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# Physics news on the Internet (based on electronic preprints)

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## 1. Search for the Higgs boson

New constraints on the possible mass of the Higgs boson have been established by combining the data of two experiments, CDF and D0, conducted at the Tevatron collider of the DOE's Fermi National Accelerator Laboratory in Batavia, Ill. It was obtained earlier at the CERN large electron–positron collider that the Higgs boson mass is greater than 114 GeV/$c^2$. On the other hand, theoretical calculations for processes involving the Higgs boson produced the upper bound on its mass as 185 GeV/$c^2$. Systematic searches are now being conducted for the Higgs boson in the possible mass range of 114–185 GeV/$c^2$ and certain intervals within this range have already been excluded (see *Usp. Fiz. Nauk* **178** 1012 (2008) [*Phys. Usp.* **51** 979 (2008)]). According to the data of CDF and D0 collaborations, the Higgs boson cannot have a mass in the range between 160 and 170 GeV/$c^2$ at a probability of 95%. In addition, the mass of the W boson has been measured in the D0 experiment with a record accuracy: $80.401 \pm 0.044$ GeV/$c^2$. The improved accuracy of measuring the W boson mass may help in Higgs searches by improving the knowledge of the boundaries of possible mass ranges and the accuracy in calculations of reactions involving the Higgs boson.

Source: http://arXiv.org/abs/0903.4001

## 2. Increasing the luminescence efficiency of carbon nanotubes

F Papadimitrakopoulos and his coworkers at the University of Connecticut in Storrs (USA) found a way to enhance the luminescence efficiency of single-walled carbon nanotubes up to a record-high level of 20%. The luminance of nanotubes is limited by defects on their surface, such as chemically absorbed oxygen molecules. Earlier attempts at suspending nanotubes in solutions produced luminescence efficiency of at most 0.5%. In the new experiment, nanotubes were coated with a layer of a compound FC12 — an analog of flavin mononucleotide (its composition is not very different from that of vitamin B2). As this coating was added, FC12 molecules self-organized themselves into a tube coaxial with the carbon nanotube; this process automatically removed extraneous molecules from the nanotube surface. The luminescent glow of nanotubes is caused by irradiating them with IR light or by electrical excitation (such as that provided by a LED). Carbon nanotubes with high-efficiency luminescence may lead to numerous useful applications, e.g. in nanoscale photodetectors and in biological sensors.

Source: *Science* **323** 1319 (2009)
http://dx.doi.org/10.1126/science.1166265

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Translated by V I Kisin

## 3. Cooling nanotubes

P Avouris and colleagues at the IBM T J Watson Research Center in New York and researchers at Duke University in North Carolina (USA) discovered that heat can be dissipated from carbon nanotubes into the substrate in contact with them even if no chemical bond exists between the two. The experiment was conducted with nanotubes on a silicon-dioxide substrate in a configuration resembling that of a field transistor. Thermal vibrations were recorded by Raman spectroscopy techniques. Heat transfer from the nanotubes is caused by electric interaction between charges: electrons in a nanotube interact with charges induced by electric fields of the substrate, energy is transferred to substrate charges close to its surface, and thermal vibrations then travel deeper into the specimen. This effect is important for solving the problem of cooling microelectronic devices with the aid of carbon nanotubes.

Source: http://physicsworld.com/cws/article/news/38051

## 4. Stochastic resonance in digital electronics

W Ditto (Arizona State University in Tempe, USA) and his colleagues have discovered that the performance of a logic gate can be stabilized by a certain level of stochastic noise. Noise typically constitutes a disruptive factor for the functioning of electronic devices; for instance, it may cause unpredictable switching of the states in logic elements. In fact, stochastic resonance emerges in some nonlinear systems, so that it becomes possible to separate the useful signal by increasing the level of broadband noise because then the sum of signal and noise exceeds a certain threshold value (on stochastic resonance see *Usp. Fiz. Nauk* **169** 39 (1999) [*Phys. Usp.* **42** 37 (1999)] and *Usp. Fiz. Nauk* **179** 296 (2009) [*Phys. Usp.* **52** 313 (2009)]). Stochastic resonance manifests itself, for example, in the case of alternating climate cycles and in systems of neurons. Arizona State University researchers mathematically modelled a logic gate with two rectangular signals plus a noise signal fed in as input; they found that as the noise level increases the logic gate begins to function predictably and this stability survives in a sufficiently broad range of noise amplitudes. The theoretical predictions were supported by the study of an electronic analog of the nonlinear system in question. Another useful property of the designed logic gate was the possibility of reversing its logic by sending a control signal.

Source: *Phys. Rev. Lett.* **102** 104101 (2009)
http://dx.doi.org/10.1103/PhysRevLett.102.104101

## 5. X-ray observations of the pulsar PSR J0108-1431

NASA's Chandra X-ray Observatory detected the oldest of the currently known isolated pulsars (those not in binary systems) emitting in the X-ray range. Radio observations established that the pulsar PSR J0108-1431 is about

170 million years old. The unexpected result was the very high luminosity of the pulsar despite its old age and slow rotation rate (at a period of about 0.8 s). Approximately 0.4% of the energy connected with the slowdown is transformed into X-ray radiation. The pulsar PSR J0108-1431 lies at a distance of 770 light years and moves at a speed of about 200 km $s^{-1}$. What continues to remain unclear is the mechanism of X-ray emission. It is possible that two components are present in the radiation: one generated in the magnetosphere of the pulsar, and the other close to the pulsar poles.

Sources: http://arXiv.org/abs/0803.0761
http://chandra.harvard.edu/press/09_releases/press_022609.html

## 6. Dark matter in dwarf galaxies

NASA's Hubble Space Telescope was used to study 29 dwarf elliptical galaxies in the core of the Perseus galaxy cluster lying at a distance of 250 million light years from the Earth. In contrast to the neighboring spiral galaxies, dwarf galaxies have smooth regular shapes without visible signs of decay caused by tidal gravitational forces exerted by the cluster core and other galaxies. This is an indication that the dwarf galaxy masses are sufficiently large to resist tidal destruction. This invisible mass is that of dark matter (hidden mass). The mass-to-luminance ratio of the investigated dwarf galaxies reaches $\sim 120$ solar units. It has thus been established that dwarf elliptical galaxies in cluster cores and dwarf spheroidals of the Local Group of galaxies contain a relatively high amount of dark matter.

Sources: http://arXiv.org/abs/0811.3197
http://hubblesite.org/newscenter/archive/releases/2009/11/full/

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