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Physics news on the Internet (based on electronic preprints)

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1. Mass of the Higgs boson

The quest for the Higgs boson is presently the hottest problem in high-energy experimental physics. The existence of this particle is predicted by the Standard Model of particle physics, which has been successfully verified in a plethora of experiments. Theoretically, the expected Higgs boson mass depends on the masses of previously discovered particles, because it is precisely the interaction with the Higgs field that imparts mass to the particles. Physicists at the Collider Detector at Fermilab near Chicago, US announced, based on experiments performed in the laboratory, an improved value of the W boson mass — 80.413 GeV, which allowed lowering the theoretical upper limit for the Higgs boson mass to 153 GeV, down from the previous limit of 166 GeV. According to experimental data, the lower limit for the predicted mass is 114 GeV. Researchers had believed that the Large Hadron Collider at CERN near Geneva, due to start later in 2007, was the firm favorite to find the Higgs boson. However, with the lower upper mass limit, the Higgs boson is now well within the range of the Tevatron collider running at Fermilab. If the Higgs boson is not found in the 114 – 153 GeV mass range, physicists will be forced to look beyond the Standard Model of particle physics to account for new effects and to explain the negative result.

Source: *Nature* **445** 239 (2007);
www.nature.com

2. Gravitation on small scales

A new experiment aimed at measuring the gravitational force at separations between attractive bodies ranging from 55 μm to 9.53 mm was conducted at the Center for Experimental Nuclear Physics and Astrophysics, University of Washington, Seattle. Investigations were made of the oscillations of a torsion pendulum comprising two attractive disks. Holes arrayed in circles were machined into the disks to play the part of 'missing masses'. When the upper disk was rotated, the mutual displacement of these masses gave rise to variations in the force of attraction, which was measured in the experiment. The apparatus was carefully calibrated and insulated from external electromagnetic action. To within the experimental error, no departures from the Newton law of gravitation were observed in the investigated range of length scales. Assuming that the correction to the gravitational potential is of the form of the Yukawa potential, i.e., gives a correction factor $1 + \alpha \exp(-r/\lambda)$, it is possible to obtain combined constraints on α and λ. These constraints improve the pre-existing experimental ones by about two orders of magnitude. In 2004, R Sundrum came up with an interesting theory wherein there exists a characteristic gravitational length $l_{\rm d} = (\hbar c/\rho_{\rm d})^{1/4} = 85$ μm related to the dark-energy density $\rho_{\rm d}$ filling the Universe. According to this theory, the force of gravity is weakened at length scales $\leqslant l_{\rm d}$. Other theories predict both a weakening and strengthening of the force of gravity in comparison with the Newton formula due to the existence of extra spatio-temporal dimensions on a microscopic scale. The experiment, in particular, includes the domain of the hypothetical characteristic length $l_{\rm d} = 85$ μm. Therefore, if extra measurements or some characteristic gravitational length do exist, their length scale should be shorter than 55 μm.

Source: *Phys. Rev. Lett.* **98** 021101 (2007);
prl.aps.org

3. Quantum Zeno effect

The quantum Zeno effect consists in the fact that observing a system lowers the rate of quantum transitions (for instance, decays) in this system. E W Streed, W Ketterle and their colleagues at MIT, Massachusetts, US carried out an experiment to investigate the quantum Zeno effect using a Bose – Einstein condensate of magnetically trapped ^{87}Rb atoms. They studied the transitions between two ground hyperfine states of these atoms. Two regimes were investigated: when the condensate was continuously observed by way of resonance light scattering and when the condensate was periodically irradiated by short light pulses. After completing the experiments, measurements were made of the number of atoms in the energy levels. The experimental data agree well with quantum-mechanical calculations. The quantum Zeno effect had also been observed in several earlier experiments, but the employment of the Bose – Einstein condensate in the new experiment enabled reaching a record strong suppression in the transition rate – by about a factor of 30.

Source: *Phys. Rev. Lett.* **97** 260402 (2006);
prl.aps.org

4. Light speed anisotropy

In European Synchrotron Radiation Facility (Grenoble, France), a group of researchers from Armenia, France, Italy, and Russia carried out an experiment in search for a possible light speed anisotropy with respect to the preferential frame of reference related to the Cosmic Microwave Background (CMB). An investigation was made of the Compton edge in the scattering of laser light from a 6-GeV accelerator electron beam. While no anisotropy had been observed in similar previous experiments, the new measurement yielded variations up to 10σ larger than the statistical errors. Also noted were diurnal variations in the signal, which were supposedly due to terrestrial rotation and, accordingly, to the variation of facility orientation with respect to the direction of terrestrial motion relative to the CMB radiation (to the axis of observed dipole radiation distribution). Such an effect may arise from the existence of hypothetical vector

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fields in space, which possess a specific direction. No systematic errors have so far been revealed in the experiment conducted, but the new result invites further independent verifications.

Source: http://arxiv.org/abs/astro-ph/0701127

5. Stellar pulsar

Observations using the Multi-Element Radio-Linked Interferometer Network (MERLIN) have shown that the radio emission of the CU Virginis star is strikingly similar to pulsar radiation, although this star is not a neutron star, unlike other pulsars. CU Vir is an ordinary magnetic chemically peculiar gas star at 80 pc from the Earth. Its magnetic axis is offset from the rotation axis of the star, and therefore the radio wave beam radiated along the rotation axis periodically (with a period of 12.5 h) illuminates the Earth to produce a pulsating signal. Also noted was a lengthening of the pulsation period — the stellar rotation period, which may be due to structural changes in the outer stellar shells. It is assumed that the rf emission mechanism of the CU Vir star is in some peculiarities similar to the emission mechanism of neutron stars, although the physical conditions in these objects are substantially different.

Source: http://arxiv.org/abs/astro-ph/0701214

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