^{139}Ce ε decay (137.641 d) 2008BeZV,1999BeZQ

Type	Author	History Citation	Literature Cutoff Date
Update	Balraj Singh	ENSDF	12-Nov-2021

Parent: ^{139}Ce: E=0.0; $J^{\pi}=3/2^{+}$; $T_{1/2}$=137.641 d *20*; Q(ε)=264.6 *20*; %ε decay=100.0

^{139}Ce-J^{π},$T_{1/2}$: From ^{139}Ce Adopted Levels.

^{139}Ce-Q(ε): From 2021Wa16 based on measured 264.6 *20* (1996Hi14, internal bremsstrahlung).

Dataset updated Nov 12, 2021 by Balraj Singh: 1. uncertainty of Iγ(165.8γ) changed to 0.05 from CA (calculated). 2. Q value reference updated to 2021Wa16. 3. Added a few more references. 4. Reorganized references in the header comments.

2008BeZV (also 1999BeZQ, 1999BeZS): DDEP evaluation of ^{139}Ce decay, the α(exp) and α_K(exp) recommended by 1985HaZA were adopted in this evaluation.

2009GaZY: measured Iγ, I(x ray), E(x ray), γ(x ray)-coin., (ce)(x ray)-coin; deduced K-capture probability.

1999Al12: measured precise energy of the 165-keV γ ray using an intrinsic Ge (LEPS-type) detector.

1996Hi14: measured (internal bremsstrahlung)γ-coin; deduced Q-value using HPGe detectors.

1994Ku43: measured Iγ/I(K x-ray); deduced K-electron capture probability.

1993Ko26 measured K x rays, Eγ; planar and coaxial intrinsic Ge and deduced 3.87 *25*≤K x ray(K capture)/K x ray(K conversion)≤5.05 *15*.

1993Mi20 measured γ(x ray) coin (CsI(Tl)). $\Gamma_{\text{invisible axion}}/\Gamma_{\gamma}<1.21\times10^{-6}$ for 166γ.

1988KoZM: measured (K x-ray)γ-coin, absolute activity; deduced K-capture probability.

1987Sc30: measured x-ray triple coincidence; deduced double K-shell ionization probability accompanying internal conversion.

1987BeYL measured (K x ray)-(166γ)-coin using Ge(Li) and Si(Li) detectors. Deduced $P_K\omega_K$=0.658 *22*.

1982RuZV: measured $T_{1/2}$ of ^{139}Ce decay, γ-emission probability using Ge(Li) detector, 4π γ-ionization counter, 4π $\beta\gamma$-coin system.

1978SeZS: measured I(ce), E(K x-ray).

1977Sc38: measured $\beta\gamma$-coin; deduced transition conversion coefficient.

1977RyZZ: report of international comparison of activity measurements of a solution of ^{139}Ce.

1976Ha11 measured (electron)(x-ray)-coin using magnetic spectrometer, and Si(Li) detector.

1976Ha36 measured (x ray)γ-coin using NaI(Tl) and Ge(Li) detectors. Deduced $P_K\omega_K$=0.726 *10*.

1976Be18: measured anisotropy in L x ray-$\gamma(\theta)$.

1975Ha43 measured x rays (Si(Li)), Eγ (NaI), and electrons using magnetic spectrometer and a scintillation detector.

1975Mo12 measured (K x ray)γ-coincidences and (K x ray)-(K x ray) coincidences; deduced δ(E2/M1) for 165.8γ.

1975Pl06 measured 4π (x,electron)γ-coincidences (4π pc,NaI), electrons (4π pc), and γ rays using 4π NaI(Tl) detector. dewduced $P_K\omega_K$=0.639 *6*.

1973Le29 (also 1973LeZO): measured I(ce), Iγ; deduced conversion coefficient.

1972Sc08 measured Eγ and x rays, ce(x ray)- and (x ray)γ-coin using Si(Li) and Ge(Li) detectors.

1972Ca07: measured I(x-ray), Iγ, I(x-ray)/Iγ ratios.

1971Ar43: measured total internal coefficient of 165.8γ.

1970Ko38: measured (ce)(K X-rays)(t); deduced half-life of 165.8 level.

1970BaYT: measured (x ray)γ(t), (ce)γ(t); deduced level $T_{1/2}$.

1967Ma07 measured εK(exp) and Auger-ce(t) using magnetic spectrometer.

1965Ge04 measured ce and ce-X_K(t) using magnetic spectrometer and scintillation detector.

1964Ha20, 1963Ha07: measured angular distributions and plane polarization of 165.8-keV γ ray by nuclear orientation; deduced δ(E2/M1).

1962Be31: measured (K x-rays)(165.8γ)(t); deduced half-life of 165.8 level.

1962Gr17: measured angular distribution and polarization of the 166-keV γ by nuclear orientation; deduced δ(E2/M1).

1962Ta03: measured ce of the 166-keV transition.

1961Kn02: measured angular distribution and polarization of the 166-keV γ by nuclear orientation; deduced δ(E2/M1).

1960St10: measured K-capture probability.

1956Ke23 measured (K x ray)-(166γ) (4π NaI). P_{LM+}/P_K=0.37 *2*.

1954Pr31: measured Eβ, Eγ, conversion electrons, lifetime of 165.8-keV level; deduced K/(L+M) ratio and K-conversion coefficient for the 165.8-keV γ ray.

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1947Ma32: measured Eβ, Iβ, Eγ, Iγ, x-rays, $T_{1/2}$ of decay of ^{139}Ce and isotopic identification.

Theoretical calculations:

2019Ba17: calculated recoil force from asymmetrical neutrino emission accompanying electron capture of polarized nuclei for pure Gamow-Teller transitions, and for mixed Fermi and Gamow-Teller transitions.

1988Ri08: calculated line shape modifications; deduced neutrino mass search implications.

^{139}La Levels

E(level)	J^π	$T_{1/2}$[†]	Comments
0.0	$7/2^+$		
165.8576 *11*	$5/2^+$	1.499 ns *19*	$T_{1/2}$: measurements via ε decay: 1.60 ns *4* (1970Ko38, ceγ(t), spect), 1.48 ns *3* (1967Ma07), 1.47 ns *6* (1965Ge04), and 1.47 ns *5* (1962Be31, K x ray-γ(t),scin).

[†] From the Adopted Levels.

ε radiations

Additional information 1.

ω_K=0.906 *26* (1977Ba48) assumed by 1975Mo12 and 1976Ha36 to extract P_K; ω_K=0.926 (1979Kr22) assumed by 1987BeYL. Evaluators used the value from 1977Ba48.

E(decay)	E(level)	Iε[†]	Log *ft*	Comments
98.7 *20*	165.8576	100	5.42 *3*	εK=0.704 *6*; εL=0.226 *4*; εM+=0.0702 *14* E(decay): from 1996Hi14: measured (internal bremsstrahlung)166γ-coin using detector HPGe. εK(exp): unweighted average of 0.735 *11* (1956Ke23), 0.68 *2* (1967Ma07), 0.78 *3* (1972Sc08), 0.705 *20* (1972Ca07), 0.726 *10* (1975Ha43), 0.705 *20* (1975Pl06), 0.801 *34* (1976Ha36), 0.695 *31* (1987BeYL), and 0.74 *3* (1994Ku43). εK(theory)=0.704 *6*. See 1988Ri08 for possible effects of finite widths of atomic levels on capture rates. Double K-shell ionization probability=2.0×10^{-6} *16* (1991Hi01. 166γ-K_α x ray-hypersatellite K_α x ray; intrinsic Ge). 1991Hi01 note that this result justifies the neglect of $P_{KK}(\varepsilon)$ in derivation of P_{KK}(ic) by 1987Sc30.
(264.6[‡] *20*)	0.0	$5.\times10^{-7}$ *5*	14.8 *5*	εK=0.8147 *4*; εL=0.1436 *3*; εM+=0.04172 *9* Iε: From $\Gamma_{\text{invisible axion}}/\Gamma_{\text{total}}$ (1993Mi20). Other: <0.0036 from log *ft* systematics (1973Ra10).

[†] Absolute intensity per 100 decays.

[‡] Existence of this branch is questionable.

γ(^{139}La)

Iγ normalization, I(γ+ce) normalization: Iε(to g.s.)<9.7×10^{-7} (1993Mi20). Other: 0.99988 *+12−24* based on log *ft* systematics (1999BeZQ,1999BeZS).

Iγ($K\alpha$ x ray)/Iγ(166γ)=0.813 *20* and Iγ($K\beta$ x ray)/Iγ(166γ)=0.197 *6* (1972Ca07, 4π CsI(Tl)) and Iγ($K\alpha$ x ray)/Iγ(166γ)=0.794 *11* (1994Ku43, (x ray)γ(166γ)) are in excellent agreement with 0.798 *8* and 0.1942 *14* calculated from the decay scheme; Iγ($K\beta$ x ray)/Iγ(166γ)=0.1430 *21* (1994Ku43) disagrees.

Continued on next page (footnotes at end of table)

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γ(^{139}La) (continued)

E_γ	I_γ †	E_i(level)	J_i^π	E_f	J_f^π	Mult.	α(exp)	$I_{(\gamma+ce)}$ †	Comments
165.8575 *11*	79.90 *5*	165.8576	5/2$^+$	0.0	7/2$^+$	M1	0.2516 *7*	100	α(K)exp=0.2146 *10* (1985HaZA); α(L)exp=0.0289 *12* (1976Ha11) ce(K)/(γ+ce)=0.1769 *21*; ce(L)/(γ+ce)=0.0238 *4*; ce(M)/(γ+ce)=0.00494 *7*; ce(N)/(γ+ce)=0.001085 *16* ce(O)/(γ+ce)=0.000177 *3*; ce(P)/(γ+ce)=1.376×10^{-5} *20*; Particle normalization/$T_{1/2}$=0.001276 *19* E_γ: from 1999Al12 (Intrinsic Ge-LEPS); recommended by 2000He14). I_γ: from I(γ+ce) and α(exp). Measured value=79.95% *6* (1982RuZV, 4πγ pc). Mult.: from α(exp) values. δ(E2/M1)=+0.034 *34* from 1963Ha07 ((γ,θ,t) and polarization). Others: −0.06 (1961Kn02), <0.02 (1962Gr17). α(exp): recommended value from 1985HaZA based on 0.2514 *11* (1962Ta03), 0.254 *6* (1971Ar43), 0.251 *2* (1975Pl06), 0.252 *5* (1976Ha11), and 0.2159 *10* (1977Sc38). α=0.2446 *12* (1973LeZO,1973Le29) discarded by 1985HaZA. Theory: α(M1)=0.261 (BrIcc, 2008Ki07). α(K)exp: recommended value based on 0.2148 *12* (1962Ta03), 0.214 *5* (1975Mo12. Combination of their α(K)exp=0.207 *9* and α(exp)=0.254 *6* (1971Ar43)), 0.214 *2* (1975Pl06), and 0.2152 *33* (1976Ha11). Theory: α(K)(M1)=0.223 *4* (BrIcc, 2008Ki07). Other: see 1985HaZA. K/L+: other: 7.4 *2* (1965Ge04). K/M+=28 *1*. L1:L2:L3::1:0.072 *3*:0.016 *1* (1965Ge04). Double K-shell ionization probability=6.0×10^{-5} *14* (1987Sc30. K x ray-K x ray coin; Ge,NaI). See also comment on ε(to 166). $\Gamma_{\text{invisible axion}}/\Gamma_\gamma$<1.21×10^{-6} (1993Mi20).

† Absolute intensity per 100 decays.

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Decay Scheme

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