

⁵⁵Fe - Comments on evaluation of decay data by M. M. Bé and V. Chisté

The initial evaluation was completed in April 1998. This revised evaluation was carried out in 2005, the literature available by December 2005 was taking into account.

1. Decay scheme

An Internal Bremsstrahlung electron capture spectrum was measured by **Isaac *et al.***, the intensity was found to be $3.24 (6) \times 10^{-5}$ relatively to K capture.

The J^π value and level energy are from **NDS 64,4** (1991). From other decay modes, the excited level energy has been determined to be 125.949 (10) keV.

2. Nuclear Data

- The Q value is from **Audi and Wapstra** (2003)
- The half-life values taking into account are, in days :

(1)	977.9	2.3	Lagoutine 1982 (DSA PC) ^a
(2)	1000.4	1.3	Houtermans 1980 (PC)
(3)	1009.0	1.7	Hoppes 1982 (PC, Si(Li))
(4)	996.8	6.0	Morel 1994 (Planar Ge)
(5)	995.0	3.0	Karmalitsyn 1998 (PC)
(6)	1003.5	2.1	Schötzig 2000 (Si(Li))
(7)	1005.2	1.4	Van Ammel 2006 (DSA PC)

^a (Method of measurement, PC = Proportional counter, DSA = Defined Solid Angle)

The (1) value is rejected because it is discrepant by Chauvenet's criterion.

With this value deleted, none of the other values has a relative weight greater than 50 %.

The Lweight calculation gives, for the six remaining values, a weighted mean value of 1003.4 d, with an external uncertainty of 1.7, an internal uncertainty of 0.7 and a reduced- χ^2 of 5.4.

This set of value is inconsistent, the three values with lower uncertainties (2, 3 and 7) are not compatible within their uncertainty limits. No trend can be distinguished.

So, the external uncertainty has been expanded so range to include the most precise value of 1000.4 d.

The adopted value is *1003.4 (30) d* or *2.747 (8) a*.

Other references not used in this evaluation due to their discrepancy or their great uncertainty comparing with the set of recent values above :

- 1037 (11) G.L. Brownell, C.J. Maletskos, Phys.Rev. 80 (1950) 1102
- 950 (7) R.P. Schuman et al., I.Inorg.Nuclear Chem. 3 (1956) 160
- 880 (44) J.S. Evens, R.A. Naumann, PPAD-2137-566 (1965) 10

2.1. Electron Capture transitions

- The EC transition energies are from $Q(\text{EC}) = 231.21$ (18) and from the individual level energies.
- The transition probabilities are deduced from the total gamma-ray transition probability balances at each level.
- The electron capture coefficients, for this allowed transition, were calculated by using the EC-capture program :

$$P_K = 0.8853$$
 (16) ; $P_L = 0.0983$ (13) ; $P_M = 0.0157$ (6) ; $P_N = 0.0006$ (2)

The LOGFT program gives :

$$P_K = 0.885$$
 (9) ; $P_L = 0.0974$ (10) ; $P_M = 0.0161$ (2) ; $P_{N+} = 0.00106$ (1)

Measurements were carried out by **Pengra et al.** :

$$P_K = 0.881$$
 (4) ; $P_L = 0.103$ (4) ; $P_{M+} = 0.0161$ (8)

Results from calculations and measurements are in good agreement, nevertheless the measured values are dependent on $\omega_K (= 0.314)$ and on the intensity of the $K\alpha$ X-ray ($= 0.89$). So, the recommended values are those of the EC-capture program.

- Several measurements or calculations were done to study the double K-shell ionization process. One can quoted **Campbell et al.**; where the total probability for double vacancies in the K shell was found to be 1.3 (2) 10^{-4} , or **Kitahara et al.** where the probability for the ejection of another K electron during the K-capture decay was estimated to be 1.01 (27) 10^{-4} . As these phenomena have very small probabilities, these results are only quoted here as a matter of interest.

2.2. Gamma transitions

A weak gamma transition is deduced from the observation of a 126 keV gamma emission. The energy is derived from the level energy.

3. Atomic Data

Several data for ω_K are deduced from measurements :

- from **Smith**, $\omega_K = 0.320$ (3) ($P_K = 0.885$ (2))
- from **Konstantinov et al.**, $\omega_K = 0.312$ (3)
- from **Dobrilovic et al.**, $\omega_K = 0.322$ (5)
- from **Kuhn et al.**, $\omega_K = 0.310$ (23)
- from **Hubbell et al.**, $\omega_K = 0.321$ (7) (deduced from photoionization cross-section measurements)

A theoretical value was also calculated by **Chen** : $\omega_K = 0.323$.

These values are in good agreement (except **Konstantinov et al.** and **Khun et al.**) with the recommended value of $\omega_K = 0.321$ (5) from the semi-empirical fit of **Bambynek 1984**.

$\overline{\omega}_L$ and η_{KL} are from **Schönfeld et al.**

3.1.1. X Radiations

- The X-ray energies were obtained by conversion of the wavelength values from **Bearden** into energies with $1 \text{ \AA} = 1.000\ 014\ 81$ (92) 10^{-10} m.
- The emission intensities are calculated by the EMISSION program from PTB with ω_K , $\overline{\omega}_L$ and η_{KL} quoted above and, $K\beta/K\alpha = 0.1359$ (14) , $K\alpha_2 / K\alpha_1 = 0.5099$ (25) (**Schönfeld et al.**).
- With $P_K = 0.8853$ (16) for this allowed transition, and $\omega_K = 0.321$ (5) the total K X-ray emission intensity is then $P_K \times \omega_K = 0.284$ (5) which can be compared with the experimental values of 0.279 (8) (**Schötzig**) and of 0.283 (2) (**Smith**).

The value given by **Smith** was obtained in an international activity measurement exercise where six laboratories reported results for $P_K \times \omega_K$. The deduced weighted mean is in good agreement with the calculated value and has a better uncertainty. However, as pointed out by **Smith**, this uncertainty is probably underestimated. So, the value of $I_K = P_K \times \omega_K \times 100 = 28.4 (5) \%$ is adopted.

3.1.2. Auger Electrons

Complete measurements of the K Auger spectrum of manganese was performed by **Kovalik et al.**, they found for the relative intensities of the K Auger groups :

$$\text{KLM/KLL} = 0.26 (2)$$

$$\text{KMM/KLL} = 0.018 (2)$$

These values are in good agreement with the recommended values calculated with the EMISSION program:

$$\text{KLM/KLL} = 0.272 (3)$$

$$\text{KMM/KLL} = 0.0185 (4)$$

The energies were taken from **Larkins** or, for the missing lines, calculated from the electron binding energies. **Kovalik et al.** also measured the energies and found a good agreement for the KLM spectrum but observed discrepancies for the KLL and KMM groups.

4.2. Gamma emissions

A weak gamma emission superimposed on the intense inner-bremsstrahlung was observed by **Zlimen et al.** and interpreted as the deexcitation of the first excited state of Mn-55. The γ -ray energy is given as 126.0 (1) keV and the γ -ray intensity as $1.3 (1) \times 10^{-7} \%$.

From the level energy 125.949 (10) keV and with a recoil energy of 0.2 eV, the retained γ -ray energy is 125.949 (10) keV.

References

- J. G. **Pengra**, H. Genz, J. P. Renier, R. W. Fink. Phys. Rev. C5,6 (1972) 2007. PL/PK, PM/PL
 L. **Dobrilovic**, D. Bek-Uzarov, M. Simovic, K. Buraei, A. Milojevic. Proc. of the International Conference on Inner-shell Ionization Phenomena CONF-720404 (1973) 128. K fluorescence yield
 Tetsuo **Kitahara**, Sakae Shimizu. Phys. Rev. C11,3 (1975) 920. P(ionisation)
 F. P. **Larkins**. At. Data Nucl. Data Tables 20,4 (1977) 338. Auger Electrons
 M. H. **Chen**. Phys. Rev. A21-2 (1980) 436. K fluorescence yield
 H. **Houtermans**, O. Milosevic, F. Reichel. Int. J. Appl. Radiat. Isotop. 31 (1980) 153. Half-life
 U. **Kuhn**, H. Genz, W. Löw, A. Richter, H. W. Müller. Z. Phys. A - Atoms and Nuclei 300 (1981) 103. K fluorescence yield
 D. D. **Hoppes**, J. M. R. Hutchinson, F. J. Schima, M. P. Unterweger. NBS-Special publication 626 (1982) 85. Half-life
 F. **Lagoutine**, J. Legrand, C. Bac. Int. J. Appl. Radiat. Isotop. 33 (1982) 711. Half-life
 D. **Smith**. Nucl. Instrum. Methods 200 (1982) 383. PkWk
 W. **Bambynek**. A. Meisel Ed. Leipzig Aug. 20-23 (1984). K fluorescence yield
 A. A. **Konstantinov**, T. E. Sazonova, S. V. Sepman, E. A. Frolov. Metrologia 26 (1989) 205. K fluorescence yield
 M. C. P. **Isaac**, V. R. Vanin, O. A. M. Helene. Z. Phys. A. 335 (1990) 243. Beta emission energies
 A. **Kovalik**, V. Brabec, J. Novak, O. Dragoun, V. M. Gorozhankin, A. F. Novgorodov, Ts. Vylov. J. Elec. Spectro. Rel. Phenomena 50 (1990) 89. Auger electrons
 J. L. **Campbell**, J. A. Maxwell, W. J. Teesdale. Phys. Rev. C. 43,4 (1991) 1656. Double K capture probability

- I. **Zlimen**, E. Browne, Y. Chan, M. T. F. da Cruz, A. Garcia, R.-M. Larimer, K. T. Lesko, E. B. Norman, R. G. Stokstad, F. E. Wietfeldt. Phys. Rev. C. 46,3 (1992) 1136. Gamma Emission
- J. H. **Hubbell**, P. N. Trehan, Nirmal Singh, B. Chand, D. Mehta, M. L. Garg, R. R. Garg, Surinder Singh, S. **Puri**. J. Phys. Chem. Ref. Data 23-2 (1994) 339. K fluorescence yield
- J. **Morel**, M. Etcheverry, M. Vallée. Nucl. Instrum. Methods A339 (1994) 232. Half-life
- E. **Schönfeld**, H. Janssen. Report PTB Ra-37 (1995). L fluorescence yield, Kb/Ka
- N. I. **Karmalitsyn**, T. E. Sazonova, A. V. Zanevsky, S. V. Sepman. Int. J. Appl. Radiat. Isotop. 49,9-11 (1998) 1363. Half-life
- U. **Schötzig**. Appl. Rad. Isotopes 53 (2000) 469. Half-life, X-ray emission intensities
- G. **Audi**, A. H. Wapstra. Nucl. Phys. A729, 1 (2003) 337 Q
- R. **Van Ammel**, S. Pommé, G. Sibbens. Appl. Rad. Isotopes 64 (2006) 1412. Half-life