Comments on Evaluation of ^{194}Ir b^{-} Decay Data

by E. Browne

Evaluation Procedures

I applied the *Limitation of Relative Statistical Weight* [1] (LWM) method for averaging numbers throughout this evaluation. The uncertainty assigned to the average value was always greater or equal than the smallest uncertainty of the values used to calculate the average.

Decay Scheme

^{194}Ir decays 100% by β^- to ^{194}Pt. Most of the decay (100 - $\Sigma\, I_{\gamma i}$ (1 + α_i) to ground state = 85.2(20) %) populates the ground state. 65Ma10 reported a value of 89% from a measurement of the β^- spectrum.

Nuclear Data

The recommended half-life of ^{194}Ir, 19.3(1) h, is a weighted average (LWM) of 19.15(3) h (72Ge10), 19.41(1) h (72Em01), 20.7(5) h (47Se33), and 19.0(2) h (47Go01). The uncertainty of 0.01 h, given by 72Em01, was changed to 0.03 h by the LWM procedure to reduced its statistical weight from 0.90 to 0.50. A value of 17.4(1) h (64Pe18), which significantly differs from the average, was not used for averaging.

Gamma Rays

Energies. Gamma-ray energies are from Ge(Li) data of 76Cl03. Energies from 74HeYW are of comparable precision, and agree with those of 76Cl03 below 1200 keV. Above this energy, however, they are systematically higher, deviating by as much as 2 keV at about 2100 keV.

Emission Probabilities. Absolute emission probabilities have been deduced from relative values (weighted averages (LWM) of values from 74HeYW and 76Cl03) normalized to 0.131(17) for the 328-keV gamma ray. 66Wi06 determined this value by measuring the combined emission probability of the 293-, 301-, and 328-keV gamma rays with a calibrated NaI detector in a standard geometry, and the source disintegration rate, using a $4\pi\beta$ counter with a > 98% efficiency. Their result was 0.160(20). This value, multiplied by $I_\gamma(328)/[I_\gamma(328)+I_\gamma(293)+I_\gamma(301)]$ = 0.821(6) to correct for the contribution of the 293- and 301-keV gamma rays, gives the recommended absolute emission probability of 0.131(17) for the 328-keV gamma ray.

Table 1 shows the relative emission probabilities reported by 76Cl03 and 74HeYW, weighted averages (LWM), χ^2/N–1, and the recommended values.

Conversion Coefficients.

Total conversion coefficients in Section 2.1 are theoretical values from 78Ro22, interpolated for the recommended transition energies, multipolarities, and mixing ratios. Multipolarities and mixing ratios from conversion-electron data for all (except the 293- and 328-keV) gamma rays are from measurements of ^{194}Au electron-capture decay. Experimental data used for multipolarity and mixing ratio assignments, and corresponding references for individual gamma rays given below are from *Nuclear Data Sheets* (89Si01).

Gamma-ray Energy (keV)	Multipolarity (Mixing ratio)	Experimental data and references
202.91	E1	α_K=0.066 (10) (71Vi15).
244.83	E2	α_K=0.14 (4) (71Vi15).
293.58	E2+M1+E0 (δ=-14 (2))	$L_1/L_2/L_3$=1.19 (8)/1.90 (12)/1.0 M_1/M_2M_3=1.2 (4)/1.8 (6)/1.0, γγ(θ) (70Ag05).
300.741	E2 (+M1) (δ>5)	α_K=0.063 (5) (64Be23), $L_1/L_2/L_3$=1.21 (15)/1.79 (22)/1.0 (70Ag05).
328.448	E2	$L_1/L_2/L_3$=1.53 (18)/1.96 (20)/1.0 M_1/M_2M_3=1.25 (25)/1.87 (34)/1.0 (70Ag05).
364.87	E2	α_K=0.047 (4) (71Vi15), $L_1/L_2/L_3$=1.88 (27)/1.94 (27)/1.0 (70Ag05).
482.86	E2	α_K=0.022 (3) (71Vi15); L_1/L_2=1.5 (3), L_1/L_3=3.0 (10) (70Ag05).
530.13	E1	α_K=0.006 (1) (71Vi15).
589.179	E2+M1 (δ=2.2 (+7) (-4))	α_K=0.018 (2) (71Vi15).
594.291	E2 (+M1) (δ>10)	α_K=0.031 (8) (71Vi15), γγ(θ) (73Si22).
607.61	E2	α_K=0.0133 (12) (71Vi15).
621.29	E1+M2 (δ=0.18 (4))	α_K=0.0074 (11) (71Vi15), γγ(θ) (74BeYP)
621.97	E2	α_K=0.0111 (16) (71Vi15).
645.146	E2	α_K=0.0109 (12) (71Vi15).
700.55	E2	α_K=0.0009 (5) (71Vi15).
889.98	E2+M1 (δ=+1.5 (4))	α_K=0.011 (2) (64Be23), γγ(θ) (83Ri14).
938.69	E2	α_K=0.0054 (4) (64Be23).
1000.12	E2+M1 (δ=1.4 (+11) (-5))	L_1/L_2=6.9 (19), L_1/L_3>18.3, α_K=0.0080 (10) (70Ag05).

Gamma-ray Energy (keV)	Multipolarity (Mixing ratio)	Experimental data and references
1048.6	M1 (+E2) (δ<0.8)	α_K=0.0105 (12) (71Vi15); L_1/L_2=14.3 (29), L_1/L_3>50 (70Ag05).
1104.85	E1	α_K=0.0022 (2) (64Be23); L_1/L_2=15.4 (25), L_1/L_3=16.3 (47) (70Ag05).
1150.75	E2	α_K=0.0038 (4) (71Vi15); L_1/L_2=6.8 (16), L_1/L_3=13 (70Ag05).
1156.61	M1 (+E2) (δ<0.6)	α_K=0.0086 (10), L_1/L_2=11.6 (17), L_1/L_3>3 (70Ag05).
1175.38	E1	α_K=0.0014 (1) (71Vi15); L_1/L_2>14, L_1/L_3>21 (70Ag05).
1183.49	M1+E2 (δ=+1.32 (9))	α_K=0.0048 (6) (71Vi15); L_1/L_2=16.9 (77) (70Ag05), $\gamma\gamma(\theta)$ (83Ri14).
1186.4	E2 (+M1) (δ>0.7)	α_K=0.004 (2) (71Vi15).
1218.78	E2	α_K=0.0035 (4) (71Vi15).
1293.67	E2+M1+E0 (δ=-0.9 (1))	α_K=0.016 (8) (71Vi15); $\gamma\gamma(\theta)$ (73Si22).
1308.15	E2 (+M1) (δ>15)	α_K=0.0031 (5) (64Be23).
1342.16	M1+E2 (δ=-0.1 to -1.5)	α_K=0.0064 (6) (71Vi15); L_1/L_2=6.6 (2), L_1/L_3=54 (24) (70Ag05); $\gamma\gamma(\theta)$ (73Si22).
1468.9	E1	α_K=0.0012 (1) (71Vi15); L_1/L_2=26 (7), L_1/L_3=21 (6) (70Ag05).
1479.2	E0	71Vi15 and 64Be23 observed electrons only. L_1/L_2=26 (7) (70Ag05).

Multipolarities between brackets in Section 2.1 were not measured, but are those expected from the decay scheme.

b$^-$ **Transitions**

β^- transition endpoint energies have been deduced from Q(β^-)=2246.9(16) keV (93Au05) and individual level energies. Transition probabilities (P_{β^-}), from total (γ + e) gamma-ray emission probability balance at each level, are given in percent (%) on the level scheme.

Atomic Data

X-ray and Auger electron emission probabilities are values calculated with the computer program RADLST [2], using gamma-ray data from Section 2.1 and atomic data from 95ScZZ.

^{194}Ir Relative Gamma-Ray Emission Probabilities						^{194}Ir Relative Gamma-Ray Emission Probabilities					
Energy (keV)	76Cl03	74HeYW	W. Avg.	χ^2/N-1	Rec. value	Energy (keV)	76Cl03	74HeYW	W. Avg.	χ^2/N-1	Rec. value
111.4 (4)	0.013 (4)				0.013 (4)	1 342.16 (6)	0.290 (11)	0.32 (9)	0.290 (11)	0,11	0.290 (11)
202.91 (15)	0.023 (5)				0.023 (5)	1 421.48 (28)	0.0048 (15)				0.0048 (15)
244.83 (5)	0.059 (4)				0.059 (4)	1,431.35 (34)	0.017 (5)				0.017 (5)
293.541 (14)	19.5 (8)	18.1 (15)	19.2 (7)	0,68	19.2 (7)	1 432.52 (12)	0.0087 (18)				0.0087 (18)
300.741 (14)	2.66 (11)				2.66 (11)	1 441.78 (14)	0.0114 (18)				0.0114 (18)
328.448 (14)	100.0 (31)	100	100 (3)		100 (3)	1 450.23 (11)	0.0125 (15)				0.0125 (15)
364.867 (15)	0.314 (10)	0.32 (9)	0.314 (10)	0,004	0.314 (10)	1 463.50 (15)	0.045 (9)				0.045 (9)
482.857 (26)	0.348 (14)				0.348 (14)	1 468.91 (7)	1.46 (6)	1.53 (12)	1.47 (5)	0,27	1.47 (6)
530.173 (30)	0.121 (5)	0.15 (5)	0.121 (5)	0,33	0.121 (5)	1 487.05 (8)	0.129 (6)	0.16 (3)	0.130 (6)	1,02	0.130 (6)
589.179 (17)	1.066 (34)				1.066 (34)	1 492.18 (13)	0.0111 (16)				0.0111 (16)
594.291 (19)	0.477 (15)				0.477 (15)	1 511.98 (10)	0.180 (22)				0.180 (22)
607.61 (8)	0.030 (3)				0.030 (3)	1 512.15 (21)	0.101 (14)	0.31 (7)			0.101 (14)
621.29 (15)	0.073 (10)				0.073 (10)	1 518.76 (14)	0.0127 (18)				0.0127 (18)
621.971 (19)	2.56 (10)	2.45 (18)*	2.53 (9)	0,29	2.53 (10)	1 565.15 (8)	0.158 (7)	0.20 (4)	0.159 (7)	1,07	0.159 (7)
645.146 (20)	8.94 (26)	9.14 (60)	8.97 (24)	0,09	8.97 (24)	1 595.77 (10)	0.0124 (12)				0.0124 (12)
699.49 (36)	0.019 (10)				0.019 (10)	1 601.90 (12)	0.0149 (15)				0.0149 (15)
700.547 (35)	0.190 (31)	0.21 (5)	0.20 (3)	0,12	0.20 (3)	1 622.20 (8)	0.490 (22)	0.50 (15)	0.490 (22)	0,001	0.490 (22)
810.66 (19)	0.019 (4)				0.019 (4)	1 670.72 (10)	0.0442 (28)	0.05 (2)	0.0443 (27)	0,08	0.0443 (28)
857.12 (19)	0.054 (6)				0.054 (6)	1 675.24 (17)	0.0066 (11)				0.0066 (11)
859.45 (18)	0.013 (6)				0.013 (6)	1 715.28 (11)	0.0100 (9)	0.010 (3)	0.0100 (9)		0.0100 (9)
889.976 (35)	0.386 (13)	0.39 (8)	0.386 (13)	0,0024	0.386 (13)	1 724.54 (15)	0.0058 (8)				0.0058 (8)
925.26 (6)	0.097 (6)	0.08 (3)	0.096 (6)	0,31	0.096 (6)	1 735.37 (12)	0.0190 (19)	0.020 (5)	0.0190 (18)	0,08	0.0190 (19)
938.690 (25)	4.57 (14)	4.56 (30)	4.57 (13)	0,001	4.57 (13)	1 757.27 (19)	0.0032 (7)				0.0032 (7)
1 000.12 (4)	0.355 (13)	0.38 (8)	0.355 (13)		0.355 (13)	1 780.69 (11)	0.0396 (28)	0.05 (2)	0.040 (3)	0,26	0.040 (3)
1 048.64 (5)	0.199 (9)	0.20 (5)	0.199 (9)		0.199 (9)	1 785.69 (11)	0.0302 (23)	0.04 (1)	0.0307 (22)	0,9	0.0307 (23)
1 104.05 (5)	0.198 (8)	0.23 (6)	0.199 (8)	0,3	0.199 (8)	1 797.48 (9)	0.134 (7)	0.14 (4)	0.134 (7)	0,02	0.134 (7)
1 150.75 (5)	4.56 (15)	4.69 (25)	4.59 (13)	0,2	4.59 (13)	1 805.75 (9)	0.249 (13)	0.24 (5)	0.248 (13)	0,03	0.248 (13)
1 156.60 (30)	0.014 (3)				0.014 (3)	1 812.59 (25)	0.0034 (10)				0.0034 (10)
1 175.38 (5)	0.463 (17)	0.43 (12)	0.462 (17)	0,07	0.462 (17)	1 829.59 (15)	0.0142 (15)	0.020 (5)	0.0147 (16)	1,2	0.0147 (16)
1 183.49 (5)	2.32 (8)	2.42 (19)	2.34 (7)	0,23	2.34 (7)	1 924.42 (14)	0.0136 (13)	0.020 (5)	0.0140 (16)	1,5	0.0140 (16)
1 186.4 (4)	0.064 (12)				0.064 (12)	2 043.72 (11)	0.0539 (34)	0.060 (15)	0.0542 (33)	0,16	0.0542 (34)
1 218.78 (5)	0.429 (17)	0.45 (8)	0.430 (17)	0,07	0.430 (17)	2 114.20 (14)	0.0199 (19)	0.020 (5)	0.0199 (18)	0,0003	0.0199 (19)
1 293.67 (6)	0.352 (23)	0.34 (9)	0.351 (22)	0,016	0.351 (22)	2 207 (1)		0.010 (3)			0.010 (3)
1 308.15 (12)	0.0099 (11)				0.0099 (11)						
* Corrected for 621.29 keV γ-ray. Value for doublet is 2.52 (18)											

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