermal 1984Vo01,2013Fi01,1972Op01 (continued)

$\gamma(^{40}\text{K})$ (continued)						
E_γ †	I_γ ‡d	E_i (level)	J_i^π	E_f	J_f^π	Comments
958.35 9	0.026 3	3027.971	(2 ⁻ ,3 ⁺)	2069.805	3 ⁻	$\sigma_\gamma=0.0009$ b 3 (2013Fi01).
^x 971.74 19	0.028 5					
976.85 ^a 6	0.109 12	5189.86	(2 ⁻)	4213.03	(2 ⁻ ,3 ⁺)	$\sigma_\gamma=0.0029$ b 3 (2013Fi01).
981.03 ^{&} 7	0.103 12	3557.32	(1 ⁻ to 4 ⁺)	2575.946	2 ⁺	$\sigma_\gamma=0.0025$ b 3 (2013Fi01). E _γ : also placed from 3768 level by 1984Vo01.
1001.05 ^{&} 5	0.081 9	4110.82	2	3109.56	1 ⁺ ,2 ⁺	
^x 1018.11 4	0.141 15					
1023.21 4	0.26 3	3599.223	2 ⁻	2575.946	2 ⁺	$\sigma_\gamma=0.0051$ b 3 (2013Fi01).
1027.09 24	0.036 8	2985.86	(2 ⁻ ,3 ⁺)	1959.072	2 ⁺	$\sigma_\gamma=0.0012$ b 3 (2013Fi01).
^x 1031.1 3	0.020 5					
1034.28 ^e 20	0.038 ^e 6	3821.47	2 ⁻	2786.646	3 ⁺	
1034.28 ^e 20	0.038 ^e 6	4020.36	(2) ⁻	2985.86	(2 ⁻ ,3 ⁺)	
1034.28 ^e 20	0.038 ^e 6	4473.05	(2 ⁻ ,3,4 ⁻)	3439.145	(2 ⁺)	
^x 1043.58 12	0.023 3					
1058.03 ^a 4	0.112 12	4544.12	(2 ⁻)	3486.09	2 ⁻	$\sigma_\gamma=0.0024$ b 3 (2013Fi01).
1062.20 8	0.052 6	3109.56	1 ⁺ ,2 ⁺	2047.339	2 ⁻	$\sigma_\gamma=0.0019$ b 3 (2013Fi01).
1068.87 3	0.40 4	3027.971	(2 ⁻ ,3 ⁺)	1959.072	2 ⁺	$\sigma_\gamma=0.0089$ b 5 (2013Fi01). E _γ : also placed from 4993 level by 1984Vo01, resolved by 2013Fi01.
1074.39 9	0.144 17	3821.47	2 ⁻	2746.93	3 ⁻	$\sigma_\gamma=0.0029$ b 3 (2013Fi01).
1077.5 ^{@f}		1877.7?		800.1430	2 ⁻	
1079.44 13	0.100 13	4473.05	(2 ⁻ ,3,4 ⁻)	3393.67	2 ⁻	$\sigma_\gamma=0.0016$ b 3 (2013Fi01).
1082.92 7	0.200 22	4110.82	2	3027.971	(2 ⁻ ,3 ⁺)	$\sigma_\gamma=0.0038$ b 5 (2013Fi01).
1086.707 19	1.11 11	2730.356	1	1643.641	0 ⁺	$\sigma_\gamma=0.0250$ b 8 (2013Fi01).
1090.9 3	0.037 9	3821.47	2 ⁻	2730.356	1	
^x 1096.72 7	0.101 11					
1100.13 18	0.042 6	4253.68	(1,2) ⁻	3153.84	(2 ⁻ ,3)	
^x 1110.50 7	0.114 12					
1113.3 3	0.029 5	2756.674	2 ⁺	1643.641	0 ⁺	$\sigma_\gamma=0.0013$ b 3 (2013Fi01).
1118.38 13	0.054 7	4104.47	(1 ⁻ ,2,3 ⁻)	2985.86	(2 ⁻ ,3 ⁺)	$\sigma_\gamma=0.0009$ b 3 (2013Fi01).
1121.77 7	0.111 12	3868.67	2 ⁻	2746.93	3 ⁻	$\sigma_\gamma=0.0021$ b 3 (2013Fi01).
1124.91 6	0.120 13	4110.82	2	2985.86	(2 ⁻ ,3 ⁺)	$\sigma_\gamma=0.0019$ b 3 (2013Fi01). E _γ : also placed from 3229, 4252 and 4789 levels by 1984Vo01, resolved by 2013Fi01.
1131.17 5	0.103 11	3887.83	(1 ⁻ ,2 ⁻)	2756.674	2 ⁺	$\sigma_\gamma=0.0014$ b 3 (2013Fi01).
1143.5 ^{@f}		1173.4?		29.8299	3 ⁻	
1144.7 5	0.08 3	4744.134	(2 ⁺)	3599.223	2 ⁻	$\sigma_\gamma=0.0016$ b 3 (2013Fi01).
1150.58 18	0.23 4	3109.56	1 ⁺ ,2 ⁺	1959.072	2 ⁺	$\sigma_\gamma=0.0042$ b 5 (2013Fi01).
1158.901 20	7.8 8	1959.072	2 ⁺	800.1430	2 ⁻	$\sigma_\gamma=0.180$ b 3 (2013Fi01).
1162.59 24	0.31 5	4149.03	(2 ⁻ ,3 ⁺)	2985.86	(2 ⁻ ,3 ⁺)	$\sigma_\gamma=0.0061$ b 5 (2013Fi01). E _γ : also placed from 3738 level by 1984Vo01, resolved by 2013Fi01.
^x 1172.20 11	0.042 5					

³⁹K(n,γ),(pol n,γ) E=thermal 1984Vo01,2013Fi01,1972Op01 (continued) $\gamma(^{40}\text{K})$ (continued)

$E_\gamma^\dagger$	$I_\gamma^{\ddagger d}$	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult. [§]	$\delta^\S$	Comments
1178.38 4	0.36 4	2069.805	3 ⁻	891.404	5 ⁻			$\sigma_\gamma=0.0078$ b 9 (2013Fi01).
1187.45 8	0.062 7	3146.42	1 ⁽⁻⁾	1959.072	2 ⁺			$\sigma_\gamma=0.0025$ b 3 (2013Fi01).
1195.81 & 7	0.055 6	3486.09	2 ⁻	2290.531	3 ⁻			$\sigma_\gamma=0.0014$ b 3 (2013Fi01).
1198.3 @ f		1228.2?		29.8299	3 ⁻			
1201.86 ^a 5	0.106 11	3599.223	2 ⁻	2397.206	4 ⁻			$\sigma_\gamma=0.0025$ b 3 (2013Fi01).
1204.36 ^a 10	0.046 6	4313.94	2 ⁻	3109.56	1 ⁺ , 2 ⁺			
1213.53 ^{a&} 8	0.047 5	4020.36	(2) ⁻	2807.88	(1,2) ⁻			$\sigma_\gamma=0.0011$ b 3 (2013Fi01).
^x 1219.47 11	0.041 5							
1221.71 7	0.067 7	3797.55	1 ⁺	2575.946	2 ⁺			$\sigma_\gamma=0.0017$ b 3 (2013Fi01).
^x 1226.31 5	0.071 8							$\sigma_\gamma=0.0016$ b 3 (2013Fi01).
1232.74 3	0.134 14	3629.98	2 ⁻ , 3 ⁻	2397.206	4 ⁻			$\sigma_\gamma=0.0034$ b 3 (2013Fi01).
1247.173 24	3.8 4	2047.339	2 ⁻	800.1430	2 ⁻	M1+E2	+0.10 4	$\sigma_\gamma=0.0883$ b 15 (2013Fi01).
1248.4 @ f		1248.4?		0.0	4 ⁻			
1255.29 ^a 9	0.107 12	5023.92	(2 ⁻ , 3, 4 ⁻)	3768.49	(2) ⁻			$\sigma_\gamma=0.0024$ b 3 (2013Fi01).
1262.1 # 3	0.068 # 13	3887.83	(1 ⁻ , 2 ⁻)	2626.003	0 ⁻			E_γ : 1261.1 9 (1970Jo04), placed from 3367 level by 1970Jo04. $\sigma_\gamma=0.0016$ b 3 (2013Fi01).
1265.54 9	0.199 23	4419.38	(2 ⁻ , 3, 4 ⁺)	3153.84	(2 ⁻ , 3)			
1267.5 ^e 3	0.105 ^e 21	3557.32	(1 ⁻ to 4 ⁺)	2289.871	1 ⁺			
1267.5 ^e 3	0.105 ^e 21	4253.68	(1,2) ⁻	2985.86	(2 ⁻ , 3 ⁺)			
1267.5 ^e 3	0.105 ^e 21	4395.86	(2) ⁻	3128.463	(2 ⁻ , 3 ⁺)			
1269.56 5	0.47 5	2069.805	3 ⁻	800.1430	2 ⁻			$\sigma_\gamma=0.0081$ b 5 (2013Fi01).
^x 1283.3 3	0.051 16							$\sigma_\gamma=0.0009$ b 3 (2013Fi01).
1303.53 7	2.7 3	2103.682	1 ⁻	800.1430	2 ⁻	D+Q ^c	+0.13 ^c 8	$\sigma_\gamma=0.0619$ b 14 (2013Fi01).
1308.9 4	0.043 17	3599.223	2 ⁻	2289.871	1 ⁺			$\sigma_\gamma=0.0018$ b 3 (2013Fi01).
								E_γ : also placed from 3599 to 2290.5 ($J\pi=3^-$), 4419 and 4537 levels by 1984Vo01, resolved by 2013Fi01.
1320.9 4	0.30 3	3367.98	(2,3) ⁻	2047.339	2 ⁻			$\sigma_\gamma=0.0074$ b 6 (2013Fi01).
1330.5 @ f		1330.5?		0.0	4 ⁻			
^x 1331.58 4	0.152 16							$\sigma_\gamma=0.0028$ b 5 (2013Fi01).
1335.48 18	0.033 6	3439.145	(2 ⁺)	2103.682	1 ⁻			
1348.06 14	0.035 4	3924.15	(2 ⁻ , 3 ⁺)	2575.946	2 ⁺			$\sigma_\gamma=0.0008$ b 5 (2013Fi01).
								E_γ : also placed from 3768 and 4104 levels by 1984Vo01, resolved by 2013Fi01.
1354.12 3	0.161 7	4110.82	2	2756.674	2 ⁺			$\sigma_\gamma=0.0039$ b 5 (2013Fi01).
1365.06 ^a 24	0.066 12	4350.69	(2 ⁻)	2985.86	(2 ⁻ , 3 ⁺)			$\sigma_\gamma=0.0016$ b 3 (2013Fi01).
1373.227 21	1.29 13	3663.798	(1 ⁻ , 2, 3, 4 ⁺)	2290.531	3 ⁻			$\sigma_\gamma=0.0283$ b 8 (2013Fi01).
^x 1377.16 11	0.122 16							
1393.16 ^{b&} 8	0.126 14	5189.86	(2 ⁻)	3797.55	1 ⁺			$\sigma_\gamma=0.0021$ b 5 (2013Fi01).
								E_γ : placed by 1984Vo01 from 4180 level.

³⁹K(n,γ),(pol n,γ) E=thermal 1984Vo01,2013Fi01,1972Op01 (continued)

$\gamma(^{40}\text{K})$ (continued)								
E_γ [†]	I_γ ^{‡d}	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult. [§]	δ [§]	Comments
1399.03 4	0.53 5	2290.531	3 ⁻	891.404	5 ⁻			$\sigma_\gamma=0.0117$ b 6 (2013Fi01).
1402.73 ^a 9	0.125 14	4960.23	(2,3 ⁻)	3557.32	(1 ⁻ to 4 ⁺)			$\sigma_\gamma=0.0033$ b 7 (2013Fi01).
1409.2 ^{@f}		1409.2?		0.0	4 ⁻			E_γ : 1970Jo04 report an γ ray at E=1410.6 9, placed from 4538 level, not observed in 1984Vo01 and 2013Fi01.
^x 1416.67 9	0.048 6							
^x 1419.01 3	0.233 24							$\sigma_\gamma=0.0034$ b 5 (2013Fi01).
1424.229 23	0.36 4	3821.47	2 ⁻	2397.206	4 ⁻			$\sigma_\gamma=0.0078$ b 6 (2013Fi01).
1427.45 18	0.022 3	4537.06	(2 ⁻)	3109.56	1 ⁺ ,2 ⁺			
1434.50 6	0.140 15	3393.67	2 ⁻	1959.072	2 ⁺			$\sigma_\gamma=0.0024$ b 5 (2013Fi01).
1438.72 4	0.218 23	3486.09	2 ⁻	2047.339	2 ⁻			$\sigma_\gamma=0.0055$ b 5 (2013Fi01).
^x 1449.98 6	0.047 5							
1452.39 ^a 12	0.0200 20	3713.09	(2) ⁻	2260.48	3 ⁺			
^x 1454.90 10	0.025 3							
^x 1460.81 10	0.049 6							$\sigma_\gamma=0.0025$ b 5 (2013Fi01).
1466.11 ^{&} 3	0.26 3	3109.56	1 ⁺ ,2 ⁺	1643.641	0 ⁺			$\sigma_\gamma=0.0053$ b 5 (2013Fi01).
^x 1473.66 16	0.036 5							
1478.01 6	0.32 3	3738.47	1 ⁺	2260.48	3 ⁺			$\sigma_\gamma=0.0041$ b 9 (2013Fi01).
1480.09 4	1.54 16	3439.145	(2 ⁺)	1959.072	2 ⁺	D(+Q) ^c	+0.22 ^c 22	δ : from $\delta=0.00$ 45 in 1988Se06. $\sigma_\gamma=0.0398$ b 10 (2013Fi01).
^x 1483.86 8	0.077 9							$\sigma_\gamma=0.0011$ b 5 (2013Fi01).
1487.42 ^e 9	0.097 ^e 12	3557.32	(1 ⁻ to 4 ⁺)	2069.805	3 ⁻			
1487.42 ^e 9	0.097 ^e 12	4473.05	(2 ⁻ ,3,4 ⁻)	2985.86	(2 ⁻ ,3 ⁺)			
1489.77 5	1.21 12	2289.871	1 ⁺	800.1430	2 ⁻			$\sigma_\gamma=0.0312$ b 9 (2013Fi01).
1496.0 [#] 3	0.051 [#] 21	3599.223	2 ⁻	2103.682	1 ⁻			$\sigma_\gamma=0.0012$ b 5 (2013Fi01).
1503.00 10	0.41 4	3146.42	1 ⁽⁻⁾	1643.641	0 ⁺			$\sigma_\gamma=0.0096$ b 6 (2013Fi01).
1509.9 ^e 3	0.022 ^e 4	3153.84	(2 ⁻ ,3)	1643.641	0 ⁺			
1509.9 ^e 3	0.022 ^e 4	3557.32	(1 ⁻ to 4 ⁺)	2047.339	2 ⁻			
^x 1517.10 9	0.122 14							$\sigma_\gamma=0.0020$ b 3 (2013Fi01).
^x 1521.02 21	0.059 9							
1530.7 3	0.058 14	3821.47	2 ⁻	2290.531	3 ⁻			
1536.84 ^{a&} 5	0.26 3	3797.55	1 ⁺	2260.48	3 ⁺			$\sigma_\gamma=0.0039$ b 5 (2013Fi01).
1551.77 9	0.102 12	3599.223	2 ⁻	2047.339	2 ⁻			$\sigma_\gamma=0.0034$ b 5 (2013Fi01).
1560.44 19	0.175 21	3629.98	2 ⁻ ,3 ⁻	2069.805	3 ⁻			$\sigma_\gamma=0.0030$ b 7 (2013Fi01).
^x 1562.78 7	0.31 3							
1566.21 ^{a&} 7	0.155 17	4960.23	(2,3 ⁻)	3393.67	2 ⁻			$\sigma_\gamma=0.0029$ b 6 (2013Fi01).
1578.97 12	0.035 4	3868.67	2 ⁻	2289.871	1 ⁺			
1597.88 ^b 4	0.29 3	3887.83	(1 ⁻ ,2 ⁻)	2289.871	1 ⁺			$\sigma_\gamma=0.0063$ b 3 (2013Fi01).
								E_γ : placed by 1984Vo01 from 3557 level.
1613.84 4	5.7 6	1643.641	0 ⁺	29.8299	3 ⁻	[E3]		$\sigma_\gamma=0.1345$ b 23 (2013Fi01).

³⁹K(n,γ),(pol n,γ) E=thermal 1984Vo01,2013Fi01,1972Op01 (continued)

$\gamma(^{40}\text{K})$ (continued)								
$E_\gamma^\dagger$	$I_\gamma^{\ddagger d}$	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult. [§]	$\delta^\S$	Comments
1619.00 4	6.2 6	2419.167	2 ⁻	800.1430	2 ⁻	D+Q ^c	+0.24 ^c 6	δ : other: +0.06 6 or +1.9 3 (1974Op01). $\sigma_\gamma=0.1461$ b 24 (2013Fi01). $\sigma_\gamma=0.0077$ b 5 (2013Fi01).
1625.67 ^a 14	0.32 4	4251.59	(1,2 ⁻)	2626.003	0 ⁻			
1634.26 [#] 8	0.277 [#] 22	3924.15	(2 ⁻ ,3 ⁺)	2289.871	1 ⁺			E_γ : 1635.1 9 (1970Jo04), placed from 3738 level by 1970Jo04. $\sigma_\gamma=0.0065$ b 5 (2013Fi01). $\sigma_\gamma=0.0032$ b 5 (2013Fi01). $\sigma_\gamma=0.0024$ b 5 (2013Fi01).
1665.43 4	0.143 15	4395.86	(2) ⁻	2730.356	1			
^x 1667.69 5	0.102 11							
1680.8 ^a 4	0.010 3	4666.46	(2 ⁻)	2985.86	(2 ⁻ ,3 ⁺)			
1691.26 6	0.111 12	3738.47	1 ⁺	2047.339	2 ⁻			$\sigma_\gamma=0.0017$ b 5 (2013Fi01).
1695.44 8	0.100 11	5063.38	(2 ⁻ ,3 ⁺)	3367.98	(2,3) ⁻			
1702.35 ^a 3	0.33 3	6098.24	(1 ⁻ ,2,3,4 ⁻)	4395.86	(2) ⁻			$\sigma_\gamma=0.0054$ b 5 (2013Fi01).
1704.70 20	0.31 16	4280.51	2 ⁻	2575.946	2 ⁺			$\sigma_\gamma=0.0075$ b 8 (2013Fi01).
1704.73 9	0.94 12	3663.798	(1 ⁻ ,2,3,4 ⁺)	1959.072	2 ⁺			$\sigma_\gamma=0.0200$ b 8 (2013Fi01).
^x 1710.19 24	0.023 4							
1718.68 4	0.166 7	4872.58	(2,3) ⁻	3153.84	(2 ⁻ ,3)			$\sigma_\gamma=0.0024$ b 5 (2013Fi01).
1725.68 ^e 17	0.033 ^e 5	4473.05	(2 ⁻ ,3,4 ⁻)	2746.93	3 ⁻			
1725.68 ^e 17	0.033 ^e 5	4872.58	(2,3) ⁻	3146.42	1 ⁽⁻⁾			
1751.76 5	0.225 23	4149.03	(2 ⁻ ,3 ⁺)	2397.206	4 ⁻			$\sigma_\gamma=0.0045$ b 5 (2013Fi01).
1754.72 ^{a&} 17	0.036 5	3713.09	(2) ⁻	1959.072	2 ⁺			
1761.10 ^e 7	0.030 ^e 4	4179.99	(3 ⁻)	2419.167	2 ⁻			
1761.10 ^e 17	0.030 ^e 4	4789.01	2 ⁻	3027.971	(2 ⁻ ,3 ⁺)			
1765.24 15	0.224 23	3868.67	2 ⁻	2103.682	1 ⁻			$\sigma_\gamma=0.0054$ b 5 (2013Fi01).
1771.4 ^e 5	0.031 ^e 9	3414.35	2 ⁺	1643.641	0 ⁺			
1771.4 ^e 5	0.031 ^e 9	3840.254	(1,2 ⁺)	2069.805	3 ⁻			
1779.14 [#] 8	0.328 [#] 22	3738.47	1 ⁺	1959.072	2 ⁺			$\sigma_\gamma=0.0077$ b 5 (2013Fi01).
1795.45 4	1.34 14	3439.145	(2 ⁺)	1643.641	0 ⁺			$\sigma_\gamma=0.0329$ b 9 (2013Fi01).
^x 1811.2 3	0.032 6							
1813.94 14	0.072 9	4104.47	(1 ⁻ ,2,3 ⁻)	2290.531	3 ⁻			
1817.9 ^{@f}		2618.1?		800.1430	2 ⁻			
1820.35 ^{b&} 5	0.27 3	4395.86	(2) ⁻	2575.946	2 ⁺			$\sigma_\gamma=0.0057$ b 6 (2013Fi01). E_γ : placed from 3924 and 4111 levels by 1984Vo01. $\sigma_\gamma=0.0166$ b 8 (2013Fi01).
1825.77 5	0.65 7	2626.003	0 ⁻	800.1430	2 ⁻			
1832.01 ^{a&} 5	0.117 12	4960.23	(2,3 ⁻)	3128.463	(2 ⁻ ,3 ⁺)			$\sigma_\gamma=0.0032$ b 6 (2013Fi01).
1838.61 8	0.44 4	3797.55	1 ⁺	1959.072	2 ⁺			$\sigma_\gamma=0.0106$ b 7 (2013Fi01).
1843.33 9	0.065 7	4419.38	(2 ⁻ ,3,4 ⁺)	2575.946	2 ⁺			
1846.72 6	0.105 11	4993.14	(2 ⁻)	3146.42	1 ⁽⁻⁾			$\sigma_\gamma=0.0026$ b 6 (2013Fi01). E_γ : also placed from 4473 level by 1984Vo01, resolved by 2013Fi01.
^x 1854.99 5	0.202 21							$\sigma_\gamma=0.0034$ b 5 (2013Fi01).

³⁹K(n,γ),(pol n,γ) E=thermal 1984Vo01,2013Fi01,1972Op01 (continued)

γ(⁴⁰K) (continued)

E _γ [†]	I _γ ^{‡d}	E _i (level)	J _i ^π	E _f	J _f ^π	Mult. [§]	δ [§]	Comments
1858.51 5	0.54 5	4149.03	(2 ⁻ ,3 ⁺)	2290.531	3 ⁻			σ _γ =0.0122 b 6 (2013Fi01).
1881.20 5	0.50 5	3840.254	(1,2 ⁺)	1959.072	2 ⁺			σ _γ =0.0104 b 6 (2013Fi01).
1888.43 8	0.098 11	4149.03	(2 ⁻ ,3 ⁺)	2260.48	3 ⁺			σ _γ =0.0017 b 6 (2013Fi01).
^x 1892.0 3	0.037 5							
^x 1901.6 4	0.029 5							
^x 1910.70 6	0.171 18							σ _γ =0.0037 b 5 (2013Fi01).
1916.51 6	0.26 3	4020.36	(2) ⁻	2103.682	1 ⁻			σ _γ =0.0043 b 5 (2013Fi01).
1919.28 [#] 20	0.149 [#] 22	4179.99	(3 ⁻)	2260.48	3 ⁺			σ _γ =0.0035 b 5 (2013Fi01).
1929.34 10	1.8 3	1959.072	2 ⁺	29.8299	3 ⁻			σ _γ =0.0447 b 10 (2013Fi01).
1930.2 3	0.5 3	2730.356	1	800.1430	2 ⁻			
1931.23 [#] 20	0.32 [#] 3	5488.76	(2 ⁻ ,3,4 ⁻)	3557.32	(1 ⁻ to 4 ⁺)			σ _γ =0.0075 b 6 (2013Fi01).
1935.7 3	0.125 22	4744.134	(2 ⁺)	2807.88	(1,2) ⁻			
1946.43 17	0.040 6	2746.93	3 ⁻	800.1430	2 ⁻			
1953.74 6	0.31 3	5063.38	(2 ⁻ ,3 ⁺)	3109.56	1 ⁺ ,2 ⁺			σ _γ =0.0051 b 6 (2013Fi01).
1956.58 5	1.84 18	2756.674	2 ⁺	800.1430	2 ⁻			σ _γ =0.0457 b 12 (2013Fi01).
1961.11 6	0.154 16	4537.06	(2 ⁻)	2575.946	2 ⁺			σ _γ =0.0037 b 6 (2013Fi01).
1964.27 ^{&} 23	0.037 6	3924.15	(2 ⁻ ,3 ⁺)	1959.072	2 ⁺			
1973.00 4	0.32 3	4020.36	(2) ⁻	2047.339	2 ⁻			σ _γ =0.0070 b 6 (2013Fi01).
^x 1994.08 15	0.188 24							σ _γ =0.0035 b 6 (2013Fi01).
2001.24 20	0.137 20	4104.47	(1 ⁻ ,2,3 ⁻)	2103.682	1 ⁻			σ _γ =0.0020 b 5 (2013Fi01).
2007.71 4	2.5 3	2807.88	(1,2) ⁻	800.1430	2 ⁻			σ _γ =0.0578 b 14 (2013Fi01).
2013.90 20	0.17 3	4744.134	(2 ⁺)	2730.356	1			
^x 2014.24 11	0.201 23							
2017.53 4	2.7 3	2047.339	2 ⁻	29.8299	3 ⁻	M1+E2	+0.07 4	δ: or -9 2 (1974Op01). Other: +0.25 21 or ≤-8 (1988Se06). σ _γ =0.0608 b 14 (2013Fi01). σ _γ =0.0043 b 6 (2013Fi01).
2022.32 17	0.165 23	4419.38	(2 ⁻ ,3,4 ⁺)	2397.206	4 ⁻			
2031.6 3	0.26 4	4789.01	2 ⁻	2756.674	2 ⁺			
2039.94 4	2.7 3	2069.805	3 ⁻	29.8299	3 ⁻	M1(+E2)	+0.2 2	σ _γ =0.0585 b 15 (2013Fi01).
2047.28 4	2.7 3	2047.339	2 ⁻	0.0	4 ⁻	E2		σ _γ =0.0605 b 15 (2013Fi01).
2057.07 5	0.141 16	4104.47	(1 ⁻ ,2,3 ⁻)	2047.339	2 ⁻			σ _γ =0.0025 b 5 (2013Fi01).
^x 2067.53 11	0.28 3							
2070.08 15	2.01 20	2069.805	3 ⁻	0.0	4 ⁻	M1(+E2)	+0.01 10	σ _γ =0.0409 b 11 (2013Fi01).
2073.74 10	6.5 7	2103.682	1 ⁻	29.8299	3 ⁻			σ _γ =0.155 b 3 (2013Fi01).
2076.1 ^{@f}		2076.1?		0.0	4 ⁻			
2077.41 [#] 13	0.33 [#] 3	4807.76	(0,1,2,3) ⁻	2730.356	1			σ _γ =0.0078 b 6 (2013Fi01).
2094.61 10	0.048 5	3738.47	1 ⁺	1643.641	0 ⁺			
2109.9 [#] 3	0.064 [#] 21	4179.99	(3 ⁻)	2069.805	3 ⁻			σ _γ =0.0015 b 5 (2013Fi01).
2115.77 14	0.031 4	4872.58	(2,3) ⁻	2756.674	2 ⁺			
^x 2122.02 5	0.121 13							σ _γ =0.0018 b 5 (2013Fi01).
2124.9 ^{@f}		2925.1?		800.1430	2 ⁻			

³⁹K(n,γ),(pol n,γ) E=thermal 1984Vo01,2013Fi01,1972Op01 (continued)

$\gamma(^{40}\text{K})$ (continued)						
$E_\gamma^\dagger$	$I_\gamma^{\ddagger d}$	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Comments
^x 2131.66 17	0.036 5					
2139.0 @f		2939.2?		800.1430	2 ⁻	
2143.37 11	0.139 16	4213.03	(2 ⁻ ,3 ⁺)	2069.805	3 ⁻	$\sigma_\gamma=0.0025$ b 5 (2013Fi01).
2149.93 5	0.43 4	4253.68	(1,2) ⁻	2103.682	1 ⁻	$\sigma_\gamma=0.0083$ b 6 (2013Fi01).
2153.81 4	0.79 8	3797.55	1 ⁺	1643.641	0 ⁺	$\sigma_\gamma=0.0178$ b 8 (2013Fi01).
2162.16 & 17	0.041 5	4789.01	2 ⁻	2626.003	0 ⁻	
2168.16 4	0.179 19	4744.134	(2 ⁺)	2575.946	2 ⁺	$\sigma_\gamma=0.0043$ b 5 (2013Fi01).
2173.67 ^a 8	0.094 10	4960.23	(2,3) ⁻	2786.646	3 ⁺	$\sigma_\gamma=0.0032$ b 5 (2013Fi01).
2183.70 20	0.47 24	4253.68	(1,2) ⁻	2069.805	3 ⁻	$\sigma_\gamma=0.0223$ b 8 (2013Fi01).
2185.70 20	0.47 24	2985.86	(2 ⁻ ,3 ⁺)	800.1430	2 ⁻	
2196.61 5	0.34 4	3840.254	(1,2 ⁺)	1643.641	0 ⁺	$\sigma_\gamma=0.0086$ b 6 (2013Fi01).
2199.8 @f		3000.0?		800.1430	2 ⁻	
2204.08 ^a & 10	0.34 4	4960.23	(2,3) ⁻	2756.674	2 ⁺	$\sigma_\gamma=0.0062$ b 7 (2013Fi01).
2206.35 10	0.75 8	4253.68	(1,2) ⁻	2047.339	2 ⁻	$\sigma_\gamma=0.0187$ b 14 (2013Fi01). E _γ : also placed from 4993 level by 1984Vo01, resolved by 2013Fi01.
2221.27 & 11	0.183 24	4179.99	(3 ⁻)	1959.072	2 ⁺	
2230.54 5	0.81 8	2260.48	3 ⁺	29.8299	3 ⁻	$\sigma_\gamma=0.0228$ b 11 (2013Fi01).
2233.0 4	0.16 16	4280.51	2 ⁻	2047.339	2 ⁻	
2241.2 @f		2271.1?		29.8299	3 ⁻	
2246.3 # 3	0.14 # 3	4350.69	(2 ⁻)	2103.682	1 ⁻	$\sigma_\gamma=0.0034$ b 6 (2013Fi01).
2260.11 & 10	0.31 3	2260.48	3 ⁺	0.0	4 ⁻	$\sigma_\gamma=0.0078$ b 6 (2013Fi01).
2263.4 @f		3063.5?		800.1430	2 ⁻	
^x 2271.19 12	0.085 10					$\sigma_\gamma=0.0017$ b 3 (2013Fi01).
2290.58 7	2.8 3	2290.531	3 ⁻	0.0	4 ⁻	$\sigma_\gamma=0.0655$ b 15 (2013Fi01).
2310.70 ^a 5	0.51 5	(7799.553)	1 ⁺ ,2 ⁺	5488.76	(2 ⁻ ,3,4 ⁻)	$\sigma_\gamma=0.0102$ b 7 (2013Fi01).
^x 2322.75 13	0.127 14					$\sigma_\gamma=0.0021$ b 5 (2013Fi01).
^x 2330.16 10	0.28 3					$\sigma_\gamma=0.0051$ b 6 (2013Fi01).
2346.05 10	0.69 7	3146.42	1 ⁽⁻⁾	800.1430	2 ⁻	$\sigma_\gamma=0.0155$ b 8 (2013Fi01).
2348.72 9	0.24 3	4395.86	(2) ⁻	2047.339	2 ⁻	$\sigma_\gamma=0.0054$ b 6 (2013Fi01).
2359.8 # 8	0.034 # 21	5488.76	(2 ⁻ ,3,4 ⁻)	3128.463	(2 ⁻ ,3 ⁺)	$\sigma_\gamma=0.0008$ b 5 (2013Fi01).
2367.17 5	0.58 6	2397.206	4 ⁻	29.8299	3 ⁻	$\sigma_\gamma=0.0177$ b 8 (2013Fi01).
^x 2373.74 5	0.102 11					$\sigma_\gamma=0.0074$ b 6 (2013Fi01).
2375.85 ^a 5	0.113 12	4666.46	(2 ⁻)	2290.531	3 ⁻	
^x 2384.99 11	0.141 15					$\sigma_\gamma=0.0042$ b 5 (2013Fi01).
2389.18 5	1.34 13	2419.167	2 ⁻	29.8299	3 ⁻	$\sigma_\gamma=0.0339$ b 11 (2013Fi01).
2393.84 ^a 12	0.108 12	4463.61	(1 ⁻ ,2,3,4 ⁻)	2069.805	3 ⁻	$\sigma_\gamma=0.0026$ b 6 (2013Fi01).
2397.12 6	0.224 23	2397.206	4 ⁻	0.0	4 ⁻	$\sigma_\gamma=0.0061$ b 6 (2013Fi01).
2403.04 ^b 9	0.119 13	5189.86	(2 ⁻)	2786.646	3 ⁺	$\sigma_\gamma=0.0038$ b 6 (2013Fi01). E _γ : placed by 1984Vo01 from 4473 level.

³⁹K(n,γ),(pol n,γ) E=thermal 1984Vo01,2013Fi01,1972Op01 (continued)

γ(⁴⁰K) (continued)

E _γ [†]	I _γ ^{‡d}	E _i (level)	J _i ^π	E _f	J _f ^π	Comments
2416.06 ^a 11	0.194 23	4463.61	(1 ⁻ ,2,3,4 ⁻)	2047.339	2 ⁻	
2418.69 15	0.63 6	2419.167	2 ⁻	0.0	4 ⁻	σ _γ =0.0158 b 8 (2013Fi01).
2422.1 ^{@f}		2422.1?		0.0	4 ⁻	
^x 2424.66 5	0.54 6					σ _γ =0.0123 b 8 (2013Fi01).
2428.28 9	0.25 3	3228.66	2 ⁻	800.1430	2 ⁻	
^x 2448.11 17	0.045 6					
^x 2450.5 3	0.031 5					
2454.7 3	0.025 4	4744.134	(2 ⁺)	2289.871	1 ⁺	
2459.48 ^a 5	0.191 20	5189.86	(2 ⁻)	2730.356	1	σ _γ =0.0041 b 5 (2013Fi01).
2467.31 10	0.067 7	4110.82	2	1643.641	0 ⁺	σ _γ =0.0011 b 5 (2013Fi01).
						E _γ : also placed from 4537 level by 1984Vo01, resolved by 2013Fi01.
^x 2471.5 3	0.025 4					
2483.8 3	0.029 8	4744.134	(2 ⁺)	2260.48	3 ⁺	
2505.0 ^{@f}		3305.2?		800.1430	2 ⁻	
^x 2518.8 3	0.045 7					
2526.5 ^{@f}		3326.6?		800.1430	2 ⁻	
2528.44 11	0.139 15	4789.01	2 ⁻	2260.48	3 ⁺	
2539.87 ^{a&} 7	0.27 3	6098.24	(1 ⁻ ,2,3,4 ⁻)	3557.32	(1 ⁻ to 4 ⁺)	σ _γ =0.0041 b 5 (2013Fi01).
^x 2542.92 6	0.77 8					σ _γ =0.0099 b 6 (2013Fi01).
2545.85 10	2.8 3	2575.946	2 ⁺	29.8299	3 ⁻	σ _γ =0.0604 b 14 (2013Fi01).
2552.64 ^a 17	0.020 3	(7799.553)	1 ⁺ ,2 ⁺	5246.85		
^x 2557.03 13	0.027 4					
^x 2564.89 19	0.055 7					
2568.8 ^e 4	0.033 ^e 6	3367.98	(2,3) ⁻	800.1430	2 ⁻	
2568.8 ^e 4	0.033 ^e 6	4213.03	(2 ⁻ ,3 ⁺)	1643.641	0 ⁺	
^x 2572.08 11	0.113 13					
2573.2 ^{@f}		3373.4?		800.1430	2 ⁻	
2577.63 10	0.32 3	4537.06	(2 ⁻)	1959.072	2 ⁺	σ _γ =0.0059 b 6 (2013Fi01).
2586.06 ^a 14	0.094 11	(7799.553)	1 ⁺ ,2 ⁺	5213.70	2 ⁻	
^x 2589.23 11	0.146 16					
2593.32 10	0.50 5	3393.67	2 ⁻	800.1430	2 ⁻	σ _γ =0.0109 b 6 (2013Fi01).
^x 2604.0 4	0.12 3					σ _γ =0.0021 b 3 (2013Fi01).
2609.98 ^{b&} 9	1.40 9	(7799.553)	1 ⁺ ,2 ⁺	5189.86	(2 ⁻)	σ _γ =0.0240 b 8 (2013Fi01).
						E _γ : placed by 1984Vo01 from 4254 level.
2614.21 9	1.16 7	3414.35	2 ⁺	800.1430	2 ⁻	σ _γ =0.0186 b 7 (2013Fi01).
2627.7 ^{a&} 3	0.18 3	5023.92	(2 ⁻ ,3,4 ⁻)	2397.206	4 ⁻	σ _γ =0.0012 b 3 (2013Fi01).
2638.93 11	1.04 7	3439.145	(2 ⁺)	800.1430	2 ⁻	σ _γ =0.0162 b 7 (2013Fi01).
2644.0 3	0.26 4	5063.38	(2 ⁻ ,3 ⁺)	2419.167	2 ⁻	σ _γ =0.0032 b 5 (2013Fi01).
^x 2659.7 4	0.098 20					

³⁹K(n,γ),(pol n,γ) E=thermal 1984Vo01,2013Fi01,1972Op01 (continued)

γ(⁴⁰K) (continued)

$E_\gamma^\dagger$	$I_\gamma^{\ddagger d}$	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Comments
2668.8 ^a 4	0.107 20	4960.23	(2,3 ⁻)	2290.531	3 ⁻	$\sigma_\gamma=0.0019$ b 5 (2013Fi01).
2680.4 ^a 5	0.073 19	5488.76	(2 ⁻ ,3,4 ⁻)	2807.88	(1,2) ⁻	$\sigma_\gamma=0.0024$ b 6 (2013Fi01).
2685.6 3	0.24 5	3486.09	2 ⁻	800.1430	2 ⁻	$\sigma_\gamma=0.0045$ b 8 (2013Fi01).
						E_γ : also placed from 4789 level by 1984Vo01, resolved by 2013Fi01.
2688.1 ^{a f} 4	0.19 5	5111.9	(2,3) ⁻	2423.7?		E_γ : placed by 2013Fi01 to a level at 2324. But this level was neither observed in other work nor listed in Table 3 of populated levels in 2013Fi01. The evaluator have considered this placement as questionable.
						$\sigma_\gamma=0.0021$ b 7 (2013Fi01).
^x 2697.6 3	0.144 22					
2702.60 16	0.28 3	4993.14	(2 ⁻)	2290.531	3 ⁻	$\sigma_\gamma=0.0041$ b 7 (2013Fi01).
2716.95 11	0.50 4	2746.93	3 ⁻	29.8299	3 ⁻	$\sigma_\gamma=0.0088$ b 7 (2013Fi01).
2726.62 7	1.58 9	2756.674	2 ⁺	29.8299	3 ⁻	$\sigma_\gamma=0.0253$ b 10 (2013Fi01).
2728.2 ^{@ f}		3528.4?		800.1430	2 ⁻	
2736.09 9	0.83 5	(7799.553)	1 ⁺ ,2 ⁺	5063.38	(2 ⁻ ,3 ⁺)	$\sigma_\gamma=0.0130$ b 8 (2013Fi01).
2747.00 18	0.26 3	2746.93	3 ⁻	0.0	4 ⁻	$\sigma_\gamma=0.0034$ b 6 (2013Fi01).
2755.2 ^{@ f}		3557.32	(1 ⁻ to 4 ⁺)	800.1430	2 ⁻	
2756.81 7	1.93 10	2786.646	3 ⁺	29.8299	3 ⁻	$\sigma_\gamma=0.0307$ b 11 (2013Fi01).
2775.21 ^a 17	0.27 3	(7799.553)	1 ⁺ ,2 ⁺	5023.92	(2 ⁻ ,3,4 ⁻)	$\sigma_\gamma=0.0038$ b 6 (2013Fi01).
2778.1 ^{@ f}		3578.3?		800.1430	2 ⁻	
2784.4 4	0.21 5	4744.134	(2 ⁺)	1959.072	2 ⁺	$\sigma_\gamma=0.0044$ b 6 (2013Fi01).
2787.0 6	0.14 5	2786.646	3 ⁺	0.0	4 ⁻	
2799.30 18	0.95 10	3599.223	2 ⁻	800.1430	2 ⁻	$\sigma_\gamma=0.0163$ b 8 (2013Fi01).
2806.53 12	1.76 13	(7799.553)	1 ⁺ ,2 ⁺	4993.14	(2 ⁻)	$\sigma_\gamma=0.0288$ b 10 (2013Fi01).
2839.71 ^{a&} 7	1.87 10	(7799.553)	1 ⁺ ,2 ⁺	4960.23	(2,3 ⁻)	$\sigma_\gamma=0.0322$ b 10 (2013Fi01).
2855.4 ^{@ f}		3655.6?		800.1430	2 ⁻	
2857.15 ^{a&} 15	0.29 3	4960.23	(2,3 ⁻)	2103.682	1 ⁻	$\sigma_\gamma=0.0063$ b 6 (2013Fi01).
2892.19 ^a 15	0.36 3	4851.22	(2 ⁻ ,3,4 ⁺)	1959.072	2 ⁺	$\sigma_\gamma=0.0071$ b 6 (2013Fi01).
^x 2897.9 7	0.061 20					
2909.3 ^{@ f}		3709.5?		800.1430	2 ⁻	
2912.6 ^b 3	0.145 21	4960.23	(2,3 ⁻)	2047.339	2 ⁻	$\sigma_\gamma=0.0037$ b 6 (2013Fi01).
						E_γ : placed by 1984Vo01 from 4873 level.
2916.3 ^{@ f}		2946.2?		29.8299	3 ⁻	
^x 2917.81 9	0.89 5					$\sigma_\gamma=0.0148$ b 8 (2013Fi01).
2919.4 ^{@ f}		3719.6?		800.1430	2 ⁻	
2922.91 20	0.33 3	4993.14	(2 ⁻)	2069.805	3 ⁻	$\sigma_\gamma=0.0068$ b 7 (2013Fi01).
2925.1 ^{@ f}		2925.1?		0.0	4 ⁻	
2926.85 10	0.73 5	(7799.553)	1 ⁺ ,2 ⁺	4872.58	(2,3) ⁻	$\sigma_\gamma=0.0116$ b 8 (2013Fi01).
2938.32 9	0.67 4	3738.47	1 ⁺	800.1430	2 ⁻	$\sigma_\gamma=0.0109$ b 7 (2013Fi01).

³⁹K(n,γ),(pol n,γ) E=thermal 1984Vo01,2013Fi01,1972Op01 (continued)

γ(⁴⁰K) (continued)

E _γ [†]	I _γ ^{‡d}	E _i (level)	J _i ^π	E _f	J _f ^π	Comments
2949.23 ^{a&} 15	0.63 4	(7799.553)	1 ⁺ ,2 ⁺	4851.22	(2 ⁻ ,3,4 ⁺)	σ _γ =0.0099 b 7 (2013Fi01).
2955.94 16	0.41 3	2985.86	(2 ⁻ ,3 ⁺)	29.8299	3 ⁻	σ _γ =0.0056 b 6 (2013Fi01).
2967.8 3	0.163 19	3768.49	(2) ⁻	800.1430	2 ⁻	σ _γ =0.0027 b 5 (2013Fi01).
2992.60 ^{a&} 14	0.50 3	(7799.553)	1 ⁺ ,2 ⁺	4807.76	(0,1,2,3) ⁻	σ _γ =0.0073 b 8 (2013Fi01).
^x 3000.4 3	0.133 17					
3007.6 ^{@f}		3807.8?		800.1430	2 ⁻	
3010.55 14	0.50 3	(7799.553)	1 ⁺ ,2 ⁺	4789.01	2 ⁻	σ _γ =0.0079 b 8 (2013Fi01).
3027.7 3	0.139 18	3027.971	(2 ⁻ ,3 ⁺)	0.0	4 ⁻	σ _γ =0.0027 b 6 (2013Fi01).
3034.43 ^a 17	0.293 24	4993.14	(2) ⁻	1959.072	2 ⁺	σ _γ =0.0077 b 6 (2013Fi01).
3040.24 13	0.62 4	3840.254	(1,2 ⁺)	800.1430	2 ⁻	σ _γ =0.0101 b 7 (2013Fi01).
3055.58 12	2.86 17	(7799.553)	1 ⁺ ,2 ⁺	4744.134	(2 ⁺)	σ _γ =0.0523 b 14 (2013Fi01).
3056.2 ^{@f}		3856.4?		800.1430	2 ⁻	
3063.5 ^{@f}		3063.5?		0.0	4 ⁻	
3063.9 ^{@f}		3093.8?		29.8299	3 ⁻	
3068.7 4	0.25 4	3868.67	2 ⁻	800.1430	2 ⁻	σ _γ =0.0051 b 6 (2013Fi01).
3088.3 5	0.19 4	3887.83	(1 ⁻ ,2 ⁻)	800.1430	2 ⁻	σ _γ =0.0038 b 7 (2013Fi01).
3098.56 20	0.37 14	3128.463	(2 ⁻ ,3 ⁺)	29.8299	3 ⁻	σ _γ =0.0143 b 8 (2013Fi01).
3100.42 20	0.37 14	4744.134	(2 ⁺)	1643.641	0 ⁺	
3128.06 13	0.61 4	3128.463	(2 ⁻ ,3 ⁺)	0.0	4 ⁻	σ _γ =0.0093 b 6 (2013Fi01).
3132.8 ^{@f}		3933.0?		800.1430	2 ⁻	
3133.49 ^{a&} 14	0.51 4	(7799.553)	1 ⁺ ,2 ⁺	4666.46	(2 ⁻)	σ _γ =0.0075 b 6 (2013Fi01).
3137.3 [#] 4	0.102 [#] 21	(7799.553)	1 ⁺ ,2 ⁺	4662.29	(2 ⁻)	σ _γ =0.0024 b 5 (2013Fi01).
3140.7 ^{@f}		3140.7?		0.0	4 ⁻	
3144.30 ^b 19	0.28 3	5213.70	2 ⁻	2069.805	3 ⁻	σ _γ =0.0046 b 5 (2013Fi01).
						E _γ : placed by 1984Vo01 from 4789 level.
3153.5 3	0.38 3	3153.84	(2 ⁻ ,3)	0.0	4 ⁻	σ _γ =0.0044 b 5 (2013Fi01).
3198.6 3	0.146 22	3228.66	2 ⁻	29.8299	3 ⁻	σ _γ =0.0034 b 5 (2013Fi01).
^x 3204.7 4	0.101 20					σ _γ =0.0021 b 5 (2013Fi01).
^x 3214.12 24	0.223 24					σ _γ =0.0048 b 5 (2013Fi01).
3220.08 21	0.24 3	4020.36	(2) ⁻	800.1430	2 ⁻	σ _γ =0.0055 b 6 (2013Fi01).
3229.4 4	0.128 21	3228.66	2 ⁻	0.0	4 ⁻	σ _γ =0.0024 b 5 (2013Fi01).
3255.9 ^a 4	0.37 7	(7799.553)	1 ⁺ ,2 ⁺	4544.12	(2 ⁻)	σ _γ =0.0066 b 6 (2013Fi01).
3258.1 ^{@f}		4058.3?		800.1430	2 ⁻	
3262.56 12	2.43 17	(7799.553)	1 ⁺ ,2 ⁺	4537.06	(2 ⁻)	σ _γ =0.0423 b 12 (2013Fi01).
3286.4 8	0.15 5	4179.99	(3 ⁻)	891.404	5 ⁻	
3304.24 11	0.99 7	4104.47	(1 ⁻ ,2,3 ⁻)	800.1430	2 ⁻	σ _γ =0.0164 b 8 (2013Fi01).
3310.9 5	0.12 3	4110.82	2	800.1430	2 ⁻	σ _γ =0.0026 b 5 (2013Fi01).
3326.44 12	0.79 6	(7799.553)	1 ⁺ ,2 ⁺	4473.05	(2 ⁻ ,3,4 ⁻)	σ _γ =0.0141 b 8 (2013Fi01).
3326.6 ^{@f}		3326.6?		0.0	4 ⁻	

³⁹K(n,γ),(pol n,γ) E=thermal 1984Vo01,2013Fi01,1972Op01 (continued)

γ(⁴⁰K) (continued)

E _γ [†]	I _γ ^{‡d}	E _i (level)	J _i ^π	E _f	J _f ^π	Comments
3336.3 ^b 10	1.7 8	(7799.553)	1 ⁺ ,2 ⁺	4463.61	(1 ⁻ ,2,3,4 ⁻)	σ _γ =0.0184 b 15 (2013Fi01). E _γ : placed by 1984Vo01 from 3368 level.
3338.2 [#] 3	0.24 [#] 6	3367.98	(2,3) ⁻	29.8299	3 ⁻	E _γ : 3339.1 6 (1972Op01), also placed by 1972Op01. σ _γ =0.0056 b 14 (2013Fi01).
3348.91 10	1.12 7	4149.03	(2 ⁻ ,3 ⁺)	800.1430	2 ⁻	σ _γ =0.0194 b 9 (2013Fi01).
3368.9 6	0.10 3	3367.98	(2,3) ⁻	0.0	4 ⁻	σ _γ =0.0021 b 5 (2013Fi01).
3380.3 4	0.22 4	(7799.553)	1 ⁺ ,2 ⁺	4419.38	(2 ⁻ ,3,4 ⁺)	σ _γ =0.0044 b 6 (2013Fi01).
3384.66 24	0.40 5	3414.35	2 ⁺	29.8299	3 ⁻	σ _γ =0.0070 b 7 (2013Fi01).
3403.59 11	1.00 7	(7799.553)	1 ⁺ ,2 ⁺	4395.86	(2) ⁻	σ _γ =0.0188 b 9 (2013Fi01).
3418.5 [#] 6	0.08 [#] 3	5488.76	(2 ⁻ ,3,4 ⁻)	2069.805	3 ⁻	E _γ : 3419.2 8, unplaced in 1970Jo04. σ _γ =0.0019 b 6 (2013Fi01).
3428.9 ^{@f}		3428.9?		0.0	4 ⁻	
^x 3429.8 7	0.09 3					
3448.8 [#] 5	0.33 [#] 8	(7799.553)	1 ⁺ ,2 ⁺	4350.69	(2) ⁻	E _γ : 3448.7 8, unplaced in 1970Jo04; 3447.0 5, unplaced in 1972Op01. σ _γ =0.0078 b 18 (2013Fi01).
3452.2 10	1.71 10	4253.68	(1,2) ⁻	800.1430	2 ⁻	σ _γ =0.0278 b 16 (2013Fi01).
3480.6 5	0.13 3	4280.51	2 ⁻	800.1430	2 ⁻	σ _γ =0.0015 b 9 (2013Fi01).
3517.7 ^{@f}		3517.7?		0.0	4 ⁻	
3518.85 10	1.05 7	(7799.553)	1 ⁺ ,2 ⁺	4280.51	2 ⁻	σ _γ =0.0209 b 10 (2013Fi01).
3526.99 ^{&} 10	1.02 7	3557.32	(1 ⁻ to 4 ⁺)	29.8299	3 ⁻	σ _γ =0.0191 b 10 (2013Fi01).
3545.95 ^{&} 6	4.7 3	(7799.553)	1 ⁺ ,2 ⁺	4253.68	(1,2) ⁻	σ _γ =0.0840 b 20 (2013Fi01).
3548.8 [#] 4	0.29 [#] 8	(7799.553)	1 ⁺ ,2 ⁺	4251.59	(1,2) ⁻	σ _γ =0.0068 b 18 (2013Fi01).
3569.30 8	0.45 3	3599.223	2 ⁻	29.8299	3 ⁻	σ _γ =0.0082 b 7 (2013Fi01).
^x 3578.2 3	0.070 12					
3586.53 13	0.217 17	(7799.553)	1 ⁺ ,2 ⁺	4213.03	(2 ⁻ ,3 ⁺)	σ _γ =0.0038 b 6 (2013Fi01).
3599.62 20	0.185 19	3629.98	2 ⁻ ,3 ⁻	29.8299	3 ⁻	σ _γ =0.0033 b 6 (2013Fi01).
3619.40 6	0.77 4	(7799.553)	1 ⁺ ,2 ⁺	4179.99	(3) ⁻	σ _γ =0.0146 b 9 (2013Fi01).
3629.94 15	0.33 3	3629.98	2 ⁻ ,3 ⁻	0.0	4 ⁻	σ _γ =0.0071 b 7 (2013Fi01).
3633.88 9	0.63 4	3663.798	(1 ⁻ ,2,3,4 ⁺)	29.8299	3 ⁻	σ _γ =0.0105 b 8 (2013Fi01).
3650.34 5	2.22 11	(7799.553)	1 ⁺ ,2 ⁺	4149.03	(2 ⁻ ,3 ⁺)	σ _γ =0.0400 b 15 (2013Fi01).
3663.32 ^b 9	0.44 3	4463.61	(1 ⁻ ,2,3,4 ⁻)	800.1430	2 ⁻	σ _γ =0.0070 b 7 (2013Fi01).
3683.3 [#] 5	0.10 [#] 3	3713.09	(2) ⁻	29.8299	3 ⁻	σ _γ =0.0024 b 6 (2013Fi01).
3688.67 15	1.49 12	(7799.553)	1 ⁺ ,2 ⁺	4110.82	2	σ _γ =0.0311 b 12 (2013Fi01).
3695.15 11	1.43 10	(7799.553)	1 ⁺ ,2 ⁺	4104.47	(1 ⁻ ,2,3 ⁻)	σ _γ =0.0260 b 11 (2013Fi01).
3737.01 10	1.14 7	4537.06	(2) ⁻	800.1430	2 ⁻	σ _γ =0.0217 b 7 (2013Fi01).
3743.2 ^a 3	0.21 3	4544.12	(2) ⁻	800.1430	2 ⁻	σ _γ =0.0029 b 5 (2013Fi01).
^x 3764.84 19	0.180 17					σ _γ =0.0035 b 6 (2013Fi01).
3778.99 10	0.93 6	(7799.553)	1 ⁺ ,2 ⁺	4020.36	(2) ⁻	σ _γ =0.0161 b 8 (2013Fi01).
3791.9 3	0.18 3	3821.47	2 ⁻	29.8299	3 ⁻	σ _γ =0.0037 b 6 (2013Fi01).

³⁹K(n,γ),(pol n,γ) E=thermal 1984Vo01,2013Fi01,1972Op01 (continued)γ(⁴⁰K) (continued)

$E_\gamma^\dagger$	$I_\gamma^{\ddagger d}$	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Comments
3822.17 ^{a&} 13	0.264 19	3821.47	2 ⁻	0.0	4 ⁻	E_γ : 3820.5 (2002Va28), also placed by 2002Va28 from $\gamma\gamma$ -coin. $\sigma_\gamma=0.0052$ b 6 (2013Fi01). $\sigma_\gamma=0.0126$ b 8 (2013Fi01). $\sigma_\gamma=0.0054$ b 6 (2013Fi01).
3838.50 7	0.62 4	3868.67	2 ⁻	29.8299	3 ⁻	
3857.97 11	0.305 21	3887.83	(1 ⁻ ,2 ⁻)	29.8299	3 ⁻	
3868.3 10	0.12 5	3868.67	2 ⁻	0.0	4 ⁻	
3874.7 3	0.28 6	(7799.553)	1 ⁺ ,2 ⁺	3924.15	(2 ⁻ ,3 ⁺)	$\sigma_\gamma=0.0090$ b 7 (2013Fi01).
3895.7 11	0.21 11	3924.15	(2 ⁻ ,3 ⁺)	29.8299	3 ⁻	
^x 3899.0 7	0.32 11					$\sigma_\gamma=0.0078$ b 8 (2013Fi01).
3911.49 18	0.96 9	(7799.553)	1 ⁺ ,2 ⁺	3887.83	(1 ⁻ ,2 ⁻)	$\sigma_\gamma=0.0189$ b 10 (2013Fi01).
3930.64 5	1.56 8	(7799.553)	1 ⁺ ,2 ⁺	3868.67	2 ⁻	$\sigma_\gamma=0.0310$ b 12 (2013Fi01).
3943.81 6	0.98 5	4744.134	(2 ⁺)	800.1430	2 ⁻	$\sigma_\gamma=0.0195$ b 10 (2013Fi01).
3959.19 5	1.48 8	(7799.553)	1 ⁺ ,2 ⁺	3840.254	(1,2 ⁺)	$\sigma_\gamma=0.0284$ b 11 (2013Fi01).
3977.83 5	1.29 7	(7799.553)	1 ⁺ ,2 ⁺	3821.47	2 ⁻	$\sigma_\gamma=0.0247$ b 11 (2013Fi01).
3989.07 ^a 14	0.242 19	4789.01	2 ⁻	800.1430	2 ⁻	$\sigma_\gamma=0.0038$ b 6 (2013Fi01).
4001.78 5	1.61 9	(7799.553)	1 ⁺ ,2 ⁺	3797.55	1 ⁺	$\sigma_\gamma=0.0296$ b 12 (2013Fi01).
4008.1 ^a 3	0.139 15	4807.76	(0,1,2,3) ⁻	800.1430	2 ⁻	
4031.58 ^{&} 14	0.221 17	(7799.553)	1 ⁺ ,2 ⁺	3768.49	(2) ⁻	$\sigma_\gamma=0.0047$ b 5 (2013Fi01).
4060.92 5	1.53 8	(7799.553)	1 ⁺ ,2 ⁺	3738.47	1 ⁺	$\sigma_\gamma=0.0275$ b 11 (2013Fi01).
4080.69 12	0.325 22	4110.82	2	29.8299	3 ⁻	$\sigma_\gamma=0.0066$ b 7 (2013Fi01).
4086.13 ^a 9	0.46 3	(7799.553)	1 ⁺ ,2 ⁺	3713.09	(2) ⁻	$\sigma_\gamma=0.0079$ b 8 (2013Fi01).
4106.7 ^{@f}		4906.9?		800.1430	2 ⁻	
4110.39 [#] 20	0.32 [#] 3	4110.82	2	0.0	4 ⁻	E_γ : 4110.6 from 2002Va28, 4110.7 8 from 1972Op01, 4111.4 10 from 1970Jo04. Also placed by 2002Va28. $\sigma_\gamma=0.0075$ b 7 (2013Fi01).
4118.5 ^{@f}		4149.03	(2 ⁻ ,3 ⁺)	29.8299	3 ⁻	
4135.58 5	3.41 18	(7799.553)	1 ⁺ ,2 ⁺	3663.798	(1 ⁻ ,2,3,4 ⁺)	$\sigma_\gamma=0.0634$ b 19 (2013Fi01).
4135.6 ^{@f}		4165.4?		29.8299	3 ⁻	
4148.4 3	0.134 18	4149.03	(2 ⁻ ,3 ⁺)	0.0	4 ⁻	
4165.4 ^{@f}		4165.4?		0.0	4 ⁻	
4169.31 9	0.71 4	(7799.553)	1 ⁺ ,2 ⁺	3629.98	2 ⁻ ,3 ⁻	$\sigma_\gamma=0.0134$ b 8 (2013Fi01).
4200.04 5	2.23 12	(7799.553)	1 ⁺ ,2 ⁺	3599.223	2 ⁻	$\sigma_\gamma=0.0448$ b 16 (2013Fi01).
4223.66 7	0.83 5	4253.68	(1,2) ⁻	29.8299	3 ⁻	$\sigma_\gamma=0.0141$ b 9 (2013Fi01).
4242.47 ^{&} 11	0.45 3	(7799.553)	1 ⁺ ,2 ⁺	3557.32	(1 ⁻ to 4 ⁺)	$\sigma_\gamma=0.0092$ b 9 (2013Fi01).
4249.5 4	0.119 16	4280.51	2 ⁻	29.8299	3 ⁻	
4280.35 22	0.37 4	4280.51	2 ⁻	0.0	4 ⁻	$\sigma_\gamma=0.0071$ b 5 (2013Fi01).
4312.8 3	0.28 4	(7799.553)	1 ⁺ ,2 ⁺	3486.09	2 ⁻	$\sigma_\gamma=0.0055$ b 5 (2013Fi01).
4319.6 [#] 5	0.068 [#] 13	4350.69	(2 ⁻)	29.8299	3 ⁻	$\sigma_\gamma=0.0016$ b 3 (2013Fi01).
4360.19 6	4.33 24	(7799.553)	1 ⁺ ,2 ⁺	3439.145	(2 ⁺)	$\sigma_\gamma=0.0874$ b 24 (2013Fi01).
4384.95 7	1.47 8	(7799.553)	1 ⁺ ,2 ⁺	3414.35	2 ⁺	$\sigma_\gamma=0.0278$ b 12 (2013Fi01).

³⁹K(n,γ),(pol n,γ) E=thermal 1984Vo01,2013Fi01,1972Op01 (continued)

γ(⁴⁰K) (continued)

E _γ [†]	I _γ ^{‡d}	E _i (level)	J _i ^π	E _f	J _f ^π	Comments
4389.32 ^b 18	0.37 3	5189.86	(2 ⁻)	800.1430	2 ⁻	σ _γ =0.0057 b 8 (2013Fi01). E _γ : placed by 1984Vo01 from 4419 level.
4405.36 11	0.42 3	(7799.553)	1 ⁺ ,2 ⁺	3393.67	2 ⁻	σ _γ =0.0073 b 8 (2013Fi01).
^x 4421.15 14	0.294 22					σ _γ =0.0056 b 7 (2013Fi01).
4431.17 16	0.59 5	(7799.553)	1 ⁺ ,2 ⁺	3367.98	(2,3) ⁻	σ _γ =0.0105 b 9 (2013Fi01).
4472.80 11	0.40 3	4473.05	(2 ⁻ ,3,4 ⁻)	0.0	4 ⁻	σ _γ =0.0074 b 5 (2013Fi01).
4506.96 7	0.77 5	4537.06	(2 ⁻)	29.8299	3 ⁻	σ _γ =0.0179 b 10 (2013Fi01).
4652.94 8	0.52 3	(7799.553)	1 ⁺ ,2 ⁺	3146.42	1 ⁽⁻⁾	σ _γ =0.0124 b 8 (2013Fi01).
4662.1 [#] 3	0.21 [#] 3	4662.29	(2 ⁻)	0.0	4 ⁻	σ _γ =0.0050 b 6 (2013Fi01).
4667.0 ^a 4	0.110 21	4666.46	(2 ⁻)	0.0	4 ⁻	
4670.84 10	0.66 4	(7799.553)	1 ⁺ ,2 ⁺	3128.463	(2 ⁻ ,3 ⁺)	σ _γ =0.0190 b 10 (2013Fi01).
4688.9 5	0.052 11	(7799.553)	1 ⁺ ,2 ⁺	3109.56	1 ⁺ ,2 ⁺	σ _γ =0.0018 b 5 (2013Fi01).
4842.8 4	0.076 12	4872.58	(2,3) ⁻	29.8299	3 ⁻	
4851.16 ^a 25	0.120 13	4851.22	(2 ⁻ ,3,4 ⁺)	0.0	4 ⁻	σ _γ =0.0020 b 7 (2013Fi01).
4860.4 ^{@f}		(7799.553)	1 ⁺ ,2 ⁺	2939.2?		
4872.47 14	0.252 19	4872.58	(2,3) ⁻	0.0	4 ⁻	
4874.5 ^{@f}		(7799.553)	1 ⁺ ,2 ⁺	2925.1?		
4906.9 ^{@f}		4906.9?		0.0	4 ⁻	E _γ : 1972Op01 report a γ ray at E=4908.6 13 placed from a 4908 level. This γ ray was not observed in 1984Vo01 and 2013Fi01.
^x 4912.4 7	0.044 11					
4929.3 ^a 3	0.183 21	4960.23	(2,3) ⁻	29.8299	3 ⁻	σ _γ =0.0028 b 5 (2013Fi01).
4962.2 4	0.107 19	4993.14	(2 ⁻)	29.8299	3 ⁻	
4991.38 5	2.18 11	(7799.553)	1 ⁺ ,2 ⁺	2807.88	(1,2) ⁻	σ _γ =0.0487 b 16 (2013Fi01).
4993.9 ^{@f}		4993.14	(2 ⁻)	0.0	4 ⁻	
5012.47 6	1.17 6	(7799.553)	1 ⁺ ,2 ⁺	2786.646	3 ⁺	σ _γ =0.0255 b 12 (2013Fi01).
5042.43 6	1.78 9	(7799.553)	1 ⁺ ,2 ⁺	2756.674	2 ⁺	σ _γ =0.0395 b 17 (2013Fi01).
5062.9 4	0.070 9	5063.38	(2 ⁻ ,3 ⁺)	0.0	4 ⁻	
5068.65 ^{&} 6	1.25 7	(7799.553)	1 ⁺ ,2 ⁺	2730.356	1	σ _γ =0.0252 b 14 (2013Fi01).
5111.5 [#] 7	0.081 [#] 21	5111.9	(2,3) ⁻	0.0	4 ⁻	σ _γ =0.0019 b 5 (2013Fi01).
5173.19 5	2.30 12	(7799.553)	1 ⁺ ,2 ⁺	2626.003	0 ⁻	σ _γ =0.0454 b 17 (2013Fi01). E _γ : 5073.19 in 1984Vo01 is a misprint.
5181.5 ^{@f}		(7799.553)	1 ⁺ ,2 ⁺	2618.1?		
5188.8 ^a 3	0.053 6	5189.86	(2 ⁻)	0.0	4 ⁻	
5216.9 ^a 6	0.020 4	5246.85		29.8299	3 ⁻	
5223.14 7	0.377 20	(7799.553)	1 ⁺ ,2 ⁺	2575.946	2 ⁺	σ _γ =0.0099 b 9 (2013Fi01).
^x 5228.86 24	0.057 5					
5377.5 ^{@f}		(7799.553)	1 ⁺ ,2 ⁺	2422.1?		
5379.84 6	7.9 4	(7799.553)	1 ⁺ ,2 ⁺	2419.167	2 ⁻	σ _γ =0.164 b 5 (2013Fi01).

³⁹K(n,γ),(pol n,γ) E=thermal 1984Vo01,2013Fi01,1972Op01 (continued)

$\gamma(^{40}\text{K})$ (continued)						Comments
$E_\gamma^\dagger$	$I_\gamma^{\ddagger d}$	$E_i(\text{level})$	J_i^π	E_f	J_f^π	
5488.5 [#] 5	0.14 [#] 3	5488.76	(2 ⁻ ,3,4 ⁻)	0.0	4 ⁻	E_γ : 5489.3 15, unplaced in 1970Jo04. $\sigma_\gamma=0.0033$ b 6 (2013Fi01). $\sigma_\gamma=0.0674$ b 21 (2013Fi01).
5509.12 7	3.17 16	(7799.553)	1 ⁺ ,2 ⁺	2289.871	1 ⁺	
5528.5 ^{@f}		(7799.553)	1 ⁺ ,2 ⁺	2271.1?		
5695.38 7	5.6 3	(7799.553)	1 ⁺ ,2 ⁺	2103.682	1 ⁻	$\sigma_\gamma=0.128$ b 3 (2013Fi01).
5723.5 ^{@f}		(7799.553)	1 ⁺ ,2 ⁺	2076.1?		
5729.21 7	2.28 12	(7799.553)	1 ⁺ ,2 ⁺	2069.805	3 ⁻	$\sigma_\gamma=0.0492$ b 20 (2013Fi01).
5751.60 7	5.5 3	(7799.553)	1 ⁺ ,2 ⁺	2047.339	2 ⁻	$\sigma_\gamma=0.122$ b 3 (2013Fi01).
5921.9 ^{@f}		(7799.553)	1 ⁺ ,2 ⁺	1877.7?		
6067.6 ^a 3	0.050 5	6098.24	(1 ⁻ ,2,3,4 ⁻)	29.8299	3 ⁻	$\sigma_\gamma=0.0014$ b 3 (2013Fi01).
6243.0 ^{@f}		(7799.553)	1 ⁺ ,2 ⁺	1556.6?		
6278.9 ^{@f}		(7799.553)	1 ⁺ ,2 ⁺	1520.7?		
6310.9 ^{@f}		6311?		0.0	4 ⁻	
6390.4 ^{@f}		(7799.553)	1 ⁺ ,2 ⁺	1409.2?		
6469.1 ^{@f}		(7799.553)	1 ⁺ ,2 ⁺	1330.5?		
6551.2 ^{@f}		(7799.553)	1 ⁺ ,2 ⁺	1248.4?		
6571.4 ^{@f}		(7799.553)	1 ⁺ ,2 ⁺	1228.2?		
6626.2 ^{@f}		(7799.553)	1 ⁺ ,2 ⁺	1173.4?		
6715.3 ^{@f}		(7799.553)	1 ⁺ ,2 ⁺	1084.3?		
6998.77 10	2.15 11	(7799.553)	1 ⁺ ,2 ⁺	800.1430	2 ⁻	$\sigma_\gamma=0.0503$ b 23 (2013Fi01).
7277.9 ^{@f}		(7799.553)	1 ⁺ ,2 ⁺	521.7?		
7768.75 19	5.6 3	(7799.553)	1 ⁺ ,2 ⁺	29.8299	3 ⁻	$\sigma_\gamma=0.113$ b 5 (2013Fi01).

[†] From 1984Vo01, unless otherwise noted. Values reported in 2013Fi01 are in a good agreement with the quoted values here but with less precision. Extensive E_γ and I_γ data are also available from 1972Op01 1970Jo04, but are much less precise, thus not considered here.

[‡] From 1984Vo01, unless otherwise noted. To convert relative I_γ values in 1984Vo01 to cross section values, multiply by 0.0235 3, which is obtained by 2013Fi01 from a least-squares fit to their cross-section values versus the corresponding relative I_γ values in 1984Vo01. Cross-section values from 2013Fi01 are given under comments.

[§] Based on $\gamma(\text{circ pol})$ in 1974Op01, unless otherwise noted.

[&] Uncertainties were increased by a factor of 2 in the least-squares fit, except for 554.741 γ , 1213.53 γ , 1393.16 γ , 1466.11 γ , 1820.35 γ , and 2539.87 γ , increased by a factor of 4. Poor fit for 554.741 γ with the fitted energy deviates by about 5 times the quoted energy uncertainty.

[@] From $\gamma\gamma$ -coin data of 2002Va28.

[#] Observed and placed in 2013Fi01, not observed in 1984Vo01. Relative intensities are deduced by evaluator by dividing cross-section values in 2013Fi01 by 0.0235 3.

^a Placed by 2013Fi01, unplaced in 1984Vo01.

^b Placed by 2013Fi01, placed differently in 1984Vo01.

^c From $\gamma\gamma(\theta)$ in 1988Se06.

³⁹K(n,γ),(pol n,γ) E=thermal [1984Vo01](#),[2013Fi01](#),[1972Op01](#) (continued)

γ(⁴⁰K) (continued)

^d Intensity per 100 neutron captures.

^e Multiply placed with undivided intensity.

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

^x γ ray not placed in level scheme.

$^{39}\text{K}(\text{n},\gamma),(\text{n},\text{n}):$ resonances 2006MuZX,1984Ma40,1973Si32

$J\pi(^{39}\text{K g.s.})=3/2^+$.

2006MuZX: Compilation of thermal neutron induced σ and resonance parameter data for nuclei of $Z=1-100$.

1984Ma40: $E=1-152$ keV neutron beams were provided by the Oak Ridge Electron Linear Accelerator (ORELA). Target was a natural potassium sample (93.26% in ^{39}K). Neutron energies were measured using time-of-flight with a 40-m flight path. Capture γ rays were detected by a pair of nonhydrogenous liquid scintillators. Measured yields. Deduced resonance energies, J , widths. A total of 64 resonances reported up to $E_n(\text{lab})=152.0$ keV.

1973Si32 (also 1971SiYI): $E=1-200$ keV. Natural target. A total 35 resonances (8 tentative) assigned to ^{40}K , up to $E_n(\text{lab})=193.1$ keV. Deduced resonance energies, J , $L(\text{n})$, widths.

Others:.

2008GuZQ: $E=10-64$ keV. Measured E_γ , I_γ . Deduced σ .

1960La05: analysis of resonance data.

1958Go01: total neutron cross sections in keV region.

 ^{40}K Levels

All resonance parameters including resonance neutron energies, $J\pi$, L , $g\Gamma_n$ and Γ_γ are directly adopted from the compilation in 2006MuZX and are based on data from 1984Ma40 and 1973Si32.

$E(\text{level})^\dagger$	$J\pi^\ddagger$	$g\Gamma_n\Gamma_\gamma/\Gamma^\#$	L	$E_n(\text{lab})$ (keV)	Comments
7800.70 6	(0 to 3) ⁻	0.0075 eV 5	1	1.108 1	$2g\Gamma_n=0.015$ eV 1.
7802.82 6	(0 to 3) ⁻	0.0653 eV 2	1	3.281 3	$2g\Gamma_n=0.1000$ eV 15.
7808.77 6	1 ⁺	0.172 eV 3	0	9.386 9	$2g\Gamma_n=54$ eV 6, $\Gamma_\gamma=0.463$ eV 8.
7811.47 6		0.0412 eV 7		12.159 13	
7811.93 6	3 ⁻	0.2577 eV 15	1	12.626 13	$2g\Gamma_n=1.3$ eV 3, $\Gamma_\gamma=0.488$ eV 5.
7813.56 6	(2) ⁻	0.1176 eV 14	1	14.302 21	$2g\Gamma_n=0.81$ eV 17, $\Gamma_\gamma=0.266$ eV 5.
7815.18 6	2 ⁻	0.1496 eV 19	1	15.958 24	$2g\Gamma_n=1.69$ eV 30, $\Gamma_\gamma=0.291$ eV 4.
7815.91 6	(3 ⁻)	0.143 eV 2	(1)	16.715 14	$2g\Gamma_n=0.320$ eV 1, $\Gamma_\gamma=0.30$ EV.
7823.96 7		0.1145 eV 20		24.97 3	
7824.53 7	2 ⁺	0.246 eV 4	0	25.55 3	$2g\Gamma_n=118.4$ eV 34, $\Gamma_\gamma=0.396$ eV 7.
7827.26 7		0.2290 eV 15		28.36 3	
7830.98 7	3 ⁻	0.535 eV 8	1	32.17 3	$2g\Gamma_n=3.6$ eV, $\Gamma_\gamma=0.869$ eV 19.
7832.10 7	2 ⁻	0.184 eV 8	1	33.32 3	$2g\Gamma_n=16.2$ eV 11, $\Gamma_\gamma=0.301$ eV 14.
7836.23 8	(2 ⁻)	0.207 eV 6	(1)	37.56 6	$2g\Gamma_n=5.8$ eV, $\Gamma_\gamma=0.343$ eV 13.
7836.33 8	(2 ⁻)	0.194 eV 6	(1)	37.66 6	$2g\Gamma_n=5.8$ eV, $\Gamma_\gamma=0.322$ eV 13.
7841.26 7	2 ⁺	0.63 eV 3	0	42.72 4	$2g\Gamma_n=674$ eV 32, $\Gamma_\gamma=0.973$ eV 4.
7843.62 8		0.115 eV 5		45.14 5	
7844.45 8	2 ⁻	0.386 eV 10	1	45.99 5	$2g\Gamma_n=52$ eV 2, $\Gamma_\gamma=0.626$ eV 17.
7850.42 8	(2) ⁻	0.220 eV 8	1	52.12 5	$2g\Gamma_n=15.9$ eV 43, $\Gamma_\gamma=0.362$ eV 13.
7852.62 8		0.129 eV 6		54.37 6	
7852.79 8	2 ⁻	0.261 eV 9	1	54.55 6	$2g\Gamma_n=20.4$ eV 54, $\Gamma_\gamma=0.429$ eV 15.
7853.39 8		0.134 eV 7		55.16 6	
7854.04 8		0.107 eV 7		55.83 6	
7855.97 8	1 ⁺	0.55 eV 5	0	57.81 6	$2g\Gamma_n=804$ eV 80, $\Gamma_\gamma=1.47$ eV 13.
7856.94 8		0.144 eV 8		58.80 6	
7857.99 8	1 ⁻	0.076 eV 8	1	59.88 6	$2g\Gamma_n=62$ eV 10, $\Gamma_\gamma=0.203$ eV 21.
7860.29 8		0.185 eV 8		62.24 6	
7866.25 9	1	0.67 eV 8	(0)	68.35 7	$2g\Gamma_n=1454.00$ eV 18, $\Gamma_\gamma=1.78$ eV 21.
7866.80 9		0.184 eV 12		68.92 7	
7873.43 10		0.053 eV 7		75.72 8	
7878.23 10		0.279 eV 12		80.64 8	
7878.74 10		0.175 eV 10		81.17 8	
7882.37 10		0.095 eV 9		84.89 8	
7885.12 11	1 ⁻	0.11 eV 3	1	87.71 9	$2g\Gamma_n=350$ eV 40, $\Gamma_\gamma=0.283$ eV 43.
7890.06 11		0.210 eV 17	1	92.78 9	$2g\Gamma_n=36$ eV 9.
7890.36 11		0.254 eV 17	1	93.09 9	

Continued on next page (footnotes at end of table)

$^{39}\text{K}(\text{n},\gamma),(\text{n},\text{n}):$ resonances **2006MuZX,1984Ma40,1973Si32** (continued) ^{40}K Levels (continued)

E(level) [†]	$J^{\pi\dagger}$	$g\Gamma_n\Gamma_\gamma/\Gamma^\#$	L	$E_n(\text{lab})$ (keV)	Comments
7893.94 12		0.278 eV 24		96.76 10	$2g\Gamma_n=225$ eV 20.
7894.47 12		0.276 eV 24		97.31 10	$2g\Gamma_n=225$ eV 20.
7896.32 12	2^-	0.149 eV 19	1	99.20 10	$2g\Gamma_n=142$ eV 32, $\Gamma_\gamma=0.239$ eV 30.
7899.05 21	2^-	0.221 eV 19	1	102.0 2	$2g\Gamma_n=45$ eV 13, $\Gamma_\gamma=0.358$ eV 31.
7900.50 21		0.215 eV 19		103.49 20	
7901.41 21		0.299 eV 20		104.42 20	
7903.13 21		0.115 eV 17		106.19 20	
7905.46 21		0.180 eV 23		108.58 20	
7905.58 21	1^+	0.34 eV 9	0	108.7 2	$2g\Gamma_n=1500$ eV 320, $\Gamma_\gamma=0.96$ eV 24.
7906.44 21		0.159 eV 21		109.59 20	
7906.81 21		0.133 eV 18		109.96 20	
7911.78 25		0.125 eV 15		115.06 25	
7914.07 25		0.49 eV 9		117.41 25	
7915.41 25		0.128 eV 15		118.79 25	$2g\Gamma_n=77$ eV 13.
7916.7 3		0.198 eV 18		120.1 3	
7919.3 3	$(2)^-$	0.308 eV 21	1	122.8 3	$2g\Gamma_n=34$ eV 9, $\Gamma_\gamma=0.503$ eV 36.
7922.6 3	(2)	0.40 eV 3		126.2 3	$2g\Gamma_n=53.0$ eV 56, $\Gamma_\gamma=0.654$ eV 61.
7923.5 3		0.268 eV 20		127.1 3	
7924.3 3		0.04 eV 2		127.9 3	
7925.7 3		0.219 eV 20		129.4 3	
7931.5 3		0.25 eV 3		135.3 3	
7932.2 3		0.37 eV 4		136.0 3	
7932.8 3		0.66 eV 4		136.6 3	
7940.1 3	2^-	1.45 eV 6	1	144.1 3	$2g\Gamma_n=215$ eV 43.
7941.0 3		0.24 eV 3		145.1 3	
7943.1 3		0.37 eV 4		147.2 3	
7944.0 3		0.33 eV 3		148.1 3	
7947.8 4		0.25 eV 4		152.0 4	
7949.6 4	(3^-)		(1)	153.9 4	$2g\Gamma_n=1600$ eV 210.
7957.8 4			(1)	162.3 4	$2g\Gamma_n=940$ eV 110.
7972.7 4	1		(1)	177.6 4	$2g\Gamma_n=840$ eV 110.
7983.1 5			1	188.3 5	$2g\Gamma_n=210$ eV 43.
7987.8 5	1^+		0	193.1 5	$2g\Gamma_n=750$ eV 150.

[†] From $E_{\text{c.m.}}+S(\text{n})$ where $S(\text{n})=7799.62$ 6 (2012Wa38) and $E_{\text{c.m.}}$ deduced from $E_n(\text{lab})$ in 2006MuZX.

[‡] L=0 gives 1^+ or 2^+ and L=1 gives $0^-, 1^-, 2^-, 3^-$, with further restriction from analysis of resonance data.

[#] $g=(2J+1)/8$.

$^{39}\text{K}(\text{d},\text{p})$ [1974Fi08,1959En57](#)

$J\pi(^{39}\text{K g.s.})=3/2^+$.

[1974Fi08](#): E=12 MeV deuteron beam was produced from the Argonne FN tandem Van de Graaff accelerator. Target was about $100 \mu\text{g}/\text{cm}^2$ ^{39}K made by evaporation of KNO_3 (99.9% enriched in ^{39}K). Reaction products were momentum analyzed with an Engel split-pole magnetic spectrograph (FWHM=15 keV) and detected in nuclear emulsions. Measured $\sigma(\theta)$. Deduced levels, J, π , L-transfers, spectroscopic factors from DWBA analysis.

[1959En57](#): E=6 MeV deuteron beam was produced from the MIT-ONR electrostatic generator and impinged on a natural KI target on a Formvar backing. Reaction products were momentum analyzed with a broad- range magnetic spectrograph. Measured $\sigma(\theta)$. Deduced levels, L- transfers from fits of theoretical stripping curves to measured differential cross sections. A total of 52 groups identified which are in agreement with data from [1974Fi08](#).

Others:.

[1959Da02](#): E=8.9 MeV. Measured $\sigma(\theta)$ for 23 groups.

[1957Te01](#): E=4 MeV. Measured $\sigma(\theta)$ for three groups at 0, 820 and 2080.

[1953Bu98](#): E=4.8-5.7 MeV. Four groups reported at 0, 32, 800 and 893.

[1950Sa03](#): E=3.90 MeV. Measured energies and relative yields of eight groups up to 4800.

Differential cross section data in lab coordinate system are also available from [1959En57](#) for a total of 52 levels.

Cross section data in c.m. ([1974Fi08](#), accurate to 15%)

Level*	$\text{d}\sigma/\text{d}\Omega$ (max.)	Level	$\text{d}\sigma/\text{d}\Omega$ (max.)
	mb/sr		mb/sr
0	3.0	3720	0.40
30	2.4	3773	≈ 0.50
801	1.8	3792	0.54
891	3.6	3827	0.53
1646	0.07	3870	3.8
1962	≈ 0.20	3928	≈ 0.26
2048	13	4025	2.6
2072	13	4080	0.15
2105	11	4109	4.2
2262	0.18	4211	0.15
2292	0.08 a	4263	8.3
2397	0.32	4298	0.60
2420	0.46	4356	0.13
2578	0.20	4401	3.6
2628	4.0	4467	4.2
2751	1.4	4546	4.0
2789	0.065	4592	2.2
2810	0.28	4663	1.2
2951	≈ 0.07	4765	≈ 0.90
2987	≈ 0.10	4794	1.6
3027	≈ 0.04	4811	2.8
3113	≈ 0.09	4878	0.36
3127	≈ 0.05	4912	2.5
3149	≈ 0.04	4948	0.70
3229	4.6	4997	0.10
3370	1.7	5030	0.10
3393	0.50	5081	0.38
3416	0.52	5116	0.46
3486	0.90	5136	1.1
3601	0.19	5158	0.44
3631	6.0	5210	0.80

*: Energy values in [1974Fi08](#)

a: 0.80 in Table 3 of [1974Fi08](#) seems a type error in view of the value shown in $\sigma(\theta)$ plot in figure 4.

$^{39}\text{K}(\text{d,p})$ [1974Fi08](#), [1959En57](#) (continued) ^{40}K Levels

Spectroscopic factor C^2S is defined by $(2J+1) \times C^2S = (2J_i+1)/N \times \sigma_{\text{exp}}/\sigma_{\text{DWBA}}$ with $N=1.53$, J_i and J the spins of the initial and final states, respectively ([1974Fi08](#)).

E(level) [†]	L ^b	(2J+1)C ² S ^b	Comments
0	3	8.1	
30 2	1+3	0.12,6.3	E(level): weighted average of 32 2 (1953Bu98), 28 2 (1959En57) and 30 5 (1974Fi08). L: 3 (1959En57).
799 5	1+3	0.07,4.6	L: 3 (1959En57).
889 5	3	8.9	
1644 5	(2)	0.10	L: 1 (1959En57).
1960 5	0+2	0.012, .076	L: isotropic (1959En57).
2046 5	1	2.6	
2070 5	1	2.6	
2103 5	1	2.2	
2260 5	(2)	0.26	
2290 5	(2,3)	0.13,0.18	E(level): probable doublet: 2290+2291 (1974Fi08). L: (1) (1959En57).
2396 5	1	0.064	
2419 5	1	0.092	
2574 6	2	0.26	
2626 5	1	0.76	
2664?			E(level): from 1959Da02 only.
2749 5	1	0.25	
2787 5	&		L: isotropic (1959En57).
2808 5	1	0.048	
2950 5	&		
2986 5			
3027 5			E(level): From 1974Fi08 . 1959En57 report an uncertain level at 3021 8. L: 1 for an uncertain level at 3021 from 1959En57 .
3111 5	0 ^a		
3126 5			L: isotropic (1959En57).
3148 5	(1) ^a		
3228 5	1	0.92	
3369 5	1	0.31	
3391 5	1	0.088	
3415 5	0+2	0.036,0.11	L: 0 (1959En57).
3484 5	1	0.17	
3600 5	1	0.034	
3630 5	1	1.1	
3657 [‡] 8			
3719 5	1		L: isotropic (1959En57).
3738 [‡] 8			
3771 5	(0,1)	0.08,0.072	L: 1 (1959En57).
3791 5	1	0.084	L: 0 (1959En57).
3825 5	1	0.080	
3838 [‡] 8			
3870 5	1	0.61	
3883 [‡] 8			
3898 [‡] 8			
3926 5			
4023 5	1	0.40	
4080 [@] 5	&		

Continued on next page (footnotes at end of table)

$^{39}\text{K}(\text{d,p})$ [1974Fi08](#), [1959En57](#) (continued) ^{40}K Levels (continued)

E(level) [†]	L ^b	(2J+1)C ² S ^b	Comments
4107 5	1	0.656	
4211 @ 5	&		
4260 5	1	1.3	
4298 @ 5	1	0.12	
4356 @ 5	&		
4400 5	1	0.58	
4466 5	1	0.68	
4544 5	1	0.63	
4589 5	1	0.30	
4662 5	1	0.16	
4765 @ 5	0	0.056	
4792 5	1	0.20	
4808 5	1	0.35	
4878 @ 5	1	0.044	
4909 5	1	0.35	
4948 @ 4	1	0.084	
4997 @ 5	&		
5030 @ 5	&		
5080 @ 5	1	0.046	
5116 @ 5	1	0.056	
5136 @ 5	1	0.12	
5158 @ 5	1	0.054	
5210 @ 5	1	0.10	
5340? 40			E(level): from 1959Da02 only.

[†] Weighted average of values from [1974Fi08](#) and [1959En57](#) if data are available from both, unless otherwise noted.

[‡] From [1959En57](#), not resolved in [1974Fi08](#).

Reported by [1959En57](#) only as a weak group.

@ From [1974Fi08](#).

& Isotropic distribution from $\sigma(\theta)$ ([1974Fi08](#)).

^a From [1959En57](#).

^b Extracted from DWBA fits to measured differential cross sections ([1974Fi08](#)).

$^{39}\text{K}(\text{d},\text{p}\gamma)$ 1970Fr10,1973We01

1970Fr10: E=3.5, 3.7 MeV deuteron beams. Target was 1 mg/cm² KI. Protons were detected by a semiconductor counter and γ rays were detected with a Ge(Li) detector. Measured E_γ , I_γ , $\text{p}\gamma$ -coin. Deduced levels, γ -ray branching ratios.

1973We01, 1970Se10: E=3.5 MeV deuteron beam was produced from the Argonne Dynamitron accelerator. Target were 1300 $\mu\text{g}/\text{cm}^2$ or 30 $\mu\text{g}/\text{cm}^2$ KI on gold backings. Protons were detected by two proton detectors and γ rays by a Ge(Li) detector. Measured E_γ , I_γ , Doppler shift attenuation. Deduced levels, half-lives, transition strengths.

2000El08: E=0.7-3.4 MeV. Measured thick target yields.

 ^{40}K Levels

$E(\text{level})^\dagger$	$J^\pi^\#$	$T_{1/2}^\text{@}$	$E(\text{level})^\dagger$	$J^\pi^\#$	$T_{1/2}^\text{@}$
0	4 ⁻		2397 3	4 ⁻	
29.6	3 ⁻		2419 [‡]	2 ⁻	0.28 ps +28-11
799.9 8	2 ⁻	0.40 ps 5	2575 [‡]	2 ⁺	0.14 ps +8-4
891.6 2	5 ⁻	1.07 ps 17	2625.7 10	0 ⁻	0.22 ps +14-8
1644	0 ⁺		2731 [‡]	1	<83 fs
1958.8 9	2 ⁺	0.42 ps +28-14	2787 [‡]	3 ⁺	<0.69 ps
2047.1 10	2 ⁻	0.31 ps 5	2808 2	(1,2) ⁻	
2069.9 13	3 ⁻	0.26 ps +14-9	3110 3	1 ⁺ ,2 ⁺	<97 fs
2103.5 9	1 ⁻	0.36 ps 7	3228 3	2 ⁻	28 fs 21
2261 [‡]	3 ⁺	49 fs +55-28	3370 5	(2,3) ⁻	
2290 [‡]	1 ⁺	0.23 ps +24-12	3629 3	2 ⁻ ,3 ⁻	<69 fs
2291 [‡]	3 ⁻	0.22 ps +13-8	3870 5	2 ⁻	

[†] From 1970Fr10, unless otherwise noted.

[‡] From 1973We01 only.

[#] From Adopted Levels.

[@] From 1973We01 using DSAM. The uncertainties are statistical only; 15% systematic uncertainty due to slowing-down estimated in the evaluation of 1978En02 are added where used in Adopted Levels.

 $\gamma(^{40}\text{K})$

$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\S$	E_f	J_f^π	$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\S$	E_f	J_f^π
29.6	3 ⁻	30		0	4 ⁻	2291	3 ⁻	2291 [‡]		0	4 ⁻
799.9	2 ⁻	770.32 10	100	29.6	3 ⁻	2397	4 ⁻	2367 [‡]		29.6	3 ⁻
		800	<3	0	4 ⁻	2419	2 ⁻	1619 [‡]		799.9	2 ⁻
891.6	5 ⁻	92 ^{&}	<4	799.9	2 ⁻			2389 [‡]		29.6	3 ⁻
		891.60 20	100	0	4 ⁻	2575	2 ⁺	2545 [‡]		29.6	3 ⁻
1958.8	2 ⁺	1158.95 30		799.9	2 ⁻	2625.7	0 ⁻	522.2 4	70 5	2103.5	1 ⁻
2047.1	2 ⁻	1247.15 30	43 4	799.9	2 ⁻			1826	30 5	799.9	2 ⁻
		2017.3 15	29 3	29.6	3 ⁻	2731	1	1087 [‡]		1644	0 ⁺
		2047.1 10	28 3	0	4 ⁻	2787	3 ⁺	828 [‡]		1958.8	2 ⁺
2069.9	3 ⁻	1178	7 2	891.6	5 ⁻	2808	(1,2) ⁻	2008 2		799.9	2 ⁻
		1270	7 2	799.9	2 ⁻	3110	1 ⁺ ,2 ⁺	1151	50 15	1958.8	2 ⁺
		2040.2 10	54 5	29.6	3 ⁻			1466	50 15	1644	0 ⁺
		2070.2 20	32 5	0	4 ⁻	3228	2 ⁻	2428	20 7	799.9	2 ⁻
2103.5	1 ⁻	460	<3	1644	0 ⁺			3198	55 10	29.6	3 ⁻
		1303.6 4	27 5	799.9	2 ⁻			3228	25 7	0	4 ⁻
		2074.0 10	73 5	29.6	3 ⁻	3370	(2,3) ⁻	3340	100	29.6	3 ⁻
2261	3 ⁺	2231 [‡]		29.6	3 ⁻	3629	2 ⁻ ,3 ⁻	1232	25 7	2397	4 ⁻
		2261 [‡]		0	4 ⁻			1559	10 5	2069.9	3 ⁻
2290	1 ⁺	646 [‡]		1644	0 ⁺			3599	20 7	29.6	3 ⁻

Continued on next page (footnotes at end of table)

³⁹K(d,pγ) [1970Fr10](#),[1973We01](#) (continued)

γ(⁴⁰K) (continued)

<u>E_i(level)</u>	<u>J^π_i</u>	<u>E_γ[†]</u>	<u>I_γ[§]</u>	<u>E_f</u>	<u>J^π_f</u>
3629	2 ⁻ ,3 ⁻	3629	45 10	0	4 ⁻
3870	2 ⁻	3840	100	29.6	3 ⁻

[†] From [1970Fr10](#) where ΔEγ is quoted, otherwise level-energy differences.

[‡] Reported in [1973We01](#) only.

[§] From [1970Fr10](#). Values are % branching from each level.

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

$^{40}\text{Ar}(\text{p},\text{n})$ 2009Bh09

2009Bh09: E=120 and 160 MeV proton beams were produced from the Indiana University Cyclotron Facility (IUCF). The target was in the form of high purity ^{40}Ar gas at 300 kPa cooled with liquid Nitrogen. Neutron energies were measured using time-of-flight method with a flight path of 81-m long and detected with 12 plastic scintillator bars each of $10 \times 15 \times 100$ cm; elastically scattered protons were detected with A fast plastic scintillator ΔE -E telescope. Deduced levels, B(GT) strengths. Comparison of B(GT) strengths with those from ^{40}Ti β decay.

Others:.

1997Jo08: E=35 MeV. Measured $\sigma(\theta)$. Deduced isovector potential parameters.

1995OrZZ: E=35 MeV. Measured $\sigma(\theta)$. Deduced structure of A=40 isobar triplets.

1975Ca18: E=22.8 MeV. Measured $\sigma(E, \theta)$. Deduced IAS.

1975Ga19: E=24 MeV. Measured $\sigma(E, \theta)$. Deduced reaction mechanism.

1973BrYB: Measured $\sigma(\theta)$.

1971Be46: E=23 MeV. Measured $\sigma(E, \theta)$.

1970No05: analyzed $\sigma(\theta)$.

1968Yo05: E=35 MeV. Measured $\sigma(\theta)$.

 ^{40}K Levels

Relative intensities given under comments are deduced by the evaluator from individual peak areas for levels as listed in 2009Bh09 divided by the total area. Efficiency corrections are probably not built in.

E(level) [†]	$\beta(>)^{\ddagger}$	Comments
2333 30	1.03 10	Relative intensity=20.1% 3. B(GT)=0.57 3 in ^{40}Ti decay. B(GT)(2730)/B(GT)(2290)=1.65 11 in ^{40}Ti decay is in severe disagreement with 0.911 5 from (p,n); 2730 and 2290 levels are identified with 2775 and 2333 levels, respectively.
2775 30	0.94 9	Relative intensity=18.27% 25. B(GT)=0.94 4 in ^{40}Ti decay.
3204 32	0.04 1	Relative intensity=0.74% 4. B(GT)=0.03 1 in ^{40}Ti decay.
3503 30	0.10 1	Relative intensity=2.01% 5.
3870 30	0.28 3	Relative intensity=5.32% 9. B(GT)=0.01 1 in ^{40}Ti decay.
4421 30	0.54 9	Relative intensity=10.4% 13. E(level): this peak unresolved from the nearby IAS.
4763 30	0.30 3	Relative intensity=5.80% 17. B(GT)=0.24 4 in ^{40}Ti decay.
5162 30	0.37 4	Relative intensity=7.11% 17. B(GT)=0.02 2 in ^{40}Ti decay.
5681 32	0.13 2	Relative intensity=2.47% 15. B(GT)=0.07 3 in ^{40}Ti decay.
6118 30	0.30 3	Relative intensity=5.66% 15. B(GT)=0.08 3 in ^{40}Ti decay.
6790 30	0.45 5	Relative intensity=8.44% 14.
7468 37	0.04 1	Relative intensity=0.74% 15.
7795 33	0.09 1	Relative intensity=1.74% 20.
7952 32	0.61 6	Relative intensity=11.3% 4.

[†] From fit to the E(p)=120 MeV spectrum.

[‡] For E(p)=120 MeV since several peaks observed with E(p)=160 are not resolved. The integrated Gamow-Teller strength is approximately 43.5% of the sum rule. Total Gamow-Teller strength=5.22 19, as compared to 3.53 13 from ^{40}Ti β decay.

$^{40}\text{Ar}(\text{p},\text{n}\gamma)$ 1979Be41,1971We09,1970Tw01

1979Be41: E=5.75 MeV proton beam was produced from the Auckland tandem Van de Graaff accelerator. Gaseous argon target.

γ -rays were detected by a Ge(Li) detector (FWHM=3 keV at 1.33 MeV). Measured $E\gamma$, $I\gamma$, DSA, $\gamma(\theta)$. Deduced levels, half-lives, J, mixing ratios, branching ratios. Comparisons with shell-model calculations.

1971We09 (also 1970Ba34): E=3.7-4.9 MeV proton beams were produced from the Frankfurt 7 MV Van de Graaff accelerator.

Gaseous argon target. γ rays were detected with a Ge(Li) detector (FWHM=2.8 keV at 1.33 MeV). Measured $E\gamma$, $I\gamma$, $\gamma(\theta)$.

Deduced levels, J, π , mixing ratios, branching ratios. Comparisons with shell-model calculations. 1971We09 and 1970Ba34 also measure lifetimes using DSAM in $(\alpha,\text{n}\gamma)$.

1970Tw01 (also 1969Tw01): E=3.2-5.2 MeV proton beams were produced from the University of Alberta Van de Graaff

accelerator. Gaseous argon target. γ rays were detected with a Ge(Li) detector (FWHM=3.5 keV at 1.33 MeV and 4.5 keV at 2.62 MeV) and a NaI crystal. Measured $E\gamma$, $I\gamma$, $\gamma(\theta)$, $\gamma\gamma(\theta)$, $\gamma(\text{pol})$. Deduced levels, J, π , γ -ray branching ratios, mixing ratios.

Others:.

1977St29: E=8.30 MeV. Measured $E\gamma$, $I\gamma$, $\text{n}\gamma$ -coin, $\gamma\gamma$ -coin, $\gamma\gamma(\theta)$. Deduced levels, J, π , γ -ray branching ratios.

1973Da18: E=5.30-6.10 MeV. Measured $E\gamma$, $I\gamma$, $\gamma\gamma$ -coin, $\gamma(\theta)$, $\gamma\gamma(\theta)$. Deduced levels, J, π , γ -ray branching ratios, mixing ratios. See most details from this study in $(\alpha,\text{n}\gamma)$.

1968Ma09: E=5 MeV. Measured lifetime of 1643 level.

1959Ly68, 1959Ho96: E=2.55, 2.878 MeV. Measured lifetime of 30-keV level (1959Ly68). Two γ rays reported at 29.4 and 771 (1959Ho96).

 ^{40}K Levels

E(level) [†]	J π @	T _{1/2} [#]	Comments
0	4 ⁻		
29.4	3 ⁻	3.88 ns 35	T _{1/2} : from $\gamma(\text{t})$ in 1959Ly68.
800	2 ⁻	222 fs 21	
891	5 ⁻	0.73 ps 14	
1643	0 ⁺ &	0.340 μs 7	J π : from 1977St29. T _{1/2} : from $\gamma\gamma(\text{t})$ in 1968Ma09.
1959	2 ⁺ &	0.513 ps 28	
2047	2 ⁻	0.319 ps 21	
2069	3 ⁻	0.73 ps +24-15	
2104	1 ⁻	0.58 ps 8	
2261	3 ⁺ &	69 fs 11	
2290	1 ⁺ &	94 fs 12	
2291	3 ⁻	155 fs 17	J π : from Adopted Levels. Others: 3 ⁻ ,4 (1979Be41), (3,4) (1971We09), 4(3) (1970Tw01,1969Tw01).
2397	4 ⁻	<38 fs	
2419	2 ⁻	0.73 ps 11	
2543	7 ⁺		J π : from Adopted Levels. E(level): very weakly populated in (p,n γ) (1973Da18). J π : from 1979Be41. Others: (2,4) (1973Da18), (2 ⁺ ,4 ⁺) in 1971We09.
2576	2 ⁺	155 fs 11	
2626	0 ⁻	215 fs 38	
2731	1	<28 fs	
2747	(2,3) ⁻	123 fs 25	
2756	2 ⁺	<24 fs	J π : from Adopted Levels. J π =2,3 ⁻ (1979Be41).
2786.6	3 ⁺	<38 fs	J π : from Adopted Levels. J π =2 ⁻ ,3 (1979Be41).
2787.4	(3,4) ⁻	<28 fs	J π : from Adopted Levels. J π =3,4,5 (1979Be41).
2808	(1,2) ⁻	0.16 ps 4	
2879	6 ⁺		populated weakly in (p,n γ) (1973Da18); also reported by 1977St29. J π : from adopted level. Other: J π =4,6 (1973Da18).
3147 [†]	1		
4384.0 3	0 ⁺		T=2 E(level),J π : from 1977St29.

[†] From 1979Be41, unless otherwise noted.

$^{40}\text{Ar}(\text{p},\text{n}\gamma)$ **1979Be41,1971We09,1970Tw01** (continued) ^{40}K Levels (continued)

[†] Rounded-off value from 1973Da18.

[#] From 1979Be41 using DSAM, unless otherwise noted. The uncertainties are purely statistical for values from 1979Be41 and a 15% systematic uncertainty due to slowing-down estimated in the evaluation of 1978En02 are added where used in Adopted Levels.

@ Above 30-keV level, the assignments are from $\gamma(\theta)$ data of 1979Be41 1971We09 and 1970Tw01.

& Positive parity from $\gamma(\text{pol})$ in 1970Tw01 and 1969Tw01.

$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\dagger$	E_f	J_f^π	Mult. [#]	$\delta^\#$	$\gamma(^{40}\text{K})$	Comments
29.4	3 ⁻	29.4 10	100	0	4 ⁻				E_γ : from 1959Ho96.
800	2 ⁻	770	100	29.4	3 ⁻	D(+Q)	0.00 1		Mult., δ : from 1970Tw01. Other: 0.00 3 (1971We09). $A_2=-0.09$ 1, $A_4=0.00$ 1 (1970Tw01), $A_2=-0.06$ 1, $A_4=0.00$ 1 (1971We09).
891	5 ⁻	891	100	0	4 ⁻	D+Q	+0.11 5		Mult., δ : from 1971We09. $A_2=-0.10$ 1, $A_4=0.00$ 1 (1971We09).
1643	0 ⁺	843	18 2	800	2 ⁻				
		1613	82 2	29.4	3 ⁻	[E3]			
1959	2 ⁺	1159	83 2	800	2 ⁻	E1(+M2)	0.00 5		Mult.: polarity from $\gamma(\text{pol})$ in 1969Tw01. δ : other: 0.00 2 (1970Tw01), 0.00 3 (1971We09). $A_2=+0.33$ 1, $A_4=+0.01$ 1 (1979Be41), $A_2=+0.29$ 1, $A_4=0.00$ 1 (1971We09), $A_2=+0.40$ 1, $A_4=0.00$ 1, $\text{POL}=-0.76$ 21 (1969Tw01).
		1929	17 2	29.4	3 ⁻	D+Q	+0.11 3		δ : other: +0.10 4 (1970Tw01), +0.10 5 (1971We09). $A_2=-0.21$ 1, $A_4=-0.01$ 1 (1979Be41), $A_2=-0.19$ 2, $A_4=+0.01$ 1 (1971We09), $A_2=-0.23$ 1, $A_4=0.00$ 2 (1970Tw01).
2047	2 ⁻	1247	40 1	800	2 ⁻	D(+Q)	+0.05 8		δ : or +0.66 41. Others: +0.13 9 (1970Tw01), +0.10 +5-10 (1971We09). $A_2=+0.47$ 3, $A_4=+0.03$ 2 (1979Be41), $A_2=+0.41$ 15, $A_4=-0.04$ 2 (1971We09), $A_2=+0.48$ 7, $A_4=+0.07$ 7 (1970Tw01).
		2017	30 1	29.4	3 ⁻	D(+Q)	0.00 2		δ : or +0.09 4, -5.7. others: +0.01 2 (1970Tw01), +0.05 3 or -9.0 20 (1971We09). $A_2=-0.12$ 2, $A_4=-0.04$ 2 (1979Be41), $A_2=-0.11$ 1, $A_4=+0.01$ 1 (1971We09), $A_2=-0.12$ 1, $A_4=-0.01$ 1 (1970Tw01).
		2047	30 1	0	4 ⁻	Q			$A_2=+0.16$ 3, $A_4=0.00$ 4 (1970Tw01), $A_2=+0.03$ 1, $A_4=+0.02$ 1 (1971We09).
2069	3 ⁻	1178	3 1	891	5 ⁻	Q			I_γ : from 1979Be41. Other: 6 2 (1971We09). $A_2=-0.18$ 7, $A_4=0.00$ 5 (1971We09). Note that sign of A_2 in 1971We09 seems in error since it is expected to be positive for a $\Delta J=2$ transition.
		1269	6 2	800	2 ⁻	D+Q	-0.20 10		I_γ : from 1979Be41. Others: 10 1 (1970Tw01), 8 2 (1971We09). δ : from 1970Tw01. Other: -0.05 15 (1971We09). $A_2=-0.69$ 10, $A_4=+0.09$ 12 (1970Tw01), $A_2=-0.26$ 10, $A_4=+0.05$ 3 (1971We09).
		2039	50 3	29.4	3 ⁻	D+Q	+0.27 10		I_γ : from 1979Be41. Others: 55 2 (1970Tw01), 46 8 (1971We09). δ : from 1970Tw01. Other: +0.25 15 (1971We09). $A_2=+0.61$ 4, $A_4=-0.01$ 5 (1970Tw01), $A_2=+0.51$ 10, $A_4=-0.05$ 2 (1971We09).
		2069	41 5	0	4 ⁻	D+Q	-0.07 5		I_γ : from 1979Be41. Others: 35 1 (1970Tw01), 40 8

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$^{40}\text{Ar}(\text{p},\text{n}\gamma)$ **1979Be41,1971We09,1970Tw01** (continued) $\gamma(^{40}\text{K})$ (continued)

$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\ddagger$	E_f	J_f^π	Mult. [#]	$\delta^\#$	Comments
								(1971We09).
								δ : from 1970Tw01. Other: -0.07 10 (1971We09).
								$A_2=-0.03$ 4, $A_4=+0.01$ 5 (1970Tw01), $A_2=0.00$ 7,
								$A_4=0.00$ 5 (1971We09).
2104	1^-	1304	30 2	800	2^-	D+Q	$+0.30$ 6	δ : from 1970Tw01. Others: $+1.0$ 5 (1971We09); $+0.05$,
								-0.53 , -1 , -4.3 (1979Be41).
								$A_2=-0.22$ 2, $A_4=0.00$ 3 (1979Be41), $A_2=-0.12$ 1,
								$A_4=0.00$ 1 (1970Tw01), $A_2=-0.17$ 5, $A_4=-0.02$ 1
								(1971We09).
		2074	70 2	29.4	3^-	Q		$A_2=+0.01$ 2, $A_4=+0.01$ 2 (1970Tw01), $A_2=0.00$ 5,
								$A_4=0.00$ 5 (1971We09).
2261	3^+	2231	81 2	29.4	3^-	E1(+M2)	$+0.01$ 9	Mult.: polarity from $\gamma(\text{pol})$ in 1970Tw01.
								δ : others: $+0.02$ 5 (1970Tw01), 0.00 10 (1971We09).
								$A_2=+0.44$ 3, $A_4=-0.03$ 2 (1979Be41), $A_2=+0.40$ 3,
								$A_4=-0.07$ 2 (1971We09), $A_2=+0.41$ 1, $A_4=-0.01$ 1,
								POL= -0.57 30 (1970Tw01).
		2261	19 2	0	4^-	D(+Q)	-0.05 6	δ : others: -0.04 6 (1970Tw01), 0.00 5 (1971We09).
								$A_2=-0.05$ 3, $A_4=-0.04$ 3 (1979Be41), $A_2=-0.09$ 2,
								$A_4=0.00$ 1 (1971We09), $A_2=-0.10$ 2, $A_4=+0.02$ 3
								(1970Tw01).
2290	1^+	331	4 2	1959	2^+			I_γ : Others: 65 2 (1970Tw01), 63 4 (1971We09).
		647	60 2	1643	0^+	D		$A_2=-0.10$ 1, $A_4=+0.05$ 2 (1979Be41), $A_2=-0.12$ 3,
								$A_4=0.00$ 5 (1971We09), $A_2=-0.15$ 3, $A_4=+0.06$ 4
								(1970Tw01).
		1490	36 3	800	2^-	D+Q	$+0.14$	I_γ : Others: 35 2 (1970Tw01), 37 4 (1971We09).
								δ : others: $>+0.3$ (1970Tw01), $+0.15$ 15 or <-3.0
								(1971We09), -0.02 5 (1973Da18).
								$A_2=-0.05$ 2, $A_4=-0.01$ 2 (1979Be41), $A_2=-0.01$ 1,
								$A_4=0.00$ 1 (1973Da18), $A_2=-0.04$ 3, $A_4=+0.10$ 1
								(1971We09), $A_2=-0.09$ 3, $A_4=-0.01$ 5 (1970Tw01).
2291	3^-	1400	16 2	891	5^-			$A_2=+0.13$ 11, $A_4=-0.11$ 12 (1973Da18).
		2291	84 2	0	4^-	D+Q	-0.8 +3-5	δ : for $J=3$. others: -1.0 3 (1970Tw01,1971We09), -0.6 +1-8
								(1973Da18).
								$A_2=+0.50$ 3, $A_4=-0.07$ 4 (1979Be41), $A_2=+0.39$ 4,
								$A_4=-0.03$ 4 (1973Da18), $A_2=+0.41$ 5, $A_4=-0.10$ 2
								(1971We09), $A_2=+0.55$ 4, $A_4=-0.04$ 5 (1970Tw01).
2397	4^-	2367	71 2	29.4	3^-	D+Q	$+0.25$ 4	δ : other: $+0.27$ 6 (1973Da18).
								$A_2=+0.21$ 3, $A_4=-0.07$ 3 (1979Be41), $A_2=+0.14$ 4,
								$A_4=+0.07$ 4 (1973Da18).
		2397	29 2	0	4^-	D+Q	-0.32 12	δ : $+2.4$ 5 (1973Da18).
								$A_2=+0.19$ 5, $A_4=-0.08$ 6 (1979Be41), $A_2=+0.08$ 4,
								$A_4=-0.23$ 4 (1973Da18).
2419	2^-	1619	79 2	800	2^-	D+Q		I_γ : other: 90 3 (1970Tw01).
								δ : -0.03 13 or $+2.2$ 7. Others: $+0.07$ 5 or $+1.8$ 2
								(1973Da18), $+0.05$ 10 or $+2.0$ 6 (1970Tw01).
								$A_2=+0.32$ 3, $A_4=-0.01$ 2 (1979Be41), $A_2=+0.39$ 1,
								$A_4=-0.03$ 1 (1973Da18), $A_2=+0.34$ 3, $A_4=+0.01$ 4
								(1970Tw01).
		2389	15 2	29.4	3^-	D+Q	-0.8 5	I_γ : other: 5 3 (1970Tw01).
								δ : from 1973Da18. Other: -0.25 or -2.6 (1979Be41).
								$A_2=+0.22$ 3, $A_4=+0.03$ 3 (1979Be41), $A_2=+0.31$ 3,
								$A_4=-0.01$ 3 (1973Da18).
		2419	6 1	0	4^-	Q(+O)	$+0.17$ 28	I_γ : other: 5 3 (1970Tw01).
								δ : other: 0.00 +15-30 (1973Da18).

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$^{40}\text{Ar}(\text{p},\text{n}\gamma)$ **1979Be41,1971We09,1970Tw01** (continued) $\gamma(^{40}\text{K})$ (continued)

$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\ddagger$	E_f	J_f^π	Mult. #	$\delta^\#$	Comments
2543	7^+	1652 [§]	88 [§] 2	891	5^-			$A_2=+0.06$ 6, $A_4=-0.13$ 7 (1979Be41), $A_2=+0.13$ 6, $A_4=+0.05$ 6 (1973Da18). δ : $+1.0$ $+2-4$ for $J=5$, 0.00 13 for $J=7$ (1973Da18). $A_2=+0.41$ 6, $A_4=-0.17$ 7 for $J=5$, $A_2=+0.10$, $A_4=+0.01$ 9 for $J=7$ (1973Da18).
2576	2^+	2542 [§] 2546	12 [§] 2 100	0 29.4	4^- 3^-	[E3] D(+Q)		δ : $+0.03$ $+7-4$ or -7.6 $+13-20$. Others: $+0.08$ 3 (1970Tw01); 0.00 3 (1973Da18). For $J=4$, $\delta=+0.06$ 2 (1970Tw01); $+0.09$ 4 (1973Da18). $A_2=-0.13$ 1, $A_4=-0.01$ 1 (1979Be41), $A_2=-0.13$ 2, $A_4=+0.02$ 1 (1973Da18), $A_2=-0.21$ 3, $A_4=+0.06$ 4 (1970Tw01). $A_2=-0.01$ 4, $A_4=+0.03$ 4 (1979Be41). $A_2=-0.09$ 14, $A_4=+0.21$ 16 (1979Be41).
2626	0^-	522 1826	69 2 31 2	2104 800	1^- 2^-	D Q		$A_2=-0.01$ 4, $A_4=+0.03$ 4 (1979Be41). $A_2=-0.09$ 14, $A_4=+0.21$ 16 (1979Be41).
2731	1	772 ^{&a} 1088	 94 4	1959 1643	2^+ 0^+	 D		I_γ : other: 73 9 (1977St29). See comment for 772 γ . $A_2=-0.13$ 4, $A_4=-0.03$ 5 (1979Be41), $A_2=-0.33$ 2, $A_4=-0.01$ 2 (1973Da18). I_γ : other: 4 3 (1977St29).
2747	$(2,3)^-$	1931 678 788 2717	6 4 <3 4 1 63 3	800 2069 1959 29.4	2^- 3^- 2^+ 3^-	 D+Q		δ : 0.0 1 for $J=2$, -0.19 14 or -3.4 $+13-29$ for $J=3$. other: -1.2 $+8-5$ for $J=2$, -0.09 $+18-9$ for $J=3$, $+0.36$ 7 for $J=4$ (1973Da18). $A_2=+0.30$ 3, $A_4=-0.01$ 4 (1979Be41), $A_2=+0.33$ 4, $A_4=+0.07$ 4 (1973Da18). δ : -0.87 $+5-16$ for $J=2$, -0.18 $+11-18$ for $J=3$. other: -0.09 $+12-8$ for $J=2$, -0.27 8 or -2.8 $+5-8$ for $J=3$, -0.27 $+15-9$ for $J=4$ (1973Da18). $A_2=+0.12$ 5, $A_4=+0.02$ 5 (1979Be41), $A_2=+0.16$ 13, $A_4=+0.07$ 13 (1973Da18). δ : $+0.19$ $+19-26$ or -2.1 $+13-7$ (1979Be41). Other: -0.02 7 or -1.7 $+5-3$ for $J=2$ (1973Da18). For $J=3$, $\delta=+0.45$ 11 (1979Be41), $+0.36$ 5 (1973Da18). $A_2=+0.38$ 4, $A_4=+0.01$ 4 (1979Be41), $A_2=+0.34$ 2, $A_4=+0.01$ 2 (1973Da18). δ : 0.00 12 or -4.7 $+20-144$ (1979Be41). Other: 0.00 3 (1973Da18). For $J=3$, $\delta=-0.47$ $+9-23$ or $+5.1$ $+63-24$ (1979Be41); -0.52 $+8-12$ (1973Da18). $A_2=-0.02$ 3, $A_4=-0.11$ 4 (1979Be41), $A_2=-0.10$ 2, $A_4=-0.02$ 2 (1973Da18).
2756	2^+	1956	66 2	800	2^-	D+Q		δ : from 1973Da18. $A_2=-0.44$ 9, $A_4=-0.11$ 9 (1973Da18). δ : $+0.03$ 14 or $+1.1$ 4 (1979Be41). Other: $+0.09$ 11 (1973Da18). For $J=2$, $\delta=-0.81$ 34 (1979Be41). $A_2=+0.43$ 2, $A_4=-0.06$ 2 (1979Be41), $A_2=+0.43$ 2, $A_4=0.00$ 2 (1973Da18).
2786.6	3^+	828	22 3	1959	2^+	D+Q	-0.09 7	δ : $>+0.09$ or $<+19$ for $J=3$, <-0.81 or $>+4.9$ for $J=4$, -0.19 $+19-34$ or -1.8 4 for $J=5$. $A_2=-0.58$ 13, $A_4=-0.11$ 4 (1979Be41). δ : -0.09 to -2.14 for $J=1$; -0.27 5 or $+5.7$ $+24-14$ for $J=2$ (1973Da18). $A_2=+0.07$ 2, $A_4=+0.02$ 2 (1973Da18).
		2756	78 3	29.4	3^-	D+Q		
2787.4	$(3,4)^-$	496 1896 2786	40 8 19 8 41 8	2291 891 0	3^- 5^- 4^-	 D+Q		
2808	$(1,2)^-$	2008 [§]	100 [§]	800	2^-			

Continued on next page (footnotes at end of table)

${}^{40}\text{Ar}(\text{p},\text{n}\gamma)$ [1979Be41](#),[1971We09](#),[1970Tw01](#) (continued) $\gamma({}^{40}\text{K})$ (continued)

$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\ddagger$	E_f	J_f^π	Mult. [#]	$\delta^\#$	Comments
2879	6^+	336 [§]	62 [§] 4	2543	7^+			$\delta < 0.10$ (1973Da18).
		1987 [§]	38 [§] 4	891	5^-	D(+Q)	-0.09 9	δ : from 1973Da18 . Other: 0.0 2 for J=4 (1973Da18). $A_2 = -0.05$ 14, $A_4 = -0.06$ 15 (1973Da18).
3147	1	1503 [§]	33 [§] 5	1643	0^+	D		Mult.: from 1973Da18 . $A_2 = -0.37$ 9, $A_4 = -0.19$ 10 (1973Da18).
		2347 [§]	67 [§] 5	800	2^-	D+Q	+0.1 2	δ : from 1973Da18 . $A_2 = -0.04$ 3, $A_4 = -0.08$ 3 (1973Da18).
4384.0	0^+	1653	24 [@] 3	2731	1			(1653 γ)(1087 γ)(θ): $A_2 = +0.42$ 19 (1977St29).
		2094	76 [@] 3	2290	1^+			(2094 γ)(646 γ)(θ): $A_2 = +0.42$ 10 (1977St29).

[†] From level-energy differences.

[‡] From weighted average of values from [1979Be41](#), [1970Tw01](#) and [1971We09](#) if available for transitions from levels up to 2261 and from [1979Be41](#) after that, unless otherwise noted.

[§] From [1973Da18](#). The energies are rounded values. The precise γ -ray energies and branching ratios given by [1973Da18](#) are most likely from their (α ,n γ) experiment.

[&] Reported only by [1977St29](#) with $I_\gamma = 23$ 8. With this large intensity, this γ ray should have been seen in the high-resolution (n, γ) experiment where only one γ ray at 770.3053 is reported. Thus this γ ray is considered as suspect by the evaluator.

[@] From [1977St29](#).

[#] From [1979Be41](#) based on measured $\gamma(\theta)$, unless otherwise noted.

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

$^{40}\text{Ar}({}^3\text{He},t)$ 1968We09,2014Ka27

$J\pi(^{40}\text{Ar g.s.})=0^+$.

1968We09: E=17.9 MeV ${}^3\text{He}$ beam was produced from the Livermore variable-energy cyclotron incident on an argon gas target.

Charged particles were detected with ΔE -E surface-barrier counter telescopes (FWHM=150 keV). Measured $\sigma(\theta)$. Deduced levels, L-transfers from DWBA analysis.

2014Ka27: E=140 MeV/nucleon ${}^3\text{He}$ beam was produced at RCNP and impinged on a ^{40}Ar gas target contained by Aramid foils.

Tritons were detected with the Grand Raiden Spectrometer. Measured $\sigma(E_t)$. Deduced levels, B(GT). Comparisons with available data and with shell-model and DWBA calculations. Relevance to neutrino capture rates.

Others:.

1972FaZT: E=35 MeV. Measured $\sigma(\theta)$ for 1650 and 4380 levels.

1970Hi06: E=35 MeV. Measured $\sigma(\theta)$ for 0^+ analog and anti-analog states.

1970No05: Analyzed shapes of $\sigma(\theta)$ distributions.

Data are from 1968We09, unless otherwise noted.

 ^{40}K Levels

E(level)	$J\pi$	L	Comments
0		3+5	E(level): 0+30 doublet (1968We09).
840 20		3+5	E(level): 800+891 doublet (1968We09).
1650 20		#	anti-analog state.
1960 20		2+4	
2290 20	$1^+ \ddagger$		
2730 $\ddagger$	$1^+ \ddagger$		B(GT)(2730 level)/B(GT)(2290 level)=0.73 5 (2014Ka27). Others quoted in 2014Ka27: 0.911 5 from (p,n) reaction (2009Bh09), 1.65 11 from analog states in ^{40}Ti β decay (1998Bh12).
2770 20			
3080 20			
3440 20			
3730 20			
3840 $\ddagger$			
4380 20		0	E(level): analog state.
5870 20			

$\ddagger$ From 2014Ka27.

$\ddagger$ From 2014Ka27, based on $\Delta J=1$, 0^+ to 1^+ excitation in charge-exchange reactions.

$\sigma(\theta)$ and DWBA comparisons fit L=1 (1968We09,1970Hi06), rather than L=0 shape. The shapes of the $\sigma(\theta)$ distributions for the 1650 (anti-analog state) and 4380 (analog state) are in anti-shape (1970Hi06,1972FaZT). 1970Hi06 suggests that modifications were needed in the conventional description of the (${}^3\text{He},t$) reaction, but 1970No05 points out that the observed $\sigma(\theta)$ shape for anti-analog states can be understood on the basis of structural relation between analog and anti-analog states together with the assumption of a pure charge-exchange mechanism.

$^{40}\text{K}(\gamma,\gamma)$:Mossbauer 2000Se01,1965Ru02,1965Ha14

2000Se01, 2002Se12: Harmonic radiation was produced from the JAERI beam line (BL11XU) of the SPring-8. Target was KCl powder. Photons were detected with a Si avalanche photodiode (APD). Measured E_γ , $\gamma(t)$. Deduced $T_{1/2}$.

1965Ru02: measured scattering at 90° .

1965Ha14: measured absorption; deduced isomer shift, linewidth.

Other: 1968Ts01.

 ^{40}K Levels

<u>E(level)</u>	<u>J^π[†]</u>	<u>$T_{1/2}$</u>	<u>Comments</u>
0	4^-		
29.834 11	3^-	4.13 ns 12	$T_{1/2}$: from 2000Se01 (also reported in 2002Se12). Other: 4.3 ns 9 (1965Ha14).

[†] From Adopted Levels.

 $\gamma(^{40}\text{K})$

<u>E_γ</u>	<u>$E_i(\text{level})$</u>	<u>J_i^π</u>	<u>E_f</u>	<u>J_f^π</u>	<u>Comments</u>
29.834 11	29.834	3^-	0	4^-	E_γ : from 2000Se01 and 2002Se12.

 $^{40}\text{K}(\gamma,\gamma)$:Mossbauer 2000Se01,1965Ru02,1965Ha14Level Scheme

$^{40}\text{Ca}(\mu^-, \nu\gamma)$ 2006Me08

2006Me08: The μ^- beam was obtained from decay of π^- beam at 90 MeV/c provided by the beamline M9B at TRIUMF. Target was pure natural calcium. γ rays were detected with two HPGe detectors. Measured $E\gamma$, $I\gamma$, $E(x \text{ ray})$, $I(x \text{ ray})$. Deduced levels, γ -ray yields.

Muonic Lyman series for natural Calcium

$\mu \text{ x ray}$	Energy	Intensity in percent
2p-1s	783.659 25	83.8 10
3p-1s	940.63 10	6.2 2
4p-1s	995.48 10	2.0 1
5p-1s	1020.81 10	2.0 1
6p-1s	1034.62 10	1.8 1
7p-1s	1042.71 20	1.4 1
(8- ∞)p-1s	1046-1063	2.8 4

Muonic Balmer series for natural Calcium

$\mu \text{ x ray}$	Energy	Intensity in percent
3d-2p	157.35 13	64.5 9
4d-2p	212.03 10	8.85 20
5d-2p	237.31 10	4.34 20
6d-2p	251.06 10	3.29 20
7d-2p	259.45 10	1.37 20
(8- ∞)d-2p	261-277	1.4 3

 ^{40}K Levels

$E(\text{level})^\dagger$	$J^\pi^\ddagger$	Percent Yield per muon capture [#]	Comments
0	4 ⁻		
29.83	3 ⁻		
800.14	2 ⁻	5.0 5	Known cascading=2.8% 5.
891.40	5 ⁻	0.2 1	Known cascading=0.03% 2.
1643.64	0 ⁺	0.5 4	Known cascading=0.37% 15.
1959.07	2 ⁺	1.2 2	Known cascading=0.04% 2.
2047.35	2 ⁻	0.9 3	
2069.81	3 ⁻	0.7 3	
2103.67	1 ⁻	0.7 2	Known cascading=0.43% 6.
2260.40	3 ⁺	<0.25	
2289.87	1 ⁺	0.5 2	
2290.49	3 ⁻	<0.24	
2397.17	4 ⁻	<0.3	
2419.17	2 ⁻	0.4 3	
2625.99	0 ⁻	0.60 8	
2730.37	1	<0.24	
2807.88	(1,2) ⁻	0.34 21	
3228.67	2 ⁻	<0.8	
3868.66	2 ⁻	<0.9	
3887.92	(1 ⁻ , 2 ⁻)	<0.6	
3923.90	(2 ⁻ , 3 ⁺)	<1.0	
4537.06	(2 ⁻)	0.9 4	

[†] As listed in 2006Me08 from literature.

$^{40}\text{Ca}(\mu^-, \nu\gamma)$ **2006Me08** (continued) ^{40}K Levels (continued)

† From Adopted Levels.

Corrected for known cascading.

$\gamma(^{40}\text{K})$						
E_γ †	Percent γ -ray yield	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult.
522.32	0.43 6	2625.99	0 ⁻	2103.67	1 ⁻	
646.22	0.37 15	2289.87	1 ⁺	1643.64	0 ⁺	
770.31	7.8 3	800.14	2 ⁻	29.83	3 ⁻	
843.49	0.3 2	1643.64	0 ⁺	800.14	2 ⁻	
891.37	0.23 10	891.40	5 ⁻	0	4 ⁻	
938.72	‡	3228.67	2 ⁻	2289.87	1 ⁺	
1086.71	<0.2	2730.37	1	1643.64	0 ⁺	
1158.90	0.85 15	1959.07	2 ⁺	800.14	2 ⁻	
1247.17	0.35 12	2047.35	2 ⁻	800.14	2 ⁻	
1303.53	0.30 8	2103.67	1 ⁻	800.14	2 ⁻	
1399.03	<0.1	2290.49	3 ⁻	891.40	5 ⁻	
1489.77	0.11 8	2289.87	1 ⁺	800.14	2 ⁻	
1613.84	0.5 2	1643.64	0 ⁺	29.83	3 ⁻	[E3]
1619.00	0.3 2	2419.17	2 ⁻	800.14	2 ⁻	
1765.24	<0.25	3868.66	2 ⁻	2103.67	1 ⁻	
1825.77	0.16 6	2625.99	0 ⁻	800.14	2 ⁻	
1929.34	0.31 15	1959.07	2 ⁺	29.83	3 ⁻	
2007.71	0.32 20	2807.88	(1,2) ⁻	800.14	2 ⁻	
2017.53	0.29 14	2047.35	2 ⁻	29.83	3 ⁻	
2039.94	0.35 17	2069.81	3 ⁻	29.83	3 ⁻	
2047.28	0.26 10	2047.35	2 ⁻	0	4 ⁻	
2070.08	0.27 10	2069.81	3 ⁻	0	4 ⁻	
2073.74	0.76 18	2103.67	1 ⁻	29.83	3 ⁻	
2230.54	<0.2	2260.40	3 ⁺	29.83	3 ⁻	
2290.58	<0.2	2290.49	3 ⁻	0	4 ⁻	
2367.17	<0.2	2397.17	4 ⁻	29.83	3 ⁻	
2389.18	0.1 1	2419.17	2 ⁻	29.83	3 ⁻	
2397.12	<0.4	2397.17	4 ⁻	0	4 ⁻	
2428.28	<0.3	3228.67	2 ⁻	800.14	2 ⁻	
3068.7	<0.4	3868.66	2 ⁻	800.14	2 ⁻	
3088.3 5	<0.3	3887.92	(1 ⁻ , 2 ⁻)	800.14	2 ⁻	
3198.6	<0.25	3228.67	2 ⁻	29.83	3 ⁻	
3737.01	0.4 2	4537.06	(2 ⁻)	800.14	2 ⁻	
3838.50	<0.4	3868.66	2 ⁻	29.83	3 ⁻	
3857.97	<0.3	3887.92	(1 ⁻ , 2 ⁻)	29.83	3 ⁻	
3895.7	<0.4	3923.90	(2 ⁻ , 3 ⁺)	29.83	3 ⁻	
4506.96	<1	4537.06	(2 ⁻)	29.83	3 ⁻	

† As listed in **2006Me08** from literature.‡ Intensity not listed by **2006Me08**, the peak is overlapped by other transitions.

$^{40}\text{Ca}(\text{n,p}\gamma),(\text{n,p})$ 1972Di10,1967An07

1972Di10: (n,p γ) E=4.85-8.05 MeV. Natural target. Measured E γ , I γ , σ at 4.85, 5.40, 5.90, 6.45, 7.00, 7.50 and 8.05 MeV.

1967An07: (n,p) E=14.4 MeV. Measured proton spectrum, $\sigma(\theta)$, FWHM=600 keV.

Other (n,p) measurements:.

1992Pa06: E=60-260 MeV. Measured $\sigma(\theta)$. Deduced distributions of Gamow-Teller (GT) ($\Delta L=0, \Delta S=1, \Delta J=1$) strength, Giant-dipole resonance (GDR, $\Delta S=0$), and Giant-spin dipole resonance (GDSR, $\Delta S=1$).

1989TrZT: Measured $\sigma(\theta)$. Deduced spin dipole resonance evidence.

1988Ma53: Analyzed single-nucleon transfer σ . Deduced gs occupation numbers, total B(GT).

1980Ba50: E=2.7-5.5 MeV. Measured σ .

1974Ba16: E=2.41-2.86 MeV. Measured σ .

1972Fo21, 1961Ur03: E=5.85 MeV. Measured $\sigma(\theta)$ for 0+30 doublet.

1969Wi12: E=14.6 MeV. Measured $\sigma(\theta)$.

1968Ka05: E=14.1 MeV. Measured $\sigma(\theta)$.

1967Me11: E=152 MeV. Measured proton spectrum.

1961Al34: E=15 MeV. Measured $\sigma(E)$.

1956Da23: (n,p γ) E=2.557 MeV. Three γ rays reported at 30, 767 and 877 from first three excited states.

Data are from 1972Di10, unless otherwise noted.

Differential cross sections (in mb/sr) at different energies (125°)						
E γ	4.85 MeV	5.40 MeV	5.90 MeV	6.45 MeV	7.00 MeV	8.05 MeV
522			0.15 8	0.30 14	0.38 15	
646	0.40 12	0.57 12	0.4 1	0.63 10	0.89 22	0.70 9
770	12.7 14	10.1 12	8.9 13	14.2 15	15.4 16	17.0 17
891		0.70 11	0.95 14	1.51 20	1.31 19	1.04 15
1087		0.12 7	0.15 6	0.49 8	0.69 15	0.97 11
1159	3.5 4	3.4 4	3.4 5	4.7 6	5.7 6	6.2 7
1248	0.60 10	0.90 11	0.80 12	1.08 13	1.12 14	1.15 13
1270	0.26 10	0.20 7	0.20 4	0.37 12	0.27 10	0.49 8
1619	0.23 11	0.90 13	0.77 12	1.24 16	0.97 13	0.90 20
1929	0.34 10	0.33 9	0.25 5	0.65 9	0.48 13	1.04 21
1957				0.41 6	0.50 12	0.50 19
2008			0.45 10	1.18 13	1.27 14	0.88 18
2018	0.62 10	0.80 12	0.62 10	0.56 12	0.51 15	0.64 12
2040	0.74 12	1.10 13	0.93 14	1.28 24	1.23 24	
2072	1.20 15	1.84 21	1.8 3	2.48 27	2.26 26	2.65 40
2231		0.57 12	0.70 13	0.61 9		
2291	0.35 15	0.41 12	0.70 13			
2367		0.41 12	0.70 13	1.05 13	1.11 20	0.70 11
2547	0.46	0.46 13	0.64 12	1.35 15	1.46 19	1.43 20

 ^{40}K Levels

E(level) [†]	J π [†]	E(level) [†]	J π [†]	E(level) [†]	J π [†]
0 [#]	4 ⁻	2070	3 ⁻	2558? [@]	
30 [#]	3 ⁻	2103	1 ⁻	2577	2 ⁺
800	2 ⁻	2261	3 ⁺	2626	0 ⁻
891	5 ⁻	2290	1 ⁺	2757	2 ⁺
1644	0 ⁺	2291	3 ⁻	2808	(1,2) ⁻
1959	2 ⁺	2397	4 ⁻		
2048	2 ⁻	2419	2 ⁻		

[†] From Adopted Levels.

[#] 0+30 and 800+891 are unresolved in (n,p) (1967An07).

Continued on next page (footnotes at end of table)

$^{40}\text{Ca}(\text{n,p}\gamma),(\text{n,p})$ **1972Di10,1967An07** (continued) ^{40}K Levels (continued)

Total cross section for $0+30=365$ mb 27 at $E=5.85$ MeV (**1972Fo21**).

@ Level not reported in any other study of ^{40}K . It is considered as suspect by the evaluator.

 $\gamma(^{40}\text{K})$

$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$d\sigma/d\Omega$ (mb/sr) ‡	E_f	J_f^π
		x828 2	0.32 11		
		x870 2	0.37 12		
		x979 2	0.35 12		
		x1332 2	0.25 10		
		x1434 2	0.58 14		
		x1453 2	0.40 12		
		x1694 2	0.40 12		
		x1881 2	0.43 13		
		x2939 2	0.34 13		
		x3475 2	0.33 13		
30	3^-	30^b 2		0	4^-
800	2^-	770	17.0 17	30	3^-
891	5^-	891	3.6 4	0	4^-
1959	2^+	1159	6.1 § 6	800	2^-
		1929	0.87 9	30	3^-
2048	2^-	1248	1.07 13	800	2^-
		2018	0.79 12	30	3^-
		2048	0.86 12	0	4^-
2070	3^-	1270	0.52 12	800	2^-
		2040	2.07 23	30	3^-
		2070 a	≈ 1.45	0	4^-
2103	1^-	2073 a	≈ 0.73	30	3^-
2261	3^+	2231	0.65 22	30	3^-
2290	1^+	646	0.75 10	1644	0^+
2291	3^-	2291	0.70 $^\&$ 13	0	4^-
2397	4^-	2367 $^\#$	0.80 16	30	3^-
2419	2^-	1619	1.15 20	800	2^-
2558?		2558	0.21 9	0	4^-
2577	2^+	2547	1.56 19	30	3^-
2626	0^-	522	0.38 $^\circ$ 15	2103	1^-
2757	2^+	1957	0.40 13	800	2^-
2808	$(1,2)^-$	2008 $^\#$	1.03 12	800	2^-
		2808 $^\#c$	0.73 14	0	4^-

† **1972Di10** give $\Delta E_\gamma=2$ keV for unplaced γ rays but not for those placed. The evaluator have assumed $\Delta E_\gamma=2$ keV also for those γ -ray energies.

‡ From **1972Di10**, at $E=7.50$ MeV, unless otherwise noted. **1972Di10** give cross section data at $E=4.85, 5.45, 5.90, 6.45, 7.00$ and 8.05 MeV also. See table of differential cross sections above.

§ May contain some contribution from ^{44}Ca .

$^\&$ At $E=5.90$ MeV.

$^\circ$ At $E=7.00$ MeV.

$^\#$ Wide peak at all neutron energies, may have another component.

a 2070 and 2073 are unresolved.

b From **1956Da23**.

c Placement of transition in the level scheme is uncertain.

x γ ray not placed in level scheme.

⁴⁰Ca(pol d,2p),(d,2p) **1991MaZN**

1991MaZN: (pol d,2p) E=56 MeV: measured $\sigma(\theta)$, analyzing powers, FWHM=400 keV.
1988BaZW: (pol d,2p) E=650 MeV; measured tensor analyzing power.
1980StZO: (d,2p): E=55 MeV. Measured $\sigma(\theta)$.

⁴⁰K Levels

E(level)
0
800
2300

$^{40}\text{Ca}(\text{t}, ^3\text{He})$ 1985Aj03

$J\pi(^{40}\text{Ca g.s.})=0^+$.

1985Aj03: E=25 MeV triton beam was produced from the Los Alamos three-stage Van de Graaff accelerator. Target was 105 $\mu\text{g}/\text{cm}^2$ 99.97% enriched ^{40}Ca . Reaction products were momentum analyzed with a Q3D spectrometer. Measured $\sigma(\theta)$. Deduced levels, J, π , L-transfers from comparisons with coupled-channel calculations.

1991Pi09: E=33 MeV. Measured $\sigma(\theta)$ with FWHM=100 keV. Fits to cross sections included finite range and multi-step DWBA.

First four states studies.

All data are from 1985Aj03, unless otherwise noted.

 ^{40}K Levels

E(level)	L [#]	Comments
0	3+5	
31 5	3	
800 5	1+3	
891 5	5	
1642 8		
1959 8	2	
2055 ⁺ 15		E(level): corresponds to 2047+2070.
2091 20	1	
2265 ⁺ 15		
2288 ⁺ 20	0+2 ^{&}	E(level): corresponds to 2290+2291.
2390 10	1+3 ^{@&}	L: for 2390+2411.
2411 15	1+3 ^{@&}	L: for 2390+2411.
2534 ⁺ 15		
2566 15		
2606 15		
2724 15	1	
2774 20		
2807 20		
2865 20		
2938 20		
3017 ⁺ 15		
3100 15		
3120 15		
3216 15	1+3	
3272 15	(0+2)	
3360 15		
3391 ⁺ 20		
3465 ⁺ 15	^{&}	E(level): corresponds to 3439+3486.
3517 ⁺ 15		
3618 ⁺ 15	1+3 ^{&}	E(level): corresponds to 3599+3630.
3653 20		
3715 ⁺ 15		
3780 ⁺ 30		
3859 ⁺ 15	1 ^{&}	E(level): corresponds to 3840+3869.
3883 15		
3995 ⁺ 15		
4091 ⁺ 15	^{&}	E(level): corresponds to 4076+4105.
4190 ⁺ 20		
4237 15	1	
4277 15	1+3	
4335 15		
4374 15		

Continued on next page (footnotes at end of table)

⁴⁰ Ca(t, ³ He) 1985Aj03 (continued)	
⁴⁰ K Levels (continued)	
E(level)	Comments
4455 15	
4508 15	
4535 [†] 15	
4781 15	σ(θ) is not forward peaked.
[†] Weak group, observed at several angles.	
[‡] Unresolved states.	
# From comparisons of measured differential cross sections with coupled-channel Born approximation (CCBA) calculations.	
@ For 2390+2411.	
& σ(θ) is of unresolved group.	

$^{40}\text{Ca}(^7\text{Li},^7\text{Be}),(^7\text{Li},^7\text{Be}\gamma)$ [1979Wi01](#),[1996Wi05](#)

[1979Wi01](#): ($^7\text{Li},^7\text{Be}$) $E=35$ MeV ^7Li beam was produced from the Florida State Super FN Tandem Van de Graaff accelerator.

Targets were made of natural CaF_2 evaporated onto $10\text{ }\mu\text{g}/\text{cm}^2$ carbon backings. Reaction products were detected with two ΔE - E Si surface barrier detector telescopes (FWHM=135 keV). Measured $\sigma(\theta)$. Deduced levels. Compared with Microscopic distorted-wave approximation (DWA) calculations.

[1996Wi05](#): ($^7\text{Li},^7\text{Be}\gamma$) $E=490$ MeV ^7Li beam was produced from K1200 cyclotron at NSCL. Targets are $10.4\text{ mg}/\text{cm}^2$ natural Calcium. Charged particles were analyzed by the A1200 magnetic analyzer and detected in a silicon position-sensitive (PSD) detector; γ rays were detected with an array of 10 CsI scintillators. Measured $E(^7\text{Be})$, $E\gamma$, particle- γ -coin. Deduced continuum isovector spin strength.

[1986NaZW](#): ($^7\text{Li},^7\text{Be}\gamma$) $E=150$ MeV. Measured σ . Deduced giant resonance excitation.

 ^{40}K Levels

E(level)	Comments
$15^{\dagger}$	E(level): unresolved doublet 0+30 (1979Wi01).
$850^{\dagger}$	E(level): unresolved doublet 800+891 (1979Wi01).
$1960^{\dagger}$	
$2270^{\dagger}$	E(level): unresolved doublet 2260+2290 (1979Wi01).
$\approx 7000^{\ddagger}$	
$\approx 11000^{\ddagger}$	E(level): T=2 analog of GDR in ^{40}Ca .

† From [1979Wi01](#).

‡ Giant resonances observed in [1996Wi05](#).

⁴⁰Ca(¹²C,¹²N),(¹³C,¹³N) 1988Vo06,1993Be19

1988Vo06: (¹²C,¹²N) E=70 MeV/nucleon ¹²C beam was produced at GANIL. Measured $\sigma(\theta)$ with the SPEC spectrometer (FWHM $\approx$ 300 keV). Deduced spin-flip giant resonances.

1993Be19 (also 1989Be50): (¹³C,¹³N) E=50 MeV/nucleon ¹³C beam was produced from the three-stage cyclotron at GANIL. Measured $\sigma(\theta)$ with the SPEC spectrometer (FWHM $\approx$ 300 keV). Deduced energy of giant dipole resonance (GDR), and GDR analog state. Microscopic DWBA.

⁴⁰K Levels

E(level)	width	Comments
0 [†]		
30 [†]		
740 [†]		
890 [†]		
11 $\times$ 10 ³ 4		E(level): wide bump interpreted as spinflip giant-dipole resonance split into several states of J π =0 ⁻ ,1 ⁻ , and 2 ⁻ (1988Vo06).
12.0 $\times$ 10 ³ 3	3.1 MeV 2	E(level),width: from 1993Be19. Corresponding energy of GDR in ⁴⁰ Ca=19.7 MeV 3.

[†] GS+30 and 740+890 are unresolved structures in 1988Vo06.

⁴¹K(n,2n),(n,2nγ) 1972Ad01,1979Ha60

1972Ad01: (n,2nγ) E=14.7 MeV. Measured cross section and nγ(t). Deduced T_{1/2}.
1979Ha60: (n,2n), (n,2nγ) E=14.9 MeV. Measured cross section and nγ(t). Deduced T_{1/2}.

⁴⁰K Levels

<u>E(level)[†]</u>	<u>Jπ[†]</u>	<u>T_{1/2}</u>	<u>Comments</u>
0	4 ⁻		
30	3 ⁻		
1644	0 ⁺	294 ns 23	E(level): rounded value from Adopted Levels. T _{1/2} : from 1972Ad01. Other: 0.26 μs 15 (1979Ha60). isomeric cross sections: 36 mb 16 (1972Ad01), 15.1 mb 54 (1979Ha60).

[†] From Adopted Levels. Energies are rounded values.

γ(⁴⁰K)

<u>E_γ</u>	<u>E_i(level)</u>	<u>J_i^π</u>	<u>E_f</u>	<u>J_f^π</u>	<u>Comments</u>
1614	1644	0 ⁺	30	3 ⁻	E _γ : rounded value from Adopted Gammas.

${}^{41}\text{K}(\text{p,d})$ 1973Wi16

$J\pi({}^{41}\text{K g.s.})=3/2^+$.

1973Wi16 (also thesis by 1973WiYW): E=15 MeV deuteron beam was produced from a tandem Van de Graaff accelerator. Targets were 100 and 200 $\mu\text{g}/\text{cm}^2$ KCOOH (99.18% in ${}^{41}\text{K}$). Reaction products were momentum analyzed with a broad-range split-pole magnetic spectrograph (FWHM=15-30 keV) and detected by a triple counter telescope. Measured $\sigma(\theta)$. Deduced levels, J, π , L-transfer, spectroscopic factors from DWBA analysis. Comparisons with shell-model calculations.
All data are from 1973Wi16, unless otherwise noted.

 ${}^{40}\text{K}$ Levels

Spectroscopic factor is defined as $C^2S=(2j+1)/N \times \sigma_{\text{exp}}/\sigma_{\text{DWBA}}$ with $N=3.33$ and j the angular momentum of transferred particle.

E(level) [†]	L [‡]	$C^2S^{\ddagger\#}$	Comments
0	3	0.51 12	
30	3	0.53 11	
800	3+1	0.074 10	C^2S : for L=3; 0.012 3 for L=1.
891	3	0.28 5	

[†] Rounded values from Adopted Levels.

[‡] Extracted from comparisons of measured differential cross sections with DWBA calculations.

[#] $f_{7/2}$ orbital assumed for L=3 and $p_{3/2}$ orbital for L=1.

$^{41}\text{K}(\text{d,t})$ 1973Wi16

$J\pi(^{41}\text{K g.s.})=3/2^+$.

1973Wi16 (also thesis by 1973WiYW): E=15 MeV deuteron beam was produced from a tandem Van de Graaff accelerator. Targets were 100 and 200 $\mu\text{g}/\text{cm}^2$ KCOOH (99.18% in ^{41}K). Reaction products were momentum analyzed with a broad-range split-pole magnetic spectrograph (FWHM=15-30 keV) and detected by a triple counter telescope. Measured $\sigma(\theta)$. Deduced levels, J, π , L-transfer, spectroscopic factors from DWBA analysis. Comparisons with shell-model calculations.
All data are from 1973Wi16, unless otherwise noted.

 ^{40}K Levels

Spectroscopic factor is defined as $C^2S=(2j+1)/N \times \sigma_{\text{exp}}/\sigma_{\text{DWBA}}$ with $N=3.33$ and j the angular momentum of transferred particle.

E(level) [†]	L [#]	C ² S [@]	Comments
0	3	0.61 9	
30	3	0.60 9	
800	3+1	0.074 10	C ² S: for L=3, 0.0053 10 for L=1.
891	3	0.34 5	
1644	2	0.06 2	
1959	2+0	0.07 2	C ² S: for L=2, 0.015 5 for L=0.
≈2000			E(level): unresolved multiplet.
2260	2	0.86 3	
2290	2(+0)	0.09 2	C ² S: for L=2, 0.11 20 for L=0.
2385 [‡] 10	2	0.16 6	
2566 [‡] 10	2	0.07 2	

[†] Rounded values from Adopted Levels.

[‡] From 1973Wi16.

[#] Extracted from comparisons of measured differential cross sections with DWBA calculations.

[@] The following orbitals are assumed for different L transfers: $s_{1/2}$ for L=0, $p_{3/2}$ for L=1, $d_{3/2}$ for L=2, $f_{7/2}$ for L=3.

$^{41}\text{Ca}(\text{d}, ^3\text{He})$ **1979Ro05**

$J\pi(^{41}\text{Ca g.s.})=7/2^-$.

1979Ro05: E=20 MeV deuteron beam was produced from the Oxford EN tandem accelerators. Target was $20 \mu\text{g}/\text{cm}^2$ radioactive ^{41}Ca evaporated onto a $100 \mu\text{g}/\text{cm}^2$ carbon backing. Reaction products were momentum analyzed with a multi-gap magnetic spectrometer (FWHM=15-20 keV) and detected in nuclear emulsions. Measured $\sigma(\theta)$. Deduced levels, J, π , L-transfers, spectroscopic factors from DWBA analysis.

1975Be45: E=40 MeV deuteron beam was produced from the University of Groningen cyclotron. Target was about $160 \mu\text{g}/\text{cm}^2$ 99.9% pure calcium. Reaction products were detected in separate counter telescopes of two silicon surface barrier detectors (FWHM=120 keV). Measured $\sigma(\theta)$. Deduced levels, J, π , L-transfers, spectroscopic factors from DWBA analysis.

All data are from **1979Ro05**, unless otherwise noted.

 ^{40}K Levels

E(level)	L [@]	C ² S ^{#@}	Comments
0	2	1.03 12	C ² S: other: 2.15 for 0+30 doublet in 1975Be45 .
30	2	0.86 6	C ² S: other: 2.15 for 0+30 doublet in 1975Be45 .
800	2	0.57 7	C ² S: other: 2.36 for 800+890 doublet in 1975Be45 .
892	2	1.46 17	C ² S: other: 2.36 for 800+890 doublet in 1975Be45 .
2070	0	0.30 2	C ² S: other: 0.39 in 1975Be45 .
2398	0	0.73 8	C ² S: other: 1.28 in 1975Be45 .
2800 [†]	0	0.61 23	C ² S: other: 0.21 for a broad peak in 1975Be45 .
3260 [‡]	(0)	0.22	E(level),L,C ² S: from 1975Be45 .

[†] Broad structure observed in **1979Ro05** and **1975Be45**.

[‡] Broad structure observed only in **1975Be45**.

[#] Relative values from **1979Ro05**. The absolute values are 19% lower with an uncertainty of 20%, unless otherwise noted.

[@] Extracted from DWBA fits to measured differential cross sections.

$^{42}\text{Ca}(\text{p}, ^3\text{He})$ [1970Ha10](#), [1970Ko13](#)

$J\pi(^{42}\text{Ca g.s.})=0^+$.

[1970Ha10](#): E=45 MeV proton beam was produced from the Berkeley 88-in cyclotron incident on a gas target. Reaction products were detected by two ΔE -E counter telescopes of three silicon detectors. Measured energy spectrum. Deduced levels, T=2 isobaric analog state.

[1970Ko13](#): E=40 MeV proton beam was produced from the cyclotron facility of the Naval Research Laboratory. Target was a 688 $\mu\text{g}/\text{cm}^2$ self-supporting foil of ^{42}Ca . Measured $\sigma(\theta)$. Deduced levels, J, π , L-transfers from DWBA analysis.

Others: [1974DeZZ](#), [1973ShZQ](#), [1972DeyF](#).

 ^{40}K Levels

<u>E(level)</u>	<u>Jπ</u>	<u>L†</u>	<u>Comments</u>
0	4^-		J π : from Adopted Levels.
1640	0^+	0	E(level): From 1970Ko13 . J π : 0^+ is confirmed by characteristic L=0 shape and is consistent with its non-population in (d, α) (1970Ko13). This state is interpreted as an anti-analog state (1970Ko13).
2290			doublet: 2290+2291 (1970Ha10).
4375 25	0^+	0	E(level): from 1970Ha10 , interpreted as T=2 analog state. J π : from L=0 transfer (1970Ko13).

† Extracted from DWBA fits to measured differential cross sections ([1970Ko13](#)).

$^{42}\text{Ca}(\text{pol d},\alpha),(\text{d},\alpha)$ 1981Sh12

1981Sh12: (pol d, α), (d, α) E=7-10 MeV deuteron beams were produced from the McMaster University Lamb-shift ion source and FN tandem accelerator. Target were enriched ^{42}Ca (about 94%) evaporated to 40 $\mu\text{g}/\text{cm}^2$ thickness on 10 $\mu\text{g}/\text{cm}^2$ carbon backings. Reaction products were momentum analyzed with an Engel split-pole magnetic spectrograph (FWHM=15-20 keV) and detected with a proportional counter. Measured $\sigma(\theta)$, tensor analyzing power at 4° . Deduced levels, J, π .

1971Pa16: (d, α) E=11.0 MeV deuteron beam was produced from a tandem Van de Graaff accelerator. Target is 50 $\mu\text{g}/\text{cm}^2$ ^{42}Ca (97% enriched) evaporated onto a carbon backing. Reaction products were detected with a $\Delta\text{E-E}$ telescope of silicon surface-barrier detectors (FWHM=35-40 keV). Measured $\sigma(\theta)$. Deduced levels, J, π . About ten groups reported up to about 4 MeV excitation energy.

1970Ko13: (d, α) E=19.7 MeV. Measured $\sigma(\theta)$. Deduced non-population of the 1644 level.

All data are from **1981Sh12**, unless otherwise noted.

 ^{40}K Levels

1644, 0^+ level was not populated in this reaction which is consistent with its interpretation by **1981Sh12** and 1970Ko13 as an anti-analog state of the 4380, 0^+ level in ^{40}Ar .

E(level)	J $\pi^\dagger$	Comments
0	UNNATURAL	$\langle T_{20} \rangle = -0.57$ 25.
29 5	NATURAL	$\langle T_{20} \rangle = +0.67$ 28.
800 5	UNNATURAL	$\langle T_{20} \rangle = -0.47$ 22.
888 5		
1959 5	NATURAL	$\langle T_{20} \rangle = +0.71$ 18.
2049 5	UNNATURAL	$\langle T_{20} \rangle = -0.29$ 21.
2262 5	UNNATURAL	$\langle T_{20} \rangle = -1.01$ 17.
2289 † 5		E(level): possibly 2290+2291.
2400 5	UNNATURAL	$\langle T_{20} \rangle = -0.87$ 12.
2413 5	UNNATURAL	$\langle T_{20} \rangle = -1.14$ 18.
2545 5	UNNATURAL	$\langle T_{20} \rangle = -0.45$ 14.
2574 5		
2634 5	0^-	J π : from Adopted Levels. $\langle T_{20} \rangle = -1.50$ 24.
2747 † 5		E(level): possibly 2748+2756.
2798 † 5		E(level): possibly 2786+2787.
2811 5		
2990 5	UNNATURAL	$\langle T_{20} \rangle = -0.01$ 23.
3033 5	UNNATURAL	$\langle T_{20} \rangle = -0.04$ 18.
3096 † 10		E(level): possibly 3100+3110.
3125 10		
3156 † 10		E(level): possibly 3146+3154.
3236 10	UNNATURAL	$\langle T_{20} \rangle = +0.29$ 30.
3293 10	UNNATURAL	$\langle T_{20} \rangle = -0.19$ 27.
3369 10		
3389 10	UNNATURAL	$\langle T_{20} \rangle = +0.17$ 22.
3415 10		
3448 10	UNNATURAL	$\langle T_{20} \rangle = -0.45$ 18.
3491 10	UNNATURAL	$\langle T_{20} \rangle = +0.25$ 13.
3568 10	(NATURAL)	$\langle T_{20} \rangle = +0.64$ 27.
3618 † 10	UNNATURAL	$\langle T_{20} \rangle = -0.47$ 23. E(level): possibly 3599+3630.
3682 10		
3710 10	(UNNATURAL)	$\langle T_{20} \rangle = -0.10$ 28.
3737 10	UNNATURAL	$\langle T_{20} \rangle = -0.2$ 6.
3770 10	(UNNATURAL)	$\langle T_{20} \rangle = +0.1$ 7.
3797 10	UNNATURAL	$\langle T_{20} \rangle = -0.54$ 25.

Continued on next page (footnotes at end of table)

$^{42}\text{Ca}(\text{pol d},\alpha),(\text{d},\alpha)$ 1981Sh12 (continued) ^{40}K Levels (continued)

E(level)	$J\pi^\dagger$	Comments
3821 10	UNNATURAL	$\langle T_{20} \rangle = +0.00$ 20.
3869 10	(NATURAL)	$\langle T_{20} \rangle = +0.9$ 3.
3892 [†] 10		E(level): possibly 3888+3902. $\langle T_{20} \rangle = +0.6$ 5.
3921 10	(UNNATURAL)	$\langle T_{20} \rangle = +0.47$ 28.
3996 10	UNNATURAL	$\langle T_{20} \rangle = -0.1$ 3.
4033 10	(UNNATURAL)	$\langle T_{20} \rangle = -1.2$ 3.
4071 10		$\langle T_{20} \rangle = -0.79$ 19.
4118 10	UNNATURAL	$\langle T_{20} \rangle = +0.07$ 15.
4154 10	(UNNATURAL)	$\langle T_{20} \rangle = -0.05$ 10.
4181 10		
4217 10	UNNATURAL	$\langle T_{20} \rangle = +0.4$ 4.
4255 10	(UNNATURAL)	$\langle T_{20} \rangle = -0.30$ 25.
4310 10	UNNATURAL	$\langle T_{20} \rangle = -0.60$ 19.
4362 [†] 10	UNNATURAL	$\langle T_{20} \rangle = -0.21$ 26. E(level): possibly 4350+4366.
4398 [†] 10	(UNNATURAL)	$\langle T_{20} \rangle = -0.22$ 19. E(level): possibly 4384+4396.
4470 10	NOT 0^-	$\langle T_{20} \rangle = +0.42$ 16.
4535 10	UNNATURAL	$\langle T_{20} \rangle = -0.04$ 75.
4590 10	UNNATURAL	$\langle T_{20} \rangle = +0.11$ 14.
4663 10	UNNATURAL	$\langle T_{20} \rangle = -0.22$ 11.
4697 10	UNNATURAL	$\langle T_{20} \rangle = -0.5$ 3.
4749 10		
4762 10	(UNNATURAL)	$\langle T_{20} \rangle = -0.03$ 21.
4786 10	(UNNATURAL)	$\langle T_{20} \rangle = -0.38$ 26.
4827 10	UNNATURAL	$\langle T_{20} \rangle = +0.30$ 10.
4848 10		
4873 [†] 10		E(level): possibly 4874+4876.
4930 10	UNNATURAL	$\langle T_{20} \rangle = +0.38$ 9.
4942 10	(UNNATURAL)	$\langle T_{20} \rangle = -0.15$ 28.
4995 10	UNNATURAL	$\langle T_{20} \rangle = -0.7$ 4.
5030 10		
5068 10	UNNATURAL	$\langle T_{20} \rangle = -0.66$ 16.
5111 [†] 10	UNNATURAL	$\langle T_{20} \rangle = -0.21$ 9. E(level): possibly 5112+5132.
5169 10		
5212 10	UNNATURAL	$\langle T_{20} \rangle = -0.36$ 13.

[†] Unresolved multiplet.[‡] From average tensor analyzing powers ($\langle T_{20} \rangle$) at 4° over 4 or 5 (in some cases 3) energies. Except for 2633 and 4033 levels, $J\pi=0^-$ is not allowed by the measured $\langle T_{20} \rangle$. In most cases of unnatural parity $J\pi=2^-$ when combined with restrictions from other experiments.

Adopted Levels, Gammas

$Q(\beta^-) = -14323.0 \text{ 28}$; $S(n) = 15635.0 \text{ 6}$; $S(p) = 8328.17 \text{ 2}$; $Q(\alpha) = -7039.76 \text{ 3}$ [2012Wa38](#)

$S(2n) = 28930.52 \text{ 20}$, $S(2p) = 14709.51 \text{ 20}$ ([2012Wa38](#)).

First identification of ^{40}Cl nuclide by A. J. Dempster (Phys. Rev., 20 (1922), p. 631).

Additional details of data for resonances in different reactions can be found in the following datasets:.

$^{36}\text{Ar}(\alpha, \gamma)$: resonances: 24 resonances from $E\alpha(\text{lab}) = 5486$ to 13330 (excitation energy in $^{40}\text{Ca} = 11978\text{--}19038$).

$^{39}\text{K}(p, \gamma)$: excitation energies and γ -decays for about 160 resonances.

$^{39}\text{K}(p, p), (p, \alpha)$: resonances: 267 resonances from $E(p)(\text{lab}) = 1102\text{--}6660$ (excitation energy in $^{40}\text{Ca} = 9403\text{--}14680$).

$^{40}\text{Ca}(p, p\alpha), (p, 2p)$: resonances: two resonances with excitation energies (in ^{40}Ca) at 11700 and 12300.

Other reactions (giant resonances, properties of compound nucleus, reaction mechanism, etc.):.

$^{12}\text{C}(^{28}\text{Si}, X)$ or $^{28}\text{Si}(^{12}\text{C}, X)$: [2002Ro35](#), [1995Na09](#), [1986Ha33](#), [1983Ra26](#), [1979Os01](#), [1979Cl02](#), [1979Ba49](#), [1973Ho37](#): reaction mechanisms.

$^{24}\text{Mg}(^{16}\text{O}, X)$: [1991Fo08](#), [1985Sa11](#), [1981Nu02](#), [1980Sa31](#), [1980Sa12](#), [1980Pa08](#), [1979Le02](#), [1979Cl02](#), [1973Ho37](#).

$^{27}\text{Al}(^{16}\text{O}, t)$: [1982Aw01](#), [1981Aw02](#): reaction mechanism.

$^{39}\text{K}(p, p), (p, \alpha)$: resonances: [1987WaZI](#), [1990Bu02](#), [1970De30](#): see dataset.

$^{40}\text{Ca}(^{40}\text{Ca}, X)$: [1997Sc40](#): giant quadrupole resonance.

$^{40}\text{Ca}(p, \pi^-)$: [1983Sh31](#): $E = 190 \text{ MeV}$. Measured σ .

$^{40}\text{Ca}(p, p\alpha), (p, 2p)$: resonances: [2001Sc25](#): see dataset.

Photonuclear reactions: $^{40}\text{Ca}(\gamma, n), (\gamma, p), (\gamma, 2n), (\gamma, pn)$, etc: [1974Br15](#), [1972Br58](#), [1971Sh23](#), [1971Is06](#), [1968Go29](#), [1966An03](#), [1964Ba24](#).

$^{40}\text{Ca}(\gamma, \pi)$: [2002Kr02](#): deduced DELTA resonance. Others: [1988St12](#), [1982Do12](#).

$^{40}\text{Ca}(e, X)$: [1976Zi02](#).

$^{40}\text{Ca}(\mu^-, \nu)$: [2003Po09](#): photon asymmetry measured in radiative muon capture in ^{40}Ca .

$^{40}\text{Ca}(\pi^+, K^+)$: [1991Pi07](#).

$^{40}\text{Ca}(K, \pi^-)$: [1981Be17](#), [1989Ta16](#): hypernuclear production.

$^{40}\text{Ca}(p\text{-bar}, X)$: [2002Ha01](#), [2001Tr23](#), [2001Tr19](#): measured anti-protonic x-rays.

$^{40}\text{Ca}(p\text{-bar}, p\text{-bar})$: [1984Ga32](#).

$^{40}\text{Ca}(p, np)$: [1984Ah04](#) (also [1983AhZY](#)): deduced neutron hole states.

$^{40}\text{Ca}(\text{pol } p, \text{pol } n)$: [1986Wa28](#): deduced spin-flip probability.

$^{40}\text{Ca}(^{20}\text{Ne}, ^{16}\text{O}\alpha)$: [1986Sh30](#).

Hyperfine structure, isotope shifts, nuclear radius measurements: [2000Mu17](#), [2000Ga58](#), [1995Ku41](#), [1993Si20](#), [1992Ve02](#),

[1992Ma20](#), [1991As06](#), [1990Go10](#), [1984Va08](#), [1983Lo13](#), [1982Ay02](#), [1982An15](#), [1980Be13](#), [1979KI01](#), [1978Br31](#), [1976Ne08](#).

Mesic atoms: [1983Ku10](#), [1981Wo02](#), [1980Po01](#), [1979Ba07](#), [1971Ku08](#), [1970Ma26](#), [1970Ku03](#), [1966Co02](#).

Mesic atoms, in most studies, deduced isotope shifts, root-mean square radius.

[1983Ku10](#), [1980Po01](#), [1979Ba07](#), [1970Ku03](#): measured pionic x rays.

[1981Wo02](#), [1970Ma26](#), [1966Co02](#): measured muonic x rays.

[1971Ku08](#): measured kaonic x rays.

Giant (dipole, quadrupole and octupole) resonances: see inelastic scattering datasets: $^{40}\text{Ca}(e, e')$; $(\pi^+, \pi'^+), (\pi^-, \pi'^-)$; (p, p') , $(\text{pol } p, p')$; (d, d') , $(\text{pol } d, d')$; $(^3\text{He}, ^3\text{He}')$; (α, α') ; (HI, HI') .

In XREF column, level population indicated by letter Z or z refers to the following level energies in different reactions:.

^{41}Ti ϵp decay (80.4 ms): 0, 3353.62, 3737, 3904.

^{43}Cr $\beta 3p$ decay (21.2 ms): 0.

^{44}V $\epsilon \alpha$ decay (111 ms): 0.

$^{14}\text{N}(^{28}\text{Si}, d)$: 6930, 8098.

$^{36}\text{Ar}(^7\text{Li}, t)$: 3900, 5265, 5615, 6290, 6525, 7010.

$^{36}\text{Ar}(^{16}\text{O}, ^{12}\text{C})$: 3353, 3900, 5250, 6900, 9900, 12400.

$^{40}\text{Ca}(p, p\alpha), (p, 2p)$: resonances: 11700, 12300.

$^{40}\text{Ca}(t, t), (\text{pol } t, t)$: 0.

Inelastic scattering: 0, 3740, 3900, 4490, 5900, 6290, 6400, 6940, 7300. Giant resonances at 7.8, 10.7, 14.0, 17.6 and 26 MeV.

$^{40}\text{Ca}(n, n'), (\text{pol } n, n')$: 0, 3353, 3737, 3904, 4491.

Adopted Levels, Gammas (continued)

⁴⁰Ca(π^+, π^+), (π^-, π^-): 0, 3353, 3736, 3908, 4492, 6256, 6583, 6700, 11700, 13400, 17500.
⁴²Ca(¹⁶O, ¹⁸O): 0.

⁴⁰Ca Levels

Cross Reference (XREF) Flags

A	⁴⁰ K β^- decay (1.248×10^9 y)	N	⁴⁰ Ca(e, e')	Others:
B	⁴⁰ Sc ε decay (182.3 ms)	O	⁴⁰ Ca(n, n' γ)	AA ⁴³ Cr $\beta^+ 3p$ decay (21.2 ms)
C	⁴ He(³⁶ Ar, α): resonances	P	⁴⁰ Ca(p, p' γ)	AB ⁴⁴ V $\varepsilon \alpha$ decay (111 ms)
D	³² S(¹² C, α)	Q	⁴⁰ Ca(p, p'), (pol p, p')	AC ¹⁴ N(²⁸ Si, d)
E	³⁶ Ar(α , γ): resonances	R	⁴⁰ Ca(d, d'), (pol d, d')	AD ³⁶ Ar(⁷ Li, t)
F	³⁶ Ar(⁶ Li, d)	S	⁴⁰ Ca(³ He, ³ He')	AE ³⁶ Ar(¹⁶ O, ¹² C)
G	³⁸ Ar(³ He, n)	T	⁴⁰ Ca(α , α' γ)	AF ⁴⁰ Ca(p, p α), (p, 2p): resonances
H	³⁹ K(p, γ)	U	⁴⁰ Ca(α , α')	AG ⁴⁰ Ca(t, t), (pol t, t)
I	³⁹ K(p, p), (p, α): resonances	V	⁴¹ Ca(d, t)	AH ⁴⁰ Ca(n, n'), (pol n, n')
J	³⁹ K(d, n)	W	⁴¹ Ca(³ He, α)	AI ⁴⁰ Ca(π^+ , π^+), (π^- , π^-)
K	³⁹ K(³ He, d)	X	⁴² Ca(p, t)	AJ ⁴² Ca(¹⁶ O, ¹⁸ O)
L	³⁹ K(³ He, d γ)	Y	(HI, xn γ)	AK Inelastic scattering
M	⁴⁰ Ca(γ , γ')	Z	⁴¹ Ti εp decay (80.4 ms)	

E(level) [†]	J π [‡]	T _{1/2} [#]	XREF	Comments
0.0	0 ⁺	stable	AB DEFGH JK MNOPQRSTUVWXYZ	Double β decay ($\varepsilon\varepsilon$) is possible, but only limits have been set on half-life from measurements. T _{1/2} : experimental limits from 2 $\varepsilon\varepsilon$ decay (2001Be79, 1999Be64): $>3.0 \times 10^{21}$ y for 0-neutrino mode; $>5.9 \times 10^{21}$ y for 2-neutrino mode. Evaluated rms charge radius=3.4776 fm 19 (2013An02). XREF: Others: AA, AB, AG, AH, AI, AJ, AK XREF: T(?). J π : L(α, α')=L(³ He, n)=L(p, t)=0 from 0 ⁺ ; E0 excitation in (e, e'). T _{1/2} : weighted average of 2.21 ns 10 in (n, n') and 2.15 ns 8 in (p, p' γ). XREF: Others: AE, AH, AI μ =+1.6 3 (2014StZZ, 1979Ni04, 1976Ja16) T=0 (1972Sc19) J π : L(α, α')=L(³ He, n)=L(p, t)=3 from 0 ⁺ ; E3 excitation in (e, e'). μ : from tilted-foil hyperfine field IPAC in (α, α') (1979Ni04) and recoil into gas in (α, α') (1976Ja16). Other: 1.56 30 (IMPAC, relative to g-factor for 4491 level in (α, α'), 1987Ma25). T _{1/2} : from (p, p' γ). XREF: Others: AH, AI, AK J π : L(α, α')=L(³ He, n)=L(p, t)=2 from 0 ⁺ ; E2 excitation in (e, e') and (γ, γ'). T _{1/2} : weighted average of 40 fs 7 in (p, γ), 29 fs +10-6 in (γ, γ'), 36 fs 14 in (n, n' γ), and 33 fs 7 in (p, p' γ). XREF: Others: AD, AE, AH, AI, AK μ =+2.6 5 (2014StZZ, 1974He13) T=0 (1972Sc19) J π : L(α, α')=L(p, t)=5 from 0 ⁺ ; E5 excitation in (e, e'). T _{1/2} : weighted average of 295 ps 5 in (α, α' γ), 272 ps 8 in (p, p' γ), and 0.38 ns 8 in (HI, xn γ).
3352.62@ 9	0 ⁺	2.17 ns 8	D FGH JKL NOPQRSTUVWXYZ	
3736.69 5	3 ⁻	41 ps 4	B D F H JKL NOPQRSTUVWXYZ	
3904.38@ 3	2 ⁺	35 fs 7	D FGH JKLMNOPQR TU XYZ	
4491.43 4	5 ⁻	289 ps 8	B D F H JKL NOPQRSTUVWXYZ	

Continued on next page (footnotes at end of table)

Adopted Levels, Gammas (continued) ^{40}Ca Levels (continued)

<u>E(level)[†]</u>	<u>J^π_‡</u>	<u>T_{1/2}[#]</u>	<u>XREF</u>	<u>Comments</u>
5211.56 ^c 17	0 ⁺	1.02 ps 21	D fgH KL OPQ XY	μ: IPAD method in (p,p'γ) (1974He13). XREF: Others: AH, AI, AK J ^π : L(p,t)=L(⁶ Li,d)=0 from 0 ⁺ . T _{1/2} : from (p,p'γ).
5248.79 5	2 ⁺	83 fs +11-9	d fgH KLMNOPQ S U XY	J ^π : L(p,t)=L(⁶ Li,d)=L(p,p')=2 from 0 ⁺ ; E2 excitation in (e,e'). T _{1/2} : weighted average of 0.15 ps 7 in (p,γ) and 94 fs 17 in (p,p'γ) and 79 fs +11-9 in (γ,γ'). XREF: Others: AD
5278.80 [@] 6	4 ⁺	0.21 ps 4	d FgH KL OPQ U Y	J ^π : L(⁶ Li,d)=L(p,p')=4 from 0 ⁺ ; γ(θ) in (p,γ). T _{1/2} : weighted average of 0.19 ps 4 in (n,n'γ), 0.225 ps 35 in (p,p'γ), and 0.16 ps +13-4 in (p,γ). XREF: Others: AD, AE
5613.52 3	4 ⁻	0.69 ps 11	B d H JKL OPQ sT VW Y	J ^π : spin from γ(θ) in (HI,xnγ) and γγ(θ) in (p,γ); parity from L(d,n)=L(³ He,d)=3 from 3/2 ⁺ and L(d,t)=L(³ He,α)=2 from 7/2 ⁻ . T _{1/2} : from (p,p'γ). Other: 69 fs 55 in (p,γ). XREF: Others: AD
5629.41 ^c 6	2 ⁺	40 fs 15	d F H MNOPQ stU XY	XREF: N(5610). J ^π : L(p,t)=2 from 0 ⁺ ; E2 excitation in (e,e'). T _{1/2} : weighted average of 42 fs 15 from (p,p'γ) and 38 fs +20-10 from (γ,γ'). XREF: Others: AD
5902.63 7	1 ⁻	15.8 fs 22	D F H JKLMNOPQ U WX	XREF: D(5900)N(5940). J ^π : L(p,t)=L(⁶ Li,d)=1 from 0 ⁺ . T _{1/2} : weighted average of 42 fs 14 from (p,p'γ) and 15.2 fs +23-18 (γ,γ'). 2004To07 in (HI,xnγ) propose this as 1 ⁻ member of Kπ=0 ⁻ band, not observed by 2004To07. XREF: Others: AK
6025.47 5	2 ⁻	171 fs 21	f H JKL OPQ uVWx	J ^π : L(³ He,d)=3 and L(d,n)=1+3 from 3/2 ⁺ ; analyzing power in (pol p,p'). T _{1/2} : from (p,p'γ).
6029.71 ^a 6	3 ⁺	0.40 ps 8	f H OP u xY	J ^π : 780.8γ and 2124.4γ E2(+M1) to 2 ⁺ ; band assignment in (HI,xnγ). T _{1/2} : from (p,p'γ). XREF: T(6100).
6160	(3 ⁻)		N TU	J ^π : L(α,α')=(3).
6285.15 4	3 ⁻	0.33 ps 4	D F H JKL NOPQ STU WX	J ^π : L(α,α')=L(p,t)=L(⁶ Li,d)=3 from 0 ⁺ . T _{1/2} : weighted average of 0.27 ps 8 in (p,γ) and 0.35 ps 4 in (p,p'γ). 2004To07 in (HI,xnγ) propose this as (3 ⁻) member of Kπ=0 ⁻ band, not observed by 2004To07. XREF: Others: AD, AI, AK
6422.4 10	2 ⁺	12 fs +5-3	M Q	J ^π : from (pol p,p'). T _{1/2} : from (γ,γ'). XREF: Others: AK
6507.87 13	4 ⁺	128 fs 21	d F H OPQ U XY	J ^π : L(p,t)=L(⁶ Li,d)=L(pol p,p')=4 from 0 ⁺ . T _{1/2} : from (p,p'γ). XREF: Others: AD
6542.80 ^c 9	4 ⁺	121 fs 21	d F H OPQ Y	XREF: O(?). J ^π : L(⁶ Li,d)=4 from 0 ⁺ ; 913.3γ stretched E2 to 2 ⁺ ; band assignment in (HI,xnγ).

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Adopted Levels, Gammas (continued)

^{40}Ca Levels (continued)				
E(level) [†]	J ^π [‡]	T _{1/2} [#]	XREF	Comments
6582.47 10	3 ⁻	0.173 fs 28	B d F H JKL NOPQ STUVWX	T _{1/2} : from (p,p'γ). XREF: Others: AD XREF: O(?)T(6560). J ^π : L(α,α')=L(p,t)=L(⁶ Li,d)=L(pol p,p')=3. T _{1/2} : from (p,p'γ). 2004To07 in (HI,xnγ) propose this as possible (3 ⁻) member of Kπ=0 ⁻ band, not observed by 2004To07.
6750.41 7	2 ⁻	96 fs 28	F H JKL OPQ UVWX	XREF: Others: AI J ^π : from analyzing power in (pol p,p') with L=3; L(³ He,d)=1 and L(d,n)=1+3 from 7/2 ⁺ . T _{1/2} : from (p,p'γ). XREF: Others: AI
6908.70 8	2 ⁺	2.41 fs +29-23	d F H MNOPQ X	J ^π : L(p,t)=L(⁶ Li,d)=L(p,p')=2 from 0 ⁺ . T _{1/2} : from (γ,γ'). Others: <35 fs from (p,γ), <10 fs from (p,p'γ). XREF: Others: AD
6930.2@ 3	6 ⁺	0.34 ps +9-17	d F l O v Y	J ^π : L(⁶ Li,d)=6; γ(θ) and band assignment in (HI,xnγ). T _{1/2} : from (HI,xnγ) by DSAM.
6931.29 6	3 ⁻	1.4 ps 6	d H l nOPQ stuvW	XREF: Others: AC, AD, AE, AK J ^π : L(³ He,α)=2 from 7/2 ⁻ ; 2439.8γ to 5 ⁻ , 1301.8γ, 1682.4γ and 3026.8γ to 2 ⁺ . T _{1/2} : from (p,γ). Other: 104 fs 28 from (p,p'γ). XREF: Others: AD, AK
6938.0 18	(1 ⁻ to 5 ⁻)	0.42 fs 17	d n P stuv	J ^π : γ to 3 ⁻ . T _{1/2} : from (p,p'γ). XREF: Others: AD, AK
6950.48 7	1 ⁻	1.01 fs 5	d GH JKLMNOPQ tuvWX	J ^π : L(p,t)=L(³ He,n)=1 from 0 ⁺ . T _{1/2} : from (γ,γ'). Other: <10 fs from (p,p'γ). XREF: Others: AD, AK
7100	(2 ⁺)		N	E(level),J ^π : from (e,e'). XREF: Others: AD
7113.1 10	1 ⁻	55 fs 28	H jK P x	J ^π : 1899.8γ and 7112.9γ to 0 ⁺ , 1485γ and 3206.8γ to 2 ⁺ ; L(³ He,d)=1 from 3/2 ⁺ ; L(d,n)=1(+3) from 3/2 ⁺ . T _{1/2} : from (p,p'γ). XREF: Others: AD
7113.73 5	4 ⁻	50 fs 21	H jKL PQ UVWx	XREF: K(7117)U(7120). J ^π : L(p,p')=5 from 0 ⁺ ; L(d,t)=L(³ He,α)=0+2 from 7/2 ⁻ . T _{1/2} : weighted average of 35 fs 21 in (p,p'γ) and 76 fs 28 in (p,γ). XREF: Others: AD
7239.07 8	(3 ⁻ ,4,5 ⁻)	0.10 ps 5	d H PQ	J ^π : 3501.4γ to 3 ⁻ and 2746γ to 5 ⁻ . T _{1/2} : from (p,p'γ).
7277.82 8	(2,3) ⁺	49 fs 35	d f H PQ	J ^π : 3541.0γ to 3 ⁻ ; L(p,p')=2 from 0 ⁺ for 7278+7301. T _{1/2} : from (p,p'γ). XREF: Others: AK
7300.67 11	0 ⁺	118 fs 35	d f H PQ U X	J ^π : L(α,α')=L(p,t)=L(⁶ Li,d)=0. T _{1/2} : from (p,p'γ). XREF: Others: AK
7397.2 ^a 10	(5 ⁺)	0.47 ps 14	PQ Y	J ^π : γ to 4 ⁺ and band assignment in (HI,xnγ). 2004To07 in (HI,xnγ) proposed this as (5 ⁻) member of Kπ=0 ⁻ band. T _{1/2} : from (p,p'γ).

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Adopted Levels, Gammas (continued)

⁴⁰ Ca Levels (continued)						
E(level) [†]	J ^π [‡]	T _{1/2} [#]	XREF			Comments
7421.9 15		0.20 ps 14		PQ	X	XREF: X(7433). T _{1/2} : from (p,p'γ).
7446.23 6	3 ⁺ ,4 ⁺	0.14 ps 5	H	PQ	X	J ^π : L(p,p')=4 from 0 ⁺ ; γ to 2 ⁺ . T _{1/2} : from (p,p'γ).
7466.35 7	2 ⁺	8 fs 4	F H	PQ TU	X	XREF: T(7500)U(?). J ^π : L(p,t)=L(p,p')=2 from 0 ⁺ ; 4113.5γ and 7465.6γ to 0 ⁺ . T _{1/2} : from (p,γ). Other: <10 fs in (p,p'γ).
7481?			H			
7532.26 5	2 ⁻	0.16 ps 4	H JKL	PQ	W	J ^π : L(³ He,d)=1 from 3/2 ⁺ ; L(³ He,α)=2; L(p,p')=3; not 3 ⁻ from (p,γ). T _{1/2} : weighted average of 0.22 ps 7 in (p,γ) and 0.149 ps 35 in (p,p'γ).
7561.17 7	4 ⁺	0.17 ps 4	F H	PQR	U X	XREF: U(?). J ^π : L(⁶ Li,d)=4. Note that L(p,t)=(2) is inconsistent and tentative.
7623.11 8	(2 ⁻ ,3,4 ⁺)	0.111 ps 28	H	PQ	X	T _{1/2} : from (p,p'γ). Other: 0.18 ps +10-5 in (p,γ). XREF: X(7625). J ^π : 1993.6γ and 2374.2γ to 2 ⁺ and 2009.5γ to 4 ⁻ . However, L(p,t)=0 for a level at 7625 could indicate there may be a separate level, if this assignment is correct.
7658.23 5	4 ⁻	<10 fs	B H jKL	PQ	vWX	T _{1/2} : from (p,p'γ). T=1 J ^π : log ft=3.3 from 4 ⁻ ; analog of g.s. in ⁴⁰ K (see 1966Er05, 1966An01).
7676.6 5	(6 ⁺)	0.20 ps 5	H j	PQ	uv Y	T _{1/2} : from (p,p'γ). J ^π : 2399.2γ (E2) to 4 ⁺ .
7694.08 4	3 ⁻	<6 fs	H JKL	PQ	uvW	T _{1/2} : from (p,p'γ). T=1 J ^π : L(d,n)=1 and L(³ He,d)=3 from 3/2 ⁺ ; 2080.6γ to 4 ⁻ ; analog of the 29.8, 3 ⁻ level in ⁴⁰ K, see 1966Er05 in (³ He,d).
7701.8 4	0 ⁺		F H	Q	u X	T _{1/2} : from (p,γ). Other: <10 fs in (p,p'γ). J ^π : L(⁶ Li,d)=L(p,t)=0.
7769.4 10	(3,4,5 ⁻)	166 fs 35	H	PQ	X	XREF: X(7757). J ^π : 2155.8γ to 4 ⁻ and 4032.5γ to 3 ⁻ ; J=(3,4,5) from γ feeding in (p,γ) (1990Ki07).
7814.7 6	0 ⁺		G	PQ	X	T _{1/2} : from (p,p'γ). E(level): from (p,p'). J ^π : L(³ He,n)=0.
7870	3 ⁻		F			J ^π : L(⁶ Li,d)=3.
7872.18 9	2 ⁺	2.44 fs +24-20	H Mn	PQ	U X	J ^π : L(p,t)=L(α,α')=2 from 0 ⁺ . T _{1/2} : from (γ,γ'). Other: <14 fs from (p,p'γ). XREF: Others: AK
7928.42 10	4 ⁺	49 fs 35	H n	PQ s U	X	J ^π : L(α,α')=L(p,p')=4 from 0 ⁺ . Note that L(p,t)=(3) is inconsistent and tentative. T _{1/2} : from (p,p'γ). XREF: Others: AK
7972.5	(≤3) ⁻		d J	s	x	J ^π : L(d,n)=1.
7974.4 ^C 8	(6 ⁺)		H		Y	E(level): band assignment in (HI,xnγ).

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Adopted Levels, Gammas (continued)

⁴⁰ Ca Levels (continued)									
E(level) [†]	J ^π [‡]	T _{1/2} [#]	XREF				Comments		
7976.55 3	2 ⁺	21 fs 21	d	PQ	s	x	J ^π : 4624γ and 7977γ to 0 ⁺ and 2699γ to 4 ⁺ . T _{1/2} : from (p,p'γ). E(level): from (p,p'γ). J ^π : L(p,t)=0 from 0 ⁺ . E(level): from (p,p').		
8018.8 10	0 ⁺		d	PQ		X	XREF: F(8050)G(8050).		
8051.8 6				Q			J ^π : L(α,α')=L(⁶ Li,d)=L(³ He,n)=L(p,p')=2 from 0 ⁺ ; E2 excitation in (γ,γ'); but L(p,t)=4 from 0 ⁺ for a level at 8085 is inconsistent and it could imply that there may be a separate level if the assignment is correct.		
8091.61 17	2 ⁺	2.94 fs +20–18	d FGH	M	PQ	U	X	T _{1/2} : from (γ,γ'). Other: <28 fs in (p,p'γ). J ^π : 1168.8γ ΔJ=2, E2 to 6 ⁺ . T _{1/2} : from (HI,xnγ) by recoil-distance method. XREF: Others: AC	
8100.1& 7	8 ⁺	12.5 ps 17	d				Y	XREF: F(8150). J ^π : spin=1 from dipole excitation in (γ,γ'); L(p,p')=3 and L(⁶ Li,d)=1 from 0 ⁺ . T _{1/2} : from (γ,γ'). Other: <14 fs in (p,p'γ).	
8113.2 5	1 ⁻	30 fs +20–9	d F	j	M	PQ		X	J ^π : 2505.3γ and 4229.4γ to 2 ⁺ and 2521.2γ to 4 ⁻ . Possible 3643.1γ to 5 ⁻ would disfavor 2 ⁻ and 3 ⁺ . L(d,n)=1+3 from 3/2 ⁺ for 8113 and 8135 doublet.
8134.77 10	(3 ⁻)	<28 fs	d	H j		PQ			T _{1/2} : from (p,p'γ). J ^π : 4451.6γ to 3 ⁻ ; J=(3,4,5) based on γ feeding in (p,γ) (1990Ki07).
8187.5 8	(3,4,5 ⁻)	<17 fs		H j		PQ		x	T _{1/2} : from (p,p'γ). E(level): from (p,p'). XREF: U(?). E(level): from (p,p'). J ^π : L(d,n)=1 from 3/2 ⁺ ; 1315γ and 2364γ to 1 ⁻ . But L(⁶ Li,d)=4 from 0 ⁺ is suggested for a 8270 group.
8195.9 6						Q		x	J ^π : L(p,t)=L(³ He,n)=L(⁶ Li,d)=0 from 0 ⁺ . J ^π : 8322.2γ to 0 ⁺ , 2038.0γ and 4586.2γ to 3 ⁻ . T _{1/2} : weighted average of 83 fs 28 in (p,γ) and 42 fs 21 in (p,p'γ).
8271 1	(≤3) ⁻			J L		PQ		U	J ^π : 1795.2γ and 1830.1γ to 4 ⁺ ; J=(2,3,4) based on γ feeding in (p,γ) (1990Ki07). XREF: J(8371). J ^π : L(d,n)=1 from 3/2 ⁺ ; 1405γ to 1 ⁻ is unlikely to be Mult=Q, ΔJ=2 based on RUL.
8276 1	0 ⁺			FG		PQ		X	T _{1/2} : from (p,p'γ). J ^π : 3872γ to 5 ⁻ . XREF: F(8380).
8323.16 8	(1 ⁻ ,2 ⁺)	58 fs 21	d	H		PQ			J ^π : L(α,α')=L(p,t)=L(⁶ Li,d)=4 from 0 ⁺ . T=1 (1990Ki07)
8338.0 3	(2 ⁺ ,3,4)		d	H		Q		X	XREF: K(8435). J ^π : L(³ He,α)=2 from 7/2 ⁻ , L(p,p')=3 from 0 ⁺ , L(d,n)=1+3 from 3/2 ⁺ ; M2 excitation in (e,e'); analog of the 800, 2 ⁻ level in ⁴⁰ K, see 1966Er05 in (³ He,d). T _{1/2} : from (p,p'γ).
8358.9 6	(0,1,2) ⁻	104 fs 21	d		J L	PQ			
8364 5	(3 ⁻ to 7 ⁻)					P			
8373.94 15	4 ⁺		F H			Q		U WX	
8424.81 11	2 ⁻	<17 fs		H JKL N		PQ		vW	

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Adopted Levels, Gammas (continued)

⁴⁰ Ca Levels (continued)						
E(level) [†]	J ^π [‡]	T _{1/2} [#]	XREF			Comments
8439.0 5	0 ⁺		FgH	PQ s	X	XREF: F(8420). J ^π : L(p,t)=L(⁶ Li,d)=0 from 0 ⁺ .
8484.02 13	(1 ⁻ ,2 ⁻ ,3 ⁻)	24 fs 14	gH k	PQ s	vWX	J ^π : 2581.3γ to 1 ⁻ , 4747.0γ to 3 ⁻ ; L(³ He,α)=(2) from 7/2 ⁻ . But L(p,t)=0 from 0 ⁺ for a level at 8483 is inconsistent and it is unlikely the same level based on RUL for the 4747.0γ, unless L(p,t)=0 is questionable.
8540 4	1,2 ⁺	14 fs 14	f	P	vw	T _{1/2} : from (p,p'γ). J ^π : 5188γ and 8540γ to 0 ⁺ ; M2 is ruled out by RUL for these transitions.
8551.1 7	5 ⁻	<17 fs	f JK N PQ	v X		T _{1/2} : from (p,p'γ). T=1 XREF: N(8500). J ^π : L(p,t)=L(p,p')=5 from 0 ⁺ , L(d,n)=L(³ He,d)=3 from 3/2 ⁺ ; analog of the 891, 5 ⁻ level in ⁴⁰ K, see 1966Er05 in (³ He,d).
8578.80 9	2 ⁺	3.6 fs +13-8	d f H M	PQ	u x	T _{1/2} : from (p,p'γ). J ^π : L(p,p')=2 from 0 ⁺ ; E2 excitation in (γ,γ').
8587 2	(2 ⁺ ,3)		d f	P	u x	T _{1/2} : from (γ,γ'). Other: <21 fs from (p,p'γ).
8633 6				PQ		J ^π : 2562γ to 2 ⁻ , 3904γ to 2 ⁺ , 3308γ to 4 ⁺ .
8665.3 8	1 ⁻		J	PQ		E(level): from ⁴⁰ Ca(p,p'γ). XREF: P(8671).
8678.29 10	4 ⁺	42 fs 35	H	P	X	E(level): from (p,p'). J ^π : L(d,n)=1; 8665γ to 0 ⁺ . J ^π : L(p,t)=4.
8701 1	(6 ⁻)				Y	T _{1/2} : from (p,γ). J ^π : suggested in (HI,xnγ); 3088γ to 4 ⁻ and 4209γ to 5 ⁻ .
8717 8				P		
8748.22 9	2 ⁺	5.8 fs +11-8	f H j M	PQ T		XREF: P(8756)T(8700). J ^π : L(p,p')=2 from 0 ⁺ ; E2 excitation in (γ,γ').
8764.18 6	3 ⁻		d H j	P	X	T _{1/2} : from (γ,γ'). XREF: P(8769)X(8752).
8810 7	2 ⁺		d f	PQ	U	J ^π : L(p,t)=3. XREF: P(8819).
8850.6 9	6 ⁻ ,7 ⁻ ,8 ⁻		J	PQ	X	J ^π : L(α,α')=2 from 0 ⁺ for a 8780 group. XREF: P(8860).
8909.0 9				Q	X	E(level): from (p,p').
8934.81 7	2 ⁺		F H j	P		J ^π : L(p,p')=7 from 0 ⁺ . Jπ=(0) ⁻ is proposed for a 8860 group in (d,n). E(level): from (p,p'). XREF: P(8922).
8935.8 ^a 9	(7 ⁺)				Y	J ^π : L(⁶ Li,d)=2 from 0 ⁺ ; 3722.1γ, 5581.8γ and 8933.7γ to 0 ⁺ , 2352.2γ and 5197.8γ to 3 ⁻ , 2905.0γ to 3 ⁺ .
8938.4 9	0 ⁺		J	PQ	X	J ^π : band assignment in (HI,xnγ). XREF: P(8949).
						E(level): from (p,p'). J ^π : L(p,t)=0. But L(d,n)=1 from 3/2 ⁺ is suggested for a level at 8931.
8978 6	5 ⁺ ,6 ⁺ ,7 ⁺		H	Q	V x	XREF: H(?)V(?). E(level): from (p,p').
8982.5 5	2 ⁺	4.5 fs +39-14	j M	r UV	x	J ^π : L(p,p')=6 from 0 ⁺ . XREF: U(8970)V(?).

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Adopted Levels, Gammas (continued) ^{40}Ca Levels (continued)

<u>E(level)[†]</u>	<u>J^π</u>	<u>XREF</u>				<u>Comments</u>
8994.50 11	(1 ⁻ , 2 ⁺)	H j	PQr	x		J ^π : E2 excitation in (γ, γ'). T _{1/2} : from (γ, γ'). XREF: P(9011).
9031.9 3	4 ⁻	H	Q	VWX		J ^π : 5641.5γ and 8993.4γ to 0 ⁺ , 2411.0γ, 2709.3γ to 3 ⁻ . J ^π : L(d,t)=L(³ He, α)=0 from 7/2 ⁻ , L(p,p')=5 from 0 ⁺ . 2004To07 in (HI,xnγ) propose (7 ⁻) for this level, but γ's to 3 ⁻ and 4 ⁻ states are inconsistent with this assignment.
9033? ^b 1	(7 ⁻)			Y		E(level): it is possible that this level is the same as the 9031.9 seen in other reactions and the 4542γ reported by 2004To07 in (HI,xnγ) could correspond to 4540.2γ in (p, γ). But the most intense 3418γ from 9031.9 level is not reported by 2004To07.
9050.1 10			Q			J ^π : band assignment in (HI,xnγ).
9080.3 11			Q	w		E(level): from (p,p').
9091.70 6	3 ⁻	H k	Q	w		E(level): from (p,p'). T=(0) (1990Ki07)
9135.66 5	2 ⁻ , 3 ⁻	f H Jk	Q	Wx		J ^π : 1977.9γ to 4 ⁻ and 3812.7γ to 4 ⁺ , 5187.0γ to 2 ⁺ and 3066.1γ to 2 ⁻ , 3188.9γ to 1 ⁻ . T=0 (1990Ki07)
9162.1 11		f k	Q	x		J ^π : L(d,n)=1 from 3/2 ⁺ , L(p,p')=3 from 0 ⁺ .
9185.3 12		k	Q			E(level): from (p,p').
9209.77 3	(2,3) ⁻	H j	Q	w		E(level): from (p,p'). T=0 (1990Ki07)
9226.69 5	(1 ⁻ , 2, 3 ⁻)	H j	q	w		J ^π : 2096.0γ to 4 ⁻ , 2259.2γ and 3307.0γ to 1 ⁻ ; L(d,n)=1 from 3/2 ⁺ . J ^π : 2276.1γ to 1 ⁻ and 2941.4γ to 3 ⁻ . Possible 9225.6γ to 0 ⁺ would disfavor 3 ⁻ .
9227.43 7	(1, 2 ⁺)	H j	q	w		J ^π : 5874.4γ to 0 ⁺ and 3201.8γ to 2 ⁻ .
9246.0 12	(7) ⁻	F	Q	X		XREF: X(9250). E(level): from (p,p').
9274.5 12			Q	X		J ^π : L(p,p')=7. But L(⁶ Li,d)=6 for a 9240 group. XREF: X(9263).
9304 5	0 ⁺			X		E(level): from (p,p'). T=1 (1972Sc19)
9305.2 [@] 8	(8 ⁺)			Y		J ^π : L(p,t)=0.
9362.54 6	3 ⁻	B F H k		U x		J ^π : band assignment in (HI,xnγ). T=0 (1990Ki07) XREF: U(9340).
9377.7 2	2 ⁻ , 3 ⁻ , 4 ⁻	H k	Q	x		J ^π : log ft=5.4 from 4 ⁻ ; 937.7γ to 2 ⁻ , 4113.5γ to 2 ⁺ . Γ _α /T _p =0.0119 5 from ⁴⁰ Sc ε decay.
9388.20 19	2 ⁺	H k				E(level): from (p, γ). J ^π : L(p,p')=3 from 0 ⁺ .
9395.6 3		H jk				J ^π : 2087.4γ, 4176.3γ and 9387.0γ to 0 ⁺ , and 2845.3γ, 2880.3γ and 4109.2γ to 4 ⁺ .
9404.85 19	2 ⁻	HIJk				E(level): from (p, γ). T=1 XREF: J(9408).
9406.3 6	0 ⁺	GH k		X		J ^π : 9403.7γ to 0 ⁺ , 2822.2γ, 3119.6γ and 5667.7γ to 3 ⁻ , 2291.1γ to 4 ⁻ ; L(p,p)=1 from 3/2 ⁺ ; γγ(θ) in (p, γ) give J=2. T _{1/2} : from (p,p),(p,α): resonances. T=1 XREF: G(9380).
9412.3 2		H Jk	q			E(level): from (p, γ). J ^π : L(³ He,n)=L(p,t)=0 from 0 ⁺ . XREF: J(9408).

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Adopted Levels, Gammas (continued) ^{40}Ca Levels (continued)

E(level) [†]	J ^π [‡]	T _{1/2} [#]	XREF				Comments
9418.8 2	3 ⁻		B	H Jk	q		T=1 XREF: J(9408).
9429.11 5	(3,4) ⁻		B	H Jk		w	J ^π : log ft=5.6 from 4 ⁻ ; 3516.0γ to 1 ⁻ . T=0 (1990Ki07) XREF: J(9431).
9432.46 18	1 ⁻	0.23 keV		HIJk		w	J ^π : log ft=5.5 from 4 ⁻ ; L(³ He,α)=(0) from 7/2 ⁻ . T=1 (1990Ki07) XREF: J(9431).
9453.95 5	3 ⁻	0.09 keV	B	HIJk	Q	W	J ^π : L(p,p)=1 from 3/2 ⁺ ; 9431.3γ to 0 ⁺ . T _{1/2} : from (p,p),(p,α):resonances. T=0 XREF: Q(?).
9499.9 15	2 ⁺			F H		U	J ^π : log ft=5.2 from 4 ⁻ ; L(d,n)=1 from 3/2 ⁺ . T _{1/2} : from (p,p),(p,α):resonances. E(level): from (p,γ).
9536.24 16				H			J ^π : L(⁶ Li,d)=2 from 0 ⁺ . E(level): from (p,γ).
9537.8 5	1 ⁻	0.4 keV		HIJ	Q		XREF: Q(?). E(level): from (p,γ). Other: 9535.2 14 in (p,p):resonances.
9564 5	(2 ⁺)			G		WX	J ^π , T _{1/2} : from (p,p),(p,α):resonances. L(p,p)=L(d,n)=1 from 3/2 ⁺ . T=(1) XREF: G(9600).
9603.0 4	3 ⁻	0.4 keV	B	HIj	T	wX	J ^π : L(³ He,n)=2 for a 9600 group. T=1 J ^π : log ft=5.6 from 4 ⁻ ; L(p,p)=1 from 3/2 ⁺ ; γγ(θ) in (p,γ) gives J=3.
9604.6 4	1 ⁻	0.19 keV 5		HIj M		wX	T _{1/2} : from (2J+1)×Γ=3.4 keV for the 9603+9605 levels in (p,p),(p,α):resonances, and Γ=0.19 keV 5 from (γ,γ') for the 9605 level.
9632.7? 11				H			T=1 T _{1/2} : from (γ,γ'). Other: 1.3 keV from (p,p),(p,α):resonances.
9640.89 7	2 ⁻			H		wX	E(level): from (p,γ). T=1 XREF: X(9620).
9655.5 9				H	q	WX	J ^π : spin from γγ(θ) and parity from a resonance formation fit in (p,γ). XREF: W(9647)X(9665). E(level): from (p,γ).
9662.2 2	≤3 ⁻			Hi j	q	WX	XREF: W(9647)X(9665). E(level): from (p,γ).
9668.71 8	3 ⁻		F	Hi jK		WX	J ^π : L(p,p)=(d,n)=1 from 3/2 ⁺ for 9662+9669. T=1 XREF: F(9700)K(9700)W(9673)X(9665).
9779.47 7	3			H			J ^π : L(⁶ Li,d)=3 from 0 ⁺ . T=1
9785.3 2	(1,2 ⁺)			H			J ^π : from γγ(θ) in (p,γ).
9802.1 7	≤3 ⁻			HI			J ^π : 2484.5γ, 6432.1γ and 9784.0γ to 0 ⁺ . E(level): from (p,γ).
9807.2? 11				H			J ^π : L(p,p)=1 from 3/2 ⁺ .
9811.0 2	(3 ⁻ , 4 ⁻ , 5 ⁻)		B	H			E(level): from (p,γ). J ^π : log ft=6.1 from 4 ⁻ .

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Adopted Levels, Gammas (continued)

^{40}Ca Levels (continued)									
E(level) [†]	J ^π [‡]	T _{1/2} [#]	XREF				Comments		
9829.43 16			B	H			E(level): from (p,γ).		
9834.97 19			B	H					
9853.5 ^c 8	(8 ⁺)					Y	J ^π : band assignment in (HI,xnγ).		
9854.43 17	≤3 ⁻			HI			XREF: Others: AE		
9859.6 3	4 ⁻ ,5 ⁻ ,6 ⁻			H		Q	E(level): from (p,γ).		
9865.15 11	1	0.100 keV 24	ef	H	M		J ^π : L(p,p)=1 from 3/2 ⁺ .		
							J ^π : L(p,p')=5 from 0 ⁺ .		
							T=1		
							J ^π : from γγ(θ) in (p,γ).		
9869.3 4	1 ⁺ ,2 ⁺	0.90 keV 21	ef	H	MN	Q	U	T _{1/2} : from (γ,γ').	
								XREF: Q(9877)U(9870).	
								J ^π : γ's to 0 ⁺ and 2 ⁺ ; M1 or E2 excitation in	
								(e,e'). L(⁶ Li,d)=2 for a 9870 group and a	
								doublet at 9868 suggested by 1980St17 in (e,e')	
								could indicate there is a separate level with	
								J ^π =2 ⁺ .	
								T _{1/2} : from (γ,γ').	
9898.5 3				H					
9921.3 2	(3 ⁻ ,4 ⁻ ,5 ⁻)		B	f	H			E(level): from (p,γ).	
								J ^π : log ft=6.3 from 4 ⁻ .	
9939.7 2				f	H				
9954.00 9	4 ⁺		B	f	H			T=0	
								J ^π : spin=4 from γγ(θ) in (p,γ); observed α	
								decay from this level in ⁴⁰ Sc ε decay implies	
								π=natural.	
9977.09 17	(3,4,5)		B	f	H			E(level): from (p,γ).	
								J ^π : log ft=7.0 from 4 ⁻ .	
9993.6 15				H					
10040.54 9	(2 ⁻ ,3 ⁻)			H	j		v	T=1	
								J ^π : γ's to 1 ⁻ and 4 ⁻ .	
10045.6 5	(3 ⁻ to 7 ⁻)			H	j		v		
10049.38 7	4 ⁻		B	H	jK	q	vw	T=1	
								XREF: K(?).	
								J ^π : log ft=6.3 from 4 ⁻ ; γ's to 2 ⁻ and 5 ⁻ ;	
								L(p,p')=5 from 0 ⁺ , L(³ He,α)=0 from 7/2 ⁻ .	
10057.9 3				f	H	j	q	vw	T=0 E(level): from (p,γ).
10065 2	(1 ⁻ ,2 ⁺)			f	I		q	v	
10080.6 2				f	H			Uv	
10130.59 19	(3 ⁻ ,4 ⁺)		B	f	HI			v	
10154 8	(3 ⁻ ,4 ⁺ ,5 ⁻)		B	f					T=0 E(level): from (p,γ).
10193 7	(3 ⁻ ,4 ⁺ ,5 ⁻)		b						T=0 E(level): from ⁴⁰ Sc ε decay.
10199.1 4	1 ⁻			HI					T=0 E(level): from (p,γ).
10205.0 8				H					T=0 E(level): from (p,γ).
10210.5 2	3 ⁻ ,4 ⁻		B	H			W		
10232.7 7				H					J ^π : log ft=5.7 from 4 ⁻ ; L(³ He,α)=0 from 7/2 ⁻ .

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Adopted Levels, Gammas (continued) ^{40}Ca Levels (continued)

$E(\text{level})^\dagger$	$J^\pi^\ddagger$	$T_{1/2}^\#$	XREF				Comments
10262.53 10	3^-		HI				T=0+1. J^π : γ 's to $1^-, 3^-, 3^+$; L(p,p)=1 from $3/2^+$ for 10263+10268; π =natural from (p, α):resonances.
10267.6 5	1^-	0.9 keV	HI				T=0 $J^\pi, T_{1/2}$: from (p,p),(p, α):resonances for a 10265 group.
10274.7 3	$3^+, 4^+, 5^+$		H		Q		XREF: Q(10287). J^π : L(p,p')=4 from 0^+ .
10277.8 2	(1^-)	1.6 keV	HI		Q		T=0 XREF: I(10275)Q(10290). E(level): from (p, γ). XREF: Q(10290).
10284.9 3	1^-	1.1 keV	Hi		Q		E(level): from (p, γ). XREF: Q(10290).
10318.8 4	1^+	26 eV 7	E H	MN	Q		T=1 XREF: Q(10328). J^π : M1 excitation in (e,e'). $T_{1/2}$: from (γ, γ'). T=0
10333.7 5	(3^-)	0.11 keV	B	HI		Q	XREF: Q(10344). J^π : $(1,3)^-$ from (p,p),(p, α):resonances; log ft=7.1 from 4^- .
10340 20	4^+				Q	U	XREF: Q(10344). J^π : L(α, α')=4.
10358.5 15			F H				XREF: F(10340). J^π : L($^6\text{Li}, d$)=8 for a level at 10340 could indicate there may be a different level.
10361.4 15			B	H			T=0
10362.8 5	1^-	0.60 keV		I			E(level): could be the same level as the 10361.4 level in (p, γ).
10364.8 5	$(1,3)^-$			I			
10376.6 5	1^-	0.6 keV		HI			
10383.79 16	$(1^-, 2^+)$			HI	K		T=0 XREF: K(?).
10415.06 6	3			H			T=1 J^π : 2853.8γ to 4^+ , 3301.2γ to 4^- , 2948.6γ to 2^+ , 3664.5γ to 2^- .
10420.4 5	1^-	0.5 keV		HI			T=0 E(level): from (p, γ).
10430.47 19	(2^+)			HI			T=0 E(level): from (p, γ).
10441.3 6				H			E(level): from (p, γ).
10443.8 2	2^-	4.0 keV		HI			E(level): from (p, γ). 10443.5 5 in (p,p),(p, α):resonances.
10447.0 5	3^-	0.44 keV	B	f	I		T=0 E(level): \$from (p,p),(p, α):resonances. J^π : $(1,3)^-$ in (p,p),(p, α):resonances with L(p)=1 from $3/2^+$; log ft=6.2 from 4^- .
10469.9 15	$(3,5)^-$		B	f H			E(level): from (p, γ). J^π : log ft=5.7 from 4^- ; α decay of this level in ^{40}Sc ε decay implies π =natural.
10474 2	(8^-)					Y	J^π : proposed in (HI,xn γ).
10478.6 15				H			
10503.0 15	$(3,4,5)^-$		B	H			E(level): from (p, γ). J^π : log ft=5.5 from 4^- .

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Adopted Levels, Gammas (continued)
⁴⁰Ca Levels (continued)

E(level) [†]	J ^π [‡]	T _{1/2} [#]	XREF		Comments
10514.7 15	(3 ⁻ ,4 ⁺ ,5 ⁻)		B	H	XREF: B(10519). J ^π : log ft=6.7 from 4 ⁻ ; α decay of this level in ⁴⁰ Sc ε decay implies π=natural.
10516.5 5	1 ⁻	1.2 keV		I	T=0 E(level): could be the same level as the 10514.7 level in (p,γ).
10517.4 5	1 ⁽⁺⁾	0.30 keV		I	
10529.8 5	(1 ⁺)	0.40 keV		HI	E(level): from (p,p),(p,α):resonances. 10527.8 15 from (p,γ).
10541.7 5	2 ⁺	0.19 keV		HI	T=0 E(level): from (p,p),(p,α):resonances. 10540.0 15 from (p,γ).
10552.1 15				H	
10582 5	(3,4,5)		B		J ^π : log ft=6.3 from 4 ⁻ .
10596.4 5	3 ⁻	0.16 keV	B	F I	T=0 XREF: F(10590). E(level): from (p,p),(p,α):resonances.
10598.6 5	(1 ⁺)	0.20 keV		I	
10607.6 5	0 ⁽⁺⁾	0.20 keV	g	I	
10618.8 5	2 ⁻	3.5 keV		I	
10621.6 5	0 ⁺	0.04 keV	g	I	T=0
10633.8 5	(1,3) ⁻	1.1 keV		HI	E(level): from (p,p),(p,α):resonances. 10632.7 2 in (p,γ).
10639.07 7	(3 ⁻ ,4,5 ⁻)			H	T=1 J ^π : 3707.6γ and 4056.3γ to 3 ⁻ , 6147.7γ to 5 ⁻ .
10646.3 4	NATURAL		g	HI	T=0 E(level): from (p,γ).
10653.12 16				H	
10656.1 5	(1 ⁻)	0.60 keV		I	T=0
10657.6 5	2 ⁺	0.35 keV		I	T=0
10666.6 5	2 ⁻	2.0 keV		I	
10670.3 3				H	
10673.58 17	2 ⁻			H	J ^π : M2 excitation in (e,e').
10675.6 5	1 ⁻	1.6 keV		HI	T=0 E(level): from (p,p),(p,α):resonances. 10673.69 15 in (p,γ).
10690.9 3				H	XREF: Others: AK
10693.1 5	1 ⁺	1.1 keV		I	XREF: Others: AK
10699.50 10	3		B	H	XREF: N(10680). J ^π : 2325.5γ to 4 ⁺ , 5085.6γ to 4 ⁻ , 2607.8γ to 2 ⁺ , 3167.1γ to 2 ⁻ . XREF: Others: AK
10701.1 5	0 ⁺	0.60 keV		I	
10720.7 3	(3,5) ⁻		B	H	E(level): from (p,γ). J ^π : log ft=5.7 from 4 ⁻ ; α decay of this level in ⁴⁰ Sc ε decay implies π=natural.
10722.3 5	1 ⁺	1.1 keV		I	XREF: Others: AK
10737.7 3	1 ⁻		F	H	T=0+1 XREF: F(10700). J ^π : 10736.2γ to 0 ⁺ , 3043.4 and 4452.3γ to 3 ⁻ ; L(⁶ Li,d)=1 from 0 ⁺ .
10740.3 5	1 ⁻	2.2 keV		I	T=0
10747.8 4	(4 ⁺)			HI	J ^π : (1 ⁻ ,2,3,4 ⁺) from 5118.0γ and 6842.8γ to 2 ⁺ , 7010.5γ to 3 ⁻ ; J ^π =(4 ⁺ ,5 ⁻) from (p,p),(p,α):resonances for a level at 10751.

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Adopted Levels, Gammas (continued) ^{40}Ca Levels (continued)

E(level) [†]	J ^π [‡]	T _{1/2} [#]	XREF		Comments
10749.0 5	0 ⁺	0.31 keV		I	
10753.74 18	(3,4,5)		B	H	J ^π : log ft=6.5 from 4 ⁻ .
10770.2 3	(1 ⁺)	0.05 keV		HI	XREF: I(10772.3).
10776.2 3	(1 ⁻)			H	E(level): from (p,γ).
10778.3 5	2 ⁺	0.18 keV		I	J ^π : possible E1 excitation in (e,e') for 10776.
10780.7 5	3 ⁻	1.0 keV	B	HI	T=0
					T=0
					E(level): from (p,p),(p,α):resonances. 10780.9 3 in (p,γ).
10783.2 5	(0 ⁻)	0.70 keV		I	
10787.6 3			F	H	XREF: F(?).
10799.9 10				H	u
10802.8 5	0 ⁽⁺⁾	0.70 keV		I	T=0
10813.6 5	(3 ⁻ ,4 ⁺ ,5 ⁻)		B	f H	T=0
					J ^π : log ft=6.3 from 4 ⁻ ; L(⁶ Li,d)=5 for 10800 group; α decay of this level in ⁴⁰ Sc ε decay implies π=natural.
10816.4 5	2 ⁻	6.0 keV		I	
10816.6 5	3 ⁺	0.50 keV		I	
10829.9 6				f H	
10833.2 5	3 ⁻	0.026 keV		f I	T=0
10848.4 4	(3,4,5) ⁻		B	f H	J ^π : log ft=5.8 from 4 ⁻ .
10849.3 5	2 ⁻	11 keV		I	
10852.2 5	1 ⁻	2.5 keV		I	T=0
10861.4 5	2 ⁺	0.045 keV		I	T=0
10869.0 5	1 ⁻	26 keV		HI	E(level): from (p,p),(p,γ):resonances. 10868.8 4 in (p,γ).
10869.7 5	0 ⁺	0.40 keV		I	
10873.9 5	1 ⁻	4.0 keV		I	
10895 ^b 1	(9 ⁻)				Y J ^π : band assignment in (HI,xnγ).
10899.3 5	1 ⁺	0.41 keV		I	
10910.0 4	(3,4,5 ⁻)		B	f H	E(level): from (p,γ).
					J ^π : log ft=6.8 from 4 ⁻ ; 7172.6γ to 3 ⁻ ; L(⁶ Li,d)=3 for 10900 group.
10914.8 5	1 ⁻	5.0 keV		I	T=0
10915.7 5	3 ⁺	0.70 keV		I	
10921.1 4	(2 ⁺ ,3,4 ⁻)			f H	J ^π : 4895.3γ to 2 ⁻ and 5641.9γ to 4 ⁺ .
10932.7 5	1 ⁻	2.0 keV		I	T=0
10933.2 5	2 ⁻	0.10 keV		I	
10934.3 5				H	
10946.9 5	2 ⁺	0.23 keV		I	T=0
10950.8 5	1 ⁻	7.0 keV		HI	T=0
					E(level): from (p,p),(p,α):resonances. 10951.5 4 in (p,γ).
10953.6 5	0 ⁽⁺⁾	0.22 keV		I	T=0
10956.0 4	3 ⁻		B	H	E(level): from (p,γ).
					J ^π : 5676.8γ to 4 ⁺ , 5342.1γ to 4 ⁻ , 5053.0γ to 1 ⁻ .
10976.2 5	(3,4,5)		B	H	J ^π : log ft=6.0 from 4 ⁻ .

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Adopted Levels, Gammas (continued) ^{40}Ca Levels (continued)

E(level) [†]	J ^π [‡]	T _{1/2} [#]	XREF			Comments
10988.0 4	(3 ⁻ ,4 ⁺)		B	H	n	E(level): from (p,γ). J ^π : log ft=7.2 from 4 ⁻ ; α decay of this level in ^{40}Sc ε decay implies π=natural; 4079.1γ, 5358.2γ to 2 ⁺ .
10988.7 5	2 ⁻	9.0 keV		I		
10989.4 5	(1 ⁺)	0.4 keV		I		
10994.7 4	(2 ⁺ ,3,4 ⁺)			H		J ^π : 5715.5γ to 4 ⁺ , 5745.3γ to 2 ⁺ .
10995 3	(1 ⁻)	6.7 keV		I		
10998.9 5	(1,3) ⁻	0.20 keV		I		T=0
11002.3 5				H	n	
11003.0 & 9	(10 ⁺)					J ^π : band assignment in (HI,xnγ).
11007.2 5	1 ⁻	5.0 keV		I		
11011.0 4	3 ⁻			H	n	T=0+1 J ^π : 6519.0γ to 5 ⁻ , 11009.4γ to 0 ⁺ . T=0
11024.0 5	(1 ⁻ ,3 ⁻)	0.11 keV		HI		
11036.3 5	(1 ⁺)	0.10 keV		I		
11037 7	(3,4,5)		B			J ^π : log ft=6.4 from 4 ⁻ .
11042.0 5	(1 ⁻ to 4 ⁺)			H		J ^π : 7136.9γ to 2 ⁺ and 7304.6γ to 3 ⁻ .
11044.5 5	2 ⁺	0.50 keV		I		T=0
11070.6 4	(3,4 ⁺)			H		J ^π : 5456.1γ to 4 ⁻ , 5790.7γ to 4 ⁺ , 5820.7γ to 2 ⁺ .
11073.5 5	2 ⁺	0.66 keV		I		
11078.4 5	1 ⁻	1.2 keV		f HI		T=0 E(level): from (p,p),(p,α):resonances.
11083.6 5	(1 ⁺)	0.35 keV		I		T=0
11089.3 5	0 ⁽⁺⁾	0.10 keV		F I		XREF: F(11100).
11091 3	(3 ⁻ ,4 ⁺)		B	I		T=0 E(level): from 1970De30 in (p,p),(p,α):resonance. 11088 I2 in ^{40}Sc ε decay. J ^π : log ft=7.1 from 4 ⁻ ; 4+(1 ⁻ ,3 ⁻) for a 11901 level from 1970De30 in (p,p),(p,α):resonance.
11107.0 5	1 ⁻	3.9 keV		I		
11112 3	0 ⁻	5.2 keV		I		
11117.0 5			b	H		
11119.0 5	2 ⁺	0.046 keV	b	I	U	XREF: U(11100).
11127.1 5				H		
11129.1 5	4 ⁺	0.11 keV		I		T=0
11142 6	(3,4,5) ⁻		B			J ^π : log ft=5.8 from 4 ⁻ .
11145.2 5	1 ⁽⁻⁾	0.20 keV		I		
11145.8 5	1 ⁺	0.20 keV		I		
11157.2 5	2 ⁻	48 keV		I		
11161.5 5	4 ⁽⁺⁾	0.040 keV		I	V	T=0
11162.9 5	2 ⁺	3.5 keV		I		
11165.2 4				H		
11167.4 5	4 ⁺	0.083 keV		I		T=0
11187.6 5	3 ⁻	1.4 keV		I k		
11202.9 5	(3) ⁻		B	I k	v	T=0 E(level): from (p,p),(p,α):resonances. J ^π : log ft=5.5 from 4 ⁻ ; α decay of this level in ^{40}Sc ε decay implies π=natural; (1,2 ⁻ ,3) from (p,p),(p,α):resonances.
11210	(0 ⁺)			F k		J ^π : L(^6Li ,d)=0.
11212.6 5	3 ⁻	2.8 keV		I k		
11217 3	3 ⁻	25 keV	B	k	v	J ^π : log ft=5.2 from 4 ⁻ .

Continued on next page (footnotes at end of table)

Adopted Levels, Gammas (continued) ^{40}Ca Levels (continued)

E(level) [†]	J^{π} [‡]	$T_{1/2}$ [#]	XREF		Comments
11217.8 5	4 ⁺	1.4 keV	I	k	
11231.4 5	2 ⁻	3.0 keV	I	v	
11236 3	1 ⁻	3.9 keV	I	v	
11246.8 5	3 ⁻	0.092 keV	I	v	T=0
11255.9 5	1 ⁺	0.30 keV	I		
11260.8 5	(0 ⁻)	6.0 keV	I		
11264.4 5	2 ⁺	0.34 keV	I		T=0
11284.3 5	(2 ⁻)	0.60 keV	I		
11289.8 5	1 ⁺	1.0 keV	I		
11300.3 5	1 ⁺	0.40 keV	I		
11302.5 5	(1 ⁻)	1.2 keV	I		
11311 4	(3 ⁻ , 4 ⁺ , 5 ⁻)		B	F	J^{π} : log $ft=6.2$ from 4 ⁻ ; α decay of this level in ^{40}Sc ε decay implies $\pi=\text{natural}$.
11320.0 5	(0 ⁻)	1.8 keV	I		
11322.0 5	2 ⁺	0.52 keV	I		T=0
11329.3 5	2 ⁺		I		
11330.7 5	1 ⁻	4.0 keV	f	I	T=0
11338.7 5	(1 ⁺)	0.20 keV	I		
11342.6 5	2 ⁻	40 keV	I		
11346.4 5	4 ⁽⁺⁾	0.020 keV	I		T=0
11351.5 5	1 ⁺	0.80 keV	I		
11362.4 5	1 ⁺	1.2 keV	I		
11366.0 5	2 ⁺	0.19 keV	I		T=0
11367.0 5	2 ⁻	4.4 keV	I		
11368.3 5	4 ⁽⁺⁾	0.021 keV	I		
11370	(5 ⁻)		F		J^{π} : L($^{6}\text{Li}, d$)=5.
11371.4 5	2 ⁺	1.4 keV	I		T=0
11382.1 5	2 ⁺	2.6 keV	I		T=0
11393.0 5	1 ⁽⁻⁾	0.10 keV	I		
11404.2 5	1 ⁻	3.5 keV	I		T=0
11407.0 5	1 ⁺	0.22 keV	I		
11414.8 5	4 ⁺	0.10 keV	B	I	T=0
11420.3 5	3 ⁻	0.30 keV	I		
11432.7 5	1 ⁻	0.30 keV	I		T=0
11436.8 5	2 ⁺	0.22 keV	I		T=0
11447.2 5	1 ⁻	5.3 keV	I		T=0
11451.4 5	1 ⁺	0.60 keV	I		
11455.4 5	3 ⁻	0.060 keV	b	I	T=0 XREF: U(11470).
11460.4 5	2 ⁺	1.17 keV	I		T=0
11465.1 5	2 ⁽⁺⁾	0.13 keV	I		T=0
11468 3	(3 ⁻ , 4 ⁺ , 5 ⁻)		B	F	T=0 J^{π} : log $ft=6.2$ from 4 ⁻ ; α decay of this level in ^{40}Sc ε decay implies $\pi=\text{natural}$.
11468.7 5	2 ⁻	0.40 keV	I		
11479.8 5	1 ⁺	0.30 keV	I		
11486.7 5	0 ⁺	0.11 keV	I		
11489.6 5	1 ⁺	0.40 keV	I		
11514.6 5	2 ⁺	0.62 keV	I		
11515.2 5	1 ⁽⁻⁾	4.23 keV	I		
11519.0 5	2 ⁺	0.70 keV	I		
11537.9 5	2 ⁻	8.0 keV	I		
11542.2 5	2 ⁺	0.62 keV	I		

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Adopted Levels, Gammas (continued)

^{40}Ca Levels (continued)				
E(level) [†]	J π [‡]	T _{1/2} [#]	XREF	Comments
11543.7 5	(1 ⁺)	0.90 keV	I	
11546.7 5	2 ⁻	18 keV	I	
11549 6	(3,5) ⁻		B	J π : log ft=5.9 from 4 ⁻ ; α decay of this level in ^{40}Sc ε decay implies π =natural.
11554.5 5	1 ⁻	31 keV	I	
11559.1 5	(2 ⁺)	0.40 keV	I	
11563.5 5	(2 ⁻)	0.40 keV	I	
11577.9 5	2 ⁻	1.0 keV	I	
11578.0 5	2 ⁺	0.23 keV	I	
11585.6 5	2 ⁻	0.15 keV	I	
11597.2 5	(2 ⁺)	0.30 keV	I	
11602.3 5	2 ⁺	0.30 keV	I	
11603.4 5	2 ⁺	0.28 keV	I	
11605.3 5	1 ⁻	13 keV	I	
11611.1 5	1 ⁻	0.86 keV	I	
11614.0 5	(2 ⁻)	0.50 keV	I	
11616 10	(3,4,5)		B	v J π : log ft=6.3 from 4 ⁻ .
11628.5 5	(3 ⁺)	0.70 keV	I	
11629.1 5	2 ⁺	0.085 keV	I	
11638.1 5	1 ⁻	0.09 keV	I	
11645.0 5	(2 ⁻)	0.60 keV	I	
11646.9 5	2 ⁺	0.60 keV	I	
11650.8 5	2(+)	0.18 keV	I	
11652.2 5	3 ⁻		I	
11653.5 5	2 ⁺	1.59 keV	I	
11661.7 5	1 ⁻	1.56 keV	I	
11663 7	(3 ⁻ ,4 ⁺ ,5 ⁻)		B	v T=0 J π : log ft=6.2 from 4 ⁻ ; α decay of this level in ^{40}Sc ε decay implies π =natural.
11672.8 5	(2 ⁻)	0.20 keV	I	
11677.1 5	2 ⁺	0.96 keV	I	U
11685.8 @ 9	(10 ⁺)			Y J π : from band assignment in (HI,xn γ).
11687.5 5	(1 ⁺)	0.50 keV	I	
11689.2 5	(2 ⁻)	0.60 keV	I	
11690	7 ⁻		F	J π : L(^6Li ,d)=7.
11692.8 5	4(+)	0.021 keV	I	
11696.3 5	0(-)	0.60 keV	I	
11703.6 5	0 ⁺	4.65 keV	I	
11704.6 5	2 ⁻	3.0 keV	I	
11707.8 5	1 ⁻	0.30 keV	I	
11708.7 @ 12	(9 ⁺)			Y J π : from band assignment in (HI,xn γ).
11713.6 5	1 ⁺	0.20 keV	I	
11715.7 5	2 ⁻	1.5 keV	I	
11721.2 5	1 ⁺	1.5 keV	I	
11724.1 5	3(-)	0.060 keV	I	
11726 5	(3,5) ⁻		B	v T=0 J π : log ft=5.7 from 4 ⁻ ; α decay of this level in ^{40}Sc ε decay implies π =natural. XREF: Others: AI
11731.0 5	1(-)	3.6 keV	I	
11731.1 5	1 ⁺	0.40 keV	I	
11738.8 5	2 ⁺	3.0 keV	I	
11742.8 5	4 ⁺	1.07 keV	I	

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Adopted Levels, Gammas (continued) ^{40}Ca Levels (continued)

E(level) [†]	J^π [‡]	$T_{1/2}$ [#]	XREF		Comments
11744.6 5	1 ⁽⁻⁾	0.55 keV	I		
11749.5 5	2 ⁻	2.57 keV	I		
11753.4 5	3 ⁻		I		
11754.0 5	1 ⁺	0.35 keV	I		
11757.3 5	2 ⁻	0.60 keV	I		
11760 10	1 ⁺			N	J^π : M1 excitation in (e,e').
11768.0 5	2 ⁻	15 keV	I		
11782.6 5	3 ⁽⁻⁾	0.041 keV	I		
11788.5 5	2 ⁺	2.5 keV	I		
11792.4 5	1 ⁺	0.46 keV	I		
11799.2 5	4 ⁽⁺⁾	0.18 keV	B I	v	XREF: Others: AI
11804.1 5	0 ⁺	0.26 keV	I		
11809.0 5	(1 ⁺)	1.1 keV	I		
11810.9 5	2 ⁺	1.8 keV	I		
11811.6 5	3 ⁻	0.26 keV	I		
11820.6 5	3 ⁻	3.5 keV	I		
11830.8 5	2 ⁺	0.30 keV	I		
11839.2 5	0 ⁺	1.05 keV	I		
11841 6	(3 ⁻ , 4 ⁺ , 5 ⁻)		B F		T=0 XREF: F(11800). J^π : log ft=5.9 from 4 ⁻ ; α decay of this level in ^{40}Sc ε decay implies π =natural.
11844.1 5	1 ⁺	0.78 keV	I		
11855.8 5	2 ⁺	0.39 keV	I		
11857.3 5	(1 ⁺)	1.3 keV	I		
11863.3 5	(3 ⁻)	0.41 keV	I		
11864.7 5	(0 ⁺)	1.6 keV	I		
11868.8 5	(4 ⁺)	0.032 keV	I		
11870.0 5	3 ⁻	0.040 keV	I		
11872.2 5	2 ⁺	0.87 keV	I		
11878.0 5	1 ⁻	0.32 keV	I		
11884.5 5	1 ⁺	0.80 keV	I		
11888.3 5	4 ⁺	0.13 keV	I		
11890.9 5	1 ⁻	20 keV	I		
11894.0 5	(2 ⁻)	1.0 keV	I		
11901.4 5	1 ⁺	0.70 keV	I		
11915.9 5	3 ⁻	1.0 keV	I		
11924.6 5	2 ⁺	2.2 keV	I		
11930.0 5	4 ⁽⁺⁾	0.030 keV	I		
11933.3 5	1 ⁻	16.1 keV	I		
11935.0 5	1 ⁺	0.9 keV	I		
11937.3 5	2 ⁻	0.60 keV	I		
11940.4 5	1 ⁺	0.40 keV	I		
11942.8 5	3 ⁻	0.48 keV	I		
11945.0 5	1 ⁻	0.40 keV	I		
11948.4 5	0 ⁺	0.31 keV	I		
11958.7 5	(2 ⁺)	1.0 keV	I	U	XREF: U(11940).
11962.9 5	0 ⁺	0.30 keV	I		
11969.8 5	1 ⁺	0.80 keV	I		
11971.0 5	2 ⁺	0.26 keV	I		
11975.1 5	1 ⁻	0.055 keV	E I		
11983.3 5	(2 ⁻)	1.0 keV	I		
11987.1 5	3 ⁻	0.38 keV	E I		
11988 1	0 ⁺	81 eV 10	E G	X	T=2

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Adopted Levels, Gammas (continued) ^{40}Ca Levels (continued)

<u>E(level)[†]</u>	<u>J^π_‡</u>	<u>T_{1/2}[#]</u>	<u>XREF</u>		<u>Comments</u>
					J ^π : L(³ He,n)=0; IAR state. %α=93 9 to ³⁶ Ar g.s.; %α<3% to first 2 ⁺ in ³⁶ Ar; %p<5% ro ³⁹ K g.s.
11994.0 5	0 ⁻	3.0 keV	E	I	
12000 5	(3,5) ⁻		B		T=0 J ^π : log ft=5.4 from 4 ⁻ ; α decay of this level in ⁴⁰ Sc ε decay implies π=natural.
12001.3 5	(2 ⁺)	1.02 keV	E	I	
12007.4 5	1 ⁺	0.55 keV		I	
12010.4 5	2 ⁻	6.0 keV		I	
12012.2 5	4 ⁺	0.010 keV		I	
12023.6 5	1 ⁺	0.90 keV		I	
12026.9 5	4 ⁺	0.22 keV		I	
12033.8 5	3 ⁻	0.31 keV		I	
12038 3	(3,4,5) ⁻		B	H	Q
12047.7 5	2 ⁺	2.65 keV	f	HI	N
12056.4 5	1 ⁻	2.0 keV	f	I	
12058.9 5	2 ⁺	1.11 keV		I	
12067.3 5	2 ⁺	1.15 keV		I	
12067.8 5	4 ⁺	1.11 keV		I	
12068 3	(3,5) ⁻		B	H	T=0 J ^π : log ft=5.6 from 4 ⁻ ; α decay of this level in ⁴⁰ Sc ε decay implies π=natural.
12076.8 5	2 ⁻	3.07 keV		HI	
12082.0 5	4 ⁽⁺⁾	0.021 keV		I	
12086.1 5	4 ⁽⁺⁾	0.011 keV		I	
12088.8 5	2 ⁻	10 keV		I	
12089.7 5	2 ⁺	24 keV	f	I	
12093.1 5	4 ⁽⁺⁾	0.060 keV		I	
12095.1 5	2 ⁺	9.4 keV	Ef	HI	
12106.0 5	4 ⁽⁺⁾	0.090 keV		I	
12110.7 5	2 ⁺	2.0 keV	f	HI	
12115.1 5	3 ⁻	0.78 keV		I	
12125.9 5	(3 ⁺)			I	
12132.7 5	(4 ⁺)	0.13 keV		I	
12134.9 5	(4 ⁺)	0.10 keV		I	
12141.2 5	2 ⁺	1.24 keV		I	
12152.3 5	4 ⁺	0.36 keV		I	
12157.8 5	4 ⁽⁺⁾	0.12 keV		I	
12159.4 5	4 ⁽⁺⁾	0.083 keV		I	
12177.7 5	1 ⁽⁻⁾	0.22 keV		I	
12180.2 5	2 ⁺	1.50 keV	F	I	XREF: F(12170).
12184.5 5	2 ⁻	2.0 keV		I	
12192.7 5	2 ⁺	1.24 keV		I	
12196.3 5	1 ⁽⁻⁾	0.95 keV		I	
12201.2 5	3 ⁻	2.1 keV	E	HI	N
12209.3 5	0 ⁻	1.0 keV		I	E(level): from (p,p),(p,α):resonances. J ^π : from (p,p),(p,α):resonances and E3 excitation in (e,e').
12211.9 5	4 ⁺	0.021 keV		I	
12217.7 5	1 ⁺	1.5 keV		I	
12224.3 5	1 ⁻	1.46 keV		I	
12226.4 5	2 ⁺	0.43 keV		I	

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Adopted Levels, Gammas (continued) ^{40}Ca Levels (continued)

E(level) [†]	J^{π} [‡]	$T_{1/2}$ [#]	XREF		Comments
12237.7 5	1 ⁺	2.0 keV		I	
12244.0 5	4 ⁺	0.030 keV		I	
12245.2 5	1 ⁻	2.0 keV		I	
12256 4		5.5 keV		I	
12270 4	(2 ⁺)	5.8 keV		I	
12280 4		4.2 keV		I	
12292 4		4.0 keV		I	
12299 4	(2 ⁺)	4.0 keV		I	XREF: Others: AF
12305 4	(1 ⁻)	6.7 keV		I	
12331 4	2 ⁺	7.3 keV		HI	
12334.9 ^c 10	(10 ⁺)				Y J^{π} : from band assignment in (HI,xn γ). XREF: Others: AE
12340	5 ⁻		F		J^{π} : L(^6Li ,d)=5.
12350 10	2 ⁻			N	J^{π} : M2 excitation in (e,e').
12357 4	(3 ⁻ ,1 ⁻)	5.5 keV		I	
12368 4		6.7 keV		I	
12376 4		5.9 keV		I	
12381 4		4.0 keV		I	
12399 4	(2 ⁺ ,1 ⁻)	6.7 keV		I	
12406 4		3.5 keV		I	
12411 4		4.0 keV		I	
12419 4		5.4 keV		HI	
12420	(1 ⁻)	<0.05 MeV	C		J^{π} : L(^{36}Ar , α)=1.
12425 4		6.4 keV		I	
12450	(4 ⁺)		F	U	J^{π} : L(^6Li ,d)=4, but L(α , α')=3 for a 12450 group is inconsistent and could indicate there may be a separate level.
12488	2 ⁻			N	J^{π} : M2 excitation in (e,e').
12490 10	1 ⁺			N	J^{π} : M1 excitation in (e,e').
12503	2 ⁻			N	J^{π} : M2 excitation in (e,e').
12530	1 ⁻	<0.03 MeV	C F		XREF: F(12520). J^{π} : L(^{36}Ar , α)=1.
12580	1 ⁻	<0.03 MeV	C		J^{π} : L(^{36}Ar , α)=1.
12591.9 10	(10 ⁺)				Y J^{π} : proposed in (HI,xn γ). XREF: Others: AE
12604				H	
12622	(2)			N	J^{π} : from (e,e').
12650	7 ⁻		F H		J^{π} : L(^6Li ,d)=7.
12668	1 ⁻	<0.05 MeV	C H		J^{π} : L(^{36}Ar , α)=1.
12688				H	
12720	3 ⁻		F		J^{π} : L(^6Li ,d)=3.
12750 10	2 ⁻			N	J^{π} : M2 excitation in (e,e').
12830 10	1 ⁺ , (2 ⁻)			N	J^{π} : most likely M1 excitation in (e,e').
12875				H	
12900	4 ⁺		F		J^{π} : L(^6Li ,d)=4.
12923 ^b 2	(11 ⁻)				Y J^{π} : from band assignment in (HI,xn γ). J^{π} : L(^{36}Ar , α)=2.
12965	2 ⁺	<0.04 MeV	C		
12980			E H		
12996				H	
13050 10	1 ⁺			N	J^{π} : M1 excitation in (e,e').
13050	4 ⁺		F		J^{π} : L(^6Li ,d)=4.
13086				H	
13113				H	

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Adopted Levels, Gammas (continued)

^{40}Ca Levels (continued)					
E(level) [†]	J^{π} [‡]	$T_{1/2}$ [#]	XREF		Comments
13115.1 ^{& 10}	(12 ⁺)				J^{π} : from band assignment in (HI,xn γ).
13125	2 ⁺	<0.04 MeV	C		J^{π} : L($^{36}\text{Ar},\alpha$)=2.
13150 ¹⁰	2 ⁻			N	J^{π} : M2 excitation in (e,e').
13170	3 ⁻	<0.02 MeV	C		J^{π} : L($^{36}\text{Ar},\alpha$)=3.
13194				H	
13195	(10 ⁻)				J^{π} : proposed in (HI,xn γ).
13200	4 ⁺				J^{π} : L($^6\text{Li},d$)=4.
13203				F	
13250				H	
13289				E	
13300	4 ⁺			H	
13301	2 ⁺	<0.04 MeV	F		J^{π} : L($^6\text{Li},d$)=4.
13345	3 ⁻	<0.03 MeV	C		J^{π} : L($^{36}\text{Ar},\alpha$)=2.
13400	0 ⁺		f		J^{π} : L($^{36}\text{Ar},\alpha$)=3.
				U	J^{π} : L(α,α')=0.
13410	3 ⁻	<0.04 MeV	C		XREF: Others: AI
13445	2 ⁻		f		J^{π} : L($^{36}\text{Ar},\alpha$)=3.
				N q	J^{π} : M2 excitation in (e,e').
					XREF: Others: AI
13470	4 ⁺		F		J^{π} : L($^6\text{Li},d$)=4.
				q	XREF: Others: AI
13480	3 ⁻	<0.03 MeV	C		J^{π} : L($^{36}\text{Ar},\alpha$)=3.
13480 ¹⁰	1 ⁺		E		J^{π} : M1 excitation in (e,e').
				N	XREF: Others: AI
13520	3 ⁻	<0.04 MeV	C		J^{π} : L($^{36}\text{Ar},\alpha$)=3.
13535.5 ^{a 13}	(11 ⁺)				J^{π} : from band assignment in (HI,xn γ).
13570	3 ⁻	<0.05 MeV	C		J^{π} : L($^{36}\text{Ar},\alpha$)=3.
13.6 $\times 10^3$ ⁴				N	
13610	1 ⁺ ,2 ⁺ ,3 ⁺				J^{π} : L(p,p')=2 from 0 ⁺ .
13620	6 ⁺			Q	J^{π} : L($^6\text{Li},d$)=6.
13620	3 ⁻	<0.04 MeV	C		J^{π} : L($^{36}\text{Ar},\alpha$)=3.
13645	3 ⁻	<0.04 MeV	C		J^{π} : L($^{36}\text{Ar},\alpha$)=3.
13670 ¹⁰	2 ⁻			N	J^{π} : M2 excitation in (e,e').
13710	3 ⁻	<0.03 MeV	C		J^{π} : L($^{36}\text{Ar},\alpha$)=3.
13720	6 ⁺		EF		J^{π} : L($^6\text{Li},d$)=6.
13760	3 ⁻	<0.04 MeV	C		J^{π} : L($^{36}\text{Ar},\alpha$)=3.
13822				H	
13830	7 ⁻			F	J^{π} : L($^6\text{Li},d$)=7.
13830	(1 ⁺ ,2 ⁺ ,3 ⁺)				J^{π} : L(p,p')=(2) from 0 ⁺ .
13850	3 ⁻	<0.03 MeV	C		J^{π} : L($^{36}\text{Ar},\alpha$)=3.
13890	(0 ⁺ ,1 ⁺)			Q	J^{π} : L(p,p')=(0) from 0 ⁺ .
13900	2 ⁺			N	J^{π} : E2 excitation in (e,e').
13910	3 ⁻	<0.02 MeV	C		J^{π} : L($^{36}\text{Ar},\alpha$)=3.
13913				H	
13921 ¹⁵	4			QR	T=(0)
					J^{π} : $\sigma(\theta)$ in (p,p').
13952	4 ⁺		E		J^{π} : L($^6\text{Li},d$)=4.
13960	3 ⁻	<0.02 MeV	C		J^{π} : L($^{36}\text{Ar},\alpha$)=3.
13993				H	
14000	4 ⁺		F		J^{π} : L($^6\text{Li},d$)=4.
14005	3 ⁻	<0.02 MeV	C		J^{π} : L($^{36}\text{Ar},\alpha$)=3.
14020	(2 ⁻ ,3 ⁻ ,4 ⁻)			Q	J^{π} : L(p,p')=(3) from 0 ⁺ .

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Adopted Levels, Gammas (continued)

^{40}Ca Levels (continued)					
E(level) [†]	J ^π [‡]	T _{1/2} [#]	XREF		Comments
14047	3 ⁻	<0.02 MeV	C		J ^π : L($^{36}\text{Ar}, \alpha$)=3.
14070 50	(0 ⁺)			U	J ^π : L(α, α')=(0).
14096			E		
14100	1 ⁺ , 2 ⁺ , 3 ⁺			Q	J ^π : L(p,p')=2 from 0 ⁺ .
14150	3 ⁻	<0.03 MeV	C		J ^π : L($^{36}\text{Ar}, \alpha$)=3.
14177	3 ⁻	<0.03 MeV	C		J ^π : L($^{36}\text{Ar}, \alpha$)=3.
14190	4 ⁺		F		J ^π : L($^6\text{Li}, d$)=4.
14200	0 ⁺ , 1 ⁺			S	J ^π : L($^3\text{He}, ^3\text{He}'$)=0. XREF: Others: AK
14210	(2 ⁻ , 3 ⁻ , 4 ⁻)			Q	J ^π : L(p,p')=(3) from 0 ⁺ .
14225	3 ⁻	<0.02 MeV	C		J ^π : L($^{36}\text{Ar}, \alpha$)=3.
14232.4 @ 10	(12 ⁺)			Y	J ^π : from band assignment in (HI,xnγ).
14262	3 ⁻	<0.02 MeV	C		J ^π : L($^{36}\text{Ar}, \alpha$)=3.
14283 15	(6)			Q	T=1 J ^π : $\sigma(\theta)$ in (p,p').
14292	3 ⁻	<0.02 MeV	C		J ^π : L($^{36}\text{Ar}, \alpha$)=3.
14312	3 ⁻	<0.02 MeV	C		J ^π : L($^{36}\text{Ar}, \alpha$)=3.
14320	(2 ⁻ , 3 ⁻ , 4 ⁻)			Q	J ^π : L(p,p')=(3) from 0 ⁺ .
14335	3 ⁻	<0.02 MeV	C		J ^π : L($^{36}\text{Ar}, \alpha$)=3.
14370	6 ⁺		F I		XREF: F(14380). J ^π : L($^6\text{Li}, d$)=6.
14390	3 ⁻	<0.03 MeV	C		J ^π : L($^{36}\text{Ar}, \alpha$)=3.
14410	2 ⁻ , 3 ⁻ , 4 ⁻		E	Q	XREF: E(14420). J ^π : L(p,p')=3 from 0 ⁺ .
14419			E		
14435	3 ⁻	<0.03 MeV	C		J ^π : L($^{36}\text{Ar}, \alpha$)=3.
14460	(2 ⁺)			I qr	J ^π : L(p,p')=2 for 14500 group; L(d,d')=0+2 for 14500 group.
14490	3 ⁻	<0.04 MeV	C		J ^π : L($^{36}\text{Ar}, \alpha$)=3.
14530	(6 ⁺)		EF I	qr	XREF: E(14509)F(14500). J ^π : L($^6\text{Li}, d$)=6.
14540	3 ⁻	<0.03 MeV	C		J ^π : L($^{36}\text{Ar}, \alpha$)=3.
14600	(1, 2 ⁺ , 3 ⁻ , 4 ⁺)			I N r	J ^π : from (e,e').
14605	3 ⁻	<0.04 MeV	C		J ^π : L($^{36}\text{Ar}, \alpha$)=3.
14640	3 ⁻	<0.03 MeV	C		J ^π : L($^{36}\text{Ar}, \alpha$)=3.
14660	1 ⁺ , 2 ⁺ , 3 ⁺		f	Qr	J ^π : L(p,p')=2 from 0 ⁺ .
14680			f I	r	J ^π : 1 ⁺ for a 15000 group in (d,d').
14690	3 ⁻	<0.03 MeV	C		J ^π : L($^{36}\text{Ar}, \alpha$)=3.
14725	3 ⁻	<0.05 MeV	C		J ^π : L($^{36}\text{Ar}, \alpha$)=3.
14750	4 ⁺		F		J ^π : L($^6\text{Li}, d$)=4.
14760	3 ⁻	<0.03 MeV	C		J ^π : L($^{36}\text{Ar}, \alpha$)=3.
14780	1 ⁺ , 2 ⁺ , 3 ⁺			Q	J ^π : L(p,p')=2 from 0 ⁺ .
14790	3 ⁻	<0.03 MeV	C		J ^π : L($^{36}\text{Ar}, \alpha$)=3.
14835	3 ⁻	<0.03 MeV	C		J ^π : L($^{36}\text{Ar}, \alpha$)=3.
14869	(9 ⁻)		EF		XREF: F(14850). J ^π : L($^6\text{Li}, d$)=(9).
14888	3 ⁻	<0.04 MeV	C		J ^π : L($^{36}\text{Ar}, \alpha$)=3.
14942	3 ⁻	<0.03 MeV	C		J ^π : L($^{36}\text{Ar}, \alpha$)=3.
15002	3 ⁻	<0.04 MeV	C		J ^π : L($^{36}\text{Ar}, \alpha$)=3.
15080			F	Qr	
15101	3 ⁻	<0.03 MeV	C		J ^π : L($^{36}\text{Ar}, \alpha$)=3.

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Adopted Levels, Gammas (continued) ^{40}Ca Levels (continued)

E(level) [†]	J^π [‡]	$T_{1/2}$ [#]	XREF		Comments
15140			F	r	
15150	3^-	<0.04 MeV	C		J^π : $L(^{36}\text{Ar}, \alpha)=3$.
15152.4 ^{& 12}	(13^+)			Y	J^π : from band assignment in (HI,xn γ).
15220	3^-	<0.03 MeV	C		J^π : $L(^{36}\text{Ar}, \alpha)=3$.
15250			F		
15260	3^-	<0.03 MeV	C		J^π : $L(^{36}\text{Ar}, \alpha)=3$.
15267.1 ^{c 14}	(12^+)			Y	J^π : from band assignment in (HI,xn γ).
15285	4^+	<0.05 MeV	C		J^π : $L(^{36}\text{Ar}, \alpha)=4$.
15306 ^{b 2}	(13^-)			Y	J^π : from band assignment in (HI,xn γ).
15330			F		
15345	4^+	<0.04 MeV	C		J^π : $L(^{36}\text{Ar}, \alpha)=4$.
15384	4^+	<0.04 MeV	C		J^π : $L(^{36}\text{Ar}, \alpha)=4$.
15435	4^+	<0.04 MeV	C		J^π : $L(^{36}\text{Ar}, \alpha)=4$.
15490	4^+	<0.04 MeV	C		J^π : $L(^{36}\text{Ar}, \alpha)=4$.
15525	4^+	<0.02 MeV	C		J^π : $L(^{36}\text{Ar}, \alpha)=4$.
15550	4^+	<0.03 MeV	C		J^π : $L(^{36}\text{Ar}, \alpha)=4$.
15580	4^+	<0.03 MeV	C		J^π : $L(^{36}\text{Ar}, \alpha)=4$.
15600			F		
15620	4^+	<0.03 MeV	C		J^π : $L(^{36}\text{Ar}, \alpha)=4$.
15670	4^+	<0.02 MeV	C		J^π : $L(^{36}\text{Ar}, \alpha)=4$.
15700			F		
15707	4^+	<0.03 MeV	C		J^π : $L(^{36}\text{Ar}, \alpha)=4$.
15748.1 ¹⁴	(12^+)			Y	J^π : from band assignment in (HI,xn γ).
15790	4^+	<0.04 MeV	C		J^π : $L(^{36}\text{Ar}, \alpha)=4$.
15840	4^+	<0.03 MeV	C		J^π : $L(^{36}\text{Ar}, \alpha)=4$.
15875	4^+	<0.03 MeV	C		J^π : $L(^{36}\text{Ar}, \alpha)=4$.
15900	3^-			U	J^π : $L(\alpha, \alpha')=3$.
15915	4^+	<0.02 MeV	C		J^π : $L(^{36}\text{Ar}, \alpha)=4$.
15950	4^+	<0.02 MeV	C		J^π : $L(^{36}\text{Ar}, \alpha)=4$.
15960	4^+	<0.02 MeV	C		J^π : $L(^{36}\text{Ar}, \alpha)=4$.
16000	5^-	<0.02 MeV	C		J^π : $L(^{36}\text{Ar}, \alpha)=5$.
16000 ⁵⁰	3^-	0.63 MeV ¹⁰		U	J^π : $L(\alpha, \alpha')=3$ from 0^+ .
16020	4^+	<0.03 MeV	C		J^π : $L(^{36}\text{Ar}, \alpha)=4$.
16065	4^+	<0.03 MeV	C		J^π : $L(^{36}\text{Ar}, \alpha)=4$.
16110	5^-	<0.02 MeV	C		J^π : $L(^{36}\text{Ar}, \alpha)=5$.
16120	4^+	<0.03 MeV	C		J^π : $L(^{36}\text{Ar}, \alpha)=4$.
16160	4^+	<0.03 MeV	C		J^π : $L(^{36}\text{Ar}, \alpha)=4$.
16210	4^+	<0.03 MeV	C		J^π : $L(^{36}\text{Ar}, \alpha)=4$.
16255	4^+	<0.02 MeV	C		J^π : $L(^{36}\text{Ar}, \alpha)=4$.
16290	4^+	<0.02 MeV	C		J^π : $L(^{36}\text{Ar}, \alpha)=4$.
16360	4^+	<0.02 MeV	C		J^π : $L(^{36}\text{Ar}, \alpha)=4$.
16395	4^+	<0.02 MeV	C		J^π : $L(^{36}\text{Ar}, \alpha)=4$.
16450	4^+	<0.02 MeV	C		J^π : $L(^{36}\text{Ar}, \alpha)=4$.
16510	4^+	<0.02 MeV	C		J^π : $L(^{36}\text{Ar}, \alpha)=4$.
16529.4 ^{@ 12}	(14^+)			Y	J^π : from band assignment in (HI,xn γ).
16545	5^-	<0.02 MeV	C		J^π : $L(^{36}\text{Ar}, \alpha)=5$.
16579.7 ^{a 16}	(13^+)			Y	J^π : from band assignment in (HI,xn γ).
16585	5^-	<0.02 MeV	C		J^π : $L(^{36}\text{Ar}, \alpha)=5$.
16610	6^+	<0.02 MeV	C		J^π : $L(^{36}\text{Ar}, \alpha)=6$.
16640	6^+	<0.02 MeV	C		J^π : $L(^{36}\text{Ar}, \alpha)=6$.

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Adopted Levels, Gammas (continued) ^{40}Ca Levels (continued)

E(level) [†]	J^{π} [‡]	$T_{1/2}$ [#]	XREF		Comments
16665	6 ⁺	<0.02 MeV	C		J^{π} : L($^{36}\text{Ar}, \alpha$)=6.
16700	(2 ⁻ , 3 ⁻ , 4 ⁻)	0.90 MeV 2		S	J^{π} : L($^3\text{He}, ^3\text{He}'$)=(3).
16735	6 ⁺	<0.02 MeV	C		J^{π} : L($^{36}\text{Ar}, \alpha$)=6.
16810	6 ⁺	<0.02 MeV	C		J^{π} : L($^{36}\text{Ar}, \alpha$)=6.
16910	6 ⁺	<0.05 MeV	C		J^{π} : L($^{36}\text{Ar}, \alpha$)=6.
16945	6 ⁺	<0.02 MeV	C		J^{π} : L($^{36}\text{Ar}, \alpha$)=6.
17010	6 ⁺	<0.03 MeV	C		J^{π} : L($^{36}\text{Ar}, \alpha$)=6.
17065	6 ⁺	<0.02 MeV	C		J^{π} : L($^{36}\text{Ar}, \alpha$)=6.
17113	6 ⁺	<0.02 MeV	C		J^{π} : L($^{36}\text{Ar}, \alpha$)=6.
17170	6 ⁺	<0.02 MeV	C		J^{π} : L($^{36}\text{Ar}, \alpha$)=6.
17210	6 ⁺	<0.03 MeV	C		J^{π} : L($^{36}\text{Ar}, \alpha$)=6.
17280	6 ⁺	<0.03 MeV	C		J^{π} : L($^{36}\text{Ar}, \alpha$)=6.
17320	6 ⁺	<0.02 MeV	C		J^{π} : L($^{36}\text{Ar}, \alpha$)=6.
17360	6 ⁺	<0.03 MeV	C		J^{π} : L($^{36}\text{Ar}, \alpha$)=6.
17410	6 ⁺	<0.03 MeV	C		J^{π} : L($^{36}\text{Ar}, \alpha$)=6.
17450	6 ⁺	<0.03 MeV	C		J^{π} : L($^{36}\text{Ar}, \alpha$)=6.
17513	6 ⁺	<0.05 MeV	C		J^{π} : L($^{36}\text{Ar}, \alpha$)=6.
17590	6 ⁺	<0.05 MeV	C		J^{π} : L($^{36}\text{Ar}, \alpha$)=6.
17669			E		XREF: AI(17500). E(level): possibly GQR. XREF: Others: AI, AK
17670	6 ⁺	<0.05 MeV	C		J^{π} : L($^{36}\text{Ar}, \alpha$)=6.
17698.6 14	(14 ⁺)			Y	J^{π} : from band assignment in (HI, xn γ).
17700	2 ⁺			U	J^{π} : L(α, α')=2.
17730	6 ⁺	<0.03 MeV	C		J^{π} : L($^{36}\text{Ar}, \alpha$)=6.
17790	6 ⁺	<0.03 MeV	C		J^{π} : L($^{36}\text{Ar}, \alpha$)=6.
17855	6 ⁺	<0.04 MeV	C		J^{π} : L($^{36}\text{Ar}, \alpha$)=6.
17859			E		
17915	6 ⁺	<0.02 MeV	C		J^{π} : L($^{36}\text{Ar}, \alpha$)=6.
17950	6 ⁺	<0.02 MeV	C		J^{π} : L($^{36}\text{Ar}, \alpha$)=6.
18000 50	2 ⁺	2.25 MeV 20		U	J^{π} : L(α, α')=2 from 0 ⁺ .
18010	6 ⁺	<0.02 MeV	C		J^{π} : L($^{36}\text{Ar}, \alpha$)=6.
18054.6 14	(14 ⁺)			Y	J^{π} : proposed in (HI, xn γ).
18077	6 ⁺	<0.05 MeV	C		J^{π} : L($^{36}\text{Ar}, \alpha$)=6.
18139	6 ⁺	<0.05 MeV	C		J^{π} : L($^{36}\text{Ar}, \alpha$)=6.
18146			E		
18174	6 ⁺	<0.03 MeV	C		J^{π} : L($^{36}\text{Ar}, \alpha$)=6.
18200	2 ⁺			N RS	XREF: N(18400).
18215? ^b 2	(15 ⁻)			Y	J^{π} : L(d, d')=0+2; L($^3\text{He}, ^3\text{He}'$)=2(+0).
18260 5	1		H		J^{π} : from band assignment in (HI, xn γ).
18260	6 ⁺	<0.05 MeV	C		J^{π} : 18256 γ D to 0 ⁺ .
18326			E		J^{π} : L($^{36}\text{Ar}, \alpha$)=6.
18328	6 ⁺	<0.05 MeV	C		J^{π} : L($^{36}\text{Ar}, \alpha$)=6.
18406	6 ⁺	<0.03 MeV	C		J^{π} : L($^{36}\text{Ar}, \alpha$)=6.
18452			E		
18485	6 ⁺	<0.02 MeV	C		J^{π} : L($^{36}\text{Ar}, \alpha$)=6.
18497.2 ^c 17	(14 ⁺)			Y	J^{π} : from band assignment in (HI, xn γ).
18547	6 ⁺	<0.03 MeV	C		J^{π} : L($^{36}\text{Ar}, \alpha$)=6.
18605	6 ⁺	<0.04 MeV	C		J^{π} : L($^{36}\text{Ar}, \alpha$)=6.

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Adopted Levels, Gammas (continued)

^{40}Ca Levels (continued)					
E(level) [†]	J^π [‡]	$T_{1/2}$ [#]	XREF		Comments
18659	6 ⁺	<0.02 MeV	C		J^π : L($^{36}\text{Ar}, \alpha$)=6.
18680 5	1			H	J^π : 18675 γ D to 0 ⁺ .
18705	6 ⁺	<0.02 MeV	C		J^π : L($^{36}\text{Ar}, \alpha$)=6.
18719.2 17	(14 ⁺)			Y	J^π : from band assignment in (HI,xn γ).
18731			E		
18765	6 ⁺	<0.04 MeV	C		J^π : L($^{36}\text{Ar}, \alpha$)=6.
18865	6 ⁺	<0.03 MeV	C		J^π : L($^{36}\text{Ar}, \alpha$)=6.
18930	6 ⁺	<0.02 MeV	C		J^π : L($^{36}\text{Ar}, \alpha$)=6.
19020	6 ⁺	<0.03 MeV	C		J^π : L($^{36}\text{Ar}, \alpha$)=6.
19037			E		
19070 5	1			H	J^π : 19065 γ D to 0 ⁺ .
19080	6 ⁺	<0.05 MeV	C		J^π : L($^{36}\text{Ar}, \alpha$)=6.
19150	6 ⁺	<0.07 MeV	C		J^π : L($^{36}\text{Ar}, \alpha$)=6.
19.18×10 ³ 37	0 ⁺	4.9 MeV 6		U	J^π : L(α, α')=0.
19195.6 ^{&} 16	(15 ⁺)			Y	J^π : from band assignment in (HI,xn γ).
19230	6 ⁺	<0.03 MeV	C		J^π : L($^{36}\text{Ar}, \alpha$)=6.
19280	6 ⁺	<0.03 MeV	C		J^π : L($^{36}\text{Ar}, \alpha$)=6.
19385	6 ⁺	<0.03 MeV	C		J^π : L($^{36}\text{Ar}, \alpha$)=6.
19450 5	1			H	J^π : 19445 γ D to 0 ⁺ .
19467	6 ⁺	<0.04 MeV	C		J^π : L($^{36}\text{Ar}, \alpha$)=6.
19525	6 ⁺	<0.02 MeV	C		J^π : L($^{36}\text{Ar}, \alpha$)=6.
19597	6 ⁺	<0.02 MeV	C		J^π : L($^{36}\text{Ar}, \alpha$)=6.
19667	6 ⁺	<0.04 MeV	C		J^π : L($^{36}\text{Ar}, \alpha$)=6.
19780	6 ⁺	<0.06 MeV	C		J^π : L($^{36}\text{Ar}, \alpha$)=6.
19850 5	1			H	J^π : 19845 γ D to 0 ⁺ .
20130 5				H	
20430 5	1			H	J^π : 19845 γ D to 0 ⁺ .
20578.6 [@] 15	(16 ⁺)			Y	J^π : from band assignment in (HI,xn γ).
20650 5	1			H	J^π : 20644 γ D to 0 ⁺ .
20940 5	1			H	J^π : 20934 γ D to 0 ⁺ .
21000 50				U	J^π : L(α, α')=0+2.
21490				H	
21690				H	
22060				H	
22060.4 ^C 20	(16 ⁺)			Y	J^π : from band assignment in (HI,xn γ).
23360	1 ⁻		M	U	J^π : L(α, α')=1; GDR. XREF: Others: AK
31×10 ³ 2	2 ⁻ , 3 ⁻ , 4 ⁻			Q	J^π : L(p,p')=3 from 0 ⁺ .
35.3×10 ³ 5				N	
42.0×10 ³				N	
58.4×10 ³ 11				N	

[†] From (p, γ), ^{40}Sc ε decay, (γ, γ') or (HI,xn γ) based on γ -ray energies. In other cases, a large number of excitation energies are from (p,p),(p, α):resonances. When levels are known from transfer particle-reactions, weighted averages of available values are taken. The following reactions have imprecise excitation energies above ≈ 8 MeV, hence level correspondence between various reactions (as given in XREF column) is considered (by the evaluator) as tentative: resonances in (α, γ); ($^6\text{Li}, d$); ($^3\text{He}, n$); (d, d'), ($^3\text{He}, ^3\text{He}'$); (α, α'); (HI, HI') and (d, t).

[‡] When no arguments are given (above 9600), the assignments are based on J^π 's determined in $^{39}\text{K}(p, \gamma)$ or $^{39}\text{K}(p, p), (p, \alpha)$:resonances. For high-spin structures ($J > 6$), assignments are based on $\gamma(\theta)$ data and expected band associations. In particle-transfer reactions, target (^{39}K) $J^\pi=3/2^+$ for (d, n) and ($^3\text{He}, d$) reactions; target (^{41}Ca) $J^\pi=7/2^-$ for ($^3\text{He}, \alpha$) and (d, t) reactions. In arguments based on γ decays, RUL (for E2 and M2 transitions) is also used when level lifetimes are known. For

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Adopted Levels, Gammas (continued) ^{40}Ca Levels (continued)

some of the high-energy levels populated only in (e,e'), $J\pi$ assignments are from measurements of $\sigma(\theta)$ and deduced transition strengths in that reaction.

Lifetimes are available from DSAM in (p,p' γ), (p, γ) and (HI,xn γ), and measured widths in (γ,γ'). Widths are from (γ,γ'), (p, γ) and (p,p),(p, α):resonances and for some levels, values are for Γ_p or deduced from (p,p) resonance strengths by assuming $\Gamma_p/\Gamma=1$ if spin values is firmly assigned. Consult individual data sets for corresponding resonance strengths.

@ (A): 4p- ^4H , 0^+ band. $Q(\text{transition})=0.74$ *I4* from life-time data; corresponds to $\beta_2 \approx 0.27$.

& (B): γ sequence based on 8^+ .

^a (C): 3^+ band.

^b (D): $K\pi=0^-$ band (2004To07) (?). This band is proposed (2004To07) as a partner of 4p-4h band based on the 3353, 0^+ state; the 1^- , 3^- and 5^- members of this band are proposed at 5902, 1^- ; 6280, 3^- or 6580, 3^- ; and 7399, (5^-), respectively. However, the 7399 level is assigned (5^+) in another in-beam γ -ray study. Assignment of (7^-) by 2004To07 for 9033 level is inconsistent with $L(p,p')=5$ for a 9029 5^- group and γ 's to 3^- and 4^- states seen in (p, γ). The 7^- assignment is only possible if the 9033 level in 2004To07 is different from a 9032 seen in other reactions.

^c (E): SD band (2001Id01,2003Ch22). $Q(\text{transition})=1.30$ *I5* over the whole band; 1.81 $+46-33$ for high-spin states; 1.18 *I4* for low-spin states (2003Ch22). $Q(\text{transition})=1.80$ $+39-29$ (2001Id01). $Q(\text{transition})$ from 2001Id01 corresponds to $\beta_2=0.59$ $+11-7$. Configuration= $8p-8h$ defined by $\pi 3^4 \nu 3^4$, where superscripts are the number of protons and neutrons occupying the $N=3$ ($f_{7/2}$) intruder orbital.

Adopted Levels, Gammas (continued)

$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\ddagger$	E_f	J_f^π	Mult. [§]	$\delta^\S$	$\gamma(^{40}\text{Ca})$	Comments
3352.62	0 ⁺	3352.6		0.0	0 ⁺	E0			Decay is mainly by e ⁺ e ⁻ pair emission. Monopole strength: $\rho^2(\text{E0})=0.0256$ 7 (2005Ki02, deduced from T _{1/2}). Other: 0.025 8 in (e,e') deduced from measured matrix element.
3736.69	3 ⁻	3736.5 3	100	0.0	0 ⁺	E3			B(E3)(W.u.)=31 +4-3 E _γ : weighted average of 3735.6 8 from ⁴⁰ Sc ε decay, 3736.8 3 from ³⁹ K(p,γ), 3737 2 from ⁴⁰ Ca(n,n'γ), 3736.7 3 from ⁴⁰ Ca(p,p'γ), and 3736.1 3 from (HI,xnγ).
3904.38	2 ⁺	551.8	<0.10	3352.62	0 ⁺	[E2]			Mult.: from γ(θ) in (p,p'γ), M3 ruled out by RUL. B(E2)(W.u.)<49 E _γ : from (p,γ). I _γ : from (p,γ). Others: <1.5 in (p,p'γ). B(E2)(W.u.)=2.2 +6-4
		3903.9 1	100	0.0	0 ⁺	E2			E _γ : weighted average of 3904.5 3 from ³⁹ K(p,γ), 3903.8 1 from ⁴⁰ Ca(γ,γ'), 3904.2 4 from ⁴⁰ Ca(n,n'γ), 3904.4 4 from ⁴⁰ Ca(p,p'γ), and 3904.0 3 from (HI,xnγ).
4491.43	5 ⁻	754.8 2	100	3736.69	3 ⁻	E2			Mult.: Q from γ(θ) in (p,p'γ) and (HI,xnγ), M2 ruled out by RUL. B(E2)(W.u.)=0.98 3 E _γ : weighted average of 755.6 8 from ⁴⁰ Sc ε decay, 754.8 3 from ³⁹ K(p,γ), 755 2 from ⁴⁰ Ca(n,n'γ), 754.7 2 from ⁴⁰ Ca(p,p'γ), and 754.8 2 from (HI,xnγ).
5211.56	0 ⁺	1307.7 3	100	3904.38	2 ⁺	[E2]			Mult.: from γγ(θ) and γ(pol) in in (p,γ). δ(O/Q)=-0.01 2 from (p,γ), +0.05 5 in (p,p'γ). B(E2)(W.u.)=17 +4-3
5248.79	2 ⁺	1344.4 3	19.4 12	3904.38	2 ⁺	M1+E2	+13 +6-3		E _γ : from (p,p'γ). B(M1)(W.u.)=8×10 ⁻⁵ +11-6; B(E2)(W.u.)=25 +8-6 E _γ ,Mult.,δ: from (p,p'γ). I _γ : weighted average of 18.9 11 from ³⁹ K(p,γ), 27 7 from ⁴⁰ Ca(n,n'γ), and 25 5 from ⁴⁰ Ca(p,p'γ).
		1896.1	6.3 8	3352.62	0 ⁺	(E2)			B(E2)(W.u.)=1.5 +6-4 E _γ : from (p,γ), 1897 2 from (n,n'γ). I _γ : weighted average of 6.4 8 from ³⁹ K(p,γ), 7 4 from ⁴⁰ Ca(n,n'γ), and 5.2 26 from ⁴⁰ Ca(p,p'γ).
		5248.9 3	100.0 15	0.0	0 ⁺	E2			Mult.: from (p,p'γ). B(E2)(W.u.)=0.143 +35-24 E _γ : weighted average of 5248.9 6 from ³⁹ K(p,γ), 5247.9 6 from ⁴⁰ Ca(p,p'γ), 5249.2 3 from ⁴⁰ Ca(γ,γ'), and 5249 2 from ⁴⁰ Ca(n,n'γ).
5278.80	4 ⁺	787.4	3.1 15	4491.43	5 ⁻	[E1]			I _γ : from (p,γ). δ: from (p,p'γ). B(E1)(W.u.)=6×10 ⁻⁵ +7-5
		1374.0 3	100.0 15	3904.38	2 ⁺	E2			E _γ ,I _γ : from (p,γ). B(E2)(W.u.)=67 +17-12 E _γ : unweighted average of 1374.5 4 from ³⁹ K(p,γ), 1374.0 2 from ⁴⁰ Ca(n,n'γ),

Adopted Levels, Gammas (continued)

$\gamma(^{40}\text{Ca})$ (continued)								
$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\ddagger$	E_f	J_f^π	Mult. [§]	$\delta^\S$	Comments
5613.52	4 ⁻	1122.7 2	41.4 28	4491.43	5 ⁻	M1+E2	-0.7 2	1373.1 1 from $^{40}\text{Ca}(\text{p},\text{p}'\gamma)$, and 1374.30 20 from (HI,xn γ). I γ : from (p, γ). Mult.: from $\gamma\gamma(\theta)$ and $\gamma(\text{pol})$ in (p, γ). $\delta(\text{O/Q})=+0.02$ 4 from (p,p' γ), -0.02 5 from (p, γ). B(M1)(W.u.)=0.0046 +23-16; B(E2)(W.u.)=6 +4-3 E γ : weighted average of 1126 3 from ^{40}Sc ϵ decay, 1121.5 6 from $^{39}\text{K}(\text{p},\gamma)$, 1122 2 from $^{40}\text{Ca}(\text{n},\text{n}'\gamma)$, and 1122.8 2 from $^{40}\text{Ca}(\text{p},\text{p}'\gamma)$. I γ : weighted average of 48 8 from ^{40}Sc ϵ decay, 41.8 28 from $^{39}\text{K}(\text{p},\gamma)$, and 39 4 from $^{40}\text{Ca}(\text{p},\text{p}'\gamma)$. Mult., δ : from $\gamma(\text{pol})$ in (p, γ). B(M1)(W.u.)=0.0033 +8-6; B(E2)(W.u.)=0.21 +15-9 E γ : weighted average of 1877.8 7 from ^{40}Sc ϵ decay, 1877.0 3 from $^{39}\text{K}(\text{p},\gamma)$, 1877 2 from $^{40}\text{Ca}(\text{n},\text{n}'\gamma)$, and 1876.9 2 from $^{40}\text{Ca}(\text{p},\text{p}'\gamma)$. I γ : from (p, γ). Mult., δ : from $\gamma(\text{pol})$ in (p, γ). B(E2)(W.u.)=3.3 +23-11 E γ : weighted average of 2275 2 from $^{40}\text{Ca}(\text{n},\text{n}'\gamma)$ and 2277.5 10 from $^{40}\text{Ca}(\text{p},\text{p}'\gamma)$. I γ : weighted average of 14.0 10 from $^{39}\text{K}(\text{p},\gamma)$, and 14 6 from $^{40}\text{Ca}(\text{p},\text{p}'\gamma)$. Other: 48 12 from $^{40}\text{Ca}(\text{n},\text{n}'\gamma)$,. B(E2)(W.u.)=0.26 +15-7 E γ : weighted average of 5628.5 2 from $^{40}\text{Ca}(\gamma,\gamma')$, 5629 2 from $^{40}\text{Ca}(\text{n},\text{n}'\gamma)$, and 5628.3 5 from $^{40}\text{Ca}(\text{p},\text{p}'\gamma)$. I γ : from (p, γ). Mult.: from $\gamma(\theta)$ in (p,p' γ) and RUL. B(E1)(W.u.)= 6.7×10^{-5} +34-17 E γ : weighted average of 5902.0 2 from $^{40}\text{Ca}(\gamma,\gamma')$, 5903 2 from $^{40}\text{Ca}(\text{n},\text{n}'\gamma)$, and 5902.6 15 from $^{40}\text{Ca}(\text{p},\text{p}'\gamma)$. Mult.: D from $\gamma\gamma(\theta)$ in (p,p' γ), polarity from level-parity change determined from other experimental evidence. B(E1)(W.u.)= 6.1×10^{-5} +19-15 E γ : from (p,p' γ). I γ : from (p, γ). B(M1)(W.u.)=0.0010 +7-4; B(E2)(W.u.)=4.7 +11-9 E γ : from (p,p' γ). I γ : from (p, γ). Mult., δ : D+Q from $\gamma\gamma(\theta)$ in (p,p' γ), polarity from no level-parity change determined from other experimental evidence. E γ ,I γ : from (p, γ). Other: I γ <3.4 in (p,p' γ). B(M1)(W.u.)<0.0037; B(E2)(W.u.)>77 E γ : from (p,p' γ).
		1877.0 2	100 3	3736.69	3 ⁻	M1+E2	-0.27 5	
5629.41	2 ⁺	2277.0 10	14.0 10	3352.62	0 ⁺	[E2]		
		5628.5 2	100.0 10	0.0	0 ⁺	E2		
5902.63	1 ⁻	5902.0 2	100	0.0	0 ⁺	E1		
6025.47	2 ⁻	2121.0 6	23 3	3904.38	2 ⁺	[E1]		
		2289.0 3	100 3	3736.69	3 ⁻	M1+E2	-2.8 5	
6029.71	3 ⁺	750.9 780.7 4	<1.2 20 4	5278.80 4 ⁺ 5248.79 2 ⁺		E2(+M1)	>2	

Adopted Levels, Gammas (continued)

$\gamma(^{40}\text{Ca})$ (continued)							
$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\ddagger$	E_f	J_f^π	Mult. [§]	$\delta^\S$
Comments							
6029.71	3 ⁺	2124.4 3	100 4	3904.38	2 ⁺	E2(+M1)	>4
I_γ : weighted average of 25 4 from ³⁹ K(p, γ), 18 6 from ⁴⁰ Ca(n,n' γ), and 15 5 from ⁴⁰ Ca(p,p' γ). Mult., δ : Q(+D) from $\gamma\gamma(\theta)$ in (p,p' γ); M2(+E1) is ruled out by RUL. B(M1)(W.u.)<0.00027; B(E2)(W.u.)>3.0 E_γ : from (p,p' γ). I_γ : from (p, γ). Mult., δ : Q(+D) from $\gamma\gamma(\theta)$ in (p,p' γ); M2(+E1) is ruled out by RUL. E_γ, I_γ : from (p, γ). Other: I_γ <23 in (p,p' γ). E_γ, I_γ : from (p, γ) only. B(E2)(W.u.)=8.2 +14-13 E_γ : weighted average of 1793.9 6 from ³⁹ K(p, γ), 1793 2 from ⁴⁰ Ca(n,n' γ), and 1793.3 2 from ⁴⁰ Ca(p,p' γ). I_γ : from (p, γ). Mult.: Q(+O) from $\gamma\gamma(\theta)$ in (p,p' γ), M2 ruled out by RUL. $\delta(\text{O/Q})$ =-0.03 17 from (p,p' γ), +0.03 2 from (p, γ). B(E1)(W.u.)=2.6 $\times 10^{-5}$ +5-4 E_γ : from (p,p' γ). I_γ : from (p, γ). Others: 80 33 from (n,n' γ), 30 7 from (p,p' γ), and 33 7 from ($\alpha, \alpha'\gamma$). Mult.: D from $\gamma\gamma(\theta)$ in (p,p' γ), polarity from level-parity change determined from other experimental evidence. E_γ, I_γ : from (p, γ). Other: I_γ <13 in (p,p' γ). B(E3)(W.u.)=4.2 +13-10 E_γ, I_γ : from (p, γ). B(E2)(W.u.)=0.49 +22-12 E_γ : from (γ, γ'). E_γ, I_γ : from (p,p' γ). Other: I_γ <3.5 in (p, γ). B(E2)(W.u.)=24 +13-9 E_γ : from (p, γ). I_γ : weighted average of 18 4 from ³⁹ K(p, γ) and 15 4 from ⁴⁰ Ca(p,p' γ). B(E2)(W.u.)=3.7 +11-8 E_γ : from (p,p' γ). I_γ : from (p, γ). Mult.: O(+Q) from $\gamma\gamma(\theta)$ in (p,p' γ), M2 ruled out by RUL. $\delta(\text{O/Q})$ =-0.09 9 from (p,p' γ). B(E2)(W.u.)=1.7 $\times 10^2$ +7-5 E_γ, I_γ : from (p, γ). Other: I_γ =17 4 in (p,p' γ). Mult.: from $\gamma\gamma(\theta)$ in (p,p' γ) and RUL. B(E2)(W.u.)>100 consistent with 6543, 4 ⁺ state as a member of SD band. E_γ, I_γ : from (p, γ). Other: I_γ =10 4 in (p,p' γ). B(E2)(W.u.)=22 +10-7 E_γ, I_γ : from (p, γ). Other: I_γ =12 4 in (p,p' γ). Mult.: (Q) from (HI,xn γ), M2 ruled out by RUL.							
6285.15	3 ⁻	2293.0 671.6 1793.4 2	<8 1.3 3 100.0 11	3736.69 3 ⁻ 5613.52 4 ⁻ 4491.43 5 ⁻	3 ⁻ 4 ⁻ 5 ⁻	E2	
		2380.0 5	27.4 7	3904.38	2 ⁺	E1	
		2548.4 6284.6	4.4 6 5.8 7	3736.69 3 ⁻ 0.0 0 ⁺	3 ⁻ 0 ⁺	[E3]	
6422.4	2 ⁺	6420.6 9	100	0.0 0 ⁺	0 ⁺	[E2]	
6507.87	4 ⁺	1229.0 @ 1259.0	4 3 17 4	5278.80 4 ⁺ 5248.79 2 ⁺	4 ⁺ 2 ⁺	[E2]	
		2603.2 3	100 4	3904.38	2 ⁺	E2	
6542.80	4 ⁺	913.3	32 3	5629.41	2 ⁺	E2	
		1264.0 1294.0	14 3 24 3	5278.80 4 ⁺ 5248.79 2 ⁺	4 ⁺ 2 ⁺	(E2)	

Adopted Levels, Gammas (continued)

$\gamma(^{40}\text{Ca})$ (continued)								
$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\ddagger$	E_f	J_f^π	Mult. [§]	$\delta^\S$	Comments
6542.80	4 ⁺	2638.1 3	100 3	3904.38	2 ⁺	E2(+M3)	-0.07 7	B(E2)(W.u.)=2.6 +8-6 E _γ : from (p,p'γ). I _γ : from (p,γ). Mult.: Q(+O) from γγ(θ) in (p,p'γ), M2 ruled out by RUL. δ(O/Q)=-0.07 7 from (p,p'γ).
6582.47	3 ⁻	969.0 2091.0	26 5 <1.1	5613.52 4 ⁻ 4491.43 5 ⁻	[E2]			E _γ , I _γ : from (p,γ). Other: I _γ =7.5 30 in (p,p'γ). B(E2)(W.u.)=0.39 +36-24 E _γ : from (p,γ). I _γ : from (p,γ). Other: 7.5 30 from (p,p'γ). B(E1)(W.u.)=2.8×10 ⁻⁵ +11-7 E _γ : from (p,γ). I _γ : weighted average of 24.2 18 from ³⁹ K(p,γ), and 34 8 from ⁴⁰ Ca(p,p'γ).
		2678.1	24.7 21	3904.38 2 ⁺	[E1]			B(M1)(W.u.)=0.00034 +60-26; B(E2)(W.u.)=1.3 +5-4 E _γ : from (p,p'γ). I _γ : from (p,γ). Mult., δ: D+Q from γγ(θ) in (p,p'γ), M2 ruled out by RUL.
6750.41	2 ⁻	2848.4 @ 10	<10	3904.38 2 ⁺				E _γ : from (p,p'γ). Other: 2845.9 from (p,γ). I _γ : from (p,γ). Others: 22 10 in (n,n'γ), 18 in (p,p'γ). B(M1)(W.u.)=0.0047 +36-17; B(E2)(W.u.)=1.1 +10-5 E _γ : from (p,p'γ). Mult., δ: from γγ(θ) in (p,p'γ) and RUL.
		3014.0 3	100	3736.69 3 ⁻	M1+E2		-0.84 16	B(E2)(W.u.)=2.1 +5-4 E _γ : from (γ,γ'). B(E2)(W.u.)=17 +17-4 E _γ : weighted average of 1651.9 7 from (HI,xnγ) and 1651.7 4 from (³ He,dγ). Other: 1651 2 from (n,n'γ). Mult.: from γ(θ) and γ(DCO) in (HI,xnγ) and RUL.
6908.70	2 ⁺	6907.6 1	100	0.0 0 ⁺	[E2]			B(E1)(W.u.)=1.1×10 ⁻⁵ +10-4 E _γ , I _γ : from (p,γ). E _γ , I _γ : from (p,γ). B(E1)(W.u.)=5.3×10 ⁻⁶ +47-19 E _γ , I _γ : from (p,γ). B(E2)(W.u.)=0.008 +10-4 E _γ , I _γ : from (p,γ). B(E1)(W.u.)=3.0×10 ⁻⁷ +37-15 E _γ , I _γ : from (p,γ). E _γ , I _γ : from (p,γ). Other: E _γ =3190.0 15 in (p,p'γ), 3193 2 in (n,n'γ). E _γ : from (p,p'γ). B(E1)(W.u.)=0.0019 +4-3
6930.2	6 ⁺	1651.8 4	100	5278.80 4 ⁺	E2			
6931.29	3 ⁻	1301.8	7.0 4	5629.41 2 ⁺	[E1]			
		1317.7	2.4 4	5613.52 4 ⁻				
		1682.4	7.4 4	5248.79 2 ⁺	[E1]			
		2439.8	1.7 4	4491.43 5 ⁻	[E2]			
		3026.8	2.4 6	3904.38 2 ⁺	[E1]			
6938.0	(1 ⁻ to 5 ⁻)	3194.5	100.0 9	3736.69 3 ⁻				
6950.48	1 ⁻	3201.0 15 6949.7 8	100 100	3736.69 3 ⁻ 0.0 0 ⁺	[E1]			

Adopted Levels, Gammas (continued)

							$\gamma(^{40}\text{Ca})$ (continued)
$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\ddagger$	E_f	J_f^π	Mult. [§]	Comments
							E_γ : weighted average of 6949.3 7 from $^{40}\text{Ca}(\gamma,\gamma')$, 6949 2 from $^{40}\text{Ca}(\text{n},\text{n}'\gamma)$, and 6952.2 15 from $^{40}\text{Ca}(\text{p},\text{p}'\gamma)$.
7113.1	1 ⁻	1485	5	5629.41	2 ⁺	[E1]	$B(\text{E}1)(\text{W.u.})=0.00010 +11-4$
		1899.8 7	22	5211.56	0 ⁺	[E1]	E_γ, I_γ : (p,p' γ) only. $B(\text{E}1)(\text{W.u.})=0.00022 +23-8$
		3206.8 6	28	3904.38	2 ⁺	[E1]	E_γ, I_γ : (p,p' γ) only. $B(\text{E}1)(\text{W.u.})=5.8 \times 10^{-5} +60-20$
		7112.9 10	100	0.0	0 ⁺	[E1]	E_γ, I_γ : from (p,p' γ). Other: $E_\gamma=3208.5$ in (p, γ). $B(\text{E}1)(\text{W.u.})=1.9 \times 10^{-5} +20-7$
7113.73	4 ⁻	1088.2	1.7 5	6025.47	2 ⁻	[E2]	E_γ, I_γ : from (p,p' γ). Other: $E_\gamma=7113.3$ in (p, γ). $B(\text{E}2)(\text{W.u.})=7 +8-4$
		1500.2	10.3 11	5613.52	4 ⁻		E_γ, I_γ : from (p, γ).
		1834.9	2.6 5	5278.80	4 ⁺	[E1]	$B(\text{E}1)(\text{W.u.})=2.1 \times 10^{-5} +22-9$
		2623.2 3	40.7 20	4491.43	5 ⁻		E_γ, I_γ : from (p, γ).
		3378.5 3	100.0 14	3736.69	3 ⁻		E_γ : from (p,p' γ). Other: 3376.9 in (p, γ). I_γ : from (p, γ).
7239.07	(3 ⁻ ,4,5 ⁻)	1624.5 7	50	5613.52	4 ⁻		E_γ, I_γ : from (p,p' γ) only.
		2746	100	4491.43	5 ⁻		E_γ, I_γ : from (p,p' γ) only.
		3501.4 5	100	3736.69	3 ⁻		E_γ, I_γ : from (p,p' γ). Other: $E_\gamma=3502.2$ in (p, γ).
7277.82	(2,3) ⁺	3541.0	100	3736.69	3 ⁻	[E1]	$B(\text{E}1)(\text{W.u.})=0.00027 +67-11$
							E_γ : from (p, γ).
7300.67	0 ⁺	1671.3	5.3 16	5629.41	2 ⁺	[E2]	$B(\text{E}2)(\text{W.u.})=1.8 +18-10$
		2050.3 5	100.0 16	5248.79	2 ⁺	[E2]	E_γ, I_γ : from (p, γ). $B(\text{E}2)(\text{W.u.})=16 +8-4$
							E_γ : from (p,p' γ). Other: 2051.9 in (p, γ).
7397.2	(5 ⁺)	1369		6029.71	3 ⁺	(E2)	E_γ : from (HI,xn γ) only.
		2119.2 6		5278.80	4 ⁺	(D)	Mult.: (Q) from (HI,xn γ), M2 ruled by RUL. E_γ : from (p,p' γ).
							Mult.: from (HI,xn γ).
7421.9		3684.9 12	100	3736.69	3 ⁻		E_γ : from (p,p' γ).
7446.23	3 ⁺ ,4 ⁺	1816.8	30.0 17	5629.41	2 ⁺		E_γ, I_γ : from (p, γ).
		1831.5 10	48.5 19	5613.52	4 ⁻	[E1]	$B(\text{E}1)(\text{W.u.})=0.00014 +10-5$
							E_γ : from (p,p' γ). Other: 1832.7 in (p, γ).
							I_γ : from (p, γ).
		2167.4	56 3	5278.80	4 ⁺		E_γ, I_γ : from (p, γ). Other: $E_\gamma=2169.1$ 15 in (p,p' γ).
		2198.0 10	100 3	5248.79	2 ⁺		E_γ : from (p,p' γ). Other: 2197.4 in (p, γ).
							I_γ : from (p, γ).
7466.35	2 ⁺	2217.5	24 3	5248.79	2 ⁺		E_γ, I_γ : from (p, γ).
		3561.8	36.0 25	3904.38	2 ⁺		E_γ, I_γ : from (p, γ).

Adopted Levels, Gammas (continued)

							$\gamma(^{40}\text{Ca})$ (continued)
$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\ddagger$	E_f	J_f^π	Mult. [§]	Comments
7466.35	2 ⁺	4113.5	21.0 18	3352.62	0 ⁺	[E2]	B(E2)(W.u.)=0.9 +12-4 E _γ ,I _γ : from (p,γ).
		7465.6	100 4	0.0	0 ⁺	[E2]	B(E2)(W.u.)=0.21 +24-8 E _γ ,I _γ : from (p,γ). Other: E _γ =7467.8 10 in (p,p'γ).
7481?		7480		0.0	0 ⁺		
7532.26	2 ⁻	1247.1	23.1 21	6285.15	3 ⁻		E _γ ,I _γ : from (p,γ).
		1506.8	11.3 10	6025.47	2 ⁻		E _γ ,I _γ : from (p,γ).
		1629.6	8.0 24	5902.63	1 ⁻		E _γ ,I _γ : from (p,γ).
		1917.6 10	57 3	5613.52	4 ⁻	[E2]	B(E2)(W.u.)=4.1 +19-12 E _γ : from (p,p'γ). Other: 1918.7 in (p,γ).
		3627.7	36 3	3904.38	2 ⁺	[E1]	I _γ : from (p,γ). B(E1)(W.u.)=1.2×10 ⁻⁵ +6-4
		3795.4 10	100 4	3736.69	3 ⁻		E _γ ,I _γ : from (p,γ).
7561.17	4 ⁺	1531.4	44 5	6029.71	3 ⁺		E _γ ,I _γ : from (p,γ).
		2312.1 10	100 13	5248.79	2 ⁺	[E2]	B(E2)(W.u.)=3.9 +17-11 E _γ : unweighted average of 2313.0 6 from ³⁹ K(p,γ) and 2311.1 3 from ⁴⁰ Ca(p,p'γ).
		3824.3	14 3	3736.69	3 ⁻	[E1]	I _γ : from (p,γ). B(E1)(W.u.)=5.4×10 ⁻⁶ +41-23
7623.11	(2 ⁻ ,3,4 ⁺)	1993.6	100 3	5629.41	2 ⁺		E _γ ,I _γ : from (p,γ).
		2009.5 7	90 3	5613.52	4 ⁻		E _γ : from (p,p'γ). I _γ : from (p,γ).
		2374.2	31.5 20	5248.79	2 ⁺		E _γ ,I _γ : from (p,γ).
		3886.2	57.4 20	3736.69	3 ⁻		E _γ ,I _γ : from (p,γ).
7658.23	4 ⁻	1373.1	33 5	6285.15	3 ⁻		E _γ ,I _γ : from (p,γ).
		2045.6 7	100 6	5613.52	4 ⁻		E _γ : weighted average of 2045.8 7 from ⁴⁰ Sc ε decay and 2045.0 10 from ⁴⁰ Ca(p,p'γ). Other: 2045.6 in (p,γ).
		3167.9 7	52 8	4491.43	5 ⁻		I _γ : from ⁴⁰ Sc ε decay. E _γ : from ⁴⁰ Sc ε decay. Other: 3166.7 in (p,γ).
		3920.0 10	59 8	3736.69	3 ⁻		I _γ : weighted average of 47 8 from ⁴⁰ Sc ε decay and 56 8 from ³⁹ K(p,γ). E _γ : from ⁴⁰ Sc ε decay. Other: 3921.3 in (p,γ).
7676.6	(6 ⁺)	2399.2 5	100	5278.80	4 ⁺	(E2)	I _γ : weighted average of 51 8 from ⁴⁰ Sc ε decay and 67 8 from ³⁹ K(p,γ). B(E2)(W.u.)=4.4 +15-9 E _γ : from (p,p'γ).
							Mult.: (Q) from γ(θ) in (HI,xnγ), M2 ruled out by RUL.
7694.08	3 ⁻	2080.6	10.1 13	5613.52	4 ⁻		E _γ ,I _γ : from (p,γ).
		3957.5 5	100.0 13	3736.69	3 ⁻		E _γ : from (p,p'γ). Other: 3957.3 in (p,γ).
7701.8	0 ⁺	3797.2	100	3904.38	2 ⁺		I _γ : from (p,γ).
7769.4	(3,4,5 ⁻)	2155.8	52 9	5613.52	4 ⁻		E _γ : from (p,γ). E _γ ,I _γ : from (p,γ).

Adopted Levels, Gammas (continued)

$\gamma(^{40}\text{Ca})$ (continued)							Comments
$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\ddagger$	E_f	J_f^π	Mult. [§]	
7769.4	(3,4,5 ⁻)	4032.5	100 9	3736.69	3 ⁻		E_γ, I_γ : from (p, γ).
7814.7	0 ⁺	2565	43	5248.79	2 ⁺		E_γ, I_γ : from (p,p' γ).
		3908	100	3904.38	2 ⁺		E_γ, I_γ : from (p,p' γ).
7872.18	2 ⁺	7871.1 1	100	0.0	0 ⁺	[E2]	B(E2)(W.u.)=0.89 +22-15 E_γ : from (γ, γ'). Others: 7871.4 in (p, γ), 7872.9 10 in (p,p' γ). I_γ : 1982Mo05 in (γ, γ') report $\Gamma_0/\Gamma=0.84$ 6 without indicating the observation of other γ branches other than the ground transition and no other γ branches were observed in other studies. So this value is not considered.
7928.42	4 ⁺	2314.8	100 18	5613.52	4 ⁻	[E1]	B(E1)(W.u.)=0.00046 +151-25
		3436.8	100 18	4491.43	5 ⁻	[E1]	E_γ, I_γ : from (p, γ). Other: $E_\gamma=2313.7$ 17 in (p,p' γ). B(E1)(W.u.)=0.00014 +46-8
		4191.5	<14	3736.69	3 ⁻		E_γ, I_γ : from (p, γ).
7974.4	(6 ⁺)	1432		6542.80	4 ⁺	(Q)	E_γ, I_γ : from (p, γ). Other: $I_\gamma=20$ in (p,p' γ).
		2695		5278.80	4 ⁺	(Q)	$E_\gamma, \text{Mult.}$: from (HI,xn γ).
7976.55	2 ⁺	2699	20	5278.80	4 ⁺	[E2]	$E_\gamma, \text{Mult.}$: from (HI,xn γ).
		4072.1 6	100	3904.38	2 ⁺		B(E2)(W.u.)>1.2
		4624	60	3352.62	0 ⁺	[E2]	B(E2)(W.u.)>0.24
		7977	20	0.0	0 ⁺	[E2]	B(E2)(W.u.)>0.0051
8018.8	0 ⁺	2770	100	5248.79	2 ⁺		
8091.61	2 ⁺	8090.6 2	100	0.0	0 ⁺	[E2]	B(E2)(W.u.)=0.72 +9-7
							E_γ : from (γ, γ'). Other: 8092.4 20 in (p,p' γ).
8100.1	8 ⁺	1168.8 3	100	6930.2	6 ⁺	E2	B(E2)(W.u.)=2.6 +4-3
							E_γ : from (HI,xn γ).
							Mult.: from $\gamma\gamma(\theta)$ and $\gamma(\text{DCO})$ in (HI,xn γ) and RUL.
8113.2	1 ⁻	8111.0 6	100	0.0	0 ⁺	[E1]	B(E1)(W.u.)=6.0 $\times 10^{-5}$ +39-17
							E_γ : from (γ, γ').
8134.77	(3 ⁻)	2505.3	82 9	5629.41	2 ⁺		E_γ, I_γ : from (p, γ).
		2521.2	24 9	5613.52	4 ⁻		E_γ, I_γ : from (p, γ).
		3643.1 @	<15	4491.43	5 ⁻		E_γ, I_γ : from (p, γ). Other: $I_\gamma=100$ in (p,p' γ).
		4229.4 10	100 30	3904.38	2 ⁺		E_γ : from (p,p' γ). Other: 4230.1 in (p, γ).
							I_γ : from (p, γ).
8187.5	(3,4,5 ⁻)	4451.6 8	100	3736.69	3 ⁻		E_γ : from (p,p' γ). Other: 4450.7 in (p, γ).
8271	(≤ 3) ⁻	1321	100	6950.48	1 ⁻		E_γ, I_γ : from (p,p' γ).
		2368	67	5902.63	1 ⁻		E_γ, I_γ : from (p,p' γ).
8276	0 ⁺	2646	100	5629.41	2 ⁺		
8323.16	(1 ⁻ ,2 ⁺)	1572.7	12.5 10	6750.41	2 ⁻		
		2038.0	2.2 5	6285.15	3 ⁻		
		2297.6	26.3 17	6025.47	2 ⁻		
		2420.5	1.9 12	5902.63	1 ⁻		
		3074.2	4.5 9	5248.79	2 ⁺		
		4586.2	100 3	3736.69	3 ⁻		

Adopted Levels, Gammas (continued)

$\gamma(^{40}\text{Ca})$ (continued)

$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\ddagger$	E_f	J_f^π	Mult. [§]	Comments
8323.16	(1 ⁻ ,2 ⁺)	8322.2	3.4 12	0.0	0 ⁺		Unobserved intensity=18 3 in (p, γ).
8338.0	(2 ⁺ ,3,4)	1795.2	100 10	6542.80	4 ⁺		
		1830.1	42 10	6507.87	4 ⁺		Unobserved intensity=25 13 in (p, γ).
8358.9	(0,1,2) ⁻	1405	100	6950.48	1 ⁻		E_γ : from (p,p' γ).
8364	(3 ⁻ to 7 ⁻)	3872	100	4491.43	5 ⁻		
8373.94	4 ⁺	4469.3	100	3904.38	2 ⁺		
8424.81	2 ⁻	2399.3	19 4	6025.47	2 ⁻		
		2522.1	24 4	5902.63	1 ⁻		
		4687.8	100 6	3736.69	3 ⁻		E_γ : from (p, γ). Other: 4688.2 15 in (p,p' γ).
8439.0	0 ⁺	2809.5	100	5629.41	2 ⁺		
8484.02	(1 ⁻ ,2 ⁻ ,3 ⁻)	2581.3	59 11	5902.63	1 ⁻		
		4747.0	100 11	3736.69	3 ⁻		
8540	1,2 ⁺	5188	67	3352.62	0 ⁺		E_γ, I_γ : from (p,p' γ).
		8540 4	100	0.0	0 ⁺		E_γ, I_γ : from (p,p' γ).
8551.1	5 ⁻	4060.8 15		4491.43	5 ⁻		E_γ, I_γ : from (p,p' γ).
8578.80	2 ⁺	8577.7 2	100	0.0	0 ⁺	[E2]	B(E2)(W.u.)=0.54 +7-6
							E_γ : from (γ, γ').
8587	(2 ⁺ ,3)	2562	25	6025.47	2 ⁻		E_γ, I_γ : from (p,p' γ).
		3308	25	5278.80	4 ⁺		E_γ, I_γ : from (p,p' γ).
		4682	17	3904.38	2 ⁺		E_γ, I_γ : from (p,p' γ).
		4850	100	3736.69	3 ⁻		E_γ, I_γ : from (p,p' γ).
8665.3	1 ⁻	8665	100	0.0	0 ⁺		
8678.29	4 ⁺	2393.1	20 8	6285.15	3 ⁻	[E1]	B(E1)(W.u.)=0.00017 +145-12
		4941.3	100 23	3736.69	3 ⁻	[E1]	B(E1)(W.u.)=0.00010 +53-5
							Unobserved intensity=34 25 in (p, γ).
8701	(6 ⁻)	3088		5613.52	4 ⁻		
		4209		4491.43	5 ⁻		
8748.22	2 ⁺	8748.4 2	100	0.0	0 ⁺	[E2]	B(E2)(W.u.)=0.26 +4-3
							E_γ : from (γ, γ'). Other: 8747.2 in (p, γ).
8764.18	3 ⁻	2734.4	47 18	6029.71	3 ⁺		
		3134.6	56 21	5629.41	2 ⁺		
		3485.2	100 30	5278.80	4 ⁺		
		4859.5	65 18	3904.38	2 ⁺		Unobserved intensity $\approx$ 26 in (p, γ).
8934.81	2 ⁺	1402.5	12.2 11	7532.26	2 ⁻		
		1657.0	3.5 5	7277.82	(2,3) ⁺		
		1821.0	1.7 4	7113.1	1 ⁻		
		1984.3	5.6 8	6950.48	1 ⁻		
		2184.3	5.6 8	6750.41	2 ⁻		
		2352.2	1.9 3	6582.47	3 ⁻		
		2905.0	3.2 11	6029.71	3 ⁺		
		2909.2	17.6 19	6025.47	2 ⁻		
		3032.1	1.7 5	5902.63	1 ⁻		

Adopted Levels, Gammas (continued)

<u>$\gamma(^{40}\text{Ca})$ (continued)</u>							
<u>E_i(level)</u>	<u>J_i^{π}</u>	<u>E_{γ}</u> [†]	<u>I_{γ}</u> [‡]	<u>E_f</u>	<u>J_f^{π}</u>	<u>Mult.</u> [§]	<u>Comments</u>
8934.81	2 ⁺	3305.2	2.9 5	5629.41	2 ⁺		
		3685.8	5.6 24	5248.79	2 ⁺		
		3722.9	3.5 8	5211.56	0 ⁺		
		5030.1	100 5	3904.38	2 ⁺		
		5197.8	2.9 13	3736.69	3 ⁻		
		5581.8	21.8 21	3352.62	0 ⁺		
		8933.7	77 5	0.0	0 ⁺		
8935.8	(7 ⁺)	1538		7397.2	(5 ⁺)	(Q)	
		2004		6930.2	6 ⁺	(D)	
8982.5	2 ⁺	8981.4 5	100	0.0	0 ⁺	[E2]	B(E2)(W.u.)=0.38 +6-5 E _{γ} : from (γ, γ').
8994.50	(1 ⁻ , 2 ⁺)	1880.7	0.44 11	7113.1	1 ⁻		
		2085.7	0.62 15	6908.70	2 ⁺		
		2244.0	0.60 8	6750.41	2 ⁻		
		2411.9	0.44 14	6582.47	3 ⁻		
		2709.3	0.64 16	6285.15	3 ⁻		
		2968.9	1.5 3	6025.47	2 ⁻		
		3364.9	8.7 7	5629.41	2 ⁺		
		3782.6	8.2 7	5211.56	0 ⁺		
		5089.8	8.3 8	3904.38	2 ⁺		
		5257.4	2.4 4	3736.69	3 ⁻		
		5641.5	2.1 6	3352.62	0 ⁺		
		8993.4	100.0 22	0.0	0 ⁺		
		1337.7	25 8	7694.08	3 ⁻		
		2746.6	25 8	6285.15	3 ⁻		
9031.9	4 ⁻	3418.2	100 13	5613.52	4 ⁻		
		3752.9	30 13	5278.80	4 ⁺		
		4540.2	70 13	4491.43	5 ⁻		
		4542 @		4491.43	5 ⁻		E _{γ} : this γ may correspond to 4540.2 γ from 9031.9 level.
		9091.70	3 ⁻	1397.5	3 ⁻		
9033?	(7 ⁻)	1468.6	1.31 16	7623.11	(2 ⁻ , 3, 4 ⁺)		
		1625.3	0.71 5	7466.35	2 ⁺		
		1813.8	2.17 24	7277.82	(2, 3) ⁺		
		1852.6	1.26 17	7239.07	(3 ⁻ , 4, 5 ⁻)		
		1977.9	0.95 16	7113.73	4 ⁻		
		2341.2	0.98 24	6750.41	2 ⁻		
		2509.1	1.79 24	6582.47	3 ⁻		
		2806.4	8.8 5	6285.15	3 ⁻		
		3061.9	4.3 7	6029.71	3 ⁺		
		3066.1	5.0 9	6025.47	2 ⁻		
		3188.9	2.6 4	5902.63	1 ⁻		

Adopted Levels, Gammas (continued)

$\gamma(^{40}\text{Ca})$ (continued)

<u>E_i(level)</u>	<u>J_i^{π}</u>	<u>E_{γ}[†]</u>	<u>I_{γ}[‡]</u>	<u>E_f</u>	<u>J_f^{π}</u>
9091.70	3 ⁻	3812.7	14.6 7	5278.80	4 ⁺
		3842.7	7.7 4	5248.79	2 ⁺
		5187.0	16.2 7	3904.38	2 ⁺
		5354.6	100.0 17	3736.69	3 ⁻
9135.66	2 ⁻ ,3 ⁻	710.8	1.72 15	8424.81	2 ⁻
		1263.5	0.55 9	7872.18	2 ⁺
		1441.5	8.9 4	7694.08	3 ⁻
		1603.4	6.3 4	7532.26	2 ⁻
		1857.8	0.43 7	7277.82	(2,3) ⁺
		2021.9	3.13 21	7113.73	4 ⁻
		2185.1	0.78 14	6950.48	1 ⁻
		2385.2	1.06 15	6750.41	2 ⁻
		2553.0	3.5 3	6582.47	3 ⁻
		2850.4	23.5 7	6285.15	3 ⁻
		3110.1	0.43 17	6025.47	2 ⁻
		3232.9	5.1 4	5902.63	1 ⁻
		3522.0	0.51 17	5613.52	4 ⁻
		3886.7	0.8 3	5248.79	2 ⁺
		5230.9	13.6 7	3904.38	2 ⁺
		5398.6	100.0 15	3736.69	3 ⁻
9209.77	(2,3) ⁻	725.7	1.53 16	8484.02	(1 ⁻ ,2 ⁻ ,3 ⁻)
		785.0	5.4 3	8424.81	2 ⁻
		1515.6	7.3 3	7694.08	3 ⁻
		2096.0	2.60 20	7113.73	4 ⁻
		2259.2	4.5 3	6950.48	1 ⁻
		2459.3	3.2 3	6750.41	2 ⁻
		2627.1	3.6 3	6582.47	3 ⁻
		2924.5	6.5 3	6285.15	3 ⁻
		3184.2	2.6 3	6025.47	2 ⁻
		3307.0	17.4 5	5902.63	1 ⁻
		3580.2	3.4 3	5629.41	2 ⁺
		5305.0	4.7 5	3904.38	2 ⁺
		5472.7	100.0 16	3736.69	3 ⁻
9226.69	(1 ⁻ ,2,3 ⁻)	1694.4	100 5	7532.26	2 ⁻
		2276.1	15.9 14	6950.48	1 ⁻
		2476.2	24.1 15	6750.41	2 ⁻
		2941.4	27.8 15	6285.15	3 ⁻
		3323.9	<3.0	5902.63	1 ⁻
		3977.7	<14	5248.79	2 ⁺
		5321.9	<3.1	3904.38	2 ⁺
		5489.6	39 3	3736.69	3 ⁻
		9225.6	<97	0.0	0 ⁺

Adopted Levels, Gammas (continued)

$\gamma(^{40}\text{Ca})$ (continued)

<u>E_i(level)</u>	<u>J_i^{π}</u>	<u>E_{γ}^{$\dagger$}</u>	<u>I_{γ}^{$\ddagger$}</u>	<u>E_f</u>	<u>J_f^{π}</u>	<u>Mult.^{$\S$}</u>
9227.43	(1,2 ⁺)	3201.8	35.0 13	6025.47	2 ⁻	
		3324.7	<1.0	5902.63	1 ⁻	
		3978.4	<4.7	5248.79	2 ⁺	
		5322.7	<1.0	3904.38	2 ⁺	
		5874.4	100 3	3352.62	0 ⁺	
		9226.3	<33	0.0	0 ⁺	
9305.2	(8 ⁺)	1628		7676.6	(6 ⁺)	(Q)
		2375		6930.2	6 ⁺	(Q)
9362.54	3 ⁻	937.7	4.4 7	8424.81	2 ⁻	
		1668.4	100.0 25	7694.08	3 ⁻	
		1704.3	26.6 20	7658.23	4 ⁻	
		1739.4	3.9	7623.11	(2 ⁻ ,3,4 ⁺)	
		2412.0	3.2	6950.48	1 ⁻	
		2612.0	3.7	6750.41	2 ⁻	
		2779.9	6.3 7	6582.47	3 ⁻	
		3077.3	9.5 25	6285.15	3 ⁻	
		3748.8	29.8 22	5613.52	4 ⁻	
		4113.5	10.7 20	5248.79	2 ⁺	
		5457.8	14.4 20	3904.38	2 ⁺	
		5625.4	8.3 15	3736.69	3 ⁻	
9388.20	2 ⁺	1694.0	7	7694.08	3 ⁻	
		2087.4	2.5	7300.67	0 ⁺	
		2845.3	28	6542.80	4 ⁺	
		2880.3	9	6507.87	4 ⁺	
		3102.9	3.2	6285.15	3 ⁻	
		3362.6	6	6025.47	2 ⁻	
		3758.6	19	5629.41	2 ⁺	
		4109.2	15	5278.80	4 ⁺	
		4139.2	8	5248.79	2 ⁺	
		4176.3	28	5211.56	0 ⁺	
		5483.4	8	3904.38	2 ⁺	
		5651.1	17	3736.69	3 ⁻	
		9387.0	100	0.0	0 ⁺	
9404.85	2 ⁻	1872.5	43	7532.26	2 ⁻	
		2127.0	2.2	7277.82	(2,3) ⁺	
		2291.1	20	7113.73	4 ⁻	
		2454.3	4	6950.48	1 ⁻	
		2496.1	8	6908.70	2 ⁺	
		2822.2	10	6582.47	3 ⁻	
		3119.6	100	6285.15	3 ⁻	M1
		3502.1	20	5902.63	1 ⁻	
		5500.1	7	3904.38	2 ⁺	

Adopted Levels, Gammas (continued)

$\gamma(^{40}\text{Ca})$ (continued)								
$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\ddagger$	E_f	J_f^π	Mult. §	$\delta^\S$	Comments
9404.85	2 ⁻	5667.7	49	3736.69	3 ⁻	M1+E2	-0.03 2	Mult.: D+Q in (p, γ), polarity from no level-parity change determined from other experimental evidence.
9418.8	3 ⁻	9403.7	7	0.0	0 ⁺			
		1724.6	10	7694.08	3 ⁻			
		1760.5	7	7658.23	4 ⁻			
		1795.6	4	7623.11	(2 ⁻ ,3,4 ⁺)			
		1886.5	5	7532.26	2 ⁻			
		2305.0	62	7113.73	4 ⁻			
		2668.3	6	6750.41	2 ⁻			
		3133.5	100	6285.15	3 ⁻			
		3393.2	5	6025.47	2 ⁻			
		3516.0	12	5902.63	1 ⁻			
		3805.1	5	5613.52	4 ⁻			
		4169.8	4	5248.79	2 ⁺			
		5681.7	18	3736.69	3 ⁻			
9429.11	(3,4) ⁻	1734.9	21 3	7694.08	3 ⁻			
		1770.8	100 6	7658.23	4 ⁻			
		1806.0	3.3 11	7623.11	(2 ⁻ ,3,4 ⁺)			
		2315.3	3.6 8	7113.73	4 ⁻			
		2846.5	26 5	6582.47	3 ⁻			
		3143.8	9.4 17	6285.15	3 ⁻			
		4937.3	81 6	4491.43	5 ⁻			
		5692.0	33 6	3736.69	3 ⁻			
		1900.2	2.5	7532.26	2 ⁻			
		2481.9	0.8	6950.48	1 ⁻			
9432.46	1 ⁻	2681.9	1.0	6750.41	2 ⁻			
		3406.8	2.3	6025.47	2 ⁻			
		5527.7	1.1	3904.38	2 ⁺			
		9431.3	100	0.0	0 ⁺			
		1029.1	4.9 6	8424.81	2 ⁻			
		1759.8	73.2 23	7694.08	3 ⁻			
9453.95	3 ⁻	1795.7	23.4 20	7658.23	4 ⁻			
		1830.8	5.9 10	7623.11	(2 ⁻ ,3,4 ⁺)			
		1921.6	3.3 7	7532.26	2 ⁻			
		2007.7	2.3 7	7446.23	3 ⁺ ,4 ⁺			
		2340.2	34.7 17	7113.73	4 ⁻			
		2703.4	6.9 7	6750.41	2 ⁻			
		3168.7	100.0 23	6285.15	3 ⁻			
		3428.3	5.9 10	6025.47	2 ⁻			
		3824.3	8.3 10	5629.41	2 ⁺			
		3840.2	33.7 20	5613.52	4 ⁻			
		4174.9	5	5278.80	4 ⁺			

Adopted Levels, Gammas (continued)

$\gamma(^{40}\text{Ca})$ (continued)								
<u>E_i(level)</u>	<u>J_i^{π}</u>	<u>E_{γ}^{$\dagger$}</u>	<u>I_{γ}^{$\ddagger$}</u>	<u>E_f</u>	<u>J_f^{π}</u>	<u>Mult.^{$\S$}</u>	<u>δ^{$\S$}</u>	<u>Comments</u>
9453.95	3 ⁻	5549.2	16.2 20	3904.38	2 ⁺			
		5716.8	11.2 13	3736.69	3 ⁻			
9603.0	3 ⁻	2489.2	61	7113.73	4 ⁻			
		3317.7	100	6285.15	3 ⁻	M1+E2	0.42 6	Mult., δ : D+Q from (p, γ), polarity form no level-parity change determined from other experimental evidence.
		5865.8	24	3736.69	3 ⁻	M1+E2	+0.18 3	Mult., δ : D+Q from (p, γ), polarity form no level-parity change determined from other experimental evidence.
9604.6	1 ⁻	2072.3	6	7532.26	2 ⁻			
		2654.0	1.3	6950.48	1 ⁻			
		2854.1	2.0	6750.41	2 ⁻			
		3579.0	5	6025.47	2 ⁻			
		5699.8	1.0	3904.38	2 ⁺			
		6251.4	1.4	3352.62	0 ⁺			
		9603.4	100	0.0	0 ⁺			
9640.89	2 ⁻	2174.5	16.7 6	7466.35	2 ⁺			
		2690.3	0.32 6	6950.48	1 ⁻			
		2732.1	1.06 11	6908.70	2 ⁺			
		3355.6	0.99 23	6285.15	3 ⁻			
		4011.2	9.94 21	5629.41	2 ⁺			
		5736.1	100.0 11	3904.38	2 ⁺			
		5903.7	82.5 11	3736.69	3 ⁻			
		9639.6	3.2	0.0	0 ⁺			
9668.71	3 ⁻	1974.5	1.5 3	7694.08	3 ⁻			
		2136.4	4.1 4	7532.26	2 ⁻			
		2222.4	1.53 25	7446.23	3 ⁺ ,4 ⁺			
		2554.9	60.6 16	7113.73	4 ⁻			
		2759.9	1.5 3	6908.70	2 ⁺			
		2918.2	4.6 4	6750.41	2 ⁻			
		3383.4	100.0 14	6285.15	3 ⁻			
		3643.1	6.8 7	6025.47	2 ⁻			
		5176.9	6.76 23	4491.43	5 ⁻			
		5763.9	8.1 5	3904.38	2 ⁺			
		5931.6	29.7 14	3736.69	3 ⁻			
9779.47	3	1031.3	17.1 15	8748.22	2 ⁺			
		1101.2	16.6 20	8678.29	4 ⁺			
		1200.7	25.1 15	8578.80	2 ⁺			
		1644.7	13.6 10	8134.77	(3 ⁻)			
		1851.0	26.6 15	7928.42	4 ⁺			
		1907.3	28.6 25	7872.18	2 ⁺			
		2218.2	95 4	7561.17	4 ⁺			
		2313.1	15	7466.35	2 ⁺			
		2870.7	21.1 25	6908.70	2 ⁺			

Adopted Levels, Gammas (continued)

$\gamma(^{40}\text{Ca})$ (continued)

<u>E_i(level)</u>	<u>J_i^{π}</u>	<u>E_{γ}^{$\dagger$}</u>	<u>I_{γ}^{$\dagger$}</u>	<u>E_f</u>	<u>J_f^{π}</u>	<u>Mult.^{$\S$}</u>	<u>δ^{$\S$}</u>	<u>Comments</u>
9779.47	3	3196.8	7.5 20	6582.47	3 ⁻			
		3236.6	6.5 15	6542.80	4 ⁺			
		3271.5	3.5 10	6507.87	4 ⁺			
		3749.6	6	6029.71	3 ⁺			
		4149.8	10.1 10	5629.41	2 ⁺			
		4165.7	100 4	5613.52	4 ⁻	D+Q	+0.07 4	Mult., δ : from (p, γ).
		4500.4	27.1 20	5278.80	4 ⁺			
		4530.4	3.5 10	5248.79	2 ⁺			
		5874.7	73 5	3904.38	2 ⁺			
		6042.3	27 3	3736.69	3 ⁻			
9785.3	(1,2 ⁺)	2484.5	2.6	7300.67	0 ⁺			
		2876.5	0.8	6908.70	2 ⁺			
		5880.5	2.9	3904.38	2 ⁺			
		6432.1	11	3352.62	0 ⁺			
		9784.0	100	0.0	0 ⁺			
9853.5	(8 ⁺)	1880		7974.4	(6 ⁺)	(Q)		
		2176		7676.6	(6 ⁺)	(Q)		
		2921		6930.2	6 ⁺	(Q)		
9865.15	1	1426.1	0.25 7	8439.0	0 ⁺			
		1773.5	1.02 11	8091.61	2 ⁺			
		1992.9	0.29 4	7872.18	2 ⁺			
		2163.3	0.74 25	7701.8	0 ⁺			
		2398.7	0.57 9	7466.35	2 ⁺			
		2564.3	4.5 3	7300.67	0 ⁺			
		2587.2	0.28 10	7277.82	(2,3) ⁺			
		2914.6	0.45 6	6950.48	1 ⁻			
		2956.3	1.54 14	6908.70	2 ⁺			
		3114.6	0.29 3	6750.41	2 ⁻			
		3962.3	0.48 7	5902.63	1 ⁻			
		4235.5	0.57 10	5629.41	2 ⁺			
		4616.1	0.35 4	5248.79	2 ⁺			
		4653.2	0.64 10	5211.56	0 ⁺			
		5960.3	7.1 3	3904.38	2 ⁺	D+Q	-0.18 3	Mult., δ : from (p, γ).
		6512.0	21.0 7	3352.62	0 ⁺			
		9863.8 20	100.0 17	0.0	0 ⁺			
9869.3	1 ⁺ ,2 ⁺	2167.4	1.1	7701.8	0 ⁺			
		2568.5	3.0	7300.67	0 ⁺			
		2960.5	1.2	6908.70	2 ⁺			
		4620.2	1.1	5248.79	2 ⁺			
		4657.3	0.8	5211.56	0 ⁺			
		5964.4	7	3904.38	2 ⁺			
		6516.1	17	3352.62	0 ⁺			

Adopted Levels, Gammas (continued)

<u>$\gamma(^{40}\text{Ca})$ (continued)</u>								
<u>E_i(level)</u>	<u>J_i^{π}</u>	<u>E_{γ}[†]</u>	<u>I_{γ}[‡]</u>	<u>E_f</u>	<u>J_f^{π}</u>	<u>Mult.[§]</u>	<u>δ[§]</u>	<u>Comments</u>
9869.3	1 ⁺ ,2 ⁺	9868.0	100	0.0	0 ⁺			
9954.00	4 ⁺	1580.0	6.5 5	8373.94	4 ⁺			
		3022.6	5.2 5	6931.29	3 ⁻			
		3371.3	2.1 5	6582.47	3 ⁻			
		3411.1	18.2 10	6542.80	4 ⁺			
		3446.0	7.2 4	6507.87	4 ⁺			
		4340.2	8.2 7	5613.52	4 ⁻			
		4674.9	100 3	5278.80	4 ⁺	M1+E2	+0.04 3	Mult., δ : from $\gamma(\text{pol})$ in (p, γ).
		5462.2	4.6 7	4491.43	5 ⁻			
		6216.8	11.2 10	3736.69	3 ⁻			
10040.54	(2 ⁻ ,3 ⁻)	1276.3	10.4 14	8764.18	3 ⁻			
		1556.5	3.5 6	8484.02	(1 ⁻ ,2 ⁻ ,3 ⁻)			
		1717.3	100.0 19	8323.16	(1 ⁻ ,2 ⁺)			
		2417.4	4.4 6	7623.11	(2 ⁻ ,3,4 ⁺)			
		2508.2	1.8 4	7532.26	2 ⁻			
		2762.6	16.1 6	7277.82	(2,3) ⁺			
		2926.7	8.5 6	7113.73	4 ⁻			
		3089.9	12.8 12	6950.48	1 ⁻			
		3457.8	2.7 4	6582.47	3 ⁻			
		4014.9	3.9 4	6025.47	2 ⁻			
		4137.7	26.3 12	5902.63	1 ⁻			
		6303.3	3.9 4	3736.69	3 ⁻			
10049.38	4 ⁻	1017.5	26.3 12	9031.9	4 ⁻			
		1861.6	1.17 12	8187.5	(3,4,5 ⁻)			
		2279.9	5.4 3	7769.4	(3,4,5 ⁻)			
		2810.2	1.7 3	7239.07	(3 ⁻ ,4,5 ⁻)			
		2935.5	32.0 9	7113.73	4 ⁻			
		3466.7	16.7 7	6582.47	3 ⁻			
		3764.0	2.88 21	6285.15	3 ⁻			
		4023.7	2.97 23	6025.47	2 ⁻			
		4435.6	2.17 21	5613.52	4 ⁻			
		5557.5	37.3 9	4491.43	5 ⁻			
		6312.2	100.0 21	3736.69	3 ⁻			
10262.53	3 ⁻	2639.3	3.9 6	7623.11	(2 ⁻ ,3,4 ⁺)			
		2796.1	43.3 25	7466.35	2 ⁺			
		2816.2	13.1 11	7446.23	3 ⁺ ,4 ⁺			
		3148.7	3.9 8	7113.1	1 ⁻			
		3679.8	11.4 8	6582.47	3 ⁻			
		4232.6	45 4	6029.71	3 ⁺			
		4359.7	7.5 11	5902.63	1 ⁻			
		4632.8	8.1 11	5629.41	2 ⁺			
		5013.4	10.0 11	5248.79	2 ⁺			

Adopted Levels, Gammas (continued)

$\gamma(^{40}\text{Ca})$ (continued)								
<u>E_i(level)</u>	<u>J_i^π</u>	<u>E_γ[†]</u>	<u>I_γ[‡]</u>	<u>E_f</u>	<u>J_f^π</u>	<u>Mult.[§]</u>	<u>δ[§]</u>	<u>Comments</u>
10262.53	3 ⁻	6357.6	100 3	3904.38	2 ⁺			
		6525.3	32 3	3736.69	3 ⁻			
10318.8	1 ⁺	2616.9	0.86 9	7701.8	0 ⁺			
		3368.2	0.50 9	6950.48	1 ⁻			
		4689.1	0.33 9	5629.41	2 ⁺			
		5106.8	0.93 7	5211.56	0 ⁺			
		6413.9	4.12 24	3904.38	2 ⁺	M1+E2	-0.16 3	Mult.,δ: D+Q from (p,γ), polarity from no level-parity change determined from other evidence.
		6965.5	14.4 5	3352.62	0 ⁺			
		10317.4	100.0 9	0.0	0 ⁺			
10415.06	3	2720.8	2.3 12	7694.08	3 ⁻			
		2791.8	96 3	7623.11	(2 ⁻ ,3,4 ⁺)			
		2853.8	6.5 6	7561.17	4 ⁺			
		2948.6	33.9 12	7466.35	2 ⁺			
		2968.7	100.0 23	7446.23	3 ⁺ ,4 ⁺			
		3137.1	5.1 8	7277.82	(2,3) ⁺			
		3301.2	9.0 10	7113.73	4 ⁻			
		3483.6	23.0 12	6931.29	3 ⁻			
		3506.2	90.2 23	6908.70	2 ⁺			
		3664.5	14.4 6	6750.41	2 ⁻			
		3832.3	7.7 8	6582.47	3 ⁻			
		3907.0	5.9 9	6507.87	4 ⁺			
		4129.7	2.1 5	6285.15	3 ⁻			
		4389.3	33.9 17	6025.47	2 ⁻			
		4785.3	4.7 9	5629.41	2 ⁺			
		4801.2	39.7 17	5613.52	4 ⁻			
		5135.9	15.5 12	5278.80	4 ⁺			
		5165.9	9.7 10	5248.79	2 ⁺			
		6510.1	20.1 17	3904.38	2 ⁺			
		6677.8	40.8 23	3736.69	3 ⁻			
10474	(8 ⁻)	1773		8701	(6 ⁻)			
10639.07	(3 ⁻ ,4,5 ⁻)	2504.2	3.1 5	8134.77	(3 ⁻)			
		3525.2	9.5 7	7113.73	4 ⁻			
		3707.6	100 3	6931.29	3 ⁻			
		4056.3	3.8 5	6582.47	3 ⁻			
		4096.1	6.89 24	6542.80	4 ⁺			
		4131.0	9.5 5	6507.87	4 ⁺			
		5025.2	32.3 14	5613.52	4 ⁻			
		5359.9	10.5 10	5278.80	4 ⁺			
		6147.1	8.6 7	4491.43	5 ⁻			
		6901.7	53.4 24	3736.69	3 ⁻			
10699.50	3	2325.5	2.0 3	8373.94	4 ⁺			

Adopted Levels, Gammas (continued)

$\gamma(^{40}\text{Ca})$ (continued)

<u>E_i(level)</u>	<u>J_i^{π}</u>	<u>E_{γ}[†]</u>	<u>I_{γ}[‡]</u>	<u>E_f</u>	<u>J_f^{π}</u>	<u>Mult.[§]</u>
10699.50	3	2607.8	1.40 18	8091.61	2 ⁺	
		3167.1	2.0 3	7532.26	2 ⁻	
		3233.0	1.8 4	7466.35	2 ⁺	
		3253.1	1.8 3	7446.23	3 ⁺ ,4 ⁺	
		3790.6	5.1 4	6908.70	2 ⁺	
		4156.5	3.9 4	6542.80	4 ⁺	
		4414.1	2.7 4	6285.15	3 ⁻	
		4669.5	7.4 6	6029.71	3 ⁺	
		5069.7	10.7 6	5629.41	2 ⁺	
		5085.6	3.9 4	5613.52	4 ⁻	
		5420.3	17.9 10	5278.80	4 ⁺	
		6794.5	100 3	3904.38	2 ⁺	
		6962.2	16 3	3736.69	3 ⁻	
10737.7	1 ⁻	3043.4	17 3	7694.08	3 ⁻	
		3828.8	8 3	6908.70	2 ⁺	
		4452.3	14.2 24	6285.15	3 ⁻	
		10736.2	100 6	0.0	0 ⁺	
10747.8	(4 ⁺)	5118.0	14.8 11	5629.41	2 ⁺	
		6842.8	100.0 12	3904.38	2 ⁺	
		7010.5	3.8 7	3736.69	3 ⁻	
10770.2	(1 ⁺)	3656.3	7.9 17	7113.1	1 ⁻	
		3861.3	14.3 17	6908.70	2 ⁺	
		5521.0	100 5	5248.79	2 ⁺	
		10768.6	76 5	0.0	0 ⁺	
10895	(9 ⁻)	1862		9033?	(7 ⁻)	(Q)
10910.0	(3,4,5 ⁻)	7172.6	100	3736.69	3 ⁻	
10921.1	(2 ⁺ ,3,4 ⁻)	4895.3	20	6025.47	2 ⁻	
		5641.9	100	5278.80	4 ⁺	
10956.0	3 ⁻	2768.2	11	8187.5	(3,4,5 ⁻)	
		3474.8	23	7481?		
		5053.0	23	5902.63	1 ⁻	
		5342.1	18	5613.52	4 ⁻	
		5676.8	100	5278.80	4 ⁺	
		7218.6	57	3736.69	3 ⁻	
10988.0	(3 ⁻ ,4 ⁺)	2010 [@]	12	8978	5 ⁺ ,6 ⁺ ,7 ⁺	
		4079.1	12	6908.70	2 ⁺	
		4702.6	25	6285.15	3 ⁻	
		5358.2	25	5629.41	2 ⁺	
		7083.0	100	3904.38	2 ⁺	
		7250.6	88	3736.69	3 ⁻	
10994.7	(2 ⁺ ,3,4 ⁺)	5715.5		5278.80	4 ⁺	

Adopted Levels, Gammas (continued)

$\gamma(^{40}\text{Ca})$ (continued)

<u>E_i(level)</u>	<u>J_i^{π}</u>	<u>E_{γ}[†]</u>	<u>I_{γ}[‡]</u>	<u>E_f</u>	<u>J_f^{π}</u>	<u>Mult.[§]</u>
10994.7	(2 ⁺ ,3,4 ⁺)	5745.3		5248.79	2 ⁺	
		7257.3		3736.69	3 ⁻	
11003.0	(10 ⁺)	1698		9305.2	(8 ⁺)	(Q)
		2902		8100.1	8 ⁺	(Q)
11011.0	3 ⁻	2672.9	27 7	8338.0	(2 ⁺ ,3,4)	
		3334.3	16 4	7676.6	(6 ⁺)	[E3]
		6519.0	100 7	4491.43	5 ⁻	[E2]
		7273.6	29	3736.69	3 ⁻	
		11009.4	14	0.0	0 ⁺	[E3]
11042.0	(1 ⁻ to 4 ⁺)	7136.9		3904.38	2 ⁺	
		7304.6		3736.69	3 ⁻	
11070.6	(3,4 ⁺)	5456.1	8	5613.52	4 ⁻	
		5790.7	15	5278.80	4 ⁺	
		5820.7	15	5248.79	2 ⁺	
		7164.9	100	3904.38	2 ⁺	
		7332.6	15	3736.69	3 ⁻	
11078.4	1 ⁻	11078		0.0	0 ⁺	
11685.8	(10 ⁺)	2381		9305.2	(8 ⁺)	(Q)
		3585		8100.1	8 ⁺	(Q)
11708.7	(9 ⁺)	2773		8935.8	(7 ⁺)	(Q)
11988	0 ⁺	1666.5 & 4	75 9	10318.8	1 ⁺	
		2119.5 4	100 9	9869.3	1 ⁺ ,2 ⁺	
12201.2	3 ⁻	12202		0.0	0 ⁺	[E3]
12331	2 ⁺	12332		0.0	0 ⁺	
12334.9	(10 ⁺)	2481		9853.5	(8 ⁺)	(Q)
		3030		9305.2	(8 ⁺)	(Q)
12591.9	(10 ⁺)	3287		9305.2	(8 ⁺)	(Q)
		4491		8100.1	8 ⁺	(Q)
12604		12602		0.0	0 ⁺	
12668	1 ⁻	9314		3352.62	0 ⁺	
		12666		0.0	0 ⁺	
12688		12686		0.0	0 ⁺	
12875		9521		3352.62	0 ⁺	
		12873		0.0	0 ⁺	
12923	(11 ⁻)	2028		10895	(9 ⁻)	
12980		12978		0.0	0 ⁺	
12996		9642		3352.62	0 ⁺	
13086		13084		0.0	0 ⁺	
13113		9759		3352.62	0 ⁺	
		13111		0.0	0 ⁺	
13115.1	(12 ⁺)	1429		11685.8	(10 ⁺)	(Q)

Adopted Levels, Gammas (continued)

$\gamma(^{40}\text{Ca})$ (continued)

<u>E_i(level)</u>	<u>J_i^{π}</u>	<u>E_{γ}^{$\dagger$}</u>	<u>E_f</u>	<u>J_f^{π}</u>	<u>Mult.^{$\S$}</u>	<u>Comments</u>
13115.1	(12 ⁺)	2112	11003.0	(10 ⁺)	(Q)	
13194		9840	3352.62	0 ⁺		
		13192	0.0	0 ⁺		
13195	(10 ⁻)	2300	10895	(9 ⁻)		
13203		13201	0.0	0 ⁺		
13289		9935	3352.62	0 ⁺		
		13287	0.0	0 ⁺		
13535.5	(11 ⁺)	1827	11708.7	(9 ⁺)	(Q)	
13822		13819	0.0	0 ⁺		
13913		10559	3352.62	0 ⁺		
		13910	0.0	0 ⁺		
13993		10639	3352.62	0 ⁺		
		13990	0.0	0 ⁺		
14232.4	(12 ⁺)	2547	11685.8	(10 ⁺)	(Q)	
		3229	11003.0	(10 ⁺)	(Q)	
15152.4	(13 ⁺)	1617	13535.5	(11 ⁺)	(Q)	
		2037	13115.1	(12 ⁺)	(D)	
15267.1	(12 ⁺)	2932	12334.9	(10 ⁺)	(Q)	
15306	(13 ⁻)	2383	12923	(11 ⁻)		
15748.1	(12 ⁺)	3156	12591.9	(10 ⁺)	(Q)	
16529.4	(14 ⁺)	2297	14232.4	(12 ⁺)	(Q)	
		3414	13115.1	(12 ⁺)	(Q)	
16579.7	(13 ⁺)	3044	13535.5	(11 ⁺)	(Q)	
17698.6	(14 ⁺)	3466	14232.4	(12 ⁺)	(Q)	
18054.6	(14 ⁺)	3822	14232.4	(12 ⁺)	(Q)	
18215?	(15 ⁻)	2909 [@]	15306	(13 ⁻)		
18260	1	18256	0.0	0 ⁺	D	Mult.: from $\gamma(\theta)$ in (p, γ).
18497.2	(14 ⁺)	3230	15267.1	(12 ⁺)	(Q)	
18680	1	18675	0.0	0 ⁺	D	
18719.2	(14 ⁺)	3452	15267.1	(12 ⁺)	(Q)	
19070	1	19065	0.0	0 ⁺	D	
19195.6	(15 ⁺)	4043	15152.4	(13 ⁺)	(Q)	
19450	1	19445	0.0	0 ⁺	D	
19850	1	19845	0.0	0 ⁺	D	
20130		20125	0.0	0 ⁺		
20430	1	20424	0.0	0 ⁺	D	
20578.6	(16 ⁺)	4049	16529.4	(14 ⁺)	(Q)	
20650	1	20644	0.0	0 ⁺	D	
20940	1	20934	0.0	0 ⁺	D	
21490		21484	0.0	0 ⁺		
21690		21684	0.0	0 ⁺		

Adopted Levels, Gammas (continued)

$\gamma(^{40}\text{Ca})$ (continued)

<u>E_i(level)</u>	<u>J_i^{π}</u>	<u>E_{γ}[†]</u>	<u>E_f</u>	<u>J_f^{π}</u>	<u>Mult.[§]</u>
22060		22053	0.0	0 ⁺	
22060.4	(16 ⁺)	3563	18497.2	(14 ⁺)	(Q)

[†] Values with uncertainties are averaged values from different γ -ray studies. A large number of values without uncertainties are from $^{39}\text{K}(\text{p},\gamma)$, which are from level-energy differences since most γ -ray energies are not available. In $^{39}\text{K}(\text{p},\gamma)$, many γ rays are shown with upper limits on intensities, these are not given here. See $^{39}\text{K}(\text{p},\gamma)$ for details.

[‡] Averaged values from different γ -ray studies if available, but most values are available only from $^{39}\text{K}(\text{p},\gamma)$.

[§] From $\gamma(\theta)$ in $(\text{HI},\text{xn}\gamma)$ and $(\text{p},\text{p}'\gamma)$, unless otherwise noted.

[&] Poor fit. Level-energy difference=1669.2.

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

Adopted Levels, Gammas

⁴⁰K β⁻ decay (1.248×10⁹ y) 1999BeZQ,1999BeZS

Parent: ⁴⁰K: E=0; Jπ=4⁻; T_{1/2}=1.248×10⁹ y 3; Q(β⁻)=1310.89 6; %β⁻ decay=89.28 11

⁴⁰K-Jπ, T_{1/2}: From Adopted Levels of ⁴⁰K.

⁴⁰K-Q(β⁻): From 2012Wa38.

⁴⁰K-%β⁻ decay: deduced by the present evaluator based on Iγ(1460γ)/Iβ⁻=0.1195 14, which is equal to I(ε to 1461 level)/Iβ⁻, and I(β⁺)/I(β⁻)=1.12×10⁻⁵ 14 from evaluation of 1973EnVA, and ε/β⁺(⁴⁰K to ⁴⁰Ar g.s.)=45.2 14 (3U theory), with all β⁺ decay proceeding to ⁴⁰Ar ground state. Previously evaluated value by 1999BeZQ,1999BeZS is 0.8914 13 based on the estimation of ε/β⁺=200 100 for the unique 3rd forbidden branch to the ⁴⁰Ar ground state.

Measurements: 2004Ko09, 2002Gr01, 2001No10, 1977Ce04, 1972Go21, 1967Mc10, 1966Fe09, 1965Le15, 1965Br25, 1962Fl05, 1962En01, 1960Sa31, 1960Eg01, 1959Ke26, 1957We43, 1956Mc20, 1955Ba25, 1955Ko21, 1955Su38, 1953Bu58, 1952Fe16, 1951Go29, 1951De34, 1950Sa52, 1949Ov01, 1948Ev09, 1947Gl07. This list is not complete, see 1978LeZA for several other references that are not present in NSR database.

The decay scheme, which includes the β⁻ decay to the ground state of ⁴⁰Ca and two levels in ⁴⁰Ar, is complete since these are the only levels in the daughter nuclides below the respective decay energies.

⁴⁰Ca Levels

<u>E(level)</u>	<u>Jπ</u>	<u>T_{1/2}</u>
0	0 ⁺	stable

β⁻ radiations

<u>E(decay)</u>	<u>E(level)</u>	<u>Iβ^{-†}</u>	<u>Log ft</u>	<u>Comments</u>
(1310.89 6)	0	89.28 13	20.75	Log ft: log f ^{3u} t from private communication from R. B. Firestone; see also 1970Wa11.

[†] For absolute intensity per 100 decays, multiply by 0.9999 12.

^{40}Sc ε decay (182.3 ms) 1982Ho09,1973De08

Parent: ^{40}Sc : $E=0$; $J\pi=4^-$; $T_{1/2}=182.3$ ms 7; $Q(\varepsilon)=14323.1$ 28; % ε +% β^+ decay=100

^{40}Sc - $J\pi$, $T_{1/2}$: From Adopted Levels of ^{40}Sc .

^{40}Sc - $Q(\varepsilon)$: From 2012Wa38.

1982Ho09: ^{40}Sc ions were produced by the $^{40}\text{Ca}(p,n)$ reaction with $E=20$ MeV proton beam provided by the University of Jyväskylä MC-20 cyclotron on a 1mg/cm^2 target of natural calcium. Charged-particles were detected with Si(Au) surface-barrier detector and γ rays were detected with a γ -ray detector. Measured β^+ delayed protons, β^+ delayed α particles, $E\gamma$, $p\gamma$ -coin, decay curve. Deduced levels, J , π , $T_{1/2}$, Γ_α/Γ_p .

1973De08: ^{40}Sc ions were produced by the (p,n) reaction on targets of natural calcium with $E=27$ MeV proton beam provided by the University Colorado cyclotron. γ rays were detected with a Ge(Li) detector. Measured $E\gamma$, $I\gamma$. Deduced levels.

^{40}Sc decays to ^{36}Ar by $\varepsilon\alpha$ (0.017% 5) and to ^{39}K by εp (0.44% 7) (1982Ho09).

Others:.

γ : 1971BIZH, 1968Ka08, 1966An01, 1965Ri06, 1955GI22.

β^+ : 1968Ar03, 1966An01.

$\beta^+\gamma$ coin: 1971BIZH.

εp : 1974Se11 (also 1973SeYM), 1969Ve04.

$T_{1/2}(^{40}\text{Sc})$: 1974Se11, 1973De08, 1972Mo08, 1969Ve04, 1968Ar03, 1966An01, 1962Sc08, 1955GI22, 1954Ty33.

 ^{40}Ca Levels

Quoted values of % p and % α in comments are % branchings per 100 parent decays in 1982Ho09.

<u>E(level)[†]</u>	<u>$J\pi^{\ddagger}$</u>	<u>E(p)(lab)[#]</u>	<u>Comments</u>
0	0 ⁺		
3735.8 8	3 ⁻		
4490.6 10	5 ⁻		
5613.1 10	4 ⁻		
6580 4	3 ⁻		
7658.3 10	4 ⁻		
9360 3	3 ⁻	1006 3	% $p=0.072$ 11, % $\alpha=8.2\text{E-}4$ 20. $E\alpha=2089$ 6. $\Gamma_\alpha/\Gamma_p=0.0119$ 5. E(level): weighted average of 9360 3 (from E(p)) and 9362 6 (from $E\alpha$).
9416 8	3 ⁻	1060 8	% $p=0.044$ 8.
9427 6	(3,4) ⁻	1071 6	% $p=0.055$ 10.
9452 3	3 ⁻	1095 @ 3	% $p=0.110$ 17.
9601 3	3 ⁻	1241 3	% $p=0.032$ 5.
9811 4	(3 ⁻ ,4 ⁻ ,5 ⁻)	1445 4	% $p=0.0088$ 15.
9829 8		1463 8	% $p=0.0026$ 7. E(level): probable doublet.
9920 3	(3 ⁻ ,4 ⁻ ,5 ⁻)	1552 3	% $p=0.0050$ 9.
9952 8	4 ⁺		% $\alpha=1.6\text{E-}4$ 10. $E\alpha=2620$ 8. $\Gamma_\alpha/\Gamma_p\geq 0.5$.
9979 5	(3,4,5)	1609 5	% $p=9\text{E-}4$ 5.
10050 4	4 ⁻	1678 4	% $p=0.0042$ 9.
10127 4	(3 ⁻ ,4 ⁺)	1752 4	% $p=0.0013$ 4, % $\alpha=1.9\text{E-}4$ 10. E(level): weighted average of 10126 4 (from E(p)) and 10129 8 (from $E\alpha$).
10154 8	(3 ⁻ ,4 ⁺ ,5 ⁻)		% $\alpha=3.2\text{E-}4$ 10. $E\alpha=2802$ 8. $\Gamma_\alpha/\Gamma_p\geq 2$.
10193 8	(3 ⁻ ,4 ⁺ ,5 ⁻)		% $\alpha=2.1\text{E-}4$ 10. $E\alpha=2837$ 8. $\Gamma_\alpha/\Gamma_p\geq 1$.
10211 4	(3,4) ⁻	1835 @ 4	% $p=0.0139$ 22.
10332 4	(3) ⁻	1953 4	% $p=4.6\text{E-}4$ 20.
10366 8		1986 8	% $p=3.0\text{E-}4$ 20.
10447 4	3 ⁻	2065 4	% $p=0.0028$ 5.

Continued on next page (footnotes at end of table)

^{40}Sc ε decay (182.3 ms) **1982Ho09,1973De08** (continued) ^{40}Ca Levels (continued)

E(level) [†]	J ^π [‡]	E(p)(lab) [#]	Comments
10470 [†] 4	(3,5) ⁻	2089 4	%p=0.0094 14, %α=7.8E-4 20. E(level): weighted average of 10471 4 (from E(p)) and 10465 7 (from Eα). Eα=3082 7. $\Gamma_{\alpha}/\Gamma_p \geq 1$.
10504 4	(3,4,5) ⁻	2121 4	%p=0.0125 19.
10519 7	(3 ⁻ ,4 ⁺ ,5 ⁻)		%α=8.3E-4 20. Eα=3132 7. $\Gamma_{\alpha}/\Gamma_p \geq 2$.
10582 5	(3,4,5)	2197 5	%p=0.0017 4.
10598 7	3 ⁻	2211 10	%p=3.5E-4 20, %α=6.9E-4 20. E(level): weighted average of 10596 10 (from E(p)) and 10599 7 (from Eα). Eα=3203 7. $\Gamma_{\alpha}/\Gamma_p = 2.0$ 7.
10693 5	3	2305 5	%p=8E-4 3.
10725 5	(3,5) ⁻		%α=0.0059 12. Eα=3316 5. $\Gamma_{\alpha}/\Gamma_p \geq 30$.
10754 8	(3,4,5)	2365 8	%p=9E-4 3.
10776 5	3 ⁻	2386 5	%p=0.0128 20.
10817 [†] 7	(3 ⁻ ,4 ⁺ ,5 ⁻)	2423 9	%p=8E-4 3, %α=4.2E-4 20. E(level): weighted average of 10814 9 (from E(p)) and 10819 7 (from Eα). Eα=3401 7. $\Gamma_{\alpha}/\Gamma_p \geq 0.5$.
10849 5	(3,4,5) ⁻	2457 5	%p=0.00380 20.
10909 5	(3,4,5 ⁻)	2516 5	%p=3.5E-4 20.
10956 8	3 ⁻	2562 8	%p=0.0020 4.
10973 7	(3,4,5)	2578 7	%p=0.0020 4.
10987 12	(3 ⁻ ,4 ⁺)		%α=1.1E-4 10. Eα=3552 12. $\Gamma_{\alpha}/\Gamma_p \geq 0.2$.
11037 7	(3,4,5)	2641 7	%p=6.9E-4 20.
11088 12	(3 ⁻ ,4 ⁺)		%α=1.0E-4 10. Eα=3643 12. $\Gamma_{\alpha}/\Gamma_p \geq 0.5$.
11114 6		2716 6	%p=0.0011 3. E(level): probably a doublet.
11142 6	(3,4,5) ⁻	2743 6	%p=0.0023 4.
11205 5	(3) ⁻		%α=0.0038 8. Eα=3748 5. $\Gamma_{\alpha}/\Gamma_p \geq 6$.
11217 5	3 ⁻	2816 [@] 5	%p=0.0068 11.
11312 [†] 5	(3 ⁻ ,4 ⁺ ,5 ⁻)	2912 5	%p=5.1E-4 20, %α=2.4E-4 10. E(level): weighted average of 11315 5 (from E(p)) and 11306 7 (from Eα). Eα=3839 7. $\Gamma_{\alpha}/\Gamma_p \geq 1$.
11418 7	4 ⁺	3012 7	%p=2.8E-4 20.
11452 9		3045 9	%p=8.3E-4 20. E(level),J ^π : probable doublet of natural-parity levels.
11472 7	(3 ⁻ ,4 ⁺ ,5 ⁻)		%α=3.6E-4 10. Eα=3988 7. $\Gamma_{\alpha}/\Gamma_p \geq 1$.
11549 6	(3,5) ⁻		%α=6.6E-4 20. Eα=4058 6. $\Gamma_{\alpha}/\Gamma_p \geq 6$.
11616 10	(3,4,5)	3205 10	%p=2.4E-4 10.
11663 7	(3 ⁻ ,4 ⁺ ,5 ⁻)		%α=2.3E-4 10. Eα=4160 7. $\Gamma_{\alpha}/\Gamma_p \geq 2$.
11724 [†] 4	(3,5) ⁻	3308 10	%p=7E-4 3, %α=9E-5 10. E(level): weighted average of 11723 4 (from E(p)) and 11727 7 (from Eα). Eα=4218 7. $\Gamma_{\alpha}/\Gamma_p \geq 0.2$.
11791 10	4	3376 10	%p=2.6E-4 20.
11841 6	(3 ⁻ ,4 ⁺ ,5 ⁻)		%α=2.8E-4 10. Eα=4320 6. $\Gamma_{\alpha}/\Gamma_p \geq 0.7$.
12001 7	(3,5) ⁻	3584 10	%p=1.0E-4 10, %α=5.0E-4 20. Eα=4462 7. $\Gamma_{\alpha}/\Gamma_p = 5$ 2.

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^{40}Sc ε decay (182.3 ms) [1982Ho09](#), [1973De08](#) (continued) ^{40}Ca Levels (continued)

E(level) [†]	J^π [‡]	E(p)(lab) [#]	Comments
12034 10	(3,4,5) ⁻	3613 10	%p=2.4E-4 10.
12066 9	(3,5) ⁻	3649 10	%p=1.2E-4 10, % α =1.6E-4 10. E α =4519 9. Γ_α/Γ_p =1.3 7.

[†] Assumed here as the same level populated in εp and $\varepsilon\alpha$ decays, although [1982Ho09](#) treated these as separate levels populated in the two decays.

[‡] From Adopted Levels, unless otherwise noted. In measurements of β^+ delayed particles, level energies are obtained from $E=S(p)(^{40}\text{Ca})+E(p)(\text{c.m.})$ for delayed proton decays; α -binding energy(^{40}Ca)+ $E\alpha(\text{c.m.})$ for delayed α decays.

$S(p)(^{40}\text{Ca})=8328.17$ 2, α -binding energy(^{40}Ca)=7039.76 3 ([2012Wa38](#)). All states above and including 9360 decay by protons to ^{39}K and/or α 's to ^{36}Ar g.s.

[#] From [1982Ho09](#).

@ Used for calibration ([1982Ho09](#)).

 ε, β^+ radiations

E(decay)	E(level)	$I\beta^+$ [‡]	$I\varepsilon$ [‡]	Log ft	$I(\varepsilon + \beta^+)$ ^{†‡}	Comments
(2257 9)	12066	0.00026 14	2.2×10^{-5} 12	5.7 3	0.00028 15	
(2289 10)	12034	0.00022 9	1.7×10^{-5} 7	5.8 2	0.00024 10	
(2322 8)	12001	0.00056 21	4.1×10^{-5} 15	5.4 2	0.00060 22	
(2482 7)	11841	0.00027 10	1.3×10^{-5} 5	5.9 2	0.00028 10	
(2532 10)	11791	0.00025 19	1.1×10^{-5} 9	6.0 4	0.00026 20	
(2599 5)	11724	0.0008 3	$3. \times 10^{-5}$ 1	5.6 2	0.00082 32	
(2660 8)	11663	0.00022 10	$8. \times 10^{-6}$ 3	6.2 2	0.00023 10	
(2707 10)	11616	0.00023 10	$8. \times 10^{-6}$ 3	6.3 2	0.00024 10	
(2774 7)	11549	0.00064 19	1.8×10^{-5} 6	5.9 2	0.00066 20	
(2851 8)	11472	0.00035 10	8.8×10^{-6} 25	6.3 1	0.00036 10	
(2871 9)	11452	0.00081 20	2.0×10^{-5} 5	5.9 1	0.00083 20	$I(\varepsilon + \beta^+)$: probably for a doublet.
(2905 8)	11418	0.00027 20	$6. \times 10^{-6}$ 4	6.4 4	0.00028 20	
(3011 6)	11312	0.0008 3	$2. \times 10^{-5}$ 1	6.1 2	0.00075 22	
(3106 6)	11217	0.0067 11	0.00011 2	5.2 1	0.0068 11	
(3118 6)	11205	0.0037 8	6.2×10^{-5} 13	5.5 1	0.0038 8	
(3181 7)	11142	0.0023 4	3.4×10^{-5} 6	5.8 1	0.0023 4	
(3209 7)	11114	0.0011 3	1.6×10^{-5} 4	6.1 1	0.0011 3	$I(\varepsilon + \beta^+)$: probably for a doublet.
(3235 12)	11088	0.00010 10	1.4×10^{-6} 14	7.2 5	0.00010 10	
(3286 8)	11037	0.00068 20	$9. \times 10^{-6}$ 3	6.4 2	0.00069 20	
(3336 12)	10987	0.00011 10	1.3×10^{-6} 12	7.2 4	0.00011 10	
(3350 8)	10973	0.0020 4	2.4×10^{-5} 5	6.0 1	0.0020 4	
(3367 8)	10956	0.0020 4	2.3×10^{-5} 5	6.0 1	0.0020 4	
(3414 6)	10909	0.00035 20	3.8×10^{-6} 22	6.8 3	0.00035 20	
(3474 6)	10849	0.0038 20	3.9×10^{-5} 20	5.8 2	0.0038 20	
(3506 8)	10817	0.0012 3	1.2×10^{-5} 3	6.3 1	0.0012 3	
(3547 6)	10776	0.0127 20	0.000119 19	5.3 1	0.0128 20	
(3569 8)	10754	0.0009 3	$8. \times 10^{-6}$ 3	6.5 2	0.0009 3	
(3598 6)	10725	0.0058 12	5.2×10^{-5} 11	5.7 1	0.0059 12	
(3630 6)	10693	0.0008 3	$7. \times 10^{-6}$ 3	6.6 27	0.0008 3	
(3725 8)	10598	0.0010 3	7.6×10^{-6} 23	6.5 1	0.0010 3	
(3741 6)	10582	0.0017 4	1.3×10^{-5} 3	6.3 1	0.0017 4	
(3804 8)	10519	0.00082 20	5.8×10^{-6} 14	6.7 1	0.00083 20	
(3819 5)	10504	0.0124 19	8.6×10^{-5} 13	5.5 1	0.0125 19	
(3853 5)	10470	0.0101 14	6.8×10^{-5} 9	5.6 1	0.0102 14	
(3876 5)	10447	0.0028 5	1.8×10^{-5} 3	6.2 1	0.0028 5	

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^{40}Sc ε decay (182.3 ms) [1982Ho09,1973De08](#) (continued) ε, β^+ radiations (continued)

E(decay)	E(level)	$I\beta^+{}^\dagger$	$I\varepsilon^\ddagger$	Log ft	$I(\varepsilon + \beta^+)^\dagger$	Comments
(3957 8)	10366	0.00030 20	1.8×10^{-6} 12	7.2 3	0.00030 20	
(3991 5)	10332	0.00046 20	2.6×10^{-6} 12	7.1 2	0.00046 20	
(4112 5)	10211	0.0138 22	7.1×10^{-5} 11	5.7 1	0.0139 22	
(4130 8)	10193	0.00021 10	1.1×10^{-6} 5	7.5 2	0.00021 10	
(4169 8)	10154	0.00032 10	1.5×10^{-6} 5	7.3 2	0.00032 10	
(4196 5)	10127	0.0015 4	7.1×10^{-6} 19	6.7 1	0.0015 4	
(4273 5)	10050	0.0042 9	1.8×10^{-5} 4	6.3 1	0.0042 9	
(4344 6)	9979	0.0009 5	$4. \times 10^{-6}$ 2	7.0 3	0.0009 5	
(4371 8)	9952	0.00016 10	$6. \times 10^{-7}$ 4	7.8 3	0.00016 10	
(4403 4)	9920	0.0050 9	2.0×10^{-5} 4	6.3 1	0.0050 9	
(4494 8)	9829	0.0026 7	9.4×10^{-6} 25	6.6 1	0.0026 7	$I(\varepsilon + \beta^+)$: probably for a doublet.
(4512 5)	9811	0.0088 15	3.1×10^{-5} 5	6.1 1	0.0088 15	
(4722 4)	9601	0.032 5	9.6×10^{-5} 15	5.7 1	0.032 5	
(4871 4)	9452	0.110 17	0.00029 5	5.2 1	0.110 17	
(4896 7)	9427	0.055 10	0.00014 3	5.5 1	0.055 10	
(4907 8)	9416	0.044 8	0.00011 2	5.6 1	0.044 8	
(4963 4)	9360	0.073 11	0.00018 3	5.4 1	0.073 11	
6.75×10^3 15	7658.3	49 4	0.042 3	3.31 4	49 4	$E\varepsilon$: $E(\beta^+)=5730$ 150 (1968Ar03). $I\beta^+$: 50 1 (1968Ar03).
(7743 5)	6580	2.1 10	0.0011 5	5.0 2	2.1 10	
8.55×10^3 20	5613.1	12 3	0.0041 10	4.6 1	12 3	$E\varepsilon$: $E(\beta^+)=7530$ 200 (1968Ar03). $I\beta^+$: 15% 1 (1968Ar03).
9.78×10^3 10	4490.6	17 5	0.0039 11	4.7 1	17 5	$E\varepsilon$: $E(\beta^+)=8760$ 100 (1968Ar03). $I\beta^+$: 15% 1 (1968Ar03).
1.060×10^4 4	3735.8	19 5	0.0034 9	4.8 1	19 5	$E\varepsilon$: $E(\beta^+)=9580$ 40 (1968Ar03). $I\beta^+$: 20% 1 (1968Ar03).

[†] From γ -ray intensity imbalance at each level or total branching of proton and alpha decays measured for each level in [1982Ho09](#).[‡] Absolute intensity per 100 decays. $\gamma(^{40}\text{Ca})$ I γ normalization: % $\varepsilon\alpha$ =0.017 5, % εp =0.44 7 ([1982Ho09](#)).

$E_\gamma^\dagger$	$I_\gamma^{\ddagger\S}$	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Mult. [‡]	$\delta^\ddagger$
755.6 8	41 4	4490.6	5 ⁻	3735.8	3 ⁻		
1126 3	12 2	5613.1	4 ⁻	4490.6	5 ⁻	M1+E2	-0.7 2
1877.8 7	25.0 15	5613.1	4 ⁻	3735.8	3 ⁻	M1+E2	-0.27 5
2045.8 7	25.5 15	7658.3	4 ⁻	5613.1	4 ⁻		
2844 3	2.1 10	6580	3 ⁻	3735.8	3 ⁻	M1+E2	+3.1 19
3167.9 7	12 2	7658.3	4 ⁻	4490.6	5 ⁻		
3735.6 8	100	3735.8	3 ⁻	0	0 ⁺	E3	
3920.0 10	13 2	7658.3	4 ⁻	3735.8	3 ⁻		

[†] From [1973De08](#).[‡] From Adopted Gammas.[§] For absolute intensity per 100 decays, multiply by 0.9954 10.

^{40}Sc ε decay (182.3 ms) 1982Ho09,1973De08

Decay Scheme

Intensities: $I_{(\gamma+ce)}$ per 100 parent decays

Legend

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

4^{-} 0 182.3 ms 7
 $Q^{+}=14323.1\ 28$
 $^{40}_{21}\text{Sc}_{19}$

		$I\beta^{+}$	$I\varepsilon$	$\text{Log } ft$
$(3,5)^{-}$	12066	0.00026	0.000022	5.7
$(3,4,5)^{-}$	12034	0.00022	0.000017	5.8
$(3,5)^{-}$	12001	0.00056	0.000041	5.4
$(3^{-},4^{+},5^{-})$	11841	0.00027	0.000013	5.9
4	11791	0.00025	0.000011	6.0
$(3,5)^{-}$	11724	0.0008	0.00003	5.6
$(3^{-},4^{+},5^{-})$	11663	0.00022	$8. \times 10^{-6}$	6.2
$(3,4,5)$	11616	0.00023	$8. \times 10^{-6}$	6.3
$(3,5)^{-}$	11549	0.00064	0.000018	5.9
$(3^{-},4^{+},5^{-})$	11472	0.00035	8.8×10^{-6}	6.3
	11452	0.00081	0.000020	5.9
4 ⁺	11418	0.00027	$6. \times 10^{-6}$	6.4
$(3^{-},4^{+},5^{-})$	11312	0.0008	0.00002	6.1
3 ⁻	11217	0.0067	0.00011	5.2
$(3)^{-}$	11205	0.0037	0.000062	5.5
$(3,4,5)^{-}$	11142	0.0023	0.000034	5.8
	11114	0.0011	0.000016	6.1
$(3^{-},4^{+})$	11088	0.00010	1.4×10^{-6}	7.2
$(3,4,5)$	11037	0.00068	$9. \times 10^{-6}$	6.4
$(3^{-},4^{+})$	10987	0.00011	1.3×10^{-6}	7.2
$(3,4,5)$	10973	0.0020	0.000024	6.0
3 ⁻	10956	0.0020	0.000023	6.0
$(3,4,5)^{-}$	10909	0.00035	3.8×10^{-6}	6.8
$(3,4,5)^{-}$	10849	0.0038	0.000039	5.8
$(3^{-},4^{+},5^{-})$	10817	0.0012	0.000012	6.3
3 ⁻	10776	0.0127	0.000119	5.3
$(3,4,5)$	10754	0.0009	$8. \times 10^{-6}$	6.5
$(3,5)^{-}$	10725	0.0058	0.000052	5.7
3	10693	0.0008	$7. \times 10^{-6}$	6.6
3 ⁻	10598	0.0010	7.6×10^{-6}	6.5
$(3,4,5)$	10582	0.0017	0.000013	6.3
$(3^{-},4^{+},5^{-})$	10519	0.00082	5.8×10^{-6}	6.7
$(3,4,5)^{-}$	10504	0.0124	0.000086	5.5
$(3,5)^{-}$	10470	0.0101	0.000068	5.6
3 ⁻	10447	0.0028	0.000018	6.2
	10366	0.00030	1.8×10^{-6}	7.2
$(3)^{-}$	10332	0.00046	2.6×10^{-6}	7.1
$(3,4)^{-}$	10211	0.0138	0.000071	5.7
$(3^{-},4^{+},5^{-})$	10193	0.00021	1.1×10^{-6}	7.5
$(3^{-},4^{+},5^{-})$	10154	0.00032	1.5×10^{-6}	7.3
$(3^{-},4^{+})$	10127	0.0015	7.1×10^{-6}	6.7
4 ⁻	10050	0.0042	0.000018	6.3

 $^{40}_{20}\text{Ca}_{20}$

^{40}Sc ε decay (182.3 ms) 1982Ho09,1973De08

Decay Scheme (continued)

Intensities: $I_{(\gamma+e)}$ per 100 parent decays

Legend

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

$\% \varepsilon + \% \beta^+ = 100$ $\xrightarrow{4^- \quad 0 \quad 182.3 \text{ ms } 7}$
 $Q^+ = 14323.1 \text{ 28}$
 $^{40}_{21}\text{Sc}_{19}$

^{41}Ti ϵp decay (80.4 ms) [1997Ho12](#),[1998Li46](#),[1998Bh12](#)

Parent: ^{41}Ti : $E=0$; $J\pi=3/2^+$; $T_{1/2}=80.4$ ms 9; $Q(\epsilon\text{p})=11860$ 28; % ϵp decay $\approx$ 100

^{41}Ti - $J\pi$, $T_{1/2}$: From Adopted Levels of ^{41}Ti .

^{41}Ti - $Q(\epsilon\text{p})$: From [2012Wa38](#).

^{41}Ti decays to ^{40}Ca by ϵp ($\approx$ 100%).

[1997Ho12](#): ^{41}Ti ions were produced by fusion reaction of $E=40\text{MeV}$ ^3He beam on a 5 mg/cm^2 natural calcium target at the IGISOL facility. Reaction products were mass-separated and implanted into $30\text{ }\mu\text{g/cm}^2$ carbon foil. Charged particles were detected with a telescope (FWHM $<30\text{ keV}$) of a gaseous ΔE detector (proportional counter) and a E detector (silicon surface-barrier detector). Another setup consisted of a plastic scintillator for beta detection, an ion-implanted silicon detector for beta and proton, a HPGe detector for γ rays. Measured $E(\text{p})$, $I(\text{p})$, $\text{p}\gamma$ -coin, $\text{p}\beta$ -coin. Deduced levels. Report 6 proton groups from ^{41}Ti decay.

[1998Li46](#): ^{41}Ti ions were produced by fragmentation of $E=500\text{ MeV/nucleon}$ ^{58}Ni beam from the heavy-ion synchrotron SIS of GSI on a 4 g/cm^2 ^9Be target. Fragments were separated by the FRS separator, identified by energy loss in an ionization chamber (MUSIC) and mass-to-charge ratio from the time-of-flight (TOF) and the magnetic rigidity of the FRS and implanted into a stack of silicon detectors for detecting β -delayed protons; γ rays were detected with an array of 14 large-volume Crystal Ball NaI detectors. Measured $E(\text{p})$, $I(\text{p})$, $\text{p}\gamma$ -coin, decay-time distribution. Deduced levels, parent $T_{1/2}$. Report 37 proton groups from ^{41}Ti decay.

[1998Bh12](#): ^{41}Ti ions were produced at GANIL by fragmentation of a 82.6 MeV/nucleon ^{50}Cr beam on a 272.4 mg/cm^2 nickel target. Fragments were separated and selected by the LISE3 spectrometer and then implanted into a stack of five Si surface-barrier detectors. γ rays were detected with five HPGe detectors. Measured $E(\text{p})$, $I(\text{p})$, $E\gamma$, $I\gamma$, $\text{p}\gamma$ -coin, $\text{p}\beta$ -coin, decay time distribution. Deduced levels, ^{41}Ti half-life. Report 29 proton groups from ^{41}Ti decay.

Other main references for measurement of $E(\text{p})$, $I(\text{p})$ from ^{41}Ti decay: [1985Zh05](#) (6 proton groups), [1974Se11](#) (17 proton groups), [1966Po12](#) (17 proton groups), [1964Re08](#) (6 proton groups).

Others: [2015Sh16](#), [1998Jo20](#), [1977Ce05](#), [1976Sz04](#), [1973Ha77](#), [1973Go06](#).

 ^{40}Ca Levels

$E(\text{level})^\dagger$	$J\pi^\ddagger$	Comments
0	0^+	
3353	0^+	
3737	3^-	
3904	2^+	$E(\text{level})$: from 1997Ho12 .

† Rounded values from Adopted Levels.

‡ From Adopted Levels.

Delayed Protons (^{40}Ca)

$E(\text{p})^\dagger$	$E(^{40}\text{Ca})$	$I(\text{p})^\ddagger\#$	$E(^{41}\text{Sc})^\S$	$E(\text{p})^\dagger$	$E(^{40}\text{Ca})$	$I(\text{p})^\ddagger\#$	$E(^{41}\text{Sc})^\S$
754 12	3904	0.29 13	5774	2804 8	0	0.89 20	3960
986 2	0	5.6 9	2095	3083 4	0	15.8 5	4246
1249 & a 15	3737	1.05 19	6102	3152 19	0	0.80 13	4317
1249 & a 15	3904	1.05 19	6270	3343 10	0	0.60 7	4512
1542 2	0	4.2 13	2666	3483 9	0	0.65 7	4656
1587 10	0	0.48 23	2712	3600 5	0	2.15 25	4776
1857 28	3904	0.8 3	6893	3691 4	0	3.7 5	4869
1977 & a 10	3353	0.56 14	6465	3749 5	0	7.4 5	4929
1977 & a 10	3904	0.56 14	7021	3832 8	0	0.62 5	5014
2063 @ a 30	3737	1.1 2	6938	3890 17	0	0.43 8	5073
2271 3	0	5.0 7	3413	4187 4	0	3.72 12	5378
2414 3	0	3.4 3	3560	4307 11	0	0.34 10	5501
2.54×10^3 a 13	0	0.62 12	3690	4385 6	0	1.69 12	5581
2656 7	0	1.5 3	3808	4570 7	0	0.88 13	5767

Continued on next page (footnotes at end of table)

^{41}Ti ε p decay (80.4 ms) [1997Ho12](#), [1998Li46](#), [1998Bh12](#) (continued)

Delayed Protons (continued)

$E(p)^{\dagger}$	$E(^{40}\text{Ca})$	$I(p)^{\ddagger\#}$	$E(^{41}\text{Sc})^{\S}$	$E(p)^{\dagger}$	$E(^{40}\text{Ca})$	$I(p)^{\ddagger\#}$	$E(^{41}\text{Sc})^{\S}$
4638 4	0	5.3 4	5840	5441 40	0	0.60 12	6673
4683 10	0	1.06 16	5886	5601 15	0	0.065 7	6827
4735 3	0	25.0 10	5940	5718 14	0	0.094 8	6947
4829 10	0	0.8 3	6036	5790 ^a 27	0	0.56 14	7021
4876 15	0	0.84 9	6084	5947 19	0	0.102 10	7182
4944 11	0	0.76 13	6154	6121 19	0	0.072 7	7360
5157 14	0	0.40 11	6372	6371 38	0	0.050 15	7617
5219 40	0	0.65 12	6435	6650 50	0	0.050 5	7903
5337 ^a 23	0	0.37 20	6557	6725 60	0	0.07 2	7980

[†] $E(p)(\text{lab})$ values are from a weighted average of [1998Bh12](#), [1998Li46](#), [1997Ho12](#) and [1974Se11](#), except where noted.

[‡] From weighted averages of [1998Li46](#), [1998Bh12](#), [1997Ho12](#), [1985Zh05](#), and [1974Se11](#).

[§] From ^{41}Ti ε decay (80.4 ms).

& 1249 and 1977 proton groups are doubly placed.

@ This group is not reported by [1997Ho12](#).

Absolute intensity per 100 decays.

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

⁴¹Ti εp decay (80.4 ms) 1997Ho12,1998Li46,1998Bh12

Decay Scheme

^{41}Ti ϵp decay (80.4 ms) 1997Ho12,1998Li46,1998Bh12

Decay Scheme (continued)

^{43}Cr $\beta^+3\text{p}$ decay (21.2 ms) 2012Au08

Parent: ^{43}Cr : $E=0$; $J\pi=(3/2^+)$; $T_{1/2}=21.2$ ms 7; $Q(\beta^+3\text{p})=10679$ SY; $\%\beta^+3\text{p}$ decay=0.18 13

^{43}Cr - $Q(\beta^+3\text{p})$: 10679 400 (syst), deduced by compiler from mass excesses of ^{43}Cr , ^{40}Ca and proton in 2012Wa38.

^{43}Cr - $J\pi, T_{1/2}$: From Adopted Levels of ^{43}Cr .

^{43}Cr - $\%\beta^+3\text{p}$ decay: From $\%\beta^+3\text{p}=0.13$ +18-8 deduced by 2012Au08 from relative $\beta^+3\text{p}$ branching of 0.14% +19-9 (2012Au08) and total proton branching of 91.0% 23, weighted average of 92.5% 28 (2007Do17) and 88% 4 (2011Po01).

2012Au08: ^{43}Cr nuclei were produced in the reaction $\text{Ni}(^{58}\text{Ni}, \text{X})$ at the LISE3 separator at GANIL. ^{43}Cr ions were separated, identified and then implanted onto the time projection chamber (TPC). Charged particles were detected in a two-dimensional strip detector combined with drift-time analysis to reconstruct the tracks of the particles in three dimensions. Characterization of the TCP was done with the β^+p decay of ^{52}Ni with reference to proton energies and branching ratios. Measured energy loss, decay event counts, angular correlation between two protons. Deduced branching ratio. Recorded events in this study: 180 events for ^{43}Cr $\beta^+2\text{p}$ emission, and three events for $\beta^+3\text{p}$ emission.

 ^{40}Ca Levels

<u>E(level)</u>	<u>$J\pi$</u>
0	0^+

⁴⁴V εα decay (111 ms) 1971Ce02

Parent: ⁴⁴V: E=0; T_{1/2}=111 ms 7; Q(εα)=8.30×10³ 18; %εα decay=?

⁴⁴V-T_{1/2}: From Adopted Levels of ⁴⁴V. 90 ms 25 from 1971Ce02.

⁴⁴V-Q(εα): From 2012Wa38.

1971Ce02: measured T_{1/2}, β-delayed α-spectra.

⁴⁰Ca Levels

<u>E(level)</u>	<u>J^π</u>
0	0 ⁺

Delayed Alphas (⁴⁰Ca)

<u>E(α)</u>	<u>E(⁴⁰Ca)</u>	<u>E(⁴⁴Ti)</u>	<u>Comments</u>
2.77×10 ³ 20	0	8.18E+3	E(α): from measured c.m energy=3050 200 (1971Ce02).

⁴⁴V εα decay (111 ms) 1971Ce02

Decay Scheme

Inelastic scattering

Includes elastic scattering: (HI,HI).

HI= ^6Li , ^7Li , ^9Be , ^{10}B , ^{11}B , ^{12}C , ^{13}C , ^{14}C , ^{14}N , ^{16}O , ^{17}O , ^{18}O , ^{20}Ne , ^{28}Si , ^{32}S , ^{37}Cl , ^{40}Ar , ^{40}Ca , ^{48}Ca , ^{86}Kr .

(^6Li , $^6\text{Li}'$):.

2010Kr06: E=240 MeV. Measured $\sigma(\theta)$, double-folding model analysis, deduced B(E3) for 3737 level.

1982Co12: E=30 MeV. Measured $\sigma(\theta)$, $\theta(\text{cm})=9^\circ - 78^\circ$; DWBA double-folding model analysis, deduced deformation lengths.

Levels at 0, 3740, 3900, 4490.

1977Bo21: E=30 MeV. Measured $\sigma(\theta)$, coupled-channel analysis, Hauser-Feshbach calculations.

1987Va31: E=34 MeV. Also $^6\text{Li}(^{40}\text{Ca}, ^{40}\text{Ca}')$ E=227 MeV. Measured $\sigma(\theta)$, DWBA analysis.

(^6Li , ^6Li):.

1989Na02: E=210 MeV. Measured $\sigma(\theta)$.

1980An16: E=28, 32 MeV.

1981Fu04: E=88 MeV. DWBA and coupled-channel analysis.

1981Sc16: E=99 MeV. Measured $\sigma(\theta)$, optical-model analysis.

1977Cu02: E=28, 34 MeV. Deduced optical-model parameters; $\sigma(\theta)$.

1976Ch27: E=50.6 MeV. Measured $\sigma(\theta)$.

1971Da33: E=30 MeV. Measured $\sigma(\theta)$.

1969Be90: E=20 MeV. Measured $\sigma(\theta)$.

(^7Li , $^7\text{Li}'$):.

1985Sa25: E=34 MeV. Measured $\sigma(\theta)$, $\theta(\text{cm})=10^\circ - 135^\circ$; DWBA coupled-channel analysis. Levels at 3740, 3900, 4490, 6290.

1982Ec01: E=45 MeV. Measured $\sigma(\theta)$, $\theta(\text{cm})=12^\circ - 80^\circ$; double folding model.

(^7Li , ^7Li):.

1980CuZZ, 1977Cu02: E=28, 34 MeV. Deduced optical-model parameters from $\sigma(\theta)$.

1969Be90: E=20 MeV. Measured $\sigma(\theta)$.

(^9Be , $^9\text{Be}'$):.

1980Ec04: E=45, 60 MeV. Measured $\sigma(\theta)$; DWBA analysis for 3^- , 5^- levels; double folding model. Levels at 3730, 3900, 4490, 5900, 6400, 6940, 7300.

(^9Be , ^9Be):.

1980Ec01: E=45, 60 MeV. Measured $\sigma(\theta)$.

1983Ec01: E=35-60 MeV. Measured $\sigma(\theta)$.

1984Fu10: E=158 MeV. Measured $\sigma(\theta)$.

1985Wi18: E=30, 45 MeV. Measured $\sigma(\theta)$.

(^{10}B , ^{10}B):.

1983BoZU: E=31 MeV. Measured $\sigma(\theta)$.

1981GIZY, 1980GI03: E=46.6 MeV. Measured $\sigma(\theta)$.

(^{11}B , $^{11}\text{B}'$):.

1981Hn01: E=51.5 MeV. Measured $\sigma(\theta)$, $\theta(\text{cm})=10^\circ - 60^\circ$; DWBA coupled-channel, double-folding model analysis. Levels at 3740, 3900, 4490. Deduced deformation lengths.

1981Hn04: E=40 MeV. Measured $\sigma(\theta)$, DWBA analysis; deduced deformation lengths.

(^{11}B , ^{11}B):.

1983BoZU: E=32, 68 MeV. Measured $\sigma(\theta)$.

1981GIZY, 1980GI03: E=51.5 MeV. Measured $\sigma(\theta)$.

1980Ma31: E=32 MeV. Measured $\sigma(\theta)$, DWBA analysis.

(^{12}C , $^{12}\text{C}'$):.

1981Bu08: E=1032 MeV. Measured $\sigma(\theta)$, $\theta=4^\circ - 16^\circ$. Data for g.s.

1986Sa29: E=10-35 MeV. Measured $\sigma(\theta)$.

1980Ku03, 1979Ku02: $^{12}\text{C}(^{40}\text{Ca}, ^{40}\text{Ca})$ E=18-40 MeV; 80-178 MeV. Measured $\sigma(\theta)$.

1978Re06, 1979Re03: E=135-150 MeV; 51 MeV. Measured σ at 180° . Optical-model analysis.

Inelastic scattering (continued)

1976MoYU: E=45 MeV. Measured $\sigma(\theta)$.

1972Sc21: E=114 MeV.

($^{13}\text{C}, ^{13}\text{C}'$):.

1977Bo17: E=68 MeV. Measured $\sigma(\theta)$, $\theta=8^\circ - 40^\circ$; CCBA analysis; levels at 3740, 3900, 4490. Deduced deformation lengths relative to those from (p,p'), normalized to 1.0 for 3900 level.

($^{14}\text{C}, ^{14}\text{C}'$):.

1981Ha23: E=51 MeV. Measured $\sigma(\theta)$; $\theta(\text{cm})=13^\circ - 53^\circ$; DWBA and CCBA analysis. Levels at 3740, 3900, 4480.

($^{14}\text{N}, ^{14}\text{N}'$):.

1978Bu10: E=161 MeV. Measured $\sigma(\theta)$, $\theta(\text{cm})=12^\circ$. Levels at 6900 and 7900. Deduced giant resonances.

1975Wi02: ($^{14}\text{N}, ^{14}\text{N}$) E=24-54 MeV. Measured $\sigma(\theta)$.

($^{16}\text{O}, ^{16}\text{O}'$):.

1982Re03, 1978Re02: E=60 MeV. Measured $\sigma(\theta)$, $\theta(\text{cm})=10^\circ - 65^\circ$; energy uncertainty ≈ 100 keV; DWBA fits with coupled channels analysis. Levels at 3740, 3900, 4490.

1981Al12: E=51.5, 54 MeV. Measured $\sigma(\theta)$.

1981Ku10: E=50-70 MeV. Measured $\sigma(\theta)$, coupled-channel analysis.

1973Be13: E=60 MeV. Measured $\sigma(\theta)$.

($^{16}\text{O}, ^{16}\text{O}$):.

1985Me14: E=1503 MeV.

1988Ro01: E=94 MeV. Measured $\sigma(\theta)$.

1979Vi13: E=40-214 MeV. Measured fusion σ .

1979Ku02: E=50 MeV. Also $^{16}\text{O}(^{40}\text{Ca}, ^{40}\text{Ca})$ E=80-178 MeV. Measured $\sigma(\theta)$.

1973Ch10: E=47, 49 MeV.

1972Gr25: E=25-45 MeV. Measured $\sigma(\theta)$.

1971Be26: E=20-40 MeV. Measured $\sigma(\theta)$.

1971Or02: E=36-48 MeV. Measured $\sigma(\theta)$.

1969Ec01: E=23-42 MeV. Measured $\sigma(\theta)$.

($^{17}\text{O}, ^{17}\text{O}'$):.

1989AlZQ: E=1428 MeV. Measured σ , $\theta(\text{cm})=\text{small}$. Energy uncertainty < 400 keV. Levels at 3740, 3900, 4490.

($^{18}\text{O}, ^{18}\text{O}'$):.

1982Re14, 1982Re03: E=62.14 MeV. Measured $\sigma(\theta)$, $\theta(\text{cm})=10^\circ - 65^\circ$; DWBA fits with coupled channels in ^{40}Ca and ^{18}O . Levels at 3740, 3900, 4490. Deduced deformation lengths.

1972Ei07: ($^{18}\text{O}, ^{18}\text{O}$) E=25-42 MeV. Measured $\sigma(\theta)$.

($^{20}\text{Ne}, ^{20}\text{Ne}'$):.

1978Ng01: E=36-95 MeV. Measured $\sigma(\theta)$; optical-model, DWBA, coupled-channel analysis.

1980Se06: ($^{20}\text{Ne}, ^{20}\text{Ne}$) E=151 MeV. Measured $\sigma(\theta)$, optical-model parameters.

($^{28}\text{Si}, ^{28}\text{Si}'$):.

1986Vi02: E=225 MeV. Measured $\sigma(\theta)$, $\theta(\text{cm})=4^\circ - 30^\circ$; DWBA analysis; energy uncertainty ≈ 400 keV. Unresolved doublet: 3740+3900. Deduced deformation length.

($^{32}\text{S}, ^{32}\text{S}'$):.

1986Bi02: E=100, 120, 151.5 MeV. Measured $\sigma(\theta)$; folding model analysis for 3740 level.

1975Re17: E=100 MeV. Measured $\sigma(\theta)$ for $\theta=20^\circ - 60^\circ$; DWBA analysis for 3900 level.

($^{32}\text{S}, ^{32}\text{S}$):.

1988Bi06: E=90, 100, 110, 120, 151.5 MeV. Measured $\sigma(\theta)$, folding-model analysis.

1984Ba27: E=100, 120, 151.5 MeV. Measured $\sigma(\theta)$; optical-model analysis.

Inelastic scattering (continued)

[1989Di06](#): E=90, 110 MeV. Measured $\sigma(\theta)$.

[1977Ri03](#): E=58-130 MeV. Measured $\sigma(\theta)$.

(³⁷Cl,³⁷Cl'):

[1997Wi17](#): E=97.3, 115.3 MeV. Measured $\sigma(\theta)$.

[1990Fe03](#): (³⁷Cl,³⁷Cl) E=120.5 MeV. Measured $\sigma(\theta)$; folding model and DWBA analysis.

(⁴⁰Ar,⁴⁰Ar'):

[1987Fr20](#): E=1760 MeV. Measured σ , $\theta(\text{lab})=2.5^\circ$. Giant resonances at 8000 and 18000.

[1978Wa18](#), [1979Wa06](#): (⁴⁰Ar,⁴⁰Ar) E=191, 236, 272 MeV. Measured $\sigma(\theta)$, optical-model parameters.

(⁴⁰Ca,⁴⁰Ca'):

[1982Bi04](#): E=160, 280, 400 MeV. Measured $\sigma(\theta)$, DWBA analysis; FWHM=1.5 MeV. Levels and giant resonances at 3740, 7800, 10700, 14000, 17600, 26000. See also [1981Ro01](#), [1980Fr02](#), [1979Tr10](#), [1977Fr14](#) from the same group where ⁴⁰Ca(⁴⁰Ca,X) reaction was studied at E(⁴⁰Ca)=284 and 400 MeV.

[2004Sc07](#), [1993Sc29](#): E=50 MeV/nucleon. Measured (⁴⁰Ca)(p) coin; deduced two-phonon double GQR and multi-phonon giant resonance features.

(⁴⁰Ca,⁴⁰Ca):

[1977Do02](#): E=55-120 MeV. Measured $\sigma(\theta)$.

[1977Ri03](#): E=58-130 MeV. Measured $\sigma(\theta)$.

[1975Do07](#): (⁴⁰Ca,⁴⁰Ca) E=110-150, 170-200 MeV. Measured σ .

(⁴⁸Ca,⁴⁸Ca):

[1990Ti04](#): E=132, 140 MeV. Measured $\sigma(\theta)$, coupled-channel analysis.

(⁸⁶Kr,⁸⁶Kr'):

[1999O102](#): E=5160 MeV. Measured $\sigma(\theta)$, $\theta=1^\circ - 6^\circ$; fitted elastic and inelastic channels from 13-25 MeV excitation. Energy uncertainty=1400 keV. Deduced E1 and E2 strength distributions.

⁴⁰Ca Levels

E(level)	J $\pi^\dagger$	L $^\#$	Comments
0	0 ⁺	0	
3740	3 ⁻	3	B(E3)=0.0164 17 (same for 3 sets), 0.0171 17 (same for 2 sets), 0.0179 18, 0.0197 20, with different optical model parameter sets (2010Kr06). $\beta_3R=0.49$ (⁶ Li, 1982Co12); 1.15 (¹¹ B, 1981Hn01); 1.29 18 (²⁸ Si, 1986Vi02). $\beta_3R(p,p')/\beta_3R(^{13}\text{C},^{13}\text{C}')=1.3$ (1977Bo17).
3900	2 ⁺	2	$\beta_2R=1.04$ (⁶ Li, 1982Co12); 0.44 (¹¹ B, 1981Hn01); 1.37 14 (²⁸ Si, 1986Vi02).
4490	5 ⁻	5	$\beta_5R=0.53$ (⁶ Li, 1982Co12); 1.15 (¹¹ B, 1981Hn01). $\beta_5R(p,p')/\beta_5R(^{13}\text{C},^{13}\text{C}')=1.9$ (1977Bo17).
5900			
6290			
6400			
6940			
7300			
$7.8 \times 10^3 \dagger$ 10			Probably lower excitation of the octupole resonance.
$10.7 \times 10^3 \dagger$ 10			
$14.0 \times 10^3 \dagger$ 10			
$17.6 \times 10^3 \dagger$ 10			GQR; wide structure.
$26 \times 10^3 \dagger$			E(level): wide structure.

Continued on next page (footnotes at end of table)

Inelastic scattering (continued) **^{40}Ca Levels (continued)**

† From Adopted Levels.

‡ Giant resonance.

Based on adopted $J\pi$.

⁴He(³⁶Ar,α):resonances **2011No12**

2011No12: E=150 MeV ³⁶Ar beam was produced from the K-130 cyclotron at the university of Jyvaskyla, Finland and entered scattering chamber of helium gas through Havar foil. Recoiling α-particles were detected by rotating array of four silicon surface detectors (FWHM=30 keV), each separated by 6° and mounted on a turntable, together with another (monitor) detector which was fixed at -15°. Measured Eα, cross section, σ(θ). Deduced excitation function, levels, and widths. R-matrix analysis of excitation function data. Discussed α-cluster structure in the quasi-continuum of ⁴⁰Ca.

⁴⁰Ca Levels

$\gamma^2_\alpha/\gamma^2_{sp}$ =relative reduced widths. Uncertainty on these values is large and probably overestimated by 30%.

$\Gamma_\alpha/\Gamma > 1.00$ values listed here are non-physical. The authors point out that thorough analysis of background contributions may correct the problem.

All resonance parameters are extracted from R-matrix fits to excitation functions and the values are approximate according to the authors. Cross sections have maximum uncertainty of 20%.

E(level) [†]	Γ	L	Comments
12420	<0.05 MeV	1	$\Gamma_\alpha/\Gamma=0.80$; $\gamma^2_\alpha/\gamma^2_{sp}=79.8\%$.
12530	<0.03 MeV	1	$\Gamma_\alpha/\Gamma=0.60$; $\gamma^2_\alpha/\gamma^2_{sp}=29.6\%$.
12580	<0.03 MeV	1	$\Gamma_\alpha/\Gamma=0.70$; $\gamma^2_\alpha/\gamma^2_{sp}=30.9\%$.
12670	<0.05 MeV	1	$\Gamma_\alpha/\Gamma=1.00$; $\gamma^2_\alpha/\gamma^2_{sp}=63.5\%$.
12740	<0.03 MeV	2	$\Gamma_\alpha/\Gamma=0.40$; $\gamma^2_\alpha/\gamma^2_{sp}=23.9\%$.
12795	<0.04 MeV	1	$\Gamma_\alpha/\Gamma=0.60$; $\gamma^2_\alpha/\gamma^2_{sp}=24.8\%$.
12835	<0.03 MeV	2	$\Gamma_\alpha/\Gamma=0.70$; $\gamma^2_\alpha/\gamma^2_{sp}=36.7\%$.
12900	<0.04 MeV	2	$\Gamma_\alpha/\Gamma=0.35$; $\gamma^2_\alpha/\gamma^2_{sp}=21.7\%$.
12965	<0.04 MeV	2	$\Gamma_\alpha/\Gamma=0.80$; $\gamma^2_\alpha/\gamma^2_{sp}=44.7\%$.
13050	<0.04 MeV	2	$\Gamma_\alpha/\Gamma=0.90$; $\gamma^2_\alpha/\gamma^2_{sp}=41.9\%$.
13125	<0.04 MeV	2	$\Gamma_\alpha/\Gamma=1.00$; $\gamma^2_\alpha/\gamma^2_{sp}=43.0\%$.
13170	<0.02 MeV	3	$\Gamma_\alpha/\Gamma=0.80$; $\gamma^2_\alpha/\gamma^2_{sp}=34.4\%$.
13245	<0.04 MeV	2	$\Gamma_\alpha/\Gamma=0.80$; $\gamma^2_\alpha/\gamma^2_{sp}=28.8\%$.
13301	<0.04 MeV	2	$\Gamma_\alpha/\Gamma=1.00$; $\gamma^2_\alpha/\gamma^2_{sp}=28.8\%$.
13345	<0.03 MeV	3	$\Gamma_\alpha/\Gamma=1.10$; $\gamma^2_\alpha/\gamma^2_{sp}=54.2\%$.
13410	<0.04 MeV	3	$\Gamma_\alpha/\Gamma=0.85$; $\gamma^2_\alpha/\gamma^2_{sp}=50.0\%$.
13480	<0.03 MeV	3	$\Gamma_\alpha/\Gamma=0.20$; $\gamma^2_\alpha/\gamma^2_{sp}=8.4\%$.
13520	<0.04 MeV	3	$\Gamma_\alpha/\Gamma=0.30$; $\gamma^2_\alpha/\gamma^2_{sp}=15.2\%$.
13570	<0.05 MeV	3	$\Gamma_\alpha/\Gamma=0.35$; $\gamma^2_\alpha/\gamma^2_{sp}=20.4\%$.
13620	<0.04 MeV	3	$\Gamma_\alpha/\Gamma=0.38$; $\gamma^2_\alpha/\gamma^2_{sp}=17.0\%$.
13645	<0.04 MeV	3	$\Gamma_\alpha/\Gamma=0.20$; $\gamma^2_\alpha/\gamma^2_{sp}=8.6\%$.
13710	<0.03 MeV	3	$\Gamma_\alpha/\Gamma=0.63$; $\gamma^2_\alpha/\gamma^2_{sp}=18.9\%$.
13760	<0.04 MeV	3	$\Gamma_\alpha/\Gamma=0.30$; $\gamma^2_\alpha/\gamma^2_{sp}=10.8\%$.
13850	<0.03 MeV	3	$\Gamma_\alpha/\Gamma=0.75$; $\gamma^2_\alpha/\gamma^2_{sp}=18.5\%$.
13910	<0.02 MeV	3	$\Gamma_\alpha/\Gamma=0.90$; $\gamma^2_\alpha/\gamma^2_{sp}=13.6\%$.
13960	<0.02 MeV	3	$\Gamma_\alpha/\Gamma=0.70$; $\gamma^2_\alpha/\gamma^2_{sp}=10.0\%$.
14005	<0.02 MeV	3	$\Gamma_\alpha/\Gamma=0.73$; $\gamma^2_\alpha/\gamma^2_{sp}=10.0\%$.
14047	<0.02 MeV	3	$\Gamma_\alpha/\Gamma=0.83$; $\gamma^2_\alpha/\gamma^2_{sp}=10.8\%$.
14150	<0.03 MeV	3	$\Gamma_\alpha/\Gamma=0.55$; $\gamma^2_\alpha/\gamma^2_{sp}=9.4\%$.
14177	<0.03 MeV	3	$\Gamma_\alpha/\Gamma=0.60$; $\gamma^2_\alpha/\gamma^2_{sp}=10.1\%$.
14225	<0.02 MeV	3	$\Gamma_\alpha/\Gamma=0.60$; $\gamma^2_\alpha/\gamma^2_{sp}=6.3\%$.
14262	<0.02 MeV	3	$\Gamma_\alpha/\Gamma=0.60$; $\gamma^2_\alpha/\gamma^2_{sp}=6.0\%$.
14292	<0.02 MeV	3	$\Gamma_\alpha/\Gamma=0.45$; $\gamma^2_\alpha/\gamma^2_{sp}=4.3\%$.
14312	<0.02 MeV	3	$\Gamma_\alpha/\Gamma=0.42$; $\gamma^2_\alpha/\gamma^2_{sp}=4.0\%$.
14335	<0.02 MeV	3	$\Gamma_\alpha/\Gamma=0.50$; $\gamma^2_\alpha/\gamma^2_{sp}=4.7\%$.
14390	<0.03 MeV	3	$\Gamma_\alpha/\Gamma=0.90$; $\gamma^2_\alpha/\gamma^2_{sp}=11.8\%$.
14435	<0.03 MeV	3	$\Gamma_\alpha/\Gamma=0.95$; $\gamma^2_\alpha/\gamma^2_{sp}=11.9\%$.

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$^4\text{He}(^{36}\text{Ar},\alpha)$:resonances **2011No12 (continued)** ^{40}Ca Levels (continued)

E(level) [†]	Γ	L	Comments
14490	<0.04 MeV	3	$\Gamma_{\alpha}/\Gamma=0.50$; $\gamma^2_{\alpha}/\gamma^2_{sp}=7.9\%$.
14540	<0.03 MeV	3	$\Gamma_{\alpha}/\Gamma=1.00$; $\gamma^2_{\alpha}/\gamma^2_{sp}=11.3\%$.
14605	<0.04 MeV	3	$\Gamma_{\alpha}/\Gamma=1.00$; $\gamma^2_{\alpha}/\gamma^2_{sp}=14.1\%$.
14640	<0.03 MeV	3	$\Gamma_{\alpha}/\Gamma=0.70$; $\gamma^2_{\alpha}/\gamma^2_{sp}=7.2\%$.
14690	<0.03 MeV	3	$\Gamma_{\alpha}/\Gamma=0.30$; $\gamma^2_{\alpha}/\gamma^2_{sp}=2.9\%$.
14725	<0.05 MeV	3	$\Gamma_{\alpha}/\Gamma=1.30$; $\gamma^2_{\alpha}/\gamma^2_{sp}=20.6\%$.
14760	<0.03 MeV	3	$\Gamma_{\alpha}/\Gamma=0.70$; $\gamma^2_{\alpha}/\gamma^2_{sp}=6.4\%$.
14790	<0.03 MeV	3	$\Gamma_{\alpha}/\Gamma=0.65$; $\gamma^2_{\alpha}/\gamma^2_{sp}=5.8\%$.
14835	<0.03 MeV	3	$\Gamma_{\alpha}/\Gamma=1.20$; $\gamma^2_{\alpha}/\gamma^2_{sp}=10.4\%$.
14888	<0.04 MeV	3	$\Gamma_{\alpha}/\Gamma=1.55$; $\gamma^2_{\alpha}/\gamma^2_{sp}=13.8\%$.
14942	<0.03 MeV	3	$\Gamma_{\alpha}/\Gamma=1.40$; $\gamma^2_{\alpha}/\gamma^2_{sp}=10.7\%$.
15002	<0.04 MeV	3	$\Gamma_{\alpha}/\Gamma=1.15$; $\gamma^2_{\alpha}/\gamma^2_{sp}=11.7\%$.
15052	<0.03 MeV	3	$\Gamma_{\alpha}/\Gamma=1.45$; $\gamma^2_{\alpha}/\gamma^2_{sp}=10.1\%$.
15101	<0.03 MeV	3	$\Gamma_{\alpha}/\Gamma=1.70$; $\gamma^2_{\alpha}/\gamma^2_{sp}=11.9\%$.
15150	<0.04 MeV	3	$\Gamma_{\alpha}/\Gamma=0.80$; $\gamma^2_{\alpha}/\gamma^2_{sp}=6.9\%$.
15220	<0.03 MeV	3	$\Gamma_{\alpha}/\Gamma=0.60$; $\gamma^2_{\alpha}/\gamma^2_{sp}=3.9\%$.
15260	<0.03 MeV	3	$\Gamma_{\alpha}/\Gamma=0.65$; $\gamma^2_{\alpha}/\gamma^2_{sp}=3.9\%$.
15285	<0.05 MeV	4	$\Gamma_{\alpha}/\Gamma=0.80$; $\gamma^2_{\alpha}/\gamma^2_{sp}=16.2\%$.
15345	<0.04 MeV	4	$\Gamma_{\alpha}/\Gamma=0.60$; $\gamma^2_{\alpha}/\gamma^2_{sp}=9.2\%$.
15384	<0.04 MeV	4	$\Gamma_{\alpha}/\Gamma=0.78$; $\gamma^2_{\alpha}/\gamma^2_{sp}=11.5\%$.
15435	<0.04 MeV	4	$\Gamma_{\alpha}/\Gamma=0.87$; $\gamma^2_{\alpha}/\gamma^2_{sp}=12.3\%$.
15490	<0.04 MeV	4	$\Gamma_{\alpha}/\Gamma=0.85$; $\gamma^2_{\alpha}/\gamma^2_{sp}=11.4\%$.
15525	<0.02 MeV	4	$\Gamma_{\alpha}/\Gamma=0.20$; $\gamma^2_{\alpha}/\gamma^2_{sp}=1.3\%$.
15550	<0.03 MeV	4	$\Gamma_{\alpha}/\Gamma=0.70$; $\gamma^2_{\alpha}/\gamma^2_{sp}=6.7\%$.
15580	<0.03 MeV	4	$\Gamma_{\alpha}/\Gamma=0.56$; $\gamma^2_{\alpha}/\gamma^2_{sp}=5.2\%$.
15620	<0.03 MeV	4	$\Gamma_{\alpha}/\Gamma=1.05$; $\gamma^2_{\alpha}/\gamma^2_{sp}=9.6\%$.
15670	<0.02 MeV	4	$\Gamma_{\alpha}/\Gamma=1.00$; $\gamma^2_{\alpha}/\gamma^2_{sp}=5.8\%$.
15707	<0.03 MeV	4	$\Gamma_{\alpha}/\Gamma=0.45$; $\gamma^2_{\alpha}/\gamma^2_{sp}=3.8\%$.
15790	<0.04 MeV	4	$\Gamma_{\alpha}/\Gamma=1.00$; $\gamma^2_{\alpha}/\gamma^2_{sp}=10.2\%$.
15840	<0.03 MeV	4	$\Gamma_{\alpha}/\Gamma=0.30$; $\gamma^2_{\alpha}/\gamma^2_{sp}=2.3\%$.
15875	<0.02 MeV	4	$\Gamma_{\alpha}/\Gamma=0.93$; $\gamma^2_{\alpha}/\gamma^2_{sp}=4.7\%$.
15915	<0.02 MeV	4	$\Gamma_{\alpha}/\Gamma=0.98$; $\gamma^2_{\alpha}/\gamma^2_{sp}=4.6\%$.
15950	<0.02 MeV	5	$\Gamma_{\alpha}/\Gamma=0.30$; $\gamma^2_{\alpha}/\gamma^2_{sp}=3.4\%$.
15960	<0.02 MeV	4	$\Gamma_{\alpha}/\Gamma=0.97$; $\gamma^2_{\alpha}/\gamma^2_{sp}=4.5\%$.
16000	<0.02 MeV	5	$\Gamma_{\alpha}/\Gamma=0.30$; $\gamma^2_{\alpha}/\gamma^2_{sp}=3.2\%$.
16020	<0.03 MeV	4	$\Gamma_{\alpha}/\Gamma=0.41$; $\gamma^2_{\alpha}/\gamma^2_{sp}=2.6\%$.
16065	<0.03 MeV	4	$\Gamma_{\alpha}/\Gamma=0.45$; $\gamma^2_{\alpha}/\gamma^2_{sp}=2.9\%$.
16110	<0.02 MeV	5	$\Gamma_{\alpha}/\Gamma=0.10$; $\gamma^2_{\alpha}/\gamma^2_{sp}=1.0\%$.
16120	<0.03 MeV	4	$\Gamma_{\alpha}/\Gamma=0.42$; $\gamma^2_{\alpha}/\gamma^2_{sp}=2.7\%$.
16160	<0.03 MeV	4	$\Gamma_{\alpha}/\Gamma=0.41$; $\gamma^2_{\alpha}/\gamma^2_{sp}=2.4\%$.
16210	<0.03 MeV	4	$\Gamma_{\alpha}/\Gamma=0.37$; $\gamma^2_{\alpha}/\gamma^2_{sp}=2.2\%$.
16255	<0.02 MeV	4	$\Gamma_{\alpha}/\Gamma=0.48$; $\gamma^2_{\alpha}/\gamma^2_{sp}=1.8\%$.
16290	<0.02 MeV	4	$\Gamma_{\alpha}/\Gamma=0.36$; $\gamma^2_{\alpha}/\gamma^2_{sp}=1.3\%$.
16360	<0.02 MeV	4	$\Gamma_{\alpha}/\Gamma=0.25$; $\gamma^2_{\alpha}/\gamma^2_{sp}=0.9\%$.
16395	<0.02 MeV	4	$\Gamma_{\alpha}/\Gamma=0.45$; $\gamma^2_{\alpha}/\gamma^2_{sp}=1.6\%$.
16450	<0.02 MeV	4	$\Gamma_{\alpha}/\Gamma=0.37$; $\gamma^2_{\alpha}/\gamma^2_{sp}=1.2\%$.
16510	<0.02 MeV	4	$\Gamma_{\alpha}/\Gamma=0.30$; $\gamma^2_{\alpha}/\gamma^2_{sp}=1.0\%$.
16545	<0.02 MeV	5	$\Gamma_{\alpha}/\Gamma=0.30$; $\gamma^2_{\alpha}/\gamma^2_{sp}=2.0\%$.
16585	<0.02 MeV	5	$\Gamma_{\alpha}/\Gamma=0.20$; $\gamma^2_{\alpha}/\gamma^2_{sp}=1.3\%$.

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$^4\text{He}(^{36}\text{Ar},\alpha)$:resonances 2011No12 (continued) ^{40}Ca Levels (continued)

E(level) [†]	Γ	L	Comments
16610	<0.02 MeV	6	$\Gamma_{\alpha}/\Gamma=0.10$; $\gamma^2_{\alpha}/\gamma^2_{sp}=1.8\%$.
16640	<0.02 MeV	5	$\Gamma_{\alpha}/\Gamma=0.30$; $\gamma^2_{\alpha}/\gamma^2_{sp}=1.9\%$.
16665	<0.02 MeV	6	$\Gamma_{\alpha}/\Gamma=0.38$; $\gamma^2_{\alpha}/\gamma^2_{sp}=6.6\%$.
16735	<0.02 MeV	6	$\Gamma_{\alpha}/\Gamma=0.38$; $\gamma^2_{\alpha}/\gamma^2_{sp}=6.2\%$.
16810	<0.02 MeV	6	$\Gamma_{\alpha}/\Gamma=0.33$; $\gamma^2_{\alpha}/\gamma^2_{sp}=5.0\%$.
16910	<0.05 MeV	6	$\Gamma_{\alpha}/\Gamma=0.33$; $\gamma^2_{\alpha}/\gamma^2_{sp}=11.5\%$.
16945	<0.02 MeV	6	$\Gamma_{\alpha}/\Gamma=0.12$; $\gamma^2_{\alpha}/\gamma^2_{sp}=1.6\%$.
17010	<0.03 MeV	6	$\Gamma_{\alpha}/\Gamma=0.40$; $\gamma^2_{\alpha}/\gamma^2_{sp}=6.4\%$.
17065	<0.02 MeV	6	$\Gamma_{\alpha}/\Gamma=0.38$; $\gamma^2_{\alpha}/\gamma^2_{sp}=4.7\%$.
17113	<0.02 MeV	6	$\Gamma_{\alpha}/\Gamma=0.60$; $\gamma^2_{\alpha}/\gamma^2_{sp}=7.1\%$.
17170	<0.02 MeV	6	$\Gamma_{\alpha}/\Gamma=0.33$; $\gamma^2_{\alpha}/\gamma^2_{sp}=3.7\%$.
17210	<0.03 MeV	6	$\Gamma_{\alpha}/\Gamma=0.40$; $\gamma^2_{\alpha}/\gamma^2_{sp}=6.6\%$.
17280	<0.03 MeV	6	$\Gamma_{\alpha}/\Gamma=0.33$; $\gamma^2_{\alpha}/\gamma^2_{sp}=5.1\%$.
17320	<0.02 MeV	6	$\Gamma_{\alpha}/\Gamma=0.10$; $\gamma^2_{\alpha}/\gamma^2_{sp}=1\%$.
17360	<0.03 MeV	6	$\Gamma_{\alpha}/\Gamma=0.25$; $\gamma^2_{\alpha}/\gamma^2_{sp}=3.6\%$.
17410	<0.03 MeV	6	$\Gamma_{\alpha}/\Gamma=0.35$; $\gamma^2_{\alpha}/\gamma^2_{sp}=4.9\%$.
17450	<0.03 MeV	6	$\Gamma_{\alpha}/\Gamma=0.33$; $\gamma^2_{\alpha}/\gamma^2_{sp}=4.5\%$.
17513	<0.05 MeV	6	$\Gamma_{\alpha}/\Gamma=0.35$; $\gamma^2_{\alpha}/\gamma^2_{sp}=7.6\%$.
17590	<0.05 MeV	6	$\Gamma_{\alpha}/\Gamma=0.20$; $\gamma^2_{\alpha}/\gamma^2_{sp}=4.1\%$.
17670	<0.05 MeV	6	$\Gamma_{\alpha}/\Gamma=0.37$; $\gamma^2_{\alpha}/\gamma^2_{sp}=7.2\%$.
17730	<0.03 MeV	6	$\Gamma_{\alpha}/\Gamma=0.55$; $\gamma^2_{\alpha}/\gamma^2_{sp}=6.1\%$.
17790	<0.03 MeV	6	$\Gamma_{\alpha}/\Gamma=0.36$; $\gamma^2_{\alpha}/\gamma^2_{sp}=3.8\%$.
17855	<0.04 MeV	6	$\Gamma_{\alpha}/\Gamma=0.28$; $\gamma^2_{\alpha}/\gamma^2_{sp}=3.8\%$.
17915	<0.02 MeV	6	$\Gamma_{\alpha}/\Gamma=0.42$; $\gamma^2_{\alpha}/\gamma^2_{sp}=2.8\%$.
17950	<0.02 MeV	6	$\Gamma_{\alpha}/\Gamma=0.50$; $\gamma^2_{\alpha}/\gamma^2_{sp}=3.2\%$.
18010	<0.02 MeV	6	$\Gamma_{\alpha}/\Gamma=0.55$; $\gamma^2_{\alpha}/\gamma^2_{sp}=3.4\%$.
18077	<0.05 MeV	6	$\Gamma_{\alpha}/\Gamma=0.27$; $\gamma^2_{\alpha}/\gamma^2_{sp}=4.0\%$.
18139	<0.03 MeV	6	$\Gamma_{\alpha}/\Gamma=0.40$; $\gamma^2_{\alpha}/\gamma^2_{sp}=3.4\%$.
18174	<0.03 MeV	6	$\Gamma_{\alpha}/\Gamma=0.43$; $\gamma^2_{\alpha}/\gamma^2_{sp}=3.6\%$.
18260	<0.05 MeV	6	$\Gamma_{\alpha}/\Gamma=0.15$; $\gamma^2_{\alpha}/\gamma^2_{sp}=1.9\%$.
18328	<0.05 MeV	6	$\Gamma_{\alpha}/\Gamma=0.40$; $\gamma^2_{\alpha}/\gamma^2_{sp}=5.1\%$.
18406	<0.03 MeV	6	$\Gamma_{\alpha}/\Gamma=0.28$; $\gamma^2_{\alpha}/\gamma^2_{sp}=2.0\%$.
18485	<0.02 MeV	6	$\Gamma_{\alpha}/\Gamma=0.87$; $\gamma^2_{\alpha}/\gamma^2_{sp}=4.1\%$.
18547	<0.03 MeV	6	$\Gamma_{\alpha}/\Gamma=0.35$; $\gamma^2_{\alpha}/\gamma^2_{sp}=2.3\%$.
18605	<0.04 MeV	6	$\Gamma_{\alpha}/\Gamma=0.28$; $\gamma^2_{\alpha}/\gamma^2_{sp}=2.4\%$.
18659	<0.02 MeV	6	$\Gamma_{\alpha}/\Gamma=0.38$; $\gamma^2_{\alpha}/\gamma^2_{sp}=1.6\%$.
18705	<0.02 MeV	6	$\Gamma_{\alpha}/\Gamma=0.27$; $\gamma^2_{\alpha}/\gamma^2_{sp}=1.1\%$.
18765	<0.04 MeV	6	$\Gamma_{\alpha}/\Gamma=0.48$; $\gamma^2_{\alpha}/\gamma^2_{sp}=3.8\%$.
18865	<0.03 MeV	6	$\Gamma_{\alpha}/\Gamma=0.45$; $\gamma^2_{\alpha}/\gamma^2_{sp}=2.5\%$.
18930	<0.02 MeV	6	$\Gamma_{\alpha}/\Gamma=0.52$; $\gamma^2_{\alpha}/\gamma^2_{sp}=1.8\%$.
19020	<0.03 MeV	6	$\Gamma_{\alpha}/\Gamma=0.25$; $\gamma^2_{\alpha}/\gamma^2_{sp}=1.3\%$.
19080	<0.05 MeV	6	$\Gamma_{\alpha}/\Gamma=0.18$; $\gamma^2_{\alpha}/\gamma^2_{sp}=1.5\%$.
19150	<0.07 MeV	6	$\Gamma_{\alpha}/\Gamma=0.40$; $\gamma^2_{\alpha}/\gamma^2_{sp}=4.6\%$.
19230	<0.03 MeV	6	$\Gamma_{\alpha}/\Gamma=0.30$; $\gamma^2_{\alpha}/\gamma^2_{sp}=1.4\%$.
19280	<0.03 MeV	6	$\Gamma_{\alpha}/\Gamma=0.73$; $\gamma^2_{\alpha}/\gamma^2_{sp}=3.4\%$.
19385	<0.03 MeV	6	$\Gamma_{\alpha}/\Gamma=0.46$; $\gamma^2_{\alpha}/\gamma^2_{sp}=2.0\%$.
19467	<0.04 MeV	6	$\Gamma_{\alpha}/\Gamma=0.34$; $\gamma^2_{\alpha}/\gamma^2_{sp}=1.9\%$.
19525	<0.02 MeV	6	$\Gamma_{\alpha}/\Gamma=0.22$; $\gamma^2_{\alpha}/\gamma^2_{sp}=0.6\%$.
19597	<0.02 MeV	6	$\Gamma_{\alpha}/\Gamma=0.80$; $\gamma^2_{\alpha}/\gamma^2_{sp}=2.1\%$.

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⁴He(³⁶Ar, α):resonances 2011No12 (continued)

⁴⁰Ca Levels (continued)

<u>E(level)[†]</u>	<u>Γ</u>	<u>L</u>	<u>Comments</u>
19667	<0.04 MeV	6	$\Gamma_\alpha/\Gamma=0.20$; $\gamma^2_\alpha/\gamma^2_{sp}=1.0\%$.
19780	<0.06 MeV	6	$\Gamma_\alpha/\Gamma=0.28$; $\gamma^2_\alpha/\gamma^2_{sp}=2.1\%$.

[†] Estimated maximum uncertainty in absolute energy=150 keV.

¹⁴N(²⁸Si,d) **1978BaYQ**

1978BaYQ: E=66,70,80 MeV. Measured deuterons using ΔE-E telescope.
At θ=0; no 10⁺ level found.

⁴⁰Ca Levels

<u>E(level)[†]</u>	<u>Jπ[†]</u>	<u>dσ/dΩ μb/sr[‡]</u>
6930	6 ⁺	≤0.2
8098	8 ⁺	≤0.2

[†] From Adopted Levels. Energies are rounded values.
[‡] At 0° and E=70 MeV.

$^{32}\text{S}(^{12}\text{C},\alpha)$ **1972Mi08**

1972Mi08: E=30 MeV ^{12}C beam was produced from the University of Pennsylvania tandem accelerator. Target was 99.6% natural H_2S in a cell. Reaction products were momentum-analyzed with a multi-angle spectrograph. Measured $\sigma(E\alpha)$. Deduced multiparticle-multihole states.

 ^{40}Ca Levels

E(level)	$J\pi^\dagger$	$d\sigma/d\Omega$ ($\mu\text{b}/\text{sr}$) ‡	Comments
0	0^+	≈ 0.31	
3350 25	0^+	3.78	
3700 25	3^-	≈ 0.91	
3910 25	2^+	6.96	
4500 25	5^-	1.04	
5180 25		5.41	
5260 25		6.84	
5610 25		11.0	E(level): doublet: 5614+5629.
5900 25		3.51	E(level): doublet.
6300 25		3.51	
6540 25		12.3	E(level): triplet: 6508+6543+6582.
6910 25		16.0	E(level): triplet: 6909+6931+6938.
7270 25		8.17	E(level): triplet: 7239+7278+7301.
7980 25		40.3	E(level): triplet: 7973+7977+8019.
8110 25		20.7	E(level): triplet: 8091+8113+8135.
8320 25		11.8	E(level): multiplet: 8323+8338+8359+8364.
8590 25		27.3	E(level): doublet: 8579+8587.
8790 25		15.7	E(level): doublet: 8764+8810.

† From Adopted Levels for levels up to 5 MeV. Higher groups are mostly unresolved multiplets.

‡ At $\theta(\text{lab})=7.5^\circ$.

$^{36}\text{Ar}(\alpha,\gamma)$:resonances 1973Wa08,1987He05,1982Pr05

1973Wa08, 1973Br34: E=5.3-16.8 MeV α beams were produced from the Australian National University tandem Van de Graaff accelerator incident on an argon gas target. γ rays were detected with a NaI detector. Measured γ -ray yields, $\sigma(\theta)$ in giant-resonance region. Deduced levels, resonance widths.

1987He05: E=5.48-5.515 MeV α beams were produced from the Oxford folded tandem accelerator incident on a gas target of ^{36}Ar . γ rays were detected with a NaI crystal and charged particles were detected with silicon detectors. Measured yields of 2814 γ from first 2^+ level of ^{39}K and 2120 γ from 11988 level of ^{40}Ca ; also measured yields of elastically scattered α particles. Deduced levels, resonance widths.

1982Pr05: E=5.495-5.505 MeV α beams were produced from the Oxford folded tandem accelerator. γ rays were detected with a NaI detector and a Ge(Li) detector. Measured $E\gamma$, $I\gamma$, γ -ray yields ($\Delta E=1$ keV). Deduced levels, resonance widths.

1967Na10: E=3-5.7 MeV. Measured σ to search for 5619 resonance. The authors made a search for 4 possible resonances at $E\alpha=5619, 5736, 5880$ and 5979 keV indicated by experiments on $^{39}\text{K}(p,\gamma)$ and (α,γ) performed by 1968Ba22 and they claimed that the strongest resonance of 5619 may have been detected but too weak for a meaningful angular distribution measurement.

 ^{40}Ca Levels

E(level) [†]	J^π &	$E\alpha(\text{lab})^\ddagger$	$(2J+1)\Gamma_\alpha\Gamma_{\gamma 0}/\Gamma$ (eV) [‡]	Comments
0	0 ⁺			
9868.0 17	1 ⁺		0.42 5	T=1 E(level),(2J+1) $\Gamma_\alpha\Gamma_{\gamma 0}/\Gamma$ (eV): from 1982Pr05.
10321.0 16	1 ⁺			T=1 E(level): from 1982Pr05.
11977		5486 [#]		
11988 2	0 ⁺	5497 [#]		T=2 E(level): from 1982Pr05. J^π : isotropic angular distribution of capture γ rays (1982Pr05). $\Gamma_{\alpha 0}=80$ ev 10, $\Gamma=81$ ev 10 (1987He05). Proton decay to 2522 level in ^{39}K based on observed 2522.4 2 γ ray in 1982Pr05; α decay to 2814 level in ^{39}K based on observed 2814 γ ray in 1987He05. 1982Pr05 have tentative evidence for four weaker γ -decay branches from this level with $E\gamma=1504, 1611, 2013$ and 2202 and $\Delta E\gamma=3$ keV.
11989		5499 [#]		
11997		5508 [#]		
12971		6590	3.4	
13249 @		6900 @	9.7	
13484		7160	3.4	
13718		7420	3.7	
13952 @		7680 @	14.6	
14096		7840	14.4	
14419		8200	4.7	
14509		8300	4.5	
14869		8700	6.3	
17669		11810	5.8	
17858		12020	5.4	
18146 @		12340 @	11.3	
18326		12540	9.4	
18452		12680	6.9	
18731 @		12990 @	10.3	
19037		13330	4.9	

[†] Deduced by evaluator based on $E(\text{level})=E\alpha(\text{c.m.})+S(\alpha)(\text{for } ^{40}\text{Ca})$, with $S(\alpha)(^{40}\text{Ca})=7039.76 \pm 3$ (2012Wa38) and $E\alpha(\text{c.m.})=(36/40)E\alpha(\text{lab})$, unless otherwise noted.

[‡] From 1973Wa08 for levels above 12500.

³⁶Ar(α,γ):resonances [1973Wa08](#),[1987He05](#),[1982Pr05](#) (continued)

⁴⁰Ca Levels (continued)

Read from the γ -ray yield curves in Fig.2 in [1987He05](#) by evaluator.
@ Unresolved doublet in [1973Wa08](#), of resonances resolved in ³⁹K(p, γ) dataset.
& From Adopted Levels.

$\gamma(^{40}\text{Ca})$

<u>E_i(level)</u>	<u>J_i^{π}</u>	<u>E_{γ}^{$\dagger$}</u>	<u>I_{γ}^{$\ddagger$}</u>	<u>E_f</u>	<u>J_f^{π}</u>	<u>Γ_γ^{$\dagger$}</u>
11988	0 ⁺	1666.5 4	42	10321.0	1 ⁺	0.34 5
		2119.5 4	58	9868.0	1 ⁺	0.45 7

^{$\dagger$} From [1982Pr05](#), with $\Gamma_{\alpha 0}/\Gamma=0.93$ 9 from [1979Fr04](#) assumed, unless otherwise noted.
 ^{$\ddagger$} From [1982Pr05](#).

$^{36}\text{Ar}(^6\text{Li},\text{d})$ [1979Fo04](#),[1994Ya04](#),[1998Ya21](#)

[1979Fo04](#), [1977Be65](#), [1975Fo04](#): E=17 MeV ^6Li beam was produced from the University of Pennsylvania tandem accelerator.

Target was 99.8% enriched ^{36}Ar in a gas cell. Reaction products were momentum analyzed with a multi-angle spectrograph (FWHM $\approx$ 30 keV) and detected in nuclear emulsion plates. Measured $\sigma(\theta)$. Deduced levels, J, π , L, α spectroscopic factors from DWBA analysis.

[1994Ya04](#), [1998Ya21](#), [1993Ya07](#): E=50 MeV ^6Li beam was produced from the isochronous cyclotron at RCNP of Osaka

University. Target was 99.8% enriched ^{36}Ar gas. Reaction products were momentum analyzed with the spectrograph RAIDEN (FWHM=50-70 keV) and detected in a focal plane counter system of a position-sensitive proportional counter, two ΔE gas proportional counters and an E plastic scintillator. Measured $\sigma(\theta)$. Deduced levels, α clusters, J, π , L, spectroscopic factors from DWBA analysis.

[1975An13](#): E=28 MeV. Measured σ and spectroscopic factor for g.s.

 ^{40}Ca Levels

E(level) [†]	L [‡]	S [‡]	Comments
0	0	0.30	
3350.5 18	0	0.21	
3736 3	3	0.06	
3909 3	2	0.26	
4494.4 9	5	0.016	
5206 6	0+2	0.18,0.18	E(level): doublet 5210+5250.
5283 4	4	0.19	
5625.9 10	2	0.05	E(level): doublet 5614+5628.
5908 3	1	0.025	
6034 5			E(level): doublet 6025+6029.
6285.1 12	3	0.026	
6501 4	4 [#]	0.030 [#]	
6534 4	4 [#]	0.036 [#]	
6577 3	3	0.087	
6756.8 17			
6900	2	0.12	E(level): from 1994Ya04 .
6936 6	6	0.25	
7300	0		E(level): unresolved multiplet with L=0 from $\sigma(\theta)$ distribution and cross section below 3% of that to g.s. (1975Fo04).
7460	(2)	(0.04)	
7560	4	0.04	
7700	0	0.18	
7870	3	0.066	
8050	2	0.15	
8150	1	0.21	
8270	4	0.055	
8280	0		E(level),L: from 1975Fo04 .
8380	4	0.043	
8420	0		E(level),L: from 1975Fo04 .
8550	3	0.076	
8600	2	0.11	
8780	2	0.11	
8930	2	0.14	
9140	(0,1)	0.50,0.15	
9240	6	0.11	
9360	3	0.10	
9500	2	0.10	
9700	3	0.20	
9870	2	0.14	
9950	1+5	0.034,0.01	
10080	2	0.20	
10150	5	0.06	

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$^{36}\text{Ar}(^6\text{Li},\text{d})$ [1979Fo04](#),[1994Ya04](#),[1998Ya21](#) (continued) ^{40}Ca Levels (continued)

$E(\text{level})^\dagger$	$L^\ddagger$	$S^\ddagger$	Comments
10340	8	0.25	L: from 1993Ya07 .
10450			
10590	3	0.10	
10690	7		
10700	1	0.28	
10800	5	0.14	
10900	3	0.11	
11100	0	0.60	
11210	0	0.62	
11300	4	0.40	
11370	5	0.12	
11470	5	0.12	
11690	7	0.10	
11800	5	0.08	
12020	2	0.15	
12100	2	0.19	
12170	2	0.13	
12340	5	0.10	
12450	4	0.061	
12520			
12650	7	0.11	
12720	3	0.20	
12900	4	0.07	
13050	4	0.06	
13200	4	0.05	
13300	4	0.045	
13400			
13470	4	0.28	
13620	6	0.016	
13720	6	0.023	
13830	7	0.18	
14000	4	0.06	
14190	4	0.07	
14380	6	0.03	
14500	6	0.03	
14680			
14750	4	0.078	
14850	(9)	(0.33)	
15060			
15140			
15250			
15330			
15600			
15700			

[†] From [1979Fo04](#) below 7000, from [1998Ya21](#) above 7400 (read from Fig.4), unless otherwise noted.

[‡] From [1994Ya04](#), extracted from DWBA fits to measured differential cross sections. [1979Fo04](#) give L and S values for levels below 7000; [1975Fo04](#) give L=0 for four levels above 7000. α spectroscopic factor is defined as $S=1/N \times (d\sigma/d\Omega)_{\text{exp}} / (d\sigma/d\omega)_{\text{DWBA}}$ where N is the normalization factor.

Doublet 6500+6530 not resolved by [1994Ya04](#); relative S values from [1979Fo04](#) using summed value of 0.066 from [1994Ya04](#).

³⁶Ar(⁷Li,t) [1970CoZA](#)

[1970CoZA](#): E=24.4 MeV. Measured $\sigma(\theta)$, $\theta=25^\circ$ to 60° .
[1970Te05](#): E=26.75 MeV. Measured triton spectra at 26° to 50° .
[1973Te04](#): ³⁶Ar(⁷Li,t) γ E=28 MeV. Measured triton spectra.

⁴⁰Ca Levels

<u>E(level)[†]</u>	<u>Comments</u>
3900	
5265	E(level): doublet: 5250+5280.
5615	E(level): doublet: 5610+5620.
6290	
6525	E(level): doublet: 6510+6540.
7010	E(level): doublet: 6910+7110.

[†] There are many additional peaks (probably multiplets) in the triton spectrum shown by [1970CoZA](#).

³⁶Ar(¹⁶O, ¹²C) **1972Br40**

1972Br40: E=45 MeV beam was produced from the Heidelberg MP tandem Van de Graaff accelerator incident on a gas target of enriched ³⁶Ar. Reaction products were detected with a ΔE-E semiconductor telescope. Measured ¹²C spectra. Deduced rotational band based on excited 0⁺.
1973Te04: (¹⁶O, ¹²Cγ) E=58 MeV. Measured (¹²C)γ coin; γ-ray data for 3904 and 5278 levels. See (HI,xnγ) dataset.

⁴⁰Ca Levels

E(level)	Jπ [†]	Comments
3353 [‡]	0 ⁺	E(level),Jπ: from Adopted Levels; not seen in (¹⁶ O, ¹² C).
3.9×10 ³ [‡] 1	(2 ⁺)	
5.25×10 ³ [‡] 10	(4 ⁺)	
6.9×10 ³ [‡] 1	(6 ⁺)	
9.9×10 ³ [‡] 1	(8 ⁺)	
12.4×10 ³ [‡] 1	(10 ⁺)	

[†] Tentative assignment based on band structure (**1972Br40**).
[‡] (A): Possible Kπ=0⁺ band.

$^{38}\text{Ar}(^3\text{He},n)$ 1977Bo16

1977Bo16: E=11.5 MeV ^3He beam was produced from the CN Van de Graaff accelerator at the Hahn-Meitner-Institut, incident on a gas target of enriched ^{38}Ar . Neutrons were detected with 16 liquid scintillators with energies determined by the time-of-flight method (flight path=17.5 m, FWHM=10 keV at E(n)=4 MeV and 50 keV at 12 MeV). Measured TOF spectrum, $\sigma(\theta)$. Deduced levels, J, π from DWBA analysis. Comparisons with available data and shell-model calculations.

1973A123: E=15 MeV ^3He beam was produced from the Rochester MP Van de Graaff accelerator. Measured neutrons by TOF, $\sigma(\theta)$, $\theta=0^\circ-40^\circ$, FWHM $\approx$ 100 keV. Deduced levels, J, π from DWBA analysis. Report data for 7 $J\pi=0^+$ states.

All data are from **1977Bo16**, unless otherwise noted.

 ^{40}Ca Levels

E(level)	J π	L [@]	d σ /d Ω (max) (mb/sr) [†]	Comments
0	0 ⁺	0	1.40	
3350 50		0	0.08	d σ /d Ω (max) (mb/sr): 0.08 also from 1973A123 .
3900 50		2	0.15 [#]	
5.21×10^3 [†] 10		(0) [†]	<0.04 [†]	
6950 50		1	0.20	d σ /d Ω (max) (mb/sr): at 10° (1977Bo16).
7800 50		0	0.10	
8050 50		2	0.16 [#]	
8280 50		0	0.56	E(level): 8280 100 from 1973A123 . d σ /d Ω (max) (mb/sr): 0.56 also from 1973A123 .
8470 50		0	0.53	
9380 50		0	0.40	E(level): 9380 100 from 1973A123 . d σ /d Ω (max) (mb/sr): 0.36 from 1973A123 .
9600 50		2	0.24 [#]	T=1
10.65×10^3 [†] 10		0 [†]	0.14 [†]	
11.98×10^3 [†] 10		0	0.28	d σ /d Ω (max) (mb/sr): 0.25 from 1973A123 .

[†] From **1973A123**.

[‡] At 0°, except where noted. **1973A123** report relative values normalized to unity for the ground state and the evaluator have renormalized those data to absolute value of 1.40 (mb/sr) for the ground state from **1977Bo16**.

[#] At 25° (**1977Bo16**).

[@] From DWBA fits to measured differential cross sections.

³⁹K(p,γ) **1990Ki07,1988Sc23**

Jπ(³⁹K g.s.)=3/2⁺.

Includes data for resonances.

1990Ki07: E=0.3-2.9 MeV proton beams were produced from the Utrecht 3 MV Van de Graaff generator (FWHM=0.2 keV at E_p=1 MeV). Targets were 30-50 μg/cm² KI evaporated onto Ta backings. γ rays were detected with two hyperpure Ge detectors and one Ge(Li) detector. Measured yields, Eγ, Iγ, Doppler-shift attenuation. Deduced resonances, levels, lifetimes. Report 113 resonances and γ decays of 26 resonances.

1988Sc23: E=1.0-1.6 MeV. Measured Eγ, Iγ. Deduced levels, J, π, γ-ray transition strengths. Report 14 resonances and 32 bound and two unbound levels.

1985Se16: E=3.79-3.85 MeV. Measured Eγ, Iγ, resonances. Report 4 resonances.

1981Ch04: E=0.7-2.9 MeV. Measured Eγ, Iγ, γ(θ). Deduced resonances, γ-ray branching ratios.

1973Di02: E=6.5-17.5 MeV. Measured γ(θ), yields. Report 12 resonances.

1971Da08 (also **1973DaYL**): E=2.6-2.82 MeV, measured resonances.

1971Ma03: E=1.344 MeV, measured Eγ, Iγ, resonance, lifetime by DSAM.

1968Ba22: E=2.9-6.0 MeV. Measured σ, resonances. Report 20 resonances.

1968Do12: E=1.344-1.575 keV, measured Eγ, Iγ, DSA, deduced levels, T_{1/2}. Report 12 levels.

1968Li12: E=1.1-2.5 MeV, measured Eγ, Iγ, DSA, deduced level, T_{1/2}, γ-ray branching ratios. Report 19 levels.

1966Le08, **1963Le08**: E=0.5-2.9 MeV. Measured γ, deduced Jπ's, mixing ratios. Report 12 resonances.

1967Le12: E=1.1-2.1 MeV. Measured Eγ, Iγ, γγ(θ), γ(pol). Deduced J, π, levels, γ-ray mixing ratios, branching ratios. Report 17 levels.

Others: **1988Al16**, **1987Gu01**, **1979Pa16** (also **1980PaZP**), **1971Si29**, **1971Ir01**, **1970De30**, **1970He08**, **1967Fe04**, **1966Go23**, **1966En04**, **1964Ta05**, **1964Si16**, **1964Ha35**, **1963Si13**, **1962Ra07**, **1962Du05**, **1961Po05**, **1961Ec03**.

⁴⁰Ca Levels

(p,γ) resonance strength is defined as S(p,γ)=(2J+1)Γ_pΓ_γ/Γ.

E(level) [†]	Jπ [‡]	T _{1/2} [@]	Comments
0	0 ⁺		
3352.64 9	0 ⁺		E(level): 3352.64 9 (1990Ki07), 3352.5 5 (1988Sc23).
3736.69 5	3 ⁻ #	≥0.35 ps	E(level): 3736.67 5 (1990Ki07), 3736.77 10 (1988Sc23). T _{1/2} : from 1968Li12 by DSAM.
3904.38 4	2 ⁺ #	40 fs 7	E(level): 3904.39 4 (1990Ki07), 3904.37 6 (1988Sc23). T _{1/2} : from 1971Ma03 by DSAM. Others: 13 fs 4 (1968Do12), 17 fs 4 (1968Li12).
4491.44 4	5 ⁻ #	≥0.17 ps	E(level): 4491.43 4 (1990Ki07), 4491.57 14 (1988Sc23). T _{1/2} : from 1968Li12 by DSAM.
5211.7 3	0 ⁺		E(level): 5211.56 17 (1990Ki07), 5212.4 4 (1988Sc23).
5248.81 6	2 ⁺ #	0.15 ps 7	E(level): 5248.79 5 (1990Ki07), 5248.98 16 (1988Sc23). T _{1/2} : from 1968Li12 by DSAM.
5278.81 6	4 ⁺ #	0.16 ps +13-4	E(level): 5278.80 6 (1990Ki07), 5279.0 3 (1988Sc23). T _{1/2} : from 1968Do12 by DSAM. Other: ≥0.13 ps (1968Li12).
5613.53 3	4 ⁻ #	69 fs 55	E(level): 5613.52 3 (1990Ki07), 5613.59 15 (1988Sc23). T _{1/2} : from 1968Li12 by DSAM. Other: >0.55 ps (1968Do12).
5629.43 8	2 ⁺		E(level): 5629.41 6 (1990Ki07), 5629.72 22 (1988Sc23).
5902.63 8	1 ⁻		E(level): 5902.63 8 (1990Ki07), 5902.64 11 (1988Sc23).
6025.47 5	2 ⁻		E(level): 6025.47 5 (1990Ki07), 6025.38 25 (1988Sc23).
6029.71 6	3 ⁺		E(level): 6029.71 6 (1990Ki07), 6029.7 4 (1988Sc23).
6285.15 4	3 ⁻	0.27 ps 8	E(level): 6285.15 4 (1990Ki07), 6285.17 10 (1988Sc23). T _{1/2} : weighted average of 0.26 ps +11-6 (1968Do12), and 0.35 ps 21 (1968Li12). J ^π : spin from γγ(θ) and γ(pol) together (1967Le12).
6507.84 13	4 ⁺		E(level): 6507.87 15 (1990Ki07), 6507.7 3 (1988Sc23).
6542.78 9	4 ⁺		E(level): 6542.80 9 (1990Ki07), 6542.5 3 (1988Sc23).
6582.54 15	3 ⁻		E(level): 6582.47 10 (1990Ki07), 6582.84 20 (1988Sc23).
6750.41 7	2 ⁻		E(level): 6750.42 7 (1990Ki07), 6750.38 17 (1988Sc23).

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$^{39}\text{K}(\text{p},\gamma)$ **1990Ki07,1988Sc23** (continued) ^{40}Ca Levels (continued)

E(level) [†]	J^{π} [‡]	$T_{1/2}$ [@]	S(p, γ) (eV) ^b	Comments
6908.70 8	2 ⁺	≤ 35 fs		E(level): 6908.70 8 (1990Ki07), 6908.67 24 (1988Sc23). $T_{1/2}$: from 1968Li12 by DSAM.
6931.29 6	3 ⁻	1.4 ps 6		
6950.49 7	1 ⁻			E(level): 6950.48 7 (1990Ki07), 6950.8 4 (1988Sc23). J^{π} : $\gamma\gamma(\theta)$ in 1967Le12 gives $J=(1,2)$.
7113.73 6	4 ⁻	76 fs 28		E(level): 7113.72 6 (1990Ki07), 7113.79 12 (1988Sc23). $T_{1/2}$: other: 0.31 ps 9 (1968Li12).
7114.0 5	1 ⁻			
7239.07 17	(3 ⁻ ,4,5 ⁻)			
7277.82 8	(2,3) ⁺			
7300.74 20	0 ⁺ #			E(level): 7300.67 11 (1990Ki07), 7301.3 3 (1988Sc23).
7446.23 6	3 ⁺ ,4 ⁺			
7466.37 8	2 ⁺ #	8 fs 4		E(level): 7466.35 7 (1990Ki07), 7466.7 3 (1988Sc23). $T_{1/2}$: weighted average of 7 fs 4 (1968Do12) and 18 fs 14 (1990Ki07).
7481?				E(level): from 1971Da08 only.
7532.26 5	2 ⁻	0.22 ps 7		E(level): 7532.25 5 (1990Ki07), 7532.29 11 (1988Sc23).
7561.18 7	4 ⁺	0.18 ps +10-5		E(level): 7561.17 7 (1990Ki07), 7561.3 3 (1988Sc23). $T_{1/2}$: from 1968Do12 by DSAM. Other: 36 fs 13 (1968Li12).
7623.11 8	(2 ⁻ ,3,4 ⁺)			
7658.23 5	4 ⁻			E(level): 7658.23 5 (1990Ki07), 7658.3 2 (1988Sc23).
7676.6	(6 ⁺)			E(level): from Adopted Levels. Seen by 1990Ki07 but energy could not be determined accurately.
7694.08 4	3 ⁻	≤ 6 fs		E(level): from 1990Ki07. Other: 7695.07 15 from 1988Sc23 is discrepant and is probably a typo. $T_{1/2}$: from 1968Li12 by DSAM.
7701.8 4	0 ⁺			E(level): 7701.9 4 (1990Ki07), 7701.4 7 (1988Sc23).
7769.4	(3,4,5) ⁻			E(level): from Adopted Levels. Seen by 1990Ki07 but energy could not be determined accurately.
7872.18 9	2 ⁺			E(level): 7872.18 9 (1990Ki07), 7872.1 5 (1988Sc23).
7928.37 22	4 ⁺			E(level): 7928.42 10 (1990Ki07), 7927.5 4 (1988Sc23).
7976?				E(level): from 1971Da08 only.
8091.61 17	2 ⁺			
8134.76 10	(3 ⁻)			E(level): 8134.77 10 (1990Ki07), 8134.4 5 (1988Sc23).
8187.69 13	(3,4,5 ⁻)			
8323.16 8	(1 ⁻ ,2 ⁺)	83 fs 28		
8338.0 3	(2 ⁺ ,3,4)			
8373.94 15	4 ⁺			
8424.81 11	2 ⁻			
8439.0 5	0 ⁺			
8484.02 13	(1 ⁻ ,2 ⁻ ,3 ⁻)			
8578.80 9	2 ⁺			
8678.29 10	4 ⁺	42 fs 35		
8748.20 9	2 ⁺			E(level): 8748.22 9 (1990Ki07), 8747.7 5 (1988Sc23).
8764.18 6	3 ⁻			$\approx 9\%$ γ -branching undetermined.
8934.81 7	2 ⁺		0.09 4	
8978?				E(level): from 1971Da08 only.
8994.50 11	(1 ⁻ ,2 ⁺)		0.15 6	
9031.9 3	4 ⁻			$\Gamma_p=1.5\Gamma_\gamma$ from intensity balance.
9091.70 6	3 ⁻		0.28 11	E(p)(lab)=783.23 11.
9135.66 5	(2,3) ⁻		0.6 2	
9209.77 5	(2,3) ⁻		0.39 16	
9226.69 5	(1 ⁻ ,2,3 ⁻)		0.28 11	S(p, γ) (eV): for 9226.69+9227.43.
9227.43 7	(1,2 ⁺)		0.28 11	S(p, γ) (eV): for 9226.69+9227.43.

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$^{39}\text{K}(\text{p},\gamma)$ **1990Ki07,1988Sc23** (continued) ^{40}Ca Levels (continued)

E(level) [†]	J^{π} [‡]	S(p, γ) (eV) ^b	Comments
9362.54 6	3 ⁻	0.43 17	
9377.7 2	(2,3,4) ⁻	0.24 10	E(p)(lab)=1076.70 18.
9388.20 19	2 ⁺	0.26 10	E(p)(lab)=1087.35 17.
9395.6 3		0.09 4	E(p)(lab)=1095.0 3.
9404.85 19	2 ^{-#}	0.36 14	E(p)(lab)=1104.43 17.
9406.3 6	0 ⁺	0.40 10	E(p)(lab)=1106.0 6.
9412.3 2		0.18 7	E(p)(lab)=1112.2 2.
9418.8 2	3 ⁻	0.6 2	E(p)(lab)=1118.76 18.
9429.11 5	(3,4) ⁻	0.2 2	
9432.46 18	1 ⁻	2.6 11	E(p)(lab)=1132.8 4.
9453.95 5	3 ⁻	0.8 3	E(p)(lab)=1154.85 11.
9499.9 15	2 ⁺	0.42 17	E(p)(lab)=1202.0 15.
9536.24 16		1.1 4	E(p)(lab)=1239.33 13.
9537.8 5	1 ⁻	0.24 10	E(p)(lab)=1240.9 5.
9603.0 4	3 ^{-#}	2.4 10	E(p)(lab)=1307.7 4. J^{π} : parity from Adopted Levels, but positive parity from 1967Le12 based on a resonance formation fit.
9604.6 4	1 ⁻	5 2	E(p)(lab)=1309.7 4.
9632.7 11		≈ 0.2	S(p, γ) (eV): 1981Ch04. Not observed by 1990Ki07 (S<0.15). E(p)(lab)=1337.2 10.
9640.89 7	2 ^{-#}	5 2	J^{π} : positive parity is impossible for a resonance formation fit (1967Le12).
9655.5 9		0.22 9	E(p)(lab)=1361.7 9.
9662.2 2		0.6 2	E(p)(lab)=1368.6 2.
9668.71 8	3 ⁻	2.4 10	
9779.49 7	3 [#]	2.2 9	E(p)(lab)=1488.53 12.
9785.3 2	(1,2 ⁺)	1.0 4	E(p)(lab)=1494.68 19.
9802.1 7		0.37 15	E(p)(lab)=1512.2 7.
9807.2 11		≈ 0.2	E(p)(lab)=1516.2 10. From 1981Ch04. Not observed by 1990Ki07 (S<0.2).
9811.0 2	(3 ⁻ ,4 ⁻ ,5 ⁻)	0.27 11	E(p)(lab)=1521.18 18.
9829.43 16		0.8 3	E(p)(lab)=1540.11 14.
9834.97 19		0.6 3	E(p)(lab)=1545.79 17.
9854.43 17		1.1 4	E(p)(lab)=1565.76 15.
9859.6 3	4 ⁻ ,5 ⁻ ,6 ⁻	0.5 2	E(p)(lab)=1571.1 3.
9865.15 11	1 [#]	6 2	E(p)(lab)=1576.74 15.
9869.3 4	1 ⁺	3.1 12	E(p)(lab)=1580.9 4.
9898.5 3		0.6 2	E(p)(lab)=1611.0 3.
9921.3 2	(3 ⁻ ,4 ⁻ ,5 ⁻)	0.43 17	E(p)(lab)=1634.33 18.
9939.7 2		0.13 5	E(p)(lab)=1653.2 2.
9954.00 9	4 ^{+#}	1.6 6	
9977.09 17	(3,4,5)	1.1 4	E(p)(lab)=1691.60 15.
9993.6 15		0.5 2	E(p)(lab)=1708.6 15.
10040.54 9	(2 ⁻ ,3 ⁻)	0.5 2	
10045.6 5			E(p)(lab)=1761.9 5.
10049.38 7	4 ⁻	4.5 19	E(p)(lab)=1765.58 12.
10057.9 3		0.17 7	E(p)(lab)=1774.5 2.
10080.6 2		0.9 4	E(p)(lab)=1797.78 18.
10130.59 19	(3 ⁻ ,4 ⁺)	1.4 6	E(p)(lab)=1849.07 17.
10136.6? 16		≈ 0.5	E(p)(lab)=1854.1 15. from 1981Ch04. Not observed by 1990Ki07 (S<0.3).
10199.1 4	1 ⁻	0.6 2	E(p)(lab)=1919.3 4.
10205.0 8		0.23 9	E(p)(lab)=1925.4 8.
10210.5 2	3 ⁻ ,4 ⁻	1.4 6	E(p)(lab)=1931.0 2.

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$^{39}\text{K}(\text{p},\gamma)$ **1990Ki07,1988Sc23** (continued) ^{40}Ca Levels (continued)

E(level) [†]	J $\pi^{\ddagger}$	S(p, γ) (eV) ^b	Comments
10232.7 7		1.3 5	E(p)(lab)=1953.8 7.
10262.53 10	3 ⁻	1.3 5	
10267.6 5	1 ⁻	0.19 8	E(p)(lab)=1989.6 5.
10274.7 3	3 ⁺ ,4 ⁺ ,5 ⁺	0.28 11	E(p)(lab)=1996.9 3.
10277.8 2	(1 ⁻)	0.7 3	E(p)(lab)=2000.1 2.
10284.9 3	1 ⁻	0.7 3	E(p)(lab)=2007.4 3.
10318.8 4	1 ⁺ #	14.3 10	J π : 1963Le08. S(p, γ) (eV): from 1981Ch04, used for calibration.
10332.5 15	(3) ⁻	0.8 3	E(p)(lab)=2056.2 15.
10358.5 15		0.6 2	E(p)(lab)=2082.9 15.
10361.4 15		2.1 8	E(p)(lab)=2085.9 15.
10375.4 15	1 ⁻	1.2 5	E(p)(lab)=2100.2 15.
10383.79 16	(1 ⁻ ,2 ⁺)	2.0 8	E(p)(lab)=2108.83 13.
10415.06 6	3	5.8 19	
10420.6 10	1 ⁻	0.8 3	E(p)(lab)=2146.6 10.
10430.47 19	(2 ⁺)	3.1 10	E(p)(lab)=2156.72 17.
10441.3 6		2.5 8	E(p)(lab)=2167.8 6.
10443.8 2	2 ⁻	1.7 5	E(p)(lab)=2170.4 2.
10469.9 15	(3,5) ⁻	0.6 2	E(p)(lab)=2197.2 15.
10478.6 15		1.0 4	E(p)(lab)=2206.1 15.
10503.0 15	(3,4,5) ⁻	1.1 4	E(p)(lab)=2231.1 15.
10514.7 15	(3 ⁻ ,4 ⁺ ,5 ⁻)	2.5 10	E(p)(lab)=2243.1 15.
10527.7 15	(1 ⁺)	3.7 15	E(p)(lab)=2256.5 15.
10539.9 15	2 ⁺	1.0 3	E(p)(lab)=2269.0 15.
10552.1 15		1.8 7	E(p)(lab)=2281.5 15.
10632.6 2	(1,3) ⁻	2.1 8	E(p)(lab)=2364.04 19.
10639.07 7	(3 ⁻ ,4,5 ⁻)	11 4	
10646.3 4	NATURAL	1.5 6	E(p)(lab)=2378.1 4.
10653.12 16		8 3	E(p)(lab)=2385.14 14.
10670.3 3		18 7	E(p)(lab)=2402.8 3.
10673.58 17	2 ⁻	5 2	E(p)(lab)=2406.13 15.
10677? 3	1 ⁻	0.7 2	E(p)(lab)=2408 3. from 1981Ch04. Not observed by 1990Ki07 (S<0.6).
10690.9 3		3.4 14	E(p)(lab)=2423.9 3.
10699.50 10	3	10 4	
10720.7 3	(3,5) ⁻	2.1 7	E(p)(lab)=2454.5 3.
10737.7 3	1 ⁻	4.6 18	24% 3 γ -branching undetermined.
10747.8 4	(4 ⁺)	15 6	
10753.74 18		4.5 18	E(p)(lab)=2488.37 16.
10770.2 3	(1 ⁺)	7 3	E(p)(lab)=2505.1 3.
10776.2 3		16 6	E(p)(lab)=2511.4 3.
10780.8 3	3 ⁻	6 2	E(p)(lab)=2516.1 3.
10787.6 3		3.0 12	E(p)(lab)=2523.1 3.
10799.9 10		1.1 4	E(p)(lab)=2535.7 10.
10813.6 5	(3 ⁻ ,4 ⁺ ,5 ⁻)	12.0 5	E(p)(lab)=2549.8 5.
10829.9 6		2.7 10	E(p)(lab)=2566.5 6.
10848.4 4	(3,4,5) ⁻	4.4 17	E(p)(lab)=2585.5 4.
10868.7 4	1 ⁻	5.2 19	E(p)(lab)=2606.3 4.
10910.0 4	(3,4,5 ⁻)	7 3	E(p)(lab)=2648.6 4.
10921.1 4	(2 ⁺ ,3,4 ⁻)	9 4	E(p)(lab)=2659.9 4.
10934.3 5		5 2	E(p)(lab)=2673.6 5.
10951.4 4	1 ⁻	16 4	E(p)(lab)=2691.1 4.
10956.0 4	3 ⁻	4.0 16	E(p)(lab)=2695.8 4.
10976.2 5	(3,4,5)	9 3	E(p)(lab)=2716.6 5.

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$^{39}\text{K}(\text{p},\gamma)$ **1990Ki07,1988Sc23** (continued) ^{40}Ca Levels (continued)

E(level) [†]	$J\pi^{\ddagger}$	S(p, γ) (eV) ^b	Comments
10988.0 4	(3 ⁻ ,4 ⁺)	8 3	E(p)(lab)=2728.6 4.
10994.7 4	(2 ⁺ ,3,4 ⁺)	11 4	E(p)(lab)=2735.5 4.
11002.3 5		2.9 12	E(p)(lab)=2743.4 5.
11011.0 4	3 ⁻	14 5	
11023.8 5	(1,3) ⁻	6 2	E(p)(lab)=2765.3 5.
11042.0 5	(1 ⁻ to 4 ⁺)	6 2	E(p)(lab)=2784.0 5.
11070.6 4	(3)	31 12	J^{π} : from 1971Da08 ; (3,4 ⁺) in Adopted Levels. E(p)(lab)=2813.3 4.
11080	1 ⁻		E(level): level from 1971Da08 . E(p)(lab)=2821.
11117.0 5		5 2	E(p)(lab)=2861.0 5.
11127.1 5		6 2	E(p)(lab)=2871.4 5.
11165.2 4		2.0 8	E(p)(lab)=2910.5 4.
12038 ^d 3	(3,4,5) ⁻		E(p)(lab)=3804 3. Γ_p (to 3352)=0.07 keV 3. Resonance strengths: 0.9 eV 4 to g.s., 1.0 eV 5 (first 2 ⁺ to g.s.), 2.3 eV 8 (first 3 ⁻ to g.s.) (1985Se16).
12049 ^d 3	2 ⁺		E(p)(lab)=3815 3. Γ_p (to 3352)=0.66 keV 13. Resonance strengths: 0.7 eV 3 to g.s., 1.2 eV 6 (first 2 ⁺ to g.s.), 0.5 eV 2 (first 3 ⁻ to g.s.) (1985Se16).
12068 ^d 3			E(p)(lab)=3834 3. Resonance strengths: 9 eV 3 to g.s. (1985Se16).
12074 ^d 3			E(p)(lab)=3841 3. Γ_p (to 3352)=0.030 keV 17. Resonance strengths: 0.7 eV 3 to g.s., 1.5 eV 6 (first 2 ⁺ to g.s.), 1.1 eV 5 (first 3 ⁻ to g.s.) (1985Se16).
12099 ^a 10		5.1 ^c	E(p)(lab)=3863 10.
12111 ^a 10		3.5 ^c	E(p)(lab)=3875 10.
12204 ^a 10		2.5 ^c	E(p)(lab)=3970 10.
12334 ^a 10		3.4 ^c	E(p)(lab)=4104 10.
12423 ^a 10		2.3 ^c	E(p)(lab)=4195 10.
12604 ^a 10		5.9 ^c	E(p)(lab)=4380 10.
12647 ^a 10		^c	E(p)(lab)=4425 10.
12668 ^a 10		14.5 ^c	E(p)(lab)=4446 10.
12688 ^a 10		4.4 ^c	E(p)(lab)=4467 10.
12875 ^a 10		6.1 ^c	E(p)(lab)=4658 10.
12980 ^a 10		4.2 ^c	E(p)(lab)=4766 10.
12996 ^a 10		^c	E(p)(lab)=4783 10.
13086 ^a 10		2.1 ^c	E(p)(lab)=4875 10.
13113 ^a 10		18.4 ^c	E(p)(lab)=4903 10.
13194 ^a 10		13.9 ^c	E(p)(lab)=4986 10.
13203 ^a 10		6.1 ^c	E(p)(lab)=4995 10.
13289 ^a 10		8.1 ^c	E(p)(lab)=5083 10.
13822 ^a 10		2.9 ^c	E(p)(lab)=5630 10.
13913 ^a 10		56.0 ^c	E(p)(lab)=5723 10.
13993 ^a 10		112.0 ^c	E(p)(lab)=5805 10.
18260 ^{&} 5	1		E(p)(lab)=10190.
18680 ^{&} 5	1		E(p)(lab)=10620.

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³⁹K(p,γ) **1990Ki07,1988Sc23** (continued)

⁴⁰Ca Levels (continued)

E(level) [†]	J ^π [‡]	Comments
19070 ^{&5}	1	E(p)(lab)=11020.
19450 ^{&5}	1	E(p)(lab)=11410.
19850 ^{&5}	1	E(p)(lab)=11820.
20130 ^{&5}		E(p)(lab)=12110.
20430 ^{&5}	1	E(p)(lab)=12420.
20650 ^{&5}	1	E(p)(lab)=12640.
20940 ^{&5}	1	E(p)(lab)=12940.
21490 ^{&5}		E(p)(lab)=13500.
21690 ^{&5}		E(p)(lab)=13710.
22060 ^{&5}		E(p)(lab)=14090.

[†] From **1990Ki07**, unless otherwise noted. Values are from a least-squares fit to γ-ray energies by authors where levels are connected by γ rays, and otherwise are deduced from E(p)(lab) as given under comments and S(p)(⁴⁰Ca). Where value (below 8750) is also available in **1988Sc23**, weighted average is taken. For levels deduced from E(p)(lab), **1990Ki07** use S(p)(⁴⁰Ca)=8328.28 9 determined in their work; the evaluator has corrected their values using the Adopted S(p)=8328.17 2 (**2012Wa38**). E(p)(lab) values are from **1990Ki07** up to 2910, from **1985Se16** for 3804-3841, from **1968Ba22** for 3863-5805, and from **1973Di02** for 10190-14090.

[‡] From Adopted Levels, unless otherwise noted. **1967Le12** and **1963Le08** report assignments based on measured γγ(θ) and γ(pol), which have been considered for J^π assignments in Adopted Levels.

Spin from pγγ(θ) (**1967Le12**).

@ From DSAM (**1990Ki07**), unless otherwise noted.

& From **1973Di02**; E(p)=6.5-17.5 MeV (Δ(E(p))≈5 keV).

^a From **1968Ba22**.

^b From **1990Ki07**, unless otherwise stated.

^c From **1968Ba22**, using Γ=26 eV for E(p)=2050 resonance (2042.0 resonance listed here).

^d From **1985Se16**.

γ(⁴⁰Ca)

E _i (level)	J _i ^π	E _γ [†]	I _γ [‡]	E _f	J _f ^π	Mult. [§]	Comments
3352.64	0 ⁺	3352.5		0	0 ⁺	[E0]	Decay is mainly by e ⁺ e ⁻ pair emission.
3736.69	3 ⁻	384.1 ^g	<0.04	3352.64	0 ⁺		
		3736.8 3	100	0	0 ⁺	[E3]	E _γ : from 1968Li12 , 3736.5 from level-energy difference.
3904.38	2 ⁺	167.7 ^g	<0.9	3736.69	3 ⁻		
		551.8 ^g	<0.1	3352.64	0 ⁺		
		3904.5 3	100	0	0 ⁺		E _γ : from 1968Li12 , 3904.2 from level-energy difference.
4491.44	5 ⁻	754.8 3	100	3736.69	3 ⁻	E2	E _γ : from 1968Li12 , 754.7 from level-energy difference. δ(M3/E2)=-0.01 2 (1967Le12), -0.05 3 (1963Le08).
		1138.8 ^g	<0.9	3352.64	0 ⁺		
		4491.2 ^g	<1.6	0	0 ⁺		
5211.7	0 ⁺	720.2 ^g	<1.3	4491.44	5 ⁻		
		1307.3	100	3904.38	2 ⁺		
		1475.0 ^g	<1.3	3736.69	3 ⁻		
5248.81	2 ⁺	757.4 ^g	<1.1	4491.44	5 ⁻		
		1344.4	15.1 9	3904.38	2 ⁺		I _γ : 14.8 11 (1988Sc23), 15.3 9 (1990Ki07).
		1512.1 ^g	<0.6	3736.69	3 ⁻		

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$^{39}\text{K}(\text{p},\gamma)$ **1990Ki07,1988Sc23** (continued) $\gamma(^{40}\text{Ca})$ (continued)

$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\ddagger$	E_f	J_f^π	Mult. [§]	$\delta^\S$	Comments
5248.81	2 ⁺	1896.1 5248.9 6	5.1 6 79.8 12	3352.64 0	0 ⁺ 0 ⁺			I_γ : 5.4 8 (1988Sc23), 4.9 6 (1990Ki07). E_γ : from 1968Li12, 5248.4 from level-energy difference.
5278.81	4 ⁺	787.4 1374.5 4	3.0 15 97.0 15	4491.44 3904.38	5 ⁻ 2 ⁺	E2		I_γ : 79.8 23 (1988Sc23), 79.8 12 (1990Ki07). I_γ : from 1988Sc23. Other: <1.1 (1990Ki07). E_γ : from 1968Li12, 1374.4 from level-energy difference.
5613.53	4 ⁻	1542.1 ^g 5278.4 ^g 334.7 ^g 364.7 ^g 401.8 ^g 1121.5 6	<0.9 <1.8 <7 <6 <6 29.5 20	3736.69 0 5278.81 5248.81 5211.7 4491.44	3 ⁻ 0 ⁺ 4 ⁺ 2 ⁺ 0 ⁺ 5 ⁻	M1+E2	-0.7 2	I_γ : from 1990Ki07. Other: <6 (1988Sc23). E_γ : from 1968Li12, 1122.1 from level-energy difference.
		1709.1 ^g 1877.0 3	<2 70.5 20	3904.38 3736.69	2 ⁺ 3 ⁻	M1+E2	-0.27 5	I_γ : 27.5 14 (1988Sc23), 31.4 14 (1990Ki07). E_γ : from 1968Li12, 1876.8 from level-energy difference.
5629.43	2 ⁺	2260.8 ^g 350.6 ^g 380.6 ^g 417.7 ^g 1138.0 ^g 1725.0 ^g 1892.7 ^g 2276.7 5628.3 13	<3 <1.1 <1.0 <1.6 <0.6 <0.8 <1.1 12.3 9 87.7 9	3352.64 5278.81 5248.81 5211.7 4491.44 3904.38 3736.69 3352.64 0	0 ⁺ 4 ⁺ 2 ⁺ 0 ⁺ 5 ⁻ 2 ⁺ 3 ⁻ 0 ⁺ 0 ⁺			I_γ : 72.5 14 (1988Sc23), 68.6 14 (1990Ki07). I_γ : 13.4 16 (1988Sc23), 12.0 9 (1990Ki07). E_γ : from 1968Li12, 5629.0 from level-energy difference.
5902.63	1 ⁻	289.1 ^g 623.8 ^g 653.8 ^g 690.9 ^g 1411.2 ^g 1998.2 ^g 2165.9 ^g 2549.9 ^g 5902.7 11	<0.6 <0.5 <0.5 <0.5 <0.7 <0.8 <9 <5 100	5613.53 5278.81 5248.81 5211.7 4491.44 3904.38 3736.69 3352.64 0	4 ⁻ 4 ⁺ 2 ⁺ 0 ⁺ 5 ⁻ 2 ⁺ 3 ⁻ 0 ⁺ 0 ⁺			I_γ : 86.6 16 (1988Sc23), 88.0 9 (1990Ki07). E_γ : from 1968Li12, 5902.2 from level-energy difference.
6025.47	2 ⁻	122.8 ^g 396.0 ^g 411.9 ^g 746.7 ^g 776.7 ^g 813.8 ^g 1534.0 ^g	<3 <0.4 <0.4 <0.4 <0.4 <0.4 <0.5	5902.63 5629.43 5613.53 5278.81 5248.81 5211.7 4491.44	1 ⁻ 2 ⁺ 4 ⁻ 4 ⁺ 2 ⁺ 0 ⁺ 5 ⁻			

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$^{39}\text{K}(\text{p},\gamma)$ **1990Ki07,1988Sc23** (continued) $\gamma(^{40}\text{Ca})$ (continued)

$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\ddagger$	E_f	J_f^π	Mult. [§]	$\delta^\S$	Comments
6025.47	2 ⁻	2121.0	18.5 22	3904.38	2 ⁺			I_γ : 22.4 16 (1988Sc23), 17.3 9 (1990Ki07).
		2288.7	81.5 22	3736.69	3 ⁻			I_γ : 77.6 16 (1988Sc23), 82.7 9 (1990Ki07).
		2672.8 ^g	<0.7	3352.64	0 ⁺			
		6025.0 ^g	<1.8	0	0 ⁺			
6029.71	3 ⁺	127.1 ^g	<4	5902.63	1 ⁻			
		400.3 ^g	<2	5629.43	2 ⁺			
		416.2 ^g	<2	5613.53	4 ⁻			
		750.9 ^g	<1	5278.81	4 ⁺			
		780.9	20 3	5248.81	2 ⁺			I_γ : 12 4 (1988Sc23), 21.2 17 (1990Ki07).
		818.0 ^g	<1	5211.7	0 ⁺			
		1538.2 ^g	<6	4491.44	5 ⁻			
		2125.3	80 3	3904.38	2 ⁺			I_γ : 88 4 (1988Sc23), 78.8 17 (1990Ki07).
		2293.0 ^g	<6	3736.69	3 ⁻			
		2677.0 ^g	<5	3352.64	0 ⁺			
		6029.2 ^g	<4	0	0 ⁺			
6285.15	3 ⁻	255.4	<0.3	6029.71	3 ⁺			
		259.7 ^g	<0.3	6025.47	2 ⁻			
		382.5 ^g	<0.3	5902.63	1 ⁻			
		655.7 ^g	<0.6	5629.43	2 ⁺			
		671.6	0.9 2	5613.53	4 ⁻			
		1006.3 ^g	<0.4	5278.81	4 ⁺			
		1036.3 ^g	<0.3	5248.81	2 ⁺			
		1073.4 ^g	<0.3	5211.7	0 ⁺			
		1793.9 6	72.0 8	4491.44	5 ⁻	Q+O	+0.03 2	E_γ : from 1968Li12, 1793.7 from level-energy difference.
								I_γ : 72.0 8 (1988Sc23), 72.6 11 (1990Ki07).
		2380.1 10	19.7 5	3904.38	2 ⁺			E_γ : from 1968Li12, 2380.7 from level-energy difference.
								I_γ : 19.7 5 (1988Sc23), 19.8 6 (1990Ki07).
		2548.4	3.2 4	3736.69	3 ⁻			I_γ : 3.0 5 (1988Sc23), 3.5 4 (1990Ki07).
		2932.4 ^g	<0.7	3352.64	0 ⁺			
		6284.6	4.2 5	0	0 ⁺			I_γ : 5.3 5 (1988Sc23), 3.1 5 (1990Ki07).
6507.84	4 ⁺	605.2 ^g	<3	5902.63	1 ⁻			
		878.4 ^g	<2	5629.43	2 ⁺			
		894.3 ^g	<2	5613.53	4 ⁻			
		1229.0 ^g	<3	5278.81	4 ⁺			
		1259.0	15 3	5248.81	2 ⁺			
		1296.1 ^g	<3	5211.7	0 ⁺			
		2016.4 ^g	<2	4491.44	5 ⁻			
		2603.4	85 3	3904.38	2 ⁺			
		2771.1 ^g	<3	3736.69	3 ⁻			
		3155.1 ^g	<3	3352.64	0 ⁺			
		6507.3 ^g	<9	0	0 ⁺			
6542.78	4 ⁺	513.1 ^g	<5	6029.71	3 ⁺			
		517.3 ^g	<2	6025.47	2 ⁻			
		640.1 ^g	<1	5902.63	1 ⁻			
		913.3	19 2	5629.43	2 ⁺			
		929.2 ^g	<2	5613.53	4 ⁻			

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$^{39}\text{K}(\text{p},\gamma)$ **1990Ki07,1988Sc23** (continued) $\gamma(^{40}\text{Ca})$ (continued)

$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\dagger$	E_f	J_f^π	Comments
6542.78	4 ⁺	1264.0	8 2	5278.81	4 ⁺	
		1294.0	14 2	5248.81	2 ⁺	
		2051.3 ^g	<2	4491.44	5 ⁻	
		2638.3	59 2	3904.38	2 ⁺	
		2806.0 ^g	<3	3736.69	3 ⁻	
		6542.2 ^g	<4	0	0 ⁺	
6582.54	3 ⁻	552.8 ^g	<0.5	6029.71	3 ⁺	
		557.1 ^g	<0.6	6025.47	2 ⁻	
		679.9 ^g	<0.5	5902.63	1 ⁻	
		953.1 ^g	<0.5	5629.43	2 ⁺	
		969.0	17 3	5613.53	4 ⁻	I_γ : 8 4 (1988Sc23), 17.8 15 (1990Ki07).
		1303.7 ^g	<0.9	5278.81	4 ⁺	
		1333.7 ^g	<0.8	5248.81	2 ⁺	
		1370.8 ^g	<0.8	5211.7	0 ⁺	
		2091.0	<0.7	4491.44	5 ⁻	I_γ : other: 3 2 (1988Sc23).
		2678.1	16.1 12	3904.38	2 ⁺	I_γ : 21 4 (1988Sc23), 15.8 10 (1990Ki07).
		2845.7	66.5 13	3736.69	3 ⁻	I_γ : 68 6 (1988Sc23), 66.4 13 (1990Ki07).
		3229.8 ^g	<3	3352.64	0 ⁺	
		6582.0 ^g	<2	0	0 ⁺	
6750.41	2 ⁻	720.7 ^g	<3	6029.71	3 ⁺	
		724.9 ^g	<2	6025.47	2 ⁻	
		847.8 ^g	<3	5902.63	1 ⁻	
		1121.0 ^g	<7	5629.43	2 ⁺	
		1136.9 ^g	<2	5613.53	4 ⁻	
		1471.6 ^g	<3	5278.81	4 ⁺	
		1501.6 ^g	<8	5248.81	2 ⁺	
		1538.7 ^g	<3	5211.7	0 ⁺	
		2258.9 ^g	<3	4491.44	5 ⁻	
		2845.9 ^g	<10	3904.38	2 ⁺	
		3013.6	100	3736.69	3 ⁻	
		3397.6 ^g	<8	3352.64	0 ⁺	
		6749.8 ^g	<8	0	0 ⁺	
6908.70	2 ⁺	879.0 ^g	<0.3	6029.71	3 ⁺	
		883.2 ^g	<0.3	6025.47	2 ⁻	
		1006.1 ^g	<0.3	5902.63	1 ⁻	
		1279.3 ^g	<0.6	5629.43	2 ⁺	
		1295.2 ^g	<0.4	5613.53	4 ⁻	
		1629.9 ^g	<0.9	5278.81	4 ⁺	
		1659.9 ^g	<0.4	5248.81	2 ⁺	
		1697.0 ^g	<0.4	5211.7	0 ⁺	
		2417.2 ^g	<0.6	4491.44	5 ⁻	
		3004.2 ^g	<0.7	3904.38	2 ⁺	
		3171.9 ^g	<0.9	3736.69	3 ⁻	
		3555.9 ^g	<1.2	3352.64	0 ⁺	
		6908.1	100	0	0 ⁺	
6931.29	3 ⁻	905.8 ^g	<0.2	6025.47	2 ⁻	

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$^{39}\text{K}(\text{p},\gamma)$ **1990Ki07,1988Sc23** (continued) $\gamma(^{40}\text{Ca})$ (continued)

$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\dagger$	E_f	J_f^π	Comments
6931.29	3^-	1028.7 ^g	<0.2	5902.63	1^-	
		1301.8	5.8 3	5629.43	2^+	
		1317.7	2.0 3	5613.53	4^-	
		1652.4 ^g	<0.3	5278.81	4^+	
		1682.4	6.1 3	5248.81	2^+	
		1719.6 ^g	<0.2	5211.7	0^+	
		2439.8	1.4 3	4491.44	5^-	
		3026.8	2.0 5	3904.38	2^+	
		3194.5	82.7 7	3736.69	3^-	
		3578.5 ^g	<0.4	3352.64	0^+	
		6930.7 ^g	<3	0	0^+	
		920.8 ^g	<2	6029.71	3^+	
		925.0 ^g	<2	6025.47	2^-	
		1047.9 ^g	<2	5902.63	1^-	
6950.49	1^-	1321.0 ^g	<2	5629.43	2^+	
		1336.9 ^g	<8	5613.53	4^-	
		1671.6 ^g	<5	5278.81	4^+	
		1701.6 ^g	<2	5248.81	2^+	
		1738.8 ^g	<2	5211.7	0^+	
		2459.0 ^g	<6	4491.44	5^-	
		3046.0 ^g	<4	3904.38	2^+	
		3213.7 ^g	<5	3736.69	3^-	
		3597.7 ^g	<6	3352.64	0^+	
		6949.8	100	0	0^+	
		1084.0 ^g	<0.3	6029.71	3^+	
		1088.2	1.1 3	6025.47	2^-	
		1211.1 ^g	<0.5	5902.63	1^-	
		1484.3 ^g	<0.4	5629.43	2^+	
7113.73	4^-	1500.2	6.7 7	5613.53	4^-	I_γ : 7.7 6 (1988Sc23), 6.2 4 (1990Ki07).
		1834.9	1.7 3	5278.81	4^+	
		1864.9 ^g	<0.6	5248.81	2^+	
		1902.0 ^g	<0.4	5211.7	0^+	
		2622.4 10	26.4 13	4491.44	5^-	E_γ : from 1968Li12, 2622.2 from level-energy difference. I_γ : 30.0 14 (1988Sc23), 25.9 5 (1990Ki07).
		3209.2 ^g	<0.8	3904.38	2^+	
		3377.0 10	64.8 9	3736.69	3^-	E_γ : from 1968Li12, 3376.9 from level-energy difference. I_γ : 62.3 20 (1988Sc23), 65.1 7 (1990Ki07).
		3760.9 ^g	<1.0	3352.64	0^+	
		7113.1 ^g	<1.2	0	0^+	
		3208.5		3904.38	2^+	
		7113.3		0	0^+	
7239.07	$(3^-, 4, 5^-)$	3502.2		3736.69	3^-	
7277.82	$(2, 3)^+$	1248.1 ^g	<3	6029.71	3^+	
		1252.3 ^g	<6	6025.47	2^-	
		1648.4 ^g	<5	5629.43	2^+	
		1664.3 ^g	<4	5613.53	4^-	
		1999.0 ^g	<10	5278.81	4^+	
		2029.0 ^g	<6	5248.81	2^+	

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$^{39}\text{K}(\text{p},\gamma)$ **1990Ki07,1988Sc23** (continued)

 $\gamma(^{40}\text{Ca})$ (continued)

$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\dagger$	E_f	J_f^π	Comments
7277.82	$(2,3)^+$	2066.1 ^g	<5	5211.7	0^+	
		2786.3 ^g	<7	4491.44	5^-	
		3541.0	100	3736.69	3^-	
		3925.0 ^g	<5	3352.64	0^+	
		7277.1 ^g	<3	0	0^+	
7300.74	0^+	1271.0 ^g	<1.2	6029.71	3^+	
		1275.3 ^g	<1.2	6025.47	2^-	
		1398.1 ^g	<6	5902.63	1^-	
		1671.3	5.0 15	5629.43	2^+	I_γ : other: 3 1 (1988Sc23). 1988Sc23 report unobserved branching of 12%.
		1687.2 ^g	<1.0	5613.53	4^-	
		2021.9 ^g	<1.3	5278.81	4^+	
		2051.9	95.0 15	5248.81	2^+	I_γ : other: 85 5 (1988Sc23). 1988Sc23 report unobserved branching of 12%.
		2809.2 ^g	<6	4491.44	5^-	
		3396.2 ^g	<5	3904.38	2^+	
		3563.9 ^g	<2	3736.69	3^-	
7446.23	$3^+, 4^+$	1416.5 ^g	<0.4	6029.71	3^+	
		1420.7 ^g	<0.4	6025.47	2^-	
		1543.6 ^g	<0.4	5902.63	1^-	
		1816.8	12.8 7	5629.43	2^+	
		1832.7	20.7 8	5613.53	4^-	
		2167.4	23.8 12	5278.81	4^+	
		2196.9 19	42.7 11	5248.81	2^+	E_γ : from 1968Li12, 2197.4 from level-energy difference.
		2234.5 ^g	<0.4	5211.7	0^+	
		2954.7 ^g	<1.4	4491.44	5^-	
		3541.7 ^g	<2	3904.38	2^+	
		3709.4 ^g	<0.9	3736.69	3^-	
		4093.4 ^g	<0.7	3352.64	0^+	
		7445.5 ^g	<0.8	0	0^+	
7466.37	2^+	1436.6 ^g	<0.4	6029.71	3^+	
		1440.9 ^g	<0.4	6025.47	2^-	
		1563.7 ^g	<0.4	5902.63	1^-	
		1836.9 ^g	<0.6	5629.43	2^+	
		1852.8 ^g	<1.1	5613.53	4^-	
		2187.5 ^g	<0.6	5278.81	4^+	
		2217.5	13.2 17	5248.81	2^+	I_γ : from 1990Ki07, not observed in 1988Sc23.
		2254.6 ^g	<0.6	5211.7	0^+	
		2974.8 ^g	<1.0	4491.44	5^-	
		3561.8	19.9 14	3904.38	2^+	I_γ : other: 28 4 (1988Sc23).
		3729.5 ^g	<1.7	3736.69	3^-	
		4113.5	11.6 10	3352.64	0^+	I_γ : other: 10 2 (1988Sc23).
		7465.6	55.3 19	0	0^+	I_γ : other: 62 4 (1988Sc23).
7481?		7480		0	0^+	
7532.26	2^-	1247.1	9.8 9	6285.15	3^-	I_γ : from 1990Ki07, not reported in 1988Sc23.
		1502.5 ^g	<1.4	6029.71	3^+	
		1506.8	4.8 4	6025.47	2^-	I_γ : from 1990Ki07, not reported in 1988Sc23.
		1629.6	3.4 10	5902.63	1^-	I_γ : from 1990Ki07, not reported in 1988Sc23.

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$^{39}\text{K}(\text{p},\gamma)$ **1990Ki07,1988Sc23** (continued) $\gamma(^{40}\text{Ca})$ (continued)

$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\dagger$	E_f	J_f^π	Comments
7532.26	2 ⁻	1902.8 ^g	<0.6	5629.43	2 ⁺	
		1918.7	24.2 14	5613.53	4 ⁻	I_γ : other: 30.5 12 (1988Sc23).
		2253.4 ^g	<1.4	5278.81	4 ⁺	
		2283.4 ^g	<3	5248.81	2 ⁺	
		2320.5 ^g	<0.7	5211.7	0 ⁺	
		3040.7 ^g	<0.9	4491.44	5 ⁻	
		3627.7	15.3 14	3904.38	2 ⁺	I_γ : other: 14.2 8 (1988Sc23).
		3795.4 10	42.5 16	3736.69	3 ⁻	E_γ : from 1968Li12, 3795.4 from level-energy difference. I_γ : other: 55.3 13 (1988Sc23).
		4179.4 ^g	<0.9	3352.64	0 ⁺	
		7531.5 ^g	<2	0	0 ⁺	
7561.18	4 ⁺	1531.4	28 3	6029.71	3 ⁺	I_γ : 30 3 (1988Sc23), 27 3 (1990Ki07).
		1535.7 ^g	<1.8	6025.47	2 ⁻	
		1658.5 ^g	<0.6	5902.63	1 ⁻	
		1931.7 ^g	<0.8	5629.43	2 ⁺	
		1947.6 ^g	<0.9	5613.53	4 ⁻	
		2282.3 ^g	<0.9	5278.81	4 ⁺	
		2313.0 6	63 8	5248.81	2 ⁺	E_γ : from 1968Li12, 2312.3 from level-energy difference. I_γ : 61 8 (1988Sc23), 65 8 (1990Ki07).
		2349.4 ^g	<1.5	5211.7	0 ⁺	
		3069.6 ^g	<0.8	4491.44	5 ⁻	
		3656.6 ^g	<4	3904.38	2 ⁺	
		3824.3	9 2	3736.69	3 ⁻	I_γ : 9 2 (1988Sc23), 8 5 (1990Ki07).
		4208.3 ^g	<0.6	3352.64	0 ⁺	
		7560.4 ^g	<1.5	0	0 ⁺	
7623.11	(2 ⁻ ,3,4 ⁺)	1593.4 ^g	<0.5	6029.71	3 ⁺	
		1597.6 ^g	<0.5	6025.47	2 ⁻	
		1720.4 ^g	<0.7	5902.63	1 ⁻	
		1993.6	35.9 10	5629.43	2 ⁺	I_γ : other: 35 10 (1988Sc23).
		2011.4 12	32.2 10	5613.53	4 ⁻	E_γ : from 1968Li12, 2009.5 from level-energy difference. I_γ : other: 10 6 (1988Sc23).
		2344.2 ^g	<0.9	5278.81	4 ⁺	
		2374.2	11.3 7	5248.81	2 ⁺	I_γ : not reported in 1988Sc23.
		2411.3 ^g	<0.5	5211.7	0 ⁺	
		3131.5 ^g	<0.7	4491.44	5 ⁻	
		3718.5 ^g	<1.0	3904.38	2 ⁺	
		3886.2	20.6 7	3736.69	3 ⁻	I_γ : other: 55 15 (1988Sc23).
		4270.3 ^g	<0.9	3352.64	0 ⁺	
		7622.3 ^g	<0.5	0	0 ⁺	
7658.23	4 ⁻	1373.1	13 2	6285.15	3 ⁻	I_γ : not reported in 1988Sc23.
		2044.6	39 3	5613.53	4 ⁻	I_γ : other: 43 6 (1988Sc23).
		2379.3 ^g	<2	5278.81	4 ⁺	
		2446.5 ^g	<2	5211.7	0 ⁺	
		3166.7	22 3	4491.44	5 ⁻	I_γ : other: 22 4 (1988Sc23).
		3753.7 ^g	<4	3904.38	2 ⁺	
		3921.3	26 3	3736.69	3 ⁻	I_γ : other: 35 6 (1988Sc23).
		4305.4 ^g	<4	3352.64	0 ⁺	
		7657.4 ^g	<0.3	0	0 ⁺	

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$^{39}\text{K}(\text{p},\gamma)$ **1990Ki07,1988Sc23** (continued) $\gamma(^{40}\text{Ca})$ (continued)

$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\ddagger$	E_f	J_f^π	Comments
7676.6	(6^+)	2397.7	100	5278.81	4^+	
7694.08	3^-	1664.4 ^g	<1.2	6029.71	3^+	
		1668.6 ^g	<1.3	6025.47	2^-	
		1791.5 ^g	<8	5902.63	1^-	
		2064.7 ^g	<1.2	5629.43	2^+	
		2080.6	9.2 12	5613.53	4^-	I_γ : other: 9.3 18 (1988Sc23).
		2415.3 ^g	<1.5	5278.81	4^+	
		2445.3 ^g	<1.5	5248.81	2^+	
		2482.4 ^g	<1.7	5211.7	0^+	
		3202.6 ^g	<2	4491.44	5^-	
		3789.6 ^g	<2	3904.38	2^+	
		3958.6 13	90.8 12	3736.69	3^-	E_γ : from 1968Li12, 3957.3 from level-energy difference. I_γ : other: 90.7 18 (1988Sc23).
		4341.3 ^g	<1.9	3352.64	0^+	
7701.8	0^+	7693.4 ^g	<3	0	0^+	
		1672.1 ^g	<5	6029.71	3^+	
		1676.3 ^g	<5	6025.47	2^-	
		3797.2	100	3904.38	2^+	
7769.4	$(3,4,5)^-$	2155.8	34 6	5613.53	4^-	
		4032.5	66 6	3736.69	3^-	
7872.18	2^+	2258.6 ^g	<6	5613.53	4^-	
		2593.3 ^g	<5	5278.81	4^+	
		2623.3 ^g	<11	5248.81	2^+	
		3967.6 ^g	<5	3904.38	2^+	
7928.37	4^+	7871.4	100 @	0	0^+	
		1898.7 ^g	<4	6029.71	3^+	
		1902.9 ^g	<4	6025.47	2^-	
		2025.7 ^g	<3	5902.63	1^-	
		2298.9 ^g	<4	5629.43	2^+	
		2314.8	50 9	5613.53	4^-	
		2649.5 ^g	<3	5278.81	4^+	
		2679.5 ^g	<6	5248.81	2^+	
		2716.6 ^g	<3	5211.7	0^+	
		3436.8	50 9	4491.44	5^-	
		4023.8 ^g	<5	3904.38	2^+	
		4191.5 ^g	<7	3736.69	3^-	
		4575.5 ^g	<4	3352.64	0^+	
		7927.6 ^g	<6	0	0^+	
7976?		1433		6542.78	4^+	
8091.61	2^+	8090.7	100	0	0^+	
8134.76	(3^-)	2505.3	28 3	5629.43	2^+	I_γ : from 1988Sc23.
		2521.2	8 3	5613.53	4^-	I_γ : from 1988Sc23.
		3643.1 ^g	<5	4491.44	5^-	I_γ : from 1988Sc23.
		4230.1	34 10	3904.38	2^+	I_γ : from 1988Sc23, 60 20 from 1990Ki07. 1988Sc23 report 30% γ -branching undetermined, 1990Ki07 report 40% 20.
8187.69	$(3,4,5^-)$	4450.7	100	3736.69	3^-	
8323.16	$(1^-, 2^+)$	1572.7	7.4 6	6750.41	2^-	
		2038.0	1.3 3	6285.15	3^-	

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$^{39}\text{K}(\text{p},\gamma)$ **1990Ki07,1988Sc23** (continued) $\gamma(^{40}\text{Ca})$ (continued)

$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\ddagger$	E_f	J_f^π	Comments
8323.16	$(1^-, 2^+)$	2297.6	15.6 10	6025.47	2^-	
		2420.5	1.1 7	5902.63	1^-	
		2693.6 ^g	<0.4	5629.43	2^+	
		2709.5 ^g	<0.3	5613.53	4^-	
		3044.2 ^g	<0.3	5278.81	4^+	
		3074.2	2.7 5	5248.81	2^+	
		3111.3 ^g	<0.3	5211.7	0^+	
		3831.5 ^g	<0.5	4491.44	5^-	
		4418.5 ^g	<1.3	3904.38	2^+	
		4586.2	59.4 19	3736.69	3^-	1990Ki07 report 11% 2 γ -branching undetermined.
		4970.2 ^g	<0.3	3352.64	0^+	
		8322.2	2.0 7	0	0^+	
8338.0	$(2^+, 3, 4)$	1795.2	60 6	6542.78	4^+	1990Ki07 report 15% 8 γ -branching undetermined.
		1830.1	25 6	6507.84	4^+	
8373.94	4^+	4469.3	70 20	3904.38	2^+	1990Ki07 report 30% 20 γ -branching undetermined.
8424.81	2^-	2395.0 ^g	<3	6029.71	3^+	
		2399.3	13 3	6025.47	2^-	
		2522.1	17 3	5902.63	1^-	
		2795.3 ^g	<6	5629.43	2^+	
		2811.2 ^g	<3	5613.53	4^-	
		3145.9 ^g	<4	5278.81	4^+	
		3175.9 ^g	<4	5248.81	2^+	
		3213.0 ^g	<4	5211.7	0^+	
		3933.2 ^g	<4	4491.44	5^-	
		4520.2 ^g	<4	3904.38	2^+	
		4687.8	70 4	3736.69	3^-	
		5071.9 ^g	<6	3352.64	0^+	
		8423.9 ^g	<1.5	0	0^+	
8439.0	0^+	2809.5	>80	5629.43	2^+	
8484.02	$(1^-, 2^-, 3^-)$	2581.3	37 7	5902.63	1^-	
		4747.0	63 7	3736.69	3^-	
8578.80	2^+	2549.0 ^g	<4	6029.71	3^+	
		2553.2 ^g	<4	6025.47	2^-	
		2949.3 ^g	<4	5629.43	2^+	
		2965.2 ^g	<4	5613.53	4^-	
		3299.8 ^g	<5	5278.81	4^+	
		3329.8 ^g	<5	5248.81	2^+	
		3367.0 ^g	<5	5211.7	0^+	
		4087.1 ^g	<4	4491.44	5^-	
		4674.1 ^g	<4	3904.38	2^+	
		4841.8 ^g	<6	3736.69	3^-	
		5225.8 ^g	<7	3352.64	0^+	
		8577.8	100	0	0^+	
8678.29	4^+	2393.1	13 5	6285.15	3^-	
		4941.3	65 15	3736.69	3^-	1990Ki07 report 22% 16 γ -branching undetermined.
8748.20	2^+	8747.2	>80	0	0^+	
8764.18	3^-	2734.4	16 6	6029.71	3^+	
		3134.6	19 7	5629.43	2^+	

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$^{39}\text{K}(\text{p},\gamma)$ **1990Ki07,1988Sc23** (continued) $\gamma(^{40}\text{Ca})$ (continued)

$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\dagger$	E_f	J_f^π	Comments
8764.18	3^-	3485.2	34 10	5278.81	4^+	1990Ki07 report $\approx 9\%$ γ -branching undetermined.
		4859.5	22 6	3904.38	2^+	
8934.81	2^+	1402.5	4.6 4	7532.26	2^-	
		1657.0	1.3 2	7277.82	$(2,3)^+$	
		1821.0	0.65 16	7113.73	4^-	
		1984.3	2.1 3	6950.49	1^-	
		2184.3	2.1 3	6750.41	2^-	
		2352.2	0.70 10	6582.54	3^-	
		2905.0	1.2 4	6029.71	3^+	
		2909.2	6.6 7	6025.47	2^-	
		3032.1	0.63 17	5902.63	1^-	
		3305.2	1.1 2	5629.43	2^+	
		3685.8	2.1 9	5248.81	2^+	
		3722.9	1.3 3	5211.7	0^+	
		5030.1	37.6 17	3904.38	2^+	
		5197.8	1.1 5	3736.69	3^-	
		5581.8	8.2 8	3352.64	0^+	
		8933.7	29 2	0	0^+	
8978?		5241		3736.69	3^-	
8994.50	$(1^-, 2^+)$	1880.7	0.33 8	7113.73	4^-	
		2085.7	0.46 11	6908.70	2^+	
		2244.0	0.45 6	6750.41	2^-	
		2411.9	0.33 10	6582.54	3^-	
		2709.3	0.48 12	6285.15	3^-	
		2968.9	1.1 2	6025.47	2^-	
		3364.9	6.5 5	5629.43	2^+	
		3782.6	6.1 5	5211.7	0^+	
		5089.8	6.2 6	3904.38	2^+	
		5257.4	1.8 3	3736.69	3^-	
		5641.5	1.6 4	3352.64	0^+	
		8993.4	74.6 16	0	0^+	
9031.9	4^-	1337.7	10 3	7694.08	3^-	
		2746.6	10 3	6285.15	3^-	
		3129.1 ^g	<3	5902.63	1^-	
		3402.3 ^g	<3	5629.43	2^+	
		3418.2	40 5	5613.53	4^-	
		3752.9	12 5	5278.81	4^+	
		3782.9 ^g	<3	5248.81	2^+	
		3820.0 ^g	<3	5211.7	0^+	
		4540.2	28 5	4491.44	5^-	
		5127.2 ^g	<5	3904.38	2^+	
		5678.8 ^g	<5	3352.64	0^+	
		9030.8 ^g	<5	0	0^+	
9091.70	3^-	1397.5	2.14 17	7694.08	3^-	
		1468.6	0.76 9	7623.11	$(2^-, 3, 4^+)$	
		1625.3	0.41 3	7466.37	2^+	
		1813.8	1.26 14	7277.82	$(2, 3)^+$	
		1852.6	0.73 10	7239.07	$(3^-, 4, 5^-)$	
		1977.9	0.55 9	7113.73	4^-	
		2341.2	0.57 14	6750.41	2^-	
		2509.1	1.04 14	6582.54	3^-	
		2806.4	5.1 3	6285.15	3^-	
		3061.9	2.5 4	6029.71	3^+	

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$^{39}\text{K}(\text{p},\gamma)$ [1990Ki07,1988Sc23](#) (continued) $\gamma(^{40}\text{Ca})$ (continued)

$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\dagger$	E_f	J_f^π	Comments
9091.70	3^-	3066.1	2.9 5	6025.47	2^-	
		3188.9	1.5 2	5902.63	1^-	
		3812.7	8.5 4	5278.81	4^+	
		3842.7	4.5 2	5248.81	2^+	
		5187.0	9.4 4	3904.38	2^+	
9135.66	$(2,3)^-$	5354.6	58.1 10	3736.69	3^-	
		710.8	1.01 9	8424.81	2^-	
		1263.5	0.32 5	7872.18	2^+	
		1441.5	5.2 2	7694.08	3^-	
		1603.4	3.7 2	7532.26	2^-	
		1857.8	0.25 4	7277.82	$(2,3)^+$	
		2021.9	1.84 12	7113.73	4^-	
		2185.1	0.46 8	6950.49	1^-	
		2385.2	0.62 9	6750.41	2^-	
		2553.0	2.03 16	6582.54	3^-	
		2850.4	13.8 4	6285.15	3^-	
		3110.1	0.25 10	6025.47	2^-	
		3232.9	3.0 2	5902.63	1^-	
		3522.0	0.30 10	5613.53	4^-	
		3886.7	0.49 17	5248.81	2^+	
		5230.9	8.0 4	3904.38	2^+	
		5398.6	58.7 9	3736.69	3^-	
9209.77	$(2,3)^-$	725.7	0.94 10	8484.02	$(1^-, 2^-, 3^-)$	
		785.0	3.3 2	8424.81	2^-	
		1515.6	4.5 2	7694.08	3^-	
		2096.0	1.60 12	7113.73	4^-	
		2259.2	2.8 2	6950.49	1^-	
		2459.3	1.95 17	6750.41	2^-	
		2627.1	2.2 2	6582.54	3^-	
		2924.5	4.0 2	6285.15	3^-	
		3184.2	1.6 2	6025.47	2^-	
		3307.0	10.7 3	5902.63	1^-	
		3580.2	2.1 2	5629.43	2^+	
		5305.0	2.9 3	3904.38	2^+	
		5472.7	61.6 10	3736.69	3^-	
		1694.4	13.3 7	7532.26	2^-	
9226.69	$(1^-, 2, 3^-)$	2276.1	2.11 18	6950.49	1^-	
		2476.2	3.2 2	6750.41	2^-	
		2941.4	3.7 2	6285.15	3^-	
		3323.9	0.29 [#] 11	5902.63	1^-	
		3977.7	1.63 ^a 18	5248.81	2^+	
		5321.9	0.30 ^b 10	3904.38	2^+	
		5489.6	5.2 4	3736.69	3^-	
		9225.6	11.8 ^c 10	0	0^+	
		3201.8	13.6 5	6025.47	2^-	
9227.43	$(1, 2^+)$	3324.7	0.29 [#] 11	5902.63	1^-	
		3978.4	1.63 ^a 18	5248.81	2^+	
		5322.7	0.30 ^b 10	3904.38	2^+	
		5874.4	39.8 12	3352.64	0^+	1990Ki07 report 5% 2 γ -branching undetermined.
		9226.3	11.8 ^c 10	0	0^+	
		937.7	1.8 3	8424.81	2^-	
9362.54	3^-	1668.4	41.0 10	7694.08	3^-	1990Ki07 report 14% 3 γ -branching undetermined.

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$^{39}\text{K}(\text{p},\gamma)$ **1990Ki07,1988Sc23** (continued) $\gamma(^{40}\text{Ca})$ (continued)

$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\ddagger$	E_f	J_f^π	Mult. [§]	$\delta^\S$	Comments
9362.54	3^-	1704.3	10.9 8	7658.23	4^-			
		1739.4	1.6	7623.11	$(2^-, 3, 4^+)$			
		2412.0	1.3	6950.49	1^-			
		2612.0	1.5	6750.41	2^-			
		2779.9	2.6 3	6582.54	3^-			
		3077.3	3.9 10	6285.15	3^-			
		3748.8	12.2 9	5613.53	4^-			
		4113.5	4.4 8	5248.81	2^+			
		5457.8	5.9 8	3904.38	2^+			
		5625.4	3.4 6	3736.69	3^-			
9388.20	2^+	1694.0	2.9	7694.08	3^-			
		2087.4	1.0	7300.74	0^+			
		2845.3	11	6542.78	4^+			
		2880.3	3.6	6507.84	4^+			
		3102.9	1.3	6285.15	3^-			
		3362.6	2.5	6025.47	2^-			
		3758.6	7.6	5629.43	2^+			
		4109.2	5.9	5278.81	4^+			
		4139.2	3.1	5248.81	2^+			
		4176.3	11	5211.7	0^+			
		5483.4	3.4	3904.38	2^+			
		5651.1	6.7	3736.69	3^-			
		9387.0	40	0	0^+			
		1872.5	16	7532.26	2^-			
9404.85	2^-	2127.0	0.8	7277.82	$(2, 3)^+$			
		2291.1	7.4	7113.73	4^-			
		2454.3	1.5	6950.49	1^-			
		2496.1	2.9	6908.70	2^+			
		2822.2	3.8	6582.54	3^-			
		3119.6	37	6285.15	3^-	D(+Q)	0.0 3	
		3502.1	7.3	5902.63	1^-			
		5500.1	2.7	3904.38	2^+			
		5667.7	18	3736.69	3^-	D+Q	-0.03 2	
		9403.7	2.6	0	0^+			
9418.8	3^-	1724.6	4.4	7694.08	3^-			
		1760.5	2.8	7658.23	4^-			
		1795.6	1.7	7623.11	$(2^-, 3, 4^+)$			
		1886.5	2.0	7532.26	2^-			
		2305.0	26	7113.73	4^-			
		2668.3	2.6	6750.41	2^-			
		3133.5	42	6285.15	3^-			
		3393.2	2.3	6025.47	2^-			
		3516.0	4.9	5902.63	1^-			
		3805.1	2.0	5613.53	4^-			
		4169.8	1.8	5248.81	2^+			
		5681.7	7.5	3736.69	3^-			
		1734.9	7.7 10	7694.08	3^-			
		1770.8	36 2	7658.23	4^-			
9429.11	$(3, 4)^-$	1806.0	1.2 4	7623.11	$(2^-, 3, 4^+)$			
		2315.3	1.3 3	7113.73	4^-			
		2846.5	9.2 16	6582.54	3^-			
		3143.8	3.4 6	6285.15	3^-			
		4937.3	29 2	4491.44	5^-			
		5692.0	12 2	3736.69	3^-			

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$^{39}\text{K}(\text{p},\gamma)$ **1990Ki07,1988Sc23** (continued) $\gamma(^{40}\text{Ca})$ (continued)

$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\ddagger$	E_f	J_f^π	Mult. [§]	$\delta^\S$	Comments
9432.46	1 ⁻	1900.2	2.3	7532.26	2 ⁻			
		2481.9	0.7	6950.49	1 ⁻			
		2681.9	0.9	6750.41	2 ⁻			
		3406.8	2.1	6025.47	2 ⁻			
		5527.7	1.0	3904.38	2 ⁺			
		9431.3	93	0	0 ⁺			
9453.95	3 ⁻	1029.1	1.47 18	8424.81	2 ⁻			
		1759.8	22.2 7	7694.08	3 ⁻			
		1795.7	7.1 6	7658.23	4 ⁻			
		1830.8	1.8 3	7623.11	(2 ⁻ ,3,4 ⁺)			
		1921.6	1.0 2	7532.26	2 ⁻			
		2007.7	0.7 2	7446.23	3 ⁺ ,4 ⁺			
		2340.2	10.5 5	7113.73	4 ⁻			
		2703.4	2.1 2	6750.41	2 ⁻			
		3168.7	30.3 7	6285.15	3 ⁻			
		3428.3	1.8 3	6025.47	2 ⁻			
		3824.3	2.5 3	5629.43	2 ⁺			
		3840.2	10.2 6	5613.53	4 ⁻			
		4174.9	1.6	5278.81	4 ⁺			
		5549.2	4.9 6	3904.38	2 ⁺			
		5716.8	3.4 4	3736.69	3 ⁻			
9603.0	3 ⁻	2489.2	33	7113.73	4 ⁻			
		3317.7	54	6285.15	3 ⁻	D+Q	0.42 6	
		5865.8	13	3736.69	3 ⁻	D+Q	+0.18 3	
9604.6	1 ⁻	2072.3	5.0	7532.26	2 ⁻			
		2654.0	1.1	6950.49	1 ⁻			
		2854.1	1.7	6750.41	2 ⁻			
		3579.0	4.1	6025.47	2 ⁻			
		5699.8	0.9	3904.38	2 ⁺			
		6251.4	1.2	3352.64	0 ⁺			
		9603.4	86	0	0 ⁺			
9640.89	2 ⁻	2174.5	7.9 3	7466.37	2 ⁺	D(+Q)	0.00 4	
		2690.3	0.15 3	6950.49	1 ⁻			
		2732.1	0.50 5	6908.70	2 ⁺			
		3355.6	0.47 11	6285.15	3 ⁻			
		4011.2	4.70 10	5629.43	2 ⁺			
		5736.1	47.3 5	3904.38	2 ⁺	D+Q	-0.09 4	δ : other: +0.03 3 (1963Le08).
		5903.7	39.0 5	3736.69	3 ⁻	D+Q	+0.05 3	δ : other: -0.29 6 (1963Le08).
		9639.6	1.5	0	0 ⁺			
9668.71	3 ⁻	1974.5	0.65 13	7694.08	3 ⁻			
		2136.4	1.83 15	7532.26	2 ⁻			
		2222.4	0.68 11	7446.23	3 ⁺ ,4 ⁺			
		2554.9	26.9 7	7113.73	4 ⁻			
		2759.9	0.67 14	6908.70	2 ⁺			
		2918.2	2.06 18	6750.41	2 ⁻			
		3383.4	44.4 6	6285.15	3 ⁻			
		3643.1	3.0 3	6025.47	2 ⁻			
		5176.9	3.00 10	4491.44	5 ⁻			
		5763.9	3.6 2	3904.38	2 ⁺			
		5931.6	13.2 6	3736.69	3 ⁻			
9779.49	3	1031.3	3.4 3	8748.20	2 ⁺			
		1101.2	3.3 4	8678.29	4 ⁺			
		1200.7	5.0 3	8578.80	2 ⁺			
		1644.7	2.7 2	8134.76	(3 ⁻)			

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$^{39}\text{K}(\text{p},\gamma)$ **1990Ki07,1988Sc23** (continued) $\gamma(^{40}\text{Ca})$ (continued)

$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\dagger$	E_f	J_f^π	Mult. [§]	$\delta^\S$	Comments
9779.49	3	1851.0	5.3 3	7928.37	4 ⁺			
		1907.3	5.7 5	7872.18	2 ⁺			
		2218.2	18.9 8	7561.18	4 ⁺			
		2313.1	3.0	7466.37	2 ⁺			
		2870.7	4.2 5	6908.70	2 ⁺			
		3196.8	1.5 4	6582.54	3 ⁻			
		3236.6	1.3 3	6542.78	4 ⁺			
		3271.5	0.7 2	6507.84	4 ⁺			
		3749.6	1.1	6029.71	3 ⁺			
		4149.8	2.0 2	5629.43	2 ⁺			
		4165.7	19.9 8	5613.53	4 ⁻	D+Q	+0.07 4	
		4500.4	5.4 4	5278.81	4 ⁺			
		4530.4	0.7 2	5248.81	2 ⁺			
		5874.7	14.6 9	3904.38	2 ⁺			
9785.3	(1,2 ⁺)	6042.3	5.4 6	3736.69	3 ⁻			
		2484.5	2.2	7300.74	0 ⁺			
		2876.5	0.7	6908.70	2 ⁺			
		5880.5	2.5	3904.38	2 ⁺			
		6432.1	9.6	3352.64	0 ⁺			
9865.15	1	9784.0	85	0	0 ⁺			
		1426.1	0.18 5	8439.0	0 ⁺			
		1773.5	0.73 8	8091.61	2 ⁺			
		1992.9	0.21 3	7872.18	2 ⁺			
		2163.3	0.53 18	7701.8	0 ⁺			
		2398.7	0.41 6	7466.37	2 ⁺			
		2564.3	3.2 2	7300.74	0 ⁺			
		2587.2	0.20 7	7277.82	(2,3) ⁺			
		2914.6	0.32 4	6950.49	1 ⁻			
		2956.3	1.10 10	6908.70	2 ⁺			
		3114.6	0.21 2	6750.41	2 ⁻			
		3962.3	0.34 5	5902.63	1 ⁻			
		4235.5	0.41 7	5629.43	2 ⁺			
		4616.1	0.25 3	5248.81	2 ⁺			
		4653.2	0.46 7	5211.7	0 ⁺			
		5960.3	5.1 2	3904.38	2 ⁺	D+Q	-0.18 3	
		6512.0	15.0 5	3352.64	0 ⁺			
9869.3	1 ⁺	9863.8	71.4 12	0	0 ⁺			$\Gamma_\gamma=1.06$ eV 15 (1988Al16).
		2167.4	0.8	7701.8	0 ⁺			
		2568.5	2.3	7300.74	0 ⁺			
		2960.5	0.9	6908.70	2 ⁺			
		4620.2	0.8	5248.81	2 ⁺			
		4657.3	0.6	5211.7	0 ⁺			
		5964.4	5.6	3904.38	2 ⁺			
		6516.1	13	3352.64	0 ⁺			
9954.00	4 ⁺	9868.0	76	0	0 ⁺			
		1580.0	3.8 3	8373.94	4 ⁺			
		3022.6	3.0 3	6931.29	3 ⁻			
		3371.3	1.2 3	6582.54	3 ⁻			
		3411.1	10.6 6	6542.78	4 ⁺			
		3446.0	4.2 2	6507.84	4 ⁺			
		4340.2	4.8 4	5613.53	4 ⁻			
		4674.9	58.2 17	5278.81	4 ⁺	M1+E2	+0.04 3	1990Ki07 report 5% 2 γ -branching undetermined.
		5462.2	2.7 4	4491.44	5 ⁻			
		6216.8	6.5 6	3736.69	3 ⁻			

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$^{39}\text{K}(\text{p},\gamma)$ **1990Ki07,1988Sc23** (continued) $\gamma(^{40}\text{Ca})$ (continued)

$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\dagger$	E_f	J_f^π	Mult. [§]	$\delta^\S$	Comments
10040.54	$(2^-, 3^-)$	1276.3	5.4 7	8764.18	3^-			
		1556.5	1.8 3	8484.02	$(1^-, 2^-, 3^-)$			
		1717.3	51.7 10	8323.16	$(1^-, 2^+)$			
		2417.4	2.3 3	7623.11	$(2^-, 3, 4^+)$			
		2508.2	0.93 18	7532.26	2^-			
		2762.6	8.3 3	7277.82	$(2, 3)^+$			
		2926.7	4.4 3	7113.73	4^-			
		3089.9	6.6 6	6950.49	1^-			
		3457.8	1.4 2	6582.54	3^-			
		4014.9	2.0 2	6025.47	2^-			
		4137.7	13.6 6	5902.63	1^-			
		6303.3	2.0 2	3736.69	3^-			
10049.38	4^-	1017.5	11.5 5	9031.9	4^-			
		1861.6	0.51 5	8187.69	$(3, 4, 5^-)$			
		2279.9	2.37 14	7769.4	$(3, 4, 5)^-$			
		2810.2	0.76 13	7239.07	$(3^-, 4, 5^-)$			
		2935.5	14.0 4	7113.73	4^-			
		3466.7	7.3 3	6582.54	3^-			
		3764.0	1.26 9	6285.15	3^-			
		4023.7	1.30 10	6025.47	2^-			
		4435.6	0.95 9	5613.53	4^-			
		5557.5	16.3 4	4491.44	5^-			
		6312.2	43.7 9	3736.69	3^-			
10262.53	3^-	2639.3	1.4 2	7623.11	$(2^-, 3, 4^+)$			
		2796.1	15.6 9	7466.37	2^+			
		2816.2	4.7 4	7446.23	$3^+, 4^+$			
		3148.7	1.4 3	7113.73	4^-			
		3679.8	4.1 3	6582.54	3^-			
		4232.6	16.1 13	6029.71	3^+			
		4359.7	2.7 4	5902.63	1^-			
		4632.8	2.9 4	5629.43	2^+			
		5013.4	3.6 4	5248.81	2^+			
		6357.6	36.0 10	3904.38	2^+			
		6525.3	11.5 10	3736.69	3^-			
10318.8	1^+	2616.9	0.71 7	7701.8	0^+			
		3368.2	0.41 7	6950.49	1^-			
		4689.1	0.27 7	5629.43	2^+			
		5106.8	0.77 6	5211.7	0^+			
		6413.9	3.4 2	3904.38	2^+	D+Q	$-0.16 3$	δ : other: $+0.09 2$ (1963Le08).
		6965.5	11.9 4	3352.64	0^+			
		10317.4	82.5 7	0	0^+			$\Gamma_\gamma=5.8 \text{ eV } 8$ (1988Al16).
10415.06	3	2720.8	0.4 2	7694.08	3^-			
		2791.8	16.7 5	7623.11	$(2^-, 3, 4^+)$			
		2853.8	1.13 11	7561.18	4^+			
		2948.6	5.9 2	7466.37	2^+			
		2968.7	17.4 4	7446.23	$3^+, 4^+$			1990Ki07 report 2.5% 18 γ -branching undetermined.
		3137.1	0.88 14	7277.82	$(2, 3)^+$			
		3301.2	1.57 17	7113.73	4^-			
		3483.6	4.0 2	6931.29	3^-			
		3506.2	15.7 4	6908.70	2^+			
		3664.5	2.50 10	6750.41	2^-			
		3832.3	1.34 14	6582.54	3^-			
		3907.0	1.02 16	6507.84	4^+			

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$^{39}\text{K}(\text{p},\gamma)$ [1990Ki07,1988Sc23](#) (continued) $\gamma(^{40}\text{Ca})$ (continued)

$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\dagger$	E_f	J_f^π	Comments
10415.06	3	4129.7	0.36 9	6285.15	3 ⁻	
		4389.3	5.9 3	6025.47	2 ⁻	
		4785.3	0.81 16	5629.43	2 ⁺	
		4801.2	6.9 3	5613.53	4 ⁻	
		5135.9	2.7 2	5278.81	4 ⁺	
		5165.9	1.69 17	5248.81	2 ⁺	
		6510.1	3.5 3	3904.38	2 ⁺	
		6677.8	7.1 4	3736.69	3 ⁻	
10639.07	(3 ⁻ ,4,5 ⁻)	2504.2	1.3 2	8134.76	(3 ⁻)	
		3525.2	4.0 3	7113.73	4 ⁻	
		3707.6	42.1 12	6931.29	3 ⁻	
		4056.3	1.6 2	6582.54	3 ⁻	
		4096.1	2.90 10	6542.78	4 ⁺	
		4131.0	4.0 2	6507.84	4 ⁺	
		5025.2	13.6 6	5613.53	4 ⁻	
		5359.9	4.4 4	5278.81	4 ⁺	
		6147.1	3.6 3	4491.44	5 ⁻	
		6901.7	22.5 10	3736.69	3 ⁻	
10699.50	3	2325.5	1.01 14	8373.94	4 ⁺	
		2607.8	0.72 9	8091.61	2 ⁺	
		3167.1	1.01 16	7532.26	2 ⁻	
		3233.0	0.9 2	7466.37	2 ⁺	
		3253.1	0.92 15	7446.23	3 ⁺ ,4 ⁺	
		3790.6	2.6 2	6908.70	2 ⁺	
		4156.5	2.0 2	6542.78	4 ⁺	
		4414.1	1.4 2	6285.15	3 ⁻	
		4669.5	3.8 3	6029.71	3 ⁺	
		5069.7	5.5 3	5629.43	2 ⁺	
		5085.6	2.0 2	5613.53	4 ⁻	
		5420.3	9.2 5	5278.81	4 ⁺	
		6794.5	51.3 16	3904.38	2 ⁺	1990Ki07 report 9.6% 18 γ -branching undetermined.
		6962.2	8.0 17	3736.69	3 ⁻	
10737.7	1 ⁻	3043.4	9.2 17	7694.08	3 ⁻	
		3828.8	4.3 14	6908.70	2 ⁺	
		4452.3	7.8 13	6285.15	3 ⁻	
		10736.2	55 3	0	0 ⁺	
10747.8	(4 ⁺)	5118.0	12.5 9	5629.43	2 ⁺	
		6842.8	84.3 10	3904.38	2 ⁺	
		7010.5	3.2 6	3736.69	3 ⁻	
10770.2	(1 ⁺)	3656.3	3.3 7	7113.73	4 ⁻	
		3861.3	6.0 7	6908.70	2 ⁺	
		5521.0	42 2	5248.81	2 ⁺	1990Ki07 report 17% 2 γ -branching undetermined.
		10768.6	32 2	0	0 ⁺	
10910.0	(3,4,5 ⁻)	7172.6	100 ^d	3736.69	3 ⁻	
10921.1	(2 ⁺ ,3,4 ⁻)	4895.3	10 ^d	6025.47	2 ⁻	
		5641.9	50 ^d	5278.81	4 ⁺	1971Da08 report 40% γ -branching uncertain.
10956.0	3 ⁻	2768.2	5 ^d	8187.69	(3,4,5 ⁻)	
		3474.8	10 ^d	7481?		
		3509.6 ^g	<5 ^d	7446.23	3 ⁺ ,4 ⁺	
		5053.0	10 ^d	5902.63	1 ⁻	
		5342.1	8 ^d	5613.53	4 ⁻	
		5676.8	44 ^d	5278.81	4 ⁺	

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$^{39}\text{K}(\text{p},\gamma)$ **1990Ki07,1988Sc23** (continued) $\gamma(^{40}\text{Ca})$ (continued)

$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\dagger$	E_f	J_f^π	Comments
10956.0	3^-	7218.6	25^d	3736.69	3^-	
10988.0	$(3^-, 4^+)$	2010 ^g	5^d	8978?		
		4079.1	5^d	6908.70	2^+	
		4702.6	10^d	6285.15	3^-	
		5358.2	10^d	5629.43	2^+	
		7083.0	40^d	3904.38	2^+	
		7250.6	35^d	3736.69	3^-	
10994.7	$(2^+, 3, 4^+)$	5715.5		5278.81	4^+	E_γ : seen in 1971Da08 .
		5745.5		5248.81	2^+	E_γ : seen in 1971Da08 .
		7257.3		3736.69	3^-	E_γ : seen in 1971Da08 .
11011.0	3^-	2672.9	$12\ 3$	8338.0	$(2^+, 3, 4)$	
		3034.9 ^g		7976?		
		3334.3	$7\ 2$	7676.6	(6^+)	
		3710.1 ^g		7300.74	0^+	
		4079.5 ^g		6931.29	3^-	
		4981.0 ^g		6029.71	3^+	
		6519.0	$45\ 3$	4491.44	5^-	I_γ : 1990Ki07 report 36% $5\ \gamma$ -branching undetermined.
		7105.9 ^g		3904.38	2^+	
		7273.6		3736.69	3^-	
		11009.4		0	0^+	
11042.0	$(1^- \text{ to } 4^+)$	7136.9		3904.38	2^+	E_γ : seen in 1971Da08 .
		7304.6		3736.69	3^-	E_γ : seen in 1971Da08 .
11070.6	(3)	5456.1	5^d	5613.53	4^-	
		5790.7	10^d	5278.81	4^+	
		5820.7	10^d	5248.81	2^+	
		7164.9	65^d	3904.38	2^+	
		7332.6	10^d	3736.69	3^-	
11080	1^-	11078		0	0^+	E_γ : seen in 1971Da08 .
12038	$(3, 4, 5)^-$	12036		0	0^+	E_γ : seen in 1985Se16 .
12049	2^+	12047		0	0^+	E_γ : seen in 1985Se16 .
12068		12066		0	0^+	E_γ : seen in 1985Se16 .
12074		12072		0	0^+	E_γ : seen in 1985Se16 .
12099		12097 ^e		0	0^+	
12111		12109 ^e		0	0^+	
12204		12202 ^e		0	0^+	
12334		12332 ^e		0	0^+	
12423		12421 ^e		0	0^+	
12604		12602 ^e		0	0^+	
12647		9293 ^e		3352.64	0^+	
12668		9314 ^e		3352.64	0^+	
		12666 ^e		0	0^+	
12688		12686 ^e		0	0^+	
12875		9521 ^e		3352.64	0^+	
		12873 ^e		0	0^+	
12980		12978 ^e		0	0^+	
12996		9642 ^e		3352.64	0^+	
13086		13084 ^e		0	0^+	

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$^{39}\text{K}(\text{p},\gamma)$ **1990Ki07,1988Sc23** (continued) $\gamma(^{40}\text{Ca})$ (continued)

$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	E_f	J_f^π	Mult. [§]	Comments
13113		9759 ^e	3352.64	0 ⁺		
		13111 ^e	0	0 ⁺		
13194		9840 ^e	3352.64	0 ⁺		
		13192 ^e	0	0 ⁺		
13203		13201 ^e	0	0 ⁺		
13289		9935 ^e	3352.64	0 ⁺		
		13287 ^e	0	0 ⁺		
13822		13819 ^e	0	0 ⁺		
13913		10559 ^e	3352.64	0 ⁺		
		13910 ^e	0	0 ⁺		
13993		10639 ^e	3352.64	0 ⁺		
		13990 ^e	0	0 ⁺		
18260	1	18256 ^f	0	0 ⁺	D&	$A_2=-0.3$ 1
18680	1	18675 ^f	0	0 ⁺	D&	$A_2=-0.5$ 1
19070	1	19065 ^f	0	0 ⁺	D&	$A_2=-0.25$ 10
19450	1	19445 ^f	0	0 ⁺	D&	$A_2=-0.3$ 1
19850	1	19845 ^f	0	0 ⁺	D&	$A_2=-0.25$ 10
20130		20125 ^f	0	0 ⁺		
20430	1	20424 ^f	0	0 ⁺	D&	$A_2=-0.3$ 1
20650	1	20644 ^f	0	0 ⁺	D&	$A_2=-0.3$ 2
20940	1	20934 ^f	0	0 ⁺	D&	$A_2=-0.5$ 1
21490		21484 ^f	0	0 ⁺		
21690		21684 ^f	0	0 ⁺		
22060		22053 ^f	0	0 ⁺		

[†] Values are deduced from level-energy differences by evaluator, with recoil correction removed, unless otherwise noted. **1990Ki07** and **1988Sc23** don't list the data of γ -ray energies with uncertainties, but state that the energies of levels connected by these observed γ rays were obtained from a least-squares fit to the γ -ray energies. Many transitions with upper limits on intensities are unlikely since they would require high multiplicities, like E4, M4, E5, and so on.

[‡] For levels up to 9000, values are from **1990Ki07**, or where values with uncertainties are also available in **1988Sc23**, weighted averages are taken; above 9000, values without uncertainties are from **1988Sc23** and the others are from **1990Ki07**, unless otherwise noted. Quoted values are %branching from each level.

[§] From $\gamma\gamma(\theta)$ and $\gamma(\text{pol})$ in **1967Le12**, unless otherwise noted.

[&] From $\gamma(\theta)$ in **1973Di02**. Quoted values of A_2 in comments are read from Fig.4 of **1973Di02**.

[@] From **1988Sc23**. 30% 20 γ -branching undetermined in **1990Ki07**.

[#] For 3323.9+3324.7.

^a For 3977.7+3978.4.

^b For 5321.9+5322.7.

^c For 9225.6+9226.3.

^d From **1971Da08**.

^e Seen in **1968Ba22**.

^f Seen in **1973Di02**.

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

³⁹K(p,p),(p,α):resonances [1987WaZI](#),[1990Bu02](#),[1970De30](#)

$J\pi(^{39}\text{K g.s.})=3/2^+$.

Other main reference: [1974Na09](#).

Most resonances decay to g.s. of ³⁹K in (p,p) and g.s. of ³⁶Ar in (p,α).

See ³⁹K(p,γ), ³⁶Ar(α,γ):resonances, and ⁴⁰Ca(p,pα),(p,2p):resonances datasets for additional resonances observed in those reaction.

All data are from (p,p₀) or (p,α₀) channels, with the exception of five resonances from [1969Va14](#) above 6 MeV which are from p₁ and p₄ channels.

[1990Bu02](#): E=2.4-4.0 MeV proton beams were produced from the TUNL KN Van de Graaff accelerator (overall FWHM≈0.45 keV). Targets were prepared by evaporating 2-3 μg/cm² K₂CO₃ (99.97% in ³⁹K) onto gold backings. Charged particles were detected with six surface barrier detectors. Measured σ(θ), for a total of 30 resonances from E(p)(lab)=2389.1 to 3998.2, all with Jπ=2⁺. Deduced widths and other relevant parameters from R-matrix analysis.

[1983Sh33](#) (same group as [1990Bu02](#)): E=3.192-3.224 MeV. Measured σ(θ). Also (pol p,α) for E=3212 keV.

[1987WaZI](#) (from the same lab as [1990Bu02](#)): E=1.9-4.0 MeV. Measured σ(θ). A total of 248 resonances reported, fifty of which were assigned 2⁺. Relevant resonance parameters for proton and α decay of these resonances are given. Only the widths are quoted here. The uncertainty is assigned by the evaluator as 0.5 keV based on overall FWHM=450 eV. The actual uncertainty may be lower than this for strong and well-resolved peaks.

[1970De30](#): E=1.03-3.23 MeV. Measured σ(θ). A total of 34 resonances reported between E(p)(lab)=1102.5 and 2983. Deduced levels, J, π, widths.

[1974Na09](#): (p,α) E=3.05-4.20 MeV. Measured σ(θ).

[1969Va14](#): E=6.28-6.73 MeV. Five resonances reported between E(p)(lab)=6350 and 6660 corresponding to p₁ and p₄ channels.

Data are from [1987WaZI](#) unless otherwise noted.

⁴⁰Ca Levels

Resonance strength is defined as, $S_p=(2J+1)\Gamma_p^2/\Gamma$ for (p,p) resonance, and $S_\alpha=(2J+1)\Gamma_p\Gamma_\alpha/\Gamma$ for (p,α) resonance. The S_α values are given in comments. The Γ_p and Γ_α parameters are also given in comments and are from [1987WaZI](#), unless otherwise noted. For other relevant parameters see [1987WaZI](#) and [1990Bu02](#).

E(level) [†]	Jπ [‡]	L ^d	S _p (keV) ^d	Comments
9402.9 10	2 ⁻ 10	1	0.7	E(level): analog of 2047 level in ⁴⁰ K (1970De30). E(p)(lab)=1102.5 10 (1970De30).
9430.1 10	1 ⁻ 10	1	0.7	E(p)(lab)=1130.4 10 (1970De30).
9452.5 10	(2,3) ⁻ 10	1	0.6	E(p)(lab)=1153.4 10 (1970De30).
9534.8 10	1 ⁻ 10	1	1.2	E(p)(lab)=1237.9 10 (1970De30).
9600.8 10	3 ⁻ 10	1	3.4 ^e	E(level): analog of 2070 level in ⁴⁰ K (1970De30). E(p)(lab)=1305.6 10 (1970De30).
9602.4 10	1 ⁻ 10	1	3.4 ^e	E(level): analog of 2103 level in ⁴⁰ K (1970De30). E(p)(lab)=1307.2 10 (1970De30).
9665.9 15	(≤3) ⁻ 15	1	1.8	E(p)(lab)=1372.4 15 (1970De30).
9799 2	(≤3) ⁻ 2	1	1.0	E(p)(lab)=1509 2 (1970De30).
9850 2	(≤3) ⁻ 2	1	1.7	E(p)(lab)=1561 2 (1970De30).
10064 2	(1 ⁻ ,2 ⁺) 2			E(p)(lab)=1781 2 , S _α =9.2 eV (1970De30).
10128 2	(3 ⁻ ,4 ⁺) 2			E(p)(lab)=1846 2 , S _α =7.9 eV (1970De30).
10199.3 5	1 ⁻	1	0.8	J ^π : from (1 ⁻ ,2) in 1987WaZI , 1 ⁻ in 1970De30 . E(level): analog of 2757 level in ⁴⁰ K (1970De30). E(p)(lab)=1919.1 5 , Γ _p =1.6 keV (1987WaZI). E(p)(lab)=1921 2 , S _α =3.4 eV (1970De30).
10265 2	1 ⁻ 2	1	2.8	E(p)(lab)=1987 2 , S _α =1.5 eV (1970De30).
10270 2	NATURAL 2			E(p)(lab)=1992 2 , S _α =1.7 eV (1970De30).
10275.3 5	(1 ⁻)			E(p)(lab)=1997.0 5 , Γ _p =1.6 keV (1987WaZI). J ^π : 2 is also possible (1987WaZI).

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³⁹K(p,p),(p,α):resonances 1987WaZl,1990Bu02,1970De30 (continued)

⁴⁰Ca Levels (continued)

E(level) [†]	Jπ [‡]	L ^d	S _p (keV) ^d	Comments
10280 ^{&} 2	1 ⁻ ^{&}	1	3.4	E(level): may be the same level as 10275. E(p)(lab)=2002 2, S _α =3.4 eV (1970De30); this resonance may be the same as 1997 in 1987WaZl.
10333.9 5	(1,3) ⁻			J ^π : from (1 ⁻ ,3 ⁻) in 1987WaZl and (1,3) ⁻ from 1970De30. E(p)(lab)=2057.1 5, Γ _p =0.11 keV, Γ _α =0.001 keV (1987WaZl). E(p)(lab)=2059 2, S _α =22 eV (1970De30).
10362.8 5	1 ⁻			E(p)(lab)=2086.8 5, Γ _p =0.60 keV, Γ _α =0.0030 keV (1987WaZl).
10364.8 5	(1,3) ⁻	1	27	J ^π : 1 ⁻ in 1987WaZl, 3 ⁻ in 1970De30. E(p)(lab)=2088.8 5, Γ _p =1.1 keV, Γ _α =0.0050 keV (1987WaZl). E(p)(lab)=2089 2, S _α =1.7 eV (1970De30).
10376.8 5	1 ⁻			E(p)(lab)=2101.1 5, Γ _p =0.60 keV, Γ _α =0.0020 keV (1987WaZl).
10385 ^{&} 2	(1 ⁻ ,2 ⁺) ^{&}			E(p)(lab)=2110 2, S _α =2.9 eV (1970De30).
10420.4 5	1 ⁻			J ^π : (0 ⁺ ,1 ⁻ ,2 ⁺) from (p,α) in 1970De30. E(p)(lab)=2145.8 5, Γ _p =0.50 keV, Γ _α =0.0028 keV (1987WaZl). E(p)(lab)=2147 2, S _α =8.8 eV (1970De30).
10432 ^{&} 2	(2 ⁺) ^{&}			E(p)(lab)=2158 2, S _α =3.8 eV (1970De30).
10443.5 5	2 ⁻			E(p)(lab)=2169.6 5, Γ _p =4.0 keV (1987WaZl).
10447.0 5	(1,3) ⁻	1	3.1	J ^π : 1 ⁻ in 1987WaZl, 3 ⁻ in 1970De30. E(p)(lab)=2173.1 5, Γ _p =0.15 keV, Γ _α =0.001 keV (1987WaZl). E(p)(lab)=2174 2, S _α =6.5 eV (1970De30).
10516.5 5	1 ⁻			J ^π : also from 1970De30. E(p)(lab)=2244.4 5, Γ _p =1.2 keV, Γ _α =0.010 keV (1987WaZl). E(p)(lab)=2245 2, S _α =18 eV (1970De30).
10517.4 5	1 ⁽⁺⁾			E(p)(lab)=2245.3 5, Γ _p =0.30 keV (1987WaZl).
10529.8 5	(1 ⁺)			J ^π : 0 is also possible (1987WaZl). E(p)(lab)=2258.0 5, Γ _p =0.40 keV (1987WaZl).
10541.7 ^b 5	2 ⁺			J ^π : from (p,α) in 1970De30. Other: 0 ⁺ from (p,p') in 1987WaZl. E(p)(lab)=2270.3 5, Γ _p =0.16 keV, Γ _α =0.025 keV (1987WaZl). E(p)(lab)=2272 2, S _α =41 eV (1970De30).
10596.4 5	3 ⁻			J ^π : from 1987WaZl, (1,3) ⁻ from (p,α) in 1970De30. E(p)(lab)=2326.4 5, Γ _p =0.15 keV, Γ _α =0.0050 keV (1987WaZl). E(p)(lab)=2327 2, S _α =63 eV (1970De30).
10598.6 5	(1 ⁺)			J ^π : 0 is also possible (1987WaZl). E(p)(lab)=2328.6 5, Γ _p =0.20 keV (1987WaZl).
10607.6 5	0 ⁽⁺⁾			E(p)(lab)=2337.8 5, Γ _p =0.20 keV (1987WaZl).
10618.8 5	2 ⁻			E(p)(lab)=2349.3 5, Γ _p =3.5 keV (1987WaZl).
10621.6 ^b 5	0 ⁺		15	J ^π : from 1987WaZl. Other: 1 ⁻ from (p,p) in 1970De30, 0 ⁺ and 2 ⁺ favored in (p,α) in 1970De30. E(level): 1970De30 suggest it could be the analog of 3230, 1 ⁻ level in ⁴⁰ K; however, the 3230 level has Jπ=2 ⁻ from Adopted Levels of ⁴⁰ K. It could be that this level in 1970De30 corresponds to the 10618.8, 2 ⁻ level above from 1987WaZl. E(p)(lab)=2352.2 5, Γ _p =0.030 keV, Γ _α =0.0080 keV (1987WaZl). E(p)=2354 3, S _α =14 eV (1970De30).
10633.8 5	(1 ⁻)			J ^π : 3 is also possible (1987WaZl). E(p)(lab)=2364.7 5, Γ _p =1.1 keV, Γ _α =0.0015 keV (1987WaZl).
10648 ^{&} 2	NATURAL ^{&}			E(p)(lab)=2379 3, S _α =4.0 eV (1970De30).
10656.1 5	(1 ⁻)			J ^π : 3 is also possible (1987WaZl). E(p)(lab)=2387.6 5, Γ _p =0.59 keV, Γ _α =0.0050 keV (1987WaZl).
10657.6 [#] 5	2 ⁺ [#]	0	1.2	J ^π : (1,3) ⁻ for 2390 resonance in (p,α) but (1,2) ⁺ and L(p,p)=0 for 2390 resonance in (p,p) in 1970De30. The 2390 resonance in (p,α) in 1970De30 could correspond to the 2387.5 resonance in 1987WaZl.

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$^{39}\text{K}(\text{p,p}),(\text{p},\alpha)$:resonances **1987WaZI,1990Bu02,1970De30** (continued) ^{40}Ca Levels (continued)

E(level) [†]	J ^π [‡]	L ^d	S _p (keV) ^d	Comments
10666.6 5	2 ⁻	1	17	E(p)(lab)=2389.1 5, $\Gamma_p=0.350$ keV, $\Gamma_\alpha=0.004$ keV (1990Bu02). E(p)(lab)=2390 3, $S_\alpha=16$ eV (1970De30). J ^π : from 1987WaZI, 1 ⁻ from (p,p) in 1970De30.
10675.6 5	1 ⁻	1	0.5	E(p)(lab)=2398.4 5, $\Gamma_p=2.0$ keV (1987WaZI). E(p)(lab)=2400 3, $S_\alpha<1$ eV (1970De30). J ^π : also from 1970De30.
10693.1 5	1 ⁺	0	0.7	E(p)(lab)=2407.6 5, $\Gamma_p=1.5$ keV, $\Gamma_\alpha=0.060$ keV (1987WaZI). E(p)(lab)=2408 3, $S_\alpha=200$ eV (1970De30). J ^π : from 1987WaZI, (1,2) ⁺ in 1970De30.
10701.1 5	0 ⁺			E(p)(lab)=2425.5 5, $\Gamma_p=1.1$ keV (1987WaZI).
10722.3 5	1 ⁺			E(p)(lab)=2426 3, $S_\alpha<1$ eV (1970De30).
10740.3 5	1 ⁻	1	1.5	E(p)(lab)=2433.7 5, $\Gamma_p=0.60$ keV, $\Gamma_\alpha=0.001$ keV (1987WaZI). E(p)(lab)=2455.5 5, $\Gamma_p=1.1$ keV (1987WaZI). J ^π : also from 1970De30.
10749.0 5	0 ⁺			E(p)(lab)=2473.9 5, $\Gamma_p=2.2$ keV, $\Gamma_\alpha=0.0060$ keV (1987WaZI). E(p)(lab)=2475 3, $S_\alpha=16$ eV (1970De30). J ^π : from 1987WaZI.
10751 3	(4 ⁺ ,5 ⁻)			E(p)(lab)=2482.9 5, $\Gamma_p=0.30$ keV, $\Gamma_\alpha=0.010$ keV (1987WaZI). J ^π : from 1970De30.
10772.3 5	(1 ⁺)			E(p)(lab)=2485 3, $S_\alpha=22$ eV (1970De30). J ^π : 2 is also possible (1987WaZI).
10778.3 [#] 5	2 ⁺ [#]			E(p)(lab)=2506.8 5, $\Gamma_p=0.050$ keV (1987WaZI).
10780.7 5	3 ⁻	1	35	E(p)(lab)=2513.0 5, $\Gamma_p=0.180$ keV, $\Gamma_\alpha=0.004$ keV (1990Bu02). J ^π : 1 ⁻ in 1987WaZI; later corrected to 3 ⁻ by the same group Other: 1 ⁻ from (p,p) in 1970De30, (1 ⁻ ,2 ⁺) from (p,α) in 1970De30 but 2 ⁺ is favored. E(level): 1970De30 suggest it could be the analog of 3365, 1 ⁻ level in ^{40}K . E(p)(lab)=2515.4 5, $\Gamma_p=1.0$ keV, $\Gamma_\alpha=0.010$ keV (1987WaZI). E(p)(lab)=2514 3, $S_\alpha=77$ eV (1970De30); it could also correspond to the 2513.0 resonance in 1990Bu02.
10783.2 5	(0 ⁻)			J ^π : 1 is also possible (1987WaZI).
10802.8 5	0 ⁽⁺⁾			E(p)(lab)=2518.0 5, $\Gamma_p=0.70$ keV (1987WaZI). J ^π : from 1987WaZI, (1 ⁻ ,2 ⁺) from (p,α) in 1970De30.
10816.4 5	2 ⁻	1	13	E(p)(lab)=2538.1 5, $\Gamma_p=0.50$ keV, $\Gamma_\alpha=0.20$ keV (1987WaZI). E(p)(lab)=2539 3, $S_\alpha=220$ eV (1970De30). J ^π : from 1987WaZI, (1 ⁻) from (p,p) in 1970De30.
10816.6 5	3 ⁺			E(p)(lab)=2552.0 5, $\Gamma_p=6.0$ keV (1987WaZI).
10833.2 5	3 ⁻			E(p)(lab)=2552 3, $S_\alpha<1$ eV (1970De30). E(p)(lab)=2552.2 5, $\Gamma_p=0.50$ keV (1987WaZI). J ^π : 3 ⁽⁻⁾ from 1987WaZI and (3 ⁻ ,4 ⁺) from (p,α) in 1970De30.
10849.3 5	2 ⁻			E(p)(lab)=2569.2 5, $\Gamma_p=0.025$ keV, $\Gamma_\alpha=0.0009$ keV (1987WaZI).
10852.2 5	1 ⁻	1	30	E(p)(lab)=2569 3, $S_\alpha=24$ eV (1970De30). E(p)(lab)=2585.8 5, $\Gamma_p=11$ keV (1987WaZI). J ^π : from (1 ⁻ ,2 ⁻) in 1987WaZI and 1 ⁻ in 1970De30.
10861.4 [#] 5	2 ⁺ [#]			E(level): analog of 3481 level in ^{40}K (1970De30). E(p)(lab)=2588.7 5, $\Gamma_p=2.5$ keV (1987WaZI). E(p)(lab)=2588 3, $S_\alpha=10$ eV (1970De30). J ^π : also from (p,α) in 1970De30.
10869.0 5	1 ⁻			E(p)(lab)=2598.2 5, $\Gamma_p=0.040$ keV, $\Gamma_\alpha=0.005$ keV (1990Bu02).
10869.7 5	0 ⁺			E(p)(lab)=2599 3, $S_\alpha=24$ eV (1970De30). E(p)(lab)=2606.0 5, $\Gamma_p=26$ keV, $\Gamma_\alpha=0.070$ keV (1987WaZI). J ^π : 2 is also possible (1987WaZI).
10873.9 5	1 ⁻			E(p)(lab)=2606.7 5, $\Gamma_p=0.40$ keV (1987WaZI). J ^π : 3 is also possible (1987WaZI).
				E(p)(lab)=2611.0 5, $\Gamma_p=4.0$ keV (1987WaZI).

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³⁹K(p,p),(p,α):resonances **1987WaZI,1990Bu02,1970De30 (continued)**

⁴⁰Ca Levels (continued)

E(level) [†]	Jπ [‡]	L ^d	S _p (keV) ^d	Comments
10899.3 5	1 ⁺			E(p)(lab)=2637.0 5, Γ _p =0.41 keV (1987WaZI).
10914.8 5	1 ⁻	1	6.9	J ^π : also from 970De30. E(p)(lab)=2652.9 5, Γ _p =5.0 keV, Γ _α =0.040 keV (1987WaZI). E(p)(lab)=2652 3, S _α =110 eV (1970De30).
10915.7 5	3 ⁺			J ^π : 1 ⁺ ,2 ⁺ in 1987WaZI ; later corrected to 3 ⁺ by the same group. E(p)(lab)=2653.9 5, Γ _p =0.70 keV (1987WaZI).
10932.7 5	1 ⁻	1	15	E(p)(lab)=2671.3 5, Γ _p =2.0 keV, Γ _α =0.0080 keV (1987WaZI). E(p)(lab)=2673 3, S _α =53 eV (1970De30).
10933.2 ^a 5	2 ⁻			E(p)(lab)=2672.0 5, Γ _p =0.10 keV (1987WaZI).
10946.9 [#] 5	2 ⁺ [#]			E(p)(lab)=2685.9 5, Γ _p =0.215 keV, Γ _α =0.011 keV (1990Bu02).
10950.8 5	1 ⁻	1	30	J ^π : also from 1970De30 . E(p)(lab)=2689.9 5, Γ _p =7.0 keV (1987WaZI). E(p)(lab)=2689 3, S _α =100 eV (1970De30).
10953.6 5	0 ⁽⁺⁾			E(p)(lab)=2692.7 5, Γ _p =0.20 keV, Γ _α =0.020 keV (1987WaZI). E(p)(lab)=2695 3, S _α =27 eV (1970De30).
10988.7 5	2 ⁻			E(p)(lab)=2728.7 5, Γ _p =9.0 keV (1987WaZI).
10989.4 5	(1 ⁺)			J ^π : 0 is also possible (1987WaZI). E(p)(lab)=2729.4 5, Γ _p =0.4 keV (1987WaZI).
10995 ^{&} 3	(1 ⁻) ^{&}	1	20	E(level): analog of 3630 level in ⁴⁰ K (1970De30). E(p)(lab)=2735 3, S _α <1 eV (1970De30).
10998.9 5	(1,3) ⁻			J ^π : also from 1970De30 . E(p)(lab)=2739.2 5, Γ _p =0.20 keV, Γ _α =0.0020 keV (1987WaZI). E(p)(lab)=2742 3, S _α =35 eV (1970De30).
11007.2 5	1 ⁻	1	2.1	J ^π : from 1987WaZI , (1,3) ⁻ in 1970De30 . E(p)(lab)=2747.7 5, Γ _p =5.0 keV, Γ _α =0.010 keV (1987WaZI). E(p)(lab)=2750 3, S _α =9 eV (1970De30).
11024.2 5	(1,3) ⁻	1	0.7	J ^π : (1 ⁻) from 1970De30 , 3 ⁽⁻⁾ in 1987WaZI , L(p,p)=1 from 3/2 ⁺ . E(p)(lab)=2765.1 5, Γ _p =0.10 keV, Γ _α =0.012 keV (1987WaZI). E(p)(lab)=2767 3, S _α =270 eV (1970De30).
11036.3 5	(1 ⁺)			J ^π : 2 is also possible (1987WaZI). E(p)(lab)=2777.5 5, Γ _p =0.10 keV (1987WaZI).
11044.5 [#] 5	2 ⁺ [#]	0	1.0	J ^π : 2 ⁺ from 1970De30 . E(p)(lab)=2785.9, Γ _p =0.50 keV, Γ _α =0.002 keV (1990Bu02). E(p)(lab)=2789 3, S _α =6 eV (1970De30).
11073.5 5	2 ⁺			E(p)(lab)=2815.7 5, Γ _p =0.66 keV, Γ _α =0.0006 keV (1987WaZI).
11078.4 5	1 ⁻			E(p)(lab)=2820.7 5, Γ _p =1.2 keV, Γ _α =0.0040 keV (1987WaZI).
11083.6 5	(1 ⁺)			J ^π : 0,2 are also possible (1987WaZI). E(p)(lab)=2826.1 5, Γ _p =0.35 keV (1987WaZI).
11089.3 5	0 ⁽⁺⁾			E(p)(lab)=2825 3, S _α =11 eV (1970De30). J ^π : from 1987WaZI , 4+(1 ⁻ ,3 ⁻) from (p,α) for a 11091 level in 1970De30 could indicate a different level. E(p)(lab)=2831.9 5, Γ _p =0.10 keV, Γ _α =0.0060 keV (1987WaZI). E(p)(lab)=2834 3, S _α =6.1 eV (1970De30).
11107.0 5	1 ⁻			E(p)(lab)=2850.1 5, Γ _p =3.9 keV (1987WaZI).
11112 ^{&} 3	0 ⁻ ^{&}	1	5.2	E(level): analog of 3768 level in ⁴⁰ K (1970De30). E(p)(lab)=2855 3, S _α <1 eV (1970De30); it could correspond to the 2850.1 resonance in 1987WaZI .
11119.0 [#] 5	2 ⁺ [#]			J ^π : also from 1970De30 . E(p)(lab)=2862.3 5, Γ _p =0.040 keV, Γ _α =0.006 keV (1990Bu02). E(p)(lab)=2865 3, S _α =21 eV (1970De30).
11129.1 5	4 ⁺			J ^π : also from 1970De30 . E(p)(lab)=2872.7 5, Γ _p =0.11 keV, Γ _α =0.0014 keV (1987WaZI). E(p)(lab)=2875 3, S _α =19 eV (1970De30).

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³⁹K(p,p),(p,α):resonances **1987WaZI,1990Bu02,1970De30** (continued)

⁴⁰Ca Levels (continued)

E(level) [†]	J ^π [‡]	L ^d	S _p (keV) ^d	Comments
11145.2 5	1 ⁽⁻⁾			E(p)(lab)=2889.2 5, Γ _p =0.20 keV, Γ _α =0.0020 keV (1987WaZI).
11145.8 5	1 ⁺			E(p)(lab)=2889.8 5, S _α =0.20 keV (1987WaZI).
11157.2 5	2 ⁻			E(p)(lab)=2901.5 5, Γ _p =48 keV (1987WaZI).
11161.5 5	4 ⁽⁺⁾			E(p)(lab)=2905.9 5, Γ _p =0.040 keV, Γ _α =0.0008 keV (1987WaZI).
11162.9 5	2 ⁺			E(p)(lab)=2907.4 5, Γ _p =3.5 keV (1987WaZI).
				E(p)(lab)=2907 3, S _α =12 eV (1970De30).
11167.4 5	4 ⁺			J ^π : also from 1970De30.
				E(p)(lab)=2912.0 5, Γ _p =0.080 keV, Γ _α =0.0030 keV (1987WaZI).
				E(p)(lab)=2914 3, S _α =31 eV (1970De30).
11187.6 5	3 ⁻			E(p)(lab)=2932.7 5, Γ _p =1.4 keV, Γ _α =0.0016 keV (1987WaZI).
11202.9 5	(2 ⁻)			J ^π : 1,3 are also possible (1987WaZI).
				E(p)(lab)=2948.4 5, Γ _p =6.0 keV (1987WaZI).
11212.6 5	3 ⁻	1	175	E(level): analog of 3867 level in ⁴⁰ K (1970De30).
				J ^π : also from 1970De30.
				E(p)(lab)=2958.4 5, Γ _p =2.8 keV, Γ _α =0.0014 keV (1987WaZI).
				E(p)(lab)=2962 3, S _α <1 eV (1970De30). Γ _p =25 keV from S _p =175 keV assuming Γ=Γ _p is much greater than Γ _p =2.8 keV, which could indicate a different level at 11317 3.
11217.8 5	4 ⁺			E(p)(lab)=2963.7 5, Γ _p =1.4 keV, Γ _α =0.001 keV (1987WaZI).
11231.4 5	2 ⁻	1	3	J ^π : from 1987WaZI, (1,2,3) ⁻ in 1970De30.
				E(p)(lab)=2977.6 5, Γ _p =3.0 keV (1987WaZI).
				E(p)(lab)=2972 3, S _α <1 eV (1970De30).
11236 ^{&} 3	1 ⁻ ^{&}	1	11.7	E(p)(lab)=2983 3, S _α <1 eV (1970De30).
11246.8 5	3 ⁻			J ^π : also from 1970De30.
				E(p)(lab)=2993.4 5, Γ _p =0.080 keV, Γ _α =0.012 keV (1987WaZI).
				E(p)(lab)=2996 3, S _α =190 eV (1970De30).
11255.9 5	1 ⁺			E(p)(lab)=3002.8 5, Γ _p =0.30 keV (1987WaZI).
11260.8 5	(0 ⁻)			J ^π : 1 is also possible (1987WaZI).
				E(p)(lab)=3007.8 5, Γ _p =6.0 keV (1987WaZI).
11264.4 [#] 5	2 ⁺ [#]			J ^π : also from 1970De30.
				E(p)(lab)=3011.4 5, Γ _p =0.325 keV, Γ _α =0.016 keV (1990Bu02).
				E(p)(lab)=3013 3, S _α =190 eV (1970De30).
11284.3 5	(2 ⁻)			J ^π : 1 is also possible (1987WaZI).
				E(p)(lab)=3032.0 5, Γ _p =0.60 keV.
11289.8 5	1 ⁺			E(p)(lab)=3037.5 5, Γ _p =1.0 keV.
11300.3 5	1 ⁺			E(p)(lab)=3048.3 5, Γ _p =0.40 keV.
11302.5 5	(1 ⁻)			E(p)(lab)=3050.6 5, Γ _p =1.2 keV.
				J ^π : 2 is also possible (1987WaZI).
11320.0 5	(0 ⁻)			E(p)(lab)=3068.5 5, Γ _p =1.8 keV.
				J ^π : 1 is also possible (1987WaZI).
11322.0 [#] 5	2 ⁺ [#]			J ^π : (1 ⁻ ,2 ⁺) from 1970De30.
				E(p)(lab)=3070.5 5, Γ _p =0.475 keV, Γ _α =0.041 keV (1990Bu02).
				E(p)(lab)=3073 3, S _α =440 eV (1970De30).
11329.3 ^a 5	2 ⁺			E(p)(lab)=3078.1 5.
11330.7 5	1 ⁻			E(p)(lab)=3079.5 5, Γ _p =4.0 keV, Γ _α =0.030 keV.
				E(p)(lab)=3083 3, S _α =52 eV (1970De30).
11338.7 5	(1 ⁺)			J ^π : 0,2 are also possible (1987WaZI).
				E(p)(lab)=3087.7 5, Γ _p =0.20 keV.
11342.6 5	2 ⁻			E(p)(lab)=3091.7 5, Γ _p =40 keV.
11346.4 5	4 ⁽⁺⁾			E(p)(lab)=3095.6 5, Γ _p =0.020 keV, Γ _α =0.0005 keV.
11351.5 5	1 ⁺			J ^π : from 1987WaZI, but π=natural from (p,α) in 1970De30 is inconsistent.
				E(p)(lab)=3100.8 5, Γ _p =0.80 keV.
				E(p)(lab)=3099 3, S _α =18 eV (1970De30).
11362.4 5	1 ⁺			E(p)(lab)=3112.0 5, Γ _p =1.2 keV.

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³⁹K(p,p),(p,α):resonances 1987WaZl,1990Bu02,1970De30 (continued)

⁴⁰Ca Levels (continued)

E(level) [†]	Jπ [‡]	Comments
11366.0 ^{#b} 5	2 ⁺ [#]	E(p)(lab)=3115.7 5, Γ _p =0.090 keV, Γ _α =0.100 keV (1990Bu02).
11367.0 5	2 ⁻	E(p)(lab)=3116.7 5, Γ _p =4.4 keV.
11368.3 5	4 ⁽⁺⁾	E(p)(lab)=3118.0 5, Γ _p =0.020 keV, Γ _α =0.0014 keV.
11371.4 5	2 ⁺	J ^π : (1 ⁻ ,2 ⁺) from 1970De30. E(p)(lab)=3121.2 5, Γ _p =1.4 keV, Γ _α =0.0040 keV. E(p)(lab)=3119 3, S _α =400 eV (1970De30).
11382.1 [#] 5	2 ⁺ [#]	J ^π : (0 ⁺ ,1 ⁻ ,2 ⁺) from (p,α) in 1970De30. E(p)(lab)=3132.2 5, Γ _p =2.500 keV, Γ _α =0.065 keV (1990Bu02). E(p)(lab)=3134 3, S _α =360 eV (1970De30).
11393.0 5	1 ⁽⁻⁾	E(p)(lab)=3143.4 5, Γ _p =0.10 keV, Γ _α =0.0004 keV.
11404.2 5	1 ⁻	E(p)(lab)=3154.9 5, Γ _p =3.5 keV, Γ _α =0.0060 keV.
11407.0 5	1 ⁺	E(p)(lab)=3157.7 5, Γ _p =0.22 keV.
11414.8 5	4 ⁺	J ^π : also from (p,α) in 1970De30. E(p)(lab)=3165.7 5, Γ _p =0.10 keV, Γ _α =0.0050 keV. E(p)(lab)=3169 3, S _α =70 eV (1970De30).
11420.3 5	3 ⁻	E(p)(lab)=3171.4 5, Γ _p =0.30 keV, Γ _α =0.0009 keV.
11432.7 5	1 ⁻	E(p)(lab)=3184.1 5, Γ _p =0.30 keV, Γ _α =0.0020 keV.
11436.8 [#] 5	2 ⁺ [#]	J ^π : also from (p,α) in 1970De30. E(p)(lab)=3188.3 5, Γ _p =0.200 keV, Γ _α =0.015 keV (1990Bu02). E(p)(lab)=3192 3, S _α =170 eV (1970De30).
11447.2 5	1 ⁻	E(p)(lab)=3199.0 5, Γ _p =5.0 keV, Γ _α =0.34 keV. E(p)(lab)=3200 3, S _α =950 eV (1970De30).
11451.4 5	1 ⁺	E(p)(lab)=3203.3 5, Γ _p =0.60 keV.
11455.4 5	3 ⁻	E(p)(lab)=3207.4 5, Γ _p =0.050 keV, Γ _α =0.010 keV.
11460.4 [#] 5	2 ⁺ [#]	J ^π : also from (p,α) in 1970De30. E(p)(lab)=3212.5 5, Γ _p =1.030 keV, Γ _α =0.140 keV (1990Bu02). E(p)(lab)=3214 3, S _α =1500 eV (1970De30).
11465.1 5	2 ⁽⁺⁾	E(p)(lab)=3217.3 5, Γ _p =0.026 keV, Γ _α =0.10 keV. E(p)(lab)=3221 3, S _α =57 eV (1970De30).
11468.7 5	2 ⁻	E(p)(lab)=3221.0 5, Γ _p =0.40 keV.
11479.8 5	1 ⁺	E(p)(lab)=3232.4 5, Γ _p =0.30 keV.
11486.7 ^b 5	0 ⁺	E(p)(lab)=3239.5 5, Γ _p =0.10 keV, Γ _α =0.0060 keV.
11489.6 5	1 ⁺	E(p)(lab)=3242.5 5, Γ _p =0.40 keV.
11514.6 [#] 5	2 ⁺ [#]	E(p)(lab)=3268.1 5, Γ _p =0.500 keV, Γ _α =0.115 keV (1990Bu02).
11515.2 5	1 ⁽⁻⁾	E(p)(lab)=3268.7 5, Γ _p =4.2 keV, Γ _α =0.030 keV.
11519.0 5	2 ⁺	E(p)(lab)=3272.6 5, Γ _p =0.70 keV.
11537.9 5	2 ⁻	E(p)(lab)=3292.0 5, Γ _p =8.0 keV.
11542.2 5	2 ⁺	E(p)(lab)=3296.4 5, Γ _p =0.60 keV, Γ _α =0.017 keV.
11543.7 5	(1 ⁺)	E(p)(lab)=3297.9 5, Γ _p =0.90 keV. J ^π : 2 is also possible (1987WaZl).
11546.7 5	2 ⁻	E(p)(lab)=3301.0 5, Γ _p =18 keV.
11554.5 5	1 ⁻	E(p)(lab)=3309.0 5, Γ _p =35 keV, Γ _α =0.60 keV.
11559.1 5	(2 ⁺)	E(p)(lab)=3313.7 5, Γ _p =0.40 keV. J ^π : 1 is also possible (1987WaZl).
11563.5 5	(2 ⁻)	E(p)(lab)=3318.3 5, Γ _p =0.40 keV. J ^π : 1 is also possible (1987WaZl).
11577.9 5	2 ⁻	E(p)(lab)=3333.0 5, Γ _p =1.0 keV.
11578.0 [#] 5	2 ⁺ [#]	E(p)(lab)=3333.1 5, Γ _p =0.180 keV, Γ _α =0.045 keV (1990Bu02).
11585.6 5	2 ⁻	E(p)(lab)=3340.9 5, Γ _p =0.15 keV.
11597.2 5	(2 ⁺)	E(p)(lab)=3352.8 5, Γ _p =0.30 keV. J ^π : 1 is also possible (1987WaZl).
11602.3 5	2 ⁺	E(p)(lab)=3358.0 5, Γ _p =0.30 keV.

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$^{39}\text{K}(\text{p,p}),(\text{p},\alpha)$:resonances **1987WaZl,1990Bu02,1970De30** (continued) ^{40}Ca Levels (continued)

E(level) [†]	J π [‡]	Comments
11603.4 [#] 5	2 ⁺ [#]	E(p)(lab)=3359.1 5, $\Gamma_p=0.250$ keV, $\Gamma_\alpha=0.030$ keV (1990Bu02).
11605.3 5	1 ⁻	E(p)(lab)=3361.1 5, $\Gamma_p=12$ keV, $\Gamma_\alpha=1.0$ keV.
11611.1 5	1 ⁻	E(p)(lab)=3367.1 5, $\Gamma_p=0.70$ keV, $\Gamma_\alpha=0.16$ keV.
11614.0 5	(2 ⁻)	E(p)(lab)=3370.0 5, $\Gamma_p=0.50$ keV. J π : 1 is also possible (1987WaZl).
11628.5 5	(3 ⁺)	E(p)(lab)=3384.9 5, $\Gamma_p=0.70$ keV. J π : 2 is also possible (1987WaZl).
11629.1 [#] 5	2 ⁺ [#]	E(p)(lab)=3385.5 5, $\Gamma_p=0.070$ keV, $\Gamma_\alpha=0.015$ keV (1990Bu02).
11638.1 ^b 5	1 ⁻	E(p)(lab)=3394.8 5, $\Gamma_p=0.080$ keV, $\Gamma_\alpha=0.010$ keV.
11645.0 5	(2 ⁻)	E(p)(lab)=3401.8 5, $\Gamma_p=0.60$ keV. J π : 1 is also possible (1987WaZl).
11646.9 [#] 5	2 ⁺ [#]	E(p)(lab)=3403.8 5, $\Gamma_p=0.600$ keV, $\Gamma_\alpha=0.002$ keV (1990Bu02). $\Gamma_p=0.20$ in 1987WaZl .
11650.8 5	2 ⁽⁺⁾	E(p)(lab)=3407.8 5, $\Gamma_p=0.10$ keV, $\Gamma_\alpha=0.080$ keV.
11652.2 ^a 5	3 ⁻	E(p)(lab)=3409.2 5.
11653.5 [#] 5	2 ⁺ [#]	E(p)(lab)=3410.5 5, $\Gamma_p=1.500$ keV, $\Gamma_\alpha=0.090$ keV (1990Bu02).
11661.7 ^b 5	1 ⁻	E(p)(lab)=3419.0 5, $\Gamma_p=0.060$ keV, $\Gamma_\alpha=1.5$ keV.
11672.8 5	(2 ⁻)	E(p)(lab)=3430.4 5, $\Gamma_p=0.20$ keV. J π : 1 is also possible (1987WaZl).
11677.1 [#] 5	2 ⁺ [#]	E(p)(lab)=3434.7 5, $\Gamma_p=0.180$ keV, $\Gamma_\alpha=0.775$ keV (1990Bu02).
11687.5 5	(1 ⁺)	E(p)(lab)=3445.4 5, $\Gamma_p=0.50$ keV. J π : 0 is also possible (1987WaZl).
11689.2 5	(2 ⁻)	E(p)(lab)=3447.2 5, $\Gamma_p=0.60$ keV. J π : 1 is also possible (1987WaZl).
11692.8 5	4 ⁽⁺⁾	E(p)(lab)=3450.9 5, $\Gamma_p=0.012$ keV, $\Gamma_\alpha=0.0090$ keV.
11696.3 5	0 ⁽⁻⁾	E(p)(lab)=3454.5 5, $\Gamma_p=0.60$ keV.
11703.6 5	0 ⁺	E(p)(lab)=3461.9 5, $\Gamma_p=4.5$ keV, $\Gamma_\alpha=0.15$ keV.
11704.6 5	2 ⁻	E(p)(lab)=3463.0 5, $\Gamma_p=3.0$ keV.
11707.8 5	1 ⁻	E(p)(lab)=3466.3 5, $\Gamma_p=0.30$ keV, $\Gamma_\alpha=0.0020$ keV.
11713.6 5	1 ⁺	E(p)(lab)=3472.2 5, $\Gamma_p=0.20$ keV.
11715.7 5	2 ⁻	E(p)(lab)=3474.4 5, $\Gamma_p=1.5$ keV.
11721.2 5	1 ⁺	E(p)(lab)=3480.0 5, $\Gamma_p=1.5$ keV.
11724.1 5	3 ⁽⁻⁾	E(p)(lab)=3483.8 5, $\Gamma_p=0.050$ keV, $\Gamma_\alpha=0.010$ keV.
11731.0 5	1 ⁽⁻⁾	E(p)(lab)=3490.4 5, $\Gamma_p=0.64$ keV, $\Gamma_\alpha=3.0$ keV.
11731.1 5	1 ⁺	E(p)(lab)=3490.5 5, $\Gamma_p=0.40$ keV.
11738.8 5	2 ⁻	E(p)(lab)=3498.2 5, $\Gamma_p=3.0$ keV.
11742.8 [#] 5	2 ⁺ [#]	E(p)(lab)=3502.1 5, $\Gamma_p=0.750$ keV, $\Gamma_\alpha=0.320$ keV (1990Bu02).
11744.6 5	4 ⁺	E(p)(lab)=3504.8 5, $\Gamma_p=0.050$ keV, $\Gamma_\alpha=0.50$ keV. J π : 2 ⁺ in 1987WaZl ; later corrected to 4 ⁺ by the same group.
11749.5 5	1 ⁽⁻⁾	E(p)(lab)=3509.7 5, $\Gamma_p=0.70$ keV, $\Gamma_\alpha=2.5$ keV.
11753.4 ^a 5	2 ⁻	E(p)(lab)=3513.1 5.
11754.0 5	3 ⁻	E(p)(lab)=3513.7 5, $\Gamma_p=0.30$ keV, $\Gamma_\alpha=0.050$ keV. J π : 1 ⁻ in 1987WaZl , later corrected to 3 ⁻ by the same group.
11757.3 5	1 ⁺	E(p)(lab)=3517.4 5, $\Gamma_p=0.60$ keV.
11768.0 5	2 ⁻	E(p)(lab)=3528.2 5, $\Gamma_p=15$ keV.
11782.6 5	3 ⁽⁻⁾	E(p)(lab)=3543.5 5, $\Gamma_p=0.021$ keV, $\Gamma_\alpha=0.020$ keV.
11788.5 [#] 5	2 ⁺ [#]	E(p)(lab)=3549.0 5, $\Gamma_p=2.200$ keV, $\Gamma_\alpha=0.340$ keV (1990Bu02).
11792.4 5	1 ⁺	E(p)(lab)=3553.5 5, $\Gamma_p=0.46$ keV.
11799.2 5	4 ⁽⁺⁾	E(p)(lab)=3560.2 5, $\Gamma_p=0.010$ keV, $\Gamma_\alpha=0.17$ keV.
11804.1 ^b 5	0 ⁺	E(p)(lab)=3565.3 5, $\Gamma_p=0.060$ keV, $\Gamma_\alpha=0.20$ keV.

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³⁹K(p,p),(p,α):resonances **1987WaZl,1990Bu02,1970De30** (continued)

⁴⁰Ca Levels (continued)

E(level) [†]	Jπ [‡]	Comments
11809.0 5	(1 ⁺)	E(p)(lab)=3570.2 5, Γ _p =1.1 keV. J ^π : 2 is also possible (1987WaZl).
11810.9 [#] 5	2 ⁺ [#]	E(p)(lab)=3572.0 5, Γ _p =0.770 keV, Γ _α =0.975 keV (1990Bu02).
11811.6 5	3 ⁻	E(p)(lab)=3572.7 5, Γ _p =0.26 keV, Γ _α =0.0020 keV.
11820.5 5	3 ⁻	E(p)(lab)=3581.9 5, Γ _p =3.5 keV, Γ _α =0.030 keV. J ^π : 1 ⁻ in 1987WaZl; later corrected to 3 ⁻ by the same group.
11830.8 ^{#b} 5	2 ⁺ [#]	E(p)(lab)=3592.4 5, Γ _p =0.070 keV, Γ _α =0.230 keV (1990Bu02).
11839.2 5	0 ⁺	E(p)(lab)=3601.0 5, Γ _p =1.0 keV, Γ _α =0.050 keV.
11844.1 5	1 ⁺	E(p)(lab)=3606.0 5, Γ _p =0.78 keV.
11855.8 [#] 5	2 ⁺ [#]	E(p)(lab)=3618.0 5, Γ _p =0.325 keV, Γ _α =0.060 keV (1990Bu02).
11857.3 5	(1 ⁺)	E(p)(lab)=3619.6 5, Γ _p =1.3 keV. J ^π : 2 is also possible (1987WaZl).
11863.3 5	(3 ⁻)	E(p)(lab)=3625.7 5, Γ _p =0.41 keV, Γ _α =0.0080 keV. J ^π : 1 is also possible (1987WaZl).
11864.7 5	(0 ⁺)	E(p)(lab)=3627.2 5, Γ _p =1.6 keV. J ^π : 1,2 are also possible (1987WaZl).
11868.8 5	(4 ⁺)	E(p)(lab)=3631.4 5, Γ _p =0.030 keV, Γ _α =0.0020 keV. J ^π : 2 is also possible (1987WaZl).
11870.0 ^b 5	3 ⁻	E(p)(lab)=3632.6 5, Γ _p =0.010 keV, Γ _α =0.030 keV. J ^π : 2 ⁺ in 1987WaZl, later corrected to 3 ⁻ by the same group.
11872.2 [#] 5	2 ⁺ [#]	E(p)(lab)=3634.8 5, Γ _p =0.450 keV, Γ _α =0.420 keV (1990Bu02).
11878.0 5	1 ⁻	E(p)(lab)=3640.8 5, Γ _p =0.30 keV, Γ _α =0.015 keV.
11884.5 5	1 ⁺	E(p)(lab)=3647.5 5, Γ _p =0.80 keV.
11888.3 5	4 ⁺	E(p)(lab)=3651.4 5, Γ _p =0.10 keV, Γ _α =0.025 keV.
11890.9 5	1 ⁻	E(p)(lab)=3654.0 5, Γ _p =20 keV.
11894.0 5	(2 ⁻)	E(p)(lab)=3657.2 5, Γ _p =1.0 keV. J ^π : 1 is also possible (1987WaZl).
11901.4 5	1 ⁺	E(p)(lab)=3664.8 5, Γ _p =0.70 keV.
11915.9 5	3 ⁻	E(p)(lab)=3679.7 5, Γ _p =1.0 keV, Γ _α =0.0040 keV.
11924.6 [#] 5	2 ⁺ [#]	E(p)(lab)=3688.6 5, Γ _p =2.200 keV, Γ _α =0.002 keV (1990Bu02).
11930.0 5	4 ⁽⁺⁾	E(p)(lab)=3694.2 5, Γ _p =0.030 keV, Γ _α =0.0015 keV.
11933.3 5	1 ⁻	E(p)(lab)=3697.5 5, Γ _p =16 keV, Γ _α =0.074 keV.
11935.0 5	1 ⁺	E(p)(lab)=3699.3 5, Γ _p =0.80 keV.
11937.3 5	2 ⁻	E(p)(lab)=3701.6 5, Γ _p =0.60 keV.
11940.4 5	1 ⁺	E(p)(lab)=3704.8 5, Γ _p =0.40 keV.
11942.8 5	3 ⁻	E(p)(lab)=3707.3 5, Γ _p =0.48 keV, Γ _α =0.0090 keV.
11945.0 5	1 ⁻	E(p)(lab)=3709.5 5, Γ _p =0.40 keV, Γ _α =0.0080 keV.
11948.4 5	0 ⁺	E(p)(lab)=3713.0 5, Γ _p =0.30 keV, Γ _α =0.010 keV.
11958.7 5	(2 ⁺)	E(p)(lab)=3723.6 5, Γ _p =1.0 keV, Γ _α =0.0050 keV. J ^π : 1 is also possible (1987WaZl).
11962.9 5	0 ⁺	E(p)(lab)=3727.9 5, Γ _p =0.30 keV, Γ _α =0.0060 keV.
11969.8 5	1 ⁺	E(p)(lab)=3735.0 5, Γ _p =0.80 keV.
11971.0 [#] 5	2 ⁺ [#]	E(p)(lab)=3736.2 5, Γ _p =0.240 keV, Γ _α =0.018 keV (1990Bu02).
11975.1 ^b 5	1 ⁻	E(p)(lab)=3740.4 5, Γ _p =0.040 keV, Γ _α =0.015 keV.
11983.3 5	(2 ⁻)	E(p)(lab)=3748.8 5, Γ _p =1.6 keV. J ^π : 1 is also possible (1987WaZl).
11987.1 5	3 ⁻	E(p)(lab)=3752.7 5, Γ _p =0.30 keV, Γ _α =0.080 keV.
11994.0 5	0 ⁻	E(p)(lab)=3759.8 5, Γ _p =3.0 keV.
12001.3 5	(2 ⁺)	E(p)(lab)=3767.3 5, Γ _p =1.0 keV, Γ _α =0.020 keV. J ^π : 1 is also possible (1987WaZl).
12007.4 5	1 ⁺	E(p)(lab)=3773.5 5, Γ _p =0.55 keV.
12010.4 5	2 ⁻	E(p)(lab)=3776.6 5, Γ _p =6.0 keV.

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³⁹K(p,p),(p,α):resonances [1987WaZI](#),[1990Bu02](#),[1970De30](#) (continued)

⁴⁰Ca Levels (continued)

E(level) [†]	J ^π [‡]	Comments
12012.2 ^b 5	4 ⁺	E(p)(lab)=3778.5 5, Γ _p =0.010 keV, Γ _α =0.0006 keV.
12023.6 5	1 ⁺	E(p)(lab)=3790.2 5, Γ _p =0.90 keV.
12026.9 5	4 ⁺	E(p)(lab)=3793.5 5, Γ _p =0.20 keV, Γ _α =0.018 keV.
12033.8 5	3 ⁻	E(p)(lab)=3800.6 5, Γ _p =0.30 keV, Γ _α =0.0050 keV.
12047.7 5	2 ⁺	E(p)(lab)=3814.9 5, Γ _p =2.5 keV, Γ _α =0.15 keV.
12056.4 5	1 ⁻	E(p)(lab)=3823.8 5, Γ _p =2.0 keV.
12058.9 5	2 ⁺	E(p)(lab)=3826.4 5, Γ _p =1.1 keV, Γ _α =0.10 keV.
12067.3 5	2 ⁺	E(p)(lab)=3835.0 5, Γ _p =1.0 keV, Γ _α =0.15 keV.
12067.8 5	4 ⁺	E(p)(lab)=3835.5 5, Γ _p =1.1 keV, Γ _α =0.01 keV. J ^π : 2 ⁺ in 1987WaZI ; later corrected to 4 ⁺ by the same group. Γ _α of 0.10 listed in 1987WaZI was later corrected to 0.01 by the same group.
12076.8 ^a 5	2 ⁻	E(p)(lab)=3844.7 5, Γ _p =3.0 keV, Γ _α =0.070 keV.
12082.0 5	4 ⁽⁺⁾	E(p)(lab)=3850.1 5, Γ _p =0.020 keV, Γ _α =0.001 keV.
12086.1 5	4 ⁽⁺⁾	E(p)(lab)=3854.3 5, Γ _p =0.010 keV, Γ _α =0.001 keV.
12088.8 5	2 ⁻	E(p)(lab)=3857.0 5, Γ _p =10.0 keV.
12089.7 5	2 ⁺	E(p)(lab)=3858.0 5, Γ _p =4.2 keV, Γ _α =20 keV.
12093.1 5	4 ⁽⁺⁾	E(p)(lab)=3861.4 5, Γ _p =0.030 keV, Γ _α =0.030 keV.
12095.1 5	2 ⁺	E(p)(lab)=3863.5 5, Γ _p =9.0 keV, Γ _α =0.40 keV.
12106.0 5	4 ⁽⁺⁾	E(p)(lab)=3874.7 5, Γ _p =0.050 keV, Γ _α =0.040 keV.
12110.7 5	2 ⁺	E(p)(lab)=3879.5 5, Γ _p =2.0 keV.
12115.1 5	3 ⁻	E(p)(lab)=3884.0 5, Γ _p =0.60 keV, Γ _α =0.18 keV.
12125.9 5	(3 ⁺)	E(p)(lab)=3895.1 5, Γ _p =1.0 keV. J ^π : 2 is also possible (1987WaZI).
12132.7 5	(4 ⁺)	E(p)(lab)=3902.1 5, Γ _p =0.060 keV, Γ _α =0.070 keV. J ^π : 2 is also possible (1987WaZI).
12134.9 5	(4 ⁺)	E(p)(lab)=3904.3 5, Γ _p =0.10 keV, Γ _α =0.0030 keV. J ^π : 2 is also possible (1987WaZI).
12141.2 [#] 5	2 ⁺ [#]	E(p)(lab)=3910.8 5, Γ _p =1.00 keV, Γ _α =0.240 keV (1990Bu02).
12152.3 5	4 ⁺	E(p)(lab)=3922.2 5, Γ _p =0.33 keV, Γ _α =0.025 keV.
12157.8 5	4 ⁽⁺⁾	E(p)(lab)=3927.8 5, Γ _p =0.080 keV, Γ _α =0.040 keV.
12159.4 5	4 ⁽⁺⁾	E(p)(lab)=3929.5 5, Γ _p =0.080 keV, Γ _α =0.0030 keV.
12177.7 5	1 ⁽⁻⁾	E(p)(lab)=3948.2 5, Γ _p =0.20 keV, Γ _α =0.020 keV.
12180.2 5	2 ⁺	E(p)(lab)=3950.8 5, Γ _p =1.4 keV, Γ _α =0.10 keV.
12184.5 5	2 ⁻	E(p)(lab)=3955.2 5, Γ _p =2.0 keV.
12192.7 [#] 5	2 ⁺ [#]	E(p)(lab)=3963.6 5, Γ _p =1.00 keV, Γ _α =0.240 keV (1990Bu02).
12196.3 5	1 ⁽⁻⁾	E(p)(lab)=3967.3 5, Γ _p =0.80 keV, Γ _α =0.15 keV.
12201.2 5	3 ⁻	E(p)(lab)=3972.3 5, Γ _p =2.0 keV, Γ _α =0.080 keV.
12209.3 5	0 ⁻	E(p)(lab)=3980.6 5, Γ _p =1.0 keV.
12211.9 ^b 5	4 ⁺	E(p)(lab)=3983.3 5, Γ _p =0.020 keV, Γ _α =0.0090 keV.
12217.7 5	1 ⁺	E(p)(lab)=3989.2 5, Γ _p =1.5 keV.
12224.3 5	1 ⁻	E(p)(lab)=3996.0 5, Γ _p =1.4 keV, Γ _α =0.060 keV.
12226.4 [#] 5	2 ⁺ [#]	E(p)(lab)=3998.2 5, Γ _p =0.425 keV, Γ _α =0.009 keV (1990Bu02).
12237.7 5	1 ⁺	E(p)(lab)=4009.8 5, Γ _p =2.0 keV.
12244.0 5	4 ⁺	E(p)(lab)=4016.2 5, Γ _p =0.020 keV, Γ _α =0.010 keV.
12245.2 5	1 ⁻	E(p)(lab)=4017.5 5, Γ _p =1.0 keV, Γ _α =1.0 keV.
12256 ^c 4		E(p)(lab)=4029 4, Γ=5.5 keV (1974Na09).
12270 ^c 4	(2 ⁺)	E(p)(lab)=4043 4, Γ=5.8 keV (1974Na09).
12280 ^c 4		E(p)(lab)=4053 4, Γ=4.2 keV (1974Na09).
12292 ^c 4		E(p)(lab)=4066 4, Γ=4.0 keV (1974Na09).
12299 ^c 4	(2 ⁺)	E(p)(lab)=4073 4, Γ=4.0 keV (1974Na09).
12305 ^c 4	(1 ⁻)	E(p)(lab)=4079 4, Γ=6.7 keV (1974Na09).

Continued on next page (footnotes at end of table)

$^{39}\text{K}(\text{p,p}),(\text{p},\alpha)$:resonances [1987WaZI](#),[1990Bu02](#),[1970De30](#) (continued) ^{40}Ca Levels (continued)

E(level) [†]	$J\pi^{\ddagger}$	Comments
12331 ^c 4	2 ⁺	E(p)(lab)=4106 4, $\Gamma=7.3$ keV (1974Na09).
12348 ^c 4		E(p)(lab)=4123 4, $\Gamma=6.0$ keV (1974Na09).
12357 ^c 4	(3 ⁻ ,1 ⁻)	E(p)(lab)=4132 4, $\Gamma=5.5$ keV (1974Na09).
12368 ^c 4		E(p)(lab)=4143 4, $\Gamma=6.7$ keV (1974Na09).
12376 ^c 4		E(p)(lab)=4152 4, $\Gamma=5.9$ keV (1974Na09).
12381 ^c 4		E(p)(lab)=4157 4, $\Gamma=4.0$ keV (1974Na09).
12399 ^c 4	(2 ⁺ ,1 ⁻)	E(p)(lab)=4175 4, $\Gamma=6.7$ keV (1974Na09).
12406 ^c 4		E(p)(lab)=4182 4, $\Gamma=3.5$ keV (1974Na09).
12411 ^c 4		E(p)(lab)=4188 4, $\Gamma=4.0$ keV (1974Na09).
12419 ^c 4		E(p)(lab)=4195 4, $\Gamma=5.4$ keV (1974Na09).
12425 ^c 4		E(p)(lab)=4202 4, $\Gamma=6.4$ keV (1974Na09).
14370 [@]		E(p)(lab)=6350 (1969Va14).
14460 [@]		E(p)(lab)=6440 (1969Va14).
14530 [@]		E(p)(lab)=6520 (1969Va14).
14600 [@]		E(p)(lab)=6590 (1969Va14).
14680 [@]		E(p)(lab)=6660 (1969Va14).

[†] From E(p)(lab) values and the adopted S(p)=8328.17 2 ([2012Wa38](#)). The E(p)(lab) values are given in comments and are from [1987WaZI](#), unless otherwise stated. Resonances listed at E(p)(lab)=2740.6 and 2764.6 by [1987WaZI](#) were later deleted by the same group. Uncertainty for E(p)(lab) is assigned here as 0.5 keV (same as FWHM), but the relative uncertainty is expected to be much smaller, probably ≈ 0.1 keV.

[‡] From [1987WaZI](#), unless otherwise stated. When $J\pi$ given in parentheses, other less likely spin(s) which give similar fits are given in comments. When parity appears in parentheses, resonance is too weak in (p,p) to determine parity unambiguously. Values from (p,p) are extracted from theoretical fits to experimental cross sections while values from (p, α) are from angular distributions of emitted α particles ([1987WaZI](#),[1970De30](#),[1974Na09](#),[1990Bu02](#)). Resonances in the (p, α) reactions have natural parities.

[#] From [1990Bu02](#). See also [1987WaZI](#) from the same group. The Γ_p and Γ_α values are also given in [1987WaZI](#).

[@] From [1969Va14](#) only from p₁ and p₄ channels.

[&] From [1970De30](#).

^a Not listed in [1987WaZI](#), but added later by the same group.

^b [1987WaZI](#) state that resonance does not appear in (p,p₀). It probably corresponds to (p,p₁).

^c From [1974Na09](#).

^d From [1970De30](#).

^e For 9600.8+9602.4 ([1970De30](#)).

$^{39}\text{K}(\text{d},\text{n})$ 1969Fu01

$J\pi(^{39}\text{K g.s.})=3/2^+$.

1969Fu01: E=6 MeV deuteron beam was produced from the 5.5 MeV Van Van de Graaff of the Hahn-Meitner-Institut Berlin.

Target was a 460 25 $\mu\text{g}/\text{cm}^2$ layer of natural potassium iodide evaporated onto a 0.3 mm tungsten backing. Neutrons were detected in liquid scintillators and neutron energies were determined by measurement of time-of-flight (flight path=7.35 m). Measured $\sigma(\theta)$, TOF spectra. Deduced levels, J, π , L, spectroscopic factors from DWBA analysis. Comparisons with available data and shell-model calculations.

Others:.

1967Ba38: E=2.9-6.2 MeV. Measured $\sigma(\theta)$ for g.s.

2000El08: E=0.7-3.4 MeV. Measured yield from γ -ray data.

All data are from 1969Fu01, unless otherwise noted.

 ^{40}Ca Levels

E(level) [†]	$J\pi^{\ddagger}$	L	$G_L^{\#}$	Comments
0	0 ⁺	2	0.84	
3353	0 ⁺	(2)	≤ 0.09	
3737	3 ⁻	1+3	0.44 3	G_L : for L=3; 0.02 for L=1. S=0.02 for L=1, 0.50 4 for L=3.
3904	2 ⁺	(2)	≤ 0.12	
4491	5 ⁻	3	0.93 13	S=0.68 10.
5614	4 ⁻	3	1.06 11	S=0.94.
5903	1 ⁻	1(+3)	0.02	G_L : ≤ 0.05 for L=3. S=0.05 for L=1.
6025	2 ⁻	1+3	0.12 4	G_L : for L=3; 0.037 for L=1. S=0.06 for L=1, 0.20 7 for L=3.
6285	3 ⁻	1(+3)	0.43	G_L : ≤ 0.3 for L=3. S=0.49 for L=1, ≤ 0.3 for L=3.
6582	3 ⁻	1(+3)	0.14	G_L : ≤ 0.2 for L=3. S=0.16 for L=1, ≤ 0.2 for L=3.
6750	2 ⁻	1+3	0.33 11	G_L : for L=3; 0.034 for L=1. S=0.05 for L=1, 0.53 18 for L=3.
6950	1 ⁻	1(+3)	0.17	G_L : ≤ 0.2 for L=3. S=0.45 for L=1.
7113	(3) ⁻	1(+3)	0.18	G_L : ≤ 0.1 for L=3. S=0.21 for L=1, ≤ 0.1 for L=3. J^π : 1 ⁻ and 4 ⁻ in Adopted Levels.
7532	(2) ⁻	1(+3)	0.49	G_L : ≤ 0.1 for L=3. S=0.78 for L=1, ≤ 0.2 for L=3.
7658		3	1.50 14	E(level): doublet: 7655+7676. S=0.69 7 for 7655, (4) ⁻ . ((2J _f +1)/(2J _i +1))S=3.0 3.
7694	(3) ⁻	1	0.05	S=0.82 8. ((2J _f +1)/(2J _i +1))S=0.10.
7972		1	0.04	
8124		1+3	0.12 4	E(level): doublet: 8113+8135. G_L : for L=3; 0.025 for L=1. S=0.03 for L=1; 0.12 4 for L=3.
8186		0		
8271	(0) ⁻	1	0.08	S=0.64. J^π : (≤ 3) ⁻ in Adopted Levels.
8371	(0) ⁻	1	0.08	S=0.64. J^π : (0,1,2) ⁻ in Adopted Levels.
8424	(2) ⁻	1+3	0.36 11	G_L : for L=3; 0.01 for L=1. S=0.58 18 for L=3. ((2J _f +1)/(2J _i +1))S=0.02 for L=1; ; 0.72 22 for L=3.

Continued on next page (footnotes at end of table)

$^{39}\text{K}(\text{d},\text{n})$ **1969Fu01** (continued) ^{40}Ca Levels (continued)

$E(\text{level})^\dagger$	$J^\pi^\ddagger$	L	$G_L^\#$	Comments
8551	$(5)^-$	3	0.98 12	$S=0.71$ 9. $((2J_f+1)/(2J_i+1))S=1.96$ 24.
8664 12		1	0.14	
8757 12				
8860 12	$(0)^-$			J^π : (6,7,8) $^-$ in Adopted Levels.
8931 12		1	0.11	$S=0.88$.
8987 12				
9137 12		1	0.17	
9228 12		1	0.16	$((2J_f+1)/(2J_i+1))S=0.32$.
9408 12	$(2)^-$	1	0.57	$E(\text{level})$: triplet: 9405+9412+9419. $S=0.43$. $S=0.35$ for 9404, $(3)^-$ level with $L=1$. $((2J_f+1)/(2J_i+1))S=1.14$ for 9404+9408.
9431 12	$(1)^-$	1	0.22 3	$E(\text{level})$: doublet: 9430+9432. $S=0.59$. $((2J_f+1)/(2J_i+1))S=0.44$ 6 for 9433+9435.
9455 12		1	0.13	$((2J_f+1)/(2J_i+1))S=0.26$.
9533 12	$(1)^-$	1	0.22	$S=0.59$. $((2J_f+1)/(2J_i+1))S=0.44$ for 9539+9540.
9601 12	$(2)^-$	1	0.37	$E(\text{level})$: doublet: 9603+9605. $S=0.59$. J^π : 1^- and 3^- in Adopted Levels.
9666 12		1	0.11	
10040 12	$(0)^-$	1	0.05 1	$S=0.44$ 8. $((2J_f+1)/(2J_i+1))S=0.11$ 2. $E(\text{level})$: from 1969Fu01 . Several levels near this energy in Adopted Levels.

† Rounded-off values from Adopted Levels for levels below 8600.

‡ From Adopted Levels up to 7 MeV; from **1969Fu01** above this energy where many groups are unresolved and it is difficult to find corresponding levels in Adopted Levels.

$^\#$ Transition strength $G_L=((2J_f+1)/(2J_i+1))C^2S=1/N \times (d\sigma/d\Omega)_{\text{exp}}/(d\sigma/d\Omega)_{\text{DWBA}}$, where J_f =spin of final state, J_i =target spin=3/2, $N=1.48$ the normalization factor. The spectroscopic factors are given under comments. Uncertainty is less than 10%, when not stated. Absolute normalization uncertainty is 30%.

³⁹K(³He,d) **1966Er05,1967Se10**

$J\pi(^{39}\text{K g.s.})=3/2^+$.

1966Er05: E=12 MeV ³He beam was produced from the Argonne tandem Van de Graaff. Target was potassium iodide (highly enriched in ³⁹K) with thickness of about 30 μg/cm² evaporated onto a self-supporting carbon backing. Reaction products were analyzed with a broad-range magnetic spectrograph and detected in nuclear emulsions. Measured $\sigma(\theta)$. Deduced levels, J, π , L, spectroscopic factors from DWBA analysis. Comparisons with shell-model calculations. Report 15 levels.

1967Se10: E=12,14,16 MeV ³He beams were produced from the Oak Ridge National Laboratory EN tandem accelerator. Target was about 100 μg/cm² natural potassium evaporated onto 30 μg/cm² carbon backings. Reaction products were detected with a Δ E-E telescope of silicon surface-barrier detectors as Δ E detector and a Li-drifted silicon detector as E detector (FWHM=50 keV). Measured $\sigma(\theta)$. Deduced levels, J, π , L, spectroscopic factors from DWBA analysis. Comparisons with available data and shell-model calculations. Report 15 levels.

1970Fo04: E=11 MeV ³He beam was produced from the Liverpool University Tandem accelerator. Target was 200 μg/cm² natural potassium (93.1% in ³⁹K) evaporated onto a thin carbon backing. Reaction products were detected with telescopes of surface-barrier counters. Measured $\sigma(\theta)$. Deduced levels, J, π , L, spectroscopic factors from DWBA analysis. Comparisons with other measurements and shell-model calculations. Report 11 levels.

1971Ca05: E=29.3 MeV ³He beam was produced from the University of Colorado four-sector variable energy cyclotron. Targets were 0.12 0.30 mg/cm² natural potassium evaporated onto 20 μg/cm² carbon foils. Reaction products were detected with Δ E-E telescopes of silicon surface-barrier detectors as Δ E detectors and Si(Li) detectors as E detectors (FWHM=100 keV). Measured $\sigma(\theta)$. Deduced levels, J, π , L, spectroscopic factors from DWBA analysis. Comparisons with available and shell-model calculations. Report 18 levels.

1968Ba64: E=18 MeV. FWHM=60-80 keV for deuteron spectra. About 20 groups reported from (³He,d) and 3 levels in (³He,d γ).

1994Ve04: E=25 MeV. Measured $\sigma(\theta)$ for g.s.

⁴⁰Ca Levels

Spectroscopic factor C²S is defined by $(2J+1)/(2J_i+1) \times C^2S = 1/N \times (d\sigma/d\Omega)_{\text{exp}} / (d\sigma/d\Omega)_{\text{DWBA}}$, where J=spin of final state,

J_i=target spin=3/2, N the normalization factor, and C the isobaric-spin Clebsch-Gordan coupling coefficient with C²=1/2 (**1966Er05**, **1967Se10**). Values given here are (2J+1)S.

Spectroscopic factors of (³ He,d) given as (2J+1)S						
Level	L	1966Er05	1967Se10	1970Fo04	1971Ca05*	1971Ca05@
0#	2	---	6.64	5.83	4.80	6.24
3736	3	5.0a	3.57a	4.2	2.8	3.4
4488	3	13.4	8.4	8.0	7.6	9.2
5616	3	11.8	7.0	6.8	5.6	7.0
5902	1	0.22	0.15	---	0.06	0.09
6026	3	≈1.8b	1.0b	---	0.8	1.05
6288	1	5.0	2.8c	4.3	1.7	2.1
6586	1	1.6	1.2	1.5	0.77	0.84
6751	1	1.0	0.96	0.94	1.50d	1.90d
6952	1	1.65	1.20	1.29	0.39	0.48
7117	1	1.90	1.54	1.40	1.33	1.54
7534	1	4.36	1.50e	---	0.80	0.95
7660	3	8.7	5.5	---	4.3	5.5
7696	3	8.17f	5.8	---	4.4	5.5
8435	3	≈3.2	5.0	---	2.3	2.8
8554	3	≈13.0	10.0	---	7.0	9.2

*: from regular DWBA (**1971Ca05**)

@: from modified DWBA (**1971Ca05**)

#: 8.0 for g.s. from **1994Ve04**

a: ≈0.08 for L=1 (**1966Er05**), <0.07 for L=1 (**1967Se10**)

b: ≈0.27 for L=1 (**1966Er05**), 0.20 for L=1 (**1967Se10**)

c: <0.7 for L=3 (**1967Se10**)

d: for L=3 (**1971Ca05**)

e: 4.0 for L=3 (**1967Se10**)

f: <0.8 for L=1 (**1966Er05**)

E(level) [†]	J π [‡]	L [#]	Comments
0	0 ⁺	2	
3353	0 ⁺	(2)	E(level): not observed, upper limit on strength: 8% of g.s. (1967Se10), 5% of 3738 level (1966Er05).
3736 5	3 ⁻	3	
3902	2 ⁺	(2)	not observed, upper limit on strength: 3% of g.s. (1967Se10), 5% of 3738 level.
4410 ^a			E(level): this group reported only by 1968Ba64 is suspect (evaluator); not included in Adopted Levels.
4488 5	5 ⁻	3	
5200 ^{&}			
5244 ^{&}			
5274 ^{&}			
5616 6	4 ⁻	3	
5902 6	1 ⁻	1	E(level): from 1966Er05 .
6026 5	2 ⁻	3	E(level): from 1966Er05 .
6288 5	3 ⁻	1	
6586.1 6	3 ⁻	1	
6751 6	2 ⁻	1	J π : (0) ⁻ in 1970Fo04 . L: other: L=3 (1971Ca05).
6952 6	1 ⁻	1	
7117 6	1 ⁻	1	J π : (3) ⁻ adopted in 1971Ca05 .
7534 6	2 ⁻	1	
7660 [@] 6	4 ⁻	3 [@]	
7696 [@] 6	3 ⁻	3 [@]	
8435 9	2 ⁻	3	E(level): from 1967Se10 . 8465 /2 from 1966Er05 . According to 1973Te04 in (³ He,d γ) this level probably corresponds to 8425 level in their γ -ray study.
8554 9	5 ⁻	3	
9140 50			E(level): from 1971Ca05 and 1968Ba64 , presumably a multiplet.
9410 50			E(level): from 1971Ca05 and 1968Ba64 , presumably a multiplet.
9700 ^a			
10050? ^a			
10380? ^a			
11200 ^a			

[†] Weighted average of values from [1966Er05](#) and [1967Se10](#), unless otherwise noted.

[‡] From Adopted Levels unless otherwise stated.

[#] From DWBA fits to measured differential cross sections ([1966Er05](#), [1967Se10](#), [1970Fo04](#) and [1971Ca05](#)).

[@] 7659+7694 doublet. L=3 with almost equal strengths for both components ([1966Er05](#)). [1967Se10](#) give L=1 for both states with (2J+1)S=5.5 for 7659 and 5.8 for 7696 levels.

[&] 0⁺, 2⁺, 4⁺ triplet with total strength <10% of g.s. ([1967Se10](#)), not observed in [1966Er05](#) and [1967Se10](#).

^a From [1968Ba64](#) only.

$^{39}\text{K}(^3\text{He,d}\gamma)$ 1973Te04

1973Te04 (also 1971Te02,1970Te01): E=18 MeV ^3He beam was produced from the Van de Graaff Tandem accelerator at CEN Saclay. Charged particles were detected with solid state detector telescopes and γ rays were detected with NaI and Ge(Li) detectors. Measured E_γ , I_γ , $d\gamma$ -coin. Deduced levels, γ -ray branching ratios.

1968Ba64: E=18 MeV. FWHM=60-80 keV for deuteron spectra. About 20 groups reported from ($^3\text{He,d}$) and 3 levels in ($^3\text{He,d}\gamma$).

 ^{40}Ca Levels

E(level) [†]	J π @	Comments
0	0 ⁺	
3353.1 [‡] 11	0 ⁺	
3737.0 3	3 ⁻	
3904.6 [‡] 3	2 ⁺	
4491.7 3	5 ⁻	
5212.2 [‡] 5	0 ⁺	
5248.2 [‡] 3	2 ⁺	
5277.7 [‡] 3	4 ⁺	
5613.7 5	4 ⁻	
5903.9 9	1 ⁻	
6026.0 4	2 ⁻	
6284.9 4	3 ⁻	
6582.2 4	3 ⁻	
6751.3 4	2 ⁻	
6929.3 [#] 5		
6952.9 12	1 ⁻	
7115.3 4	4 ⁻	
7531.4 11	2 ⁻	
7658.8 11	4 ⁻	
7694.7 6	3 ⁻	
8267.9 12	(0 ⁻)	J π : from 1973Te04. Adopted J π =(≤ 3) ⁻ .
8358.1 13	(0 ⁻)	J π : from 1973Te04. Adopted J π =(0,1,2) ⁻ .
8425.5 16	2 ⁻	E(level): according to 1973Te04 this level is strongly fed in ($^3\text{He,d}$); probably corresponds to 8435 9 from 1967Se10 in ($^3\text{He,d}$).
8552.8 16	5 ⁻	

[†] From a least-squares fit to γ -ray energies.

[‡] Not observed in other ($^3\text{He,d}$) measurements, probably populated by (p,p' γ) in 1973Te04.

[#] Possibly a close doublet (2-3 keV apart) according to 1973Te04, since the Doppler shifts for the two γ 's barely overlap. Level not reported in any other ($^3\text{He,d}$) experiment, probably populated by (p,p' γ) in 1973Te04.

@ From Adopted Levels, unless otherwise noted.

 $\gamma(^{40}\text{Ca})$

$E_i(\text{level})$	J π_i	E_γ [†]	I_γ [†]	E_f	J π_f	$E_i(\text{level})$	J π_i	E_γ [†]	I_γ [†]	E_f	J π_f
3737.0	3 ⁻	3736.6 3	100	0	0 ⁺	5613.7	4 ⁻	1123.0 8	30	4491.7	5 ⁻
3904.6	2 ⁺	3904.6 [‡] 4	100	0	0 ⁺			1876.5 4	70	3737.0	3 ⁻
4491.7	5 ⁻	754.7 2	100	3737.0	3 ⁻	5903.9	1 ⁻	5903.4 10	100	0	0 ⁺
5212.2	0 ⁺	1307.5 [‡] 4	100	3904.6	2 ⁺	6026.0	2 ⁻	2121.0 6	20	3904.6	2 ⁺
5248.2	2 ⁺	1343.5 [‡] 10	17	3904.6	2 ⁺			2289.0 3	80	3737.0	3 ⁻
		1895 [§]	3	3353.1	0 ⁺	6284.9	3 ⁻	1793.1 2	70	4491.7	5 ⁻
		5247.9 [‡] 6	80	0	0 ⁺			2380.0 5	25	3904.6	2 ⁺
5277.7	4 ⁺	1373.1 1	100	3904.6	2 ⁺			6285 [§]	5	0	0 ⁺

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$^{39}\text{K}(^3\text{He},\text{d}\gamma)$ **1973Te04** (continued) $\gamma(^{40}\text{Ca})$ (continued)

$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\dagger$	E_f	J_f^π	$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\dagger$	E_f	J_f^π
6582.2	3 ⁻	2845.1 3	100	3737.0	3 ⁻	7531.4	2 ⁻	1917.6 10	100	5613.7	4 ⁻
6751.3	2 ⁻	2848.4 10	15	3904.6	2 ⁺	7658.8	4 ⁻	2045.0 10	100	5613.7	4 ⁻
		3014.0 3	85	3737.0	3 ⁻	7694.7	3 ⁻	3957.5 5	100	3737.0	3 ⁻
6929.3		1651.7 4	50	5277.7	4 ⁺	8267.9	(0 ⁻)	1315 [§]	60	6952.9	1 ⁻
		3190.0 15	50	3737.0	3 ⁻			2364 [§]	40	5903.9	1 ⁻
6952.9	1 ⁻	6952.2 15	100	0	0 ⁺	8358.1	(0 ⁻)	1405.2 5	>90	6952.9	1 ⁻
7115.3	4 ⁻	1502 [§]	20	5613.7	4 ⁻	8425.5	2 ⁻	4688.2 15	100	3737.0	3 ⁻
		2623.2 3	20	4491.7	5 ⁻	8552.8	5 ⁻	4060.8 15	100	4491.7	5 ⁻
		3378.5 3	60	3737.0	3 ⁻						

[†] From **1973Te04**. Values reported in **1973Te04** are combination of their results from both ($^3\text{He},\text{d}\gamma$) and ($\text{p},\text{p}'\gamma$) measurements and the authors didn't distinguish which values are from ($^3\text{He},\text{d}\gamma$) or ($\text{p},\text{p}'\gamma$). So the evaluator have used the same values in the two data sets but only consider values from ($\text{p},\text{p}'\gamma$) in Adopted Gammas to avoid duplication, unless comparable values are also available from ($^3\text{He},\text{d}\gamma$) measurements other than **1973Te04**. Values given here are only for levels populated in ($^3\text{He},\text{d}$) dataset, unless otherwise noted. For complete data of **1973Te04**, see ($\text{p},\text{p}'\gamma$) dataset.

[‡] Probably from ($\text{p},\text{p}'\gamma$) in **1973Te04**, since the decaying level was not observed in ($^3\text{He},\text{d}$) measurements.

[§] From figure 2 of **1973Te04**; not given in authors' table I. Values are level-energy differences.

⁴⁰Ca(γ, γ') **2002Ha13,1982Mo05**

2002Ha13 (also **2001Ba66,2000Ha34,2000Zi04**): E=9.9 MeV bremsstrahlung source was produced from the superconducting linear electron accelerator S-DALINAC at Darmstadt University of Technology. Target was 4358 mg ^{nat}CaO. γ rays were detected with two HPGe detectors surrounded by a BGO scintillation detector. Measured $E\gamma$, $I\gamma$, $\gamma\gamma(\theta)$, strengths. Deduced levels, J, widths.

1982Mo05 (also **1977SaYN**): E=8.5, 11.3, 11.7 MeV bremsstrahlung sources were produced from the MUSL-2 accelerator of the University of Illinois. Target was 3.0 g/cm² metallic Ca plate (96.97% in ⁴⁰Ca). γ rays were detected with Ge(Li) detectors. Measured $E\gamma$, $I\gamma$, $\gamma\gamma(\theta)$, strengths. Deduced levels, J, widths.

Others:.

1987Gu01: E=9603.9, 9864.6, 9868.8, 10321.0 keV from ³⁹K(p, γ) resonances. Measured σ , $E\gamma$. Deduced widths for four levels.

1977La15: E=6.95 MeV from ¹⁹F(p, $\alpha\gamma$); measured σ , $\gamma(\theta)$ for two levels at 6914 and 6954.

1968Me06: E=6.91, 6.95 MeV from ¹⁹F(p, $\alpha\gamma$); measured σ , deduced spin and widths for 6910, 6950 levels.

1962Ra07: ³⁹K(p, γ) resonances as source to measure.

Absorption lineshapes for 9866, 9869 doublet.

1961Ec03: E=10.3 MeV from ³⁹K(p, γ) resonances as source. Deduced widths for 10.3 MeV level.

1961De22: E=35 MeV bremsstrahlung source; measured $\sigma(\theta)$ for $E\gamma=17-23$ MeV; deduced parameters for giant-dipole resonance.

1999Pr01: E=58, 74 MeV. Measured $\sigma(\theta)$. Deduced electromagnetic polarizability.

⁴⁰Ca Levels

E(level) [†]	J ^π [‡]	T _{1/2} or Γ ^{&}	Γ_0 [@]	Comments
0	0 ⁺			
3904.0 1	2 ⁺	29 fs +10-6	0.016 4	
5249.6 3	2 ⁺ #	79 fs +11-9	0.0046 5	T _{1/2} or Γ : using adopted branching $\Gamma_0/\Gamma=0.796$ 10.
5628.9 2	2 ⁺ #	38 fs +20-10	0.0105 35	Γ_0 : unweighted average of 0.0140 eV 13 (2002Ha13) and 0.007 eV 3 (1982Mo05).
				T _{1/2} or Γ : using adopted branching $\Gamma_0/\Gamma=0.877$ 8.
5902.5 2	1 ⁻	15.2 fs +23-18	0.030 4	Γ_0 : weighted average of 0.033 eV 4 (2002Ha13) and 0.025 eV 5 (1982Mo05).
6421.2 9	2 ⁺ #	12 fs +5-3	0.039 12	J ^π : 2 ⁺ from 1982Mo05 , but measured intensity ratio in 2002Ha13 is consistent with J=1.
				Γ_0 : unweighted average of 0.027 eV 7 (2002Ha13) and 0.050 eV 6 (1982Mo05).
6908.2 1	2 ⁺	2.41 fs +29-23	0.189 20	Γ_0 : weighted average of 0.221 eV 36 (2002Ha13), 0.190 eV 20 (1982Mo05), 0.13 eV 6 (1977La15), 0.18 eV 3 (1968Me06).
6949.9 7	1 ⁻	1.01 fs 5	0.452 20	Γ_0 : weighted average of 0.49 eV 7 (2002Ha13), 0.450 eV 20 (1982Mo05), 0.41 eV 8 (1977La15), 0.47 eV 6 (1968Me06).
7871.9 1	2 ⁺	2.44 fs +24-20	0.187 17	T _{1/2} or Γ : using adopted branching $\Gamma_0/\Gamma=1$. 1982Mo05 report $\Gamma_0/\Gamma=0.84$ 6 without indicating the observation of other γ branches other than the ground transition and no such observation is from other studies. So this γ branching value is not considered in Adopted Gammas.
				Γ_0 : weighted average of 0.176 eV 32 (2002Ha13) and 0.190 eV 17 (1982Mo05).
8091.5 2	2 ⁺	2.94 fs +20-18	0.155 10	Γ_0 : weighted average of 0.166 eV 16 (2002Ha13) and 0.150 eV 10 (1982Mo05).
8110.9 6	1 ⁻	30 fs +20-9	0.015 6	Γ_0 : weighted average of 0.025 eV 9 (2002Ha13) and 0.012 eV 5 (1982Mo05).
8578.7 2	2 ⁺	3.6 fs +13-8	0.128 34	Γ_0 : unweighted average of 0.161 eV 13 (2002Ha13) and 0.094 eV 12 (1982Mo05).
8749.4 2	2 ⁺	5.8 fs +11-8	0.078 12	Γ_0 : weighted average of 0.088 eV 11 (2002Ha13) and 0.065 eV 12 (1982Mo05).
8982.5 5	2 ⁺	4.5 fs +39-14	0.101 47	Γ_0 : weighted average of 0.148 eV 15 (2002Ha13) and 0.054 eV 10 (1982Mo05).
9603.9		0.19 keV 5	4.9 18	E(level), T _{1/2} or Γ , Γ_0 : from 1987Gu01 .
9866.0 20		0.104 keV 24	1.36 25	E(level): from 1982Mo05 . Other: 9864.6 (1987Gu01).
				T _{1/2} or Γ : weighted average of 0.100 keV 24 (1987Gu01) and 0.110 keV 30

Continued on next page (footnotes at end of table)

⁴⁰Ca(γ,γ') **2002Ha13,1982Mo05 (continued)**

⁴⁰Ca Levels (continued)

E(level) [†]	Jπ [‡]	T _{1/2} or Γ ^{&}	Γ ₀ [@]	Comments
9868.9		0.90 keV 21	0.80 26	(1962Ra07). Most of the Γ is ascribed to proton decay (1962Ra07). Γ ₀ : from 1962Ra07. Γ ₀ ² /Γ=44 meV 18 from (1982Mo05). E(level): from 1987Gu01. T _{1/2} or Γ: weighted average of 0.90 keV 21 (1987Gu01) and 1.06 keV 20 (1962Ra07). Most of the width is ascribed to proton decay (1962Ra07). Γ ₀ : from 1962Ra07.
10318.0 20	1 ⁺	26 eV 7	5.5 8	E(level),Jπ: from 1982Mo05. Other: 10321.0 (1987Gu01). Jπ=1 ⁺ in Adopted Levels. Jπ=2 ⁺ from 1961Ec03. Γ ₀ : from 1982Mo05. Others: 6.6 eV 8 (1987Gu01), 3.60 eV 24 (1961Ec03). Γ from 1982Mo05. Others: 91 eV 15 (1987Gu01), 10.3 eV 17 (1961Ec03). Γ _γ =6.4 eV 9 (1982Mo05), 4.5 eV 6 (1961Ec03). Γ _p =20 eV 5 (1982Mo05), 5.8 eV 18 (1961Ec03). Γ ₀ /Γ=0.21 2 (1982Mo05).
20×10 ³				E(level): giant-dipole resonance (1961De22). Γ _γ /Γ=0.0053, 0.0058 (1961De22).

[†] From 2002Ha13, unless otherwise stated. Values available from 1982Mo05 are in general agreement with those from 2002Ha13.

[‡] Spins are from 2002Ha13 and 1982Mo05 based on measured ratios of intensities of the elastically scattered γ lines at 130° to those at 90°, with ratio=1.36 for J=1 and 0.44 for J=2 (1982Mo05); parities are from Adopted Levels; unless otherwise noted.

[#] From Adopted Levels.

[@] From 2002Ha13 (in eV), unless otherwise stated.

[&] Values of half-lives are deduced from Γ₀ and adopted γ branching Γ₀/Γ=1 assuming no particle decay, unless otherwise stated.

γ(⁴⁰Ca)

E _γ [†]	E _i (level)	J _i ^π	E _f	J _f ^π	E _γ [†]	E _i (level)	J _i ^π	E _f	J _f ^π
3903.8 1	3904.0	2 ⁺	0	0 ⁺	8110.0 6	8110.9	1 ⁻	0	0 ⁺
5249.2 3	5249.6	2 ⁺	0	0 ⁺	8577.7 2	8578.7	2 ⁺	0	0 ⁺
5628.5 2	5628.9	2 ⁺	0	0 ⁺	8748.4 2	8749.4	2 ⁺	0	0 ⁺
5902.0 2	5902.5	1 ⁻	0	0 ⁺	8981.4 5	8982.5	2 ⁺	0	0 ⁺
6420.6 9	6421.2	2 ⁺	0	0 ⁺	9602.7	9603.9		0	0 ⁺
6907.6 1	6908.2	2 ⁺	0	0 ⁺	9864.7 20	9866.0		0	0 ⁺
6949.3 7	6949.9	1 ⁻	0	0 ⁺	9867.6	9868.9		0	0 ⁺
7871.1 1	7871.9	2 ⁺	0	0 ⁺	10316.6 20	10318.0	1 ⁺	0	0 ⁺
8090.6 2	8091.5	2 ⁺	0	0 ⁺					

[†] From level-energy difference with the uncertainty taken from level energy, unless otherwise noted. 2002Ha13 report level energies based on observed ground state transitions. Values available from 1982Mo05 are in general agreement with those from 2002Ha13 but with less precision.

$^{40}\text{Ca}(\gamma, \gamma')$ 2002Ha13,1982Mo05Level Scheme

⁴⁰Ca(e,e') **1995Pe01,1982Bu05,1970It01**

Most measurements report $\sigma(\theta)$ distributions and deduce transition strengths for states excited in (e,e').

1995Pe01: E=28.4, 34.9, 45.7, 54.6, 56.5 MeV. Data for 8 M1 levels and 5 M2 levels from 9870 to 13670. $\Delta E(\text{level})=10$. The authors also quote data for 18 levels from Darmstadt group (R. Benz, Diploma thesis 1984; W. Gross, Diploma thesis 1981; both from Darmstadt).

1982Bu05 (also **1982BuZR**): E=31-65 MeV; measured $\sigma(E,\theta)$, form factors. Deduced levels with $\Delta E(\text{level})=50$, transition strengths, widths.

1970It01: E=183, 250 MeV; measured $\sigma(\theta)$; DWBA analysis. $\Delta E(\text{level})=100$. Report 11 levels.

1978Gr03 (also **1978Gr02,1977Gr26**): E=31-67 MeV. Data for 3353, 6950 levels.

1970Go10: E=44-54 MeV. $\Delta E(\text{level})=200$; giant resonances.

1984Og01: E=70-200 MeV. Report 3 groups.

1984Ha29: E=81.6-380 MeV. 3352 level studied.

1980St17: E=39 MeV. $\Delta E(\text{level})=5$. Data for 10319 level.

1979Gr09: E=44, 50 MeV. $\Delta E(\text{level})=5$. Data for 10319 level.

1974Na15: E=700-750 MeV. Measured electron-proton coin; deduced proton-separation energies. Report 5 groups at 10.4, 13.6, 18.4, 35.3 and 58.4 MeV.

1973Ha13: E=66-121 MeV; measured form factors. Data for 3737 and 3904 levels.

1971Fa15: E=39-56 MeV. Data for 5940, 6940, 8430 and 10340 levels.

1971He08: E=198, 250, 300 MeV. Data for 3740 and 4480 levels.

1970St10, 1968St20: E=28-60 MeV. Data for 0⁺ state.

1969Ei03: E=20-60 MeV. Data for 3730, 3900 and 6940 levels.

1968Zi06: E=282.8 MeV.

1964Ho06: E=80-190 MeV. Data for 11000, 12200, 13900 and 14600 levels.

1963Bi04: E=120, 150, 180, 220 MeV. Report 8 levels.

1961Pe21: E=120, 150, 180 MeV.

1956He83: E=187 MeV. Data for 3730 level.

1956Ha91: E=183 MeV. Data for 3730+3900 level.

Others:

(e,e'): **2001Di23, 1986De12, 1985Me05** (also **1984Me06**), **1983De25, 1981Fr03, 1978Zi04, 1975To02, 1968Fr11, 1964We08, 1962Ed02**.

(e,e): **1997Wi23, 1983Em01, 1979Si21, 1973Si15** (also **1971Si08, 1971SiYF**).

(e,e'p) and (e,e'α): giant resonances deduced: **2001Di24, 2001Di23, 1998Ko20, 1995Di03, 1994Vo05, 1976Mo17, 1973Ca14, 1971Mo06**.

(e,e'n): **1994Ta12**.

⁴⁰Ca Levels

1963Bi04 give B(EL)(↓), these have been converted to B(EL)(↑).

E(level) [†]	J ^π _‡	T _{1/2}	Comments
0	0 ⁺		
3352 5	0 ⁺		E(level): from 1984Ha29 . Monopole matrix element M(E0)=2.66 e*fm ² 41, weighted average of 2.53 e*fm ² 41 (1978Gr02), 3.6 fm ² 11 (1968St20). From monopole strength $\rho^2 E0 = [M(E0)]^2 / [e^2 R^4]$ where R=R ₀ A ^{1/3} with R ₀ =1.2 fm, one gets $\rho^2 E0=0.025$ 8. Width of e ⁺ e ⁻ pair emission $\Gamma_\pi=3.7E-7$ eV 23 (1970St10). T _{1/2} : from B(E3)↑. Other: 30 ps 6 from Γ_γ in 1970St10 . B(E3)↑=0.0167 16, unweighted average of 0.0100 11 (1963Bi04 , from $\beta_3=0.066$ 7), 0.0190 21 (1956He83 , from $\beta_3=0.125$ 14 with 10% uncertainty from normalization added by the evaluator), 0.0211 25 (1969Ei03), 0.0149 7 (1973Ha13), 0.0183 7 (1970It01 , average of 0.0185 7 and 0.0180 7), 0.0166 12 (1971He08 , from B(E3)(W.u.)=24.9 18). $\Gamma_\gamma=15$ μeV 3 (1970St10). T _{1/2} : from B(E2)↑. Other: 29 fs 6 from Γ_γ in 1970St10 .
3740	3 ⁻	50 ps 5	
3900	2 ⁺	36 fs +5-4	

Continued on next page (footnotes at end of table)

⁴⁰Ca(e,e') **1995Pe01,1982Bu05,1970It01 (continued)**

⁴⁰Ca Levels (continued)

E(level) [†]	J ^π [‡]	T _{1/2}	Comments
4490	5 ⁻		B(E2)↑=0.0088 10, weighted average of 0.015 5 (1963Bl04, from β ₂ =0.016 5), 0.0084 10 (1969Ei03), 0.0090 10 (1973Ha13). Other: 0.012 (1970It01, from B(E2)(W.u.)=3.0). Γ _γ =0.016 eV 3 (1970St10). J ^π : from 1970It01 and 1963Bl04.
5250	2 ⁺		B(E5)↑=2.12E-4 22, weighted average of 2.07E-4 22 (1963Bl04, from β ₅ =0.048 5), 2.8E-4 8 (1970It01, from B(E5)(W.u.)=17 5 average of 20 +9-5 and 16.3 45). Others: 1.62E-4 10 or 2.95E-4 25 (1971He08, depending on shape factor).
5610	2 ⁺		B(E2)↑=0.0031 3 (1970It01, from B(E2)(W.u.)=0.4).
5940 70			B(E2)↑=0.0016 (1970It01, from B(E2)(W.u.)=0.4).
6160	3 ⁻		E(level): from 1971Fa15, 5900 100 from 1970It01.
6290	3 ⁻	0.30 ps +7-6	E(level): from 1963Bl04. B(E3)↑=0.00073 18 (1963Bl04, from β ₃ =0.0048 12).
6590	3 ⁻		E(level): from B(E3)↑ here and the adopted γ branchings in Adopted Gammas.
6900	3 ⁻		B(E3)↑=0.0031 3 (1970It01, from B(E3)(W.u.)=4.6 4).
6910	2 ⁺		B(E3)↑=0.00166 13 (1970It01, from B(E3)(W.u.)=2.5 2).
6930	3 ⁻		E(level),J ^π : from 1963Bl04. This level could correspond to the 6931, 3 ⁻ or the 6938 level in Adopted Levels. 1969Ei03 report a composite of 6930,3 ⁻ and 6910,2 ⁺ . E(level),J ^π : from 1978Gr03. 1969Ei03 report a composite of 6930,3 ⁻ and 6910,2 ⁺ . Γ ₀ =0.190 eV 6 (1978Gr03).
6950	1 ⁻		B(E2)↑=0.00070 9 (1969Ei03).
7100	2 ⁺		E(level),J ^π : from 1969Ei03. According to 1969Ei03, it could be an unresolved triplet of 6910 (2 ⁺), 6930 (3 ⁻) and 6950 (1 ⁻). Other: 6900 reported in 1963Bl04.
7900	(2 ⁺ ,4 ⁺)		B(E3)↑=0.0011 3 (1963Bl04, from β ₃ =0.007 2), while 0.0092 13 from 1969Ei03 for the 6930 component of the 6910+6930 composite; however, T _{1/2} =1.4 ps 6 and no observation of g.s. transition from the 6931.29, J ^π =3 ⁻ level in γ studies indicates a much smaller B(E3)↑.
8428 5	2 ⁻		E(level),J ^π : from 1978Gr03. E=6940 70 from 1971Fa15, 6950 100 from 1970It01.
8500	5 ⁻		Γ ₀ =0.51 eV 5 (1978Gr03).
9868 5	1 ⁺ ,2 ⁺		E(level),J ^π : from 1963Bl04.
10319 5	1 ⁺		B(E2)↑=0.0163 18 (1963Bl04, from β ₂ =0.018 2).
10400			J ^π : from 1970It01; 4 ⁺ from 1963Bl04; could correspond to the 7872, 2 ⁺ level or 7928, 4 ⁺ level in Adopted Levels.
10670 10	2 ⁻		B(E4)↑=0.00028 5 (1963Bl04, from β ₄ =0.011 2). Others: B(E2)↑=0.0053 or B(E4)↑=0.00053 from B(E2)(W.u.)=1.3 or B(E4)(W.u.)=5 in 1970It01.
10776 6	(1 ⁻)		E(level),J ^π : from 1980St17.
11000	(3,4)		Γ ₀ =0.026 eV +10-8 (1971Fa15).
11760 10	1 ⁺		J ^π : from 1963Bl04. Other: (2 ⁺ ,4 ⁺ ,5 ⁻) (1970It01).
			B(E5)↑=1.16E-4 13 (1963Bl04, from β ₅ =0.027 3). Other: B(E2)↑=0.0016 or B(E5)↑=0.00012 from B(E2)(W.u.)=0.4 or B(E5)(W.u.)=7.0 in 1970It01.
			E(level),J ^π : from 1980St17, probably a doublet of 2 ⁺ and 1 ⁺ separated by 5 keV. Other: 9870 10 with J ^π =1 ⁺ ,2 ⁺ from 1995Pe01.
			B(M1)↑=0.32 9 (1995Pe01), 0.43 4 (quoted by 1995Pe01 from Darmstadt group).
			E(level): from 1979Gr09, probably the isobaric analog of the 2730 level in ⁴⁰ K.
			B(M1)↑=1.06 8 (1995Pe01), 1.11 5 (quoted by 1995Pe01 from Darmstadt group), 1.12 7 (1979Gr09).
			Γ=7.0 eV +29-22 (1971Fa15).
			E(level): from 1974Na15, 1d _{3/2} state, ΔE=1.4 MeV.
			Γ=9.2 MeV 13 (1974Na15).
			E(level),J ^π : from 1995Pe01. Other: 10676 (quoted by 1995Pe01 from Darmstadt group).
			B(M2)↑=0.16 5 (1995Pe01), 0.15 3 (quoted by 1995Pe01 from Darmstadt group).
			E(level),J ^π : from 1979Gr09.
			E(level),J ^π : from 1964Ho06, ΔE=100 keV.
			E(level),J ^π : from 1995Pe01. Other: 11775 (quoted by 1995Pe01 from Darmstadt group).
			B(M1)↑=0.35 3 (1995Pe01).

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$^{40}\text{Ca}(\text{e},\text{e}')$ **1995Pe01,1982Bu05,1970It01 (continued)** ^{40}Ca Levels (continued)

E(level) [†]	J π [‡]	Comments
12040 10	1 ⁺	E(level),J π : from 1995Pe01. Other: 12044, J π =2 ⁻ (quoted by 1995Pe01 from Darmstadt group); J π =2 ⁺ in Adopted Levels. B(M1) $\uparrow$ =0.09 4 (1995Pe01).
12200	3 ⁻	from 1964Ho06, ΔE =50. B(E3) $\uparrow$ =2.93E-4 20 (1964Ho06, from B(E3)(W.u.)=0.44 3).
12350 10	2 ⁻	E(level),J π : from 1995Pe01. Other: 12332, J π =(1 ⁻ ,2 ⁺) (quoted by 1995Pe01 from Darmstadt group). B(M2) $\uparrow$ =0.41 21 (1995Pe01).
12488	2 ⁻	E(level),J π : from Darmstadt group with B(M2) $\uparrow$ =0.17 5, quoted in 1995Pe01.
12490 10	1 ⁺	E(level),J π : from 1995Pe01. B(M1) $\uparrow$ =0.10 2 (1995Pe01).
12503	2 ⁻	E(level),J π : from Darmstadt group with B(M2) $\uparrow$ =0.17 5, quoted in 1995Pe01.
12622	(2)	E(level),J π : from Darmstadt group with B(M2) $\uparrow$ =0.19 7, quoted in 1995Pe01.
12750 10	2 ⁻	E(level),J π : from 1995Pe01. Other: 12749 (quoted by 1995Pe01 from Darmstadt group). B(M2) $\uparrow$ =0.13 6 (1995Pe01), 0.06 6 (quoted by 1995Pe01 from Darmstadt group).
12830 10	1 ⁺ ,2 ⁻	E(level),J π : from 1995Pe01, 2 ⁻ is less probable. Other: 12830 (quoted by 1995Pe01 from Darmstadt group). B(M1) $\uparrow$ =0.14 3 (1995Pe01), 0.06 4 (quoted by 1995Pe01 from Darmstadt group).
13050 10	1 ⁺	E(level),J π : from 1995Pe01. Other: 13049 (quoted by 1995Pe01 from Darmstadt group). B(M1) $\uparrow$ =0.26 4 (1995Pe01), 0.25 2 (quoted by 1995Pe01 from Darmstadt group).
13150 10	2 ⁻	E(level),J π : from 1995Pe01. Other: 13147 (quoted by 1995Pe01 from Darmstadt group). B(M2) $\uparrow$ =0.48 6 (1995Pe01), 0.34 9 (quoted by 1995Pe01 from Darmstadt group).
13445	2 ⁻	E(level),J π : from Darmstadt group with B(M2) $\uparrow$ =0.55 7, quoted in 1995Pe01.
13480 10	1 ⁺	E(level),J π : from 1995Pe01. Other: 13480, J π =2 ⁻ ,(1 ⁺) (quoted by 1995Pe01 from Darmstadt group). B(M1) $\uparrow$ =0.26 10 (1995Pe01).
13600		E(level): from 1974Na15, 2s _{1/2} state, ΔE =0.4 MeV. Γ =12.0 MeV 9 (1974Na15).
13670 10	2 ⁻	E(level),J π : from 1995Pe01. Other: 13666 (quoted by 1995Pe01 from Darmstadt group). B(M2) $\uparrow$ =0.66 16 (1995Pe01), 0.27 6 (quoted by 1995Pe01 from Darmstadt group).
13900	2 ⁺	E(level),J π : from 1964Ho06, ΔE =100 keV. B(E2) $\uparrow$ =7.3E-4 8 (1964Ho06, from B(E2)(W.u.)=0.18 2).
14600	(1,2 ⁺ ,3 ⁻ ,4 ⁺)	E(level),J π : from 1964Ho06, ΔE =100 keV.
18400		E(level): from 1974Na15, 1d _{5/2} state, ΔE =1.6 MeV. Γ =9.9 MeV 14 (1974Na15).
35300		E(level): from 1974Na15, 1p state, ΔE =0.5 MeV. Γ =23.5 MeV 23 (1974Na15).
42000		
58400		E(level): from 1974Na15, 1s state, ΔE =1.1 MeV. Γ =31.9 MeV 11 (1974Na15).

[†] From 1970It01 with ΔE =100 keV for levels up to 8500; from 1995Pe01 above 8500, unless otherwise noted.[‡] From measurements of $\sigma(\theta)$ and deduced transition strengths (1995Pe01,1970It01,1963Bl04); from Adopted Levels if not noted.

$^{40}\text{Ca}(\pi^+, \pi^{+'}), (\pi^-, \pi^{-'})$ [1981Mo17](#), [1984Bo02](#), [1982Bi09](#)

[1981Mo17](#): $E(\pi^+)$, $E(\pi^-)$ =180 MeV. Measured $\sigma(\theta)$, DWIA analysis, FWHM=150 keV.

[1982Bi09](#): $E(\pi^+)$, $E(\pi^-)$ =80 MeV. Measured $\sigma(\theta)$, $\theta=50^\circ - 120^\circ$. Deduced GQR, DWBA analysis.

[1984Bo02](#), [1981Bo26](#): $E(\pi^+)$, $E(\pi^-)$ =116, 180, 292.5 MeV. Measured $\sigma(\theta)$, $\theta=20^\circ - 70^\circ$.

[2002Af05](#): $E(\pi^+)$, $E(\pi^-)$ =116-292.5 MeV. Analyzed $\sigma(\theta)$ by DWBA. Deduced deformation parameters. Data of [1984Bo02](#) used.

[1977Mi19](#) (also [1978Mi05](#)): $E(\pi^+)$ =50 MeV. Measured $\sigma(\theta)$, $\theta=40^\circ, 80^\circ$.

[1978Eg03](#): $E(\pi^+)$ =130 MeV. Measured $\sigma(\theta)$.

[1979Ar01](#): $E(\pi^+)$ =163, 261 MeV. Deduced GQR.

[1984Ma42](#): $E(\pi^+)$, $E(\pi^-)$ =675.7 MeV. Measured $\sigma(\theta)$, DWBA analyses, deduced optical-model parameters.

[1985U101](#): $E(\pi^+)$, $E(\pi^-)$ =135 MeV. Measured $\sigma(\theta)$, deduced GQR, giant monopole and low-energy giant octupole resonances.

(π^+, π^+) , (π^-, π^-) : $\sigma(\theta)$ and optical model parameters:.

[1997Ka22](#) (672.5 MeV), [1988Wr01](#) (19.5, 30 MeV), [1984Le01](#) (80 MeV), [1983Je01](#) (114-215 MeV), [1982Da13](#) and [1980DaZR](#) (64.8 MeV), [1981Gr09](#) (130, 180, 230 MeV), [1978In04](#) (115 MeV), [1978DrZS](#) (isobar resonance energy), [1977Eg02](#) (130 MeV).

Others:.

(π^+, π^+) : $\sigma(\theta)$ and optical model parameters:.

[1983Ob02](#) (20 MeV), [1981Pr03](#) (30, 50 MeV), [1979Bi07](#) (40 MeV), [1976WaZB](#) (145, 174, 204 MeV).

(π^-, π^-) : $\sigma(\theta)$ and optical model parameters:.

[1997Ka22](#) (400 MeV), [1994Bu09](#) (40 MeV), [1990Se04](#) (30, 50 MeV).

 ^{40}Ca Levels

$E(\text{level})^\dagger$	$L^\ddagger$	$B_L(\Pi^-), B_L(\Pi^+)^\#$	Comments
0			
3352	0		
3736	3	0.56, 0.5	$B_L(\Pi^-), B_L(\Pi^+)$: from 1982Bi09 .
3908	2		
4492	5	0.095, .081	
6256	3	0.085, .074	
6583	3	0.102, .161	
6700@			
11700@			
13400&	0, 2&	0.15, 0.13&	
17500&	2&	0.26&	

† From [1981Mo17](#), unless otherwise noted.

‡ From DWIA analysis in [1981Mo17](#), unless otherwise noted. Values are also reported in [1984Bo02](#) and [1982Bi09](#).

$^\#$ From [2002Af05](#) (Data of [1984Bo02](#) used), unless otherwise noted.

@ From [1977Mi19](#).

& From [1982Bi09](#); from $(\pi^+, \pi^{+'})$.

⁴⁰Ca(n,n'),(pol n,n') 1990OI02,1977Ba49,1986Ho05

Also includes (n,n) and (pol n,n).

1990OI02: (n,n') E=21.6 MeV. Measured $\sigma(\theta)$ for g.s., 3737 and 4491 levels. Deduced deformation parameters.

1977Ba49: (n,n') E=11, 20 MeV. Measured $\sigma(\theta)$. DWBA analysis. Deduced deformation parameters.

1986Ho05, 1986De17 (also 1987HoZU): (n,n'), (pol n,n') E=11-17 MeV. Measured $\sigma(\theta)$, $Ay(\theta)$ for unresolved 3737+3904 levels.

Others:.

2011Mu10: (n,n) E=9.9-85 MeV. Measured σ .

1989Ra06: (n,n) E=thermal. Measured bragg diffraction pattern, scattering lengths.

1988Is03: (n,n') E=18-60 MeV. Measured $\sigma(\theta)$. Deduced optical-model parameters.

1987AI03, 1987AI02 (also 1986AIZS): (n,n') E=21.7, 25.5 MeV. Measured $\sigma(\theta)$. Deduced deformation parameters.

1986Wi01: (n,n). Analyzed $\sigma(\theta)$.

1982To11: (pol n,n) E=9.9, 11.9, 13.9 MeV. Measured $\sigma(\theta)$, $Ay(\theta)$. Deduced optical-model parameters.

1981De21 (also 1980DeZO): (n,n) E=30.3, 40 MeV. Measured $\sigma(\theta)$.

1980Ba50: (n,n') E=2.7-5.5 MeV. Measured total $\sigma(E)$.

1979Ja26: (n,n) E=2-3 MeV. Measured $\sigma(\theta)$.

1977Ra16, 1977Ra12: (n,n) E=11, 20, 26 MeV. Measured $\sigma(\theta)$.

1977Fe01: (n,n) E=11 MeV. Measured $\sigma(\theta)$.

1973Ba69: (n,n') E=3.52 MeV. Measured lifetime of 3353 level.

1973Wy03: (n,n'). Measured σ , deduced resonances.

1964Mc20: (n,n') E=14.1 MeV. Measured $\sigma(\theta)$.

1959KI46: (n,n'), pulsed neutrons from ³H(p,n) reaction. Measured lifetime for 3353 level by detecting time decay of $\gamma^{\pm}$ radiation.

This state was also excited in 1959KI46 using (p,p' γ).

⁴⁰Ca Levels

E(level) [†]	J π [‡]	T _{1/2}	L	β_L	Comments
0	0 ⁺				
3353	0 ⁺	2.21 ns 10			T _{1/2} : weighted average of 2.36 ns 14 (1959KI46) and 2.14 ns 10 (1973Ba69).
3737	3 ⁻		3	0.314 16	β_L ,L: from 1990OI02, 5% uncertainty in β_L . Others: β_L =0.359 21 (1977Ba49), 0.33 (1987AI03).
3904	2 ⁺		2	0.096 10	β_L ,L: from 1977Ba49. Other: β_L =0.10 (1987AI03).
4491	5 ⁻		5	0.229 12	β_L ,L: from 1990OI02, 5% uncertainty in β_L . Others: β_L =0.26 4 (1977Ba49), 0.23 (1987AI03).

[†] Rounded-off energy from Adopted Levels.

[‡] From Adopted Levels.

⁴⁰Ca(n,n'γ) [1972Di10,1972Ni05,1984El12](#)

[1972Di10](#): E=4.85-8.05 MeV neutron beams were produced via D(d,n) reaction with pulsed deuteron beams provided by the Oak Ridge National Laboratory 6-MV Van de Graaff accelerators. Target was natural calcium. γ rays were detected with a 45-cm³ coaxial Ge(Li) detector. Measured Eγ, σ(Eγ) at 6 different neutron energies. Deduced levels.

[1972Ni05](#): Fission-spectrum neutrons were produced from the McMaster reactor. γ rays were detected with Ge(Li) and NaI(Tl) detectors. Measured Eγ, Iγ. Deduced levels, γ-ray branching ratios.

[1984El12](#) (also [1989Ge09](#)): E=fast. Measured γ, lifetime by DSA.

[1981KaZL](#): E=fast. Measured Eγ, Iγ, Doppler-shift attenuation. Deduced levels, T_{1/2}.

Others:.

[1963Ho08](#): E=14 MeV. Measured Eγ.

Differential cross sections (mb/sr) at different energies (125°) (1972Di10)							
Eγ	4.85 MeV	5.40 MeV	5.90 MeV	6.45 MeV	7.00 MeV	7.50 MeV	8.05 MeV
755	0.55 10	1.20 15	1.3 2	2.6 3	3.2 3	3.1 3	4.1 4
780					0.18 9	0.20 6	0.23 7
1122			0.32 6	0.91 14	1.14 18	1.10 24	1.45 22
1303		0.70 11	0.95 14	1.51 20	1.31 19	1.20 20	1.04 15
1345			0.41 8	0.33 5	0.28 4	0.61 15	0.39 11
1374		0.30 15	1.3 2	2.33 25	2.9 3	2.6 3	2.7 3
1651						0.50 10	0.66 11
1793					0.91 22	0.75 10	1.09 13
1877			0.42 8	0.81 9	0.69 13	0.63 10	0.75 19
2124				0.70 15	1.15 15	1.09 15	1.10 15
2288				1.70 20	2.7 4	2.7 5	2.6 4
2380					0.22 11	0.60 25	0.70 15
2605					0.64 22	0.45 22	
2854						0.16 7	
3013						0.74 14	0.45 11
3193						0.55 10	
3737	9.8 10	9.8 10	8.0 12	10.1 10	12.6 13	12.5 13	14.4 15
3905	12.6 13	9.6 10	8.6 13	9.7 10	10.5 11	10.0 10	8.7 9
5249		0.26 7	1.5 2	2.20 22	2.35 24	2.23 25	1.71 18
5629			0.3 1	1.7 3	1.3 3	1.05 15	1.7 3
5903				0.66 8	1.17 17	0.95 11	0.97 13
6909						1.02 17	1.40 20
6949						0.51 8	0.79 12

⁴⁰Ca Levels

E(level) [†]	J ^{π&}	T _{1/2}	Comments
0	0 ⁺		
3353	0 ⁺		Decays by pair production and consequently by annihilation radiation (1972Di10).
3737	3 ⁻		
3904	2 ⁺	36 fs 14	T _{1/2} : from DSAM (1984El12,1989Ge09). Other: 33 fs 30 by DSAM (1981KaZL).
4491	5 ⁻		
5212	0 ⁺		E(level): from 1972Ni05 . Other: 5208 (1972Di10).
5249	2 ⁺		
5279	4 ⁺	0.19 ps 4	T _{1/2} : from DSAM (1981KaZL).
5614	4 ⁻		
5629	2 ⁺		
5903	1 ⁻		
6025	2 ⁻		
6030	3 ⁺		
6285	3 ⁻		
6508 [‡]	4 ⁺		

Continued on next page (footnotes at end of table)

⁴⁰Ca(n,n'γ) **1972Di10,1972Ni05,1984E112** (continued)

⁴⁰Ca Levels (continued)

E(level) [†]	Jπ&	E(level) [†]	Jπ&
6543? [@]	4 ⁺	6909 [‡]	2 ⁺
6582? [@]	3 ⁻	6930 ^{‡#}	6 ⁺
6750 [‡]	2 ⁻	6931 ^{‡#}	3 ⁻
		6950 [‡]	1 ⁻

[†] Rounded values from Adopted Levels, unless otherwise noted.

[‡] From **1972Di10** only.

[#] According to Adopted Levels and Gammas, 1651γ and 3193γ are from two separate levels near 6930, although **1972Di10** seem to show only one level.

[@] The evaluator have put these levels here from the placements of some unplaced γ rays in **1972Di10** based on Adopted Gammas.

& From Adopted Levels.

γ(⁴⁰Ca)

E _γ [†]	dσ/dΩ (mb/sr) at 125° [§]	E _i (level)	J _i ^π	E _f	J _f ^π	Comments
755 2	3.1 3	4491	5 ⁻	3737	3 ⁻	
780 2	0.20 6	6030	3 ⁺	5249	2 ⁺	Iγ(780)/Iγ(2124)=10/80 (1972Ni05).
1122 2	1.10 24	5614	4 ⁻	4491	5 ⁻	Iγ(1124)/Iγ(1880)=30/70 (1972Ni05).
1262 ^{#a} 2	0.37 12	6543?	4 ⁺	5279	4 ⁺	
1308 [@]	1.20 20	5212	0 ⁺	3904	2 ⁺	1303 in 1972Di10 includes a line from ⁴⁰ K.
1345 2	0.61 15	5249	2 ⁺	3904	2 ⁺	Iγ(1344)/Iγ(5249)=20/80 (1972Ni05).
1374.0 2	2.6 3	5279	4 ⁺	3904	2 ⁺	E _γ : from 1981KaZL . Other: 1374 2, may include contribution from ⁴⁰ K line (1972Di10).
1651 [‡] 2	0.50 10	6930	6 ⁺	5279	4 ⁺	
1793 2	0.75 10	6285	3 ⁻	4491	5 ⁻	may include contribution from ⁴⁰ K line (1972Di10).
1877 2	0.63 10	5614	4 ⁻	3737	3 ⁻	
1897 [#] 2	0.16 8	5249	2 ⁺	3353	0 ⁺	
2121 ^{@&}		6025	2 ⁻	3904	2 ⁺	E _γ : 2124 in 1972Di10 is probably a doublet 2120+2124. Iγ(2120)/Iγ(2290)=20/80 (1972Ni05).
2124 2	1.09 15	6030	3 ⁺	3904	2 ⁺	
2275 [#] 2	0.50 13	5629	2 ⁺	3353	0 ⁺	Iγ(2277)/Iγ(5627)=9/91 (1972Ni05).
2288 2	2.7 5	6025	2 ⁻	3737	3 ⁻	Doublet 2288+2294.
2293 [@]		6030	3 ⁺	3737	3 ⁻	E _γ : 2288γ in 1972Di10 is a doublet 2288+2293. Iγ(2294)/Iγ(2124)=10/80 (1972Ni05).
2380 2	0.60 25	6285	3 ⁻	3904	2 ⁺	Iγ(2379)/Iγ(1793)=25/75 (1972Ni05).
2605 [‡] 2	0.45 22	6508	4 ⁺	3904	2 ⁺	
2679 ^{#a} 2	0.22 9	6582?	3 ⁻	3904	2 ⁺	
^x 2748 [#]	0.72 16					
2854 [‡] 2	0.16 7	6750	2 ⁻	3904	2 ⁺	
3013 [‡] 2	0.74 14	6750	2 ⁻	3737	3 ⁻	
3193 [‡] 2	0.55 10	6931	3 ⁻	3737	3 ⁻	
^x 3503 [#]	0.23 10					
3737 2	12.5 13	3737	3 ⁻	0	0 ⁺	
3904.2 4	10.0 10	3904	2 ⁺	0	0 ⁺	E _γ : from 1981KaZL , 3905 2 from 1972Di10 .
5249 2	2.23 25	5249	2 ⁺	0	0 ⁺	
5629 2	1.05 15	5629	2 ⁺	0	0 ⁺	includes contribution from ¹⁶ O (1972Di10).
5903 2	0.95 11	5903	1 ⁻	0	0 ⁺	

Continued on next page (footnotes at end of table)

$^{40}\text{Ca}(\text{n},\text{n}'\gamma)$ [1972Di10](#),[1972Ni05](#),[1984El12](#) (continued) $\gamma(^{40}\text{Ca})$ (continued)

E_γ [†]	$\text{d}\sigma/\text{d}\Omega$ (mb/sr) at 125° [§]	$E_i(\text{level})$	J_i^π	E_f	J_f^π
6909 [‡] 2	1.02 17	6909	2^+	0	0^+
6949 [‡] 2	0.51 8	6950	1^-	0	0^+

[†] From [1972Di10](#), unless otherwise stated. [1972Di10](#) give $\Delta E_\gamma=2$ keV for unplaced γ rays but not for those placed. The evaluator have assumed $\Delta E_\gamma=2$ keV also for those γ -ray energies.

[‡] γ from [1972Di10](#) only.

[§] From [1972Di10](#) for $E(\text{n})=7.5$ MeV. Values for other neutron energies are listed in the table of differential cross sections above.

[&] Transition from [1972Ni05](#) only.

[@] From level-energy difference.

[#] Unplaced γ from [1972Di10](#) only. Placements are made by evaluator based on Adopted Gammas if applicable.

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

^x γ ray not placed in level scheme.

$^{40}\text{Ca}(\text{p,p}'), (\text{pol p,p}') \quad 1975\text{No04}, 1981\text{Ej02}, 1987\text{Ya11}$

- 1975No04:** E=35.2 MeV proton beam was produced from the Michigan State University cyclotron. Target was a 40 $\mu\text{g}/\text{cm}^2$ metallic Ca (enriched to 99.9% in ^{40}Ca). Scattered protons were momentum-analyzed with an Engel split-pole magnetic spectrograph (FWHM=4.5 keV) and detected with nuclear track plates. Measured proton spectra. Deduced levels from 3353 to 9275.
- 1981Ej02:** E=65 MeV proton beam was produced from the Osaka University Research Center for Nuclear Physics cyclotron. Target was a natural Ca foil (96.94% in ^{40}Ca) of 1.2 mg/cm^2 thickness. Scattered particles were momentum-analyzed with the magnetic spectrograph RAIDEN (FWHM=15 keV) and detected by the $\Delta\text{E-E}$ telescope of position-sensitive detectors. Measured $\sigma(\theta)$. Deduced levels, J, π , L from DWBA analysis. Report levels up to 10337.
- 1987Ya11:** E=65.1 MeV proton beam was produced from the AVF cyclotron of the Research Center for Nuclear Physics at Osaka University. Target was 1.4 mg/cm^2 metallic foil of natural Ca. Reaction products were momentum-analyzed with the RAIDEN magnetic spectrograph (FWHM=23 keV). Measured $\sigma(\theta)$. Deduced levels, J, π , L from DWBA analysis. Report levels between 13420 and 15080.
- 1972Gr26:** E=25, 30, 35, 40 MeV proton beams were produced from Michigan State University sector-focused cyclotron. Target was a rolled self-supported 2 mg/cm^2 foil of enriched ^{40}Ca (99.973%). Scattered particles were detected with two surface-barrier Ge(Li) detectors (FWHM=30 keV). Measured $\sigma(\theta)$. Deduced levels, J, π , L deformation parameters, transition strengths from DWBA analysis. Comparisons with shell-model calculations. Report levels up to 10277.
- Other references from which results are used in this dataset:
- 1956Br98:** E=7.17-8.00 MeV.
- 1964Ya02:** E=55 MeV.
- 1965Gr11:** E=14.6, 17.3 MeV. Measured $\sigma(\theta)$, deduced deformation parameters.
- 1968Wi05:** E=155 MeV. Measured $\sigma(\theta)$, $\text{pol}(\theta)$, DWBA.
- 1970BI03:** E=20.3 MeV, pol p. Measured $\sigma(\theta)$, deduced deformation parameters.
- 1976Ka29:** E=185 MeV. Measured $\sigma(\theta)$.
- 1976Al19:** E=1.044 GeV. Measured $\sigma(\theta)$.
- 1982BI10:** E=800 MeV; pol p. Measured $\sigma(\theta)$, $\text{Ay}(\theta)$. Deduced deformation parameters.
- 1982Ho13:** E=65 MeV; pol p. Measured $\sigma(\theta)$, $\text{Ay}(\theta)$, DWBA analysis.
- 1980Ad03:** E=800 MeV, pol p. Measured $\sigma(\theta)$, $\text{Ay}(\theta)$. Deduced deformation parameters. DWBA analysis of known $J\pi$ states.
- 1980Ca14:** E=800 MeV. Measured $\sigma(\theta)$, deduced octupole giant resonance, DWBA analysis.
- 1981An08:** E=201 MeV. Measured $\sigma(\theta)$, deduced M1 strength.
- 1985Ho14, 1984Ho16:** E=334 MeV; pol p. Measured $\sigma(\theta)$, $\text{Ay}(\theta)$, DWIA analysis.
- 1985Se14:** E=500 MeV; pol p. Measured $\sigma(\theta)$, $\text{Ay}(\theta)$.
- 1987Fr05:** E=362 MeV; pol p. Measured $\sigma(\theta)$, $\text{Ay}(\theta)$.
- 1989Le04:** E=362 MeV; pol p. Measured $\sigma(\theta)$, $\text{Ay}(\theta)$.
- 1993Se02:** E=200 MeV; pol p. Measured $\sigma(\theta)$, $\text{Ay}(\theta)$, FWHM=30-50 keV.

Others (p,p'):

- 2012Us02, 2011Us01, 2011Us03:** E=200 MeV. Measured $\sigma(\theta)$. Deduced fine structure of ISGQR, level density.
- 2000Ba18:** E=319 MeV; pol p. Measured $\sigma(\theta)$, spin-flip probabilities.
- 1993Gr02:** E=497, 581 MeV; pol p. Measured spin-flip observables.
- 1991Ke13:** E=318 MeV; pol p. Measured $\sigma(\theta)$, $\text{Ay}(\theta)$.
- 1990Ba14:** E=300, 800 MeV; pol p. Measured spin-flip probability.
- 1989Sa23:** E=65 MeV. Measured $\sigma(\theta)$, FWHM=20-25 keV.
- 1989Ba55:** E=319 MeV; pol p. Measured absolute $\sigma(\theta)$.
- 1989Ho11:** E=500 MeV. Measured $\sigma(\theta)$.
- 1989Li15:** E=500 MeV; pol p. Measured $\sigma(\theta)$, FWHM=70 keV. Deduced giant resonance (L=2,4) strengths.
- 1988Ba06:** E=318 MeV; pol p. Measured $\sigma(\theta)$.
- 1987GI02:** E=319 MeV; pol p. Measured $\sigma(\theta)$, spin-flip probability.
- 1987Ba22:** E=500 MeV; pol p. Measured $\sigma(\theta)$, $\text{Ay}(\theta)$, DWBA.
- 1986Aa01:** E=500 MeV; pol p. Measured spin-rotation parameters.
- 1983Mi25:** E=650 MeV; pol p. Measured $\sigma(\theta)$, DWIA analysis.
- 1982Ga02:** E=800 MeV. Deduced deformation lengths.
- 1982Aa04:** E=497 MeV; pol p. Measured proton depolarization tensor parameters.
- 1981Co08:** E=31,32,35.5,40,42 MeV, pol p. Measured spin-flip probability.

$^{40}\text{Ca}(\text{p,p}'), (\text{pol p,p}') \quad 1975\text{No04}, 1981\text{Ej02}, 1987\text{Ya11}$ (continued)

1980Va10: E=60.3 MeV. Measured $\sigma(\theta)$, DWBA analysis.
 1977Vo09: E=19 MeV. Measured $\sigma(\theta)$.
 1977U101: E=7-10 MeV. Measured proton-pair coin.
 1975Ma07: E=155 MeV. Measured $\sigma(\theta)$.
 1974PI02: E=20 MeV, pol p. Measured $\sigma(\theta)$, $\text{pol}(\theta)$.
 1973Go42: E=20-25 MeV, pol p. Measured $\sigma(\theta)$, $A_Y(\theta)$.
 1972Co11: E=1 GeV. Measured $\sigma(\theta)$.
 1970Wh06: E=5.8-6.6 MeV. Measured $\sigma(\theta)$.
 1970Ka44: E=185 MeV. Measured $\sigma(\theta)$, deduced B(EL).
 1970In03: E=185 MeV. Measured $\sigma(\theta)$, $\text{pol}(\theta)$ for first 3^- .
 1968Va27: E=6.28-6.73 MeV. Deduced IAR.
 1968Ba64: E=13 MeV. FWHM=50 keV. About 25 groups reported.
 1966Wa12: E=160 MeV.
 1966Ma13: E=11.5 MeV.
 1966Li02: E=155 MeV. Measured $\sigma(\theta)$.
 1965Ru01: E=4.26 MeV.
 1965Ha28: E=156 MeV.
 1964St15: E=40 MeV.
 1964Bo27: pol p.
 1964Ti02:.
 1963Ro30: E=150 MeV.
 1963Ho26: E=155 MeV.
 1962Va14: E=6.6 MeV.
 Others: 1964Ti02, 1958Go90, 1955Be73.

(p,p), (pol p,p): deduced optical-model parameters from $\sigma(\theta)$:

1989Gr12: E=200 MeV; pol p.
 1988Hu10: E=200, 300, 400, 500 MeV; pol p.
 1988Ho05: E=497.5 MeV; pol p.
 1988Le10: E=200, 362, 400 MeV; pol p.
 1988Ot04: E=200, 500, 800 MeV; pol p.
 1988BI07: E=320, 400, 650 MeV; pol p.
 1986Mc05: E=21-48.4 MeV. Measured $\sigma(\theta)$.
 1986Fe01: E=800 MeV; pol p.
 1983Ba05: E=800 MeV; pol p.
 1982Sc17: E=80.2, 181.5 MeV; pol p.
 1982Sa19: E=65 MeV; pol p.
 1982Al18: E=1 GeV.
 1981Ra21: E=497 MeV, pol p.
 1981Ra02: E=800 MeV.
 1981No07: E=65 MeV, pol p.
 1981Na02: E=80.2, 135.1, 160 MeV.
 1981Ho26: E=500 MeV, pol p.
 1980Fa07: E=35.2 MeV.
 1979Sa38: E=65 MeV, pol p.
 1979Ig01: E=800 MeV, pol p.
 1977Ch29: E=1 GeV.
 1975Al08: E=1 GeV.
 1974PI05: E=20, 24.5 MeV, pol p.
 1974Gu14: E=5-6 MeV.
 1974Co09: E=156 MeV.
 1973Be41: E=40 MeV, pol p.
 1973Ba79: E=1 GeV.

⁴⁰Ca(p,p'),(pol p,p') **1975No04,1981Ej02,1987Ya11** (continued)

1972Lo10: E=10.8-16.3 MeV.
 1972K103: E=2.3-2.8 MeV, pol p.
 1971Va09: E=10-180 MeV.
 1971Hn02: E=30.3 MeV, pol p.
 1971Di17: E=10-22 MeV.
 1971Br22: E=21.0, 23.5, 26.3, 48.0 MeV.
 1970Ma54: E=25, 30, 35, 40 MeV.
 1969Fu07: E=61.4 MeV.
 1968Pr16: E=6.3-6.9 MeV.
 1967Gr19: E=35.8, 45.5 MeV.

Level energy data: 1987Ya11, 1981Ej02, 1975No04, 1981An08, 1972Gr26, 1965Gr11.
 L-transfers: 1972Gr26, 1993Se02, 1984Ho16, 1976Al19, 1976Ka29, 1970Bl03, 1965Gr11, 1964Ya02.
 J π from (pol p,p'): 1993Se02, 1989Le04, 1987Fr05, 1985Ho14, 1982Bl10, 1982Ho13, 1968Wi05.

⁴⁰Ca Levels

Differential cross sections at 15.4° in $\mu\text{b/sr}$ (from 1975No04) are listed under comments. 1975No04 give cross sections at 30.7° also. Both sets of data were normalized to cross section for 4492, 5⁻ level as determined by 1972Gr26. The uncertainties are 10%, unless otherwise stated.
 B(EL)(W.u.) values given under comments are from 1972Gr26.

E(level) [†]	J π	L $\ddagger$	β_{LR} [#]	Comments
0	0 ⁺	0		
3352.1 3	0 ⁺ ^c	0		L: from 1993Se02. d σ /d Ω =126 $\mu\text{b/sr}$.
3736.4	3 ⁻	3	1.39 ^e	β_3 =0.41 (1985Se14) J π : from (pol p,p') (1968Wi05,1982Ho13,1982Bl10,1987Fr05,1989Le04). β_{LR} : others: 1.40, 1.38, 1.35, 1.32 from E=25, 30, 35, 40 MeV data (1972Gr26). B(E3)(W.u.)=28.7 20 (1972Gr26). Other β_3 =0.340 (1982Bl10). d σ /d Ω =11300 $\mu\text{b/sr}$, %EWSR=22.1 (1972Gr26).
3904.1	2 ⁺	2	0.52 ^e	β_2 =0.14 (1985Se14) J π : from (pol p,p') (1987Fr05,1984Ho16). β_{LR} : others: 0.42, 0.43, 0.42, 0.43 from E=25, 30, 35, 40 MeV data (1972Gr26), 0.43 (1984Ho16). Other β_2 =0.133 (1982Bl10). d σ /d Ω =2240, %EWSR=3.2 (1972Gr26). B(E2)(W.u.)=2.05 20 (1972Gr26).
4491.5	5 ⁻	5	0.76 ^e	J π : from (pol p,p') (1987Fr05,1982Bl10). β_{LR} : others: 0.91, 0.86, 0.83, 0.80 from E=25, 30, 35, 40 MeV data (1972Gr26). Other β_5 =0.215 (1982Bl10). d σ /d Ω =1560, %EWSR=6.4 (1972Gr26). B(E5)(W.u.)=20.6 21 (1972Gr26).
5213.8 5				d σ /d Ω =13 4.
5249.5	2 ⁺ ^b	2	0.12	β_{LR} : others: 0.14, 0.15, 0.12 from E=30, 25, 40 MeV data (1972Gr26), 0.11 (1984Ho16). d σ /d Ω =575. B(E2)(W.u.)=0.26 5, %EWSR=0.3 (1972Gr26).
5279.3 3		4	0.14	β_{LR} : others: 0.15, 0.16, 0.13 from E=30, 25, 40 MeV data (1972Gr26). %EWSR=0.2 (1972Gr26). d σ /d Ω =122.
5614.3		5	0.33	β_{LR} : others: 0.36, 0.42, 0.31 from E=30, 25, 40 MeV data (1972Gr26). %EWSR=1.2 (1972Gr26). d σ /d Ω =194.

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$^{40}\text{Ca}(\text{p,p}'), (\text{pol p,p}') \quad \text{1975No04, 1981Ej02, 1987Ya11 (continued)}$ ^{40}Ca Levels (continued)

$E(\text{level})^\dagger$	J^π	$L^\ddagger$	$\beta_{\text{LR}}^\#$	Comments
5630.1 3	$2^+{}^b$	2	0.15 ^e	L: from 1984Ho16. β_{LR} : 0.13 (1984Ho16). $d\sigma/d\Omega=248$. $B(E2)(\text{W.u.})=0.13 \ 5$ (1972Gr26).
5903.3 3		1		$d\sigma/d\Omega=503$.
6026.2 3	2^-	3	0.18	J^π : from (pol p,p') (1982Ho13). β_{LR} : others: 0.20, 0.23, 0.17 from E=30, 25, 40 MeV data (1972Gr26). %EWSR=0.7 (1972Gr26). $d\sigma/d\Omega=268$.
6285.8	$3^-{}^c$	3	0.38 ^e	β_{LR} : others: 0.46, 0.43, 0.41, 0.40 from E=25, 30, 35, 40 MeV data (1972Gr26). $d\sigma/d\Omega=1471$. $B(E3)(\text{W.u.})=3.1 \ 3$, %EWSR=3.4 (1972Gr26).
6422	2^+	2	<0.04	$E(\text{level}), L, \beta_{\text{LR}}$: from 1984Ho16 only.
6508.4 3		4	0.18	β_{LR} : others: 0.17, 0.18, 0.17 from E=30, 25, 40 MeV data (1972Gr26). %EWSR=0.5 (1972Gr26). $d\sigma/d\Omega=114$.
6543.6 4				$d\sigma/d\Omega=32$.
6583.3 3	$3^-{}^c$	3	0.34 ^e	β_{LR} : others: 0.41, 0.36, 0.33, 0.32 from E=25, 30, 35, 40 MeV data (1972Gr26). $d\sigma/d\Omega=975$. $B(E3)(\text{W.u.})=2.5 \ 3$, %EWSR=2.4 (1972Gr26).
6750.9 3	2^-	3	0.22	J^π : from (pol p,p') (1982Ho13). β_{LR} : others: 0.24, 0.27, 0.21 from E=30, 25, 40 MeV data (1972Gr26). %EWSR=1.1 (1972Gr26). $d\sigma/d\Omega=410$.
6909.1 3	$2^+{}^b$	2	0.49 ^e	β_{LR} : others: 0.44, 0.43, 0.42, 0.45 from E=25, 30, 35, 40 MeV data (1972Gr26), 0.42 (1984Ho16). $d\sigma/d\Omega=2316$. $B(E2)(\text{W.u.})=2.25 \ 23$, %EWSR=5.7 (1972Gr26).
6931.8 3		≥ 3		$d\sigma/d\Omega=190$.
6950.9 4		1		$d\sigma/d\Omega=2457$.
7113.9 4		5	0.29	L: other: 3 (1965Gr11). β_{LR} : others: 0.32, 0.40, 0.27 from E=30, 25, 40 MeV data (1972Gr26). %EWSR=1.2 (1972Gr26). $d\sigma/d\Omega=164$.
7278.0 4				$d\sigma/d\Omega=76$.
7300.7 5		2	0.09	L: 1972Gr26 did not resolve the 7278 and 7301 level and assigned $L=(0,2)$ for a level at 7292 with %EWSR=0.3. β_{LR} : others: 0.10, 0.10, 0.09 from E=30, 25, 40 MeV data (1972Gr26). $d\sigma/d\Omega=25 \ 4$.
7425? 1				$E(\text{level})$: very weak state and assignment is tentative (1975No04). $d\sigma/d\Omega<10$.
7447.1 6		4	0.16	β_{LR} : others: 0.17, 0.20, 0.15 from E=30, 25, 40 MeV data (1972Gr26). %EWSR=0.5 (1972Gr26). $d\sigma/d\Omega=33 \ 5$.
7466.2 6	$2^+{}^b$	2	<0.07	L, β_{LR} : from 1984Ho16. $d\sigma/d\Omega=46$.
7532.5 5		(3)	0.17	$E(\text{level}), L$: 1972Gr26 did not resolve this level from 7561 but assigned $L=3$ and (4), respectively. β_{LR} : others: 0.17, 0.19, 0.15 from E=30, 25, 40 MeV data (1972Gr26). %EWSR=0.7 (1972Gr26). $d\sigma/d\Omega=221$.
7561.6 5		(4)	0.20	β_{LR} : others: 0.20, 0.23, 0.19 from E=30, 25, 40 MeV data (1972Gr26). %EWSR=0.8 (1972Gr26). $d\sigma/d\Omega=146$.

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$^{40}\text{Ca}(\text{p,p}'), (\text{pol p,p}') \quad 1975\text{No04}, 1981\text{Ej02}, 1987\text{Ya11} \text{ (continued)}$ ^{40}Ca Levels (continued)

E(level) [†]	J ^π	L [‡]	β _L R [#]	Comments
7623.5 5				dσ/dΩ=49.
7658.5				dσ/dΩ=59.
7676.4 6		(≥6)		dσ/dΩ=34 (30.7°).
7694.4 6				dσ/dΩ=44 (30.7°).
7701.2 6				dσ/dΩ=42 (30.7°).
7769.4? 10				E(level): very weak state and assignment is tentative (1975No04).
				dσ/dΩ=8 2.
7814.7 6				dσ/dΩ=15 2 (30.7°).
7871.7 5	2 ⁺ ^b	2	0.23	dσ/dΩ=696.
				β _L R: others: 0.25, 0.28, 0.23 from E=30, 25, 40 MeV data (1972Gr26).
				B(E2)(W.u.)=0.92 15, %EWSR=1.8 (1972Gr26).
7927.9 5		4	0.29	dσ/dΩ=333.
				B(E4)(W.u.)=2.2 2, %EWSR=1.7 (1972Gr26).
				β _L R: others: 0.31, 0.34, 0.29 from E=30, 25, 40 MeV data (1972Gr26).
7976.3 6				E(level): doublet.
				dσ/dΩ=92.
8018.8? 10				E(level): very weak state and assignment is tentative (1975No04).
				dσ/dΩ=15 3.
8051.8 6				dσ/dΩ=52.
8091.2 6	2 ⁺ ^b	2	0.17	dσ/dΩ=269.
				β _L R: others: 0.17, 0.18, 0.16 from E=30, 25, 40 MeV data (1972Gr26), 0.21 (1984Ho16).
				B(E2)(W.u.)=0.38 6, %EWSR=1.0 (1972Gr26).
8113.1? 6		3	0.16	β _L R: others: 0.17, 0.19, 0.15 from E=30, 25, 40 MeV data (1972Gr26).
				%EWSR=0.7 (1972Gr26).
				dσ/dΩ=115.
8138.1? 10				E(level): very weak state and assignment is tentative (1975No04).
				dσ/dΩ<20.
8186.8? 10		(6)	0.15	E(level): very weak state and assignment is tentative (1975No04).
				E(level): unresolved from 8196 in 1972Gr26, %EWSR=0.8.
				β _L R: others: 0.22 from E=25 data (1972Gr26).
				dσ/dΩ=15 4.
8195.9 6				dσ/dΩ=33 5.
8271 & 1				dσ/dΩ=170 34.
8276 & 1				dσ/dΩ=250 50.
8323.1 6				dσ/dΩ=23 5.
8339.1 6				dσ/dΩ=36.
8358.9? 6				dσ/dΩ=121.
8373.3 6		(4)	0.35 ^e	E(level): unresolved from 8359 in 1972Gr26, but they assigned L=4 for E=8366 and associated it with a previously reported 8371 level.
				β _L R: others: 0.32, 0.31, 0.31, 0.33 from E=25, 30, 35, 40 MeV data (1972Gr26).
				dσ/dΩ=348.
				B(E4)(W.u.)=2.0 2, %EWSR=2.1 (1972Gr26).
8424.2 7	2 ⁻	3	0.25	J ^π : from (pol p,p') (1985Ho14, 1982Ho13).
				β _L R: others: 0.27, 0.29, 0.25 from E=30, 25, 40 MeV data (1972Gr26).
				%EWSR=1.7 (1972Gr26).
				dσ/dΩ=279.
8439.0 7				dσ/dΩ=100.
8484.3 7				dσ/dΩ=50.
8551.1 7		5	0.19	dσ/dΩ=169.
				β _L R: for E=8535, others: 0.20, 0.23, 0.18 from E=30, 25, 40 MeV data (1972Gr26).
				%EWSR=0.6 (1972Gr26).
8578.2 7	2 ⁺	2	0.17	J ^π : from 1982Ho13 and 1984Ho16.
				β _L R: others: 0.18, 0.17, 0.17 from E=30, 25, 40 MeV data (1972Gr26), 0.16 (1984Ho16).
				%EWSR=1.1 (1972Gr26).
				dσ/dΩ=439.

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$^{40}\text{Ca}(\text{p,p}'), (\text{pol p,p}') \quad 1975\text{No04}, 1981\text{Ej02}, 1987\text{Ya11} \text{ (continued)}$ ^{40}Ca Levels (continued)

E(level) [†]	J ^π	L [‡]	β _L R [#]	Comments
8665.3 8				dσ/dΩ=112.
8747.7 8	2 ⁺ ^b	2	0.15	β _L R: others: 0.15, 0.17, 0.14 from E=30, 25, 40 MeV data (1972Gr26), 0.12 (1984Ho16). %EWSR=0.9 (1972Gr26). dσ/dΩ=392.
8850.6 9		7	0.09	β _L R: others: 0.10, 0.10, 0.09 from E=30, 25, 40 MeV data (1972Gr26). β _L R: 0.28 for L=6. %EWSR=0.1 (1972Gr26). dσ/dΩ=42.
8909.0 9				dσ/dΩ=24.
8938.4 9				dσ/dΩ=66.
8978 6		6	0.17	E(level): from 1981An08 and 1987Ya11. %EWSR=0.5 (1972Gr26). dσ/dΩ=50.
8995.0 10				dσ/dΩ=177.
9032.7 10		5	0.16	%EWSR=0.5 (1972Gr26). dσ/dΩ=47.
9050.1 10				dσ/dΩ=20 5.
9080.3 11				dσ/dΩ=32 6.
9093.0 11				dσ/dΩ=177.
9136.1		3	0.23	%EWSR=1.6 (1972Gr26). dσ/dΩ=131.
9162.1 11				dσ/dΩ=30 5.
9185.3 12				dσ/dΩ=317.
9209.0 12				dσ/dΩ=75.
9227.5 12				β _L R: 0.23 for L=5.
9246.0 12		7	0.06	%EWSR=0.1 (1972Gr26). dσ/dΩ=40 12.
9274.5 12				dσ/dΩ=38.
9363 5		3	0.16	E(level): weighted average of 9372 8 (1981Ej02) and 9360 5 (1972Gr26). %EWSR=0.8 (1972Gr26).
9414 5		3	0.26	E(level): weighted average of 9418 8 (1981Ej02) and 9413 5 (1972Gr26). %EWSR=2.0 (1972Gr26).
9465 8				%EWSR=0.5 (1972Gr26).
9547 8		4	0.15	E(level): from 1972Gr26.
9591 4		3	0.12	%EWSR=0.5 (1972Gr26). E(level): weighted average of 9657 8 (1981Ej02) and 9642 6 (1972Gr26).
9647 7				E(level): from 1972Gr26.
9859 4		5	0.19	%EWSR=0.7 (1972Gr26).
9877 8	(2 ⁺)	2	0.14	E(level): doublet. L: 0,1 (1984Ho16) for second component. β _L R: from 1984Ho16 for a doublet at 9868. J ^π : 1 ⁺ in Adopted Levels.
10052 3		5	0.19	E(level): weighted average of 10058 8 (1981Ej02) and 10051 3 (1972Gr26). %EWSR=0.8 (1972Gr26).
10276 3		4	0.18	E(level): weighted average of 10267 8 (1981Ej02) and 10277 3 (1972Gr26). %EWSR=0.9 (1972Gr26).
10290 8				J ^π : from (pol p,p') (1985Ho14).
10328 8	1 ⁺			E(level): 10344 in Fig.10 and 10337 in Fig.2 of 1981Ej02.
10344 8				E(level),L: from 1981An08.
12030		0		%EWSR=0.6 (1987Ya11).
13420 40		(2) ^d		
13450 @ 40				
13510 @ 40				

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$^{40}\text{Ca}(\text{p,p}'),(\text{pol p,p}') \quad 1975\text{No04}, 1981\text{Ej02}, 1987\text{Ya11} \text{ (continued)}$ ^{40}Ca Levels (continued)

E(level) [†]	J ^π	L [‡]	Comments
13610 40		2 ^d	%EWSR=0.8 (1987Ya11).
13700 40		2 ^d	%EWSR=1.1 (1987Ya11).
13830 40		(2) ^d	%EWSR=1.1 (1987Ya11).
13890 40		(0) ^d	%EWSR=3.3 (1987Ya11).
13921 ^a 15	(4 ⁻)		T=0 (1989Sa23) J ^π : from $\sigma(\theta)$ (1989Sa23); but L=(4) in 1987Ya11. %EWSR=0.3 (1987Ya11).
14020 40		(3) ^d	%EWSR=0.5 (1987Ya11).
14100 40		2 ^d	%EWSR=0.7 (1987Ya11).
14210 40		(3) ^d	%EWSR=0.2 (1987Ya11).
14283 ^a 15	(6 ⁻)		T=1 (1989Sa23) J ^π : from $\sigma(\theta)$ (1989Sa23).
14320 40		(3) ^d	%EWSR=0.5 (1987Ya11).
14410 40		3 ^d	%EWSR=0.6 (1987Ya11).
14500 40		2 ^d	E(level): doublet: 14490+14530. %EWSR=1.3 (1987Ya11).
14660 40		2 ^d	%EWSR=1.0 (1987Ya11).
14780 40		2 ^d	%EWSR=1.0 (1987Ya11).
15080 [@] 40			
31×10 ³ 2		3	E(level),L: from 1980Ca14. Γ=10 MeV 2 (1980Ca14).

[†] From 1975No04 for levels up to 9300 (level energies where no uncertainties are stated were used as calibrants); from 1981Ej02 for levels between 9370 and 10350 (only ΔE=8 keV indicated in Fig.10 for peaks above 10000 but should be smaller for the peaks below 10000 in Fig.2 with better statistics); from 1987Ya11 for levels between 13500 and 15100 (ΔE=40 keV); unless otherwise noted.

[‡] From 1972Gr26, unless otherwise noted.

From E=35 MeV data in 1972Gr26, values from E=30, 25 and 40 MeV data are given under comments, unless otherwise noted.

@ Multiplet.

& Incompletely resolved doublet with average centroid 8274.5 and L=1.

^a From 1981Ej02.

^b From 1984Ho16.

^c From 1993Se02.

^d From 1987Ya11.

^e From 1980Ad03.

⁴⁰Ca(p,p'γ) **1973Te04,1969Po04,1969An09**

1973Te04: E=12 MeV ³He beam was produced from the Van de Graaff Tandem accelerator at CEN Saclay. Charged particles were detected with solid state detector telescopes and γ rays were detected with NaI and Ge(Li) detectors. Measured Eγ, Iγ, pγ-coin, Doppler-shift attenuation. Deduced levels, lifetimes, γ-ray branching ratios.

1969Po04: E=8.5-9.0 MeV beams were produced from the Stanford University Tandem Van de Graaff accelerator. Target was 2 mg/cm² evaporated metallic calcium. Measured Eγ, Iγ, γ(θ), Doppler-shift attenuation. Deduced levels, J, π, γ-ray branching ratios, transition strengths.

1969An09: E=8.5-10 MeV proton beams were produced from the Oxford University tandem generator incident on natural calcium targets of different thickness. γ rays were detected with Ge(Li) detectors and NaI counter. Measured Eγ, Iγ, pγ(θ), γγ(θ), Doppler-shift attenuation. Deduced levels, T_{1/2}, J, π, lifetimes.

1968Ma05, 1969Ma19, 1971Ma03: E=8-10, 7.73, 7.32 MeV. Measured pγγ coin, pγ(θ), γγ(θ), lifetimes by DSAM.

1966Gr03: E=13.065 MeV. Measured pγ coin, pγ(θ).

Others:.

1988Ga22: E=10.2 MeV. Measured pair production spectra.

1984Sc37: E=5.08 MeV. Measured γγ(θ) for double γ decay from first excited 0⁺ state.

1980Al13: E=6.253 MeV. Measured pγ(θ), pγ(t).

1977U101: E=7-10 MeV. Measured proton-pair coin, deduced E0 branching from 0⁺ levels.

1974He13: E=7.68, 9.27 MeV. Measured γ(θ,H,t), hyperfine fields and magnetic moment.

1973Te04, 1971Te02, 1970Te01, 1969Te03: E=12 MeV. Measured pγ coin, lifetimes by DSAM.

1972Ta17: E=8.7 MeV. Measured pγ(t).

1972Si01: E=10.81 MeV. Measured pγγ coin, pγ(θ), lifetimes by DSAM.

1970Ha27: E≈5.08 MeV. Measured γγ coin.

1969Ca17: E=6.14 MeV. Measured γγγ coin.

1968Ba64: (p,p'γ) E=13 MeV. 16 levels reported.

1967Sc39: E=5.4 MeV. Measured pγ(t).

1965Ne04 (also **1963Ro30**): E=150 MeV. Measured pγ coin, pγ(θ).

1963Su12: E=4.4, 5.08 MeV. Measured pγγ coin; deduced E0 branch.

Others: **1967Ba02, 1966Go23** (also **1963Go34,1961Go30,1960Go20,1958Go90**), **1962Ne02, 1960Wa15, 1959Kl46, 1959Ch28, 1958Hi66, 1958Be15, 1957Ty36, 1955Be73.**

⁴⁰Ca Levels

E(level) [†]	J ^π [#]	T _{1/2} [‡]	Comments
0	0 ⁺		
3352.7 6	0 ⁺	2.15 ns 8	T _{1/2} : from 1966Go23 (also 1967Sc39). Other: 1.9 ns 7 (1973Te04).
3736.96 24	3 ⁻	41 ps 4	T _{1/2} : from 1972Ta17 by particle-gamma delayed coincidence technique.
3904.63 24	2 ⁺	33 fs 7	T _{1/2} : from lifetime=47 fs 10, weighted average of 64 fs 19 (1968Ma05), 0.07 ps 5 (1969Po04), 30 fs 20 (1973Te04), 48 fs 10 (1971Ma03), 40 fs 16 (1972Si01).
4491.6 3	5	272 ps 8	g=+0.54 10 (1974He13)
5212.4 4	(0 ⁺)	1.02 ps 21	T _{1/2} : from 1969Ma19 by delayed coincidence. Other: >7 ps (1969Po04).
5248.6 3	2 ⁺	94 fs 17	T _{1/2} : from 1969Po04 . Other: 1.8 ps +10-5 (1968Ma05), 0.7 ps (1973Te04).
5277.7 3	4 ⁺	225 fs 35	J ^π : 1 is not ruled out; adopted Jπ=0 ⁺ .
5614.1 3	4 ⁻	0.69 ps 10	T _{1/2} : from lifetime=135 fs 26, weighted average of 190 fs 30 (1968Ma05), 150 fs 70 (1969Po04), 110 fs 20 (1973Te04).
5628.8 4	2 ⁺	42 fs 15	T _{1/2} : from lifetime=324 fs 50, weighted average of 260 fs 80 (1968Ma05), 0.41 ps 10 (1969Po04), 330 fs 50 (1973Te04), 340 fs 80 (1972Si01), 310 fs 60 (1971Ma03).
5903.3 13	1 ⁻	42 fs 14	J ^π : stretched dipole to J=3 and γ to J=5.
6025.9 4	2,3	171 fs 21	T _{1/2} : from lifetime=0.99 ps 15, weighted average of 0.95 ps +28-19 (1969An09), 0.83 ps 20 (1969Po04), 1.10 fs 15 (1973Te04).
			J ^π : assigned to this level which was not resolved from 5613 by 1966Gr03 .
			T _{1/2} : from lifetime=61 fs 22, weighted average of 76 fs 21 (1969An09), 30 fs 30 (1973Te04).
			Other: T _{1/2} <70 fs (1969Po04).
			T _{1/2} : from 1969An09 . Other: 10 fs 10 (1973Te04), <70 fs (1969Po04).
			T _{1/2} : from lifetime=246 fs 30, weighted average of 0.26 ps 3 (1969An09), 0.17 ps 9

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$^{40}\text{Ca}(\text{p},\text{p}'\gamma)$ **1973Te04,1969Po04,1969An09** (continued) ^{40}Ca Levels (continued)

E(level) [†]	J ^π #	T _{1/2} [‡]	Comments
			(1969Po04), 240 fs 30 (1973Te04).
6029.1 4	2,3	0.40 ps 8	J ^π : 2 ⁻ in Adopted Levels. T _{1/2} : from lifetime=0.58 ps 12, weighted average of 0.56 ps 19 (1969An09), 0.44 ps +17-12 (1969Po04), 0.70 fs 12 (1973Te04).
6284.9 3	3	0.35 ps 4	J ^π : 3 ⁺ in Adopted Levels. T _{1/2} : from lifetime=0.50 ps 5, weighted average of 410 fs 12 (1968Ma05), 0.57 ps 10 (1969Po04), 0.50 fs 5 (1973Te04).
6508.0 4	4 ⁺	128 fs 21	T _{1/2} : from lifetime=184 fs 30, weighted average of 0.16 ps 6 (1969An09), 190 fs 30 (1973Te04).
6542.9 4	4 ⁺	121 fs 21	T _{1/2} : from lifetime=174 fs 30, weighted average of 0.19 ps 6 (1969An09), 170 fs 30 (1973Te04).
6582.2 4	2,3	173 fs 28	J ^π : 3 ⁻ in Adopted Levels. T _{1/2} : from lifetime=250 fs 40, weighted average of 0.25 ps 7 (1969An09), 250 fs 40 (1973Te04).
6751.3 4	2 ⁻	96 fs 28	J ^π : from 1972Si01. T _{1/2} : from lifetime=138 fs 40, weighted average of 120 fs 40 (1973Te04), 185 fs 65 (1972Si01).
6910.8 10		<10 fs	E(level): could be the 6830+6931 doublet.
6929.3 5		104 fs 28	
6938.1 16		0.42 ps 17	
6952.6 13		<10 fs	
7112.4 5		55 fs 28	
7115.2 4		35 fs 21	
7238.4 5		97 fs 49	
7278.1 6		49 fs 35	
7298.9 6		118 fs 35	
7397.0 7		0.47 ps 14	
7422.0 13		0.20 ps 14	
7446.3 7		140 fs 49	
7468.5 10		<10 fs	
7531.4 8		149 fs 35	
7559.7 4		166 fs 42	
7623.3 6		111 fs 28	
7658.7 7		<10 fs	
7677.0 6		208 fs 49	
7694.7 6		<10 fs	
7771.9 9		166 fs 35	
7814 @ 3			
7873.7 10		<14 fs	
7927.2 7		49 fs 35	
7977.1 5		21 fs 21	
8018 @ 3			
8087.5 21		<28 fs	
8115.3 20		<14 fs	
8134.6 7		<28 fs	
8188.8 9		<17 fs	
8268 @ 4			
8275 @ 4			
8321.8 9		42 fs 21	
8357.8 14		104 fs 21	
8364 @ 5			
8425.5 16		<17 fs	
8437 @ 4			
8485.4 21		24 fs 14	

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⁴⁰Ca(p,p'γ) 1973Te04,1969Po04,1969An09 (continued)

⁴⁰Ca Levels (continued)

E(level) [†]	T _{1/2} [‡]	E(level) [†]	E(level) [†]
8541.0 11	14 fs 14	8671 @ 6	8819 @ 10
8552.6 16	<17 fs	8676 @ 6	8860 @ 10
8573 4	<21 fs	8717 @ 8	8922 @ 10
8587 @ 6		8756 @ 8	8949 @ 10
8633 @ 6		8769 @ 8	9010 @ 10

[†] From a least-squares fit to γ-ray energies, where no uncertainty in Eγ is given, ΔEγ=1 keV is assumed by the evaluator; unless otherwise noted. Above 6580, all levels are from 1973Te04.

[‡] From DSAM, weighted average are taken from all available data. Above 6751, all levels are from 1973Te04, unless otherwise noted.

From 1969An09 and 1966Gr03. Parities are from Δπ suggested by RUL. Values from Adopted Levels are listed under comments in cases where these differ.

@ Values are from 1973Te04. No Eγ values with uncertainties are reported by 1973Te04 from these levels.

γ(⁴⁰Ca)

A₂ and A₄ coefficients are from 1969An09 and/or 1966Gr03.

E _i (level)	J _i ^π	E _γ [†]	I _γ [‡]	E _f	J _f ^π	Mult. [§]	δ [§]	Comments
3352.7	0 ⁺	3353		0	0 ⁺	E0		Decays to g.s. by electron-positron internal pair formation. I(ce)/I(e+e- internal pair)=0.00694 20 (1962Ne02); I(2-photon)/I(e+e- internal pair)=0.00036 9 (weighted average from 1984Sc37 and 1973Be24). Earlier measurements: only upper limits deduced.
3736.96	3 ⁻	3736.7 3	100	0	0 ⁺	E3		A ₂ =+0.81 3, A ₄ =+0.17 6, A ₆ =+0.33 8 (1966Gr03).
3904.63	2 ⁺	552 &	<1.5	3352.7	0 ⁺	E3		E _γ , I _γ : from 1968Ma05.
		3904.4 4	100	0	0 ⁺	E2		A ₂ =+0.59 3, A ₄ =-1.20 5 (1966Gr03).
4491.6	5	754.7 2	100	3736.96	3 ⁻	Q(+O)	+0.05 5	δ: from 1966Gr03.
		4491 &	<0.5	0	0 ⁺			A ₂ =+0.33 5, A ₄ =-0.26 8 (1966Gr03).
								E _γ , I _γ : from 1966Gr03. This transition is unlikely since it would require multipolarity=E5 based on Jπ=5 ⁻ in Adopted Levels.
5212.4	(0 ⁺)	1307.7 3	100	3904.63	2 ⁺			A ₂ =0.00 1, A ₄ =-0.01 1 (1966Gr03).
		5212 &		0	0 ⁺			I _γ : I(e+e- internal pair)<0.14 (1977U101).
5248.6	2 ⁺	1344.4 3	19 4	3904.63	2 ⁺	M1+E2	+13 +6-3	I _γ : from 1969An09. Others: 15 4 (1969Po04), 20 (1968Ma05), <10 (1966Gr03), 17 (1973Te04).
								δ: from 1969An09.
								A ₂ =-0.02 4, A ₄ =-0.20 6 (1969An09).
		1512 &	<2	3736.96	3 ⁻			E _γ , I _γ : from 1968Ma05 only.
		1895	4 2	3352.7	0 ⁺	(E2)		I _γ : from 1969An09, not seen in 1969Po04. Others: <2.5 (1968Ma05), 3 (1973Te04).
		5247.9 6	77 4	0	0 ⁺	E2		I _γ : from 1969An09. Others: 84 4 (1969Po04), 80 (1968Ma05), 80 (1973Te04).
								A ₂ =+0.46 3, A ₄ =-0.63 3 (1969An09).
								A ₂ =+0.49 3, A ₄ =-0.39 5 (1966Gr03).
5277.7	4 ⁺	786 &	<3	4491.6	5			E _γ , I _γ : from 1968Ma05 only.
		1373.1 1	100	3904.63	2 ⁺	Q(+O)	+0.02 4	δ: from 1966Gr03.
								A ₂ =+0.46 4, A ₄ =-0.28 5 (1966Gr03).

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⁴⁰Ca(p,p'γ) 1973Te04,1969Po04,1969An09 (continued)

γ(⁴⁰Ca) (continued)

E _i (level)	J _i ^π	E _γ [†]	I _γ [‡]	E _f	J _f ^π	Mult. [§]	δ [§]	Comments
5277.7	4 ⁺	1541 &	<7	3736.96	3 ⁻			E _γ , I _γ : from 1968Ma05 only.
5614.1	4 ⁻	1122.8 2	28 3	4491.6	5			I _γ : from 1969Po04, in better agreement with data from ε decay and (p,γ). Others: 15 5 (1969An09), 15 (1968Ma05), 30 (1973Te04).
		1876.9 2	72 3	3736.96	3 ⁻	D		I _γ : from 1969Po04, in better agreement with data from ε decay and (p,γ). Others: 85 5 (1969An09), 85 (1968Ma05), 70 (1973Te04).
								A ₂ =-0.75 20 (1966Gr03).
5628.8	2 ⁺	1724 &	<3	3904.63	2 ⁺			E _γ , I _γ : from 1969An09 only.
		2277.5 10	12 5	3352.7	0 ⁺			I _γ : weighted average of 10 5 (1969An09), 16 8 (1966Gr03). Others: 10 (1968Ma05), 15 (1973Te04).
		5628.3 5	88 5	0	0 ⁺	E2		I _γ : weighted average of 90 5 (1969An09), 84 8 (1966Gr03). Others: 90 (1968Ma05), 85 (1973Te04).
								A ₂ =+0.38 5, A ₄ =+0.53 9 (1966Gr03).
5903.3	1 ⁻	2167 &	<5	3736.96	3 ⁻			I _γ : from 1966Gr03. Other: <6 from 1969An09.
		2551 &	<5	3352.7	0 ⁺			I _γ : from 1966Gr03. Other: <7 from 1969An09.
		5902.6 15	100	0	0 ⁺	D		A ₂ =-0.51 3 (1966Gr03).
6025.9	2,3	2121.0 6	25 3	3904.63	2 ⁺			I _γ : from 1969An09. Others: 17 +4-7 (1969Po04), 20 (1973Te04).
								A ₂ =+0.41 15, A ₄ =+0.07 22 (1969An09).
								δ: δ(O/Q)=0.0 1 (1969An09).
		2289.0 3	75 3	3736.96	3 ⁻	D+Q	-2.8 5	I _γ : from 1969An09. Other: 83 +7-4 (1969Po04), 80 (1973Te04).
								A ₂ =+0.02 5, A ₄ =-0.22 8 (1969An09).
								δ: other: -4.7 +20-10 (1966Gr03) for doublet.
6029.1	2,3	6025 &	<3	0	0 ⁺			E _γ , I _γ : from 1969An09 only.
		751	<3	5277.7	4 ⁺			I _γ : from 1969An09. Other: <20 (1969Po04).
		780.7 4	13 4	5248.6	2 ⁺	Q(+D)	>2	I _γ : from 1969Po04. Other: 15 (1973Te04), 9 to 21 (1969An09).
								A ₂ =+0.07 15, A ₄ =+0.53 22 (1969An09).
								δ(Q/D)>4 (1969An09).
		2124.4 3	87 4	3904.63	2 ⁺	Q(+D)	>4	I _γ : from 1969Po04. Other: 85 (1973Te04), 50 to 79 (1969An09).
								A ₂ =+0.06 7, A ₄ =+0.23 10 (1969An09).
								A ₂ =+0.13 12, A ₄ =+0.95 11 (1969Po04, derived from data in 1966Gr03).
								Mult., δ: from 1969An09.
		2292	<20	3736.96	3 ⁻			I _γ : from 1969Po04. Other: <41 (1969An09).
								A ₂ =+0.16 7, A ₄ =+0.03 9 (1969An09).
								A ₂ =+0.00 7, A ₄ =-0.33 13 (1966Gr03).
6284.9	3	6029 &	<6	0	0 ⁺			E _γ , I _γ : from 1969An09 only.
		1007 &	<10	5277.7	4 ⁺			E _γ , I _γ : from 1968Ma05 only.
		1037 &	<10	5248.6	2 ⁺			E _γ , I _γ : from 1968Ma05 only.
		1793.3 2	77 5	4491.6	5	Q(+O)	-0.03 17	I _γ : weighted average of 78 5 (1969Po04), 72 6 (1966Gr03) and 80 5 (1966Le08). Others: 74 (1968Ma05), 70 (1973Te04).
								δ: from 1966Gr03.
								A ₂ =+0.18 4, A ₄ =-0.05 7 (1966Gr03).
		2380.0 5	23 5	3904.63	2 ⁺	D		I _γ : weighted average of 22 5 (1969Po04), 28 6 (1966Gr03) and 20 5 (1966Gr03). Others: 25 (1968Ma05), 25 (1973Te04).
								A ₂ =-0.52 12, A ₄ =0.00 17 (1966Gr03).
		2548	<10	3736.96	3 ⁻			E _γ , I _γ : from 1968Ma05. Other: I _γ <10 (1966Le08).

Continued on next page (footnotes at end of table)

$^{40}\text{Ca}(\text{p},\text{p}'\gamma)$ **1973Te04,1969Po04,1969An09** (continued) $\gamma(^{40}\text{Ca})$ (continued)

$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\ddagger$	E_f	J_f^π	Mult. [§]	$\delta^\S$	Comments
6284.9	3	2932 ^{&} 6284	<5 1	3352.7 0	0 ⁺ 0 ⁺			E_γ, I_γ : from 1966Le08 only. I_γ : from 1968Ma05. Other: 5 (1973Te04), <10 (1966Le08).
6508.0	4 ⁺	479 ^{&} 879 ^{&} 1230 ^{&} 1260 2603.2 3	<5 <5 3 2 13 3 84 5	6029.1 5628.8 5277.7 5248.6 3904.63	2,3 2 ⁺ 4 ⁺ 2 ⁺ 2 ⁺	E2(+M3)	-0.09 9	E_γ, I_γ : from 1969An09 only. E_γ, I_γ : from 1969An09 only. E_γ, I_γ : from 1969An09 only. I_γ : from 1969An09. Other: 15 (1973Te04). I_γ : from 1969An09. Other: 85 (1973Te04). δ : from 1969An09. $A_2=+0.38$ 3, $A_4=-0.40$ 4 (1969An09).
6542.9	4 ⁺	914 1265 1295 2638.1 3	12 3 7 3 9 3 72 9	5628.8 5277.7 5248.6 3904.63	2 ⁺ 4 ⁺ 2 ⁺ 2 ⁺	E2 E2(+M3)	 -0.07 7	I_γ : from 1969An09. Other: 20 (1973Te04). $A_2=+0.53$ 12, $A_4=-0.28$ 19 (1969An09). I_γ : from 1969An09. Other: 5 (1973Te04). I_γ : from 1969An09. Other: 5 (1973Te04). I_γ : from 1969An09. Other: 70 (1973Te04). δ : from 1969An09. $A_2=+0.41$ 3, $A_4=-0.35$ 4 (1969An09).
6582.2	2,3	969 2090 2677 2845.1 3	5 2 5 2 23 5 67 10	5614.1 4491.6 3904.63 3736.96	4 ⁻ 5 2 ⁺ 3 ⁻	D+Q	+3.1 +26-11	E_γ, I_γ : from 1969An09 only. E_γ, I_γ : from 1969An09 only. I_γ : from 1969An09. Other: 20 (1973Te04). I_γ : from 1969An09. Other: 80 (1973Te04). Mult., δ : from 1969An09. $A_2=+0.11$ 15, $A_4=-0.39$ 21 (1969An09).
6751.3	2 ⁻	6582 ^{&} 2848.4 10 3014.0 3	<6 15 85	0 3904.63 3736.96	0 ⁺ 2 ⁺ 3 ⁻	M1+E2	-0.84 16	E_γ, I_γ : from 1969An09 only. Mult., δ : from $\text{p}\gamma(\theta)$ and $\text{p}\gamma\gamma(\theta)$ (1972Si01); polarity from RUL.
6910.8		6910.2 10	100	0	0 ⁺			
6929.3		1651.7 4 3190.0 15	50 50	5277.7 3736.96	4 ⁺ 3 ⁻			
6938.1		3201.0 15	>80	3736.96	3 ⁻			
6952.6		6952.2 15	100	0	0 ⁺			
7112.4		1485 1899.8 7 3206.8 6 7112.9 10	3 14 18 65	5628.8 5212.4 3904.63 0	2 ⁺ (0 ⁺) 2 ⁺ 0 ⁺			
7115.2		1501 2623.2 3 3378.5 3	20 20 60	5614.1 4491.6 3736.96	4 ⁻ 5 3 ⁻			
7238.4		1624.5 7 2746 3501.4 5	20 40 40	5614.1 4491.6 3736.96	4 ⁻ 5 3 ⁻			
7278.1		3541.0 5	>80	3736.96	3 ⁻			
7298.9		1670 ^{&} 2050.3 5	<10 >80	5628.8 5248.6	2 ⁺ 2 ⁺			
7397.0		2119.2 6	>80	5277.7	4 ⁺			
7422.0		3684.9 12	>80	3736.96	3 ⁻			
7446.3		1831.5 10 2169.1 15 2198.0 10	30 40 30	5614.1 5277.7 5248.6	4 ⁻ 4 ⁺ 2 ⁺			
7468.5		7467.8 10	100	0	0 ⁺			
7531.4		1917.6 10 3794	30 70	5614.1 3736.96	4 ⁻ 3 ⁻			

Continued on next page (footnotes at end of table)

$^{40}\text{Ca}(\text{p},\text{p}'\gamma)$ **1973Te04,1969Po04,1969An09** (continued) $\gamma(^{40}\text{Ca})$ (continued)

$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\ddagger$	E_f	J_f^π	$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\ddagger$	E_f	J_f^π
7559.7		2311.1 3	40	5248.6	2 ⁺	8134.6		2506	20	5628.8	2 ⁺
		3822	60	3736.96	3 ⁻			3643	40	4491.6	5
7623.3		1994	25	5628.8	2 ⁺			4229.4 10	40	3904.63	2 ⁺
		2009.5 7	25	5614.1	4 ⁻	8188.8		4451.6 8	>80	3736.96	3 ⁻
		3886	50	3736.96	3 ⁻	8268		1315	60	6952.6	
7658.7		2045.0 10	50	5614.1	4 ⁻			2364	40	5903.3	1 ⁻
		3167	27	4491.6	5	8275		2646	>60	5628.8	2 ⁺
		3921	23	3736.96	3 ⁻	8321.8		2296	15	6025.9	2,3
7677.0		2399.2 5	>80	5277.7	4 ⁺			4584.1 15	85	3736.96	3 ⁻
7694.7		3957.5 5	>90	3736.96	3 ⁻	8357.8		1405.2 5	>90	6952.6	
7771.9		2158	30	5614.1	4 ⁻	8364		3872	>80	4491.6	5
		4034.3 15	70	3736.96	3 ⁻	8425.5		4688.2 15	>90	3736.96	3 ⁻
7814		2565	30	5248.6	2 ⁺	8437		2808	>80	5628.8	2 ⁺
		3908	70	3904.63	2 ⁺	8485.4		4748.1 20	>90	3736.96	3 ⁻
7873.7		7872.9 10	100	0	0 ⁺	8541.0		5188	40	3352.7	0 ⁺
7927.2		2313.7 13	40	5614.1	4 ⁻			8540 4	60	0	0 ⁺
		3435	50	4491.6	5	8552.6		4060.8 15	100	4491.6	5
		4190	10	3736.96	3 ⁻	8573		8572 4	100	0	0 ⁺
7977.1		2699	10	5277.7	4 ⁺	8587		2562	15	6025.9	2,3
		4072.1 6	50	3904.63	2 ⁺			3309	15	5277.7	4 ⁺
		4624	30	3352.7	0 ⁺			4682	10	3904.63	2 ⁺
		7977	10	0	0 ⁺			4850	60	3736.96	3 ⁻
8018		2770	>80	5248.6	2 ⁺	8671		8670	100	0	0 ⁺
8087.5		8092.4 20	100	0	0 ⁺	8756		8755	100	0	0 ⁺
8115.3		8114.4 20	100	0	0 ⁺	9010		9009	100	0	0 ⁺

[†] Weighted average of **1973Te04**, **1969Po04** and **1968Ma05** if available. Above 6580 level, all gammas are from **1973Te04**, where values with no $\Delta E\gamma$ are from level-energy differences.

[‡] From **1969An09**, **1969Po04** and **1966Gr03** below 6580 level; above 6580 level, all gammas are from **1973Te04**, unless otherwise noted. Quoted values are % branching from each level.

[§] From $\text{p}\gamma\gamma(\theta)$ (**1966Gr03**); RUL used for $\Delta\pi$ assignment.

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

⁴⁰Ca(p,pα),(p,2p):resonances 2001Sc25

2001Sc25: E=100 MeV. Measured $\sigma(\theta)$, DWBA analysis.

1994Vo05: (p,p'α) E=99.1 MeV, deduced electric giant resonances.

1981Na03: (p,pα) E=101.3 MeV. Measured $\sigma(\theta)$. DWIA analysis.

1981Ca02: (p,pα) E=101.5 MeV. Measured $\sigma(\theta)$. DWIA analysis.

1976Ba38: (p,pα) E=157 MeV. Measured $\sigma(\theta)$.

1969Ja12: (p,2p) E=385 MeV.

1964Ru05: (p,2p) E=150 MeV.

⁴⁰Ca Levels

E(level)	Comments
11700	E(level): resonance in (p,p'p) to ³⁹ K g.s. from a broad peak at 10.9-12.5 MeV, FWHM=800 (2001Sc25).
12300	E(level): resonance in (p,p'a) to ³⁶ Ar g.s. from a broad peak at 12.0-12.6 MeV, FWHM=300 (2001Sc25).

⁴⁰Ca(d,d'),(pol d,d') 1966Ni02,1968Ha31,1989Ec01

Includes (d,d) and (pol d,d).

1966Ni02: E=12.8 MeV deuteron beam was produced from the 120-cm cyclotron of the Institute of Nuclear Physics in Caracow.

Reaction products were momentum-analyzed with a broad-range magnetic-ion spectrometer (FWHM=150 keV). Measured $\sigma(\theta)$.

Deduced levels, J, π deformation parameters from DWBA analysis.

1968Ha31: E=7.5 MeV deuteron beam was produced from the ONR electrostatic generator. Target was 4.8 $\mu\text{g}/\text{cm}^2$ ⁴⁰Ca evaporated onto thin carbon plus formvar foils. Reaction products were momentum-analyzed with the MIT multi-angle spectragraph. Measured $\sigma(\theta)$, $\theta=22.5^\circ-157.5^\circ$. Deduced levels.

1989Ec01: (pol d, d') E=23.2 MeV polarized deuteron beam was produced from the Munich Lamb-shift source. Reaction products were momentum-analyzed with the Q3D magnetic spectrograph (FWHM=15-20 keV). Measured $A_y(\theta)$, $\theta=15^\circ-110^\circ$. Deduced levels, J, π , L from DWBA analysis.

Others:.

1980Wi12: E=108 MeV. Measured $\sigma(\theta)$, $\theta=4^\circ-20^\circ$.

1989Sa23: E=56 MeV. Measured $\sigma(\theta)$ for 14-MeV level, FWHM=25 keV. Compared (d,d') and (p,p') results.

1992Mo17: (pol d,d') E=400 MeV. Measured $A_y(\theta)$, deduced spin-transfer parameter (ΔS).

1974PeZW: (d,d') and (pol d,d') E=29 MeV.

(d,d): most references report $\sigma(\theta)$ and deduce optical-model parameters:.

1980Im01 (E=4.50-5.43 MeV), **1977An24** (E=1.8-3.0 MeV), **1970Ve02** (E=13.6 MeV), **1970Se01** (E=11.12 MeV), **1970Fi01** (E=11.8 MeV), **1970Bu08** (E=28 MeV), **1970Br27** (E=10 MeV), **1968Le05** (E=5-6.5 MeV), **1968Ga13** (E=28 MeV), **1968Be36** (E=7.0, 7.2 MeV).

(pol d,d): $A_y(\theta)$ and optical-model parameters:.

1998Oh05 (E=270 MeV), **1994Mo21**, **1994Ko47** (E=380 MeV), **1987Ta15** (E=22 MeV), **1987Er03** (E=52 MeV), **1986Ma32** (E=56 MeV), **1985Ng01** (E=700 MeV), **1984Fr14** (E=20 MeV), **1982Cl03** (E=20 MeV), **1982Cl01** (E=18-23 MeV), **1980Ha14** (E=56 MeV), **1977Pe07**, **1974Ro09** and **1974PeZW** (E=30 MeV), **1971Bo44** and **1971Bo39** (E=1.6-3.0 MeV), **1969Sc02** (E=5,7,9,11 MeV).

⁴⁰Ca Levels

E(level) [†]	J π [#]	Γ [@]	L $\dagger$	B _L ^{&}	Comments
0			0		L: from $A_y(\theta)$ in 1989Ec01 .
3352 8			0	0.07	L: from 1966Ni02 .
3735 8			3	0.31	L: 1966Ni02 , 1980Wi12 and 1989Ec01 . B _L : other: 0.32 (1968Ha31), 0.21 (1980Wi12 , average of two values for different potentials). $\Delta S=0$ (1992Mo17).
3903 8			2		L: from 1989Ec01 , very weakly populated level in 1966Ni02 .
4480			5	0.15	E(level),L: from 1966Ni02 .
7561					E(level): from 1989Sa23 .
9000					E(level): from 1992Mo17 ; $\Delta S=0$.
13921 15					E(level): from 1989Sa23 and 1992Mo17 ; T=0, $\Delta S=1$.
14.5 $\times 10^3$ 2	0 ⁺ & 2 ⁺	1.5 MeV 2	0+2		E(level),J π ,L: from 1980Wi12 .
15.0 $\times 10^3$	1 ⁺				E(level),J π : from 1992Mo17 , T=0.
18.2 $\times 10^3$ 5	0 ⁺ & 2 ⁺	4.0 MeV 3	0+2		E(level),J π ,L: from 1980Wi12 .

[†] From **1968Ha31**, unless otherwise stated.

[‡] From DWBA fits to measured differential cross sections (**1966Ni02**, and **1989Ec01**), unless otherwise noted.

[#] From $A_y(\theta)$ in (pol d,d') (**1989Ec01**,**1992Mo17**).

[@] From **1980Wi12**.

[&] Average of values in **1966Ni02** for two different sets of optical parameters.

⁴⁰Ca(t,t),(pol t,t) [1987En06](#),[1980Ha08](#),[1969Fl06](#)

Measured $\sigma(\theta)$, deduced optical-model parameters.

[1987En06](#): (t,t) E=33 MeV.

[1980Ha08](#): (pol t,t) E=17 MeV. Measured $A_y(\theta)$.

[1969Fl06](#): (t,t) E=20 MeV.

[1969MuZZ](#): (t,t) E=7-29 MeV.

⁴⁰Ca Levels

<u>E(level)</u>	<u>Jπ</u>
0	0 ⁺

⁴⁰Ca(³He,³He') **1967Gi05,1978Ta05,1976Mo07**

Includes (³He,³He).

1967Gi05: E=37.7 MeV. Measured $\sigma(\theta)$, $\theta(\text{cm})=20^\circ-95^\circ$ FWHM=100 keV. Deduced levels, J, π , L, deformation parameters from DWBA analysis.

1978Ya05: E=120 MeV. Measured σ at $\theta=1.2^\circ$ in coincidence α decay, angular correlation of α decay. Deduced isoscalar multipole resonances.

1976Mo07: E=70 MeV. Measured (³He)(p)(θ), (³He)(α)(θ) for giant resonance.

Others:.

1973Mo10: E=71 MeV. Measured $\sigma(\theta)$.

1974Mo13: E=29 MeV. Measured $\sigma(\theta)$, $\theta(\text{cm})=20^\circ-100^\circ$. DWBA analysis of the first 0^+ excited state.

1980Le25: E=108.5 MeV. Measured $\sigma(\theta)$, deduced giant-monopole resonance. DWBA analysis.

1982Ta05: E=170 MeV. Measured GQR at E=20 MeV.

1984Ta11: E=197 MeV. Measured $\sigma(\theta)$.

(³He,³He): optical-model parameters from $\sigma(\theta)$ data:.

1986Ab08 (E=10,12,14,16,18 MeV), **1984ChZT** (E=132 MeV), **1982Ve13** (E=25 MeV), **1981Gr05** (E=50.4 MeV), **1980Tr02** (E=41 MeV), **1978Ch04** (E=27.7,51.4,73.2,83.5 MeV), **1975Br26** (E=24.5-28 MeV), **1973Wi07** (E=217 MeV), **1973Ro18** (E=8,11 MeV), **1973Mo13** and **1972Mo04** (E=29 MeV), FRNC-TH-443 (1973) (E=7,8,11 MeV), **1971Ur01** (E=21 MeV), **1971Ra35** (E=13 MeV), **1969Zu02** (E=15 MeV), **1965Cl04** (E=8-10.25 MeV).

⁴⁰Ca Levels

E(level) [†]	Γ &	L [‡]	B _L [‡]	Comments
0				
3310 50		0		E(level): 3350 from 1974Mo13 . L: from 1974Mo13 .
3730 25		3	0.23	
4480 25		5	0.079	
5250 50				
5650 50				
5940?				E(level): from 1967Gi05 only.
6280 25		3	0.078	
6590 50		3	0.062	
6940 25		2+3		
7950 25				
8470 50				
14200 [#]	0.20 MeV 15	0 ^a		1976Mo07 observed α decay to ³⁶ Ar (g.s.,1970 and 4300 (multiplet)) and p decay to ³⁹ K (g.s.,2520 and higher levels) for a resoance at E=13.5-15.6 MeV.
16700 [#]	0.90 MeV 20	(3) ^a		
18200 [@]	2.2 MeV 2	2(+0) ^a		1976Mo07 observed α decay to ³⁶ Ar (g.s.,1970 and 4300 multiplet) and p decay to ³⁹ K (g.s.,2520 and higher levels) for a resoance at E=15.6-22.5 MeV. L: 2 from 1978Ta05 , a weak L=0 component is also suggested in 1980Le25 from DWBA analysis.

[†] **1967Gi05**, unless otherwise noted.

[‡] From DWBA fits to measured differential cross sections in **1967Gi05**, unless otherwise noted.

[#] From **1978Ta05**, α decay to ³⁶Ar g.s.

[@] From **1978Ta05**, α decay to ³⁶Ar states near 4000.

& From fits to resonance peaks (**1978Ya05**).

^a From **1978Ya05** based on measured angular correlation of α decay.

$^{40}\text{Ca}(\alpha, \alpha')$ [1981Va09](#), [1967Li13](#), [1965Sp01](#)

[1981Va09](#)(also [1980Va10](#)): E=120 MeV beam was produced from the KVI cyclotron. Target was 500 $\mu\text{g}/\text{cm}^2$ ^{40}Ca . Scattered particles were detected with two ΔE -E Si surface barrier counter telescopes (FWHM= 90-150 keV) or momentum-analyzed with a magnetic spectrograph (FWHM=50 MeV). Measured $\sigma(\theta)$. Deduced levels, J, π , L, deformation parameters from DWBA analysis; isoscalar multipole strength distribution, EWSR, widths. Report 39 excitation energies up to 21.10 MeV.

[1967Li13](#), [1966Be19](#): E=31 MeV α beam was produced from the MIT cyclotron. Target was 1 mg/cm^2 natural calcium metal (96.92% in ^{40}Ca). Scattered particles were detected by a silicon surface barrier detector (FWHM=90-100 keV). Measured $\sigma(\theta)$. Deduced levels, J, π , L, deformation parameters from DWBA analysis. Comparisons with theoretical calculations. Report 21 levels up to 8600. This work is an improvement of the work reported in [1965Ba03](#) by the same authors.

[1966Sp01](#), [1965Sp01](#) (also [1966Po03](#)): E=50.9 MeV beam was produced from the Berkeley 88-inch cyclotron. Target was 0.64 mg/cm^2 natural Ca (97% in ^{40}Ca). Scattered particles were detected with a Si(Li) detector (FWHM=115 keV). Measured $\sigma(\theta)$. Deduced levels, J, π , L, deformation parameters from DWBA analysis. Report 13 α groups.

[1965Ba03](#): E=30.5 MeV. FWHM=120 keV. An improvement of this work is reported in [1967Li13](#).

[1970Sc24](#): E=29 MeV; measured $\sigma(\theta)$, $\theta=15^\circ-176^\circ$; deduced levels. Report 27 levels up to 8380.

[1974De42](#): E=24.0, 28.5, 31.0 MeV. Report 12 levels up to 6540.

[1981Lu05](#): E=98.5, 116.8, 129.4 MeV; measured $\sigma(\theta)$. Report 10 excitation energies between 13.2 to 22.5 MeV.

[1962Be23](#): E=22 MeV. About 10 α groups reported.

Data for selected levels or giant resonances:.

[2003Yo11](#): E=240 MeV. Measured cross section for isoscalar E0 strength between 6 and 11 MeV at small angles.

[2001Yo07](#), [2001Yo06](#), [1997Yo07](#): E=240 MeV; measured $\sigma(\theta)$; deduced E0, E1, E2 widths.

[1992Po02](#): E=120 MeV; measured $\sigma(\theta)$, deduced isoscalar dipole strength.

[1983Br21](#): (α, α') , $(\alpha, 2\alpha)$ E=120 MeV; $\sigma(\theta)$ at giant resonance. Deduced monopole strength.

[1981Yo04](#): E=99, 117, 129 MeV.

[1979Ro09](#): E=104 MeV; giant resonances at E=13.3-21.8 MeV.

[1978Mo10](#): E=96, 115 MeV; giant resonance near E=8.8 MeV.

[1978De25](#): E=40-62 MeV.

[1977Ai07](#): E=1.37 MeV.

[1976Ru02](#): E=79.1 MeV; measured $\sigma(\theta)$, deduced levels, L from DWBA analysis. Report 5 levels.

[1976Yo02](#): E=96, 115 MeV; giant resonance.

[1974Ru01](#) (also [1974RuZS](#)): E=115 MeV; giant resonance.

[1973Bi12](#): E=166 MeV.

[1971Ta15](#): E=166 MeV.

[1970Br07](#): E=44 MeV; $\sigma(\theta)$, $\theta=15^\circ-180^\circ$.

[1968Bu10](#): E=25 MeV.

[1961Sa04](#): E=44 MeV.

Others:.

[2014De04](#): E=136 MeV.

[1990Fi07](#): (α, α) E=56 MeV.

[1987Se09](#): E=5-9 MeV.

[1985Zw02](#), [1982Zw01](#), [1986ZwZZ](#): (α, α') , $(\alpha, 2\alpha)$, $(\alpha, \alpha p)$ E=120 MeV; $\sigma(\theta)$ for giant resonance.

[1983Fr03](#): E=4.4-9.1 MeV.

[1981Gu01](#): E=23-80 MeV.

[1980Gi02](#): E=104 MeV.

[1979Ka03](#): E=65 MeV.

[1979Ba14](#): E=1.37 GeV.

[1978Se16](#): E=6-18 MeV.

[1978Gu08](#), [1978Gu25](#), [1978Gu28](#): E=21-47 MeV.

[1978Fr22](#): E=104 MeV.

[1978Lo04](#): E=36.2-61.0 MeV.

[1977SmZX](#): E=30 MeV.

[1977Bu15](#): E=27.2 MeV.

[1976Eb03](#): E=20-26 MeV.

[1976Ch19](#): E=24.4-85.6 MeV.

[1976Br11](#): E=166 MeV.

$^{40}\text{Ca}(\alpha, \alpha')$ **1981Va09, 1967Li13, 1965Sp01 (continued)**

1975Ap01: E=19, 24.1, 26.5 MeV.
 1975Tr01: E=24-29 MeV.
 1975Mo04: E=96.6 MeV.
 1975Le19: E=79.1 MeV.
 1975Ei04: E=100 MeV.
 1974Go22: E=141.7 MeV.
 1974Mo22: E=96 MeV.
 1974In02: E=40 MeV.
 1974RuZS:.
 1972St28: E=40.7-72.3 MeV.
 1972Oe01: E=24,29 MeV.
 1972Br30: E=166 MeV.
 1971LeYV: E=166 MeV.
 1971Le18: E=18-22 MeV.
 1970Fe02: E=42 MeV.
 1969La20, 1969La37: E=23 MeV.
 1969Jo05 (also 1968JoZZ): E=5.0-12.5 MeV.
 1969Ga22: E=18-29 MeV.
 1969Be30, 1966Be19: E=29,31 MeV.
 1968Ro20: E=12-18 MeV.
 1966Gr09: E=27-40 MeV.
 1965Ta06: E=22.2 MeV.
 1962Sa15: E=43 MeV.

 ^{40}Ca Levels

E(level) [†]	L [†]	β_{LR} [‡]	Comments
0	0		
3350 20	0	0.07	%EWSR=0.2 (1981Va09).
3740 20	3	0.90	β_{LR} : others: 0.88 (1970Br07), 0.85 (1965Sp01), 0.90 (sharp cut-off) or 0.97 (smooth cut-off) (1968Bu10), 0.85 (1965Sp01). %EWSR=11.6 (1981Va09).
3900 20	2	0.37	β_{LR} : others: 0.34 (1965Sp01), β_L =0.097 (1967Li13). %EWSR=3.4 (1981Va09).
4490 20	5	0.39	β_{LR} : others: 0.38 (1970Br07), 0.53 (sharp cut-off) or 0.58 (smooth cut-off) (1968Bu10), 0.35 (1965Sp01). %EWSR=0.2 (1981Va09).
5250 [#] 20			E(level): 5250 20 in 1981Va09 and 5260 30 in 1967Li13 for the 5250+5280 doublet.
5280 [#]			
5630 20	2	0.13	L: assignment of L=4 in 1965Ba03 is erroneous according to 1967Li13 of the same authors. β_{LR} : others: β_L =0.046 (1967Li13). %EWSR=0.6 (1981Va09).
5910 20	1		L: (1) from 1981Va09; L=1 from 1967Li13 and 1965Ba03. Other: L=3 with β_{LR} =0.18 (1965Sp01).
6020 30			E(level): from 1967Li13. Also reported in 1974De42 and 1970Sc24; not reported in 1981Va09.
6160	(3)	0.39	E(level), L, β_{LR} : from 1961Sa04 and 1970Br07 only.
6290 20	3	0.36	β_{LR} : other: 0.40 (1965Sp01). %EWSR=3.1 (1981Va09).
6500 30			E(level): from 1967Li13.
6540 [@]	3	0.31	L: from 1965Ba03.
6580 [@]	3	0.31	%EWSR=2.4 (1981Va09).
6740	(3)	0.41	E(level), L, β_{LR} : from 1961Sa04 and 1970Br07 only. A level at 6790 with adopted $J\pi=(2^-)$ is reported in 1970Sc24.
6940 20	(3)	0.37	E(level): multiplet since several levels near this energy in Adopted Levels. β_{LR} : others: 0.21 for L=2 and 0.36 for L=3 (1965Sp01).

Continued on next page (footnotes at end of table)

$^{40}\text{Ca}(\alpha, \alpha')$ **1981Va09, 1967Li13, 1965Sp01 (continued)** ^{40}Ca Levels (continued)

E(level) [†]	Γ^a	$L^\dagger$	$\beta_{LR}^\ddagger$	Comments
7110 30				L: others: L=1+(2) from 1967Li13 and 1965Ba03; none adopted by the evaluator since this level could be an unresolved multiplet. E(level): from 1967Li13. L: the assignment of L=(6) in 1965Ba03 should be discarded according to 1967Li13 of the same authors as 1965Ba03. E(level): reported only in 1970Sc24.
7300				
7470 & 30				
7570 & 30				
7680 30				E(level): from 1967Li13.
7900 20		2	0.28	L: from 1981Va09. Other: 4 (1965Ba03). β_{LR} : other: $\beta_L=0.078$ (1967Li13). %EWSR=3.9 (1981Va09).
7940 30		4	0.29	E(level): from 1967Li13. L: from 1965Sp01, 1966Be19, 1967Li13. β_{LR} : from 1965Sp01. Other: $\beta_L=0.094$ (1967Li13).
8100 20		2	0.22	β_{LR} : others: 0.24 (1965Sp01), $\beta_L=0.083$ (1967Li13). %EWSR=2.5 (1981Va09).
8290 & 30		(2)		L: from 1967Li13 with $\beta_L=0.049$.
8380 20		4	0.21	L: the assignment of L=5 by 1965Ba03 is incorrect according to 1967Li13 of the same authors as 1965Ba03. β_{LR} : others: 0.24 (1965Sp01), $\beta_L=0.083$ (1967Li13). %EWSR=1.1 (1981Va09).
8600 20		2	0.17	β_{LR} : other: 0.19 (1965Sp01). %EWSR=1.6 (1981Va09).
8780 20		2	0.12	%EWSR=0.8 (1981Va09).
8970 20		(2)	0.13	%EWSR=1.0 (1981Va09).
9340 20		3	0.17	%EWSR=1.0 (1981Va09).
9500 20				
9870 20				
10080 20				
10340 20		4	0.17	%EWSR=0.8 (1981Va09).
10590 20	0.48 MeV 5	(3)	0.10	Γ : 0.52 MeV 8 from E=117 MeV data (1981Lu05). L: from 1981Va09. Other: 1 (1981Lu05). %EWSR=0.4 (1981Va09).
10800 20		(3)	0.11	%EWSR=0.5 (1981Va09).
11100 20		(2)	0.27	%EWSR=5.2 (1981Va09).
11470 20		(3)	0.10	%EWSR=0.4 (1981Va09).
11690 20		2	0.14	L: other: 0 (1983Br21). %EWSR=1.5 (1981Va09).
11940 20		(2)	0.15	%EWSR=1.7 (1981Va09).
12170 50		2	0.11	
12450 50	0.16 MeV	3	0.15	Γ : from 1981Va09.
12720 50		(2)	0.09	
13000 50		2	0.11	L: other: 0 (1983Br21).
13400 50	0.40 MeV 8	0		Γ : 0.36 MeV 6 from E(beam)=117 MeV data (1981Lu05). L: from 1981Lu05 and 1983Br21. Other: L=(2) from 1981Va09 with $\beta_{LR}=0.07$. other: 0+2 from α decay to ^{36}Ar g.s. (1982Zw01, 1983Br21, 1985Zw02). %EWSR $\approx$ 7 (1981Lu05).
14070 50		0	0.05	L: (0) from 1981Va09; L=0 from 1983Br21.
14260 50	1.63 MeV	2	0.37	Γ : from 1981Va09.
14850 50	0.68 MeV 8	2	0.09	E(level): others: 14.5 MeV 3 (1981Lu05), average energy of 14300 for an excitation region of 13.3-15.3 MeV (1979Ro09). Γ : 0.51 MeV 7 from E(beam)=117 MeV data (1981Lu05). L: other: 1+2 for an excitation region with average energy of 14.3 MeV

Continued on next page (footnotes at end of table)

$^{40}\text{Ca}(\alpha, \alpha')$ **1981Va09, 1967Li13, 1965Sp01 (continued)** ^{40}Ca Levels (continued)

$E(\text{level})^\dagger$	Γ^a	$L^\ddagger$	$\beta_L R^\ddagger$	Comments
				(1979Ro09). $\beta_L^2=0.0041$ for $L=1$ and 0.0036 for $L=2$ (1979Ro09). $E=14.5$ 3, width= 0.68 MeV 8, $L=2$ (1981Lu05), 99 MeV data. $E=14.6$ 3, width= 0.51 MeV 7, $L=2$ (1981Lu05), 117 MeV data.
15140 50 16000 50	0.63 MeV 10	(2) 3	0.09	Γ : Other: 0.65 MeV from 1981Va09. L : from 1981Lu05. Other: $1+2$ (1979Ro09) with $\beta_L^2=0.0033$ for $L=1$ and 0.0024 for $L=2$; 2 (1981Va09) with $\beta_L R=0.15$. $E=15.8$ 4, width= 0.63 MeV 10, $L=3$ (1981Lu05).
18000 50	2.25 MeV 20	2	0.69	Γ : 2.53 MeV 40 from $E=117$ MeV data and 2.56 MeV 40 from $E=130$ data (1981Lu05), 3.26 MeV (1981Va09), 3.5 MeV 3 (1975Mo04), 3.5 MeV 3 (1976Yo02), 2.9 MeV 6 (2001Yo07). $\beta_L R$: other: 0.72 (1976Yo02), $\beta_L^2=0.0164$ (1979Ro09), $\beta_L=0.14$ (1974Ru01). $\%EWSR=108$ 12 (2001Yo07).
19.18×10^3 37 21100 50	4.9 MeV 6	0 0+2	0.18, 0.20	$E(\text{level}), \Gamma, L$: from 2001Yo07, $\%EWSR=97$ 11. L : from 1979Ro09 and 1981Va09. $\beta_L R$: other: $\beta_L^2=0.0019$ for $L=0$ and 0.0018 for $L=2$ (1979Ro09).
23.36×10^3 70	5.3 MeV 9	1		$E(\text{level}), \Gamma, L$: from 1997Yo07, 2001Yo07. $\%EWSR=62$ +10-20 (2001Yo07).

† From 1981Va09, unless otherwise noted. Data are also available from 1965Ba03, 1967Li13, 1965Sp01, 1981Lu05.

‡ Quoted values are from 1981Va09; data from other measurements are also available and given under comments.

$^\#$ Only 1974De42 report 5250 and 5280 as separate levels. 5250 20 in 1981Va09 and 5260 30 in 1967Li13 for the 5250+5280 doublet; 1970Sc24 report a triplet of 5210+5250+5280.

$^\circ$ Only 1974De42 report 6540 and 6580 as distinct levels. 6570 20 with $\beta_L R=0.31$ from 1981Va09, 6580 with $\beta_L R=0.31$ from 1965Sp01, 6560 3 from 1965Ba03 and 6580 30 from 1967Li13 for 6540+6580 doublet.

$^\&$ Reported in 1967Li13 only.

a From $E(\text{beam})=99$ MeV data in 1981Lu05, unless otherwise noted. Data for $E(\text{beam})=117$ MeV data from 1981Lu05 are given in comments.

$^{40}\text{Ca}(\alpha, \alpha' \gamma)$ 1962Be23, 1968Ko02

1962Be23: E=22 MeV. Measured $E\gamma$, $\alpha\gamma$ coin with a NaI crystal and a solid-state detector (FWHM=150 keV). Deduced levels.

1968Ko02: E=31 MeV. Measured $E\alpha$, $E\gamma$ for 6290, 6560 levels; $\alpha\gamma(\theta)$ for 6940 level.

Others:.

1988Ka21, 1987Ma25: E=13.62 MeV. Measured $\alpha\gamma$ coin, lifetime for 4490 level, g factors for 3740 and 4490 levels.

1979Ni04: E=16.17 MeV. Measured $\alpha\gamma(\theta)$, g-factor for 3740 level.

1976Ja16, 1976Ja20, 1977LiZM: E=16.17 MeV. Measured $\alpha\gamma(\theta, H)$; γ -factor by recoil in vacuum for 3740 level.

1959Sh62: E=43 MeV. Measured $\alpha\gamma(\theta)$ for 4490 level.

 ^{40}Ca Levels

E(level) [†]	J π [‡]	T _{1/2}	Comments
0	0 ⁺		
3348	0 ⁺		
3730	3 ⁻		g=0.55 13 g: weighted average of +0.56 13 from 1976Ja16 and +0.52 18 from 1979Ni04.
3900	2 ⁺		
4483	5 ⁻	295 ps 5	T _{1/2} : from 3740 $\gamma(t)$ (1988Ka21, 1987Ma25). g-factor(3730)/g-factor(4483)=1.01 10 (1987Ma25).
5500 [#]			
5700 [#]			
6100 [#]			
6290 [@]	3 ⁻ [@]		
6560 [@]	3 ⁻ [@]		
6940 [@]	(1 ⁻) [@]		E(level), J π : possible doublet or triplet, but from decay mode and DWBA fit to $\sigma(\theta)$, principally 1 ⁻ (1968Ko02).
7500 [#]			
8700 [#]			
9600 [#]			

[†] From 1962Be23, unless otherwise stated.

[‡] From Adopted Levels, unless otherwise stated.

[#] From α group in coincidence with γ rays (1962Be23).

[@] From 1968Ko02.

$^{40}\text{Ca}(\alpha, \alpha' \gamma)$ **1962Be23, 1968Ko02 (continued)** $\gamma(^{40}\text{Ca})$

$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^\ddagger$	E_f	J_f^π	Mult.	Comments
3730	3^-	3730	100	0	0^+		$A_2=+0.92$ 7; $A_4=+0.03$ 12; $A_6=-0.85$ 8 (1987Ma25)
3900	2^+	3900	100	0	0^+		
4483	5^-	583 [§]	<10	3900	2^+		
		753	100	3730	3^-	Q	$A_2=+0.32$ 7; $A_4=-0.40$ 7 (1987Ma25)
		1135 [§]	<10	3348	0^+		
		4483 [§]	<5	0	0^+		
6290	3^-	1810	75 5	4483	5^-		E_γ, I_γ : reported in 1968Ko02 .
		2390	25 5	3900	2^+		E_γ, I_γ : reported in 1968Ko02 .
6560	3^-	2660 [§]	<10	3900	2^+		E_γ, I_γ : reported in 1968Ko02 .
		2830	100	3730	3^-		E_γ, I_γ : reported in 1968Ko02 .
6940	(1^-)	3040 [§]		3900	2^+		E_γ : reported in 1968Ko02 .
		3210 [§]		3730	3^-		E_γ : reported in 1968Ko02 .
		6940	60 10	0	0^+		E_γ, I_γ : reported in 1968Ko02 . 1968Ko02 report that this transition takes 60% 10 of the total γ -ray transition intensities from 6940 level.

[†] From level-energy differences. Reported in **1962Be23**, unless otherwise noted.

[‡] % branching from each level.

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

$^{41}\text{Ca}(\text{d,t})$ 1975Be45

$J\pi(^{41}\text{Ca g.s.})=7/2^-$.

1975Be45: E=40 MeV deuteron beam was produced from the University of Groningen cyclotron. Target was about $160 \mu\text{g}/\text{cm}^2$ 99.9% pure calcium. Reaction products were detected in separate counter telescopes of two silicon surface barrier detectors (FWHM=80 keV). Measured $\sigma(\theta)$. Deduced levels, J, π , L-transfers, spectroscopic factors from DWBA analysis.

All data are from 1975Be45, unless otherwise noted.

 ^{40}Ca Levels

Spectroscopic factor C^2S is defined by $C^2S=(2j+1)/N \times \sigma_{\text{exp}}/\sigma_{\text{DWBA}}$ with $N=3.33$ and j the spin of transferred particle (1975Be45).

E(level)	L [†]	C ² S [†]	Comments
0	3	0.79	
3350	(3)	<0.02	
3740	0+2	0.16,0.22	
4490	2	0.58	
5610	2	0.50	
6030	(2)	0.10	
6580	0+2	0.27	C^2S : for L=2.
6750	2	0.18	
6940	(2)	0.20	E(level): unresolved triplet: 6930+6940+6950.
7110	0+2	0.05,0.23	
7675	2	1.2	E(level): unresolved doublet: 7660+7690.
8450	2	0.24	E(level): unresolved doublet: 8420+8480.
8550	2	0.68	
9030	0	0.15	
10060	0	0.42	
11220 [‡]	2	0.8 [‡]	
11700 [‡]	2	0.4 [‡]	

[†] Extracted from DWBA fits to measured differential cross sections (1975Be45).

[‡] Tentatively assigned as $d_{5/2}$ pickup, since they are too strong to be L=0 (1975Be45).

$^{41}\text{Ca}(^3\text{He},\alpha)$ 1974CI08

$J\pi(^{41}\text{Ca g.s.})=7/2^-$.

1974CI08: E=20 MeV ^3He beam was produced from the Rochester MP tandem accelerator. Target was about $25\text{ }\mu\text{g}/\text{cm}^2$ enriched Ca (81.8% in ^{41}Ca) on $30\text{ }\mu\text{g}/\text{cm}^2$ carbon backing. Reaction products were momentum-analyzed with a split-pole magnetic spectrometer and detected with photographic emulsions. Measured $\sigma(\theta)$. Deduced levels, J, π , L, spectroscopic factors from DWBA analysis. Comparisons with available data.

Other:.

1975Ap01: E=16, 27 MeV ^3He beams were produced from the FN tandem Niels Bohr Institute. Target was CaCO_3 evaporated onto a thin carbon foil (81% in ^{41}Ca , thickness of $20\text{ }\mu\text{g}/\text{cm}^2$). Scattered particles were detected with solid state detectors. Measured $\sigma(\theta)$. Deduced levels, J, π , spectroscopic factors from DWBA analysis for 0, 3730, 4490 and 5610 levels.

All data are from 1974CI08, unless otherwise noted.

 ^{40}Ca Levels

Cross sections given under comments are in mb/sr (1974CI08).

Spectroscopic factor is defined as: $C^2S=(2j+1)/N \times (d\sigma/d\Omega)_{\text{exp}}/(d\sigma/d\Omega)_{\text{DWUCK}}$, where j is the angular momentum of transferred particle and N=23 is the normalization factor (1974CI08).

E(level)	$J\pi^\dagger$	L [#]	$C^2S^\#$	Comments
0	0^+	[3] †	$0.98^\dagger$	C^2S : other: 0.92 (1975Ap01). $d\sigma/d\Omega(\text{max})=1.65$.
3350? 5	0^+	[3] †	$0.01^\dagger$	$d\sigma/d\Omega(\text{max})=0.03$.
3732 5	3^-	2	0.57	C^2S : other: 0.65 (unresolved from L=3, 3350 level, 1975Ap01). $d\sigma/d\Omega(\text{max})=0.59$.
4488 5	5^-	[2] †	$1.1^\dagger$	C^2S : other: 1.2 (1975Ap01). $d\sigma/d\Omega(\text{max})=1.20$.
5610 5		2	0.89	C^2S : other: 0.92 (1975Ap01). $d\sigma/d\Omega(\text{max})=1.12$.
5901? 5		2	<0.003	$d\sigma/d\Omega(\text{max})<0.005$.
6029 5	2^-	[2] †	$0.17^\dagger$	$d\sigma/d\Omega(\text{max})=0.26$.
6288 5		2	0.05	$d\sigma/d\Omega(\text{max})=0.09$.
6583 5		0+2	0.04,0.21	$d\sigma/d\Omega(\text{max})=0.41$.
6748 5	2^-	[2] †	$0.22^\dagger$	$d\sigma/d\Omega(\text{max})=0.31$.
6930 5		2	0.07	$d\sigma/d\Omega(\text{max})=0.10$.
6950 5		2	0.06	$d\sigma/d\Omega(\text{max})=0.13$.
7112 5		0+2	0.13,0.20	$d\sigma/d\Omega(\text{max})=0.66$.
7531 5		2	0.03	$d\sigma/d\Omega(\text{max})=0.04$.
7656 5		2	1.3	$d\sigma/d\Omega(\text{max})=1.93$.
7693 5		2	1.3	$d\sigma/d\Omega(\text{max})=1.88$.
8374 5		(2)	0.08	$d\sigma/d\Omega(\text{max})=0.09$.
8423 5	2^-	[2] †	$0.62^\dagger$	$d\sigma/d\Omega(\text{max})=0.82$.
8483 5		(2)	0.21	$d\sigma/d\Omega(\text{max})=0.25$.
8551 5	5^-	[2] †	$1.7^\dagger$	$d\sigma/d\Omega(\text{max})=2.14$.
9035 5		0	0.33	$d\sigma/d\Omega(\text{max})=1.47$.
9080 5		(0)	0.06	$d\sigma/d\Omega(\text{max})=0.29$.
9145 5		(2)	0.11	$d\sigma/d\Omega(\text{max})=0.13$.
9222 5		(2)	0.05	$d\sigma/d\Omega(\text{max})=0.08$.
9435 5		(0)	0.05	$d\sigma/d\Omega(\text{max})=0.22$.
9460 5				$d\sigma/d\Omega(\text{max})=0.21$.
9559 5				$d\sigma/d\Omega(\text{max})=0.38$.
9605 5		(2)	0.31	$d\sigma/d\Omega(\text{max})=0.58$.
9647 5		(2)	≤ 0.1	$d\sigma/d\Omega(\text{max})\approx 0.10$.
9673 5				$d\sigma/d\Omega(\text{max})=0.89$.
10055 5		0	0.98	$d\sigma/d\Omega(\text{max})=6.07$.
10214 5		0	0.18	$d\sigma/d\Omega(\text{max})=0.76$.

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${}^{41}\text{Ca}({}^3\text{He},\alpha)$ [1974CI08](#) (continued)

${}^{40}\text{Ca}$ Levels (continued)

[†] From Adopted Levels.

[‡] L-value fixed by adopted $J\pi$ considerations ([1974CI08](#)).

[#] From DWBA fits to measured differential cross sections.

⁴²Ca(¹⁶O, ¹⁸O) [1976Ei02](#)

[1976Ei02](#): E=56 MeV. Measured $\sigma(\theta)$, $\theta(\eta M)=4^\circ - 70^\circ$; finite range DWBA analysis.

⁴⁰Ca Levels

<u>E(level)</u>	<u>J^{π}</u>	<u>L</u>	<u>dσ/dΩ (max) (μb/sr)</u>
0	0 ⁺	0	120

Adopted Levels

$Q(\beta^-) = -11.67 \times 10^3$ 16; S(n)=14422 24; S(p)=529.6 29; $Q(\alpha) = -5531.2$ 28 2012Wa38

S(2n)=32120 200 (syst), S(2p)=6300.5 28, Q(εp)=5994.9 28 (2012Wa38).

Other reactions:.

⁴⁰Ca(γ, π^-): 1985To14, 1982To10: E=400 MeV. Measured σ , deduced pion production. 1973Gr21: E=340 MeV. Measured σ .

⁴⁰Ca(π^+, π): 1987Bo43, 1986Ir02, 1986Er09, 1984Er03, 1984Bo51, 1983Ba13, 1982Ba50: E=120, 165, 230 MeV. Measured $\sigma(\theta)$.

⁴⁰Ca($\pi^+, \pi + \pi^-$): 2001Ca53, 2000Bo38, 2000Gr28, 1999Bo25, 1997Bo15, 1996Bo09: E=283 MeV, measured pion invariant mass spectra.

⁴⁰Ca($^6\text{Li}, ^6\text{He}$): 1974Ga11: E=38 MeV. Upper limits on cross sections estimated for excitation energy up to 1700 as: $<2.5 \mu\text{b}$ for $10^\circ < 0.4 \mu\text{b}$ for 30° . No peaks were observed in ^6He spectra.

⁴⁰Ca($^6\text{Li}, ^6\text{He}$): 1980GuZW: E=92 MeV. Measured σ , deduced T=1 magnetic giant resonance. Details of this study are not available.

Delayed 2-proton radioactivity of ⁴²Cr to levels in ⁴⁰Sc is possible but none has been detected by 2001Gi01. An unexplained proton group at 2490 30 from ⁴²Cr decay could be an L=0 2-proton transition from IAS to first excited 0⁺ state in ⁴⁰Sc, but no γ rays were observed.

In (¹²C, ¹²B), 1988Vo06 identify population of 1⁺ states in 4.9-5.0 MeV region at low angles; a 6⁻ state near 6 MeV at larger angles; and strong low-lying states of unnatural parity characterized by L=1, L=3 and L=5 transitions giving rise to 2⁻, 4⁻ and 6⁻ states, respectively. Population of a spin-flip dipole resonance ($J\pi=0^-, 1^-, 2^-$) is suggested by strong enhancement of cross section in the 7-15 MeV range.

All levels populated in ⁴⁰Ti ϵ decay are proton unbound.

⁴⁰Sc Levels

Cross Reference (XREF) Flags

- A ⁴⁰Ti ϵ decay (52.4 ms)
- B ⁴⁰Ca($^3\text{He}, t$)
- C ⁴⁰Ca($^{12}\text{C}, ^{12}\text{B}$)
- D ⁴⁰Ca(p,n),(pol p,n)

E(level) [†]	J π [‡]	T _{1/2}	XREF	Comments
0	4 ⁻	182.3 ms 7	BCD	% ϵ +% β^+ =100; % ϵ p=0.44 7; % $\epsilon\alpha$ =0.017 5 T=1 J^π : log ft =4.7 to 5 ⁻ , log ft =4.8 to 3 ⁻ (see ⁴⁰ Sc ϵ decay),. T _{1/2} : weighted average of 179 ms 2 (1962Sc08), 186 ms 4 (1966An01), 182.7 ms 8 (1968Ar03), and 183 ms 3 (1972Mo08). % $\epsilon\alpha$, % ϵ p: from 1982Ho09. dominant configuration=($\pi f_{7/2}, \nu d_{3/2}^{-1}$) (1986Ch19) in (p,n). T=1 dominant configuration=($\pi f_{7/2}, \nu d_{3/2}^{-1}$) (1986Ch19) in (p,n). XREF: C(740). J^π : from DWBA analysis of $\sigma(\theta)$ in ($^3\text{He}, t$) and L($^{12}\text{C}, ^{12}\text{B}$)=(1) from 0 ⁺ .
34.3 15	(3 ⁻)		BCD	
772.1 16	(2 ⁻)		BCD	
893.5 20	(5 ⁻)		BCD	
1670.7 19	(1 ⁻ &2 ⁻)		B	J^π : from DWBA analysis of $\sigma(\theta)$ for a possible triplet in ($^3\text{He}, t$).
1703.2 22			B	
1797.0 24	(3 ⁻)		B	J^π : from $\sigma(\theta)$.
1871 3			B	
1933 3			B	
2276 7	1 ⁺		A	
2370 4	(4 ⁻)		B D	XREF: D(2300). E(level): from ($^3\text{He}, t$). J^π : from DWIA analysis of $\sigma(\theta)$ in (p,n) for a complex structure and DWBA analysis of $\sigma(\theta)$ in ($^3\text{He}, t$). In higher-energy ($^3\text{He}, t$) experiments of 1984Ta11, a

Continued on next page (footnotes at end of table)

Adopted Levels (continued) ^{40}Sc Levels (continued)

<u>E(level)[†]</u>	<u>J^π[‡]</u>	<u>XREF</u>	<u>Comments</u>
			1 ⁺ level at 2370 is proposed from $\sigma(\theta)$ data with the speculation that this state may be the analog of T=1 <i>10310</i> , 1 ⁺ state or T=1 <i>9400</i> , 0 ⁺ state in ^{40}Ca .
			dominant configuration= $(\pi f_{7/2}, \nu s_{1/2}^{-1})$ (1986Ch19) in (p,n).
2746 7	1 ⁺	A D	T=1 XREF: D(2700).
2933 11	1 ⁺	A	
3030	(3 ⁻)	B	J ^π : from DWBA analysis of $\sigma(\theta)$ in (^3He ,t).
3135 17	1 ⁺	AB	XREF: B(3140).
3221 60	1 ⁺	A	
3330 17	1 ⁺	AB	XREF: B(3360).
3409 62	1 ⁺	AB	XREF: B(3450).
3494 8		AB	XREF: A(3534).
			E(level): uncertain in ^{40}Ti ε decay.
3648 9	1 ⁺	A	
3780 9	1 ⁺	A	
3.9×10^3 1	(1 ⁻ , 2 ⁻)	A D	XREF: A(?).
			E(level), J ^π : from DWIA analysis of $\sigma(\theta)$ for a complex structure in (p,n). E=3856 42 from ^{40}Ti ε decay.
4060 22	1 ⁺	A	
4129 21	1 ⁺	A	
4264 9	1 ⁺	A D	XREF: D(4300).
			E(level): from ^{40}Ti ε decay, complex structure in (p,n).
4359 8	0 ⁺	A	T=2 J ^π : $\log ft=3.26$ from 0 ⁺ ; IAS of ^{40}Ti g.s.
4518 12	1 ⁺	A	
4649 11	1 ⁺	A	
4819 19	1 ⁺	A	
4895? 15		A	
5014 22	1 ⁺	A	
5080 29	1 ⁺	A	
5221? 29		A	
5354 62	1 ⁺	A	
5567 41	1 ⁺	A	
5702 21	1 ⁺	A	
5879 82	1 ⁺	A	
6005 20	1 ⁺	A	
6120 62	1 ⁺	A	
6419 62	1 ⁺	A	
7.5×10^3 25	(6 ⁻)	D	T=1 J ^π : from DWIA analysis of $\sigma(\theta)$ for a complex structure in (p,n).
			dominant configuration= $(\pi f_{7/2}, \nu d_{5/2}^{-1})$ (1983An06 , 1986Ch19) in (p,n).
12.9×10^3 37	(0 ⁻ , 1 ⁻ , 2 ⁻)	AB D	XREF: D(12000).
			E(level): from (^3He ,t).
			J ^π : from DWIA analysis of $\sigma(\theta)$ for a giant resonance in (p,n).

[†] From (^3He ,t) for levels up to E=1933 keV and from ^{40}Ti ε decay, unless otherwise noted.[‡] 1⁺ assignments for levels above E=1933 keV are from ^{40}Ti ε decay based on $\log ft < 5.2$ from 0⁺; assignments for levels up to E=1933 keV are from DWBA analysis of $\sigma(\theta)$ in (^3He ,t) if applicable, unless otherwise noted.

^{40}Ti ε decay (52.4 ms) [1998Bh12](#),[1998Li46](#),[1990De43](#)

Parent: ^{40}Ti : $E=0$; $J\pi=0^+$; $T_{1/2}=52.4$ ms 3; $Q(\varepsilon)=11.67\times 10^3$ 16; % ε +% β^+ decay=100

^{40}Ti - $T_{1/2}$: From Adopted Levels of ^{40}Ti .

^{40}Ti - $Q(\varepsilon)$: From [2012Wa38](#).

^{40}Ti decays to ^{39}Ca by εp ($\approx 100\%$).

[1998Bh12](#) (also [1998Le45](#),[1997Tr11](#)): ^{40}Ti ions were produced at GANIL by fragmentation of a 82.6 MeV/nucleon ^{50}Cr beam on a 272.4 mg/cm² nickel target. Fragments were separated and selected by the LISE3 spectrometer and then implanted into a stack of five Si surface-barrier detectors. γ rays were detected with five HPGe detectors. Measured $E(p)$, $I(p)$, $E\gamma$, $I\gamma$, $p\gamma$ -coin, $p\beta$ -coin, decay time distribution. Deduced levels, decay branching ratios, reduced transition strengths, ^{40}Ti half-life. Comparisons with data from other measurements.

[1998Li46](#) (also [2001Li56](#),[1997Li25](#)): ^{40}Ti ions were produced at GSI by fragmentation of a 500 MeV/nucleon ^{58}Ni beam from the heavy-ion synchrotron SIS on a 4 g/cm² ^9Be target. Fragments were separated by the separator FRS by energy loss determined by a multiple sampling ionization chamber (MUSIC) and mass-to-charge ratio determined with FRS. Selected ^{40}Ti ions were implanted into a stack of eight Si detectors. γ rays were detected with an array of 14 large-volume Crystal Ball NaI detectors. Measured $E(p)$, $I(p)$, $E\gamma$, $I\gamma$, $p\gamma$ -coin, decay time distribution. Deduced levels, decay branching ratios, reduced transition strengths, ^{40}Ti half-life. Comparisons with data from other measurements.

Other measurements:

[1990De43](#): ^{40}Ti isotope identified and four proton groups.

[2001Gi01](#) (also [2001Gi02](#)): four most intense proton groups reported. Also measured $T_{1/2}$.

Comparison of proton energies (E _p (lab))												
1998Bh12			1998Li46		2001Gi01		2007Do17		adopted		E _x	
p1			242	80					242	80	3221	62*
p1			400	60					400	60	3409	62
p1	747	36	759	60					750	36	3780	9*
p2			951	86					951	86	4517	12*
p1	1111	20	1157	60					1116	20	4129	21*
p1	1325	7	1322	25	1332	25	1329	19	1326	7	4358	8*
p1	1608	17	1580	40					1604	17	4649	11*
p0	1701	6	1705	10	1703	10	1695	19	1701	6	2275	7
p1	1849	14							1849	14	4895	15
p1	1957	21	1992	40					1965	21	5014	22*
p1	2027	28							2027	28	5080	29*
p0	2160	6	2167	10	2154	9	2159	18	2160	6	2746	7
p0	2341	10	2366	40					2342	10	2932	11
p0	2542	16	2518	46					2539	16	3134	17
p0			2609	60					2609	60	3221	62*
p0	2728	16	2733	40					2729	16	3329	17
p0	2957	47	2907	40					2928	40	3533	41
p0	3039	8	3045	40					3039	8	3647	9
p0	3170	8	3158	27					3169	8	3780	9*
p0	3242	41							3242	41	3856	42
p0	3443	21	3407	88					3441	21	4060	22
p0	3487	25							3487	25	4129	21*
p0	3639	8	3632	46					3639	8	4263	9
p0	3734	7	3731	10	3736	14	3744	20	3734	7	4358	8*
p0	3887	11	3972	100					3887	11	4517	12*
p0	4017	10							4017	10	4649	11*
p0	4184	18	4137	60					4180	18	4818	19
p0	4371	23	4347	74					4369	23	5013	22*
p0	4433	31	4481	88					4438	31	5080	29*
p0	4572	28							4572	28	5220	29
p0			4702	60					4702	60	5353	62
p0			4909	40					4909	40	5566	41
p0	5034	20	5107	60					5041	20	5701	21
p0			5213	80					5213	80	5878	82
p0	5336	19							5336	19	6004	20
p0			5448	60					5448	60	6119	62

p0 5740 60 5740 60 6418 62

Notes:

1. Adopted proton energy is from weighted average if applicable.

2. $E_x = E_p * 1.0259 + 529.6$ 29+ $E_x(^{39}\text{Ca})$.

$E_x(^{39}\text{Ca}) = 0$ for decay to ^{39}Ca ground state (p0 mode),

$E_x(^{39}\text{Ca}) = 2468.5$ 9 for p1 mode, 3026 3 for p2 mode.

Values marked with (*) are the averages from two proton groups.

Comparison of proton intensities(%branching)											
E_p	E_x	1998Bh12#	1998Li46	2001Gi01	2007Do17&	adopted*					
p1	242	3221		1.32	40					1.32	40
p1	400	3409		0.70	30					0.70	30
p1	750	3780	0.49 17	0.77	43					0.53	17
p2	951	4518		0.80	32					0.80	32
p1	1116	4129	0.53 13	0.77	42					0.55	13
p1	1326	4359	3.58 60	4.35	82	5.8 20	2.9 14			3.85	60
p1	1604	4649	0.38 18	0.40	20					0.39	18
p0	1702	2276	23.76 59	22.5	21	21.7 30	18.1 19			23.2	9
p1	1849	4895	1.41 32							1.41	32
p1	1965	5014	0.85 26	0.95	43					0.88	26
p1	2027	5080	0.44 11							0.44	11
p0	2160	2746	29.80 66	28.5	19	27.4 36	24.2 19			29.1	10
p0	2342	2933	1.94 41	0.60	18					1.94	41
p0	2539	3135	0.91 21	1.01	56					0.92	21
p0	2609	3221		1.05	42					1.05	42
p0	2729	3330	0.58 17	1.6	11					0.58	7
p0	2928	3534	0.11 11	0.69	28					0.69	28
p0	3039	3648	1.73 20	1.43	78					1.71	20
p0	3169	3780	2.09 23	3.4	16					2.12	23
p0	3242	3856	0.11 11							0.11	11
p0	3441	4060	0.43 14	0.57	30					0.46	14
p0	3487	4129	0.33 14							0.33	14
p0	3639	4264	2.05 22	1.09	27					2.05	22
p0	3734	4359	21.71 54	22.8	19	23.8 36	20.0 20			21.72	54
p0	3887	4518	1.83 28							1.83	28
p0	4017	4649	1.59 23	1.40	42					1.55	23
p0	4180	4819	0.72 17	1.27	53					0.77	17
p0	4369	5014	0.53 23	0.97	40					0.64	23
p0	4438	5080	0.42 24	0.73	22					0.59	22
p0	4572	5221	0.11 11							0.11	11
p0	4702	5354		0.55	21					0.55	21
p0	4909	5567		0.16	10					0.16	10
p0	5041	5702	0.24 9	0.41	30					0.25	9
p0	5213	5879		0.30	12					0.30	12
p0	5336	6005	0.21 7							0.21	7
p0	5448	6120		0.18	10					0.18	10
p0	5740	6419		0.11	6					0.11	6
sum of I_p :		99.9 16	101.4 44			95.8 13@				103.9 18	

Notes:

*: Adopted proton intensity is from weighted average if applicable.

If data from 1998Bh12 and 1998Li46 are not consistent within error, value from 1998Bh12 is taken, unless otherwise noted.

@: total proton branching ratio reported in 2007Do17

#: Intensities are deduced by the evaluator from peak areas in Table2 of 1998Bh12 with the total 24106 implantations of ^{40}Ti .

&: 2007Do7 report a γ transition with $E_\gamma = 2467.3$ 5 and

$I_\gamma = 8.5$ 54 in ^{39}Ca from its first excited state.

^{40}Ti ε decay (52.4 ms) **1998Bh12,1998Li46,1990De43** (continued) ^{40}Sc Levels

E(level) [†]	J π [‡]	E(p0)(lab) [#]	Comments
0	4 ⁻		J π : from Adopted Levels.
2276 7	1 ⁺	1701 @ 6	
2746 7	1 ⁺	2160 @ 6	
2933 11	1 ⁺	2342 10	
3135 17	1 ⁺	2539 16	
3221 62	1 ⁺	2609 & 60	E(p0)(lab): E(p1)=242 80 (in 1998Li46 only) to 2468.5 level in ^{39}Ca .
3330 17	1 ⁺	2729 16	
3409 62	1 ⁺	400 & 60	E(p0)(lab): value is for proton group to 2468.5 level in ^{39}Ca (p1 mode).
3534 41		2928 40	
3648 9	1 ⁺	3039 8	
3780 9	1 ⁺	3169 8	E(p0)(lab): E(p1)=750 36 to 2468.5 level in ^{39}Ca .
3856? 42		3242 ^a 41	
4060 22	1 ⁺	3441 21	
4129 21	1 ⁺	3487 25	E(p0)(lab): E(p1)=1116 20 to 2468.5 level in ^{39}Ca .
4264 9	1 ⁺	3639 8	
4359 8	0 ⁺	3734 @ 7	T=2
			E(p0)(lab): E(p1)=1326 7 to 2468.5 level in ^{39}Ca .
4518 12	1 ⁺	3887 ^a 11	E(p0)(lab): E(p2)=951 86 (in 1998Li46 only) to 3026 level in ^{39}Ca .
4649 11	1 ⁺	4017 10	E(p0)(lab): E(p1)=1604 17 to 2468.5 level in ^{39}Ca .
4819 19	1 ⁺	4180 18	
4895? 15		1849 ^{ab} 14	E(p0)(lab): proton group to 2468.5 level in ^{39}Ca (p1 mode).
5014 22	1 ⁺	4369 23	E(p0)(lab): E(p1)=1965 21 to 2468.5 level in ^{39}Ca .
5080 29	1 ⁺	4438 31	E(p0)(lab): E(p1)=2027 28 to 2468.5 level in ^{39}Ca (in 1998Bh12 only).
5221? 29		4572 ^a 28	
5354 62	1 ⁺	4702 & 60	
5567 41	1 ⁺	4909 & 40	
5702 21	1 ⁺	5041 20	
5879 82	1 ⁺	5213 & 80	
6005 20	1 ⁺	5336 ^a 19	
6120 62	1 ⁺	5448 & 60	
6419 62	1 ⁺	5740 & 60	

[†] Deduced by the evaluator from proton energies. See details in the table of "Comparison of proton intensities" above.

[‡] For excited states, the assignments are from allowed β decays from 0⁺ as indicated by log ft values and are adopted in Adopted Levels.

[#] Weighted average of values from 1998Bh12 and 1998Li46 if applicable, unless otherwise noted. See details in the table of "Comparison of proton energies" above.

@ Weighted average from 1998Bh12, 1998Li46, 2001Gi01 and 2007Do17.

& From 1998Li46 only.

^a From 1998Bh12 only.

^b This proton group is considered as suspect by the evaluator. With I(p)=1.4 in 1998Bh12, this group should have been seen by 1998Li46. In addition 1998Bh12 do not list, in their table III, a level at 4895 in ^{40}Sc corresponding to this proton group.

^{40}Ti ε decay (52.4 ms) [1998Bh12](#), [1998Li46](#), [1990De43](#) (continued)

ε, β^+ radiations						Comments
E(decay)	E(level)	$I\beta^+$ @	$I\varepsilon$ @	Log ft	$I(\varepsilon + \beta^+)^{\dagger @}$	
$(5.25 \times 10^3 \text{ } 17)$	6419	0.11 6	0.00026 15	4.8 3	0.11 [‡] 6	
$(5.55 \times 10^3 \text{ } 17)$	6120	0.18 10	0.00035 20	4.8 3	0.18 [‡] 10	
$(5.67 \times 10^3 \text{ } 16)$	6005	0.21 7	0.00038 13	4.7 2	0.21 [#] 7	
$(5.79 \times 10^3 \text{ } 18)$	5879	0.30 12	0.00050 21	4.6 2	0.30 [‡] 12	
$(5.97 \times 10^3 \text{ } 16)$	5702	0.25 9	0.00038 14	4.8 2	0.25 9	
$(6.10 \times 10^3 \text{ } 17)$	5567	0.16 10	0.00022 14	5.0 3	0.16 [‡] 10	
$(6.32 \times 10^3 \text{ } 17)$	5354	0.55 21	0.0007 3	4.6 2	0.55 [‡] 21	
$(6.45 \times 10^3 \& \text{ } 16)$	5221?	0.11 11	0.00013 13	5.3 5	0.11 [#] 11	
$(6.59 \times 10^3 \text{ } 16)$	5080	1.03 25	0.0011 3	4.4 2	1.03 25	$I(\varepsilon + \beta^+)$: 0.59 22 for $E(p_0)=4438$ (average of 1998Li46 and 1998Bh12) and 0.44 11 from $E(p_1)=2027$ (1998Bh12 only).
$(6.66 \times 10^3 \text{ } 16)$	5014	1.5 3	0.0015 3	4.3 1	1.5 3	$I(\varepsilon + \beta^+)$: 0.64 23 for $E(p)=4369$ and 0.88 26 for $E(p)=1965$.
$(6.78 \times 10^3 \& \text{ } 16)$	4895?	1.4 3	0.0014 3	4.3 1	1.4 3	
$(6.85 \times 10^3 \text{ } 16)$	4819	0.77 17		4.6 1	0.77 17	
$(7.02 \times 10^3 \text{ } 16)$	4649	2.0 3	0.0017 3	4.3 1	1.98 29	$I(\varepsilon + \beta^+)$: 1.59 23 for $E(p_0)=4017$ and 0.39 18 for $E(p_1)=1604$.
$(7.15 \times 10^3 \text{ } 16)$	4518	2.6 4	0.0021 4	4.2 1	2.6 4	$I(\varepsilon + \beta^+)$: 1.83 28 for $E(p_0)=3887$ (in 1998Li46 only) and 0.80 32 for $E(p_2)=951$ (in 1998Li46 only).
$(7.31 \times 10^3 \text{ } 16)$	4359	25.6 8	0.0188 16	3.3 1	25.6 8	$I(\varepsilon + \beta^+)$: 21.72 54 for $E(p_0)=3734$ and 3.85 60 for $E(p_1)=1326$.
$(7.41 \times 10^3 \text{ } 16)$	4264	2.05 22	0.00144 19	4.4 1	2.05 22	
$(7.54 \times 10^3 \text{ } 16)$	4129	0.88 19		4.8 1	0.88 19	$I(\varepsilon + \beta^+)$: 0.33 14 for $E(p_0)=3487$ (in 1998Bh12 only) and 0.55 13 for $E(p_1)=1116$ (average of 1998Bh12 and 1998Li46).
$(7.61 \times 10^3 \text{ } 16)$	4060	0.46 14		5.1 2	0.46 14	
$(7.81 \times 10^3 \& \text{ } 17)$	3856?	0.11 11		5.8 5	0.11 [#] 11	
$(7.89 \times 10^3 \text{ } 16)$	3780	2.6 3	0.00150 20	4.4 1	2.65 29	$I(\varepsilon + \beta^+)$: 2.12 23 for $E(p_0)=3169$ and 0.53 17 for $E(p_1)=750$.
$(8.02 \times 10^3 \text{ } 16)$	3648	1.71 20		4.7 1	1.71 20	
$(8.14 \times 10^3 \text{ } 17)$	3534	0.7 3		5.1 2	0.7 3	$I(\varepsilon + \beta^+)$: from 1998Li46 . Other: 0.11 11 from 1998Bh12 .
$(8.26 \times 10^3 \text{ } 17)$	3409	0.7 3		5.1 2	0.7 [‡] 3	
$(8.34 \times 10^3 \text{ } 16)$	3330	0.58 17		5.2 2	0.58 17	$I(\varepsilon + \beta^+)$: from 1998Bh12 . Other: 1.6 11 from 1998Li46 .
$(8.45 \times 10^3 \text{ } 17)$	3221	2.4 6	0.0011 3	4.6 1	2.4 [‡] 6	$I(\varepsilon + \beta^+)$: 1.1 4 for $E(p_0)=2609$ and 1.3 4 for $E(p_1)=242$ in 1998Li46 .
$(8.54 \times 10^3 \text{ } 16)$	3135	0.92 21		5.1 1	0.92 21	
$(8.74 \times 10^3 \text{ } 16)$	2933	1.9 4		4.8 1	1.9 4	$I(\varepsilon + \beta^+)$: from 1998Bh12 . Other: 0.60 18 from 1998Li46 .
$(8.92 \times 10^3 \text{ } 16)$	2746	29.1 7	0.0109 7	3.67 5	29.1 10	
$(9.39 \times 10^3 \text{ } 16)$	2276	23.2 9	0.0073 5	3.89 5	23.2 6	

[†] Deduced by evaluator from proton decay intensities from each level. The adopted proton intensities are from weighted average of values in [1998Bh12](#), [1998Li46](#), [2001Gi01](#) and [2007Do17](#) if available, unless otherwise noted. See details in the table of "Comparison of proton energies" above.

[‡] From [1998Li46](#) only.

[#] From [1998Bh12](#) only.

@ Absolute intensity per 100 decays.

& Existence of this branch is questionable.

$^{40}\text{Ca}(\text{p,n}),(\text{pol p,n})$ 1986Ch19

1986Ch19: (pol p,n): E=134 MeV polarized beam (also E=135 MeV unpolarized beam) was produced from the Indiana University Cyclotron Facility (IUCF). Target was a 29.2 mg/cm² 99.97% enriched ^{40}Ca (19.0 mg/cm² for unpolarized beam). Neutrons were detected in large-volume, mean-timed fast-plastic scintillators and neutron energies were determined from neutron time-of-flight (71-m flight path with FWHM=220-415 keV, and 125.2-m flight path for unpolarized beam with FWHM=220-350 keV). Measured $\sigma(\theta)$, analyzing power, polarization transfer coefficients. Deduced levels, J, π , L from comparisons with DWIA calculations. See also [1987Wa31](#), [1986Wa28](#), [1986ChZQ](#).

Other measurements:.

[2004Wa14](#), [2002Wa06](#), [1999Wa08](#): (pol p,pol n): E=345 MeV. Measured σ and analyzing power.

[2002Ha14](#): (pol p,n) E=197 MeV. Measured polarization transfer coefficients, $\sigma(E,\theta)$.

[1996Wa09](#), [1994Wa24](#): (pol p,pol n) E=135 MeV. Measured $\sigma(\theta)$, Deduced isovector spin-dipole resonances.

[1994Ta24](#), [1993Ch13](#): (pol p,pol n) E=494 MeV. Measured polarization transfer coefficients. Deduced isovector spin response.

[1994Sa36](#): (pol p,n) E=50, 80 MeV. Measured polarization transfer coefficients.

[1987Ra23](#): (p,n) E=7-9 MeV. Measured thick target γ and neutron yields.

[1984NaZX](#): (p,n) E=119.3 MeV. Measured σ . Deduced strength for 1^+ states.

[1983Ta16](#): (p,n) E=59.3, 118.3, 159.3 MeV. Measured $\sigma(\theta)$. Deduced Gamow-Teller transition strengths.

[1983An06](#): (p,n) E=133.5 MeV. Measured $\sigma(\theta)$. Deduced levels.

[1981Ga26](#): (p,n) E=200 MeV. Measured $\sigma(\theta)$. Deduced resonances.

[1980KnZX](#): (p,n) E=60, 135 MeV. Measured $\sigma(\theta)$.

[1969Ov01](#), [1966Br17](#): (p,n) E=2-20 MeV. Measured σ . Deduced Q value.

[2001Ka19](#): (pol p,n): calculations and comparison with data.

 ^{40}Sc Levels

E(level) [†]	J π [‡]	L ^{&}	Comments
0 [@]	4 ⁻	3	T=1 E(level): analog of the 4 ⁻ , T=1 state at E=7.7 MeV in ^{40}Ca (1986Ch19). dominant configuration= $(\pi f_{7/2}, \nu d_{3/2}^{-1})$ (1986Ch19).
30 [@]	(3 ⁻)	3	T=1 dominant configuration= $(\pi f_{7/2}, \nu d_{3/2}^{-1})$ (1986Ch19).
770 [@]	(2 ⁻)		Strongly populated state.
890 [@]	(5 ⁻)		
2.3×10^3 [#] 1	(4 ⁻)	3	dominant configuration= $(\pi f_{7/2}, \nu s_{1/2}^{-1})$ (1986Ch19).
2.7×10^3 1	1 ⁺	0	T=1 E(level): analog of the 1 ⁺ , T=1 state at E=10.3 MeV in ^{40}Ca (1983Ta16 , 1986Ch19).
3.9×10^3 [#] 1	(1 ⁻ , 2 ⁻)	(1)	
4.3×10^3 [#] 1	1 ⁺	0	
7.5×10^3 [#] 25	(6 ⁻)	(5)	T=1 E(level), J π , L: for a complex between 5 and 10 MeV. E(level) is taken as the median value of the range. dominant configuration= $(\pi f_{7/2}, \nu d_{5/2}^{-1})$ (1983An06 , 1986Ch19).
12×10^3 [#] 6	(0 ⁻ , 1 ⁻ , 2 ⁻)	1	E(level), J π , L: for a giant resonance between 6 and 18 MeV. E(level) is taken as the median value of the range.

[†] From [1986Ch19](#), unless otherwise noted.

[‡] As proposed by [1986Ch19](#), parentheses are added evaluator.

[#] Complex structure.

[@] 0+30 and 770+890 form unresolved structures. Energies are rounded values from Adopted Levels.

[&] From [1986Ch19](#), based on comparisons of measured $\sigma(\theta)$ and analyzing powers with DWIA calculations.

⁴⁰Ca(³He,t) **1971Sc02,1971Lo16,2000Ha06**

1971Sc02: E=28 MeV ³He beam was produced from the MP tandem of the University of Rochester. Target was a 60 μg/cm² natural calcium foil. Reaction products were momentum analyzed with an Engel split-pole spectrometer (FWHM=15 keV) and detected in NTB emulsions. Measured σ(θ). Deduced levels.

1971Lo16: E=30.2 MeV ³He beam was produced from the sector-focused Saclay cyclotron. Target was a 0.25 mg/cm² thick natural Ca foil. Reaction products were detected and identified by an E-ΔE silicon solid-state-detector telescope (FWHM=20 keV). Measured σ(θ). Deduced levels, J, π from DWBA analysis.

2000Ha06: E=26.064, 26.076 MeV ³He beams were produced from the TUNL FN tandem Van de Graaff accelerator. Target was 47 μg/cm² natural Ca evaporated onto a 22 μg/cm² carbon backing. Reaction were momentum analyzed with an Engel splitpole magnetic spectrograph (FWHM=15 keV) and detected by a position-sensitive avalanche counter. Measured σ(θ). Deduced levels.

Other measurements:

2011St03: E=420 MeV. Measured σ(θ). Deduced relative dipole strength distribution. 105 new excited states in the region of 0.4-16.0 MeV were found but no details are given by authors.

1991Gr03: E=75 MeV. Measured σ at 0°. Deduced isovector giant resonances.

1991Br20 (also **1988Ro17**): E=0.9-2 GeV. Measured σ(θ). Deduced spin multipole Gamow-Teller transition strengths.

1984Va43: E=75, 81 MeV. Measured σ(θ). Deduced transition strengths.

1984Ta11: E=197 MeV. Measured σ(E,θ). Deduced levels, giant-dipole resonance, isovector GQR analog.

1982Ta05: E=130, 170 MeV. Measured σ(θ). Deduced GQR and IAS of T=1 GDR.

1966Ma58: measured Q value.

⁴⁰Sc Levels

E(level) [†]	J ^π [‡]	σ(relative) ^b	Comments
0 ^a	4 ⁻	1.5	
34.3 ^a 15	(3 ⁻)	1.6	E(level): 33.6 15 (1971Sc02), 34 (1971Lo16), 35.1 16 (2000Ha06).
772.1 ^a 16	(2 ⁻)	2.0	E(level): 772 2 (1971Sc02), 772 (1971Lo16), 772.2 16 (2000Ha06).
893.6 ^a 20	(5 ⁻)	5.2	E(level): 892 2 (1971Sc02), 892 (1971Lo16), 895.1 20 (2000Ha06).
1670.8 19	(1 ⁻ & 2 ⁻)	1.2	E(level): 1667 4 (1971Sc02), 1680 (1971Lo16), 1671.6 19 (2000Ha06).
1703.2 [@] 22			E(level): possibly a triplet (1971Sc02).
1796.9 24	(3 ⁻)	1.0	E(level): 1799 4 (1971Sc02), 1799 (1971Lo16), 1796.1 24 (2000Ha06).
1871 [@] 3			
1933 [@] 3			
2370 ^a 4		6.1	E(level), J ^π : a peak at 2370 is reported by 1982Ta05 . Possible J ^π =1 ⁺ from small L-transfer suggested by σ(θ) data of 1984Ta11 who speculate that this state may be the analog of T=1 10310, 1 ⁺ state or T=1 9400, 0 ⁺ state in ⁴⁰ Ca. σ(θ) data of 1971Lo16 suggests 4 ⁻ .
3030 [#] 20	(3 ⁻)		
3140 [#]			
3360 [#]			
3450 ^{#&}		0.5	
3494 ^{&} 8			E(level): from 1971Sc02 only.
12.9×10 ³ 37			E(level): GDR (1984Ta11 , 1982Ta05).

[†] Weighted average of values from **1971Sc02** and **2000Ha06**.

[‡] From **1971Lo16**, based on comparisons of measured σ(θ) with DWBA calculations.

[#] From **1971Lo16** only.

[@] From **2000Ha06** only.

[&] 3450 in **1971Lo16** and 3494 in **1971Sc02** may correspond to the same level.

^a Reported in high-energy experiments of **1984Ta11**, **1982Ta05** also.

^b At 40° (**1971Sc02**).

$^{40}\text{Ca}(^{12}\text{C}, ^{12}\text{B})$ 1988Vo06

1988Vo06: $E=70$ MeV/nucleon ^{12}C beam. Measured $\sigma(E, \theta)$ with the spectrometer SPEG at GANIL (FWHM ≈ 300 keV). Deduced levels, J , π .

 ^{40}Sc Levels

1988Vo06 identify population of 1^+ states in 4.9-5.0 MeV region at low angles; a 6^- state near 6 MeV at larger angles; and strong low-lying states of unnatural parity characterized by $L=1$, $L=3$ and $L=5$ transitions giving rise to 2^- , 4^- and 6^- states, respectively. Population of a spin-flip dipole resonance ($J\pi=0^-, 1^-, 2^-$) is suggested by strong enhancement of cross section in the 7-15 MeV range.

<u>E(level)</u>	<u>$J\pi^\dagger$</u>	<u>$L^\dagger$</u>
$0^\ddagger$	4^-	(3)
$30^\ddagger$	(3^-)	
$740^\#$	(2^-)	(1)
$890^\#$	(5^-)	

† As proposed by 1988Vo06, parentheses are added by the evaluator. All assignments are the same in Adopted Levels.

‡ g.s. and 30 form a weak unresolved group.

$^\#$ 740 and 890 are unresolved and form a dominant structure in the spectrum.

Adopted Levels

S(n)=19120 *SY*; S(p)= 1.97×10^3 *I6*; Q(α)= -4.82×10^3 *I6* [2012Wa38](#)

Δ (S(n))=260 (syst,[2012Wa38](#)).

S(2n)=35660 *340* (syst), S(2p)=1370 *I60*, Q(ϵ p)=11140 *I60* ([2012Wa38](#)).

Mass measurement: [2001Li56](#), [1977St29](#).

⁴⁰Ti produced in the following studies:.

[1990De43](#): ⁵⁸Ni(⁵⁸Ni,X) E=65 MeV/nucleon. Magnetic analysis of fragments and time-of-flight method.

[1998Bh12](#) (also [1998Le45](#),[1997Tr11](#)): Ni(⁵⁰Cr,X) E=82.6 MeV/nucleon. Fragments were separated by LISE3 spectrometer.

[1998Li46](#) (also [2001Li56](#),[1997Li25](#)): ⁹Be(⁵⁸Ni,X) E=500 MeV/nucleon followed by isotopic separation by projectile fragment recoil separator.

[2007Do17](#): Ni(⁵⁸Ni,X) E=74.5 MeV/nucleon. Fragments were separated by the ALPHA-LISE3 separator at the SISSI-LISE3 facility of GANIL.

⁴⁰Ti Levels

Cross Reference (XREF) Flags

A ⁴⁰Ca(π^+ , π^-)

E(level)	J π	T _{1/2}	XREF	Comments
0	0 ⁺	52.4 ms 3	A	<p>%ϵ+%β^+=100; %ϵp=100 (1998Bh12,1998Li46)</p> <p>%β^+ delayed γ activity in ⁴⁰Sc <3% from integrated β strength of 99.0% <i>I6</i> (1998Bh12) and 101% <i>5</i> (1998Li46). No β^+ delayed γ activity was seen by 1998Li46. 2007Do07 report a transition with Eγ=2467.3 <i>5</i> and absolute Iγ=8.5 <i>54</i> in ³⁹Ca from its first excited state.</p> <p>%ϵp: other: 2007Do17 report 95.8 <i>I3</i>, which gives Iγ=4.2 <i>I3</i> for γ transitions in ⁴⁰Sc presumably ending up feeding the ⁴⁰Sc ground state.</p> <p>T_{1/2}: from 2007Do17. Others: 53.5 ms <i>25</i> (2001Gi01,2001Gi02), 52.7 ms <i>15</i> (reported in 1998Bh12 as the average of 53.6 ms <i>6</i> from an independent analysis of the same data in 1997Tr11, and 51.7 ms <i>6</i> in 1997Tr11), 54 ms <i>2</i> (1998Li46, 55 ms <i>2</i> in 1997Li25), and 56 ms +<i>I8-I2</i> (1990De43).</p>

$^{40}\text{Ca}(\pi^+, \pi^-)$ [1997Fo09](#), [1995Si01](#), [1990Mo02](#)

In most of the following studies, $\sigma(\theta)$ were measured for the excitations of nonanalog g.s. in ^{40}Ti deduced in a double charge-exchange reaction.

[1997Fo09](#): E=45-90 MeV, measured $\sigma(\theta)$, deduced g.s. transitions resonance structure.

[1995Si01](#): E=32-79.26 MeV, measured $\sigma(\theta)$, deduced core polarization.

[1991Wa04](#), [1982Mo12](#): E=164 MeV. Measured $\sigma(\theta)$.

[1991Mo05](#), [1990Mo02](#): E=295 MeV, measured $\sigma(\theta)$, deduced double- isovector GDR.

[1989Gr06](#): E=180, 240 MeV. Measured total σ .

[1985Mo18](#), [1983Bl08](#): E=120-210 MeV, measured $\sigma(\theta)$.

[1983Bl08](#): E=120-210 MeV. Measured σ .

[1981KaZW](#): E=175-310 MeV. Measured $\sigma(\theta)$.

[1979Da16](#): E=290 MeV. Measured σ .

[1979LaZK](#): E=291 MeV. Measured $\sigma(\theta)$.

 ^{40}Ti Levels

<u>E(level)</u>	<u>Jπ</u>	<u>Comments</u>
0	0 ⁺	d σ /d Ω =0.60 $\mu\text{b/sr}$ 16 at E(π^+)=64.19 MeV and 30° (1995Si01).

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