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PACS number: **01.90. + g**

Physics news on the Internet (based on electronic preprints)

DOI: 10.1070/PU2001v044n01ABEH000923

1. Gravitational waves

In the very near future, large-scale gravitational-wave detectors such as LIGO and VIRGO will be put into operation (for reviews, see *Usp. Fiz. Nauk* **170** 743 (2000) [*Phys. Usp.* **42** 691 (2000)] and *Usp. Fiz. Nauk* **171** 3 (2001) [*Phys. Usp.* **44** 1 (2001)]). The much less sensitive measuring devices of the past thirty years, while failing to detect gravitational waves, have yielded an important negative result — the upper limits on the wave amplitude and the number of their sources. The best limits to date come from the IGEC project, a network of five cryogenic resonant detectors located in America, Europe, and Australia. The sensitivity of IGEC would be sufficient, for example, to detect a gravitational signal from the center of our galaxy had the energy equivalent of $\simeq 0.1$ of the solar mass gone into gravitational waves. Measurements performed in 1997 – 1998 failed to separate any signal from the instrument noise background, and reducing noise is currently one of the key problems the LIGO and VIRGO projects have to overcome. Gravitational waves, predicted by A Einstein in 1918, are a deformation of the space-time geometry and may be generated by masses performing variable-acceleration motion. Researchers hope to detect gravitational bursts from the merger of binary neutron stars or black holes in other galaxies, or from supernova explosions. The detection of gravitational waves from mergers of black holes would provide a test of general relativity in the high field range. It is also assumed that a background of relic gravitational radiation that came into being immediately after the Big Bang may be filling the whole of the Universe.

Source: http://prl.aps.org
Phys. Rev. Lett. **85** 5046 (2000)

2. Anapole moment

The SAMPLE experiment at the MIT/Bates Linear Accelerator Center reports having discovered an anapole (toroidal dipole) moment in the proton. A proton with such a moment interacts differently with positive- and negative-circularly polarized electrons. This effect, due to the parity-violating weak interactions, was predicted theoretically but thus far has not been observed experimentally in elementary particles (for a discussion on the anapole moment see *Usp. Fiz. Nauk* **167** 1214 (1997) [*Phys. Usp.* **40** 1161 (1997)]). The SAMPLE researchers studied the scattering of a highly energetic electron beam from hydrogen and deuterium targets with the aim, originally, of assessing the relative contributions of u-, d-, and s-quarks to the proton magnetic moment. It was found that the s-quark contributes no more than 6% to the proton magnetic moment, which is less than expected.

Source: http://unisci.com/

Uspekhi Fizicheskikh Nauk **171** (1) 118 (2001)
Translated by E G Strel'chenko

3. Superconductivity in fullerenes

The fullerenes C_{60} are insulators under normal conditions, but when doped by alkali metal ions they start conducting a current and at low temperatures become superconductors, with a maximum transition temperature $T_c = 40$ K. Since alkali metals are donors for (i.e. donate electrons to) C_{60}, a theoretical prediction has been made that a rise in T_c might be achieved via acceptor doping. Such doping, however, is complicated by the fact that C_{60} is strongly electronegative and so pushes charged holes away. Bell Lab researchers overcame this problem without relying on doping but instead injecting holes into the crystal by means of an electrical field between a pair of electrodes attached to the crystal surface. In this way, a transition temperature of 54 K — a record high for non-copper oxide superconductors — was achieved. This increase is presumably due to the deformation of the crystal lattice and the associated change in the nature of the interaction between the electrons and phonons (vibrational excitations of the lattice). See *Usp. Fiz. Nauk* **170** 113 (2000) [*Phys. Usp.* **43** 111 (2000)] for a recent review.

Source: http://physicsweb.org/

4. Magnetar

Anomalous X-ray pulsars, cosmic lone rangers avoiding being involved in a multiple star system, produce regular X-ray bursts whose source of energy is not yet known. Two models have been put forward. In one, the energy comes from the accretion disk left over from the moment the neutron star was created; in the other, from the decay of a magnetic field of 10^{15} G, 100 times that of an ordinary neutron star (the 'magnetar' model). Evidence in favor of the magnetar now comes from the observation, made with the 10-meter Keck telescope in Hawaii, of an optical object at the position of the anomalous X-ray pulsar $0142+61$, whose emission might originate from the magnetosphere of a magnetar. The accretion scenario is excluded because the accretion disk would have to be much brighter than actually observed. The magnetar model was originally proposed as an explanation for the sporadic gamma-ray bursts, presumed to be created by the fracturing of the neutron star surface when charged particles are accelerated in a strong magnetic field.

Source: http://xxx.lanl.gov/abs/astro-ph/0011561

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