 

PACS number: **01.90. + g**

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

DOI: 10.1070/PU2004v047n01ABEH001718

## 1. Making light stop

M D Lukin and A S Zibrov (both of the P N Lebedev Physics Institute, RAS) and their Harvard colleague M Bajcsy succeeded in stopping a light pulse in a medium in an experiment they performed at Harvard University. In previous light-stopping experiments, photons in the signal pulse had been transformed into spin excitations in a resonantly absorbing medium in which another control laser beam was used to achieve the effect of electromagnetically induced transparency. When the control beam was adiabatically turned off, the signal light pulse continued to exist in the form of spin excitations, and when the control beam was turned back on, the pulse transformed into photons again (see *Usp. Fiz. Nauk* **171** 231 (2001) [*Phys. Usp.* **44** 217 (2001)] for more details). In a new experiment by D M Lukin and colleagues, the stopped pulse could exist in exactly the form of photons, not spin excitations. This was achieved by using counterpropagating control beams which produced an interference pattern in rubidium vapor. First, as before, the light pulse was transferred into a spin excitation by adiabatically turning off one of the control beams. After that, however, when both control beams were simultaneously turned on, the light pulse regenerated from spin excitations turned out to be localized between the standing wave's neighboring nodes. Due to the Bragg reflection taking place in the (periodic) structure, the light pulse did not move as a whole. Turning off one of the control beams made the pulse move again.

Source: *Nature* **426** 638 (2003); www.nature.com

## 2. Magnetism of carbon

In recent years, a number of organic substances have been discovered which, while they do not contain metal atoms, possess magnetic properties at low temperatures. Recently, Japanese scientists announced that they had discovered weak magnetic properties in noncrystalline carbon reduced from hydrogen compounds. This result has caused doubts, however: many research workers believed metal impurities might have been present in the substance. Now, P Esquinazi and his colleagues performed an experiment which showed that ultrapure graphite irradiated with an accelerator proton beam is weakly ferromagnetic even at room temperature. It is believed that the protons injected into the crystal lattice of carbon modify the structure of electron coupling in a certain way, thus leading to ferromagnetism. A complete theoretical explanation of the effect observed is still lacking.

Source: *Phys. Rev. Lett.* **91** 227201 (2003)
http://www.prl.aps.org

## 3. A pulsar in a close pair

Astronomers using the 64-m radio telescope in Australia have discovered a pulsar PSR J0737-3039, which is in a binary system with another neutron star. This neutron star pair has a record short orbital period of just 2.4 h, so that relativistic effects in its orbital motion are much more pronounced than in the Hulse – Taylor pulsar PSR B1913-16. In particular, the astronomers discovered a shift in the perihelion of the pair's orbit — similar to the perihelion shift of Mercury — which is due to the spacetime curvature and has a value of 16.88° per year. Due to the emission of gravitational waves, the neutron stars will merge in about 85 million years, and the effect of a decreasing orbit will already be noticeable in 15 months. There is a danger, however, that due to the relativistic precession of the axis of rotation, the pulsar will become invisible in the nearest future. The masses of the pulsar and its companion neutron star are 1.24 and 1.35 solar masses, respectively. The pulsar PSR J0737-3039 is relatively close to earth — only 600 parsecs away — but its radio luminosity is very low. Weak pulsars like PSR J0737-3039 are difficult to detect, so such close pairs of neutron stars may be abundant in the galaxy. Earlier calculations of the neutron star merger rate relied on five known neutron star pairs. The detection of the pulsar J0737-3039 allowed the conclusion that the merger rate is nearly an order of magnitude higher than previously believed. The merger of neutron stars is accompanied by a powerful burst of gravitational waves. According to optimistic estimates, gravitational wave detectors due to start operating will be able to detect one burst each year or two. The study of the pulsar PSR J0737-3039 and the possible detection of gravitational wave bursts in the future provide good opportunities for verifying the predictions of Einstein's general theory of relativity.

Source: *Nature* **426** 531 (2003); www.nature.com
http://www.arXiv.org/abs/astro-ph/0312071

Compiled by *Yu N Eroshenko*

*Uspekhi Fizicheskikh Nauk* **174** (1) 106 (2004)
Translated by E G Strel'chenko