# $^{13}$N – Comments on evaluation of decay data by V. Chisté and M. M. Bé

## 1) Decay Scheme

$^{13}$N disintegrates by $\beta^+$ emission (99,818 (13) %) and electron capture (0,182 (13) %) to the ground state of the stable nuclide $^{13}$C.

## 2) Nuclear Data

The Q value (2220,44 (27) keV) is from the evaluation of Audi and Wapstra (1995Au04), and has been calculated using the formula:

Q = $M(A,Z) - M(A,Z-1)$,
where M(A,Z) and M(A,Z–1) are the measured atomic masses of $^{13}$N and $^{13}$C, respectively.

The $E_{\beta+}$ deduced from this Q value ($E_{\beta+}$ = 1198,45 (27) keV) agrees with the weighted average value of 1199,00 (36) keV, deduced from measured values (see § **$\beta^+$ Transition and Electron Capture Transition**).

The measured $^{13}$N half–life values (in minutes) are given below:

**$T_{1/2}$**

| Reference | Value (min) |
|---|---|
| Ward (1939Ward) | 9,93 (3) |
| Siegbahn (1945Siegbahn) | 10,13 (10) |
| Cook (1948Cook) | 10,2 (1) |
| Churchill(1953Ch34) | 10,048 (32) |
| Wilkinson (1955Wi43) | 10,08 (4) |
| Daniel (1957Da08) | 9,960 (30) |
| Deineko (1957De22) | 10,02 (10) |
| Norbeck (1957No17) | 10,07 (6) |
| Arnell (1958Ar15) | 9,960 (30) |
| King (1960Ki02) | 9,93 (5) |
| Janecke (1960Ja12) | 9,965 (5) |
| Ebrey (1965Eb01) | 9,96 (2) |
| Bormann (1965Bo42) | 10,05 (5) |
| Ritchie (1968Ri15) | 9,963 (9) |
| Singh (1973SiYS) | 10,0 (5) |
| Azuelos (1977Az01) | 9,965 (10) |
| Katoh (1989Katoh) | 9,962 (20) |

The weighted average has been calculated using the Lweight computer program (version 3).

The Siegbahn (1945Siegbahn) and Cook (1948Cook) values have been shown to be outliers by the Lweight program, based on the Chauvenet's criterion. For the remaining 15 statistically consistent values, the largest contribution to the weighted average comes from the value of Janecke (1960Ja12), with statistical weight of 54 %. The reduced–$\chi^2$ is 1,65.

The adopted value is the weighted average : *9,9670 min*, with an uncertainty of *0,0037 min.*

### 2.1) $\beta^+$ Transition and Electron capture transition.

The $\beta^+$ and electron capture probabilities shown in Tables 2.1 and 2.2, respectively, have been deduced by using a K/$\beta^+$ ratio of (1,68 ± 0,12).$10^{-3}$ measured by Ledingham (1963Le22) and normalizing to a total probability ($P_{\beta+}$ + $P_{EC}$) of 100 %. This experimental K/$\beta^+$ ratio is close to the following theoretical values:
a) 1,864 $10^{-3}$ calculated with LOGFT program;
b) 1,939 $10^{-3}$ calculated by Fitzpatrick (1973Fitzpatrick);
c) 1,800 $10^{-3}$ given by Bambynek (1977Ba48);
d) 1,78 $10^{-3}$ given by Ledingham (1963Le22).
The uncertainties were estimated by standard error–propagation techniques.

The *lg ft* value for $\beta^+$ transition (3,654) has been calculated with the program LOGFT for an allowed transition. This value agrees with 3,637 suggested by Ajzenberg–Selove (1981Aj01, 1986Aj01 and 1991Aj01).

The partial sub shell capture probabilities $P_K$ and $P_L$ were calculated for an allowed transition using the computer program EC–Capture.

A weighted average (1199,0 (4) keV) of the $\beta^+$ end–point energy has been deduced (using the Lweight computer program, version 3) from the following measured values (in keV):

| Reference | Values (keV) |
|---|---|
| Hornyak (1950Ho01) | 1202 (5) |
| Grabowsky (1954Grabowsky) | 1185 (25) |
| Daniel (1957Da08) | 1190 (3) |
| Fitzpatrick (1973Fitzpatrick) | 1198,5 (9) |
| Raman (1978Raman) | 1198,7 (4) |

The largest contribution (with an statistical weight of 81 %) to the weighted average of these 5 values comes from the value of Raman (1978Raman). The weighted average is 1199,00 keV, with an internal uncertainty of 0,36 keV and a reduced–$\chi^2$ of 2,2. This value agrees with $E_{\beta+}$ (1198,45 (27) keV), which was deduced from the adopted Q value (1995Au04) in this evaluation.

## 3) Gamma–ray Emissions

The annihilation radiation emission intensity ($I_{\gamma511}$) is $P_{\beta+}$ ( = 99,818 (13)), multiplied by 2, without the correction factor for the annihilation–in–flight processus in the medium. That is, $I_{\gamma511}$ = 199,636 (26) %.

### 4) Atomic Data

Atomic K–fluorescence yield ($\omega_K$) is from Bambynek (1984Bambynek).

## 5) References


1939Ward W. Ward, Proc. Cambridge Phil. Soc. 35 (1939) 523 [$T_{1/2}$].
1945Siegbahn S. Siegbahn, Arkiv F. Art. Mat. Fys. 32A (1945) 9 [$T_{1/2}$].
1948Cook C. S. Cook, L. M. Langer, C. Price Jr., M. B. Sampson, Phys. Rev. 74 (1948) 502 [$T_{1/2}$].
1950Ho01 B. Hornyak, Phys. Rev. 77 (1950) 160 [end–point energy].
1952Aj38 F. Ajzenberg, Rev. Mod. Phys. 24 (1952) 321 [$T_{1/2}$ , end–point energy, log ft].
1953Ch34 J. L. W. Churchill, W. M. Jones, S. E. Hunt, Nature 172 (1953) 460 [$T_{1/2}$].
1954Grabowsky N. Grabowsky, Bull. Acad. Pol. Sci. 2 (1954) 379 [end–point energy].
1955Wi43 D. H. Wilkinson, Phys. Rev. 100 (1955) 32 [$T_{1/2}$].
1955Aj61 F. Ajzenberg, Rev. Mod. Phys. 27 (1955) 77 [$T_{1/2}$ , end–point energy, log ft].
1957No17 E. Norbeck Jr., C. S. Littlejohn, Phys. Rev. 108 (1957) 754 [$T_{1/2}$].
1957De22 S. Deineko, A. Ia. Taranov, A. K. Valter, Sov. Phys. JETP 5 (1957) 201 [$T_{1/2}$].
1957Da08 H. Daniel, U. Schmidt–Rohr, Z. Naturforsch 12A (1957) 750 [$T_{1/2}$, end point energy].
1958Ar15 S. E. Arnell, J. Dubois, O. Almen, Nucl. Phys. 6 (1958) 196 [$T_{1/2}$].
1958St50 D. Strominger, J. L. Hollander, G. T. Seaborg, Rev. Mod. Phys. 30 (1958) 585 [$T_{1/2}$ , end point energy, Q, log ft].
1960Ki02 J. D. King, R. N. H. Haslam, R. W. Parsons, Can. J. Phys. 38 (1960) 231 [$T_{1/2}$].
1960Ja12 V. J. Janecke, Z. F. Naturf. 15A (1960) 593 [$T_{1/2}$].
1963Le22 K. W. D. Ledingham, J. A. Payne, R. W. P. Drever, Proc. Int. Conf. Role of Atomic Electrons in Nuclear Transformations 2 (1963) 359 [K/β+ ratio].
1965Eb01 T. G. Ebrey, P. R. Gray, Nucl. Phys. 61 (1965) 479 [$T_{1/2}$].
1965Bo42 M. Bormann, E. Fretwurst, P. Schehka, G. Wrege, Nucl. Phys. 63 (1965) 438 [$T_{1/2}$].
1968Vatai E. Vatai, Proc. Conf. Electron Capture and higher order processes in Nucl. Decay 2 (1968) 71 [K/β+ ratio].
1968Ri15 A. I. M. Ritchie, Nucl. Inst. Meth. 64 (1968) 181 [$T_{1/2}$].
1973SiYS J. Singh, Proc. Nucl. Phys. and Solid State Phys. Symp. 15B (1972) 1 [$T_{1/2}$].
1973Fitzpatrick M. L. Fitzpatrick, K. W. D. Ledingham, J. Y. Gourlay, J. G. Lynch, J. Phys. A6 (1973) 713 [K/β+ ratio].
1976Aj04 F. Ajzenberg–Selove, Nucl. Phys. A268 (1976) 1 [$T_{1/2}$ , Q, log ft].
1977Az01 G. Azuelos, J. E. Kitching, K. Ramavataram, Phys. Rev. C15 (1977) 1847 [$T_{1/2}$].
1977Ba48 W. Bambynek, H. Behrens, M. H. Chen, B. Crasemann, M. L. Fitzpatrick, K. W. D. Ledingham, H. Genz, M. Muttere, R. L. Intemann, Revs. Modern Phys. 49 (1977) 77 [Electron Capture].
1978Raman S. Raman, C. A. Houser, T. A. Walkiewicz, I. S. Towner, Atomic Data and Nucl. Data Tables 21 (1978) 567 [$T_{1/2}$ , end point energy, Q, log ft].
1981Aj01 F. Ajzenberg–Selove, Nucl. Phys. A360 (1981) 1 [$T_{1/2}$ , Q, log ft].
1984Bambynek W. Bambynek, Proc. X–ray and Inner–Shell Processes in Atoms, Molecules and Solids, Leipzig, Aug. 20–23, 1984. Edited by A. Meisel [Atomic Data]
1986Aj01 F. Ajzenberg–Selove, Nucl. Phys. A449 (1986) 1 [$T_{1/2}$ , Q, log ft].
1989Katoh T. Katoh, K. Kawade, H. Yamamoto, JAERI–M–089–083 (1989) [$T_{1/2}$]
1991Aj01 F. Ajzenberg–Selove, Nucl. Phys. A523 (1991) 1 [$T_{1/2}$ , Q, log ft].
1995Au04 G. Audi, A.H. Wapstra, Nucl. Phys. A595 (1995) 409 [Q].
2000Codata Codata Group, Revs. Modern Phys. 72 (2000) 351 [$m_0c$].