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1. Anisotropic Ginzburg–Landau theory for the Ca_{0.8}La_{0.2}Fe_{0.98}Co_{0.02}As₂ single crystal

Iron-based superconductors containing calcium or rare-earth elements possess a number of interesting properties, but their studies were earlier obstructed because of the absence of highquality single crystals. High-quality $2 \times 1 \times 0.05$ -mm³ Ca_{0.8}La_{0.2}Fe_{0.98}Co_{0.02}As₂ single crystals have been synthesized by X Xing (Southwest University, Nanjing, People's Republic of China) and colleagues through the slow heating and cooling of a mixture of substances in a quartz tube (a selfflux method). This superconductor proved to have a high critical current density of 2×10^6 A cm⁻² at a temperature of 5 K. The second peak on the hysteresis loop and the anisotropy of the upper critical field were investigated by varying the magnitude and direction of the external magnetic field. The upper field scaling was described by generalizing the Ginzburg-Landau theory undertaken by G Blatter, V B Geshkenbein, and A I Larkin [see Phys. Rev. Lett. 68 875 (1992)]. The study of the normal-state single-crystal Ca_{0.8}La_{0.2}Fe_{0.98}Co_{0.02}As₂ has revealed a nonmonotone temperature dependence of the negative Hall coefficient with the minimum at a temperature $T \simeq 175$ K, below which semiclassical Kohler's rule was violated.

Source: Supercond. Sci. Technol. 29 055005 (2016) http://dx.doi.org/10.1088/0953-2048/29/5/055005

2. Superconductivity in NbN nanowires

K Yu Arutyunov (Moscow Institute of Electronics and Mathematics and P L Kapitza Institute for Physical Problems, Russia) and colleagues have manufactured a set of NbN nanowires with different lateral sizes smaller than the superconducting coherence length and examined their electron transport properties. The measurements showed that the critical current Ic follows the classical Ginzburg-Landau prediction for a quasi-one-dimensional superconducting channel: $I_c \propto (1 - T/T_c)^3/2$, and the temperature dependence of the resistance R(T) is indicative of the decisive role of the phase slip effect due to thermal fluctuations with a possible small contribution of the phase slip quantum effect (on account of quantum fluctuations). The intrinsic electronic inhomogeneities in the examined highly disordered nanowires are either absent or have no significant effect on their resistive state properties. Similar investigations of inhomogeneities in thin NbN films were earlier hampered by the shunting of some conducting film areas by other conductive areas.

Source: http://arXiv.org/abs/1602.07932

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3. Anomalous Doppler effect in Bose–Einstein condensate

Researchers from Germany and Italy, J Marino, A Recati, and I Carusotto, have theoretically validated the idea of an experiment aimed at studying analogs of some quantum effects. The observation of an impurity atom motion in Bose-Einstein condensate with a velocity exceeding the speed of sound in the condensate is proposed. Given this, the anomalous Doppler effect must take place, which was discussed by V L Ginzburg and colleagues [see, e.g., V L Ginzburg and V P Frolov, Pis'ma Zh. Eksp. Teor. Fiz. **43** 265 (1986)]—that is, transitions will proceed from lower to higher atomic electron levels and radiation (phonons) will be emitted and the energy for transitions and radiation in this process will be drawn from the kinetic energy of the translational motion of the atom. Furthermore, an analog of the Casimir effect and quantum frictional force will be observed. It is proposed that, as a realistic spectroscopic experiment, the motion of ⁶Li atoms in Bose-Einstein condensate of ⁷Li atoms should be investigated, and the transitions between the hyperfine-splitted levels should be observed.

Source: http://arXiv.org/abs/1605.07642

4. The existence of diphoton resonance at 750 GeV has not been confirmed

The ATLAS and CMS Collaborations operating at the Large Hadron Collider in CERN have recently reported the observation of an unusual high-mass diphoton resonance in proton-proton collisions at an energy of 750 GeV with a statistical significance of $\sim (2-4)\sigma$. Many hypotheses were put forward with possible explanations of this resonance, for example, the existence of new particles. However, according to the new data, obtained in the same ATLAS and CMS experiments in 2016, the existence of the indicated resonance was not confirmed at a pp-collision energy of 13 TeV. No statistically significant excess over that predicted by the Standard Model was revealed. This result, in combination with the data obtained earlier at 8 TeV, imposes restrictions on the parameters of some models involving 'new physics'. In particular, the currently most stringent restrictions were obtained on the parameters of gravitons in the Randall-Sundrum theory that might decay into two photons.

Source: http://arXiv.org/abs/1609.02507

5. Black holes in a globular cluster

When observing the radial distribution of stars in the globular cluster NGC 6101, E Dalessandro (University of Bologna, Italy) and colleagues arrived at the conclusion that this cluster does not exhibit mass segregation (concentration of more massive stars closer to the cluster center) that would have certainly occurred since the instant of its formation. M Peuten and his colleagues from the University of Surrey (Great Britain) carried out computer simulation of cluster dynamics to establish that this contradiction can be eliminated by assuming a rather large fraction (~ 1%) of the whole cluster mass to exist in the form of stellar-mass black holes. The presence of a black hole with an intermediate mass of ~ $10^3 M_{\odot}$ in the center of NGC 6101 is discussed as an alternative explanation. In his famous paper "What problems of physics and astrophysics now seem to be especially important and interesting (thirty years later, already on the verge of XXI century)?" [see *Phys. Usp.* **42** 353 (1999); *Usp. Fiz. Nauk* **169** 419 (1999)], V L Ginzburg ascribed the physics of black holes to the most relevant subjects in modern astrophysics.

Source: Mon. Not. R. Astron. Soc. **462** 2333 (2016) http://arXiv.org/abs/1609.01720

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