 © 2001 Uspekhi Fizicheskikh Nauk, Russian Academy of Sciences

PACS number: **01.90. + g**

Physics news on the Internet (based on electronic preprints)

DOI: 10.1070/PU2001v044n11ABEH001093

1. Ferromagnetic carbon

Many organic materials have been observed to exhibit ferromagnetic properties at low (below 65 K) temperatures. Now an international group of scientists led by T L Makarova has for the first time found ferromagnetism at room temperature in Rh-C_{60}, a polymerized form of fullerene with a rhombohedral structure in which the C_{60} molecules form flat graphite-like layers. Rh-C_{60} has a Curie temperature of 500 K and shows a hysteresis typical of ferromagnetic materials. Careful analysis showed that the finding cannot be explained by the presence of magnetic impurities. This follows, in particular, from the fact that a sample of Rh-C_{60} loses its ferromagnetic properties on heating and depolymerization. The discovery team believes that ferromagnetism in Rh-C_{60} is due to unpaired electrons or alternatively to the electronic properties of the polymer's structural defects. Although the ferromagnetism of Rh-C_{60} is relatively weak, it is still strong enough for small pieces of Rh-C_{60} to be attracted by a common magnet. The discovery may help the development of nonmetallic magnets for future technological applications.

Source: Makarova T L, Sundqvist B, Höhne R, Esquinazi P, Kopelevich Ya, Scharff P, Davydov V A, Kashevarova L S, Rakhmanina A V *Nature* **413** 716 (2001); www.nature.com

2. Decay of a uniformly accelerated proton

While in the Standard Model of elementary particles the proton is stable, the Grand Unification theory predicts that it can decay. The experimental search for proton decay has thus far met with no success. The only result obtained is a limit on the proton lifetime, $\tau > 3 \times 10^{33}$ years. This limit, as well as calculations within the Standard model are valid for the proton at rest. However, as long ago as 1965 V L Ginzburg and S I Syrovatskiĭ showed that an accelerated proton is not stable and should decay into a neutron, a positron, and a neutrino. The Brazil physicists D A T Vanzella and G E A Matsas investigated the question of what this decay would look like for an observer who is accelerating together with the proton. It was found that the proton by itself does not have to decay — contrary to what one observes (mentally) to occur in a laboratory reference frame at rest. The paradox is resolved by considering that a thermal background of various kinds of particles should exist in an accelerated frame. This phenomenon is known as the Unruh effect and is related to the difference in the state of the vacuum between the accelerated frame and that at rest (Ginzburg V L, Frolov V P *Usp. Fiz. Nauk* **153** 633 (1987) [*Sov. Phys. Usp.* **30** 1073 (1987)]). Vanzella and Matsas established that from the accelerated observer's viewpoint the proton does not decay — but rather is destroyed — on colliding with thermal background particles. For the rest observer, however, these particles do not exist. According to calculations, a proton's lifetime before its decay in the laboratory frame equals its pre-collision lifetime as seen from the viewpoint of the accelerated observer. Unfortunately, to detect the decay of an accelerated proton experimentally is not as yet possible because of the need for creating very large accelerations.

Source: *Phys. Rev. Lett.* **87** 151301 (2001); http://prl.aps.org

Uspekhi Fizicheskikh Nauk **171** (11) 1200 (2001)
Translated by E G Strel'chenko

3. Controlling Bose – Einstein condensate

A team of German researchers headed by J Reichel has developed a technique to obtain a Bose – Einstein condensate on a flat surface and to move it along the surface with the help of electric fields. First, two parallel 50-μm-wide gold wires were deposited lithographically onto an insulating substrate. Then onto the surface of this device, called a 'chip', rubidium atoms were transferred from a standard magneto-optical trap. The magnetic field of the current flowing through the chip's wires created a microtrap, in which rubidium atoms were cooled into the Bose – Einstein condensation state by an alternating electromagnetic field. By sending electrical pulses along the wires it was possible to move the condensate over distances of up to 1.6 mm along the chip surface. It was found that, contrary to previous belief, the proximity of the condensate to the surface does not destroy the coherence of the atomic states.

Source: *Nature* **413** 498 (2001); www.nature.com

4. Oxidation mechanism of CO

J R Hahn and W Ho using a scanning tunneling microscope have investigated the mechanism whereby single molecules of CO_2 form in the process of oxidation of CO molecules. In one experiment, a few oxygen atoms and a CO molecule were adsorbed onto the surface of a silver plate. With the help of the microscope tip, the CO molecule was moved in the space between two neighbouring O atoms, and when the CO – O distance became 1.78 Å, O – CO – O complexes appeared, which have never been observed experimentally even though the possibility of their formation has been discussed theoretically. When an electron tunneled from the microscope tip to an O – CO – O complex, the latter broke up into a CO_2 molecule and a separate O atom. In another experiment, only adsorbed O atoms were present on the surface, and a CO molecule was attached to the tip. As CO approached an oxygen atom, a CO molecule went over to the surface and reacted with O to form CO_2. The experiments identified individual O atoms (rather than their molecular combination O_2) as the species with which CO reacts on the surface.

Source: *Phys. Rev. Lett.* **87** 166102 (2001); http://prl.aps.org

5. The Blandford – Znajek effect

The spectrum of radiation from the core of the bright Seyfert galaxy MCG-6-30-15 has been measured with the help of the space-based X-ray telescope, XMM-Newton. A detailed study was made of the spectral region close to the iron line Kα at an energy ~ 6 keV. The line is rather broad and has a redshift, suggesting that it formed in the very central part of the gaseous accretion disk around a black hole. As it turned out, the standard models of accretion disks cannot explain the profile of the line, nor the strength of emission it produces. The XMM researchers believe that the unusual spectral feature they observed can be explained by assuming that the extra emission is generated not in the accretion disk but rather close to the event horizon of a rotating black hole. A mechanism in which a magnetic field acts to transform the rotation energy of a block hole into radiation was proposed in the theoretical work of R D Blandford and R Znajek in 1977. The XMM-Newton data may be the first direct evidence for this mechanism.

Source: http://xxx.lanl.gov/abs/astro-ph/0110520

Compiled by *Yu N Eroshenko*