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1. Asymmetry in neutron capture by hydrogen

Electroweak parity-violating forces make a certain contribution to the quark interaction inside protons and neutrons, thus causing some small correlation between nucleon spins and momenta. The NPDGamma Collaboration has registered this contribution for the first time in an experiment with a neutron source at Oak Ridge National Laboratory, USA. Measured was the cross section of polarized neutron capture by liquid parahydrogen molecules. The gamma-ray emission accompanying these captures is asymmetric — photons emerge more often in the neutron-spin than in the opposite direction. The asymmetry parameter $A_{\gamma}^{\rm np} = [-3.0 \pm 1.4\ ({\rm stat.})\ \pm 0.2\ ({\rm syst.})] \times 10^{-8}$ was measured in the experiment. Since the calculations of this effect encounter technical difficulties, the obtained data will be useful in verifying the applied theoretical models.

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2. The Casimir torque

In 1961, I E Dzyaloshinsky, E M Lifshitz, and L P Pitaevsky shown in their paper published in *Usp. Fiz. Nauk* **73** 381 (1961) [see also the translation of this paper in *Sov. Phys. Usp.* **4** 153 (1961)], that under certain conditions the Casimir effect can induce torque. The quantitative theory of this effect was formulated in a paper by E I Kats in *Zh. Eksp. Teor. Fiz.* **60** 1172 (1971) [Kats E I S*ov. Phys. JETP* **33** 634 (1971), and then the theory of this phenomenon was developed by V A Parsegian and G H Weiss in *J Adhes.* **3** 259 (1972), Yu S Barash and V L Ginzburg in *Usp. Fiz. Nauk* **116** 5 (1975) [*Sov. Phys. Usp.* **18** 305 (1975)], Yu S Barash in *Radiophys. Quantum Electron.* **21** 1138 (1978), and others. The torque comes into play when nearby bodies possess optically anisotropic properties. The spectral composition of quantum fluctuations of the electromagnetic field in the space between the bodies depends on the mutual orientation of the principal optical axes of these bodies, and therefore the bodies try to rotate to a position with the lowest total energy. This theoretical prediction has been confirmed for the first time in a paper by D A T Somers (the University of Maryland, USA) et al. They measured the Casimir torque between a solid birefringent crystal and a liquid 5CB class crystal. A polarized light beam was transmitted through the crystals and the variation in its brightness, depending on the angle between the principal axes of the crystals, was investigated. The turn of the liquid-crystal molecules under the effect of the Casimir torque influenced the light transmission. Thus, a liquid crystal was simultaneously used to induce the torque and for measurements. The surface density of the torque was measured to be $\sim 3 \times 10^{-9}$ N m m^{-2}. The experiment demonstrated a perfect agreement with the theoretical calculations for both the sign and the strength of the Casimir torque. (See also the recent review written by E I Kats for the centenary of E M Lifshitz and published in *UFN* (Kats E I *Usp. Fiz. Nauk* **185** 964 (2015) [Kats E I *Phys. Usp.* **58** 892 (2015)]).)

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Translated by M V Tsaplina

3. High-pressure superconductivity of LaH_{10}

Two teams of researchers have independently reported their observation of a signature of superconductivity in lanthanum hydride under high pressure at a record high temperature. This substance relates to a conventional superconductors described by the Bardeen–Cooper–Schrieffer and Migdal-Eliashberg theories. The recent discovery of superconductivity in H_2S at a temperature of 203 K (see the recent review by Eremets M I and Drozdov A P "Vysokotemperaturnye obychnye sverkhprovodniki" *Usp. Fiz. Nauk* **186** 1257 (2016) [Eremets M I, Drozdov A P "High-temperature conventional superconductivity" *Phys. Usp.* **59** 1154 (2016)] published in the special *Usp. Fiz. Nauk* issue devoted to the centenary of V L Ginsburg) aroused new interest in this type of superconductors, since theoretically they encounter no obstacle to their superconductivity, even at room temperature. M I Eremets (Max Planck Institute for Chemistry, Germany) and his colleagues revealed that the pressure dependence of the critical temperature in LaH_{10} has a maximum in the region of $T_{\rm c} = 250 - 252$ K at a pressure of 170 GPa. The sample was compressed in a diamond anvil. Superconductivity was noticed through a drop in electric resistance and the isotopic effect upon replacing conventional hydrogen with deuterium. Moreover, $T_{\rm c}$ depended on an external magnetic field because of its effect on the Cooper pairs. The other team, guided by R J Hemley (George Washington University, USA) performed a similar experiment with a diamond anvil to observe a drop in resistivity of an LaH_{10} sample upon cooling to 280 K (7 °C) at a pressure of $\sim$ 196 GPa. These results give hope of obtaining room-temperature superconductivity in the nearest future.

Sources: https://arxiv.org/abs/1812.01561
https://arxiv.org/abs/1808.07695

4. Coherence time of a graphene-based qubit

W D Oliver (Massachusetts Institute of Technology, USA) and his colleagues have become the first to measure the coherence time (55 ns) of a superconducting qubit in which the Josephson junction is made with graphene-based heterostuctures. Graphene lowers dissipation, which improves coherence. A graphene layer was placed between two layers of hexagonal boron nitride h-BN on an aluminum substrate. The obtained heterostructure is a so-called layered van der Waals material. The energy spectrum of the created transmon qubit is analogous to the spectrum of ballistically travelling massless Dirac fermions. Layered van der Waals materials had already been obtained earlier, but the properties of their quantum coherence have not been examined. The new experiment demonstrated coherence and the possibility of controling the state of the created qubit using electric voltage. (For the use of graphene in nanoelectronics, see also the recent review in *Usp. Fiz. Nauk*: Ratnikov P V, Silin A P "Dvumernaya grafenovaya elektronika: sovremennoe sostoyanie i perspektivy" ("Two-dimensional graphene electronics: current status and prospects" *Usp. Fiz. Nauk* **188** 1249 (2018) [Ratnikov P V, Silin A P *Phys. Usp.* **61** 1139 (2018)].)

Source: *Nature Nanotechnology,*
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5. Intermediate-mass black hole in the Galaxy

S Takekawa (National Astronomical Observatory of Japan) and co-authors have discovered evidence of the existence near the center of the Galaxy of an intermediate-mass black hole (BH) — between the masses of stellar-origin BHs and the masses of supermassive BHs. In the gas cloud HCN-0.009-0.044, molecular spectral lines were observed using an array of ALMA radio telescopes. High-resolution observations showed that the cloud consists of a bulk structure and a narrow stream that experience fast Kepler motion around the dynamical center with a mass of $(3.2 \pm 0.6) \times 10^4 M_{\odot}$, which is about one percent of the mass of the central BH in the Galaxy. The small size of the massive object ($\leqslant 0.07$ pc) and the absence of visible stars imply that it is most probably a BH. This BH must have been formed in the center of a globular star cluster destroyed by tidal forces near the center of the Galaxy. The BH then entrapped the cloud HCN-0.009-0.044 which flew by it. The massive object inside HCN-0.009-0.044 is already the third such candidate for an intermediate-mass BH near the center of the Galaxy.

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