

PACS number: **01.90.+g**

Physics news on the Internet (based on electronic preprints)

DOI: 10.1070/PU2008v051n09ABEH006485

1. Search for Higgs boson at the Tevatron accelerator

Three rare events concerning the production of pairs of Z bosons in proton – antiproton collisions were identified by an international team of researchers in the D0 experiment at the US Department of Energy's Fermilab at the Tevatron accelerator. ZZ pairs are the most massive among a series of observed pairs of gauge bosons that include photons and W and Z bosons. The next step may be the observation of a Z boson paired with a Higgs boson — the last particle predicted by the Standard Model but not yet found experimentally. The D0 detector recorded electrons and muons produced in the decays of Z bosons. Evidence for the production of ZZ pairs was found earlier this year by the CDF collaboration at the Tevatron but the D0 experiment observed this process at a higher confidence level — at 5.3σ. By combining D0 and CDF experimental data collected at the Tevatron accelerator, it was possible to establish a new restriction on the possible parameters of the Higgs boson. The range of masses in the vicinity of 170 GeV/c^2 is now excluded with 95% probability. These results show that the Tevatron experiments are now very close to observing the Higgs boson and further progress is possible as statistical data are accumulated. The Higgs boson is also expected to be observed at the Large Hadron Collider at CERN, which is now going through the test phase.

Sources: http://arXiv.org/abs/0808.0703,
http://www.physorg.com/news137076565.html

2. Quantum mechanical effects

Two groups of researchers at the University of California at Santa Barbara carried out new experiments testing the principles at the foundation of quantum mechanics. M Hofheinz and coworkers demonstrated for the first time the possibility of controllably creating photons within a resonator in Fock states — quantum states with an exactly determined number of particles. This became possible owing to fabricating a very high quality resonator. Microwave photons were sent into the resonator through a superconducting tunneling junction (SQUID). The state of the electromagnetic field in the resonator was examined with a superconducting quantum 'qubit' whose response showed quantum jumps corresponding to individual photons; in this way, it was possible to register the existence of photons in the resonator, ranging from one to six in number. N Katz and his colleagues conducted an experiment with a superconducting qubit (a Josephson contact closed by a superconducting loop and bridged by a capacitor) and were able to confirm the theory describing a partial collapse of the wave function and its return to the initial state under 'weak' quantum measurements that introduce a very small perturbation into the quantum system under study. The restoration effect of the initial quantum state was studied in a theoretical paper by A Jordan and A Korotkov in 2006.

Sources: *Nature* **454** 310 (2008)
http://dx.doi.org/10.1038/nature07136,
http://arXiv.org/abs/0806.3547

Uspekhi Fizicheskikh Nauk **178** (9) 1012 (2008)
DOI: 10.3367/UFNr.0178.200809i.1012
Translated by V I Kisin

3. Inverse cascade in superfluid helium

Researchers at Lancaster University (Great Britain) and the Institute of Solid State Physics (Chernogolovka) studied heat transfer via second sound in superfluid helium. An electric heater powered by a sinusoidally varying voltage was placed at one end of a cylindrical cryostat. Heat waves were transported along the cryostat by second sound at speeds of up to 20 m s^{-1}. The transfer process was appreciably affected by the nonlinearity of the medium. At sufficiently low amplitudes of thermal vibrations, as predicted by A N Kolmogorov's theory, transformation ('cascading') of long-wavelength to short-wavelength modes and their damping on small scales were observed. However, an effect of inverse cascading with energy pumped into long-wave perturbations was unexpectedly discovered beginning at a certain amplitude of the voltage adjusted to be in resonance with cryostat. The researchers point out that the wave equations for second sound in liquid helium resemble those for wave propagation on the surface of water, and therefore the discovered inverse cascade may have common features with the buildup of giant ocean waves.

Source: *Phys. Rev. Lett.* **101** 065303 (2008)
http://dx.doi.org/10.1103/PhysRevLett.101.065303

4. Carbon tubes

A group of American and Chinese researchers at Los Alamos National Laboratory and Fudan University synthesized new carbon structures — tubes 40 – 100 μm in diameter and several centimeters in length. These tubes resemble the familiar carbon nanotubes but are thousands of times larger and visible even to the naked eye. The cylindrical walls of the tubes are about 1 μm thick and are formed of several layers of graphene with multiple inner pores on different scales. The average tube density is not very different from that of carbon 'nanofoam'. The tubes show very high mechanical strength and are semiconducting. The carbon tubes were obtained by chemical vapor deposition from a mixture of ethylene and paraffin oil heated to a temperature of 850 °C in a quartz tube furnace. The tubes may find numerous useful applications both in the production of superstrong fabrics and structures and in microelectronic systems and machines.

Source: http://physicsworld.com/cws/article/news/35364

5. New evidence in favor of dark energy

In 1995, R Crittenden and N Turok suggested using the Integrated Sachs – Wolfe (ISW) effect to study the dynamics of galactic superclusters. The effect consists in a cosmic microwave background (CMB) photon propagating through an expanding supercluster and gaining additional energy through its interaction with a nonstationary gravitational field. A group of astrophysicists led by I Szapudi at the University of Hawaii succeeded in detecting this small effect (on the order of 10^{-6} in magnitude) at a confidence level better than 4σ. Szapudi and his colleagues studied cross-correlations between the location of galaxy superclusters and supervoids from the Sloan Digital Sky Survey Luminous Red Galaxy and a temperature map of cosmic microwave background. Supeclusters and supervoids project to warm and cold spots, respectively, on the CMB map. This data allowed the researchers to expose the effect of additional accelerated expansion of galaxy superclusters; as follows from the general relativity theory, accelerated expansion is caused by the presence in the Universe of dark energy that delivers negative pressure.

Sources: http://arXiv.org/abs/0805.2974v2,
http://arXiv.org/abs/0805.3695v2

Compiled by *Yu N Eroshenko*