# $^{64}$Cu $\varepsilon$ decay (12.7006 h) 2012Be24,2012Lu14,2010Wa46

History

| Type | Author | Citation | Literature Cutoff Date |
|---|---|---|---|
| Full Evaluation | Balraj Singh and Jun Chen | NDS 178,41 (2021). | 12-Nov-2021 |

Parent: $^{64}$Cu: E=0.0; $J^\pi=1^+$; $T_{1/2}$=12.7006 h *20*; Q($\varepsilon$)=1674.62 *21*; $\%\varepsilon+\%\beta^+$ decay=61.52 *30*

$^{64}$Cu-$J^\pi$,$T_{1/2}$: From $^{64}$Cu Adopted Levels.

$^{64}$Cu-Q($\varepsilon$): From 2021Wa16.

$^{64}$Cu-$\%\varepsilon+\%\beta^+$ decay: $\%\varepsilon+\%\beta^+$=61.52 *30* from 100−$\%\beta^-$ with $\%\beta^-$=38.48 *30* from weighted average of 38.4 *12* (2007Qa02), 38.06 *30* (2002We02), 38.34 *56* (1986Ka03) and 39.04 *33* (1983Ch47). Measured $\%\beta^+$=17.68 *11*, weighted average of 17.69 *19*, 17.55 *15* and 17.65 *60* in 2012Be24, 17.56 *11* (2010Wa46), 17.8 *4* (2007Qa02), 17.93 *20* (1986Ka03), and 17.86 *14* (1983Ch47). Measured $\%\varepsilon$=43.40 *56*, weighted average of 43.8 *14* (2007Qa02), 43.73 *52* (1986Ka03) and 43.10 *46* (1983Ch47).

2012Be24: EURAMET 1085 measurements for spectroscopic properties of $^{64}$Cu decay made at five different laboratories: LNE-LNHB (France), PTB (Germany), CMI (Czech Republic), NPL (UK), and IFIN-HH (Romania). Results were evaluated for emission probabilities and half-life of $^{64}$Cu decay as follows: $\%\beta^-$=38.48 *26*; $\%\beta^+$=17.52 *15*; $\%\varepsilon$(to $^{64}$Ni g.s.)=43.53 *20*; I($\varepsilon$)/[I($\beta^+$)+I($\beta^-$)]=0.786 *10*; photon emission probability of 1345.7-keV $\gamma$ ray=0.4748% *34*; and $T_{1/2}$=12.7004 h *20*. See also DDEP evaluation 2011BeZW by M.M. Be and R.G. Helmer.

2018Be13: measured absolute activity at NIST by $4\pi\beta\gamma$ live-timed anticoincidence method using liquid scintillator for $\beta$ and NaI(Tl) detector for $\gamma$ activity. Comparison with standards from other laboratories, based on which authors concluded that improved data are needed for determination of consistent I($\beta^+$)/I($\beta^-$) branching ratios.

2018Ya06: measured photon emission probability of 1345.7-keV $\gamma$ ray at the IPEN metrology lab in Sao Paulo as 0.472% *10* by $4\pi\beta\gamma$-coin method using proportional counter for $\beta$ detection.

2017Pi09: measured photon emission probability of 1345.7-keV $\gamma$ ray as 0.4721% *26*, and half-life of $^{64}$Cu decay at NIST using four different methods for half-life.

2012Am05: measured photon emission probability of 1345.7-keV $\gamma$ ray, intensity of K$\alpha$- and K$\beta$-x rays, and half-life of $^{64}$Cu decay at CEA, LIST, Saclay as a part of EURAMET 1085 project. Following values were determined: 0.472% *12* for emission probability of 1345.7-keV $\gamma$, I(511 radiation)=35.1% *3*, I(K$\alpha$ x rays)=14.41% *15*, I(K$\beta$ x rays)=2.01% *3*.

2012Lu14: measurement of emission probabilities of 1345.7-keV $\gamma$ ray and 511-keV radiation, together with half-life of $^{64}$Cu decay at IFIN-HH, Bucharest as part of EURAMET project 1085. Values obtained were: 0.481% *17* for photon emission probability of 1345.7-keV $\gamma$ ray, 35.3% *12* for 511-keV radiation, and $T_{1/2}$=12.696 h *12*.

2010Wa46: measurement of emission probabilities of 1345.7-keV $\gamma$ ray and 511-keV radiation, together with half-life of $^{64}$Cu decay at PTB, Germany as part of EURAMET project 1085. Values obtained were: 0.474% *5* for photon emission probability of 1345.7-keV $\gamma$ ray, 35.12% *22* for 511-keV radiation, and $T_{1/2}$=12.704 h *5*.

2011InZZ: measured KLL-Auger spectrum.

2008Fa12: measured temperature dependence of half-life.

2007Qa02: measurement of emission probabilities of 1345.7-keV $\gamma$ ray, I($\beta^-$), I($\beta^+$), and I($\varepsilon$) at Julich, Germany. Values obtained were: 0.54% *3* for photon emission probability of 1345.7-keV $\gamma$ ray, 38.4% *12* for I($\beta^-$), 17.8% *4* for I($\beta^+$), 43.8% *14* for I($\varepsilon$).

2006Fe11: measured near-zero-energy electron yields as a function of source thickness.

1986Ka03, 1983Ch47: Measured $\beta^+$, $\beta^-$, $\gamma$, $4\pi\beta\gamma$, $T_{1/2}$.

2002We02: measured $\%\beta^-$ from analysis of $^{64}$Zn and $^{64}$Ni atoms.

2005QaZY: positron branching measured, but no results available.

$T_{1/2}$($^{64}$Cu decay): see $^{64}$Cu Adopted Levels, Gammas dataset for detailed comments about half-life measurements.

$\beta^-$: 1984Co12+1983Sc31 (search for massive neutrinos), 1959Sc27, 1959Sc71, 1949Bo16, 1949Ow06, 1949La24, 1948Co02, 1946Br03, 1941To01, 1939Ty01. Theory: 1972Ma72.

$\beta$ longitudinal polarization: 1957Vi21, 1957Ha17.

K-shell ionization (calculation): 1988Ba78.

$\gamma$: 1984Ke14, 1982RuZV, 1974HeYW, 1974Ar22, 1972Cr02, 1970Di01, 1969GuZV, 1968Ke12, 1959Sc71, 1953Dz30, 1952Vl03, 1952Br31, 1951Me58, 1950Ku51, 1950Bo34, 1949Hu21, 1948Ku10, 1948Me26, 1948Co14, 1947De07.

$\beta^-$, $\beta^+$: 1984Co12+1983Sc31 (search for massive neutrinos), 1959Sc27, 1951Pl17, 1949Bo16, 1949Ow06, 1949La24, 1948Co02, 1947Pe10, 1946Br03, 1941To01, 1939Ty01. Theory: 1972Ma72.

Fluorescence yields (K-shell vacancies etc.) (using $\gamma^\pm$ K x ray coin and $\gamma^\pm$ $\beta$ K x ray coin techniques): 1980Sc20, 1980Sc03, 1979Do10.

Additional information 1.

Polarization of positrons through $\gamma^\pm$ ($\theta$): 1966Fu16, 1957Ha17.

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Others: 1960La13, 1957Ku57, 1956Dz26, 1951Hi88, 1950Re51.

### $^{64}$Ni Levels

| E(level) | Jπ† | T1/2† |
|---|---|---|
| 0.0 | 0+ | |
| 1345.79 *6* | 2+ | 1.086 ps *35* |

† From the Adopted Levels.

### ε,β+ radiations

| E(decay) | E(level) | Iβ+ † | Iε† | Log *ft* | I(ε+β+)† | Comments |
|---|---|---|---|---|---|---|
| (328.83 *22*) | 1345.79 | | 0.472 *4* | 5.504 *4* | 0.472 *4* | εK=0.8835; εL=0.09963; εM+=0.01691<br>I(ε+β+): from %I(1345.8γ). |
| (1674.62 *21*) | 0.0 | 17.49 *15* | 43.56 *25* | 4.969 *2* | 61.05 *30* | av Eβ=278.008 *90*; εK=0.6330 *2*; εL=0.06883 *3*; εM+=0.011629 *4*<br>E(decay): 1673.4 *10* from measured E(β+)=651.4 *10* (1983Ch47). Others: 1959Sc71, 1951Hi88, 1949Ow06, 1948Co02, 1947Pe10, 1946Br03, 1941To01, 1939Ty01.<br>I(ε+β+): from adopted %ε+%β+(g.s.+1346)=61.52 *30* and %ε+%β+(1346 level)=0.472 *4*. |

† Absolute intensity per 100 decays.

### γ($^{64}$Ni)

%I(Kα X ray)=14.41 *15*, %I(Kβ X ray)=2.01 *3* (2012Am05,2012Be24).

| Eγ | Iγ† | Ei(level) | Jiπ | Ef | Jfπ | Mult. | α‡ | Comments |
|---|---|---|---|---|---|---|---|---|
| 1345.77 *6* | 0.472 *4* | 1345.79 | 2+ | 0.0 | 0+ | E2 | 1.63×10−4 | α(K)=0.0001113 *16*; α(L)=1.085×10−5 *16*; α(M)=1.528×10−6 *22*<br>α(N)=6.59×10−8 *10*; α(IPF)=3.94×10−5 *6*<br>Eγ: from 1974HeYW; Δ(Eγ)=0.16 keV quoted in 2004BeZR (see evaluation of $^{64}$Cu decay) seems a misprint.<br>Iγ: weighted average of 0.472 *10* (2018Ya06), 0.469 *4* (2017Pi09), 0.476 *6*, 0.472 *12* and 0.481 *17* in 2012Be24, 0.474 *5* (2010Wa46), 0.471 *11* (1983Ch47), and 0.487 *20* (1986Ka03). Other: 0.54 *3* from 2007Qa02 is discrepant.<br>Mult.: from the Adopted dataset. |

† Absolute intensity per 100 decays.

‡ 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.

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### Decay Scheme

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