# Comments on evaluation of $^{26}$Al Electron-Capture and Positron Decay Data by Shiu-Chin Wu and E. Browne

The *Limitation of Relative Statistical Weight* [2] (LWM) method, used for averaging numbers throughout this evaluation, provided a uniform approach for the analysis of discrepant data. The uncertainty assigned to the recommended values was always greater than or equal to the smallest uncertainty of the values used to calculate the average.

**Decay Scheme**

$^{26}$Al decays 100% by EC + $\beta^+$ to $^{26}$Mg 2+ states at 1808.72 and 2938.41 keV. A measured relative emission probability for the positron annihilation radiation (511 keV) produced a total $\beta^+$ branching of 82(2)% (72Sa02). This branching agrees well with a value of 81.7% predicted by theory[1].

**Nuclear Data**

The recommended half-life of $^{26}$Al, 7.17(24) $\times$ $10^5$ y, is a weighted average ($\chi^2$/N-1=0.64, LWM) of 7.16(32) $\times$ $10^5$ y, from partial $T_{1/2}$ ($\beta^+$)= 8.73(30) $\times$ $10^5$ y, $\beta^+$ counting and mass spectrometric analysis [3], combined with $\beta^+$(%)=82(2) from measurement of positron annihilation radiation (72Sa02)); 7.05(24) $\times$ $10^5$ y, by specific activity and mass spectrometric analysis [4]; 7.8 (5) $\times$ $10^5$ y, by specific activity from a source produced by $^{26}$Mg(p,n) $^{26}$Al (the number of $^{26}$Al atoms in the source were estimated by using the reaction cross section) [5]; and 7.02 (56) $\times$ $10^5$ y, by counting the atoms of $^{26}$Al that did not disintegrate in the source (Accelerator Mass Spectrometry) [6]. The internal uncertainty in the weighted average is 0.17 $\times$ $10^5$ y. However, we adopted a conservative value of 0.24 $\times$ $10^5$ y. (the lowest uncertainty in the input experimental half-life results), because of possible correlations between the measured values.

**Gamma Rays**

Gamma-ray energies and relative emission probabilities are from measurements with Ge(Li) detectors (72Sa02). Since EC + $\beta^+$ feeding to the ground state of $^{26}$Mg is not expected ($\Delta$J=5), the sum of the relative emission probabilities of the 1808.65 (0.9976) and 2938 keV (0.025(2)) gamma rays to the ground state of $^{26}$Mg was used to normalize the decay scheme (See Table 1). A conservative estimate based on data reported by 73Ra10 gives *Log ft*>24 for a fourth forbidden unique transition. This value corresponds to $I_{EC}$<0.0005% for a possible (but yet unobserved) EC transition to 26Mg ground state. In this calculation we assumed a fractional uncertainty of 2% for the relative emission probability of the 1808.65 keV gamma ray. This value, which is based on the fractional uncertainty of the annihilation radiation (1.641(32)) quoted by 72Sa02, has a negligible effect on the uncertainty of its absolute gamma-ray emission probability.

Table 1 : Gamma-ray Energies and Relative Emission Probabilities from $^{26}$Al EC + $\beta^+$ Decay

| Energy (keV) | Relative Emission Probability (per disint.) |
|---|---|
| annihil. rad. | 1.641(32)* |
| 1129.67(10) | 0.025(2) |
| 1808.65(7) | 0.9976 |
| 2938 | 0.0024(4) |

* Corrected for annihilation of positrons in flight

Gamma-ray multipolarities and mixing ratios are from 78En08. Conversion coefficients, are insignificant, however, theoretical interpolated values between Z=10 and Z=14 from 76Ba63 have been included in this evaluation.

**Electron Capture and Positron Emission (**$b^+$)

Electron-capture and $\beta^+$ end-point energies given in Tables 2.2 and 2.3 are equal to $Q_{EC}$ = 4004.19(6) (95Au04) minus the individual level energies, and to the electron-capture energies minus 2 $m_0c^2$ (1022 keV), respectively. EC + $\beta^+$ feedings to the 1808.72 keV and 2938.41 keV levels are from gamma-ray emission probability balances. The individual electron-capture and positron emission probabilities are based on theoretical [1] $\beta^+$ / EC ratios. The total measured positron absolute emission probability (82(2)%) agrees well with a value of 81.7%, calculated for a second forbidden unique transition using a theoretical $\beta^+$ / (EC + $\beta^+$) ratio of 0.840. $\beta^+$ ($P_{\beta+}$ ) and EC ($P_{EC}$) are given in percent (%) on the decay scheme. Fractional atomic shell electron-capture probabilities are theoretical values [7], calculated with the LOGFT computer program [8].

**Atomic Data**

The X-ray and Auger electron emission probabilities given in section 3 are values calculated by using the computer program RADLST [9], the electron capture probabilities from section 2.2, and atomic data from 96Sc06.

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