^{56}Co ε decay 1990Me15,1988Wa26,2008Dr04

History

Type	Author	Citation	Literature Cutoff Date
Full Evaluation	Huo Junde, Huo Su, Yang Dong	NDS 112, 1513 (2011)	29-Oct-2009

Parent: ^{56}Co: E=0.0; J$^{\pi}$=4^{+}; $T_{1/2}$=77.236 d *26*; Q(ε)=4566.0 *20*; %ε+%β^{+} decay=100.0

Sources produced by ^{56}Fe(p,n) and ^{55}Mn(α,3n). Production by ^{54}Fe(α,pn) and ^{56}Fe(α,p3n) (1996La20).

^{56}Co ε decay has been recommended as calibration standards for Eγ and Iγ see 1983LoZV, 1990Me15, 1990Ni03, 1990Tr06, 1991BaZS, 1999He10.

1990Me15: measured Eγ, Iγ for multi γ-ray calibration standards.

1988Wa26: measured Eγ.

1986Br01: measured $\gamma(\theta)$ from oriented nuclei.

1984Oh03: measured $\gamma(\theta)$ from oriented nuclei.

1980St20: measured Eγ, Iγ, $\gamma\gamma(\theta)$, $\gamma\gamma$-coin with Ge(Li). Recalculated α(K)exp from 1965Pe18.

1980Sh28: measured Eγ, Iγ, $\gamma\gamma$-coin and $\gamma\gamma(\theta)$.

1992ScZZ: measured γ-ray emission probabilities.

2008Dr04: measured Iγ with HPGe.

2005MaZS: evaluation of γ-ray emission probabilities in the decay of ^{56}Co.

2006BeZL: evaluation and recommendation of decay data for radionuclides.

Adopted decay scheme is taken mainly from 1980St20.

^{56}Fe Levels

E(level)[†]	J$^{\pi}$	$T_{1/2}$	Comments
0.0	0^{+}		
846.7778 *19*	2^{+}		
2085.1045 *25*	4^{+}		
2657.5894 *25*	2^{+}		
2959.972 *4*	2^{+}		
3122.970 *3*	4^{+}		
3369.95 *7*	2^{+}		
3445.348 *3*	3^{+}		
3856.495 *3*	3^{+}		
4048.888 *6*	3^{+}		
4100.363 *3*	4^{+}[‡]	55 fs *25*	$T_{1/2}$: from DSA (1981Mu05).
4119.936 *3*	3^{+}[‡]		
4298.096 *3*	4^{+}	110 fs *50*	$T_{1/2}$: from DSA (1981En03). J$^{\pi}$: J=4 from $\gamma(\theta)$ in 1986Br01.
4394.93 *5*	3^{+}		
4447.7 *4*	(2^{-},3,4)		
4458.406 *18*	4^{+}		

† From Eγ and decay scheme using least-squares adjustment procedure.
‡ Consistent with $\gamma(\theta)$ from oriented nuclei (1984Oh03).

ε,β^{+} radiations

β-measurement: Eβ+=1464 keV *15*(Iβ≥90%); Eβ+=440 keV *30*(Iβ≤10%) (1961Ha16); Eβ+=1459 keV *2* (Iβ=18.1%), Eβ+=440 keV (Iβ≈0.8%) (1965Pe18).

LOGFT(L) Value too low for a second-forbidden non-unique transition. Direct feeding to this level is expected to be negligible.

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^{56}Co ε decay 1990Me15,1988Wa26,2008Dr04 (continued)

ε,β^+ radiations (continued)

E(decay)	E(level)	Iβ^+ †	Iε†	Log *ft*	I($\varepsilon+\beta^+$)†	Comments
(107.6 *20*)	4458.406		0.209 *7*	6.910 *23*	0.209 *7*	εK=0.8768; εL=0.10464 *22*; εM+=0.01853 *5*
(118.3 *21*)	4447.7		0.0167 *5*	8.095 *21*	0.0167 *5*	εK=0.8781; εL=0.10361 *19*; εM+=0.01832 *4*
(171.1 *20*)	4394.93		0.2159 *18*	7.319 *12*	0.2159 *18*	εK=0.8818; εL=0.1005; εM+=0.01770
(267.9 *20*)	4298.096		3.688 *13*	6.488 *7*	3.688 *13*	εK=0.8847; εL=0.09810; εM+=0.01722
(446.1 *20*)	4119.936		9.940 *18*	6.509 *4*	9.940 *18*	εK=0.8867; εL=0.09645; εM+=0.01690
(465.6 *20*)	4100.363		12.66 *4*	6.442 *4*	12.66 *4*	εK=0.8868; εL=0.09635; εM+=0.01688
(517.1 *20*)	4048.888		3.965 *13*	7.038 *4*	3.965 *13*	εK=0.8871; εL=0.09612; εM+=0.01683
(709.5 *20*)	3856.495		16.85 *5*	6.687 *3*	16.85 *5*	εK=0.8877; εL=0.09555; εM+=0.01672
(1120.7 *20*)	3445.348	0.0082 *8*	21.9 *4*	6.974 *8*	21.9 *4*	av Eβ=45.3 *9*; εK=0.8881; εL=0.09496; εM+=0.01660
(1196.1 *20*)	3369.95	6.0×10^{-5} *20*	0.015 *5*	10.19 *15*	6.0×10^{-5} *20*	av Eβ=76.7 *9*; εK=0.8849; εL=0.09456; εM+=0.01653
(1443.0 *20*)	3122.970	1.041 *20*	9.01 *6*	7.580 *4*	10.05 *6*	av Eβ=178.7 *9*; εK=0.7966 *15*; εL=0.08497 *16*; εM+=0.01485 *3*
(1606.0 *20*)	2959.972	0.0067 *13*	0.018 *4*	10.37 *9*	0.025 *5*	av Eβ=247.1 *9*; εK=0.6496 *21*; εL=0.06923 *23*; εM+=0.01210 *4*
(2480.9 *20*)	2085.1045	18.4 *14*	2.44 *19*	8.62 *4*	20.8 *16*	av Eβ=631.2 *9*; εK=0.1044 *4*; εL=0.01109 *5*; εM+=0.001938 *8*
(3719.2 *20*)	846.7778	0.25 *17*	0.005 *3*	11.7 *3*	0.25 *17*	av Eβ=1205.8 *10*; εK=0.01753 *4*; εL=0.001860 *4*; εM+=0.0003249 *8*

† Absolute intensity per 100 decays.

γ(^{56}Fe)

Iγ normalization: Based on assing no $\varepsilon+\beta^+$ decay to the ground state and σ(I(γ+ce)(gs)=100, see 2005MaZS.

Experimental internal conversion coefficients are calculated from Ice of 1965Pe18 and adopted Iγ, normalizing to α(K)=0.00026 for the 847γ (1980St20).

For other γ-measurements, see 1967Hj01, 1967Ma03, 1968Gu05, 1969Au09, 1970Ph01, 1971Ag04, 1971Ca14, 1971Ge07, 1971Ge08, 1971Ta18, 1974HeYW, 1974Ho25, 1975Ka06, 1975Mc07, 1977Ge12, 1979Gr01, 1979Sh16, 1980Yo05, 1982Gr10, 1983Me17, 1983Mo20, 1996La20. For $\gamma\gamma$-coincidence see 1980St20.

E$_\gamma$†	I$_\gamma$‡d	E$_i$(level)	J$^\pi_i$	E$_f$	J$^\pi_f$	Mult.#	δ^b	Comments
263.434 *5*	0.0220 *3*	4119.936	3$^+$	3856.495	3$^+$			
411.145 *4*	0.024 *3*	3856.495	3$^+$	3445.348	3$^+$			
486.55 *11*	0.054 *2*	3856.495	3$^+$	3369.95	2$^+$			
655.003 *5*	0.043 *4*	4100.363	4$^+$	3445.348	3$^+$			
674.570 *5*	0.024 *3*	4119.936	3$^+$	3445.348	3$^+$			
733.514 *4*	0.191 *3*	3856.495	3$^+$	3122.970	4$^+$	M1+E2@	−0.02 *2*	α(K)exp=0.00025 *6* (1980St20)
787.743 *5*	0.311 *3*	3445.348	3$^+$	2657.5894	2$^+$	M1+E2@	+0.85 *35*	α(K)exp=0.00027 *3* (1980St20)
846.770 *2*	100	846.7778	2$^+$	0.0	0$^+$	E2		α(K)exp=0.00026 (1980St20)
852.732 *4*	0.049 *3*	4298.096	4$^+$	3445.348	3$^+$			
896.510 *6*	0.073 *3*	3856.495	3$^+$	2959.972	2$^+$			
977.372 *5*	1.422 *6*	4100.363	4$^+$	3122.970	4$^+$	M1(+E2)@	+0.07 *+3−2*	α(K)exp=0.000139 *5* (1980St20) B(M1)(W.u.)=(0.048 *22*); B(E2)(W.u.)=(0.5 *5*) δ: others: +1.17 *42* or −0.09 *18* (1971Ag04), +0.12 *1* (1980Sh28), +0.15 *11* (1974Ho25). +0.077 *+81−64* (1984Oh03).
996.948 *5*	0.111 *4*	4119.936	3$^+$	3122.970	4$^+$	M1+E2		δ: −0.34 *+14−11* or −2.1 *6* (1986Br01).

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^{56}Co ε decay 1990Me15,1988Wa26,2008Dr04 (continued)

γ(^{56}Fe) (continued)

E_γ[†]	I_γ[‡d]	E_i(level)	J^π_i	E_f	J^π_f	Mult.[#]	δ[b]	Comments
1037.843 *4*	14.06 *4*	3122.970	4^+	2085.1045	4^+	M1(+E2)[@]	0.00[a] *5*	α(K)exp=0.000133 *10* (1980St20) δ: from 1038-1238 cascade (1980Sh28). Others: 0.00 *4* from 1038−(1238)−847 cascade (1980Sh28), −0.02 *2* (1974Ho25), +0.01 *4* (1971Ag04), +0.02 *2* (1971Ta18), −0.003 *10* (1986Br01).
1088.894 *9*	0.055 *4*	4048.888	3^+	2959.972	2^+	M1+E2	+0.43 *12*	
1140.368 *6*	0.132 *3*	4100.363	4^+	2959.972	2^+			
1159.944 *6*	0.094 *6*	4119.936	3^+	2959.972	2^+	M1+E2	+0.064 *+16−36*	
1175.101 *4*	2.253 *6*	4298.096	4^+	3122.970	4^+	M1+E2[a]	+0.14 *4*	α(K)exp=0.000094 *21* (1980St20) B(M1)(W.u.)=0.07 *4*; B(E2)(W.u.)=2.1 *16* δ: others: +0.41 *+7−8* or −0.33 *9* (1980Sh28), −1,70 *+26−33* (74h025), +1.6 *3* or −0.25 *10* (1971Ag04).
1198.888 *5*	0.049 *5*	3856.495	3^+	2657.5894	2^+			
1238.288 *3*	66.50 *12*	2085.1045	4^+	846.7778	2^+	E2[@]		α(K)exp=0.000101 *2* (1980St20)
1271.92 *6*	0.0200 *7*	4394.93	3^+	3122.970	4^+			
1335.40 *3*	0.1225 *12*	4458.406	4^+	3122.970	4^+			
1360.212 *4*	4.286 *12*	3445.348	3^+	2085.1045	4^+	M1+E2	−0.11 *1*	α(K)exp=0.000076 *2* (1980St20) δ: others: −0.12 *5* (1980Sh28), −0.136 *13* (1974Ho25), −0.11 *2* (1971Ta18), −0.11 *2* (1971Ag04), −0.116 *+13−12* (1984Oh03).
1442.746 *6*	0.180 *4*	4100.363	4^+	2657.5894	2^+			
1462.322 *6*	0.074 *4*	4119.936	3^+	2657.5894	2^+			
1640.475 *5*	0.0616 *19*	4298.096	4^+	2657.5894	2^+			
1771.357 *4*	15.42 *6*	3856.495	3^+	2085.1045	4^+	M1+E2[@]	−0.004 *+5−2*	α(K)exp=0.0000472 *18* (1980St20) δ: others: 0.00 *3* (1980Sh28), 0.00 *2* (1980Sh28), −0.01 *1* (1974Ho25), −0.02 *1* (1971Ta18), −0.023 *8* (1971Ag04), −0.022 *+5−6* (1984Oh03).
1810.757 *4*	0.640 *3*	2657.5894	2^+	846.7778	2^+	M1+E2[&]	−0.17[c] *3*	
1963.741 *8*	0.707 *4*	4048.888	3^+	2085.1045	4^+	M1+E2	+0.22 *3*	α(K)exp=0.000039 *2* (1980St20) δ: others: +0.23 *7* or +8.6 *+10−31* (1984Oh03), +0.163 *54* (74h025), +0.22 *7* (1980Sh28), +0.19 *6* (1971Ag04).
2015.215 *5*	3.018 *12*	4100.363	4^+	2085.1045	4^+	M1+E2[@]	+0.68 *5*	α(K)exp=0.000039 *2* (1980St20) B(M1)(W.u.)=0.008 *4*; B(E2)(W.u.)=1.8 *9* δ: other: +0.74 *+5−6* (1984Oh03).
2034.791 *5*	7.774 *28*	4119.936	3^+	2085.1045	4^+	M1+E2	−0.073 *5*	α(K)exp=0.0000372 *13* (1980St20) δ: others: −0.087 *12* (1974Ho25), −0.065 *8* (1971Ag04), −0.0070 *+9−8* (1984Oh03).
2113.135 *5*	0.377 *3*	2959.972	2^+	846.7778	2^+	M1+E2[&]	+0.27[c] *3*	
2212.944 *4*	0.388 *4*	4298.096	4^+	2085.1045	4^+	M1+E2	−3.0 *10*	B(M1)(W.u.)=0.00019 *15*;

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^{56}Co ε decay 1990Me15,1988Wa26,2008Dr04 (continued)

γ(^{56}Fe) (continued)

$E_γ$[†]	$I_γ$[‡d]	E_i(level)	$J^π_i$	E_f	$J^π_f$	Mult.[#]	δ[b]	Comments
								B(E2)(W.u.)=0.7 *4* $E_γ$: weighted average of values of 1988Wa26 and 1979He19. δ: others: −2.0 *+6−10* 0R 0.30 *+19−15* (74h025), +2.6 *+20−10* or −0.5 *2* (1971Ag04), −2.8 *+13−11* (1984Oh03).
2276.131 *4*	0.118 *4*	3122.970	4+	846.7778	2+	E2[&]		
2373.24 *3*	0.080 *4*	4458.406	4+	2085.1045	4+			
2523.09 *11*	0.059 *4*	3369.95	2+	846.7778	2+	M1+E2[&]	+0.25[&] *15*	
2598.500 *4*	16.98 *4*	3445.348	3+	846.7778	2+	M1+E2[@]	−0.28 *2*	α(K)exp=0.000026 *1* (1980St20) δ: others: −0.27 *+5−4* (1980Sh28), −0.266 *16* (1974Ho25), −0.28 *3* (1971Ta18), −0.278 *11* (1971Ag04). −0.27 *+9−12* (1984Oh03).
2657.527 *4*	0.0190 *17*	2657.5894	2+	0.0	0+			
3009.645 *4*	1.037 *13*	3856.495	3+	846.7778	2+	M1+E2[@]	+0.065 *5*	α(K)exp=0.000026 *7* (1980St20) δ: others: <+0.25 (1974Ho25), +0.05 *5* or −4.8 *+12−19* (1971Ag04), 0.042 *+35−36* (1984Oh03).
3202.029 *8*	3.211 *12*	4048.888	3+	846.7778	2+	M1+E2[@]	+0.50 *1*	α(K)exp=0.000021 *1* (1980St20) δ: others: +0.43 *6* (1974Ho25), +0.51 *6* (1971Ag04), +0.46 *9* (1980Sh28), +0.524 *+20−19* (1984Oh03).
3253.503 *4*	7.928 *21*	4100.363	4+	846.7778	2+	E2		α(K)exp=0.0000195 *9* (1980St20) B(E2)(W.u.)=1.4 *7*
3273.079 *4*	1.877 *2*	4119.936	3+	846.7778	2+	M1+E2[@]	+0.420 *4*	α(K)exp=0.0000191 *17* (1980St20) δ: others: 0.37 *6* or 1.56 *20* (1974Ho25), +0.41 *6* or +1.63 *20* (1971Ag04), +0.430 *21* (1984Oh03).
3369.86 *11*	0.0101 *7*	3369.95	2+	0.0	0+			
3451.232 *4*	0.950 *5*	4298.096	4+	846.7778	2+	E2		α(K)exp=0.0000113 *20* (1980St20) B(E2)(W.u.)=0.21 *10* α(K)exp: Others: 0.0000116 *21* or 0.0000147 *15* (1976MeZM).
3548.05 *6*	0.1956 *15*	4394.93	3+	846.7778	2+	M1+E2	−0.30 *2*	δ: others: −0.18 *14* or >6.7 (74h025), −0.26 *20* or <−3.7 (1971Ag04), −0.228 *+46−42* (1984Oh03).
3600.8 *4*	0.0167 *5*	4447.7	(2−,3,4)	846.7778	2+			
3611.53 *3*	0.0086 *3*	4458.406	4+	846.7778	2+			

† From 2006BeZl.
‡ From weighted average of values of 2006BeZL and 2008Dr04.
# From 1984Oh03, based on γ(θ) from oriented nuclei, except as noted.
@ Based on α(K)exp (1980St20).
& From adopted γ radiations.

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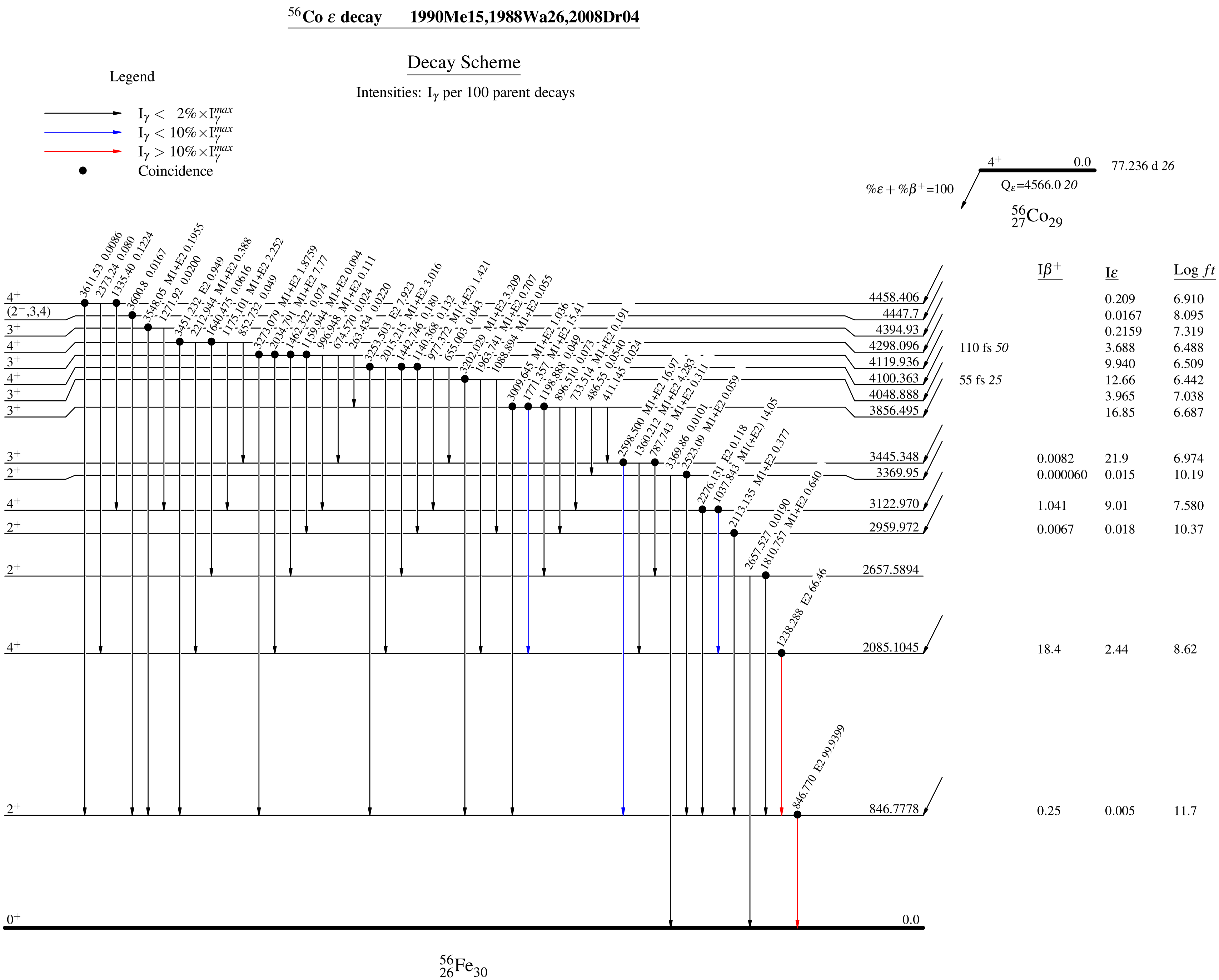
^{56}Co ε decay 1990Me15,1988Wa26,2008Dr04 (continued)

$\gamma(^{56}Fe)$ (continued)

[a] From 1980Sh28.
[b] From 1986Br01, based on $\gamma(\theta)$ from oriented nuclei, except as noted.
[c] From 1984Oh03.
[d] For absolute intensity per 100 decays, multiply by 0.999399 *23*.



^{56}Co ε decay 1990Me15,1988Wa26,2008Dr04
Decay Scheme
Intensities: I_γ per 100 parent decays
Legend
$I_\gamma < 2\% \times I_\gamma^{max}$
$I_\gamma < 10\% \times I_\gamma^{max}$
$I_\gamma > 10\% \times I_\gamma^{max}$
Coincidence
4^+ 0.0 77.236 d 26
Q_ε=4566.0 20
$\%\varepsilon + \%\beta^+$=100
$^{56}_{27}Co_{29}$
$I\beta^+$
$I\varepsilon$
Log ft
4^+ 4458.406 0.209 6.910
$(2^-,3,4)$ 4447.7 0.0167 8.095
3^+ 4394.93 0.2159 7.319
4^+ 4298.096 110 fs 50 3.688 6.488
3^+ 4119.936 9.940 6.509
4^+ 4100.363 55 fs 25 12.66 6.442
3^+ 4048.888 3.965 7.038
3^+ 3856.495 16.85 6.687
3^+ 3445.348 0.0082 21.9 6.974
2^+ 3369.95 0.000060 0.015 10.19
4^+ 3122.970 1.041 9.01 7.580
2^+ 2959.972 0.0067 0.018 10.37
2^+ 2657.5894
4^+ 2085.1045 18.4 2.44 8.62
2^+ 846.7778 0.25 0.005 11.7
0^+ 0.0
3611.53 0.0086
2373.24 0.080
1335.40 0.1224
3600.8 0.0167
3548.05 M1+E2 0.1955
1271.92 0.0200
3451.232 E2 0.949
2212.944 M1+E2 0.388
1640.475 0.0616
1175.101 M1+E2 2.252
852.732 0.049
3273.079 M1+E2 1.8759
2034.791 M1+E2 7.77
1462.322 0.074
1159.944 M1+E2 0.094
996.948 M1+E2 0.111
674.570 0.024
263.434 0.0220
3253.503 E2 7.923
2015.215 M1+E2 3.016
1442.746 0.180
1140.368 0.132
977.372 M1(+E2) 1.421
655.003 0.043
3202.029 M1+E2 3.209
1963.741 M1+E2 0.707
1088.894 M1+E2 0.055
3009.645 M1+E2 1.036
1771.357 M1+E2 15.41
1198.888 0.049
896.510 0.073
733.514 M1+E2 0.191
486.55 0.0540
411.145 0.024
2598.500 M1+E2 16.97
1360.212 M1+E2 4.283
787.743 M1+E2 0.311
3369.86 0.0101
2523.09 M1+E2 0.059
2276.131 E2 0.118
1037.843 M1(+E2) 14.05
2113.135 M1+E2 0.377
2657.527 0.0190
1810.757 M1+E2 0.640
1238.288 E2 66.46
846.770 E2 99.9399
$^{56}_{26}Fe_{30}$

$^{56}_{26}Fe_{30}$-6