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1. Isospin asymmetry in B-meson decays

The LHCb Collaboration (with Russian researchers among the participants in this teamwork) has reported measuring the isospin asymmetry in decays of B mesons produced in pp collisions at the Large Hadron Collider (CERN). The asymmetry manifests itself in slight differences in the probabilities of the decays $B^0 \to K^0\mu^+\mu^-$ and $B^+ \to K^+\mu^+\mu^-$. At the 4σ confidence level (for the quantity integrated over energy), the measured asymmetry was found to be greater than predicted by the Standard Model of elementary particles. Earlier indications of this discrepancy were also obtained in CDF, Belle, and BaBar experiments. If the asymmetry is proved to be the case, its explanation may require going beyond the confines of the Standard Model.

Source: http://arXiv.org/abs/1205.3422vl

2. Electronic anisotropy in superconductors

S Kasahara (Kyoto University, Japan) and his colleagues have investigated the anisotropy of the electronic properties of the isovalent-doping $BaFe_2(As_{1-x}P_x)_2$ compound in a large area of the phase diagram on the $T-x$ plane. Anisotropy known as electronic 'nematicity' (a unidirectional self-organized state breaking the rotational symmetry of the underlying lattice) had earlier been discovered both in Fe-based and in cuprate superconductors. In this experiment, a piezoelectric transducer measured the torque required for rotating the sample in a magnetic field. In the case of nonzero electronic anisotropy, rotation of the sample causes periodic modulation of torque. In the past, it was assumed that nematicity emerges near the transition to the antiferromagnetic state at a temperature close to the temperature T_s of structural rearrangement of the crystal lattice. According to the new measurements, however, the transition to the nematicity state is a thermodynamic phase transition and occurs in a wide range of x at a temperature T^* which is considerably higher than T_s. It is now established, therefore, that nematicity may exist in a non-magnetic region of the phase diagram and even in the region of superconduction. This data poses a question about the relation of the mechanism of nematicity emergence to that of the pseudogap observed in superconductors in the nonmagnetic state. The authors of the paper hypothesize that the electronic nematicity in $BaFe_2(As_{1-x}P_x)_2$ can be explained in terms of a certain ordering of electron orbitals in iron atoms.

Source: *Nature* **486** 382 (2012)
http://dx.doi.org/10.1038/naturelll78

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Translated by V I Kisin

3. Plasmons in graphene

Quasiparticles known as plasmons have already been observed earlier on the graphene surface using indirect methods of electron spectroscopy. Two groups of researchers (D N Basov et al., and F H L Koppens et al.) have independently conducted similar experiments in which plasmons were examined in a more direct way. The tip of an atomic-force microscope was placed close to a graphene sheet lying on the surface of a silicon crystal over a layer of SiO_2. The tip was illuminated with light of an IR laser; this light was transformed into the near field which induced surface plasmons with a wavelength of about 200 nm. These plasmons first generated concentric waves around the tip and then, moving along the graphene sheet, were reflected from the sample edges and from inhomogeneities, creating an interference pattern of standing waves in the upshot. The waves caused variations in the potential of that same tip of the microscope and, ultimately, their distribution was recorded with a pseudoheterodyne interferometer using the pattern of the IR radiation reflection from an oscillating (in order to modulate the signal) tip. An electric field applied with the aid of additional electrodes made it possible to control the concentration of positive charge carriers (holes) and, therefore, the wavelength and damping rate of plasmons. In the future, this method may prove useful for governing information in microelectronic graphene-based devices.

Sources: *Nature*, online publication as of June 20, 2012
http://dx.doi.org/10.1038/naturel 1253
http://dx.doi.org/10.1038/naturel 1254

4. Gravitational analogue of the Aharonov–Bohm effect

M A Hohensee (University of California, Berkeley) and his colleagues have presented a theoretical foundation for the idea of a laboratory experiment to measure the gravitational analogue of the Aharonov–Bohm effect. They showed that such an experiment appears quite feasible if one uses atomic interferometers in which atoms possess sufficiently large coherence time. The change in the phase of the wave function depends on the gravitational field. The proposal consists in transferring the atom to the state constituting the superposition of two spatial positions, one of which is located near a massive body producing the field, and in measuring some time later the interference of these states. The parts making up the massive body should approach the atom in such a way that it stays in a local minimum of the potential, so no gravitational force acts on it from the side of this body. This constitutes the analogy to the Aharonov–Bohm effect in quantum mechanics. In other words, only the change with time in the magnitude of the gravitational potential is important and not its spatial gradient. This experiment will also make it possible to measure the gravitational redshift in a situation without the gravitational force. Even though the best scenario would be to conduct the experiment in space in

microgravity conditions, it can be performed in a terrestrial laboratory, too. In this case, the background gravitational potential can be subtracted by comparing the results of two experiments: with additional masses, and without them. If this experiment is implemented, its results will be important, in particular, for testing theories of gravitation.

Source: *Phys. Rev. Lett.* **108** 230404 (2012)
http://dx.doi.org/10.1103/PhysRevLett.108.230404

5. Residual gas jets from the center of the Galaxy

At present, the central black hole in the Milky Way is in a quiet 'sleepy' state and is absorbing the relatively small amount of matter; only weak X-ray flares are occasionally observed. In the past, however, the activity of the galactic nucleus could have been higher, for instance, due to the violent accretion of matter of destroyed stars. Gas jets, similar to those observed in active galaxies, could have been formed along the axis of the accretion disk, when acted upon by a magnetic field. M Su and D P Finkbeiner of the Harvard-Smithsonian Center for Astrophysics have tentatively detected in data from the Fermi Gamma-ray Space Telescope weak traces of jets that existed millions of years ago. These structures were identified in the gamma-ray band after careful elimination of background signals created mostly by the interaction of cosmic rays with interstellar IR and galactic radio emission. The traces compose two fine structures (gamma-ray bubbles) about 10 kpc long inside thicker cocoons on both sides of the galactic disk. The confidence of identification of the jet traces approaches 5.2σ. They fall on a straight line passing exactly through the center of the Galaxy but are tilted by 15° to the disc axis. It appears possible that jet residues and gamma-ray bubbles, discovered recently by the same authors, share a common origin. Gamma emission of both jet residues and of gamma-ray bubbles is generated owing to the inverse Compton effect, except that the spectrum of the jets is harder.

Source: http://arXiv.org/abs/1205.5852

Prepared by *Yu N Eroshenko*
(e-mail: erosh@ufn.ru)