^{111}In - Comments on evaluation of decay data by V.P. Chechev.

The initial ^{111}In decay data evaluation was done by V.P. Chechev in 1998 (1999Be). This current (revised) evaluation has been carried out in March 2006. The literature available by March 2006 has been included.

1 Decay Scheme

Transitions to the ground state and the exited level of 245 keV of ^{111}Cd have not been observed. Limits on the electron capture branches to these levels can be deduced from the log ft systematics of 1998Si17. The transitions to the levels at 0 and 245 keV are 4th and 2nd forbidden with expected log ft's of > 22 and > 10.6, respectively. The corresponding electron capture branch limits are < 1.0×10^{-14} % and < 5×10^{-4} %, respectively (2003Bl10).

The upper limit of 0.01 % has been found for the electron capture branch to the excited level of 396 keV by Meyer and Landrum (1972MeZD).

2 Nuclear Data

Q_{EC} value is from 2003Au03.

The evaluated ^{111}In half-life is based on the experimental data given in Table 1.

Table 1. Experimental values of the ^{111}In half-life (in days)

Reference	Author(s)	Value	Comments
1949He06	Helmholz et al.	2.84 (3)	
1957Ma26	Maier	2.81 (1)	
1968Li08	Liskien	2.84 (11)	
1968Sm08	Smend et al.	2.96 (8)	
1972Em01	Emery et al.	2.83 (1)	
1972Gu19	Gureev et al.	2.84	Uncertainty is not quoted
1978La21	Lagoutine et al.	2.802 (1)	Quoted uncertainty, corresponding to 99.7 % confidence level, has been reduced by a factor 3
1980Ho17	Houtermans et al.	2.8071 (15)	
1982HoZY	Hoppes et al.	2.8048 (5)	Replaced by 1992Un01
1983Wa26	Walz et al.	2.8049 (5)	
1986Ru09	Rutledge et al.	2.8048 (1)	
1992Un01	Unterweger et al.	2.80477 (53)	Cited also in 2002Un02
2004Sc04	Schrader	2.8063 (7)	

The value of 1972Gu19 has been omitted because of the absence of an estimated uncertainty. The value of 1982HoZY has been omitted as it is replaced in 1992Un01. The value of 1968Sm08 has been omitted as outlier using the Chauvenet's criterion. Hence the ten values have been used for the statistical data processing.

The uncertainty of 1986Ru09 was increased to 0.00030 to adjust weights according to the LRSW method. A weighted average for the final data set is 2.8049 with an internal uncertainty of 0.00021 and an external uncertainty of 0.00034 and a reduced $\chi^2/\nu = 2.5$. An unweighted average is 2.815 (5).

Different statistical procedures (1994Ka08) give the following results: UINF, PINF and NORM – 2.8049 (3), LWM – 2.815 (10), IEXW – 2.805 (13), RAJ – 2.8049 (2), BAYS and MBAYS – 2.8049 (4).

The adopted value of the ^{111}In half-life is 2.8049 (4) days.

The evaluated half-life of the metastable level of 396 keV (^{111}Cd^m) is based on the experimental results given in Table 2.

Table 2.Experimental values of the ^{111}Cd^m half-life (in minutes)

Reference	Author(s)	Value
1945Wi11	Wiedenbeck	48.7 (3)
1948Ho37	Hole	50 (2)
1949He06	Helmholz et al.	48.6 (3)
1968Bo28	Bornemisza-Pauspertl et al.	49.4 (7)
1987Ne01	Nemeth et al.	48.54 (5)
1997We13	Wen et al.	48.30 (15)

The uncertainty of 1987Neo1 was increased to 0.12 to adjust weights according to the Limitation of Relative Statistical Weight (LRSW) method. A weighted average for the final data set is 48.50 with an internal uncertainty of 0.085 and an external uncertainty of 0.082 and a reduced χ^2/ν = 0.93. An unweighted average is 48.9 (3).

Different statistical procedures (1994Ka08) give the following results: IEXW, LWM, MBAYS, NORM and UINF – 48.50 (9), PINF – 48.50 (8), RAJ – 48.51(9), BAYS – 48.50 (11).

The adopted value of the ^{111}Cd^m half-life is 48.50 (9) minutes.

2.1 Electron Capture Transitions

The electron capture transition energies have been calculated from Q_{EC} value and the ^{111}Cd level energies given in Table 3 from 2003Bl10. The electron capture transition probability $P\varepsilon_{0,2} = 5\ (5) \cdot 10^{-5}$ has been evaluated taking into account the observed upper limit of $1 \cdot 10^{-4}$ (1972MeZD). The fractional electron capture probabilities P_K, P_L, P_M have been calculated using the LOGFT computer program.

Table 3. ^{111}Cd levels populated in the ^{111}In ε-decay

Level number	Energy, keV	Spin and parity	Half-life	Probability of EC-transition (x100)
0	0.0	$1/2^+$	Stable	$< 1.0 \times 10^{-14}$
1	245.35 (4)	$5/2^+$	84.5 ns	$< 5 \times 10^{-4}$
2	396.16 (5)	$11/2^-$	48.50 min	0.005 (5)
3	416.63 (5)	$7/2^+$	0.12 ns	99.995 (5)

2.2 g Transitions

The energies of γ-ray transitions are virtually the same as the γ-ray energies because nuclear recoil is negligible. The γ-ray transition probabilities have been calculated from the γ-ray emission probabilities and the evaluated total internal conversion coefficients (α_T).

The evaluated α_T values for $\gamma_{1,0}$ (245 keV) and $\gamma_{3,1}$ (171 keV) gamma-ray transitions have been obtained from the sets of 5 data including theoretical values (Table 4). The values of α_K, α_L, α_M have been calculated from the evaluated α_T using the theoretical ratios $\alpha_K/\alpha_L/\alpha_M/\alpha_{NO}$. The relative uncertainties of α_K, α_L, α_M have been taken as 2 %.

The theoretical α_T has been used for the E3 $\gamma_{2,1}$ (151 keV) gamma-ray transition (see also 1973Pathak).

Table 4. Experimental, theoretical and evaluated values of the total internal conversion coefficients (α_T)

	1956St64	1966Sp04	1975Sh29	1985Ka29	Theory (2006Ra03)	Evaluated
$\gamma_{1,0}$ (245 keV)	0.0621 (15)	0.0618 (15)	0.0634 (30)	0.0620 (7)	0.0637 (9)	0.0625 (7)
$\gamma_{3,1}$ (171 keV)	0.099 (3)	0.100 (3)	0.124 (6)	0.1018 (13)	0.1068 (15)	0.1036 (24)

The theoretical α_T values have been calculated using the BRICC computer program (2006Ra03).

The gamma-ray transition multipolarities have been adopted from measurements of 1956St54 and 1974Kr03. The gamma-ray multipolarity mixing ratio δ(E2/M1) of the $\gamma_{3,1}$ (171 keV)-transition has been evaluated using the following data:

0.146(3)	Steffen (1956St64)
0.141(3)	Budz-Jorgensen (1973)
0.145	Kreische and Lampert (1974Kr03)
0.144(3)	Weighted average of 1956St04 and 1973Budz-Jorgensen

The adopted value of 0.144 (3) corresponds to an E2 admixture of 2.07 (9) %.

3 Atomic Data

3.1. Fluorescence yields

The fluorescence yield data ω_K, ϖ_L, n_{KL} are from 1996Sc06 (Schönfeld and Janßen).

3.2. X Radiations

The energy values for X-rays have been calculated from the wavelengths given by Bearden (1967Be65). The relative emission probabilities of KX ray components have been taken from 1996Sc06.

3.3. Auger Electrons

The energies of Auger electrons are from 1977La19 (Larkins) and Table of Isotopes. The ratios P(KLX)/P(KLL), P(KXY)/P(KLL) are taken from 1996Sc06.

4 Electron Emissions

The energies of the conversion electrons have been calculated from the gamma transition energies and the electron binding energies. The emission probabilities of conversion electrons have been deduced from the evaluated P(γ) and ICC values.

The total absolute emission probability of K Auger electrons has been calculated with the EMISSION computer program using the adopted ω_K = 0.842 (4).

The absolute total emission probability of L Auger electrons has been calculated with the EMISSION computer program using the adopted ϖ_L = 0.0632 (16).

Experimental data on conversion electrons (1951Mc61, 1966Sp04, 1975Sh29) and Auger electrons (2005Ya03) are concordant with the adopted values

5 Photon Emissions

5.1 X-ray Emissions

The absolute emission probabilities of Cd KX-rays have been calculated with the EMISSION computer program using the adopted values of P_K and ω_K (Cd).

The absolute emission probabilities of Cd LX-rays have been calculated with the EMISSION computer program using the adopted values of P_L, ϖ_L (Cd), P_K, ω_K (Cd), n_{KL} (Cd).

5.2 g-ray Emissions

The energy of $\gamma_{2,1}$-ray (151 keV) has been taken from 1975Sh29.

The energy of the $\gamma_{3,1}$-ray (171 keV) has been evaluated using the experimental results given below:

172.1 (5)	McGinnis (1951Mc11) - Omitted from data processing
171.29 (3)	Sparrman et al. (1966Sp04)
171.20 (10)	Heath (1974HeYW)
171.28 (3)	Shevelev et al. (1975Sh29)
171.28 (3)	Weighted average (adopted value)

The energy of the $\gamma_{1,0}$-ray (245 keV) has been evaluated using the experimental results given below:

246.6 (7)	McGinnis (1951Mc11) - Omitted from data processing
245.35 (4)	Sparrman et al.(1966Sp04)
245.27 (10)	Heath(1974HeYW)
245.35 (4)	Shevelev et al. (1975Sh29)
245.35 (4)	Weighted average (adopted value)

The absolute emission probabilities of $\gamma_{2,1}$ (151 keV), $\gamma_{3,1}$ (171 keV) and $\gamma_{1,0}$(245 keV) gamma rays have been calculated using the below relations:

$P\gamma_{2,1}$ ($\times$100) = 99.995 (5)/(1 + α_T ($\gamma_{2,1}$))
$P\gamma_{3,1}$ ($\times$100) = 0.005 (5)/(1 + α_T ($\gamma_{3,1}$))
$P\gamma_{1,0}$ ($\times$100) = 100/(1 + α_T($\gamma_{1,0}$)).

In 1975Sh29 the latter value has been estimated as ~ 0.003.

The relative intensity of $\gamma_{1,0}$ / $\gamma_{3,1}$ from 0.90 to 0.97 has been measured with an accuracy not better than 3 % in the above works. This accuracy is considerably worse in comparison with the calculation from the decay scheme using α_T values.

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