Comments on evaluation of decay data
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This evaluation was completed in June 2015 with a literature cut-off at the same date.

Decay Scheme

^{169}Er decays by beta minus emission to the first excited level and the ground state of ^{169}Tm and with a very small branch to the second excited level at 118 keV.
Level energies, spins and parities (J^{π}) were taken from the evaluation by Baglin (2008Ba31).

Nuclear Data

The Q^- value is from Wang *et al.* (2012Wa38).

Half-life

The recommended value was derived from measurements listed in Table 1.

Table 1. Measurement results and recommended value of ^{169}Er half-life.

Reference	$T_{1/2}$ (d)	Uncertainty (d)	Remarks
1948Ke11	9,4	0,2	
1956Bi30	9,0	0,2	
1958Pa16	9,5		Omitted, no uncertainty
1960Wi10	9,8	0,5	
1961Bj02	9,6	0,1	
1963Ra15	9,0	0,1	
1977My02	9,40	0,02	
2004Sc04	9,36	0,04	
χ^2 /n-1 =	4		
χ^2 crit. =	2,8		
UWM =	9,36		
LWM =	9,370	0,048	
Adopted	**9,38**	**0,02**	Simple mean of 1977My02 and 2004Sc04, with lowest uncertainty

The set of the seven values is discrepant with a χ^2/n-1 of 4, the *Limitation of Relative Statistical Weight Method* recommends the increase of the uncertainty given in 1977My02 to 0,034 in order to limit its weight to 50%, then the weighted mean is 9,37 with the external uncertainty of 0,05.
However, the earliest values range from 9 to 9,8 d, where the two latest ones are in good agreement and more precise, thus the simple mean of 1977My02 and 2004Sc04 is adopted with the lowest experimental uncertainty, i.e. ***9,38 (2) d.***

Characteristics of Electron Emissions

Two experimental results exist for the intensity of the β transition to the 8,4 keV level: 42 (1) % (1959Ch31) and 45 (5) % (1965Du02). The adopted value is the simple mean with the uncertainty taken from 1965Du02 (the uncertainty given by 1959Ch31 includes only the statistical part). Then I_β = 43,5 (50) % rounded to 44 (5) %. Consequently, the β transition intensity to the ground state is 56 (5) %.

The intensity of the first forbidden unique β transition to the 118 keV level was derived from the intensities of the 109,7 and 118 keV γ rays and the conversion coefficients (see following sections), that is : Pβ ~ 0,016 %.

The lg *ft* values were calculated using the Logft program and the mean energy using the BetaShape program (2014Mo20 and 2012Mo38).

Conversion electron energies and intensities were derived from the decay scheme parameters.

The full energy spectrum of the Auger electrons has been calculated using the procedures and programs described in Lee *et al.* (2012Le09). Based on the adopted values of the transition energies, absolute gamma-ray intensities, multipolarities and mixing ratios (see below), an ENSDF input file was created. As the ^{169}Er decays by β^- decay, the main source of the primary atomic vacancies is internal conversion, dominantly of the 8,4102 keV transition. The BrIcc program (2008Ki07) was used to calculate all relevant sub-shell conversion coefficients. For the main part of the calculations, the BrIccEmis code (2012Le09) was used. It evaluates the primary vacancy distribution, then it propagates the atomic vacancies using a full Monte Carlo approach. Atomic transition energies were calculated with the RAINE code (2002Ba85), taking into account the presence of all atomic vacancies during the recombination process. Atomic transition rates have been taken from the Evaluated Atomic Data Library, Perkins *et al.* (1991PeZZ). The Auger (and X-ray) data presented here have been obtained from a calculation based on 1 million radioactive decays.

Detailed Auger and Coster-Kronig electrons in the M sub shells.

	M1-Shell				
	M1 vacancies = 20,4				
	Auger M1-XY	CK M1M2X	CK M1M3X	CK M1M4X	CK M1M5X
(keV)	1,787	0,0374	0,112	0,482	0,528
%	2,1	5,1	9,97	1,34	1,89

	M2-Shell			
	M2 vacancies = 12,34			
	Auger M2-XY	CK M2M3X	CK M2M4X	CK M2M5X
(keV)	1,468	0,026	0,265	0,311
%	2,5	0,9	7,1	1,36

	M3-Shell		
	M3 vacancies = 18,2		
	Auger M3-XY	CK M3M4X	CK M4M5X
(keV)	1,263	0,190	0,324
%	5,41	1,54	11,1

	M4-Shell		M5-Shell	
	M4 vacancies = 10,1		M5 vacancies = 14,4	
	Auger M4-XY	CK M4M5X	Auger M5-XY	
(keV)	0,89 – 0,95		0,85	
%	9,88	0,08	14,4	

Summary of the Auger electron emissions

Auger transition	Mean energy (keV)	Electrons per 100 decays
L_{total}	5,293	0,0103
MMX	0,274	40,3
MXY	1,211	34.3
M_{total}	0,704	74,6
NNN	0,092	75,8
NNX	0,092	34,4
NXY	0,225	0,59
N_{total}	0,099	116,1
OOX	0,0095	3,86
OXY	0,030	8,75
O_{total}	0,024	12,6
Total	0,317	203,3

Gamma-ray transitions

The 8,4 keV γ transition is strongly converted, several studies of the conversion in the sub-shells lead to attribute it a M1+E2 character. The measured ICC ratios and total ICC values are summarized below:

Reference	Shell	Icc(Unc)	Type
1958Sh64	M2/M1	0,42 (6)	Ratio
1958Sh64	M3/M1	0,48 (7)	Ratio
1958Sh64	N23/M1	0,25 (3)	Ratio, excluded
1958Sh64	M45/M1	0,043 (11)	Ratio
1958Sh64	O123/M1	0,029 (10)	Ratio, excluded
1959Ch31	MN	106 (6)	ICC, Excluded, discrepant > 20 σ
1964Ka02	T	325 (35)	Total ICC
1965Du02	M2/M1	0,33 (6)	Ratio
1965Du02	M3/M1	0,39 (6)	Ratio
1967Ma42	M2/M1	0,31 (2)	Ratio
1967Ma42	M3/M1	0,34 (2)	Ratio
1967Ma42	N2/N1	0,25 (2)	Ratio
1967Ma42	N3/N1	0,41 (4)	Ratio
1967Ma42	M/N	4,2 (3)	Ratio
1967Ma42	N/O	6,4 (6)	Ratio
1968Ca06	M2/M1	0,368 (14)	Ratio
1968Ca06	M3/M1	0,380 (14)	Ratio
1968Ca06	M4/M1	0,009 (2)	Ratio
1968Ca06	M5/M1	0,010 (2)	Ratio
1968Ca06	N1/M1	0,221 (6)	Ratio
1968Ca06	N2/M1	0,064 (3)	Ratio

1968Ca06	N3/M1	0,076 (2)	Ratio
1968Ca06	N45/M1	0,0020 (2)	Ratio, outlier
1968Ca06	O1/M1	0,037 (1)	Ratio
1968Ca06	O23/M1	0,0208 (6)	Ratio, outlier
1968Wa05	T	220 (50)	Total ICC
2001KoZQ	O2/O1	0,30 (4)	Ratio
2001KoZQ	O3/O1	0,24 (4)	Ratio
2001KoZQ	P1/O1	0,054 (12)	Ratio
2015In**	M2/M1	0,34 (4)	Ratio
2015In**	N3/N1	0,40 (6)	Ratio
Reduced χ^2		2,7	
Mixing Ratio		**0,0306 (16)**	Deduced from parabolic search

The adopted mixing ratio of 0,0306 (16) was deduced from the experimental values listed above by the program BrIccMixing. This program uses two procedures to determine the best parameter values and uncertainties:
(a) Chi-squared fit, based on the CFIT [1980Ry04] program;
(b) Searching the $\chi^2(ICC_{Theor}, ICC_{Exp})$ hypersurface.

The total conversion coefficient is then α_T = 251 (10). This value is consistent with the experimental ICC of 220 (50) determined by Wagner (1968Wa05), but not with the value of 325 (35) obtained by Kankeleit *et al,* (1964Ka02) or 106 (6) by Charpak and Suzor (1959Ch31), it is also not consistent with the value of 148 (26) deduced from the Yb-169 decay scheme. It is noteworthy that this latter value was derived from a series of measurements of the absolute γ ray intensities, including the 8,7 keV ray, carried out by several laboratories, thus it should be considered as confident.

The 109,7 keV γ transition is a mixture of M1 and E2, the adopted mixing ratio is 2,17 (4) % as determined in the ^{169}Yb evaluation (2004BeZQ).
With the conversion coefficients given by the BrIcc program, the transition probabilities are:
$P\gamma_{109}$ = 0,0152 (3) %
$P\gamma_{118}$ ~ 0,0013 %

Gamma-ray emissions

From the β intensity and the α_T coefficient as determined above, the intensity of the 8,4 keV γ ray is 0,174 (21) %,
Bisi (1956Bi30) reported that if a γ -ray of 110 keV occurs it would have an intensity lower than 10^{-4} per β decay. Later, Sharma *et al,* (1970Sh09) measured the gamma spectrum in the decay of ^{169}Er, observed two rays with energy 109,7 and 118,2 keV respectively, but gave only the intensity of the sum, *i.e,* 0,005 (1) %, Looking at the spectrum shown in 1970Sh09, the intensity of the 109,7 keV ray seems to be about four times greater than the intensity of the 118,2 keV ray. But in the decay of ^{169}Yb, which has been extensively studied (2002Be05), the ratio $\gamma_{109}/\gamma_{118}$ is 9,28 (7); this leads to $I\gamma_{109}$ = 0,0045 (9) % and $I\gamma_{118}$ ~ 0,0005 %,

The energy spectrum of the X-rays has been evaluated using the same procedure as for the Auger electrons. The mean energy and intensity of each major X-ray group is for 100 β decays.

X-ray transition	Mean energy (keV)	X rays (%)
M_{total}	1,496	0,529
N_{total}	0,208	0,043
O_{total}	0,037	1,44
Total	0,674	2,03

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