

**¹³³I - Comments on evaluation of decay data
by M. Galán**

1) Decay Scheme

¹³³I disintegrates by β^- emission to excited levels in ¹³³Xe, included the isomeric state ¹³³Xe^m at 233 keV ($T_{1/2} = 2,198$ (13) d).

¹³³I ground state has $J^\pi = 7/2^+$ (1976FU06).

2) Nuclear Data

The Q value is from AME2003 (2003Au03): $Q(\beta^-) = 1757$ (4) keV.

Level energies have been obtained from a least-squares fit to γ -ray energies (GTOL computer code) from 1976ME16. The energy of the isomeric level is from the ¹³³Xe^m evaluation. Spin and parities are from 1995RA12 except for the 1386-keV level. For this level the adopted value is $J^\pi(1386) = 7/2^+$ as proposed by 1976ME16 based on M1+E2 to $5/2^+$ (deduced from $\delta(856) = +3,7$ (3) (1974KO26 and 1977KR13)). J^π for 743-, 875-, 911-, and 1236-keV levels are uncertain.

The measured ¹³³I half-life values, in hours, are:

Reference	Value (h)	Comments
1968RE04	20,9 (1)	
1966EI01	20,8 (2)	
1965AN05	20,3 (3)	Rejected by Chauvenet's criterion
1955WA35	20,9 (3)	
1953KA28	20,8 (2)	
LWeight for Excel Code		
Nb of input values	4	
Reduced χ^2	0,10	
Weighted Mean	20,86	
Internal uncertainty	0,09	
External uncertainty	0,03	
Ave Tool Code		
Nb of input values	4	
	Mean	Reduced χ^2
LWM	20,87 (8)	0,11
NRM	20,87 (8)	0,11
RT	20,87 (8)	

The half-life was calculated by the Lweight for Excel code (version 2004) and by AveTool code. In both codes the value of 1965AN05 was rejected based on the Chauvenet's criterion. Ave Tool was run again without the value from 1965AN05. The results of the three statistical methods LWM (Limitation of

Relative Statistical Weight), NRM (Normalised Residual Method) and RT (Rajeval Technique) given by AveTool are also shown in the table. The recommended value is 20,87 (8) h.

2.1) b Transitions

The energies of the β transitions were deduced from the Q value and the level energies in ^{133}Xe , the later deduced from γ -ray transition energies. Some experimental values (1966Ei01) with the adopted ones are compared in the table:

Beta Transition	Adopted (keV)	1966Ei01 (keV)
$\beta_{0,9}$	521 (4)	500 (30)
$\beta_{0,6}$	882 (4)	890 (30)
$\beta_{0,3}$	1227 (4)	1230 (30)
$\beta_{0,1}$	1524 (4)	1540 (30)

The β^- probabilities and associated uncertainties have been deduced from γ -ray transition intensity balance at each level of the decay scheme, assuming no β^- transition to the ground state. These values are compared to the β^- emission probabilities measured by 1966Ei01, 1971SA09 and 1976ME16. The $\lg ft$ values were calculated using the program LOGFT for the Allowed, 1st Forbidden and 1st Unique Forbidden β^- transitions.

Beta Transition	Adopted (%)	1966Ei01 (%)	1971SA09 (%)	1976ME16 (%)
$\beta_{0,13}$	0,414 (15)	0,5	0,5	0,42
$\beta_{0,12}$	1,25 (4)	3,5	1,1	1,26
$\beta_{0,11}$	0,397 (12)	0,4	0,3	0,4
$\beta_{0,10}$	3,75 (7)	3,7	2,9	3,68
$\beta_{0,9}$	3,12 (6)	3,3	3,2	3,16
$\beta_{0,8}$	0,58 (5)	0,5	0,5	0,62
$\beta_{0,7}$	0,026 (18)	-	-	-
$\beta_{0,6}$	4,16 (13)	2,3	3,5	4,1
$\beta_{0,5}$	1,81 (6)	-	2,3	1,81
$\beta_{0,3}$	83,44 (21)	85,4	83,2	83,5
$\beta_{0,1}$	1,07 (6)	1,4	1,4	1,07

A beta transition of about 1080 keV to the 680-keV level was observed by 1966Ei01 with a β^- probability = 0,3 %. 1971SA09 reported 0,2 % β^- probability for this transition.

2.2) g-ray Transitions

Transition Probabilities

For the 233-keV gamma transition probability, the adopted value is 2,88 (2) % measured by 1976ME16. Other transition probabilities have been calculated from the γ -ray emission probabilities using the recommended internal conversion coefficients.

Mixing ratios and internal conversion coefficients

For the 233-keV γ -ray transitions the adopted δ (mixing ratio) is from $^{133}\text{Xe}^m$ evaluation. The adopted δ values for the 417-, 422-, 529-, 680- and 1298-keV are from 1977KR13. The adopted values were

deduced from angular correlation data. For the 768-, 820 and 856 γ -ray transitions the adopted δ values are from 1974KO26 obtained by directional distributions of γ -rays. For the 909-keV line a $\delta(909) = +0,40$ (6) has been adopted, as was reported by 1974KO26 if the $J^\pi(1589) = 5/2^+$.

The internal conversion coefficients (ICC) were calculated using the BrIcc computer code, which interpolated ICC values from tables of Band *et al.* (2002BA85).

Only experimental measurements of α_K and K/L values were found for the internal transition of 233-keV (see $^{133}\text{Xe}^m$ evaluation).

3) Atomic Data

Atomic values (ω_K , $\overline{\omega}_L$ and η_{KL}) are from 1996SC06.

ω_K	$0,888 \pm 0,005$
$\overline{\omega}_L$	$0,097 \pm 0,005$
η_{KL}	$0,902 \pm 0,004$

The X-ray and Auger electron emission probabilities have been deduced from γ -ray and conversion electron data by using the computer code EMISSION. Results were verified with RADLST computer code.

4) Electron Emissions

The conversion electron emission probabilities have been computed from γ -ray emission probabilities and theoretical ICC values.

5) Photon Emissions

Energies

γ -ray energies and uncertainties are from level scheme. The isomeric transition γ -ray energy is from 2000HE14 (see ^{133m}Xe evaluation).

g-ray emissions

The gamma emission intensities are from 1976ME16. A 2 % was increased by the evaluator in the uncertainty to account for uncertainty calibration, as cited by 1976ME16. Other experimental measurements are shown in table 1. In table 1 the absolute intensity values reported by 1974KO26 are just compared to the absolute intensity values recommended in this evaluation. The evaluator has not used the values of 1974KO26 in the present evaluation because detailed information, such as the detector calibration and uncertainty, calculation procedure or experimental conditions under which the absolute gamma intensities were achieved, are absent.

The normalization factor has been deduced from the decay scheme using the formulas:

$$N = \frac{100 - P_{g+ce}(233keV)}{\sum_i I_{g_i} [1 + a_{T_i}]} \quad \text{and} \quad dN^2 = \left(\frac{\partial N}{\partial P_{g+ce}} \right)^2 + \sum_i \left(\frac{\partial N}{\partial I_{g_i}} dI_{g_i} \right)^2 + \sum_i \left(\frac{\partial N}{\partial a_{T_i}} da_{T_i} \right)^2,$$

where the sum is over all γ -ray transitions to the ground state (g.s.), thus considering no direct β^- feeding to the g.s. For the 233-keV γ transition probability, $P_{\gamma+ce}(233 \text{ keV})$, an absolute value of 2,88 (2) %, determined by 1976ME16, has been accepted. From the estimated α_T (BrIcc) and the evaluated relative γ

emission intensities (Table 1) the deduced normalization factor is 0,0863 (16). This result was checked with the value of 0,0863 (16) reported by GABS computer code.

In Table 5.2 Gamma Emissions. The absolute gamma emission intensity of 0,293 (4) % for the 233-keV line has been estimated by the evaluator from $P_{\gamma+ce} = 2,88$ (2) % and $\alpha_T = 8,84$ (12).

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Reference	g _{150,39}	g _{176,97}	g _{203,7}	g _{245,95}	g _{262,702}	g _{267,173}	g _{345,43}	g _{361,09}	g _{372,05}	g _{381,59}
1959HO97							-			
1966EI01					0,18 (5)					
1971SA09					5,0	1,5	3,0			
1976ME16	0,34 (7)	0,9 (2)	0,05	0,4 (1)	4,13 (7)	1,35 (6)	1,2 (2)	1,3 (4)	0,11 (6)	0,52 (5)
Recommended	0,34 (7)	0,9 (2)	0,05	0,4 (1)	4,13 (11)	1,35 (7)	1,2 (2)	1,3 (4)	0,11 (6)	0,52 (5)
1974KO26					0,35 (3)	0,10 (2)	0,06 (2)	0,16 (3)	0,16 (3)	
Absolute	0,029 (6)	0,078 (18)	0,00432 (8)	0,035 (9)	0,356 (12)	0,117 (7)	0,104 (18)	0,11 (4)	0,009 (6)	0,045 (5)

Reference	g _{386,85}	g _{417,56}	g _{422,901}	g _{438,87}	g _{510,530}	g _{510,82}	g _{522,40}	g _{529,872}	g _{537,73}	g _{554,8}
1959HO97								1000		
1966EI01			4,0 (10)		24,8 (37)			1000		
1971SA09		1,6	3,0		17 (4)					
1976ME16	0,68 (5)	1,77 (11)	3,58 (6)	0,46 (5)	21,0 (2)	< 0,1	< 1	1000 (4)	0,41 (8)	< 0,01
Recommended	0,68 (5)	1,77 (11)	3,58 (9)	0,46 (5)	21,0(5)	< 0,1	< 1	1000 (20)	0,41 (8)	< 0,01
1974KO26		0,12 (2)	0,26 (2)		1,85 (5)			87,7 (2)		
Absolute	0,059 (5)	0,153 (10)	0,309 (10)	0,040 (5)	1,81 (6)	0,004 (5)	0,04 (5)	86,3 (2)	0,035 (7)	0,0004 (5)

Reference	g _{556,17}	g _{567,1}	g _{617,974}	g _{648,76}	g _{670,10}	g _{678,65}	g _{680,247}	g _{706,578}	g _{768,382}	g _{789,59}
1959HO97								20		
1966EI01			3,0 (8)				10 (2)	17,3 (26)	5,9 (15)	
1971SA09			4,2				8,8	18	5,4	0,6
1976ME16	0,23 (3)	0,04 (3)	6,25 (6)	0,65 (15)	0,49 (6)	0,25 (8)	7,47 (9)	17,3 (2)	5,29 (9)	0,58 (4)
Recommended	0,23 (3)	0,04 (3)	6,25 (14)	0,65 (15)	0,49 (6)	0,25 (8)	7,47 (17)	17,3 (4)	5,29 (14)	0,58 (4)
1974KO26			0,53 (2)				0,61 (2)	1,47 (4)	0,43 (2)	0,04 (1)
Absolute	0,020 (3)	0,003 (3)	0,539 (15)	0,056 (13)	0,042 (6)	0,022 (7)	0,645 (19)	1,49 (4)	0,457 (15)	0,050 (4)

Reference	g _{820,506}	g _{856,278}	g _{875,329}	g _{909,67}	g _{911,49}	g _{1018,1}	g _{1035,58}	g _{1052,296}	g _{1060,07}	g _{1087,71}
1959HO97			90					10		
1966EI01	2,2 (6)	13,7 (21)	58 (5)	4 (1)				7,2 (18)	1,6 (4)	
1971SA09	2,0	14	52	4,4				5,7	1,0	
1976ME16	1,78 (6)	14,3 (4)	51,8 (2)	2,46 (7)	0,53 (7)	0,07 (3)	0,10 (2)	6,39 (7)	1,59 (6)	0,14 (2)
Recommended	1,78 (6)	14,3 (4)	51,8 (11)	2,46 (9)	0,53 (7)	0,07 (3)	0,10 (2)	6,39 (15)	1,59 (7)	0,14 (2)
1974KO26	0,15 (1)	1,18 (4)	4,42 (11)	0,25 (2)				0,54 (2)	0,14 (1)	
Absolute	0,154 (6)	1,23 (4)	4,47 (12)	0,212 (9)	0,046 (6)	0,006 (3)	0,0086 (18)	0,551 (16)	0,137 (7)	0,0121 (18)

Reference	g _{1236,441}	g _{1298,223}	g _{1327,2}	g _{1350,38}	g _{1386,15}	g _{1589,94}
1959HO97	20	40				
1966EI01	17,2 (26)	27,4 (41)		1,6 (4)		
1971SA09	18	25		1,8		0,5
1976ME16	17,3 (2)	27,0 (2)	< 0,005	1,72 (4)	0,10 (3)	0,034 (5)
Recommended	17,3 (4)	27,0 (6)		1,72 (5)	0,10 (3)	0,034 (5)
1974KO26	1,45 (4)	2,25 (6)		0,14 (1)		
Absolute	1,49 (4)	2,33 (7)	0,00022 (22)	0,148 (5)	0,0086 (26)	0,0029 (4)

The 1959HO97 values were reported to $I(529) = 100$. In the table they have been reported to 1000 for the $I(529)$.

1966EI01 did not observe the 744-keV level, so they reported $I(509,8) = 25\%$ for the γ -transition from the 1385- to the 875-keV levels instead for the 744-233 keV transition. The 1966EI01 values were reported to $I(529) = 100$. In the table they have been reported to 1000 for the $I(529)$. The uncertainty in the 1966EI01 values are estimated by the evaluator following the notes given by the authors: $\pm 8\%$ for relative intensities > 5 ; $\pm 15\%$ for relative intensities > 1 ; $\pm 25\%$ for relative intensities < 1 .

The 1971SA09 values were reported to $I(529) = 100$. In the table they have been reported to 1000 for the $I(529)$.

In 1974KO26 the absolute γ emission probabilities are given but the details of the measurements are absent.

For the relative γ intensities less than ($<$) a certain value, the adopted absolute value is the result given by GABS computer code.