

C

What was then a measured value has shifted to a defined quantity. For decades c was measured to a precision of some few parts per billion using wavelengths from krypton-86, but the advent of lasers made the old approach obsolete. Rather than continually choosing more stable transitions, the *Bureau International des Poids et Mesures* decided to fix c , thereby shifting any uncertainty in its value to the definition of a meter. In 1983, delegates for the international body governing such measures made the decision official. At the *Conference Generale des Poids et Mesures*, the speed of light was defined as exactly 299,792,498 meters per second. No experimental results will alter that value. Conference delegates also redefined the SI unit of the meter, without changing its value, based on this set quantity.

h

Recent findings have landed Planck's constant in the hot seat: values for h , derived from four electrical experiments and one X-ray crystal density experiment with silicon, differ significantly. Such uncertainty calls into question the related physical values. Current work is investigating this discrepancy by measuring anew the volume of highly enriched silicon. The BIPM is looking to fix Planck's constant as a defined quantity by 2011.

G

G , the Newtonian constant of gravitation, was first calculated using results from Henry Cavendish's 1798 experiment to determine Earth's density. Since then, it has seen little refining. G is perhaps the most difficult constant to measure. Strong though it may seem, at the subatomic level gravity's tug barely compares to that of the other fundamental forces. No shield exists to isolate experimental effects from the influence of other bodies' gravity, so G 's precision is limited by experimenters knowing exactly what mass surrounds an experiment. Although an unusual result some years ago spurred a host of new experiments, "doing any better than 10 parts per million in precision is tough," says National Institute of Standards and Technology scientist emeritus Barry Taylor.

R_∞

Rydberg's constant, R_∞ , related to the wavelengths of an element's spectral lines, ranks both among the most precise and most improved. Its precision, with an uncertainty of 6.6 parts per trillion, has increased by four and a half orders of magnitude since the pocket table was first published. It owes such gains to advances in theoretical work—particularly predictions of energy levels of the hydrogen atom—that broke new ground for experimental work.

α

The fine structure constant, α , has recently seen a great leap forward in precision to 0.7 parts per billion. The improvement came from a combination of a much better measurement of the electron's magnetic moment μ_e , with an uncertainty of 0.76 parts per trillion, and a new set of theoretical calculations that relate α to μ_e . Any more refining by this approach will take a serious commitment: supercomputer calculations conducted over more than 10 years evaluated the 891 Feynman diagrams needed for the theoretical calculation. The next level of precision requires 12,672 diagrams.

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| c | $= 2.997930 (3) \times 10^{10} \text{ cm sec}^{-1}$ |
| e | $= 4.80286 (9) \times 10^{-10} \text{ esu}$ |
| m | $= 9.1083 (3) \times 10^{-28} \text{ gm}$ |
| h | $= 6.62517 (23) \times 10^{-27} \text{ erg sec}$ |
| \hbar | $= 1.05443 (9) \times 10^{-27} \text{ erg sec}$ |
| k | $= 1.38044 (7) \times 10^{-16} \text{ erg deg}^{-1} \text{ K}$ |
| G | $= 6.670 (5) \times 10^{-8} \text{ dyne cm}^2 \text{ gm}^{-2}$ |
| N_0 | $= 6.02486 (16) \times 10^{23} \text{ gm-mole}^{-1}$ |
| R_0 | $= 8.31696 (34) \times 10^7 \text{ erg mole}^{-1} \text{ deg}^{-1} \text{ C}$ |
| V_0 | $= 22.4207 (6) \times 10^3 \text{ cm}^3 \text{ mole}^{-1}$ |
| F' | $= N_0 e / c = 9652.19 (11) \text{ emu gm-mole}^{-1}$ |
| R_∞ | $= e^2 m / 4\pi \hbar^3 c = 109737.309 (12) \text{ cm}^{-1}$ |
| α^{-1} | $= hc / e^2 = 137.0373 (6)$ |
| e/mc | $= 1.75890 (2) \times 10^7 \text{ emu gm}^{-1}$ |
| h/e | $= 1.37942 (2) \times 10^{-17} \text{ erg sec esu}^{-1}$ |
| a_0 | $= \hbar^2 / me^2 = 0.529172 (2) \times 10^{-8} \text{ cm}$ |
| r_0 | $= e^2 / mc^2 = 2.81785 (4) \times 10^{-13} \text{ cm}$ |
| 1 amu | $= 931.141 (10) \text{ Mev}$ |
| M_p | $= 938.211 (10) \text{ Mev}$ |
| m | $= 0.510976 (7) \text{ Mev}$ |

Text: Krista Zala
Pocket card courtesy
of Harvey Lynch