^{55}Fe - 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) × 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(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 ω_K (= 0.314) and on the intensity of the Kα 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**, ω_K = 0.320 (3) (P_K = 0.885 (2))
- from **Konstantinov et al.**, ω_K = 0.312 (3)
- from **Dobrilovic et al.**, ω_K = 0.322 (5)
- from **Kuhn et al.**, ω_K = 0.310 (23)
- from **Hubbell et al.**, ω_K = 0.321 (7) (deduced from photoionization cross-section measurements)

A theoretical value was also calculated by **Chen** : ω_K = 0.323.
These values are in good agreement (except **Konstantinov et al.** and **Khun et al.**) with the recommended value of ω_K = *0.321 (5)* from the semi-empirical fit of **Bambynek 1984**.

ϖ_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 Å = 1.000 014 81 (92) 10^{-10} m.
- The emission intensities are calculated by the EMISSION program from PTB with ω_K , ϖ_L and η_{KL} quoted above and, Kβ/Kα = 0.1359 (14) , Kα_2 / Kα_1 = 0.5099 (25) (**Schönfeld *et al.***).
- With P_K = 0.8853 (16) for this allowed transition, and ω_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 :
KLM/KLL = 0.26 (2)
KMM/KLL = 0.018 (2)
These values are in good agreement with the recommended values calculated with the EMISSION program:
KLM/KLL = 0.272 (3)
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) × 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.

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