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1. Light beam stopped

In an experiment performed by R L Walsworth, M D Lukin and their colleagues at Cambridge University, USA, the group velocity of a light pulse sent through a gas of rubidium atoms was slowed to zero and the beam was fully restored after it existed in the form of spin waves for some period of time. The experiment was conducted at gas temperatures between 70 and 90 °C. The control laser beam brought the atoms into a state in which they were unable either to absorb or spontaneously emit light, thus making the light beam immune to distortions. In the medium prepared in this way the light pulse, with the control beam turned off, transformed into spin excitations of the Rb atoms and could exist in this state for times as long as 0.5 ms. In other words, the light beam, kilometers long when in a vacuum, shrank to a mere few centimeters in the gas. The most interesting finding is the ability of the light beam to re-emit and to assume its original shape on repeatedly turning on the control laser beam. The team believes that their distortion-free light trapping technique holds the promise of potentially large number of applications, particularly in quantum computer design. Similar light-trapping experiments were conducted by the group of L V Lui at Harvard, USA.

Source: *Phys. Rev. Lett.* **86** 783 (2001); http://prl.aps.org

2. Metallofullerenes inside a nanotube

Nanotubes containing fullerene C_{60} molecules were first obtained in 1988 by D Luzzi and colleagues. However, the electrical properties of nanotubes are practically unaffected by the presence of C_{60} molecules. Now a considerable degree of control over these properties has been achieved in experiments in Japan by putting metallofullerenes C_{82} inside a nanotube. A C_{82} metallofullerene is a hollow, spherical molecule of carbon with a metal atom (in this case, gadolinium) at its center. It had been known previously that the metal donates some of its electrons to carbon thus changing the electric properties of C_{82}. The new experiment was planned to see how nanotube properties would be influenced by this effect. For this purpose, nanotubes of a special kind — with metallofullerene molecules placed at 1.5 nm intervals along the entire tube length — were produced under strong electric field and high pressure conditions. These nanotubes were in fact one-dimensional crystals. Measurements showed that the temperature dependence of electrical resistivity is different for such nanotubes than for empty ones. Considering that nanotubes are at the forefront of modern microelectronics, these experiments are of particular importance as the first evidence that the electrical properties of nanotubes may be controllable.

Source: *Phys. Rev. Lett.* **85** 5384 (2000);
http://publish.aps.org/FOCUS/

Uspekhi Fizicheskikh Nauk **171** (2) 231 – 232 (2001)
Translated by E G Strel'chenko

3. Conductivity of DNA molecules

Until recently it was not certain whether molecules of deoxyribonucleic acid (DNA) conduct or insulate at low temperatures. Experimental evidence on this point was contradictory. Now a team in France lead by A Yu Kasumov have shown that DNA can conduct current under certain conditions. In the team's experiments DNA molecules were placed between rhenium and carbon electrodes 0.5 μm apart, and the temperature was lowered to the value at which both electrodes became superconducting. It was found that at temperatures above 1 K the resistance of one DNA molecule is about 100 kOhm. Cooling DNA to below 1 K, however, gives rise to the so-called 'proximity induced' superconductivity effect, due to the flow of holes and electrons from the electrodes, and the resistance of DNA falls off dramatically. The physical mechanism responsible for this phenomenon is not yet known.

Source: *Science* **291** 280 (2001); http://physicsweb.org/

4. New evidence for black holes

The Chandra team seems to have provided the strongest evidence yet for the existence of black holes by observing radiation from several X-ray novae — binary systems consisting of a normal star and a compact object (neutron star or black hole) orbiting one another. Theorists believe matter flows from the ordinary star to the compact object thus surrounding this latter by an accretion disk. Both in the disk itself, and also as the matter falls into the compact object, a large amount of energy is released, some of it in the form of X-ray emission. A neutron star, unlike a black hole, has a solid surface, and the matter hitting this surface releases about a hundred times more energy than it would were it a black hole. According to the so-called 'advection' models, black holes mostly consume energy in the form of a hot gas, with little or no radiation — a feature which enables one, in principle, to distinguish a neutron star from a black hole. Chandra observations have revealed a number of low-luminosity X-ray novae thus providing strong evidence for the presence of black holes in these binary systems.

Source: http://xxx.lanl.gov/abs/astro-ph/0012452

5. Microlensing

The microlensing effect denotes the gravitational focusing of light from a star by a massive object in a line of sight from Earth to the star (see *Usp. Fiz. Nauk* **167** 913 (1997) [*Phys.*

Usp. **40** 869 (1997)] and *Usp. Fiz. Nauk* **170** 184 (2000) [*Phys. Usp*. **43** 210 (2000)] for more details). While the MACHO team examines stars of the Large Magellanic Cloud (LMC) and assumes them to be lensed by invisible compact objects in the halo of the Milky Way galaxy, some people believe that microlensing is actually done by objects located outside the Milky Way — possibly in the LMC itself — and that the light undergoing the effect comes from behind the LMC. This view was disproved by the Hubble images of the stars previously studied by the MACHO project. The images showed that the stars are located in the LMC, implying that the lenses are in the halo of the Milky Way galaxy and that they contribute to the universe's hidden mass.

Source: http://xxx.lanl.gov/abs/astro-ph/0008282

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