Physics – Uspekhi **44** (12) 1315 – 1316 (2001)

PACS number: **01.90.+g**

Physics news on the Internet (based on electronic preprints)

DOI: 10.1070/PU2001v044n12ABEH001094

1. Superconductivity in C_{70} fullerenes

Superconductivity in electron-doped C_{60} fullerenes was observed about ten year ago. Since then, the question has remained open: Is fullerene C_{70} superconducting under these conditions? Now experiments by J H Schon and colleagues answer this question positively and show the superconducting transition temperature of doped C_{70} crystals to be 7 K. This finding is important for testing theoretical models relating the size of the molecules to the superconducting properties of a material. If, as expected, electron-photon coupling increases with the decrease in the molecular size, then C_{36} fullerenes could have T_c larger than that of C_{60} — and indeed close to the T_c of the high-temperature superconductors.

Source: *Nature* **413** 831 (2001), www.nature.com

2. Superconductivity in thin wires

Conductors with a small cross section cannot be ideal superconductors because of the fluctuation-induced wave function phase slippage — or quantum phase slip (QPS) effect — which causes the wave function to jump from one state to another via the tunneling mechanism, thus giving rise to a voltage difference and hence to an electrical resistance. Close to the superconducting transition temperature, $T \approx T_c$, this phenomenon is due to the appearance of thermodynamically non-equilibrium Cooper pairs. This effect has been seen in whiskers. Another possible origin of the QPS effect is quantum fluctuations, which should even be present at $T = 0$, but thus far there is no definitive experimental evidence concerning the role of quantum fluctuations. Indeed, some workers doubt the possibility that the QPS effect due to quantum fluctuations can be observed experimentally. This view has now been dispelled by M Tinkham and his colleagues at Harvard, who measured the temperature variation of resistance for 20 thin superconducting wires 10 to 22 nm in diameter. The wires consisted of a molybdenum-germanium compound deposited on the surface of a carbon nanotube. The results are in excellent agreement with a theoretical model according to which the electrical resistance at $T \geqslant T_c/2$ is dominated by thermodynamic fluctuations, and that at lower temperatures, by quantum fluctuations.

Source: *Phys. Rev. Lett.* **87** 217003 (2001),
http://prl.aps.org

3. Magnetochiral anisotropy

Molecules of substances with natural optical activity exhibit chirality, i. e., have right-hand and left-hand stereoisomers. If a solution or a crystal of such a substance contains stereoisomers of only one type, it rotates the polarization plane of light traveling through it. If a medium with natural optical activity is placed in a magnetic field then, along with the Faraday effect, the effect of so-called magnetochiral anisotropy should occur, i.e., the refractive index of the medium n should depend on whether the light travels in or opposite to the magnetic field direction. However, from 1997 – 1998 experiments the difference Δn between these refractive indices is two orders of magnitude larger than predicted. Now, more accurate experiments have been carried out by M Vallet and his colleagues. The researchers employed a photodiode to study the beats due to the interference of two laser beams differing slightly in frequency. The beams were sent in opposite directions and passed subsequently through two vessels which contained oppositely handed stereoisomers and were placed in oppositely directed magnetic fields. This configuration enabled the team to compensate the effects of the natural optical activity and the Faraday effects and so to separate out the weak effects of magnetochiral anisotropy. The measured value of Δn, unlike in previous experiments, was found to be close to the theoretical one.

Source: *Phys. Rev. Lett.* **87** 183003 (2001)
http://prl.aps.org

4. Pyroelectric accelerator

The term pyroelectric material refers to a dielectric material that is polarized spontaneously in the absence of external electric fields. Polarization can occur below the Curie temperature if the material is heated or deformed. J Brownridge of the University of New York and S Shafroth of the University of North Carolina have used the electric field in a pyroelectric material to create a directed electron beam up to 170 keV in energy. Although the intensity of such beams is low, they are capable of producing X-ray fluorescence and so may be used to generate X-rays, widely used in applied research.

Source: *Physics News Update*, Number 564
http://www.aip.org/physnews/update/

5. The core of an active galaxy

The activity of galaxy and quasar cores is explained best in terms of a torus (or disk) of dust and gas whose material accretes onto a supermassive black hole at its centre. The fall of matter into the black holes is accompanied by the emission of radiation over a wide frequency range. In particular, strong infrared radiation is believed to be due the absorption by the torus of highly energetic emissions which are then re-emitted in the infrared. Also, the electromagnetic interaction between the torus and the hole ensures that the energy of the rotation of the hole is extracted in the form of two counterpropagating jets of material. However, the infrared observations of the core of the galaxy M87 at the Gemini observatory in Hawaii have yielded a surprising result. Although the resolving power of the 8-meter telescope would be enough to observe a torus,

Uspekhi Fizicheskikh Nauk **171** (12) 1380 (2001)
Translated by E G Strel'chenko

no torus was actually seen. This implies that the torus either does not exist or is very weak — at least a thousand times weaker than the jet. The galaxy M87 is one of the closest active galaxies of its type and is located about 50 million light years from Earth in the Virgo Cluster of galaxies. The absence of a noticeable torus in this galaxy may lead physicists to revise most of their current models of active galactic cores.

Source: http://unisci.com

Compiled by *Yu N Eroshenko*