

⁴⁴Sc ε decay (4.0420 h) 1990Me15,1976Co06,1983Gu11

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

Parent: ⁴⁴Sc: E=0.0; J^π=2⁺; T_{1/2}=4.0420 h 25; Q(ε)=3652.7 18; %ε+%β⁺ decay=100

⁴⁴Sc-J^π,T_{1/2}: From ⁴⁴Sc Adopted Levels.

⁴⁴Sc-Q(ε): From 2021Wa16.

1990Me15, 1976Co06: Source of ⁴⁴Sc was prepared by the (γ,n) reactions on natural Sc at the Livermore linear accelerator or by the (α,dxn) reaction on natural Ca metal at the Berkeley 88-inch cyclotron. γ rays were detected with a Ge(Li) detector. Measured Eγ, Iγ. Deduced levels, branching ratios, log ft.

Additional information 1.

1983Gu11: Ge(Li) detectors. Measured Eγ, Iγ. Deduced levels, Iβ.

1973Si05: Activity of ⁴⁴Sc from a ⁴⁴Ti source deposited on thin mylar in a spot of 0.3 cm diameter. A 25 cm³ and a 70 cm³ Ge(Li) detectors for detecting γ-rays. Measured Eγ, Iγ, γγ-coin. Deduced levels, branching ratios.

Other main references: 1990Sc08, 1974HeYW.

Others:

T_{1/2}(⁴⁴Sc): 1954An25, 1950Br52, 1948Wa13, 1945Hi05, 1942Sm01, 1940Wa01.

Isotopic identification: 1937Wa07, 1937Wa04, 1937Wa05, 1937Po04, 1938Bu05, 1938Co01, 1938Ge01, 1939Bo05, 1940Wa01, 1946Bi27, 1950Br52, 1951Ba84, 1954An25, 1954Sh30, 1963Di06, 1963K106, 1973Si05.

β⁺: 1937Ja03, 1942Sm01, 1950Br52, 1950Cu14, 1954La40, 1955Bi23, 1958Ko92, 1934Zy01.

γ,γγ: 2006Va23, 1981Yu03, 1973Si05, 1973Gr28, 1972Vo03, 1972Ta36, 1971Ok03, 1970Le05, 1970Ei07, 1968Ki03, 1968Wa21, 1963Di06, 1961Mc03, 1955Bi23, 1950Br52, 1950Cu14.

γγ(θ): 1968Wa21, 1971Ok03.

βγ(circ pol): 1965Ma06, 1962Ma13, 1962Bi02, 1958Bo90.

ε/β⁺: 1983Ba41 (also 1976St21).

The total released energy calculated by RADLIST is 3652.9 20, as compared with 3652.7 18 (2021Wa16), indicating completeness of the ⁴⁴Sc decay scheme.

⁴⁴Ca Levels

E(level) [‡]	J ^π [†]	T _{1/2} [†]
0.0	0 ⁺	
1157.045 14	2 ⁺	2.94 ps 12
2656.527 19	2 ⁺	30 fs 3
3301.47 5	2 ⁺	35 fs 18
3307.941 26	3 ⁻	0.15 ps 6

[†] From the Adopted Levels.

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

ε,β⁺ radiations

The log ft systematic trend of second-forbidden transitions suggests log ft>10.6 (1998Si17) for the 2⁺ to 0⁺ ε transition to ⁴⁴Ca ground state. This limit corresponds to Iε<0.005%.

E(decay)	E(level)	Iβ ⁺ [‡] #	Iε [#]	Log ft [‡]	I(ε+β ⁺) [†] #	Comments
(344.8 @ 18)	3307.941		0.0011 3	7.22 12		εK=0.8976 5; εL=0.08770 33; εM+=0.01471 17
(351.2 18)	3301.47		0.0051 8	6.57 7		εK=0.8976 5; εL=0.08767 33; εM+=0.01471 17
(996.2 18)	2656.527		1.021 15	5.177 10		εK=0.8988 5; εL=0.08665 32; εM+=0.01452 17
(2495.7 18)	1157.045	94.278 11	4.696 11	5.3257 22	98.974 16	av Eβ=630.2 8; εK=0.0427 8; εL=0.00410 8; εM+=6.86×10 ⁻⁴ 14

Continued on next page (footnotes at end of table)

^{44}Sc ε decay (4.0420 h) 1990Me15,1976Co06,1983Gu11 (continued) ε, β^+ radiations (continued)

<u>E(decay)</u>	<u>E(level)</u>	<u>Comments</u>
		av $E\beta=630.2$ 8; $\varepsilon\text{K}=0.0427$ 8; $\varepsilon\text{L}=0.00410$ 8; $\varepsilon\text{M}+=6.86\times 10^{-4}$ 14 $I\beta^+$: 94.27 5 from ratio $\varepsilon/\beta^+=0.0499$ 5, weighted average of 0.0499 5 (1983Ba41) and 0.0497 23 (1976St21). From the annihilation radiation intensity of 188 3 (1990Sc08) one obtains $I\beta^+(1157)=94.0\%$ 15 and $I\varepsilon(1157)=4.97\%$ 15. These values are consistent with values above but less accurate.

† From %I γ intensity balance at each level.

‡ Calculated using the LOGFT code.

Absolute intensity per 100 decays.

@ Existence of this branch is questionable.

⁴⁴Sc ε decay (4.0420 h) [1990Me15](#),[1976Co06](#),[1983Gu11](#) (continued)

γ(⁴⁴Ca)

I_γ normalization: assuming no ε+β⁺ to g.s. and ΣI(γ+ce)(g.s.)=100%.

<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>δ[†]</u>	<u>α[#]</u>	<u>Comments</u>
1157.022 15	1000 3	1157.045	2 ⁺	0.0	0 ⁺	E2		6.92×10 ⁻⁵ 10	α(K)=5.93×10 ⁻⁵ 8; α(L)=5.09×10 ⁻⁶ 7; α(M)=6.05×10 ⁻⁷ 8 α(N)=3.43×10 ⁻⁸ 5; α(IPF)=4.15×10 ⁻⁶ 6 %I _γ =99.8867 30 E _γ : weighted average of 1157.031 15 (1990Me15), 1157.015 15 (1983Gu11), 1156.92 15 (1974HeYW), 1156.9 6 (1973Si05), 1157.0 3 (1970Ei07), 1156.6 5 (1968Wa21). I _γ : from 1990Me15 . Other: 1000 (1983Gu11), 1000 5 (1974HeYW), 1000 5 (1968Wa21).
1499.449 15	9.10 15	2656.527	2 ⁺	1157.045	2 ⁺	M1+E2	-0.123 17	9.68×10 ⁻⁵ 14	α(K)=2.93×10 ⁻⁵ 4; α(L)=2.508×10 ⁻⁶ 35; α(M)=2.98×10 ⁻⁷ 4 α(N)=1.695×10 ⁻⁸ 24; α(IPF)=6.47×10 ⁻⁵ 9 %I _γ =0.909 15 E _γ : weighted average of 1499.489 25 (1990Me15), 1499.436 15 (1983Gu11), 1499.20 20 (1974HeYW), 1499.4 3 (1973Si05), 1499.6 6 (1970Ei07), 1499.0 5 (1968Wa21). I _γ : weighted average of 9.0 2 (1990Me15), 9.22 37 (1983Gu11), 9.0 10 (1974HeYW), 9.1 4 (1973Si05), 9.2 5 (1968Wa21), 9.12 15 (1990Sc08). δ: values from this dataset: -0.137 17 (1968Wa21), -0.07 3 (1971Ok03). %I _γ =0.0037 7 E _γ : weighted average of 2144.3 1 (1990Me15), 2144.43 20 (1983Gu11), 2144.8 8 (1973Si05). I _γ : weighted average of 0.02 2 (1990Me15), 0.039 7 (1973Si05). Other: 0.035 (1983Gu11). Accurate value is lacking due to large corrections to this peak from single escape of 2656.5γ.
2144.33 10	0.037 7	3301.47	2 ⁺	1157.045	2 ⁺				
2150.840 [@] 22	0.011 3	3307.941	3 ⁻	1157.045	2 ⁺				%I _γ =0.00110 30 E _γ : from ⁴⁴ K decay (1976Co06 , 1990Me15). I _γ : γ ray reported by 1976Co06 (1990Me15) only. Its existence and assignment is considered (evaluator) uncertain due to lack of confirmation in other studies of ⁴⁴ Sc decay.
2656.48 4	1.12 3	2656.527	2 ⁺	0.0	0 ⁺	E2		0.000643 9	α(K)=1.185×10 ⁻⁵ 17; α(L)=1.014×10 ⁻⁶ 14;

⁴⁴Sc ε decay (4.0420 h) **1990Me15,1976Co06,1983Gu11 (continued)**

γ(⁴⁴Ca) (continued)

<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>
3301.35 6	0.014 4	3301.47	2 ⁺	0.0	0 ⁺	E2	0.000919 13	<p>α(M)=1.204×10⁻⁷ 17 α(N)=6.85×10⁻⁹ 10; α(IPF)=0.000630 9 %I_γ=0.1119 30 E_γ: weighted average of 2656.478 30 (1990Me15), 2656.435 50 (1983Gu11), 2657.14 20 (1974HeYW), 2656.4 5 (1973Si05), 2656.6 6 (1970Ei07), 2655.9 8 (1968Wa21). I_γ: weighted average of 1.11 4 (1990Me15), 1.11 3 (1983Gu11), 1.4 5 (1974HeYW), 1.3 1 (1973Si05), 0.9 1 (1968Wa21), 1.15 6 1990Sc08. α(K)=8.37×10⁻⁶ 12; α(L)=7.16×10⁻⁷ 10; α(M)=8.50×10⁻⁸ 12 α(N)=4.84×10⁻⁹ 7; α(IPF)=0.000910 13 %I_γ=0.0014 4 E_γ: weighted average of 3301.3 1 (1990Me15), 3301.361 55 (1983Gu11), 3301.6 15 (1973Si05). I_γ: unweighted average of 0.0064 8 (1990Me15), 0.016 2 (1983Gu11), 0.018 3 (1973Si05).</p>

[†] From the Adopted Gammas.

[‡] For absolute intensity per 100 decays, multiply by 9.99×10⁻² 3.

[#] Total theoretical internal conversion coefficients, calculated using the BrIcc code (2008Ki07) with Frozen orbital approximation based on γ-ray energies, assigned multipolarities, and mixing ratios, unless otherwise specified.

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

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Decay Scheme

Legend

Intensities: I_γ per 100 parent decays

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

