^{108}Ag – Comments on evaluation of decay data by V. Chisté and M. M. Bé

The full decay data evaluation was completed in 2005. The literature available by January 2005 was included.

1. Decay Scheme

^{108}Ag disintegrates by electron capture (2,19 (14) %) and β^+ emission (0,283 (20) %) to excited states of ^{108}Pd and by β^- emission (97,53 (14) %) to excited states of ^{108}Cd .

2. Nuclear Data

The Q values are from the 2003Au03 evaluation.

Level energies, spin, parities and half-life of excited states are from J. Blachot (2000Bl21, see also 1982Ha61).

The half-life of the ^{108}Ag ground state has been determined from the following data (in minutes):

1958Gu09	2,43 (5)
1960Wa10	2,42 (2)
1965Eb01	2,41 (2)
1971Jo07	2,38 (3)
1974HeYW	2,41 (1)
1974Ry01	2,37 (1)
1991Yamamoto	2,353 (9)
Adopted	2,382 (11)

The half-life weighted average has been calculated by Lweight program (version 3).

The evaluator has chosen to take into account the seven values with associated uncertainty for the calculation. The largest contributions to the weighted average come from values of Head (1974HeYW), Ryves (1974Ry01) and Yamamoto (1991Yamamoto) (25 %, 25 % and 31 %, respectively).

The weighted average value is *2,382 min* with a reduced-χ^2 value of 4,35. The external uncertainty is 0,011 min. Then, the adopted value is 2,382 (11) min.

2.1 β^- transition

The maximum energy of the β^- transitions in the decay of ^{108}Ag to excited states in ^{108}Cd is calculated from:

$$E_{\beta-} = Q(\text{from 2003Au03}) - E_{\text{level in Cd-108}}(\text{from 2000Bl21})$$

For the probabilities of the β^- transitions, the published data are (table 1):

Table 1: β^- transition measured intensity values in %.

Populated Level	1953Pe16	1960Wa10	1962Fr07	1965Fr01
β^- ^{108}Cd ground state	97,3	93,8	95,0 (3)	95,9 (3)
β^- ^{108}Cd 632 keV	0,8	1,9	1,73 (10)	1,75 (10)

For the β^- ^{108}Cd ground state transition, the values given by 1953Pe16 and 1960Wa10 have no uncertainties and the other two values are from the same author; the evaluators have chosen the most recent value published by L. Frevert (1965Fr01). This value, 95,9 (3) %, is important to determine the decay-scheme normalization factor (see **Gamma Ray Transition and Emission**).

For the β^- transition to the ^{108}Cd 632 keV level, the adopted value (1,63 (26) %), consistent with the Frevert value (1,75 (10) %) (table 1) has been deduced from the decay scheme balance.

The total β^- branching ratio was deduced taking into account that gamma-ray adopted relative emission intensities (see **4.1 Gamma Emissions**), the normalization factor (see **4.1 Gamma Emissions)** and the $I_{\beta+,\varepsilon}$ (g.s.) = 2,01 (12) % (see **2.3 Electron capture transition**):

$I_{\beta+-,\varepsilon} = I_{\beta+,\varepsilon}$ (g.s.) + N * [I_γ (433 keV) + I_γ (931 keV) + I_γ (1441 keV) + I_γ (1539 keV)]
$I_{\beta+-,\varepsilon}$ = 2,01 (12) % + 0,0046 (7) ∗ [100 + 0,105 (8) + 0,585 (28) + 0,205 (14)] = 2,47 (14) %

And $I_{\beta-}$ = 100 − 2.47 (14) % = 97,53 (14) %

The lg ft values have been calculated by Logft program (version 7.2a).

2.2 β^+ transition

The maximum energy of the β^+ transitions in the decay of ^{108}Ag is calculated by the same way as for the β^- transition.

For the probability of β^+ transition to the ground state, the published data are (table 2):

Table 2: β^+ transition probability measured values in %.

Level Populated	1953Pe16	1960Wa10	1962Fr07	1965Fr01
β^+ ^{108}Pd ground state	0,14	0,36	0,28 (2)	0,28 (2)

From the total of 0,283 (20) % (2 transitions: to the 433-keV level and to the ground state) β^+ transition decaying by this mode, 0,28 (2) %, measured by Frevert (1965Fr01) go directly to the ground state. Most of the remaining 0,0026 (3) % (2000Bl21 and 1982Ha61) populate the 433-keV level (from theoretical ratio ε/β^+) (this electron-capture transition to the 433-keV level hasn't been measured by Frevert (1965Fr01)).

2.3 Electron capture transition

Some values for the electron capture branching ratio (in %) have been found in the literature, as shown in the following table:

Populated Level	1953Pe16	1960Wa10	1962Fr07	1965Fr01
EC ^{108}Pd ground state	1,5	3,35	2,49 (25)	1,73 (12)
EC ^{108}Pd 433 keV level	0,06	0,18	0,19 (3)	0,19 (3)
EC ^{108}Pd 1052 keV level	0,22	0,42	0,26 (3)	0,27 (3)

For the ground state, the adopted value is the most recent measurement of Frevert (1965Fr01). For the other levels, the electron-capture probabilities have been deduced from the imbalance at each level of the decay scheme. It can be noted that for the levels at 433 keV and 1052 keV the adopted electron capture branchings of 0,19 (8) % and 0,243 (39) %, respectively, are consistent with the Frevert measured values.

P_K, P_L, P_M values have been calculated for allowed electron-capture transitions in the decay of ^{108}Ag to the excited states in Pd-108 using the EC-Capture computer program.

2.4 Gamma transitions

Probabilities

The transitions probabilities have been calculated from the gamma-ray emission intensities and the internal conversion coefficients (see **Gamma ray emission**).

Multipolarity and internal conversion coefficients

For the 433- ([E2]), 633-(E2) and 1441-keV ([E2]) gamma-ray transitions, multipolarities are from J. Blachot (2000Bl21, see also 1982Ha61)

The internal conversion coefficients (α_T, α_K and α_L) for these transitions have been calculated using the ICC Computer Code (program Icc99v3a – GETICC dialog). The adopted values have been interpolated from the new tables of Band (2002Ba85).

Their uncertainties are taken as 3 % of the calculated values with the ICC computer code.

3. Atomic data

Atomic values, ω_K, ϖ_L and η_{KL}, are from Schönfeld (1996Sc06).
The X-ray and Auger electrons emission probabilities are calculated from the data set values by using the program EMISSION.

4. Photon Emissions
4.1 Gamma Emissions

The measured relative emission intensities are given in table 3, they are relative to the 433-keV gamma ray taken as 100. Energy values are in keV.

Table 3: Measured relative gamma emission intensities in %.

Energy (keV)	Okano et al. (1971Ok01)	Singhal (1973Si02)	Adopted values
383,13 (16)	none	0,18 (6)	0,18 (6)
388,36 (7)	none	0,37 (12)	0,37 (12)
433,938 (5)	100	100	100
497,13 (12)	0,25 (9)	0,45 (11)	0,33 (7)
618,86 (5)	54,1 (24)	52,4 (26)	53,3 (18)
632,98 (5)	355,1 (149)	349,6 (175)	353 (11)
880,26 (10)	0,65 (3)	0,64 (5)	0,647 (26)
931,07 (12)	0,091(16)	0,11 (1)	0,105 (8)
1007,22 (5)	2,71 (11)	2,79 (14)	2,74 (9)
1106,01 (7)	0,26 (2)	0,33 (3)	0,282 (17)
1441,15 (5)	0,56 (4)	0,61 (4)	0,585 (28)
1539,94 (7)	0,20 (2)	0,21 (2)	0,205 (14)

The adopted values are the weighted averages of the two values given with uncertainties. One set of values, N. D. Johnson (1971Jo07), was not taken into account by the evaluator because the measured relative emission probabilities were relative to that of the 633 keV gamma ray and not to that of the 433 keV gamma ray as done by the other authors (normalization could introduce an overestimation of uncertainties).

The normalization factor to convert the relative emission intensities to absolute emission intensities is calculated with the formula:

$$\text{Normalization} = \frac{100 - I_{\beta-}(g.s.) - I_{\beta+,\varepsilon}(g.s)}{(\sum(1 + \alpha_T)P_{rel})}$$

where the sum is to be done over all the gamma transitions to the ground state, and:
$I_{\beta-}$ (g.s.)= 95,9 (3) % and $I_{\beta+,\varepsilon}$ (g.s.) = 2,01 (12) %. (see explanations above)

From the theoretical α_T and the evaluated relative emission intensities (table 3), the calculated normalization factor is 0,0046 (7). The uncertainties were propagated on the above formula. Absolute emission intensities are given in table 4.

Table 4: Absolute emission intensities for the γ-rays in the decay of the ^{108}Ag (in %).

Energy (keV)	Relative Emission intensity	Absolute emission intensity
383,13 (16)	0,18 (6)	0,00083 (30)
388,36 (7)	0,37 (12)	0,0017 (6)
433,938 (5)	100	0,46 (7)
497,13 (12)	0,33 (7)	0,00152 (40)
618,86 (5)	53,3 (18)	0,245 (39)
632,98 (5)	353 (11)	1,62 (26)
880,26 (10)	0,647 (26)	0,00298 (48)
931,07 (12)	0,105 (8)	0,00048 (8)
1007,22 (5)	2,74 (9)	0,0126 (20)
1106,01 (7)	0,282 (17)	0,00130 (22)
1441,15 (5)	0,585 (28)	0,00269 (44)
1539,94 (7)	0,205 (14)	0,00094 (16)

5. References

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