^{60}Co β^- decay (1925.28 d)

History

Type	Author	Citation	Literature Cutoff Date
Full Evaluation	E. Browne, J. K. Tuli	NDS 114, 1849 (2013)	31-Dec-2012

Parent: ^{60}Co: E=0.0; J$^\pi$=5$^+$; T$_{1/2}$=1925.28 d *14*; Q(β^-)=2822.8 *2*; %β^- decay=100.0

Based on an evaluation by R. G. Helmer, January 1998 including some general comments from previous evaluation (1993Ki10). This evaluation was done as part of a collaboration of evaluators from Laboratoire National Henri Becquerel (LNHB) in France; Physikalisch-Technische Bundesanstalt (PTB) in Germany; HMS Sultan and AEA Technology in the United Kingdom; Khlopin Radium Institute (KRI) in Russia; Centro de Investigaciones Energeticas, Medioambientales, y Tecnologicas (CIEMAT) and Universidad Nacional a Distancia (UNED) in Spain; and Brookhaven National Laboratory (BNL), Lawrence Berkeley National Laboratory (LBNL), and Idaho National Engineering and Environmental Laboratory (INEEL) in the United States. See also: 1999BeZQ, 1999BeZS.

^{60}Co generally from ^{59}Co(n,γ). Measured Eγ, Iγ with Compton suppression spectrometer, Ge(Li) and NaI detectors (1976Ca18). Measured Eβ, Iβ, Eγ with magnetic spectrometer, Ge(Li) detector (1968Ha03). Measured $\gamma(\theta)$ from ^{60}Co polarized in Fe by low-temperature techniques with Ge(Li) and NaI detectors (1980Kr05). Measured $\gamma\gamma$(t) with combined plastic-NaI detectors and centroid shift technique (1976Kl04). Measured Eβ in iron-free spectrometer (1968Wo02). For $\beta(\theta)$ emitted from polarized ^{60}Co, see 1980Ch14. For $\gamma\gamma(\theta)$ measurements, see 1969Kh11. Measured Iγ by detecting neutrons from the d(γ,n) reaction caused by the 2505 γ-ray (1978Fu05).

For K-shell ionization in the β^- decay of ^{60}Co, see 1983Ki04.

Others: 2008Sy01, 2006Pa20, 2004Ge20, 2004Ka07, 2003Lu04, 1983La06, 1982Er10, 1977Lo01, 1976Bo16, 1976Hu09, 1973Fu15, 1972Le14, 1970Wa19, 1970Di01, 1970Ri20, 1969Va20, 1969Ra23, 1961Ca05, 1956Wo09, 1954Ke04.

Decay scheme is internally consistent since the total decay energy computed from this scheme is 2821.0 *2* keV compared to the Q value of 2822.8 *2*.

1998Ku24: measured “Near-Zero Energy” electrons (distribution, peak= 0.2 eV, FWHM=1 eV) intensity=0.14 per β^- decay.

2010Wa40: measured β- asymmetry by polarizing a ^{60}Co source using a low-temperature nuclear orientation method.

^{60}Ni Levels

E(level)	J$^{\pi\dagger}$	T$_{1/2}$	Comments
0.0	0$^+$	stable	The β^- feeding of this level is a unique 4th forbidden transition. From the systematics (1998Si17), the log*ft* of this transition will be >23 and the corresponding intensity will be <1.0x10^{-10}%.
1332.508 *4*	2$^+$	0.9 ps *3*	T$_{1/2}$: from $\gamma\gamma$(t) by 1976Kl04.
2158.612 *21*	2$^+$		
2505.748 *4*	4$^+$	3.3 ps *10*	T$_{1/2}$: see Adopted Levels.

† From ^{60}Ni Adopted Levels.

β^- radiations

E(decay)†	E(level)	I$\beta^{-\ddagger}$	Log *ft*	Comments
317.88 *10*	2505.748	99.88 *3*	7.512 *2*	av Eβ=95.77 *15* Iβ^-: from 100.00 − I$_{\beta-}$(1332) − I$_{\beta-}$(2158).
670# *20*	2158.612	0.000 *2*	≥14.0^{2u}	Iβ^-: from the log *ft* systematics (1998Si17), the lowest log *ft* values for unique second forbidden decays are 13.86 for ^{10}Be and 14.36 and 14.61 for higher masses. For a reasonable lower limit of 14.4 for the log *ft* for this transition, the β intensity would be less than 0.001%. Therefore, the evaluator has assigned the most probable value as 0.000 with an uncertainty of 0.002.
1492 *20*	1332.508	0.12 *3*	14.70^{2u} *11*	av Eβ=625.87 *21* Iβ^-: average of measured values of 0.15 *1* (1954Ke04), 0.010 *2* (1956Wo09), 0.12 (1961Ca05), and 0.08 *2* (1968Ha03).

Continued on next page (footnotes at end of table)

^{60}Co β^- decay (1925.28 d) (continued)

β^- radiations (continued)

† From 1968Ha03, except as noted.
‡ Absolute intensity per 100 decays.
# Existence of this branch is questionable.

$\gamma(^{60}$Ni)

A possible γ of 467 keV with Iγ<0.0004% (1969Va20) and <0.00023 (1976Ca18) from the known level at 2626 keV to the 2158 level is not included here. At the lower intensity limit, the I$_\beta$ to the 2626 level would be <0.001%.

E_γ [‡]	I_γ [#a]	E_i(level)	J_i^π	E_f	J_f^π	Mult. [@]	δ [@]	α [†&]	Comments
347.14 *7*	0.0075 *4*	2505.748	4$^+$	2158.612	2$^+$	[E2]		0.00557 *8*	α=0.00557 *8*; α(K)=0.00499 *7*; α(L)=0.000503 *7*; α(M)=7.06×10^{-5} *10*; α(N+..)=2.90×10^{-6} *4* α(N)=2.90×10^{-6} *4* I$_\gamma$: from consideration of <0.005 (1955Wo44), 0.0078 *12* (1969Va20), <0.006 (1970Di01), 0.00758 *50* (1976Ca18), and 0.0069 *10* (1977Lo01).
826.10 *3*	0.0076 *8*	2158.612	2$^+$	1332.508	2$^+$	M1+E2	+0.9 *3*	0.000337 *18*	α=0.000337 *18*; α(K)=0.000303 *17*; α(L)=2.97×10^{-5} *17*; α(M)=4.18×10^{-6} *23*; α(N+..)=1.80×10^{-7} *1* α(N)=1.80×10^{-7} *10* I$_\gamma$: from 1976Ca18; others: 0.0055 *47* (1969Va20) and 0.003 *2* (1972Le14).
1173.228 *3*	99.85 *3*	2505.748	4$^+$	1332.508	2$^+$	E2(+M3)	−0.0025 *22*	0.0001722 *25*	α=0.0001722 *25*; α(K)=0.0001500 *21*; α(L)=1.465×10^{-5} *21*; α(M)=2.06×10^{-6} *3* α(N)=8.88×10^{-8} *13*; α(IPF)=5.42×10^{-6} *8* I$_\gamma$: from I$_\gamma$(1173)=(I$_{\beta-}$(2505) − I$_\gamma$(347)[1.0+α(347)] − I$_\gamma$(2505)[1.0+α(2505)]) / [1.00+α(1173)+α_π(1173)]= 99.87 *3* / 1.000174 *4*. δ: from 1980Kr05. α: from 1985HaZA evaluation of measured values; from theory (1976Ba63) α=1.65x10^{-4}, α_K=1.50x10^{-4}, and α_L=1.48x10^{-5} *4*. α: α_π=6.2*10^{-6} *7* interpolated from theoretical values of 1979Sc31; this value is negligible since it is only about 5% of the corresponding α.
1332.492 *4*	99.9826 *6*	1332.508	2$^+$	0.0	0$^+$	E2		0.0001625 *23*	α=0.0001625 *23*; α(K)=0.0001137 *16*; α(L)=1.108×10^{-5} *16*; α(M)=1.560×10^{-6} *22* α(N)=6.73×10^{-8} *10*; α(IPF)=3.61×10^{-5} *5* I$_\gamma$: from I$_\gamma$(1332)=(100.00 − I$_\gamma$(2158)[1.0+α(2158)] − I$_\gamma$(2505)[1.0+α(2505)]) / [1.00+α(1332)+α_π(1332)]= 99.9988 *2* / 1.000162 *6*. In the evaluation 1991BaZS, this is computed in the same fashion, but is given as 99.983% *6*; the origin of the larger uncertainty is not clear. α: α and α_K from 1985HaZA evaluation of measured values; from theory (1976Ba63) α=1.25x10^{-4}, α_K=1.14x10^{-4}, and α_L=1.13x10^{-5}. α: α_π=3.4*10^{-5} *4* interpolated from theoretical values of 1979Sc31; 3.0×10^{-5} *3* (1994GrZW).

$^{60}_{28}$Ni$_{32}$-3

^{60}Co β^- decay (1925.28 d) (continued)

$\gamma(^{60}Ni)$ (continued)

E_γ[‡]	I_γ[#a]	E_i(level)	J^π_i	E_f	J^π_f	Mult.[@]	α[†&]	Comments
2158.57 *3*	0.0012 *2*	2158.612	2^+	0.0	0^+	[E2]	0.000439 *7*	α=0.000439 *7*; α(K)=4.45×10^{-5} *7*; α(L)=4.32×10^{-6} *6*; α(M)=6.08×10^{-7} *9*; α(N+..)=0.000390 *6* α(N)=2.64×10^{-8} *4*; α(IPF)=0.000389 *6* I_γ: from consideration of 0.0012 *2* (1955Wo44), <0.002 (1969Ra23), 0.0092 *16* (1970Di01), 0.0005 *2* (1972Le14), 0.0020 *13* (1973Fu15), and 0.00111 *18* (1976Ca18).
2505.692 *5*	2.0×10^{-6} *4*	2505.748	4^+	0.0	0^+	E4	8.63×10^{-5} *12*	α=8.63×10^{-5} *12*; α(K)=7.76×10^{-5} *11*; α(L)=7.58×10^{-6} *11*; α(M)=1.069×10^{-6} *15*; α(N+..)=4.62×10^{-8} *7* α(N)=4.62×10^{-8} *7* I_γ: from consideration of <4×10^{-5} (1970Di01), 9×10^{-6} *7* (1973Fu15), <1×10^{-3} (1977HaXC), 2.0×10^{-6} *4* (1978Fu05), and 5.2×10^{-6} *20* (1988Se09).

† Additional information 1.

‡ From 2000He14 for 1173 and 1332 γ rays. The others were deduced from the level energies from a fit to the γ-ray energies. In addition to the 1173 and 1332 values, the input to this fit included 346.93 *7* (1978Ca18 where the authors average their result and that of 1969Va20); 826.06 [from $^{59}Co(p,\gamma)^{60}Ni$ (1975Er05)]; 2158.57 *10* [from $^{59}Co(p,\gamma)$ (1975Er05)]. Other measured γ energies include: 346.95 *10* (1969Va20)], 826.18 *20* (1969Va20), 826.28 *9* (1976Ca18, but includes value of 1969Va20), 2158.8 *4* (1970Di01), 2158.9 *2* (1969Ra07), and 2159.6 *8* (1969Ho22).

I(K x ray)=0.0112 computed from decay scheme.

@ From ^{60}Ni Adopted gammas, except as noted.

& Interpolated using program BRICC, unless otherwise noted.

a Absolute intensity per 100 decays.

$^{60}_{28}Ni_{32}$-4

^{60}Co β^- decay (1925.28 d)

Decay Scheme