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Physics news on the Internet (based on electronic preprints)

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1. Hydrogen ^{7}H

A group of Russian researchers from the Joint Institute for Nuclear Research in Dubna and the Russian Research Center 'Kurchatov Institute,' in collaboration with their colleagues from Japan, France, Great Britain, and Sweden, have for the first time detected the isotope ^{7}H, the heaviest hydrogen isotope yet found (^{5}H was discovered in 1991). Although heavy isotopes are very unstable, advances in experimental techniques — in particular the use of secondary beams of short-lived radioactive nuclei — now have allowed the creation and detection of the isotope ^{7}H. At the RIKEN laboratory in Japan, a secondary beam of ^{8}He separated from a beam of decaying radioactive ^{18}O nuclei collided with gaseous hydrogen at a temperature of 35 K and a pressure of 10 atm. The isotope ^{7}H, consisting of six neutrons and one proton, was produced by knocking a proton out of the ^{8}He nucleus. The production of ^{7}H isotopes was signaled by a peak in the energy spectrum of the reaction products near the tritium-neutrons ($t + 4n$) threshold.

Source: *Phys. Rev. Lett.* **90** 082501 (2003);
http://prl.aps.org

2. Superconductivity in cobalt oxide

Cuprate high-temperature superconductors consist of alternating layers of copper oxide and other elements and compounds. Since their discovery in 1986, there has been a search for non-copper- oxide superconducting materials with the same structure. Now T. Sasaki and colleagues in Japan have for the first time discovered superconductivity in cobalt oxide, a material whose layers are separated by layers of sodium with added water molecules. The latter increase the separation between the cobalt oxide layers, a circumstance which, the researchers believe, is crucial for superconductivity to occur. The superconducting transition temperature is approximately 5 K. Superconductivity was detected by a change in magnetic susceptibility and a decrease in electrical resistance. The ions of cobalt in the new superconductors form a triangular lattice — unlike the cuprates with their square lattice of copper ions.

Source: *Nature* **422** 53 (2003); www.nature.com

3. Two-dimensional discrete solitons

An optical soliton is a light pulse which maintains its envelope shape when traveling in a nonlinear optical medium even if perturbing factors are at work. A succession of several light solitons (discrete, or *N*-solitons) can occur in a nonlinear optical medium with periodically varying properties. Until recently, discrete optical solitons have been observed only in one-dimensional optic waveguides. A theory of two-dimensional solitons for ion-sound plasma waves has been developed by B B Kadomtsev and V I Petviashvili. Now J W Fleischer and his colleagues have for the first time created two-dimensional, discrete optical solitons. The two-dimensional optical lattice was obtained by modulating the index of refraction of a crystal by using powerful, interfering, plane coherent light waves. Many crystals, Bose – Einstein condensates, and biological systems may have periodically varying nonlinear optical properties.

Source: *Nature* **422** 147 (2003); www.nature.com

4. The search for new physics

Newton's law of gravitation at submillimiter distances was tested in a series of recent experiments (see, for example, *Usp. Fiz. Nauk* **170** 680 (2000) [*Phys. Usp.* **43** 638 (2000)]). Now a new experiment, the most accurate yet, has been conducted at the University of Colorado, which measured gravitational attraction between two tungsten plates 0.1 mm apart. Low-frequency noise was eliminated by setting one plate into 1000 Hz vibrations and measuring the resonant vibration imparted to the second plate via the gravitational field. No deviations from Newton's law were found down to a distance of 0.1 mm. The violation of the inverse- square law is predicted by theories involving compactified extra spatial dimensions. The Colorado experiments place certain restrictions on these theories.

Source: *Nature* **421** 922 (2003); www.nature.com

A new experimental limit of the photon mass has been established by J Luo and his colleagues in China. The team studied the rotation of a current-carrying steel toroidal solenoid. From A Proca's system of equations extending Maxwell's equations to the case of nonzero photon mass, it follows that the solenoid must experience a force from the magnetic vector potential of cosmic magnetic fields. The team found no such effect within experimental error, giving $m_\gamma < 10^{-51}$ as an upper limit of the photon mass.

Source: *Phys. Rev. Lett.* **90** 081801 (2003)
http://prl.aps.org

5. Nanosecond pulses from the Crab pulsar

Using the 130-meter radio telescope, astronomers at the National Observatory in New Mexico have discovered additional peaks only a few nanoseconds long in the profile of radio pulses from a pulsar located inside the Crab nebula in the constellation Taurus. The pulsar (a rotating neutron star) was formed in the supernova explosion seen in 1054. A new data processing technique used by the researchers ruled out the effects of radio wave dispersion in the cosmic plasma. Nanosecond pulses may have formed in spatial regions no more than a few meters across near the neutron star. These regions are thus the smallest objects ever observed beyond the solar system and possibly the brightest radio sources known. The mechanism by which nanosecond pulses are generated is not yet known.

Source: *Nature* **422** 141 (2003); www.nature.com

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