

PACS number: **01.90. + g**

Physics news on the Internet (based on electronic preprints)

DOI: 10.3367/UFNe.0182.201209b.0940

1. Investigation of decays of ^{19}Ne nuclei

Measurements of the lifetimes of neutrons and of the electron asymmetry in their decays are important for a more precise determination of the element V_{ud} of the Cabibbo–Kobayashi–Maskawa matrix and for placing bounds on predicted right-handed weak currents. However, higher accuracy is achieved, not in experiments with individual neutrons, but in β-decay experiments on ^{19}Ne nuclei, despite certain complications connected with the structure of these nuclei. According to new experiments carried out at the TRIUMF Isotope Separator and Accelerator (Vancouver, Canada), the half-life of the ^{19}Ne nucleus is 17.262 ± 0.007 s, which disagrees with the value measured earlier in other experiments by 2.5σ. At the same time, the measured value of the asymmetry parameter A_β deviates to some extent from the predictions of the Standard Model. At the moment, the cause of these deviations remains unknown.

Source: *Phys. Rev. Lett.* **109** 042301 (2012)
http://dx.doi.org/10.1103/PhysRevLett.109.042301

2. Josephson effect in superconductor – topological insulator devices

Researchers at Stanford University and the SLAC National Accelerator Laboratory (USA) have discovered unconventional properties of the Josephson junction in the hybrid system composed of two superconductors separated by a thin layer of topological Bi_2Se_3 insulator. The titanium and aluminum contacts were deposited onto the Bi_2Se_3 substrate by electron lithography, and the gap between the contacts acted as a quantum barrier. Two important differences from familiar Josephson junction behavior were found, although there is no complete explanation for them yet. First, the product of critical current by contact resistance in the normal phase was found to be inversely proportional to the width of the junction, while in conventional Josephson junctions this product is constant. Second, the first minimum of the oscillating supercurrent is produced in a magnetic field which is five times weaker than the corresponding quantity for the minimum quantum flux of the magnetic field possible for a given area of the junction.

Source: *Phys. Rev. Lett.* **109** 056803 (2012)
http://dx.doi.org/10.1103/PhysRevLett.109.056803

3. Transistor based on phase transition

M Nakano and his colleagues in Japan have demonstrated a field-effect transistor based on the 'dielectric–metal' bulk phase transition triggered by an electric field. In the past, it was only possible to induce this transition in layers of nanometer thickness, as the Thomas–Fermi screening did not allow the field to penetrate deeper into the film. VO_2 films 10 to 70 nm thick were grown on TiO_2 substrates by laser deposition. Vanadium dioxide, VO_2, is a Mott insulator; hence, the name 'Mott transistor' for the new promising device. The important new feature of the experiment lay in covering the VO_2 film with a drop of organic ionic liquid, into which the transistor gate was immersed. A voltage of only ≈ 1 V generated in the surface layer of VO_2 a strong electric field which induced a phase transition to the metallic state, not only on the surface, but also in the bulk of the VO_2 film, and this increased the total conductivity of the film by two orders of magnitude. No such effect could be obtained with solid contacts and without the ionic liquid. The mechanism of the phase transition of the first kind in the bulk of VO_2 (evidenced by a hysteresis curve) has not been determined yet. One possibility is that Thomas–Fermi screening is overcome due to the correlation between electrons and the inherent collective interactions between electrons and the crystal lattice.

Source: *Nature* **487** 459 (2012)
http://dx.doi.org/10.1038/nature11296

Uspekhi Fizicheskikh Nauk **182** (9) 940 (2012)
DOI: 10.3367/UFNr.0182.201209b.0940
Translated by V I Kisin

4. Kinematic Sunyaev–Zel'dovich effect

Using high-resolution observations of the cosmic microwave background with the Atacama Cosmology Telescope (ACT) radio telescope, the kinematic Sunyaev–Zel'dovich effect has been reliably recorded for the first time by a large team of astronomers involving N Hand et al.. In contrast to the ordinary Sunyaev–Zel'dovich effect, which was first observed in 1983, the kinematic effect is associated with the motion of clusters relative to the average Hubble flow. Such motion, known as peculiar, is a consequence of gravitational instability and occurs simultaneously with increasing density perturbations which initiate the formation of galaxy clusters. Scattering of cosmic microwave background photons by the gas of the moving cluster results in a slight shift of the brightness temperature in proportion to the peculiar velocity along the line of sight. In contrast to previously applied methods, the new study measured the relative velocities in closely spaced pairs of clusters identified by the BOSS data collection. Their positions were compared with a map of the distribution of cosmic microwave background radiation at the frequency of 148 GHz on a patch of the sky measuring $3^\circ \times 110^\circ$. The effect has not been registered for individual objects (this was prevented by the weakness of signals at the noise level), but for a statistically large set of clusters. The results obtained are in good agreement with the formation theory of large-scale structures in the standard cosmological model.

Source: *Phys. Rev. Lett.* **109** 041101 (2012)
http://arXiv.org/abs/1203.4219

5. Dark matter in the vicinity of the Sun

S Garbari (Institute for Theoretical Physics, University of Zurich, Switzerland) and her colleagues have carried out a new study of the distribution of dark matter (hidden mass) in the galactic neighborhood of the Solar System by studying the kinematics of 2016 stars (spectral type K orange dwarfs) and by analyzing the solutions of the Jeans equations and numerical modeling of the mass distribution and the dynamics of the stars in the Galaxy. Modeling helped to create trial catalogs for testing statistical hypotheses, reducing to a minimum the number of model assumptions that were made in previous papers and sometimes led to erroneous results. The final result demonstrates that the local density of dark matter in the vicinity of the Solar System is $0.85^{+0.57}_{-0.50}$ GeV cm^{-3}. Models of the spherical halo of the Galaxy typically yield somewhat lower mean value near 0.3 GeV cm^{-3}. If this discrepancy is not a statistical fluctuation, it could be explained to be a result of the oblateness of the Galactic halo or of the presence of an additional dark matter disk.

Source: http://arXiv.org/abs/1206.0015v2

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