

NEWS

Shifting constant could shake laws of nature

From the speed of light to the charge on an electron, the fundamental constants of physics had been assumed to be immutable. But that comfortable assumption is being challenged.

The latest in a series of experiments to question this view suggests that over the past 12 billion years, the ratio of the mass of a proton to that of an electron may have decreased. The result has left physicists curious, sceptical, and more than a little stumped.

Protons are about 1,836 times heavier than electrons. The exact mass ratio can be calculated by observing how a cloud of hydrogen molecules (each composed of two protons and two electrons) absorbs ultraviolet laser light. Wim Ubachs of the Free University in Amsterdam, the Netherlands, and his team have done just that, producing data hundreds of times more accurate than those obtained from previous experiments (see *Nature* doi:10.1038/news060417-7; 2006).

Using the Very Large Telescope in Paranal, Chile, they compared their results obtained with hydrogen in the lab with observations of light from two distant quasars. This light shines through clouds of hydrogen around 12 billion light years away. The lab result was smaller by 0.002% (E. Reinhold *et al. Phys. Rev. Lett.* **96**, 151101; 2006).

A change of 20 parts per million over 12 billion years isn't large — “not jelly”, as Andy

Fabian of the University of Cambridge, UK, puts it. But it could point to previously unknown subtleties in the way the Universe is put together. Such an effect is not explained by anything in physicists' standard model of particle physics.

The result has a confidence level of about 3.5-sigma, a statistical term that translates into a 0.3% possibility that it could be down to chance. That's good enough to be called an “indication”, says Ubachs, but for such an important potential result it is not a cast-iron observation.

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“You don't want to book a ticket to Stockholm on a 3.5-sigma result,” chuckles John Webb, a physicist at the University of New South Wales in Sydney, Australia, who has also studied changes in the proton–electron mass ratio. “But they’ve done the best job of anyone so far on comparing the proton and electron mass.”

The mass-ratio effect has until now received less attention than the fine-structure constant, α , a measure of the electromagnetic force that keeps electrons in place inside atoms and molecules. Webb has been at the forefront of efforts to probe whether or not the mass ratio changes over time (J. K. Webb *et al. Phys. Rev. Lett.* **87**, 091301; 2001). He expects to publish his most detailed study later this year, which relies on light from many more quasars than used in previous analyses.

But the work is controversial. Webb says he has been criticized by senior astrophysicists



Weird stuff: observations of matter billions of light years away suggest the proton–electron mass ratio has changed over eons.

for even tackling the problem. “It’s as though you’re knocking a pillar of physics,” he says.

John Barrow, a cosmologist at the University of Cambridge, adds that astronomers are often more sceptical than physicists simply because they are more aware of how complicated —

NASA

US particle physics fights for survival

The United States must make a bid to host the International Linear Collider (ILC), according to a report out this week from the National Academy of Sciences. If the multi-billion-dollar particle accelerator is not built on US soil, the nation's high-energy physics community may be doomed.

High-energy physicists globally have endorsed the ILC as the next big project for the field. The collider,

30 kilometres in length, would smash together electrons and their anti-particles, known as positrons, at 500 GeV in the hope of probing fundamental particles, including the yet-to-be-discovered Higgs particle.

“Without a serious bid, the community is going to atrophy,” warns Harold Shapiro, an economist from Princeton University who chaired the panel that produced the report; the

panel was convened by the US Department of Energy and the National Science Foundation, which together fund the lion's share of high-energy physics research in the United States. In addition to recommending that the government make a strong bid for the project, the panel suggests that it invests in high-energy astrophysics and neutrino research. There are currently around 2,000

high-energy physicists working in the United States.

The report comes at a precarious time for high-energy physics in America. Earlier this year, budget cutbacks forced the Relativistic Heavy Ion Collider to take a private donation to continue operations, and the Tevatron, the nation's premier accelerator at the Fermi National Accelerator Laboratory, or Fermilab, in Batavia, Illinois, is expected to



and potentially error-prone — quasar spectroscopy can be. Fabian is certainly cautious about Ubachs' result. "Extraordinary claims require extraordinary evidence," he says, pointing out that many results at a similar confidence level turn out to be wrong. The most

likely error source lies in assumptions about the behaviour of the distant hydrogen cloud, he says. Some parts of the cloud could be hotter or moving faster than other parts, and the hydrogen might be mixed with a smattering of other elements.

Even if further studies do push the confidence level across the five-sigma threshold that physicists regard as convincing, the reason for the changed mass ratio is not understood, nor whether it is an ongoing effect. If true "the laws of physics as we currently understand them are incorrect at their very core," says Michael Murphy of the University of Cambridge, who works with Webb. "A new set of physics laws must be found which explain the new observations."

It is unlikely that protons are simply losing weight. But various versions of string theory suggest that extra dimensions occupied by a particle might affect properties such as its mass. Subtle changes in these dimensions could make physical constants vary slightly, explains Barrow. However, "there's absolutely no observational evidence to support this vast array of ideas," cautions Fabian. The paucity of hard evidence for string theory may be partly responsible for the upsurge in interest in variable constants, Barrow adds; results like Ubachs' could eventually provide a good way to assess the ideas. "I'm sure we'll see some theory papers about this," he says. "I might write one myself."

Fabian agrees that the problem has been receiving more attention over the past few years, but that "it's still a minority interest". The research needs intensive work on the very biggest telescopes, "a large investment in something that could turn out to be zero". But he agrees that it is an important problem to tackle: "Let's keep shaking the pillars to make sure they're rigid."

Mark Peplow

shut down within three to four years (see *Nature* 435, 728–729; 2005). "There doesn't seem to be a next step in place," Shapiro says. "This is a moment where important decisions have to be made."

Although the report will strengthen scientists' case for the project, Mike Lubell, head of public affairs for the American Physical Society in Washington DC, cautions that the collider —

estimated to cost at least \$6 billion — still faces an uphill battle. "In an era where the government is not keen on

raising taxes or cutting defence funding, a big project like this is going to run

into a lot of problems," he says. "I think this report will be very welcome in Europe," says Brian Foster, a physicist at the University of Oxford, UK, who is heading the European design

effort for the collider. Foster says that the Large Hadron Collider, a \$2.5-billion accelerator being built at CERN, the European particle-physics laboratory in Geneva, Switzerland, is consuming most of the continent's resources. A strong US bid for the ILC, he says, will strengthen the prospects of the collider, although he adds that Russia, Japan and China have all expressed interest in hosting it. ■ Geoff Brumfiel

ON THE RECORD

"The challenge will be to produce large quantities of this glue without it sticking to everything."

Indiana University bacteriologist Yves Brun discusses plans to mass-produce a powerful, natural glue formed by *Caulobacter crescentus*.

"A few years ago this kind of thing happened in Britain."

Chinese government spokesman Qin Gang rebuts a report from the British Transplantation Society that accuses China of harvesting organs from executed prisoners. Britain executed its last prisoner in 1955; Gang did not elaborate.

Sources: Indiana University, Reuters

SCORECARD



Cephalopod quirks
Squids are found to have genetically inherited personality traits, such as shyness.



Climateprediction.net
A programming glitch delays the distributed computing climate-modelling project by months.



Campus health
A mumps outbreak sweeps the US Midwest, prompting health officials to administer thousands of vaccines.



Medicinal pot
The US Food and Drug Administration declares there is no proof that smoking marijuana eases illness.

NUMBER CRUNCH

A study in *The Lancet* quantifies the US government's return on 28 phase III clinical trials funded by the National Institutes of Health.

\$335 million was the total cost of the trials.

470,339 years of healthy life will be gained by patients over a ten-year span.

\$15 billion is the estimated economic benefit that these trials will provide over the next ten years.

Source: Johnston, S. C. et al. *Lancet* 367, 1319–1327 (2006)