^{195}Au - Comments on evaluation of decay data by V. Chisté and M. M. Bé

This evaluation was completed in June 2012, including all publications by this date.

1 Decay Scheme

^{195}Au disintegrates 100 % by electron-capture transitions to the ground state level and excited levels of ^{195}Pt. Good agreement is found between the effective $Q^{\pm}$ value (227 (5) keV) calculated from the decay scheme data and that recommended (226.8 (10) keV) from the atomic mass evaluation of Audi and Meng (2012Au06).

2 Nuclear Data

The Q^{+} value is from the atomic mass evaluation of Audi *et al.* (2011AuZZ).

The recommended ^{195}Au half-life has been deduced from the experimental values (in days) given in Table 1:

Table 1: Experimental values of ^{195}Au half-life.

Reference	Experimental value (d)	Comments
R. M. Steffen (1949St17)	180 (15)	
G. Wilkinson (1949Wi08)	185 (3)	
A. Bisi (1959Bi07)	192 (5)	Omitted, outlier.
M. Bresesti (1960Br11)	199 (3)	Omitted, outlier.
N. A. Bonner (1962Bo12)	185 (1)	
G. Harbottle (1963Ha17)	182.9 (5)	
D. D. Hoppes (1982HoZJ)	186.09 (4)	Omitted, superseded by 2002Un02.
M. P. Unterweger (2002Un02)	186.098 (47)	
Recommended value	**184.7 (14)**	**χ^2 = 6**

A weighted average was calculated by using LWEIGHT computer program (version 3). The Bisi (1959Bi07) and Bresesti (1960Br11) values were showed to be outliers, based on the Chauvenet's criterion, and thus were omitted in the final calculation. The largest contribution to the weighted average comes from the value of Unterweger (2002Un02), with a relative statistical weight of 99 %. The LWEIGHT program increased the uncertainty of the 2002Un02 value from 0.047 to 0.44 in order to reduce its relative statistical weight to 50 %.

The recommended value of ^{195}Au half-life is the weighted average of 184.7 d with a final uncertainty of 1.4 d, expanded to include the most precise value of M. P. Unterweger. The reduced-χ^2 value is 6.

2.1 Electron capture transition

The energies of the electron-capture transitions in the decay of ^{195}Au → ^{195}Pt have been obtained from the Q^{+} value (2011AuZZ) and the level energies given in Table 2 from C. Zhou (1999Zh11).

Table 2: ^{195}Pt levels populated in the decay of ^{195}Au and the evaluated electron-capture transition probabilities.

Level Number	Level energy, (keV)	Spin and Parity [a]	Evaluated $P_{\varepsilon c}$ (%)
0	0	$1/2^-$	9.5 (4)
1	98.882 (4)	$3/2^-$	57.6 (35)
2	129.777 (5)	$5/2^-$	32.8 (30)
3	199.526 (12)	$3/2^-$	0.0149 (14)
4	211.398 (6)	$3/2^-$	0.0210 (18)

[a] Given by C. Zhou (1999Zh11).

For the ^{195}Pt ground state, the adopted electron-capture transition probability of 9.5 (4) % is from S. C. Goverse (1973Go05).

The electron-capture transition probabilities to the ^{195}Pt excited levels and the associated uncertainties (Table 2) were deduced from the γ transition probability balance at each level of the decay scheme.

The partial electron-capture transition probabilities P_K, P_L, P_{MNO} and log ft values were calculated for the 1st forbidden and 1st forbidden unique electron-capture transitions using the LOGFT computer code.

2.2 γ Transitions

The γ transition probabilities were obtained using the γ-ray emission intensities and the relevant internal conversion coefficients (see **5.2 Gamma Emissions**).

For all γ transitions, the internal conversion coefficients (ICC) and the associated uncertainties were interpolated from theoretical values of I. M. Band *et al.* (2002Ba85) using the BrIcc computer program (2008Ki07) for the "frozen orbital" approximation.

For multipolarity and mixing ratio of the γ-ray transitions, the evaluators used:
1) The multipolarities of the 129-, 199- and 211-keV γ transitions are from C. Zhou (1999Zh11):

129-keV γ-ray: E2;
199-keV γ-ray: M1 + E2, |δ| = 1.2 (2);
211-keV γ-ray: M1 + E2, |δ| = 0.38 (3).

2) For the 30- and 98-keV γ transitions (M1 + E2), the mixing ratios (δ) were calculated from experimental ICC's (α), using BriccMixing program, version 2.2a (the same package of BrIcc computer program, http://bricc.anu.edu.au/index.php) and the adopted values of δ are shown in the table 3.

Table 3: Experimental ICC's (α) and adopted mixing ratios (δ).

E_γ (keV)	Experimental α	Adopted mixing ratio (δ)
30.895 (7)	α_L = 30.2 (39); α_M = 6.9 (9) (1969Fi08) α_{L1} = 17.9 (46); α_{L2} = 1.40 (64); α_{L3} = 0.25 (8) (1970To19) α_{L1} = 23.0 (28); α_{L2} = 2.50 (30); α_{L3} = 0.43 (5) (1970Ah05)	- 0.013 (7), χ^2 = 1.7
98.882 (4)	α_K = 8.4 (5) (1959Bi07) α_K = 5.8 (15) (1959Mc69) α_K = 6.01 (15) (1964Go19) α_K = 5.8 (5); α_L = 0.82 (7); α_M = 0.186 (15) (1969Fi08) α_K = 6.9 (15); α_{L1} = 0.92 (20); α_{L2} = 0.088 (17); α_{L3} = 0.027 (6) (1970To19) α_K = 5.6 (7); α_{L1} = 0.870 (36); α_{L2} = 0.119 (8); α_{L3} = 0.033 (3) (1970Ah05)	-0.122 (+14,-13), χ^2 = 3.3

3 Atomic Data

Atomic values, ω_K, ϖ_L and n_{KL} are from Schönfeld and Janβen (1996Sc06).
The X-ray and Auger electron emission probabilities were calculated from the data set values using the computer program EMISSION.

4 Electron emissions

The conversion electron emission probabilities were deduced from the ICC values and the γ-ray emission intensities.

5 Photon Emissions

5.1 X-rays

The X-ray absolute intensities were deduced from the decay data using the EMISSION computer code and are compared in Table 4 with measured values found in the literature. A reasonable agreement has been found between the experimental and calculated values.

Table 4: Experimental and recommended (calculated) values of the total K X-ray absolute intensities.

	1964Go19 *	1967Sc18 *	1968Ja11*	1970Ah05 *	1972Ha21	Recommended
K X-rays	92.5	99 (13)	87.2	98 (7)	99 (5)	94.6 (35)

*Using normalization factor of 0.1121 (15) (see **5.2 Gamma Emissions**)

5.2 Gamma emissions

The γ-ray energies given in section 5.2 were deduced from the decay scheme using the ^{195}Pt level energies adopted by C. Zhou (1999Zh11).

The experimental relative γ-ray emission probabilities in ^{195}Au decay were obtained by averaging all the available measured values. The normalization factor to convert relative γ-ray emission probabilities to absolute values was calculated with the formula:

$$\text{Normalization} = \frac{100 - P_{\varepsilon c}(g.s.)}{\sum(1 + \alpha_T)P_{rel}} = 0.1121\ (15)$$

where the sum is to be done over all the gamma transitions populated the ground state, P_{rel} is a relative γ-ray emission probability and $P_{\varepsilon c}$ (g.s.) = 9.5 (4) %, given by S. C. Goverse (1973Go05)**.** From the theoretical total ICC α_T and the evaluated relative γ-ray emission probabilities (Table 5), the calculated normalization factor is 0.1121 (15).

The experimental γ-ray emission probabilities relative to the 98-keV γ-ray taken equal to 100 are given in Table 5.

The evaluated relative γ-ray emission probability values are the weighted means calculated with the LWEIGHT computer program (version 3).

Our recommended relative and absolute γ-ray emission probabilities are given in Table 6.

Table 5: Experimental and evaluated relative γ-ray emission probabilities (%).

Reference	1965Ha13	1967Sc18	1970Ah05	1972Ha21	1974HeYW	Evaluated	Reduced χ^2
Energy (keV)							
30.895 (7)	12.3 (18)		6.8 (5)	7.08 (41)		7.1 (7)	4.3
98.882 (4)	100	100	100	100	100	100	
129.777 (5)	7.7 (8)	7.2 (8)	7.4 (5)	7.64 (44)	8.0 (6)	7.62 (26)	0.2
199.526 (12)		0.093 (10)			0.078 (9)	0.083 (7)	0.9
211.398 (6)	0.25 (3)*	0.119 (11)			0.102 (11)	0.108 (9)	0.8

* the experimental value has been shown to be an outlier value according to Lweight computer program.

Table 6: Recommended relative and absolute γ-ray emission probabilities (%).

Eγ (keV)	Relative γ-ray emission probability (%)	Absolute γ-ray emission probability (%)
30.895 (7)	7.1 (7)	0.80 (8)
98.882 (4)	100	11.21 (15)
129.777 (5)	7.62 (26)	0.854 (29)
199.526 (12)	0.083 (7)	0.0093 (8)
211.398 (6)	0.108 (9)	0.0121 (10)

6 References

1949St17 R. M. Steffen, O. Huber, F. Humbel, Helv. Phys. Acta 22(1949)167 [Half-life].

1949Wi08 G. Wilkinson, Phys. Rev. 75(1949)1019 [Half-life].

1959Bi07 A. Bisi, E. Germagnoli, L. Zappa, Nuovo Cim. 11(1959)843 [Half-life, Experimental α's].

1959Mc69 F. K. McGowan, P. H. Stelson, Phys. Rev. 116(1959)154 [Experimental α's].

1960Br11 M. Bresesti, J. C. Roy, Can. J. Chem. 38(1960)197 [Half-life].

1962Bo12 N. A. Bonner, W. Goishi, W. H. Hutchin, G. M. Iddings, H. A. Tewes, Phys. Rev. 127(1962)217 [Half-life].

1963Ha17 G. Harbottle, Nucl. Phys. 41(1963)604 [Half-life].

1964Go19 W. Goedbloed, E. Mastenbroek, A. Kemper, J. Blok, Physica 30(1964) [Experimental α's, I_γ].

1965Ha13 J. R. Harris, G. M. Rothberg, N. Benczer-Koller, Phys. Rev. 138(1965)B554 [I_γ].

1967Sc18 R. Schöneberg, D. Gföller, A. Flammersfeld, Z. Phys. 203(1967)453 [I_γ].

1968Ja11 A. Jasinski, C. J. Herrlander, Arkiv Fysik 37(1968)585 [K X-rays].

1969Fi08 T. Fink, N. Benczer-Koller, Nucl. Phys. A138(1969)337 [Experimental α's].

1970Ah05 B. Ahlesten, A. Bäcklin, Nucl. Phys. A154(1970)303 [Experimental α's, I_γ].

1970To19 L. H. Toburen, R. G. Albridge, Z. Phys. 240(1970)185 [Experimental α's].

1972Ha21 J. S. Hansen, J. C. McGeorge, R. W. Fink, R. E. Wood, P. V. Rao, J. M. Palms, Z. Phys. 249(1972)373 [I_γ, K X-rays].

1973Go05 S. C. Goverse, J. van Pelt, J. van den Berg, J. C. Klein, J. Blok, Nucl. Phys. A201(1973)326 [$P_{\varepsilon c}$(g.s.)].

1974HeYW R. L. Heath, ANCR - 1000 – 2(1974) [I_γ].

1982HoZJ D. D. Hoppes, J. M. R. Hutchinson, F. J. Schima, M. P. Unterweger, NBS - SP – 626(1982)85 [Half-life].

1996Sc06 E. Schönfeld, H. Janβen, Nucl. Instrum. Meth. Phys. Res. A369(1996)527 [Atomic data].

1999Zh11 C. Zhou, Nucl. Data Sheets 86(1999)676 [Spin, level energies].

2002Un02 M. P. Unterweger, Appl. Rad. Isotopes 56(2002)125 [Half-life].

2002Ba85 I. M. Band, M. B. Trzhaskovskaya, C. W. Nestor, Jr., P. O. Tikkanen, S. Raman, Atomic Data Nucl. Data Tables 81(2002)1 [Theoretical ICC].

2008Ki07 T. Kibédi, T. W. Burrows, M. B. Trzhaskovskaya, P. M. Davidson, C. W. Nestor Jr. , Nucl. Instrum. Meth. Phys. Res. A589(2008)202 [Theoretical ICC].

2012Au06 M. Wang, G. Audi, A.H.Wapstra, F.G. Kondev, M. MacCormick, X. Xu, B. Pfeiffer, Chinese Physics C36 (2012) 1603 [Q].