^{38}Ca ε decay (443.76 ms) 2015Pa32,1996An09,2015Bl02

Type	Author	History Citation	Literature Cutoff Date
Full Evaluation	Jun Chen	NDS 152, 1 (2018)	30-Sep-2017

Parent: ^{38}Ca: E=0; $J^\pi=0^+$; $T_{1/2}$=443.76 ms *35*; Q(ε)=6742.26 *6*; %ε+%$β^+$ decay=100.0

^{38}Ca-Q(ε): From 2017Wa10.

^{38}Ca-$T_{1/2}$: From Adopted Levels of ^{38}Ca.

2015Pa32(also 2014Pa09): ^{38}Ca source was produced by ^{1}H(^{39}K,2n) reaction with a 30 MeV/nucleon ^{39}K beam provided by K500 superconducting cyclotron at Texas A&M University incident on a hydrogen gas cell. Reaction products were separated using the MARS spectrometer and nearly pure ^{38}Ca beam were implanted in a tape system, collected for 1.6 seconds, moved to a shielded area and counted for 1.54 seconds with a HPGe detector for γ rays and a scintillator for positron measurements. Measured Eγ, Iγ, Eβ, Iβ, βγ-coin. Deduced levels, β decay branching ratios, log *ft*. Comparisons with available data and shell-model calculations.

1996An09: ^{38}Ca source was produced by bombarding a Ti target with the 1 GeV pulsed proton beam from the PS Booster at CERN. Fragments were separated with the on-line mass separator ISOLDE and directed into a moving tape system. γ rays were detected with two Ge detectors and β particles were detected with a thin cylindrical plastic scintillator surrounding the tape in a near 4π geometry. Measured Eγ, Iγ, γγ-coin, βγ-coin. Deduced levels, β decay branching ratios, log *ft*. Comparisons with available data and shell-model calculations.

2015Bl02: ^{38}Ca was produced by projectile fragmentation of ^{40}Ca beam of 50.5 MeV/nucleon on a natural nickel target and separated by LISE3 separator at GANIL. Isotope identification was performed event-by-event using a plastic scintillator (0.45 mm thick) coupled to two photomultipliers used in coincidence to measure energy loss and time-of-flight. ^{38}Ca isotopes were transported after implanting on a tape to a detection setup for decay measurements. β particles were counted by a plastic scintillator (5 mm thick) and γ rays by a HPGe detector. Measured Eγ, Iγ, Eβ, Iβ, βγ-coin. Deduced levels, β-decay branching ratios and γ-ray emission probabilities, log *ft*, parent half-life. Comparisons with shell-model calculations.

Others:

1980Wi13 (also 1980WiZQ thesis): measured Eγ, Iγ.

1969Ga27, 1968Ka15: measured Eγ, Iγ, isotopic half-life.

2006Bo11 (also 2007Ri08): mass measurement of ^{38}Ca (penning-trap method), deduced Q value.

1998Ba80: measured βγ coin, search for the feeding of 2993, 0^- state.

1972Zi02: measured isotopic half-life.

Additional information 1.

1957Cl23: first isotopic identification and half-life measurement.

Review and analysis of superallowed β transition: 2015Ha07 (also 2006Ha12,2005Ha27,2005Ha15,2005Ha65).

This decay is important from the point-of-view of superallowed (0^+ to 0^+) β transition from ^{38}Ca g.s. to 130.4, 0^+ isomer in ^{38}K.

The following levels and gammas listed by 1980Wi13 have not been included here since the intensities of the deexciting γ rays were given as upper limits only but which have not been reported by 1996An09 with a better detection sensitivity: 2402 (1944γ, Iγ<1.1); 2646 (2646γ, Iγ<0.46); 3316 (3185γ, Iγ<0.29, 3316γ, Iγ<0.27); 3739 (3739γ, Iγ<0.36); 3841 (3710γ, Iγ<0.59); 4214 (4084γ, Iγ<0.29); 4318 (4318γ, Iγ<0.19); 4395 (4395γ, Iγ<0.37).

Total decay energy deposit of 6613 keV *9* calculated by RADLIST code is in a good agreement with the expected value of 6612 keV (all to 130 level).

^{38}K Levels

E(level)†	J^π†	$T_{1/2}$†	Comments
0	3^+		
130.2	0^+	924.4 ms *3*	%IT=0.0330 *43*; %ε+%$β^+$=99.9670 *43* %IT from Adopted Levels.
458.5	1^+		
1697.7	1^+		
2993?	0^-		E(level): reported in 1998Ba80.
3341.1	1^+		
3855.8	1^+		

Continued on next page (footnotes at end of table)

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^{38}K Levels (continued)

E(level)†	Jπ†
3976.3	1^+
4174.9	$(1)^+$

† From Adopted Levels. Level energies are round-off values.

ε,β+ radiations

E(decay)	E(level)	Iβ+ ‡	Iε‡	Log *ft*	I(ε+β+)†‡	Comments
(2567.36 *6*)	4174.9	0.004 *2*	0.0001 *1*	5.3 *2*	0.004 *2*	av Eβ=663.38 *55*; εK=0.03057 *8*; εL=0.003004 *7*; εM+=0.0004865 *1*
(2765.96 *6*)	3976.3	0.110 *12*	0.0027 *3*	4.05 *5*	0.113 *12*	av Eβ=753.32 *37*; εK=0.02136 *3*; εL=0.002098 *3*; εM+=0.0003399 *5*
(2886.46 *6*)	3855.8	0.025 *12*	0.00049 *23*	4.8 *2*	0.025 *12*	av Eβ=809.35 *47*; εK=0.01745 *3*; εL=0.001714 *3*; εM+=0.0002776 *5*
(3401.16 *6*)	3341.1	0.34 *4*	0.0032 *4*	4.16 *6*	0.34 *4*	av Eβ=1049.25 *38*; εK=0.008390 *9*; εL=0.0008240 *9*; εM+=0.00013345 I(ε+β+): 1996An09 give 0.369 *13*.
(3749.26# *6*)	2993?	<0.0046	$<2.9\times10^{-5}$	>6.3	<0.0046	av Eβ=1214.54; εK=0.005578; εL=0.0005477; εM+=8.871×10^{-5} I(ε+β+): limit from measurement by 1998Ba80 at the 95% confidence level.
(5044.56 *6*)	1697.7	19.44 *13*	0.0381 *5*	3.426 *3*	19.48 *13*	av Eβ=1836.21 *25*; εK=0.0017540 *7*; εL=0.000172; εM+=2.788×10^{-5} *1* I(ε+β+): weighted average of directly measured values of 19.49 *27* (2015Bl02) and 19.48 *13* (2015Pa32). Note that the value of 19.99 *30* in 1996An09 is deduced from calculated Iβ=76.5 to 130 level based on expected log *ft*=3.4875 *9* for superallowed (0^+ to 0^+) β transitions.
(6283.76 *6*)	458.5	2.84 *6*	0.00250 *6*	4.80 *1*	2.84 *6*	av Eβ=2440.34 *30*; εK=0.0007903 *3*; εL=7.755×10^{-5} *3*; εM+=1.2558×10^{-5} *5* I(ε+β+): 1996An09 give 2.96 *15*.
(6612.06 *6*)	130.2	77.14 *18*	0.0568 *6*	3.487 *1*	77.20 *18*	av Eβ=2601.07; εK=0.0006606 *1*; εL=6.482×10^{-5} *1*; εM+=1.0497×10^{-5} *2* I(ε+β+): from 100−Σ(I(ε+β+) to other levels). Note that the value of 76.52 in 1996An09 is a calculated value from expected log *ft*=3.486. Additional information 2.

† From Iγ intensity imbalance at each level, based on measured I(ε+β+) branching to 1698 level.
‡ Absolute intensity per 100 decays.
# Existence of this branch is questionable.

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γ(^{38}K)

Iγ normalization: From Σ(γ from 1698 level)-Σ(γ to 1698 level)=19.48 *13*, the adopted measured I(ε+β$^+$) branching to 1698 level (2015Pa32).

E_γ[†]	I_γ[‡#]	E_i(level)	J_i^π	E_f	J_f^π	Comments
328.1 *2*	14.96 *26*	458.5	1^+	130.2	0^+	I_γ: weighted average of 14.89 *26* (2015Pa32), 15.0 *10* (1996An09), 12.6 *16* (1980Wi13), and 11.8 *13* (2015Bl02). The value from 2015Bl02 is deduced from absolute Iγ(328)=2.30 *25* relative to absolute Iγ(1568)=19.51 *27* measured by 2015Bl02.
1239	0.26 *5*	1697.7	1^+	458.5	1^+	I_γ: weighted average of 0.36 *13* (2015Pa32) and 0.24 *5* (1996An09). Other: <1.0 (1980Wi13).
1567.4 *2*	100	1697.7	1^+	130.2	0^+	E_γ: 1567.7 *5* from 1968Ka15.
1643	0.25 *15*	3341.1	1^+	1697.7	1^+	I_γ: unweighted average of 0.10 *7* (2015Pa32) and 0.40 *5* (1996An09). Other: <1.0 (1980Wi13).
1698	0.08 *4*	1697.7	1^+	0	3^+	I_γ: from 1996An09. Others: <0.08 (2015Pa32), <0.82 (1980Wi13).
2534[@]	<0.021	2993?	0^-	458.5	1^+	E_γ,I_γ: from 1998Ba80.
2883	0.06 *4*	3341.1	1^+	458.5	1^+	I_γ: from 2015Pa32. 2015Pa32 claim that the value of 0.7 *2* from 1996An09 could be a misprint according to the γ spectrum in Fig.5 of 1996An09. Other:<0.33 (1980Wi13).
3210.7 *7*	1.44 *9*	3341.1	1^+	130.2	0^+	E_γ: 3210 *2* from 1969Ga27. I_γ: weighted average of 1.50 *9* (2015Pa32), 1.38 *10* (1996An09), 1.39 *15* (1980Wi13), and 1.4 *5* (2015Bl02). The value from 2015Bl02 is deduced from absolute Iγ(3210)=0.28 *10* relative to absolute Iγ(1568)=19.51 *27* measured by 2015Bl02.
3341[@]	<0.24	3341.1	1^+	0	3^+	E_γ,I_γ: γ from 1980Wi13.
3516.4 *14*	0.04 *3*	3976.3	1^+	458.5	1^+	I_γ: from 1996An09. Others: <0.03 (2015Pa32), <0.42 (1980Wi13).
3716	0.02 *1*	4174.9	$(1)^+$	458.5	1^+	I_γ: from 1996An09. Others: <0.05 (2015Pa32), <0.45 (1980Wi13).
3725.4 *19*	0.13 *6*	3855.8	1^+	130.2	0^+	I_γ: unweighted average of 0.07 *3* (2015Pa32) and 0.19 *2* (1996An09). Other: <0.36 (1980Wi13).
3848.0 *19*	0.54 *5*	3976.3	1^+	130.2	0^+	I_γ: weighted average of 0.51 *7* (2015Pa32), 0.56 *5* (1996An09), and 0.6 *5* (2015Bl02). The value from 2015Bl02 is deduced from absolute Iγ(3848)=0.12 *9* relative to absolute Iγ(1568)=19.51 *27* measured by 2015Bl02. Other: <0.81 (1980Wi13).

[†] From Adopted Gammas, unless otherwise noted.
[‡] Relative intensity normalized to I(1567γ)=100.
[#] For absolute intensity per 100 decays, multiply by 0.1946 *14*.
[@] Placement of transition in the level scheme is uncertain.

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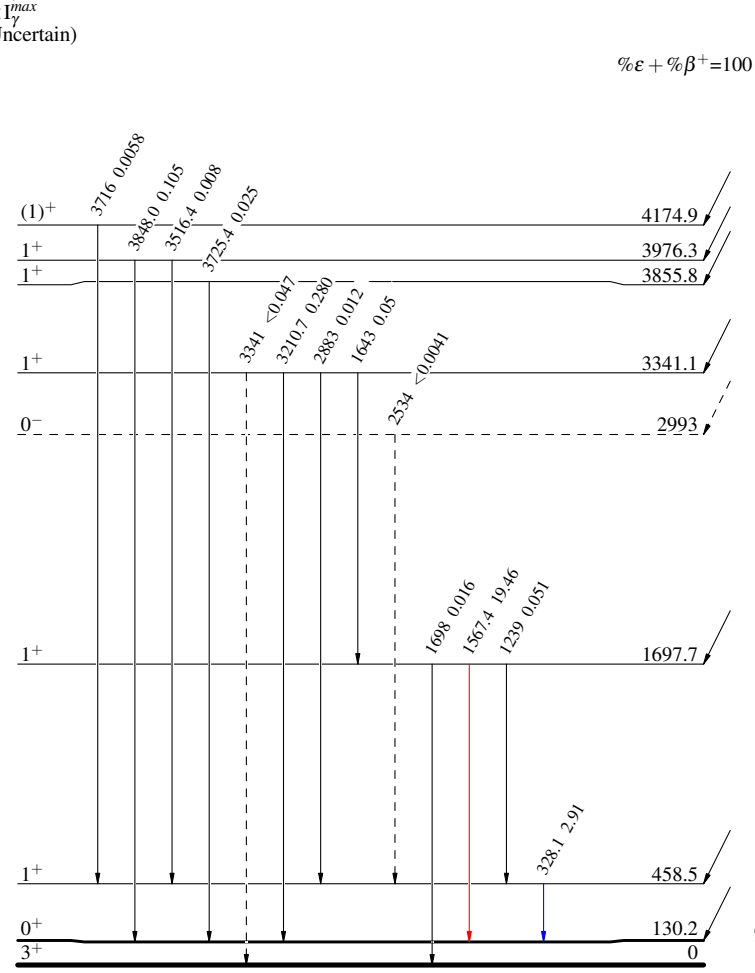
Decay Scheme

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

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



	Iβ+	Iε	Log *ft*
4174.9	0.004	0.0001	5.3
3976.3	0.110	0.0027	4.05
3855.8	0.025	0.00049	4.8
3341.1	0.34	0.0032	4.16
2993	<0.0046	<0.000029	>6.3
1697.7	19.44	0.0381	3.426
458.5	2.84	0.00250	4.80
130.2	77.14	0.0568	3.487