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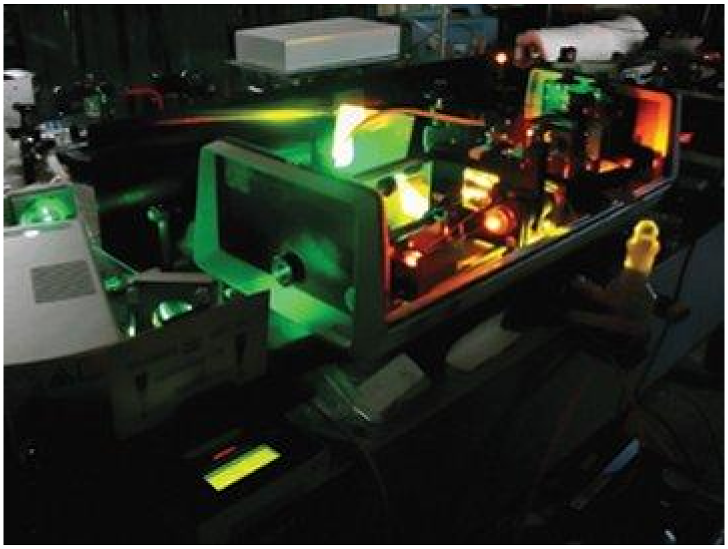
Universe in Flux: Constant of nature might have changed

Peter Weiss

Scientists have long assumed that a few characteristics of the cosmos are as unvarying as the laws of physics themselves. These so-called constants of nature include the speed of light in a vacuum and the masses of some elementary particles.



BEAMING. Measurements of hydrogen molecules conducted with this laser system suggest that a constant of nature has changed its value since the universe was young.
Laser Center, Vrije Univ.

Now, a team of physicists and astronomers in the Netherlands, Russia, and France has found signs that one of the constants has undergone a subtle shift since the infancy of the universe.

The new findings indicate that the ratio between the mass of the proton and that of the electron—a number known as mu—might have decreased by about two-thousandths of a percent in the past 12 billion years, say Elmar Reinhold, now of the European Space Agency in Noordwijk, the Netherlands, and his colleagues. The evidence for the change in the constant, which has a current value of 1,836.153, emerged from light-absorption patterns of hydrogen molecules, the scientists report in the April 21 *Physical Review Letters*.

"If correct, it is a revolutionary result," comments Victor V. Flambaum of the University of New South Wales in Sydney, Australia. "It doesn't matter that the variation is small. If mu varies, we need new theoretical physics and cosmology."

Flambaum notes that variations in constants of nature as the cosmos evolves are part of some speculative theories of the universe, such as string theory, that call for dimensions beyond the familiar three of space plus one of time.

Since 2001, Flambaum and his colleagues have presented growing evidence that another constant, known as alpha or the fine-structure constant, has also varied (SN: 10/6/01, p. 222: http://www.sciencenews.org/articles/20011006/bob16.asp). That variation, however, is less than the newly determined change in mu. Investigations by several other teams have found no evidence that alpha, which represents the strength of the electromagnetic force, has changed its value (SN: 5/14/05, p. 318: Available to subscribers at http://www.sciencenews.org/articles/20050514/note15.asp; 5/8/04, p. 301: Available to subscribers at http://www.sciencenews.org/articles/20040508/note10.asp).

To arrive at the new findings for mu, Alexandre V. Ivanchik of the Ioffe Institute in St. Petersburg, Russia, and Patrick Petitjean of the Astrophysics Institute of Paris made extraordinarily precise telescope measurements of radiation coming from two quasars. The researchers focused on wavelengths absorbed by frigid clouds of hydrogen molecules in space. Because looking deep into space is equivalent to looking back in time, the quasar-radiation measurements probe characteristics of hydrogen molecules as they existed less than 2 billion years after the Big Bang.

Meanwhile, Reinhold and other members of the team, led by Wim Ubachs of the Free University of Amsterdam, determined with unprecedented accuracy the wavelengths of light that hydrogen molecules absorb from laser beams in the laboratory today, 13.7 billion years after the Big Bang.

The scientists found the wavelengths to be slightly different in the two sets of data. Because the wavelengths that hydrogen molecules absorb depend on the value of mu, the results suggest that mu has changed.

Nonetheless, the absorption evidence gathered so far from two quasars isn't strong enough to prove that mu varies, say members of the team and other scientists.

Investigators studying alpha have looked at 143 quasar systems, yet the notion that alpha has varied remains controversial, notes Michael T. Murphy of the University of Cambridge in England, one of the scientists who, with Flambaum, reported the alpha variation.

Scientists "need absolutely cast-iron proof" beyond the current study because the implications are so profound, agrees Lennox L. Cowie of the University of Hawaii, Manoa in Honolulu.

References:

Barrow, J.D., and J. Magueijo. 2005. Cosmological constraints on a dynamical electron mass. *Physical Review D* 72(Aug. 15):043521. Abstract available at http://link.aps.org/abstract/PRD/v72/e043521.

Ivanchik, A., P. Petitjean, *et al*. 2005. A new constraint on the time dependence of the proton-to-electron mass ratio: Analysis of the Q 0347-383 and Q 0405-443 spectra. *Astronomy & Astrophysics* 440(September II):45-52. Abstract available at http://dx.doi.org/10.1051/0004-6361:20052648.

Reinhold, E., . . . A. Ivanchik, P. Petitjean, and W. Ubachs. 2006. Indication of a cosmological variation of the proton-electron mass ratio based on laboratory measurement and reanalysis of H_2 spectra. *Physical Review Letters* 96(April 21):151101. Abstract available at http://link.aps.org/abstract/PRL/v96/e151101.

Tzanavaris, P., . . . M.T. Murphy, V.V. Flambaum, *et al*. 2005. Limits on variations in fundamental constants from 21-cm and ultraviolet quasar absorption lines. *Physical Review Letters* 95(July 22):041301. Abstract available at http://link.aps.org/abstract/PRL/v95/e041301.

Ubachs, W., and E. Reinhold. 2004. Highly accurate H_2 Lyman and Werner band laboratory measurements and an improved constraint on a cosmological variation of the proton-to-electron mass ration. *Physical Review Letters* 92(March 12):101302. Abstract available at http://link.aps.org/abstract/PRL/v92/e101302.

Further Readings:

Barrow, J.D., and J.K. Webb. 2005. Inconstant constants. *Scientific American* 292(June):56. Article.

Weiss, P. 2005. Galactic data shore up a constant. *Science News* 167(May 14):318. Available to subscribers at http://www.sciencenews.org/articles/20050514/note15.asp.

______. Primordial nukes. *Science News* 167(March 12):170-172. Available to subscribers at http://www.sciencenews.org/articles/20050312/bob9.asp.

______. 2004. Fundamental constant didn't vary after all. *Science News* 165(May 8):301. Available to subscribers at http://www.sciencenews.org/articles/20040508/note10.asp.

______. 2001. Constant changes. *Science News* 160(Oct. 6):222-223. Available at http://www.sciencenews.org/articles/20011006/bob16.asp.

Sources:

Lennox L. Cowie
University of Hawaii, Manoa
Institute for Astronomy
2680 Woodlawn Drive
Honolulu, HI 96822-1897

Victor V. Flambaum
School of Physics
University of New South Wales
Sydney, NSW 2052
Australia

Alexandre V. Ivanchik
Ioffe Physical Technical Institut
Polytekhnicheskaya 26
194021 Saint Petersburg
Russia

Michael T. Murphy
Institute of Astronomy
University of Cambridge
Madingley Road
Cambridge CB3 0HA
United Kingdom

Patrick Petitjean
Institut d'Astrophysique de Paris—CNRS
98-bis Boulevard Arago

F-75014 Paris
France

Elmar Reinhold
Laser Centre
Vrije Universiteit
De Boelelaan 1081
1081 HV Amsterdam
Netherlands

Wim Ubachs
Laser Centre
Vrije Universiteit
De Boelelaan 1081
1081 HV Amsterdam
Netherlands

http://www.sciencenews.org/articles/20060429/fob1.asp
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