^{62}Cu ε decay (9.67 min) 1971JoZN,1975Ca40,1970Va11

History

Type	Author	Citation	Literature Cutoff Date
Full Evaluation	Alan L. Nichols, Balraj Singh, Jagdish K. Tuli	NDS 113, 973 (2012)	15-Apr-2012

Parent: ^{62}Cu: E=0.0; $J^\pi=1^+$; $T_{1/2}$=9.67 min *3*; Q(ε)=3958.90 *48*; %ε+%$β^+$ decay=100.0

^{62}Cu-J^π: From Adopted Levels of ^{62}Cu.

^{62}Cu-Q(ε): From 2011AuZZ. 2003Au03 give 3948 *4*.

^{62}Cu-$T_{1/2}$: Weighted average of two sets of data from 1997Zi06 (also 2002Un02). Others: 10.5 min *5* (1937He05, also Nature 138, 723 (1936); Physica 4, 160 (1937)); 10.5 min *3* (1937Bo10), 10.0 min *1* (1937Ri01), 9.92 min *5* (1939Cr03), 10.1 min *1* (1947Le07), 9.88 min (1948Wa13), 9.9 min (1948Pe03), 9.80 min *7* (1951Go43), 9.8 min (1952Ma28), 9.73 min *2* (1954Be84), 10.1 min *2* (1954Nu27), 9.94 min *4* (1958Po07), 9.90 min *4* (1961Sa19), 9.76 min *2* (1965Eb01), 9.79 min *6* (1965Li11), 9.7 min (1966Ch24), 9.7 min *1* (1969Bo11), 9.73 min *2* (1969Jo07), 9.80 min *2* (1975Ca40). Weighted average of all data listed with quantified uncertainties is 9.76 min *2*, but with reduced χ^2=2.5 to 5.4 depending on which method is used. LWM gives 9.90 min *17* in order to include the most precise value.

1971JoZN, 1969Jo07 (thesis): source from ^{62}Ni(p,n) at 7, 13 MeV and from decay of ^{62}Zn parent. Measured Eγ, Iγ, and conversion electrons using a double-focusing magnetic spectrometer. 1969Jo07 report four gamma rays and intensity of 511 annihilation radiation, but the latter is revised in 1971JoZN. More details can be found in the thesis (1971JoZN).

1975Ca40: source from ^{63}Cu(n,2n) at 14 MeV. Measured Eγ, Iγ for seven γ rays.

1970Va11: source from ^{62}Ni(p,n) at 6.8 MeV; measured Eγ, Iγ for nine γ rays.

1969Es03: source from ^{62}Zn parent produced in Cu(p,2n); measured Eγ, Iγ for five γ rays.

Others:

1993Os06 (also 2001Ko07): measured $β^+$ spectrum, deduced maximum Eβ, and Q(ε)=3967 *16*.

1976Ca31: measured γγ(θ) using Ge(Li) and NaI(Tl) detectors; deduced E2/M1 mixing ratio for second 2^+ to first 2^+ transition.

1967An01: source from ^{62}Zn parent produced in Cu(p,2n); measured $β^+$ spectrum by a double-focusing iron yoke β spectrometer; deduced Eβ(max)=2934 *7*.

1964Sa32: source from ^{62}Zn parent produced in Cu(p,2n). Measured $β^+$ and ce spectra using double-focusing β spectrometer.

1954Nu27: source from ^{62}Zn parent produced in Cu(d,3n). Measured upper limit of γ intensity of <5% relative to total $β^+$ emission for 350-650 keV region, and <3% for higher-energy region. Deduced Eβ(max)=2910 *10*.

Half-life measurements of ^{62}Cu g.s.: 2002Un02, 1997Zi06, 1975Ca40, 1969Jo07, 1969Bo11, 1966Ch24, 1965Li11, 1965Eb01, 1961Sa19, 1958Po07, 1954Nu27, 1954Be84, 1952Ma28, 1951Go43, 1947Le07, 1939Cr03.

Production and identification of ^{62}Cu isotope: 1937Ri01, 1937He05, 1937Bo10, 1938St05, 1946Me01, 1950Gh62, 1950Ha65, 1954Nu27.

β measurements: 1949Be17, 1950Ha65, 1954Nu27, 1958Cr86, 1964Sa32, 1967An01.

βγ coin: 1958Cr86 (1750β-1173γ coin).

Other γ-ray measurements: 1955Re08, 1957Br20, 1958Bu10.

Total decay energy of 3959.0 keV *12* deduced (by RADLIST code) from proposed decay scheme is in agreement with the expected value of 3958.9 keV *5*, indicating that decay scheme is complete.

^{62}Ni Levels

E(level)†	J^π‡	Comments
0.0	0^+	
1172.97 *10*	2^+	
2048.63 *12*	0^+	J^π: from γγ(θ) (1976Ca31).
2301.95 *8*	2^+	
2890.6 *4*	0^+	
3158.1 *10*	2^+	
3257.7 *4*	2^+	
3270.9 *3*	$1^+,2^+$	
3370.2 *3*	$1^+,2^+$	
3861.7 *11*	$1^+,2^+$	

Continued on next page (footnotes at end of table)

^{62}Cu ε decay (9.67 min) 1971JoZN,1975Ca40,1970Va11 (continued)

^{62}Ni Levels (continued)

† From least-squares fit to Eγ data.
‡ From Adopted Levels.

ε,β$^+$ radiations

E(decay)	E(level)	Iβ$^+$ †	Iε†	Log *ft*	I(ε+β$^+$)†	Comments
(97.2 *12*)	3861.7		0.00037 *7*	5.60 *9*	0.00037 *7*	εK= 0.8711 *3*; εL= 0.11001 *25*; εM+= 0.01891 *5*
(588.7 *6*)	3370.2		0.0128 *17*	5.69 *6*	0.0128 *17*	εK= 0.8856; εL= 0.09788; εM+=0.01657
(688.0 *6*)	3270.9		0.0058 *5*	6.17 *4*	0.0058 *5*	εK= 0.8859; εL= 0.09756; εM+=0.01651
(701.2 *6*)	3257.7		0.0049 *10*	6.26 *9*	0.0049 *10*	εK= 0.8860; εL= 0.09753; εM+=0.01650
(800.8 *11*)	3158.1		0.0018 *4*	6.81 *10*	0.0018 *4*	εK= 0.8862; εL= 0.09730; εM+=0.01646
(1068.3 *6*)	2890.6		0.0006 *3*	7.54 *22*	0.0006 *3*	εK= 0.8867; εL= 0.09690; εM+=0.01638
(1656.9 *5*)	2301.95	0.019 *1*	0.053 *2*	5.98 *2*	0.072 *3*	av Eβ= 270.5 *4*; εK= 0.6497 *10*; εL= 0.07066 *11*; εM+= 0.01194 *2*
(1910.3 *5*)	2048.63	0.076 *4*	0.066 *3*	6.00 *2*	0.142 *7*	av Eβ= 379.6 *4*; εK= 0.4148 *9*; εL= 0.04505 *9*; εM+= 0.00761 *2* E(β$^+$)=870 *10* (1964Sa32).
(2785.9 *5*)	1172.97	0.138 *6*	0.013 *1*	7.03 *2*	0.151 *7*	av Eβ= 772.1 *5*; εK= 0.07888 *13*; εL= 0.00855 *2*; εM+=0.001443 *1* E(β$^+$)=1750 *10* (1964Sa32), Iβ=1.8%.
(3958.9 *5*)	0.0	97.599 *25*	2.009 *20*	5.158 *2*	99.608 *24*	av Eβ= 1320.7 *5*; εK= 0.01790 *2*; εL=0.0019367 *2*; εM+=0.000327 *1* E(decay): Eβ+(max)=2945 *16* (2001Ko07,1993Os06), 2934 *7* (1967An01), 2923 *7* (1964Sa32), 2910 *10* (1954Nu27). I(ε+β$^+$): 100−(feeding to excited states). Other: Iβ=93.9% (1964Sa32).

† Absolute intensity per 100 decays.

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γ(^{62}Ni)

Iγ normalization: from absolute I(1172.9γ), weighted average of 0.00337 *17* (1971JoZN), 0.00350 *21* (1970Va11). Other: 0.0039 *4* (1975Ca40). These values are obtained from measured I(1173γ)/I($\gamma^{\pm}$)=0.00172 *9* (1971JoZN), 0.00179 *11* (1970Va11), theoretical ε/β^+ ratios and for different levels populated. Other I(1173γ)/I($\gamma^{\pm}$)=0.00199 (1975Ca40) has not been used − disagrees with values from 1971JoZN and 1970Va11.

Iγ normalization: Additional information 2.

Measured intensity of $\gamma^{\pm}$ annihilation radiation: 58100 *30* (1971JoZN), 55900 *34* (1970Va11), 50260 (1975Ca40), relative to 100 for 1173γ. Normalization factor is determined from these values.

E_γ[‡]	I_γ[‡&]	E_i(level)	J_i^π	E_f	J_f^π	Mult.[@]	δ[@]	α[†]	Comments
(479.6[#])	0.07 *2*	3370.2	$1^+,2^+$	2890.6	0^+				I_γ: <0.13 (1971JoZN).
(856.2[#])	0.04 *2*	3158.1	2^+	2301.95	2^+				I_γ: <0.11 (1971JoZN).
875.66 *7*	43 *2*	2048.63	0^+	1172.97	2^+	E2		3.35×10^{-4}	α(K)=0.000301 *5*; α(L)=2.96×10^{-5} *5*; α(M)=4.16×10^{-6} *6*; α(N)=1.781×10^{-7} *25* (876γ)(1173γ)(θ): A_2=+0.38 *4*, A_4=+1.19 *8* (1976Ca31).
(968.9[#])	0.09 *2*	3270.9	$1^+,2^+$	2301.95	2^+				I_γ: <0.11 (1971JoZN).
(971[#])	0.03 *1*	3861.7	$1^+,2^+$	2890.6	0^+				I_γ: <0.12 (1971JoZN).
1067.0 *10*	0.19 *10*	3370.2	$1^+,2^+$	2301.95	2^+				
1128.82 *14*	9.3 *5*	2301.95	2^+	1172.97	2^+	M1+E2	+3.19 *11*	0.000181 *6*	α(K)=0.0001616 *23*; α(L)=1.579×10^{-5} *23*; α(M)=2.22×10^{-6} *4* α(N)=9.57×10^{-8} *14*; α(IPF)=1.89×10^{-6} *3* α=0.000181 *6*; α(K)=0.000161 *5*; α(L)=1.58×10^{-5} *5*; α(M)=2.22×10^{-6} *7*; α(N)=9.57×10^{-8} *14* α(IPF)=1.88×10^{-6} *12* δ: +3.0 +7-20 from γγ(θ) data (1976Ca31), uncertainty at 90% confidence level. (1129γ)(1173γ)(θ): A_2=−0.31 *6*, A_4=+0.26 *12* (1976Ca31).
1172.97 *10*	100	1172.97	2^+	0.0	0^+	E2		1.72×10^{-4}	α(K)=1.501×10^{-4} *21*; α(L)=1.466×10^{-5} *21*; α(M)=2.06×10^{-6} *3*; α(N)=8.89×10^{-8} *13* α(IPF)=5.39×10^{-6} *8*
(1222.3[#])		3270.9	$1^+,2^+$	2048.63	0^+				I_γ: <0.08 (1971JoZN).
(1321.6[#])	0.3 *1*	3370.2	$1^+,2^+$	2048.63	0^+				I_γ: <0.11 (1971JoZN).
1717.6 *4*	0.81 *12*	2890.6	0^+	1172.97	2^+	E2		2.52×10^{-4}	α(K)=6.78×10^{-5} *12*; α(L)=6.58×10^{-6} *12*; α(M)=9.27×10^{-7} *16*; α(N)=4.03×10^{-8} *6* α(IPF)=1.77×10^{-4} *7* Mult.: E2(+M1), δ=−4.1 +*13*−*30*.
1985.0 *10*	0.30 *10*	3158.1	2^+	1172.97	2^+	(M1+E2)	+0.13 *8*	3.05×10^{-4}	α(K)=4.94×10^{-5} *7*; α(L)=4.78×10^{-6} *7*; α(M)=6.74×10^{-7}

$^{62}_{28}Ni_{34}$-3

^{62}Cu ε decay (9.67 min) 1971JoZN,1975Ca40,1970Va11 (continued)

γ(^{62}Ni) (continued)

E_γ ‡	I_γ ‡&	E_i(level)	J_i^π	E_f	J_f^π	Mult. @	α †	$I_{(\gamma+ce)}$ &	Comments
									10; α(N)=2.93×10^{-8} *5* α(IPF)=2.50×10^{-4} *4*
(2048.6)		2048.63	0$^+$	0.0	0$^+$	E0		0.109 *15*	$I_{(\gamma+ce)}$: from ce(K)(2048γ)/ce(K)(876γ)=0.084 *11* (1981Pa10) in (p,p′γ).
2084.8 *4*	1.4 *3*	3257.7	2$^+$	1172.97	2$^+$				
2097.6 *3*	0.84 *11*	3270.9	1$^+$,2$^+$	1172.97	2$^+$				
2301.95 *8*	12.3 *6*	2301.95	2$^+$	0.0	0$^+$	E2	5.04×10^{-4}		α(K)=3.97×10^{-5} *6*; α(L)=3.85×10^{-6} *6*; α(M)=5.42×10^{-7} *8*; α(N)=2.35×10^{-8} *4* α(IPF)=4.59×10^{-4} *7*
3158.2 *10*	0.18 *4*	3158.1	2$^+$	0.0	0$^+$				
3257.3 *10*	0.042 *19*	3257.7	2$^+$	0.0	0$^+$				
3271.4 *4*	0.21 *3*	3270.9	1$^+$,2$^+$	0.0	0$^+$				
3370.3 *3*	2.46 *14*	3370.2	1$^+$,2$^+$	0.0	0$^+$				
3861.7 *11*	0.08 *2*	3861.7	1$^+$,2$^+$	0.0	0$^+$				

† Additional information 1.
‡ Weighted averages of values from 1969Es03, 1970Va11, 1971JoZN and 1975Ca40.
# Expected γ from Adopted Levels, Gammas dataset; not reported in studies of EC decay.
@ From Adopted Gammas, unless otherwise stated.
& For absolute intensity per 100 decays, multiply by 0.00342 *17*.

$^{62}_{28}Ni_{34}$-4

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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)
- Coincidence

Decay Scheme

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