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1. Mobility of electrons in graphene

Researchers at the Institute for Microelectronics Technology and High Purity Materials of the Russian Academy of Sciences (IPTM RAN, Chernogolovka, Russia) S V Morozov and K S Novoselov, in collaboration with colleagues in Great Britain, the Netherlands, and the USA, have found that mobility of electrons in graphene (which is a 2D sheet of carbon just one atom thick) greatly exceeds the known values of electron mobility in all other materials, and at room temperature is close to 2×10^5 cm^2 V^{-1} s^{-1}. This means that electrons in graphene can travel over distances of thousands of interatomic distances without undergoing scattering. As temperature increases, especially above 200 K, mobility decreases owing to scattering by phonons. The unique electron properties of graphene may prove useful for applications in microelectronics, for instance, for designing chemical sensors and generators and detectors of radio waves in the THz wavelength range. However, for practical applications of graphene it will be necessary to develop a technology for preparing specimens of graphene with a lower concentration of defects than is possible at the moment. The unique properties of graphene were outlined in detail in reports of Yu E Lozovik and S V Morozov at the session of the Physical Sciences Division of the RAS on February 27, 2008. These reports and other materials of the session are to be published in one of the nearest future issues of the *Phys. Usp*.

Source: *Phys. Rev. Lett.* **100** 016602 (2008);
http://dx.doi.org/10.1103/PhysRevLett.100.016602
http://www.gpad.ac.ru/prog/sessions/session08_02_27.htm

2. Spontaneous coherence in Bose – Einstein condensate of magnons

V E Demidov and his colleagues in Germany, Ukraine, and the USA studied the room-temperature dynamics of the Bose – Einstein condensate of magnons (quasiparticles corresponding to spin wave quanta) by the Brillouin light scattering technique. Single-crystalline 5-μm-thick ribbons of yttrium-iron garnet (YIG) were irradiated by 30 ns microwave pumping pulses. If the magnon concentration in a specimen exceeded a certain critical level, irradiation transferred some of magnons coherently into the Bose – Einstein condensate state. The time of magnon thermalization and the condensate decay time were much longer than 30 ns, so that most of the time the evolution of the condensate was unaffected by radiation. Data on Bose – Einstein condensation of magnons at low temperatures and under continuous exposure to external factors were reported earlier. In this experiment, a free magnon condensate was observed for the first time at room temperature and direct confirmation of the quantum nature of magnon condensation was obtained.

Source: *Phys. Rev. Lett.* **100** 047205 (2008);
http://dx.doi.org/10.1103/PhysRevLett.100.047205

3. A mixture of different degenerate Fermi gases

W Ketterle and colleagues at the Massachusetts Institute of Technology were earlier able to create ultracold mixtures of fermionic atoms of one element residing in two different spin states. M Taglieber and his colleagues in Germany are the first to create a mixture of degenerate Fermi gases of different atoms, namely, ^{6}Li and ^{40}K. The problem in preparing such mixtures lies in the difficulties involved in simultaneously cooling different Fermi atoms: they have different masses and a low cross section of scattering by each other. The new experiment used the technique of sympathetic cooling, in which evaporatively cooled bosonic ^{87}Rb atoms were placed into the trap, together with ^{6}Li and ^{40}K atoms. Owing to a high interaction cross section between the ^{87}Rb and ^{40}K atoms, the latter were efficiently cooled. Simultaneously, the ^{87}Rb atoms acted as catalysts for the interaction between ^{6}Li and ^{40}K, and this made it possible to cool the gas of ^{6}Li atoms to a degenerate state. Experiments with a mixture of degenerate atoms open up important horizons for further research. For instance, there are plans to create spatially inhomogeneous superfluid states in gas mixtures; some theoretical computations indicate that such systems exist in certain types of high-temperature superconductors. It may also be possible to synthesize ultracold ground-state molecules consisting of different fermionic atoms.

Source: *Phys. Rev. Lett.* **100** 010401 (2008);
http://dx.doi.org/10.1103/PhysRevLett.100.010401

4. Antiatoms in a trap

The ATRAP collaboration working at CERN has succeeded in detecting, for the first time, anti-hydrogen atoms in an atomic trap. Previous experiments had already produced antiatoms, but it was not possible until now to hold antiprotons and positrons in a trap long enough to form trapped antiatoms. The new experiment operated a combined trap composed of Penning and Ioffe atomic traps. Both traps used electric and magnetic fields for confining particles. The Penning trap confined accelerator-produced antiprotons and positrons from a radioactive source. The Ioffe trap confined the resulting antiatoms which were then studied with spectroscopic instruments.

Source: http://www.aip.org/pnu/2008/split/856-2.html

5. Intermediate-mass black hole

Data obtained by the Hubble Space Telescope and Gemini Observatory point to harboring an intermediate-mass black

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hole in the globular stellar cluster, ω Centauri. This cluster is one of the largest and most massive members of globular clusters in the Milky Way and displays a record-high velocity dispersion. Furthermore, stars in this cluster differ in chemical composition and age. These properties may constitute an indication that the globular cluster ω Centauri is not a classical globular cluster but instead is the nucleus of a small galaxy captured into our Galaxy. An alternative hypothesis was proposed, namely that ω Centauri was formed as a result of merging of two globular clusters. According to the new observations, the dispersion of stellar velocities and the density of invisible dark matter increase toward the center of the cluster. An analysis of dynamic models both with isotropic and with anisotropic distributions of stellar velocities showed that in all likelihood this growth is caused by the presence of a black hole with a mass of approximately $4 \times 10^4 M_{\odot}$ at the center of the cluster. Another scenario (the presence of a dense cluster of neutron stars and stellar-mass black holes in the central region of ω Centauri) is rather improbable, as this cluster does not manifest any signs of strong dynamic relaxation. In view of this, the scenario with no central black hole was rejected with a significance level of 99%. The mass of the black hole falls somewhat above the linear 'mass – velocity dispersion' curve (but within the distribution width) known for massive galaxies and extrapolated to the area of small masses.

Source: http://arxiv.org/abs/0801.2782

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