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1. Structure of metallofullerenes

One interesting property of fullerenes is that they can contain atoms of elements within them. In recent years, the dimetallofullerenes $Sc_2@C_{84}$ with two atoms of scandium have received the attention of researchers. According to theoretical calculations, which have been confirmed by nuclear magnetic resonance studies, $Sc_2@C_{84}$ molecules have three isomers, in one of which scandium atoms are situated non-symmetrically around the centre of the molecule. Until recently, no experimental data on the structure of non-symmetric isomers were available. Now, using an original technique, K Suenaga and his colleagues, all in Japan, have for the first time investigated the structure of individual $Sc_2@C_{84}$ molecules and, in particular, studied an isomer with a non-symmetric arrangement of scandium atoms. The researchers placed carbon nanotubes in a gaseous fullerene medium at high temperature, as a result of which metallofullerene molecules filled the tubes. The metallofullerenes within the tubes were in a steady state and therefore convenient for study with a high resolution transmission electron microscope. Moreover, carbon nanotubes are highly transparent to electrons and do not distort the image. The new method made it possible to observe individual scandium atoms within fullerene molecules.

Source: *Phys. Rev. Lett.* **90** 055506 (2003)
http://prl.aps.org

2. Molecular switch

A team of researchers from Switzerland and France directly measured the energy needed for an organic molecule to make an intramolecular conformational transition from one stable position to another. Under high vacuum conditions, one part of an organic molecule was rotated about the carbon C–C bond with respect to the other part in a contactless fashion using the tip of an atomic force microscope. The energy required to 'switch' the molecule was found to be 47×10^{-21} J, four orders of magnitude less than when triggers based on computer chip field transistors are used.

Source: *Phys. Rev. Lett.* **90** 066107 (2003)
http://prl.aps.org

3. Nanowire laser

C Lieber and his colleagues at Harvard University have for the first time demonstrated an electrically pumped nanowire laser. Unlike electrically pumped semiconductor lasers, the new laser consists of a long cadmium-sulphide single crystal 80 – 200 nm in diameter. Such structures are called nanowires. Laser radiation is generated when the current flowing through the nanowire exceeds 200 μA. The new laser may have practical applications even though its lasing mechanism is not yet well understood.

Source: *Science* **299** 531 (2003); www.sciencemag.org

Uspekhi Fizicheskikh Nauk **173** (3) 322 (2003)
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4. Testing Lorentz invariance

Experimental tests of Lorentz invariance (see, for example, *Usp. Fiz. Nauk* **172** 233 (2002) [*Phys. Usp.* **45** 220 (2002)]) have placed limits on the quantities characterizing the possible anisotropy of the speed of light and on the way the speed of light depends on the observer's velocity. However, there are parameters involved in some Lorentz violating extensions of the Standard Model of elementary particles for which no clear-cut limits could be provided by these tests, V A Kostelecky and N Mewes showed in 2002. J A Lipa and his colleagues at Stanford University now have conducted a new experiment and obtained limits on some of these parameters. The experiment involved two microwave cavities made of niobium, which were cooled to 1.5 K. One of the cavities was aligned along the Earth's radius and the other in the east-west direction. The authors examined the beating of the electromagnetic waves in the cavities for a number of periods of the Earth's diurnal rotation. No Lorentz violation was observed. It was found that 4 linear combinations of unknown theoretical parameters did not exceed 10^{-13} and that 4 other combinations did not exceed 4×10^{-13}. A similar but even more precise space-based experiment is currently being planned.

Source: *Phys. Rev. Lett.* **90** 060403 (2003)
http://prl.aps.org

5.The number of baryons in the Universe

A team of astronomers from the USA and Italy have used the UV detector onboard the FUSE satellite and the space-based XMM-Newton and Chandra X-ray telescopes to detect clouds of baryonic gas in the Local group of galaxies (a system which includes our Galaxy, the Andromeda Nebula, and dozens of dwarf galaxies). According to Big Bang nucleosynthesis theory, baryons account for about 4% of the density of the Universe. However, the observable stars, gas, and dust thus far have provided only one-third of this amount. The newly discovered clouds may contain the missing two-thirds, their total mass in the Local group being approximately 10^{12} solar masses. This (combined with the mass of dark matter) is enough for the Local group to be a gravitationally bound system. Earlier, the high temperature and low density of the baryon clouds prevented their detection. F Nicastro and his colleagues detected the clouds by taking advantage of the fact that ultraviolet radiation from galactic cores is absorbed by oxygen ions present in a gas. By using the Doppler effect, the radial velocities of the clouds were found not to exceed 100 km/s, suggesting that the clouds belong to the Local group rather than being peripheral objects of our Galaxy.

Source: *Nature* **421** 719 (2003); www.nature.com

Compiled by *Yu N Eroshenko*