



$$J = \frac{1}{2}$$

e MASS (atomic mass units u)

The primary determination of an electron's mass comes from measuring the ratio of the mass to that of a nucleus, so that the result is obtained in u (atomic mass units). The conversion factor to MeV is more uncertain than the mass of the electron in u; indeed, the recent improvements in the mass determination are not evident when the result is given in MeV. In this datablock we give the result in u, and in the following datablock in MeV.

| <u>VALUE (10^{-6} u)</u> | <u>DOCUMENT ID</u> | <u>TECN</u> | <u>COMMENT</u> |
|---|----------------------|-------------|------------------------|
| 548.5799045 ± 0.00000024 | MOHR | 05 | RVUE 2002 CODATA value |
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | |
| 548.5799092 ± 0.0000004 | ¹ BEIER | 02 | CNTR Penning trap |
| 548.5799110 ± 0.0000012 | MOHR | 99 | RVUE 1998 CODATA value |
| 548.5799111 ± 0.0000012 | ² FARNHAM | 95 | CNTR Penning trap |
| 548.579903 ± 0.000013 | COHEN | 87 | RVUE 1986 CODATA value |

¹ BEIER 02 compares Larmor frequency of the electron bound in a $^{12}\text{C}^{5+}$ ion with the cyclotron frequency of a single trapped $^{12}\text{C}^{5+}$ ion.

² FARNHAM 95 compares cyclotron frequency of trapped electrons with that of a single trapped $^{12}\text{C}^{6+}$ ion.

e MASS

2002 CODATA gives the conversion factor from u (atomic mass units, see the above datablock) as 931.494 043 (80). Earlier values use the then-current conversion factor. The conversion error dominates the masses given below.

| <u>VALUE (MeV)</u> | <u>DOCUMENT ID</u> | <u>TECN</u> | <u>COMMENT</u> |
|---|------------------------|-------------|------------------------|
| 0.510998918 ± 0.000000044 | MOHR | 05 | RVUE 2002 CODATA value |
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | |
| 0.510998901 ± 0.000000020 | ^{3,4} BEIER | 02 | CNTR Penning trap |
| 0.510998902 ± 0.000000021 | MOHR | 99 | RVUE 1998 CODATA value |
| 0.510998903 ± 0.000000020 | ^{3,5} FARNHAM | 95 | CNTR Penning trap |
| 0.510998895 ± 0.000000024 | ³ COHEN | 87 | RVUE 1986 CODATA value |
| 0.5110034 ± 0.0000014 | COHEN | 73 | RVUE 1973 CODATA value |

³ Converted to MeV using the 1998 CODATA value of the conversion constant, 931.494013 ± 0.0000037 MeV/u.

⁴ BEIER 02 compares Larmor frequency of the electron bound in a $^{12}\text{C}^{5+}$ ion with the cyclotron frequency of a single trapped $^{12}\text{C}^{5+}$ ion.

⁵ FARNHAM 95 compares cyclotron frequency of trapped electrons with that of a single trapped $^{12}\text{C}^{6+}$ ion.

$$(m_{e^+} - m_{e^-}) / m_{\text{average}}$$

A test of *CPT* invariance.

| <u>VALUE</u> | <u>CL%</u> | <u>DOCUMENT ID</u> | <u>TECN</u> | <u>COMMENT</u> |
|--|------------|--------------------|-------------|--------------------------|
| $<8 \times 10^{-9}$ | 90 | ⁶ FEE | 93 CNTR | Positronium spectroscopy |
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | | |
| $<4 \times 10^{-8}$ | 90 | CHU | 84 CNTR | Positronium spectroscopy |
| ⁶ FEE 93 value is obtained under the assumption that the positronium Rydberg constant is exactly half the hydrogen one. | | | | |

$$|q_{e^+} + q_{e^-}|/e$$

A test of *CPT* invariance. See also similar tests involving the proton.

| <u>VALUE</u> | <u>DOCUMENT ID</u> | <u>TECN</u> | <u>COMMENT</u> |
|--|-----------------------|-------------|---------------------|
| $<4 \times 10^{-8}$ | ⁷ HUGHES | 92 RVUE | |
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | |
| $<2 \times 10^{-18}$ | ⁸ SCHAEFER | 95 THEO | Vacuum polarization |
| $<1 \times 10^{-18}$ | ⁹ MUELLER | 92 THEO | Vacuum polarization |
| ⁷ HUGHES 92 uses recent measurements of Rydberg-energy and cyclotron-frequency ratios. | | | |
| ⁸ SCHAEFER 95 removes model dependency of MUELLER 92. | | | |
| ⁹ MUELLER 92 argues that an inequality of the charge magnitudes would, through higher-order vacuum polarization, contribute to the net charge of atoms. | | | |

e MAGNETIC MOMENT ANOMALY

$$\mu_e/\mu_B - 1 = (g-2)/2$$

The CODATA value assumes the $g/2$ values for e^+ and e^- are equal, as required by *CPT*.

| <u>VALUE (units 10^{-6})</u> | <u>DOCUMENT ID</u> | <u>TECN</u> | <u>CHG</u> | <u>COMMENT</u> |
|---|--------------------|-------------|------------|-------------------|
| 1159.6521859 ± 0.0000038 | MOHR | 05 RVUE | | 2002 CODATA value |
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | | |
| 1159.6521869 ± 0.0000041 | MOHR | 99 RVUE | | 1998 CODATA value |
| 1159.652193 ± 0.000010 | COHEN | 87 RVUE | | 1986 CODATA value |
| 1159.6521884 ± 0.0000043 | VANDYCK | 87 MRS | - | Single electron |
| 1159.6521879 ± 0.0000043 | VANDYCK | 87 MRS | + | Single positron |

$$(g_{e^+} - g_{e^-}) / g_{\text{average}}$$

A test of *CPT* invariance.

| VALUE (units 10^{-12}) | CL% | DOCUMENT ID | TECN | COMMENT |
|---|-----|-------------------------|---------|-----------------------------|
| -0.5 ± 2.1 | | ¹⁰ VANDYCK | 87 MRS | Penning trap |
| ● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ● | | | | |
| < 12 | 95 | ¹¹ VASSERMAN | 87 CNTR | Assumes $m_{e^+} = m_{e^-}$ |
| 22 \pm 64 | | SCHWINBERG | 81 MRS | Penning trap |
| ¹⁰ VANDYCK 87 measured $(g_-/g_+) - 1$ and we converted it. | | | | |
| ¹¹ VASSERMAN 87 measured $(g_+ - g_-)/(g - 2)$. We multiplied by $(g - 2)/g = 1.2 \times 10^{-3}$. | | | | |

e ELECTRIC DIPOLE MOMENT

A nonzero value is forbidden by both T invariance and P invariance.

| VALUE (10^{-26} e cm) | CL% | DOCUMENT ID | TECN | COMMENT |
|---|-----|------------------------|--------|-------------------------|
| 0.069 ± 0.074 | | REGAN | 02 MRS | ²⁰⁵ Tl beams |
| ● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ● | | | | |
| 0.18 \pm 0.12 \pm 0.10 | | ¹² COMMINS | 94 MRS | ²⁰⁵ Tl beams |
| - 0.27 \pm 0.83 | | ¹² ABDULLAH | 90 MRS | ²⁰⁵ Tl beams |
| - 14 \pm 24 | | CHO | 89 NMR | Tl F molecules |
| - 1.5 \pm 5.5 \pm 1.5 | | MURTHY | 89 | Cesium, no B field |
| - 50 \pm 110 | | LAMOREAUX | 87 NMR | ¹⁹⁹ Hg |
| 190 \pm 340 | 90 | SANDARS | 75 MRS | Thallium |
| 70 \pm 220 | 90 | PLAYER | 70 MRS | Xenon |
| < 300 | 90 | WEISSKOPF | 68 MRS | Cesium |
| ¹² ABDULLAH 90, COMMINS 94, and REGAN 02 use the relativistic enhancement of a valence electron's electric dipole moment in a high-Z atom. | | | | |

e⁻ MEAN LIFE / BRANCHING FRACTION

A test of charge conservation. See the "Note on Testing Charge Conservation and the Pauli Exclusion Principle" following this section in our 1992 edition (Physical Review **D45**, 1 June, Part II (1992), p. VI.10).

Most of these experiments are one of three kinds: Attempts to observe (a) the 255.5 keV gamma ray produced in $e^- \rightarrow \nu_e \gamma$, (b) the (K) shell x ray produced when an electron decays without additional energy deposit, e.g., $e^- \rightarrow \nu_e \bar{\nu}_e \nu_e$ ("disappearance" experiments), and (c) nuclear de-excitation gamma rays after the electron disappears from an atomic shell and the nucleus is left in an excited state. The last can include both weak boson and photon mediating processes. We use the best $e^- \rightarrow \nu_e \gamma$ limit for the Summary Tables.

Note that we use the mean life rather than the half life, which is often reported.

e⁻ \rightarrow $\nu_e \gamma$ and astrophysical limits

| VALUE (yr) | CL% | DOCUMENT ID | TECN | COMMENT |
|---|-----|-------------|---------|------------------------------|
| $> 4.6 \times 10^{26}$ | 90 | BACK | 02 BORX | $e^- \rightarrow \nu \gamma$ |

• • • We do not use the following data for averages, fits, limits, etc. • • •

| | | | | |
|------------------------|----|---------------------|----------|---|
| $>3.4 \times 10^{26}$ | 68 | BELLI | 00B DAMA | $e^- \rightarrow \nu\gamma$, liquid Xe |
| $>3.7 \times 10^{25}$ | 68 | AHARONOV | 95B CNTR | $e^- \rightarrow \nu\gamma$ |
| $>2.35 \times 10^{25}$ | 68 | BALYSH | 93 CNTR | $e^- \rightarrow \nu\gamma$, ^{76}Ge detector |
| $>1.5 \times 10^{25}$ | 68 | AVIGNONE | 86 CNTR | $e^- \rightarrow \nu\gamma$ |
| $>1 \times 10^{39}$ | | $^{13}\text{ORITO}$ | 85 ASTR | Astrophysical argument |
| $>3 \times 10^{23}$ | 68 | BELLOTTI | 83B CNTR | $e^- \rightarrow \nu\gamma$ |

$^{13}\text{ORITO}$ 85 assumes that electromagnetic forces extend out to large enough distances and that the age of our galaxy is 10^{10} years.

Disappearance and nuclear-de-excitation experiments

| VALUE (yr) | CL% | DOCUMENT ID | TECN | COMMENT |
|-----------------------|-----|---------------------|----------|------------------------------------|
| $>6.4 \times 10^{24}$ | 68 | $^{14}\text{BELLI}$ | 99B DAMA | De-excitation of ^{129}Xe |

• • • We do not use the following data for averages, fits, limits, etc. • • •

| | | | | |
|-----------------------|----|---------------------|----------|--|
| $>4.2 \times 10^{24}$ | 68 | BELLI | 99 DAMA | Iodine L-shell disappearance |
| $>2.4 \times 10^{23}$ | 90 | $^{15}\text{BELLI}$ | 99D DAMA | De-excitation of ^{127}I (in NaI) |
| $>4.3 \times 10^{23}$ | 68 | AHARONOV | 95B CNTR | Ge K-shell disappearance |
| $>2.7 \times 10^{23}$ | 68 | REUSSER | 91 CNTR | Ge K-shell disappearance |
| $>2 \times 10^{22}$ | 68 | BELLOTTI | 83B CNTR | Ge K-shell disappearance |

$^{14}\text{BELLI}$ 99B limit on charge nonconserving e^- capture involving excitation of the 236.1 keV nuclear state of ^{129}Xe ; the 90% CL limit is 3.7×10^{24} yr. Less stringent limits for other states are also given.

$^{15}\text{BELLI}$ 99D limit on charge nonconserving e^- capture involving excitation of the 57.6 keV nuclear state of ^{127}I . Less stringent limits for the other states and for the state of ^{23}Na are also given.

e REFERENCES

| | | | | |
|-----------|-----|-------------------------|--|--------------------------|
| MOHR | 05 | RMP 77 1 | P.J. Mohr, B.N. Taylor | (NIST) |
| BACK | 02 | PL B525 29 | H.O. Back <i>et al.</i> | (BOREXINO/SASSO Collab.) |
| BEIER | 02 | PRL 88 011603 | T. Beier <i>et al.</i> | |
| REGAN | 02 | PRL 88 071805 | B.C. Regan <i>et al.</i> | |
| BELLI | 00B | PR D61 117301 | P. Belli <i>et al.</i> | (DAMA Collab.) |
| BELLI | 99 | PL B460 236 | P. Belli <i>et al.</i> | (DAMA Collab.) |
| BELLI | 99B | PL B465 315 | P. Belli <i>et al.</i> | (DAMA Collab.) |
| BELLI | 99D | PR C60 065501 | P. Belli <i>et al.</i> | (DAMA Collab.) |
| MOHR | 99 | JPCRD 28 1713 | P.J. Mohr, B.N. Taylor | (NIST) |
| Also | | RMP 72 351 | P.J. Mohr, B.N. Taylor | (NIST) |
| AHARONOV | 95B | PR D52 3785 | Y. Aharonov <i>et al.</i> | (SCUC, PNL, ZARA+) |
| Also | | PL B353 168 | Y. Aharonov <i>et al.</i> | (SCUC, PNL, ZARA+) |
| FARNHAM | 95 | PRL 75 3598 | D.L. Farnham, R.S. van Dyck, P.B. Schwinberg | (WASH) |
| SCHAEFER | 95 | PR A51 838 | A. Schaefer, J. Reinhardt | (FRAN) |
| COMMINS | 94 | PR A50 2960 | E.D. Commins <i>et al.</i> | |
| BALYSH | 93 | PL B298 278 | A. Balysh <i>et al.</i> | (KIAE, MPIH, SASSO) |
| FEE | 93 | PR A48 192 | M.S. Fee <i>et al.</i> | |
| HUGHES | 92 | PRL 69 578 | R.J. Hughes, B.I. Deutch | (LANL, AARH) |
| MUELLER | 92 | PRL 69 3432 | B. Muller, M.H. Thoma | (DUKE) |
| PDG | 92 | PR D45, 1 June, Part II | K. Hikasa <i>et al.</i> | (KEK, LBL, BOST+) |
| REUSSER | 91 | PL B255 143 | D. Reusser <i>et al.</i> | (NEUC, CIT, PSI) |
| ABDULLAH | 90 | PRL 65 2347 | K. Abdullah <i>et al.</i> | (LBL, UCB) |
| CHO | 89 | PRL 63 2559 | D. Cho, K. Sangster, E.A. Hinds | (YALE) |
| MURTHY | 89 | PRL 63 965 | S.A. Murthy <i>et al.</i> | (AMHT) |
| COHEN | 87 | RMP 59 1121 | E.R. Cohen, B.N. Taylor | (RISC, NBS) |
| LAMOREAUX | 87 | PRL 59 2275 | S.K. Lamoreaux <i>et al.</i> | (WASH) |

| | | | | |
|------------|-----|-------------|--|-------------------|
| VANDYCK | 87 | PRL 59 26 | R.S. van Dyck, P.B. Schwinberg, H.G. Dehmelt | (WASH) |
| VASSERMAN | 87 | PL B198 302 | I.B. Vasserman <i>et al.</i> | (NOVO) |
| Also | | PL B187 172 | I.B. Vasserman <i>et al.</i> | (NOVO) |
| AVIGNONE | 86 | PR D34 97 | F.T. Avignone <i>et al.</i> | (PNL, SCUC) |
| ORITO | 85 | PRL 54 2457 | S. Orito, M. Yoshimura | (TOKY, KEK) |
| CHU | 84 | PRL 52 1689 | S. Chu, A.P. Mills, J.L. Hall | (BELL, NBS, COLO) |
| BELLOTTI | 83B | PL 124B 435 | E. Bellotti <i>et al.</i> | (MILA) |
| SCHWINBERG | 81 | PRL 47 1679 | P.B. Schwinberg, R.S. van Dyck, H.G. Dehmelt | (WASH) |
| SANDARS | 75 | PR A11 473 | P.G.H. Sandars, D.M. Sternheimer | (OXF, BNL) |
| COHEN | 73 | JPCRD 2 664 | E.R. Cohen, B.N. Taylor | (RISC, NBS) |
| PLAYER | 70 | JPB 3 1620 | M.A. Player, P.G.H. Sandars | (OXF) |
| WEISSKOPF | 68 | PRL 21 1645 | M.C. Weisskopf <i>et al.</i> | (BRAN) |
