

¹¹⁰Ag – Comments on evaluation of decay data by R. G. Helmer

1) Decay Scheme

The β^- emission to ¹¹⁰Cd from the ¹¹⁰Ag ground state occurs in 99,70% (6) of the decays and the remaining 0,30% (6) is by electron capture to ¹¹⁰Pd.

2) Q values and half-lives

The Q values from the 1995Au04 evaluation for the decay of the ¹¹⁰Ag ground state are 2892,2 (16) keV for the β^- decay and 892 (11) keV for the electron-capture decay.

The half-life of the ¹¹⁰Ag ground state has been determined from the following data (in seconds):

1935Am01	22	omitted, no uncertainty
1938Po03	22	omitted, no uncertainty
1938Re04	23	omitted, no uncertainty
1944Fl01	24	omitted, no uncertainty
1946Hi06	24,5 (3)	
1954Bo39	24 (2)	
1957Se19	24,2 (12)	
1962Ma38	24,42 (14)	
1967Yu01	24,93 (22)	
1970Va08	24,7 (7)	
Adopted	24,56 (11)	

The adopted value is the weighted average of the six values with uncertainties, and the reduced- χ^2 value is 0,82, so the values are consistent.

3) g-ray data

The energies for the γ -rays from the decay of ¹¹⁰Ag (24 s) were determined as shown in Table 1. The precise energies from the ¹¹⁰Ag^m (249 d) isomer decay are adopted where appropriate.

Table 1. γ -ray energies from the β^- decay of ¹¹⁰Ag (24 s).

1970Va08	1972Ka34 ^a	Adopted ^b
	295,3 (1)	295,3 (2)
657,8 (2)	657,6 (1)	657,7600 (11) ^c
815,5 (3)	815,5 (1)	815,5 (2)
817,8 (12)	818,2 (1)	818,0244 (18) ^c
	1074,0 (1)	1074,0 (2)
1125,9 (3)	1125,8 (1)	1125,699 (20) ^d
1186,4 (7)	1186,3 (1)	1186,3 (2)

1421,8 (13)	1421,4 (1)	1421,5 (2)
1475,8 (13)	1475,8 (1)	1475,7792 (23) ^c
1630,0 (12)	1629,9 (1)	1629,9 (2)
1674,2 (9)	1674,3 (1)	1674,3 (2)
1783,3 (13)	1783,6 (7)	1783,46 (3) ^d
	2004,4 (2)	2004,4 (2)

^a The author's uncertainties are quoted to 0,01 keV, but the energies are only given to 0,1 keV, so the last digit in the uncertainty is of no use.

^b For energies from 1972Ka34 and 1970Va08, a minimum uncertainty of 0,2 keV has been used for the adopted value.

^c From evaluation of 2000He14,

^d From adopted value from ¹¹⁰Ag^m decay.

The relative emission probabilities of the γ -rays from the decay of ¹¹⁰Ag (24 s) were determined from the measurements in Table 2 :

Table 2: Relative emission probabilities of the γ -rays from the decay of ¹¹⁰Ag (24 s)

E _{γ} (keV)	1970Va08	1972Ka34	Adopted
295		0,17 (3)	0,17 (3)
657	100,	100,	100,
815	0,79 (12)	0,85 (2)	0,85 (2)
818	0,10 (9)	0,20 (1)	0,20 (1)
1074		0,02 (1)	0,02 (1)
1125	0,36 (3)	0,34 (1)	0,34 (1)
1186	0,056 (2)	0,06 (1)	0,06 (1)
1421	0,044 (30)	0,05 (1)	0,05 (1)
1475	0,11 (5)	0,08 (1)	0,08 (1)
1629	0,048 (30)	0,05 (1)	0,05 (1)
1674	0,15 (6)	0,16 (1)	0,16 (1)
1783	0,17 (9)	0,10 (1)	0,10 (1)
2004		0,08 (1)	0,08 (1)

The normalization of the relative emission probabilities for the γ -rays from the decay of ¹¹⁰Ag (24 s) depends on the probability of the β branch to the ground state of ¹¹⁰Cd and the fact that 0,30(6)% of the decays are by electron capture to ¹¹⁰Pd (1961Fr01). The intensity of the β branch to the ¹¹⁰Cd ground state can be obtained from the ratio of the emission probabilities for the branches to the 657-keV level and the ground state, $I_{\beta}(657)/I_{\beta}(0)$, as deduced from the decomposition of the β spectrum. However, the following results for this ratio are very inconsistent.

	$I_{\beta^-(657)}/I_{\beta^-(0)}$
1962Ka07	0,14 (5)
1963Da03	0,21
1963Fr07	0,0465 (25)
1967Mo12	0,070 (22)
Adopted	0,047 (4)

The adopted value is the weighted average of the three values with uncertainties. For this average the internal uncertainty is 0,0025 and the external uncertainty is 0,0038. Although the reduced- χ^2 value is 2,30, this does not necessarily imply an inconsistent set since one has only three values. If one does consider it an inconsistent set and applies the Limitation of Relative Statistical Weight rule (1985ZiZY, 1992Ra08) of reducing the relative weight of the 1963Fr07 value from 98% to 50%, the weighted average becomes 0,064 with an internal uncertainty of 0,014, a reduced- χ^2 value of 1,6, and an external uncertainty of 0,018.

From this β^- branching ratio, the 0,30 (6)% electron-capture, and 0,1% β^- branching to higher energy levels, the branch to the ground state is 95,1(4) % and that to the 657-keV level is 4,5(4) %. The emission probability of the 657-keV γ -ray is then 4,6 (4) % of the decays of the ground state including both the direct and indirect feeding.

Table 3: Absolute emission probabilities for the γ -rays from the decay of the ¹¹⁰Ag ground state.

E_{γ}	P_{γ} (%)
295	0,0078 (16)
657	4,6 (4)
815	0,039 (4)
818	0,0092 (9)
1074	0,0009 (5)
1125	0,0156 (14)
1186	0,0028 (5)
1421	0,0023 (5)
1475	0,0037 (6)
1629	0,0023 (5)
1674	0,007 (1)
1783	0,0046 (8)
2004	0,0037 (6)

The γ -ray multiplicities and mixing ratios were taken from the 2000De11 evaluation and are as follows:

E1: 1421 -keV
 E2: 657, 815, 1074, 1186,1475, 1783, 2004 -keV
 M1+E2: 818 [d = - 1,36 (7)] ; 1125 [d = + 0,33 (8)]
 E2(+M1): 1629 [d = + 0,06 (3)]
 (E1): 295 -keV

4) Atomic data

From the EMISSION code and the decay data, the following information was obtained.

Quantity	Pd (Z=46)	Cd (Z=48)
ω_K	0,820(4)	0,842(4)
ω_L average	0,0536 (13)	0,0632 (16)
n_{KL}	0,975 (4)	0,953 (4)
$K_{\alpha 2}/K_{\alpha 1}$	0,5293 (25)	0,5317 (25)
K_{β}/K_{α}	0,2099 (17)	0,2151 (18)

Due to the high energy of the strong transitions, the Auger electrons are negligible and no related data are included here.

The K X-ray emission probabilities are calculated as follows:

From the decay of ¹¹⁰Ag (24 s), the Pd X-rays per 100 decays of parent:

$K_{\alpha 2}$	0,060 (12)
$K_{\alpha 1}$	0,114 (23)
K_{β}	0,037 (8)

and the Cd X-rays per 100 decays of parent:

$K_{\alpha 2}$	0,00322 (28)
$K_{\alpha 1}$	0,0061 (6)
K_{β}	0,00200 (18)

5) β^- decay intensities

The β^- decay intensities for the decay of the ¹¹⁰Ag ground state are simply deduced from the above data and the γ -ray probability balances.

6) References

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