^{32}P – Comments on evaluation of decay data by V. Chisté and M. M. Bé

1) Decay Scheme

^{32}P disintegrates by β^- emission (100 %) to the ground state of the stable nuclide ^{32}S.

2) Nuclear Data

The Q value (1710,66 (21) keV) is from Audi and Wasptra evaluation (1995Au04), and has been calculated with 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 ^{32}P and ^{32}S, respectively.

This value is in agreement with a weighted average value of 1708 (7) keV, which was calculated from measured values of the β^- end-point energy (see **β^- Transition**).

The measured ^{32}P half-life values (in days) are given below:

$T_{1/2}$

Reference	Value (days)	Comments
Ambrosen (1934Ambrosen)	17,5 (11)	Omitted from analysis
Preiswerk (1935Preiswerk)	15,0 (15)	″
Sizoo (1936Sizoo)	15,0 (1)	″
Newson (1937Newson)	14,5 (3)	″
Capron (1938Capron)	14,5 (3)	″
Cacciapuoti (1938Ca01)	14,30 (3)	
Mulder (1940Mulder)	14,07 (3)	Omitted, outlier
Klema (1948Kl28)	14,35 (5)	
Sinclair(1951Si25)	14,60 (5)	Omitted, outlier
Lockett (1953Lo09)	14,50 (4)	Omitted, outlier
Bayly (1956Bayly)	14,30 (9)	
Anders (1957An03)	14,223 (30)	Original Uc × 2
Daniel (1958Da10)	14,2 (3)	
Robert (1959Ro51)	14,55 (6)	Omitted, outlier
Marais (1961Ma46)	14,282 (20)	Original Uc × 2
Goodier (1966Go16)	14,290 (28)	Original Uc × 2
Pernaa (1969Pe04)	14,32 (1)	
Lagoutine (1969La34)	14,268 (42)	
Belyaev (1977Be59)	12 (2)	Omitted, outlier
Mudhole (1977Mu07)	14,35 (5)	
Precker (1979Pr14)	14,28 (4)	
Coursey (1994Co02)	14,26 (1)	

The first five and less precise historical values were omitted from analysis. In several cases original uncertainties have been enlarged to take into account systematic uncertainties in measurements.
The Mulder, Sinclair, Locket, Robert and Belyaev values have been shown to be outliers by the Lweight program, based on the Chauvenet's criterion. With the remaining 12 values, the weighted average is 14,284 d with an internal uncertainty of 0,006 d, an external uncertainty of 0,01 d and a reduced-χ^2 of 2,89.

The adopted value is the weighted average: *14,284 d*, with a final uncertainty expanded to include the most precise value of Coursey ((1994Co02), 14,26 (1) days)) and is *0,036 d*.

The large dispersion of the original set of data (reduced-χ^2 = 31,4) is explained by the fact that ^{32}P is mainly produced by ^{32}S(n, γ)^{32}P reaction, then, resulting samples always contain ^{33}P as an impurity which could be not correctly taking into account.

β^- Transition transition

Evaluators calculated, with LOGFT program, a *lg ft* of 7,9 for this allowed transition. The value agrees with those suggested by Endt (1967En05, 1973EnVA, 1978En02 and 1990En08).

The weighted mean of the β^- end-point energy (or Q) has been calculated (with the Lweight program, version 3) using the following measured values (in keV):

Reference	Values (keV)
Lyman (1937Lyman)	1690 (24)
Newson (1937Newson)	1590 (30)
Capron (1938Capron)	1680 (50)
Siegbahn (1946Si09)	1712 (8)
Langer (1949La06)	1689 (10)
Warshaw (1950Warshaw)	1708 (8)
Agnew (1950Ag01)	1718 (10)
Jensen (1952Je12)	1704 (8)
Antoneva (1954Antoneva)	1712 (8)
Pohm (1956Po07)	1712 (6)
Ricci (1957Ri41)	1695 (15)
Daniel (1958Da10)	1705 (4)
Johnson (1958Jo33)	1711 (3)
Nichols (1961Ni02)	1707 (1)
Fehrentz (1961Ferentz)	1705 (4)
Bosch (1963Bo31)	1706 (11)
Canty (1966Ca10)	1697 (2)
Fischbeck (1968Fi04)	1710(2)
Flothmann (1969Fl02)	1701,2 (4)
Persson (1971Pe03)	1707 (4)
Booij (1971Bo01)	1706 (4)
Zemann (1971Ze04)	1711 (2)
Moore (1976Mo12)	1712,0 (8)
Greenwood (1993Gr17)	1710,0(30)
Kojima (2001Ko07)	1708 (2)

Evaluators calculated the weighted average of these 25 values using the Lweight program (version 3) as 1705,0 keV with an uncertainty of 3,8 keV and a reduced-χ^2 of 9,6. The Lyman (1937Lyman), Newson (1937Newson), Capron (1938Capron), Langer (1949La06), Agnew (1950Ag01), Ricci (1957Ri41) and Canty (1966Ca31) values have been shown to be outliers by the Lweight program, based on the Chauvenet's criterion. For the remaining 18 values, the weighted average is 1708,0 keV with an internal

uncertainty of 0,36 keV, an external uncertainty of 1,1 keV and a reduced-χ^2 of 8,6. The final uncertainty is 7,0 keV (expanded so range includes the most precise value of Flothmann (1969Fl02)). This value is in agreement with the adopted Q value (1995Au04) in this evaluation.

References

1934Ambrosen J. Ambrosen, Z. Phys. 91 (1934) 43 [Half-life].
1935Preiswerk P. Preiswerk , H. Von Halban, Compt. Rend. 201 (1935) 722 [Half-life].
1936Sizoo G. J. Sizoo, C. P. Koene, Physica 3 (1936) 1053 [Half-life].
1937Lyman E. M. Lyman, Phys. Rev. 51 (1937) 1 [End-point energy].
1937Newson H. W. Newson, Phys. Rev. 51 (1937) 624 [Half-life, End-point energy].
1938Capron P. C. Capron, Physica 5 (1938) 882 [Half-life, End-point energy].
1938Ca01 N. B. Cacciapuoti, Nuovo Cimento 15 (1938) 213 [Half-life].
1940Mulder D. Mulder, G. W. Hoeksema , G. J. Sizoo, Physica 7 (1940) 849 [Half-life].
1946Si09 K. Siegbahn, Phys. Rev. 70 (1946) 127 [End-point energy].
1948Kl28 E. D. Klema, A. O. Hanson, Phys. Rev. 73 (1948) 106 [Half-life].
1949La06 L. M. Langer, H. C. Price Jr, Phys. Rev. 76 (1949) 641 [End-point energy].
1950Ag01 H. M. Agnew, Phys. Rev. 77 (1950) 655 [End-point energy].
1950Warshaw S. D. Warshaw, J. J. L. Chen, G. L. Appleton, Phys. Rev. 80 (1950) 288 [End-point energy].
1951Si25 W. K. Sinclair, A. F. Holloway, Nature 167 (1951) 365 [Half-life].
1952Je12 E. N. Jensen, R. T. Nichols, J. Clement, A. Pohm, Phys. Rev. 85 (1952) 112 [End-point energy].
1953Lo09 E. E. Lockett, R. H. Thomas, Nucleonics 11 (1953) 14 [Half-life].
1954Antoneva H. M. Antoneva, Izv. Akad. Nauk. (Ser. Fiz.) 18 (1954) 93 [End-point energy].
1956Bayly J. G. Bayly, Can. J. Research 28A (1956) 520 [Half-life].
1956Po07 A. V. Pohm, R. C. Waddell , E. N. Jensen, Phys. Rev. 101 (1956) 1315 [End-point energy].
1957An03 O. U. Anders, W. W. Wayne Meinke, Nucleonics 15 (1957) 68 [Half-life].
1957Ri41 R. A. Ricci, Physica 23 (1957) 693 [End-point energy].
1958Da10 H. Daniel, Nucl. Phys. 8 (1958) 191 [Half-life, End-point energy].
1958Jo33 O. E. Johnson, R. G. Johnson, L. M. Langer, Phys. Rev. 112 (1958) 2004 [End-point energy].
1959Ro51 J. Robert, Annales de Physique 4 (1959) 89 [Half-life].
1961Ni02 R. T. Nichols, R. E. McAdams, E. N. Jensen, Phys. Rev. 122 (1961) 172 [End-point energy].
1961Ferentz D. Fehrentz, H. Daniel, Nucl. Instr. Meth. 10 (1961) 185 [End-point energy].
1961Ma46 P. G. Marais, J. Deist, South Africain J. Agricultural Science 4 (1961) 627 [Half-life].
1963Bo31 H. E. Bosch, T. Urstein, Nucl. Instr. Meth. 24 (1963) 109 [End-point energy].
1966Ca10 M. J. Canty, W. F. Davidson, R. D. Connor, Nucl. Phys. 85 (1966) 317 [End-point energy].
1966Go16 I. W. Goodier, D. H. Pritchard, Int. J. Appl. Rad. Isotopes 17 (1966) 121 [Half-life].
1967En05 P. M. Endt, C. van der Leun, Nucl. Phys. A105 (1967) 1 [End-point energy, Half-life, Q, lg ft].
1968Fi04 H. J. Fischbeck, Phys. Rev. 173 (1968) 1078 [End-point energy].
1969Fl02 D. Flothmann, W. Wiesner, R. Lohken, H. Rebel, Z. Phys. 225 (1969) 164 [End-point energy].
1969Pe04 D. W. Pernaa, Int. J. Appl. Rad. Isotopes 20 (1969) 613 [Half-life].
1969La34 F. Lagoutine, J. Legrand, Y. Le Gallic, Int. J. Appl. Rad. Isotopes 20 (1969) 868 [Half-life].
1971Bo01 H. M. W. Booij, E. A. van Hoek, H. van der Molen, W. F. Slot, J. Blok, Nucl. Phys. A160 (1971) 337 [End-point energy].
1971Pe03 B. I. Persson, I. Plesser, Nucl. Phys. A167 (1971) 470 [End-point energy].
1971Ze04 H. Zemann, Nucl. Phys. A175 (1971) 385 [End-point energy].
1973EnVA P. M. Endt, C. van der Leun, Nucl. Phys. A214 (1973) 1 [End-point energy, Half-life, Q, lg ft].

1976Mo12	R. B. Moore, S. I. Hayakawa, D. M. Rehfield, Nucl. Instr. Meth. 133 (1976) 457 [End-point energy].
1977Mu07	T. S. Mudhole, Indian J. Pure and Appl. Phys. 15 (1977) 284 [Half-life].
1977Be59	B. N. Belyaev, S. S. Vasilenko, A. I. Egorov, A. I. Pautov, Izv. Akad. Nauk. (Ser. Fiz.) 41 (1977) 1611/ Bull. Acad. Sci. USSR, Phys. Ser. 41(1977)66 [Half-life].
1978En02	P. M. Endt, C. van der Leun, Nucl. Phys. A310 (1978) 1 [End-point energy, Half-life, Q, lg ft].
1979Pr14	J. Precker, K. Blansdorf, Atomkernenergie 34 (1979) 136 [Half-life, End-point energy].
1985Wa02	A. H. Wapstra, Nucl. Phys. A432 (1985) 1 [End-point energy].
1990En08	P. M. Endt, Nucl. Phys. A521 (1990) 1 [End-point energy, Half-life, Q, lg ft].
1993Gr17	R. C. Greenwood, M. H. Putnam, Nucl. Instr. Meth. Phys. Res. A337 (1993) 106 [End-point energy].
1994Co02	B. M. Coursey, J. M. Calhoun, J. Cessna, D. B. Golas, F. J. Schima, M. P. Unterweger, Nucl. Instr. Meth. Phys. Res. A339 (1994) 26 [Half-life].
1995Au04	G. Audi, A. H. Wapstra, Nucl. Phys. A595 (1995) 409 [Q].
1996Sc06	E. Schönfeld, H. Janβen, Nucl. Phys. Instr. Meth. Phys. Res. A369 (1996) 527 [Atomic data].
2001Ko07	Y. Kojima, M. Shibata, H. Uno, K. Kawade, A. Taniguchi, Y. Kawase, K. Shizuma, Nucl. Instr. Meth. Phys. Res. A458 (2001) 656 [End-point energy].