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1. Testing the Standard Model

Recently, several fresh experiments have been performed to test the predictions of the Standard Model of elementary particles (for background see *Usp. Fiz. Nauk* **169** 1299 (1999) [*Phys. Usp.* **42** 1193 (1999)]. Experiments at the Stanford Linear Accelerator Center (SLAC) in California and the KEK laboratory in Japan have observed the charge parity (CP) violation in a system of B mesons. CP-violation manifests itself as a slight difference in decay times between the B meson and its antiparticle. The results of both experiments on measuring a parameter called sine two beta are in more precise agreement with the predictions of the Standard Model.

The $g-2$ collaboration at the Brookhaven National Laboratory in New York has now performed a new measurement of the anomalous magnetic moment of the muon. The accuracy of the experiment is two times better than in previous experiments of the same group (see *Usp. Fiz. Nauk* **171** 306 (2001) [*Phys. Usp.* **44** 290 (2001)]). The measured anomalous muon's magnetic moment is drastically different in value from that calculated within the Standard Model. This discrepancy may suggest that there are extra particles or new interactions beyond the Standard Model — for example, those predicted by the superstring theory. The measurements of the muon's anomalous magnetic moment and neutrino oscillation data present the only deviations from the Standard Model currently known.

Source: *Physics News Update*, Number 600,
http://www.aip.org/physnews/update/
Phys. Rev. Lett. **89** 101804 (2002).
http://prl.aps.org

2. Superconductivity in magnesium diboride

S Louie, M Cohen and colleagues at the University of California at Berkeley and the Lawrence Berkeley National Laboratory have put forward a new theoretical explanation for the anomalous superconducting properties of magnesium diboride (MgB_2). According to their *ab initio* calculations, MgB_2 has not one energy gap like conventional low-temperature superconductors, but two energy gaps with a different transition temperature for each. The combination of these temperatures gives an overall transition temperature for magnesium diboride of 39 K. The two superconducting energy gaps appear due to the strong interaction between electron orbitals and phonons in the hexagonal layers of the crystal lattice formed by boron atoms. The experimentally observed temperature dependence of the specific heat capacity of MgB_2 is also successfully explained by the two-gap model.

Source: *Nature* **418** 758 (2002); http://www.nature.com

Uspekhi Fizicheskikh Nauk **172** (9) 1110 (2002)
Translated by E G Strel'chenko

3. Quantum properties of plasmons

It is known that photons can pass through holes in a metal foil, whose diameter is smaller than the photon wavelength. The passage occurs due to the conversion of photons into surface plasmons (electron excitations) and the subsequent re-emission of photons by plasmons on the other side of the foil. A team at the University of Leiden in the Netherlands studied the passage of pairs of photons in entangled quantum states through a set of holes in a gold foil. The photon wavelength in this experiment was three times the hole diameter. As it turned out, most of the photon pairs remained in entangled states after passage through the foil. The experimental finding is unexpected in that the quantum correlation of a photon pair persists in spite of the fact that plasmons consist of $\sim 10^{10}$ electrons and are therefore macroscopic systems. This experiment appears to be the first to observe the quantum properties of plasmons. A theoretical description of the effect discovered has not yet been given.

Source: *Nature* **418** 304 (2002); http://www.nature.com

4. Tracing supermassive black hole merger

There exist many galaxies which are known to interact and to merge. Once two galaxies have merged, supermassive black holes residing at their cores are supposed to gradually sink toward the center of the combined galaxy and to form a binary system. It has been unclear, however, whether there is enough time for the black holes to merge under the action of dynamic friction and due to gravitational radiation. According to many calculations, the time required for the black hole merger to occur exceeds the current age of the Universe. A study by D Merritt (USA) and R D Ekers (Australia) provides a serious argument in favor of the merger scenario. The structure of radio galaxies is observed to contain 'jets' directed along the axes of rotation of the central black holes. Importantly, jets are found more often in more massive galaxies (i.e. those with larger-mass black holes) than in less massive ones. Calculations by D Merritt and R D Ekers showed that immediately before a merger, the jet ejected by the more massive black hole undergoes a sharp tilt at an average angle of 50 degrees. The tilt is due to the addition of the black holes' intrinsic and orbital angular momenta. Observations based on images taken with the VLA radio telescope show that about 7% of radio galaxies indeed have X-type jets with the brightness in one direction much lower than in the others. This jet configuration is evidence for the sharp tilt the jets undergo — most likely when the merger takes place. A slow precession of the axis of rotation would lead to S-type jets observed in other radio galaxies. The result of the study adds optimism to the search for the gravitational wave bursts which accompany the black hole merger.

Source: http://www.arXiv.org/abs/astro-ph/0208001

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