^{65}Zn ε+β^+ decay (243.93 d) 2006Be34

Type	Author	History Citation	Literature Cutoff Date
Full Evaluation	Jun Chen	NDS 202,59 (2025)	25-Feb-2025

Parent: ^{65}Zn: E=0; J$^\pi$=5/2$^-$; T$_{1/2}$=243.93 d *9*; Q(ε+β^+)=1351.7 *4*; %ε+β^+ decay=100
^{65}Zn-J$^\pi$,T$_{1/2}$: From Adopted Levels of ^{65}Zn.
^{65}Zn-Q(ε+β^+): From 2021Wa16.
Additional information 1.
2006Be34: measured Eγ, Iγ, with a planar HPGe detector and X rays with a Si(Li) detector. Deduced absolute γ-ray emission probability for 1116γ from an international EUROMET exercise which includes results of nine participants. See also 2005BeZX.
2023Ha16: measured Eγ, Iγ, X-rays with a Silicon Drift Detector centered inside the Modular Total Absorption Spectrometer (MTAS). Deduced electron capture branches proceeding through excited states versus those to the ground state.
2014Bo01: measured precise Eγ of 1115γ with a HPGe detector at Diakoniekrankenhaus Schwabisch Hall.
1972De24: ^{65}Zn source was prepared by electro-deposition onto a 10-20 μg/cm^2 thick VYNS foil. γ rays were detected with a NaI detector; X rays, electrons and β^+ particles were detected with a 4π-proportional gas-flow counter. Measured Eγ, Iγ, Iβ^+, $\beta\gamma$-coin, γ(t). Deduced parent T$_{1/2}$, absolute γ-ray and β^+ emission probabilities.
2006Bo01: standardization of ^{65}Zn ε decay using 4π(LS)$\beta\gamma$-coin at LNHB. Deduced ^{65}Zn T$_{1/2}$.
2006Ko31: measured T$_{1/2}$, absolute γ-ray emission probability with 4$\pi\beta\gamma$-coin. 2006Ko31 is part of EUROMET exercise in 2006Be34 and the %Iγ result in 2006Ko31 has been taken into account in 2006Be34.
2005Iw01: measured absolute intensity of 1116γ using 4$\pi\beta\gamma$-coin. Participant of EUROMET exercise in 2006Be34 and the result is taken into account in 2006Be34.
2003Lu06: measured absolute intensity of 1116γ and ^{65}Zn T$_{1/2}$ at LNHB. Participant of EUROMET exercise in 2006Be34.
1996Gr13: standardization of ^{65}Zn ε decay using 4$\pi\beta\gamma$-coin.
1994Al53: measured γ-ray emission probability relative to Iγ of 661.7γ from ^{137}Cs decay using Cd-Te detectors in situ γ spectrometer. Iγ(1115.6γ)/Iγ(661.7γ)=0.89 *6*.
1994Ar22: measured E (K ray) and I(K X ray) with a Si(Li) detector at BESSY electron storage ring.
1994Le29: measured Kβ/Kα ratio of X-ray emission probability.
1994So25, 1992Ba66: measured K-shell fluorescence yield.
1991Sy01: measured K-shell ionization probability of 2.2$\times$10^{-3} *4* using a triple coincidence spectrometer.
1990Ku11: measured K/β^+ ratio using single and coincidence counting with Ge(Li), Si(Li), NaI detectors.
1990Sc08: measured Eγ, Iγ, x-ray, 4$\pi\beta\gamma$ coincidences two Ge(Li) detectors for γ rays and a Si(Li) detector for β particles at PTB, Germany. Deduced absolute emission probability for 1116γ.
1988Av02,1982Le31: search for axions.
1986Ca08: measured Kα x ray, Kβ x ray, intensity ratio with a Si(Li) detector.
1984Bu34: measured ce with a magnetic spectrometer.
1983Nh02,1983Na06: measured (K X-ray)γ-coin.
1979Da20: measured γ(θ,t) with a NaI detector.
1977Bo10: measured K/β^+ ratios with NaI(Tl) detectors.
1973Po10: measured absolute intensity of 1116γ.
1970Me27: measured Eγ, Iγ, I(ce) with a magnetic spectrometer.
1970Kr06: measured (X ray)γ-coin. Deduced L/K, M/L capture ratios.
1968Ba74: measured X rays. Deduced K X-ray emission rate, fluorescence yield.
1968Ha47: measured Eγ, Iγ, γ(t) with NaI(Tl) and Ge(Li) detectors. Deduced parent T$_{1/2}$, K/β^+, ε decay branching ratios.
1968Le03: measured Eγ of 1115γ with a Ge(Li) detector.
1968Mc13: measured I(X ray). Deduced L/K capture ratio.
1968St05: measured Iγ, $\gamma\gamma$-coin with NaI and Ge(Li) detector.
1967Bl03: measured Eγ of 1115γ with a Ge(Li) detector.
1967Mu15: measured Iγ, I(X ray). Deduced K-shell capture probability, capture branching, fluorescence yield.
1967Ra03: measured Eγ of 1115γ with magnetic spectrometer and Ge(Li) detector.
1966Ha07: measured α(exp), α(K)exp with a magnetic spectrometer.
1966Ra21: measured absolute intensity of 1116γ.
1965Le24: measured I(X ray). Deduced K- and L-shell capture probabilites.
1965Ma09: measured Eγ of 1115γ.
1963Ta04,1963Ta19: measured I(K Xray), K/β^+.

^{65}Zn ε+β^+ decay (243.93 d) 2006Be34 (continued)

1962Sh10: measured conversion coefficient of 1115γ.
1962Oc02: measured L/K capture ratio.
1962Kr01: measured K capture probability.
1960Ri06: measured Eγ, Iγ, Eβ, parent $T_{1/2}$.
1959Gl55: measured absolute intensity of 1116γ and positrons.
1953Pe14: measured K/β^+ and conversion coefficient of 1116γ.
1949Ma57: measured Eβ+, Eγ with a magnetic spectrometer.
Others: 1962Ta17, 1961Ko10, 1954Zw02.

^{65}Cu Levels

E(level)†	J$^\pi$†	$T_{1/2}$†
0.0	3/2$^-$	
770.80 *7*	1/2$^-$	101 fs *6*
1115.549 *2*	5/2$^-$	0.285 ps *11*

† From Adopted Levels.

ε,β^+ radiations

av Eβ: Additional information 3.

E(decay)	E(level)	Iβ^+ †‡	Iε†‡	Log *ft*	I(ε+β^+)‡	Comments
(236.2 *11*)	1115.549		50.12 *7*	5.90 *1*	50.12 *7*	εK=0.87497 *28*; εL=0.10703 *20*; εM+=0.017994 *71* I(ε+β^+): from γ+ce intensity balance.
(1351.7 *15*)	0.0	1.45 *3*	48.43 *6*	7.45 *1*	49.88 *7*	av Eβ=142.83 *17*; εK=0.85547 *60*; εL=0.09901 *18*; εM+=0.016534 *64* E(decay): measured value: 1347 *2* from endpoint of β^+ spectrum=325 *2* (1949Ma57). I(ε+β^+): from 100−%I(ε+β^+ to 1116 level). Iβ^+: measured value: 1.421 *7* from the measured Iγ(511)=2.842% *13* which includes correction for annihilation in flight (2006Be34). Other measured values: 1.40 *2* (2006Ko31), 1.46 *2* (1972De24), 1.49 *5* (1968Ha47), 1.40 *4* (1963Ta04), 1.2 *3* (1962Be28), 1.70 *10* (1959Gl55), 1.74 *2* (1953Pe14). Additional information 2. K/β^+ ratio =30.15 from theory; measured 30.3 *10* (1990Ku11), 30.7 *11* (1984ScZP), 31.3 *20* (1977Bo10), 28.8 *5* (1972De24), 27.7 *15* (1968Ha47), 30.3 *12* (1963Ta04), 28.0 *32* (1953Pe14). I(ε+β^+ to g.s.)/I(ε+β^+ to excited)=0.9684 *13*(stat) *13*(syst) (2023Ha16).

† From I(ε+β^+) and theoretical ε/β^+ ratio calculated by BetaShape.
‡ Absolute intensity per 100 decays.

γ(^{65}Cu)

Additional information 4.

%I(K x-ray)=38.87 *22*, from weighted average of several measurements in the EUROMET exercise (2006Be34). Others: 39.4 *6* (1963Ta19), 39.27 *26* (1968Ha47).

%I(Kα X-ray)=34.6 *3* (1994Ar22).

%I(annihilation) =2.842 *13* (2006Be34). Others: 3.40 *20* (1959Gl55), 2.4 *6* (1962Be28), 2.88 *15* (1968Ha47), 2.86 *6* (1972De24), 2.84 *4* (1990Sc08), 2.81 *3* (2006Ko31).

E_γ‡	I_γ#	E_i(level)	J^π_i	E_f	J^π_f	Mult.‡	δ‡	α†	Comments
345.1 *3*	0.00253 *18*	1115.549	5/2$^-$	770.80	1/2$^-$	[E2]		0.00626 *9*	α(K)=0.00561 *8*; α(L)=0.000574 *8*; α(M)=8.04×10^{-5} *12* α(N)=2.325×10^{-6} *33* I_γ: deduced from Iγ(344)/Iγ(1116)=5.07×10^{-5} *37* in 2006Be34. Other: 1968St05 report a measured ratio of 6.0×10^{-5} *6*.
770.7 *1*	0.00268 *22*	770.80	1/2$^-$	0.0	3/2$^-$	M1+E2	0.099 *6*	0.000384 *5*	α(K)=0.000345 *5*; α(L)=3.41×10^{-5} *5*; α(M)=4.80×10^{-6} *7* α(N)=1.470×10^{-7} *21* I_γ: deduced from Iγ(771)/Iγ(1116)=5.36×10^{-5} *44* in 2006Be34.
1115.539 *2*	50.12 *7*	1115.549	5/2$^-$	0.0	3/2$^-$	M1+E2	−0.34 *5*	0.0001833 *27*	α(K)=0.0001639 *24*; α(L)=1.615×10^{-5} *24*; α(M)=2.271×10^{-6} *33* α(N)=6.97×10^{-8} *10*; α(IPF)=9.62×10^{-7} *18* E_γ: from 2000He14 recommendation, based on measured energy difference (1971He20) between this γ from ^{65}Zn ε decay and Eγ=1087.6842 *7* from ^{198}Au β^- decay. Other: 1115.696 *8* (2014Bo01), 1115.41 *12* (1968Le03), 1115.5 *5* (1968Ha47), 1115.37 *10* (Ge(Li)) and 115.5 *4* (magnetic spectrometer) (1967Ra03), 1115.51 *7* (1967Bl03), 1115.3 *13* (1965Ma09). I_γ: Weighted average of 50.08 *6* (2023Ha16), 50.22 *11* (2006Be34, combining results of 9 participants in EUROMET exercise), 49.3 *8* (1973Po10), 52.4 *10* (1968Ha47), 51.3 *15* (1966Ra21), 50.7 *5* (1963Ta04), 51.3 *30* (1959Gl55). Other: 46 (1946Go06); 50.75 *10* (1972De24), 50.2 *10* (1990Sc08), 49.76 *21* (2003Lu06), 49.71 *33* (2005Iw01), and 50.15 *28* (2006Ko31) are superseded by EUROMET parcitpants in 2006Be34 according to Table 1 and 3b of 2006Be34. Additional information 5. α: From the theoretical tables of 1979Sc31, the internal pair formation coefficients are α_π(M1)≈1.2x10^{-6} and α_π(E2)≈ 1.6x10^{-6}, so α_π(1116)≈1.3x10^{-6}. This value is only 1% of the conversion coefficient, so it is negligible. Measured value: α(exp)=1.70×10^{-4} *19* (1962Sh10), 2.56×10^{-4} *29* (1953Pe14).

$^{65}_{29}Cu_{36}$-3

γ(^{65}Cu) (continued)

† Additional information 6.
‡ From Adopted Gammas. Supporting arguments from this dataset are given under comments where available.
# Absolute intensity per 100 decays.

$^{65}_{29}Cu_{36}$-4

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Decay Scheme