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Yu.N. Eroshenko

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1. Study of $B^0 \to K^{*0}\mu^+\mu^-$ decays

In recent years, experiments at the Large Hadron Collider and the KEKB accelerator have revealed some deviations from the predictions of the Standard Model (SM) of elementary particles in the properties of the $B^0 \to K^{*0}\mu^+\mu^-$ decay. This rare process is mediated by loop diagrams and is therefore sensitive to a possible contribution from new particles and interactions beyond the SM. The LHCb Collaboration has performed new and, to date, the most precise measurements of the angular parameters of the $B^0 \to K^{*0}\mu^+\mu^-$ decay [1]. Compared to previous studies, three times as many events were registered; the analysis also allowed for interference effects and lepton masses and all kinematic variables were considered, including the invariant mass $m(K^+\pi^-)$ of the kaon and pion system. The results continue to show discrepancies between the measured CP-averaged variables and SM predictions at the $(2.6-4.1)\sigma$ level. It is possible that in the $B^0 \to K^{*0}\mu^+\mu^-$ decay a contribution from physics beyond the SM shows up, but further studies are required to clarify the issue.

2. Testing the ER = EPR conjecture

In 2013, L. Susskind and J. Maldacena proposed that quantum correlations imply a connection between entangled quantum systems in the form of wormholes — tunnels through spacetime. In this picture, the Einstein–Podolsky–Rosen effect is associated with Einstein–Rosen bridges (conventionally, ER = EPR). I. Javed and E. Wilson-Ewing from the University of New Brunswick, Canada, have placed a stringent constraint on models of this type [2]. In a hydrogen atom, the electron is quantum-entangled with the proton. If the ER = EPR model is valid, part of the electron's electric field would have to pass (or 'leak') into the throat of the quantum wormhole, which would appear as a reduction in the electron's effective charge. This would shift the levels of hyperfine splitting and violate the atom electric neutrality, which are constrained in experiments at approximately the $\sim 10^{-20}$ level. This yields the constraint $\alpha \geqslant 10^{-9}$ on the parameter α associated with the quantum entanglement entropy. Thus, if the ER = EPR conjecture is correct, its manifestations must be extremely weak, whereas appreciable effects ($\alpha \sim 1$) are ruled out by hydrogen spectroscopy and atomic charge neutrality.

Yu.N. Eroshenko Institute for Nuclear Research,
Russian Academy of Sciences,
prosp. 60-letiya Oktyabrya 7a, 117312 Moscow, Russian Federation
E-mail: erosh@ufn.ru

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3. Piezoelectric effect in a diamond film

For over a century, diamond was believed not to exhibit piezoelectricity — that is, not to become electrified when deformed. J. Jing (the University of Hong Kong, China) and their co-authors have reported the first observation of the piezoelectric effect in ultrathin diamond membranes fabricated by exfoliation using adhesive tape [3]. The effect was discovered accidentally when the diamond films were found to deform in the vicinity of charged objects. Then membranes were covered by electrodes (layers of gold), and electrization was found to occur under controlled bending. The strongest response with a piezoelectric constant of approximately ~ 82.2 V m H^{-1} was obtained for membranes about ~ 5 μm thick. The effect persisted upon heating and demonstrated high stability. Calculations have shown that the polarization charge in polycrystalline diamond membranes accumulates at grain boundaries and that these boundaries are the source of the effect. This discovery lays the basis for the use of diamond films in sensors and other devices.

4. Rotation of a pair of dust particles in a plasma flow

A dust plasma is a weakly ionized gas containing solid particles of micron and submicron size [4]. Researchers at the Joint Institute for High Temperatures of RAS, the Moscow Institute of Physics and Technology, and HSE University revealed the rotation of pairs in symmetric dust particles in a nonequilibrium gas-discharge plasma [5]. Two spherical particles became negatively charged and levitated in the near-electrode region of a high-frequency gas discharge. Their motion was recorded with a high-speed camera. At a pressure of 8 Pa and a discharge power of 7 W, the system underwent a transition from random oscillations to consistent rotational motion of particles at a frequency of 1.7 Hz, following nearly circular trajectories around one another while maintaining a stable phase shift. In the absence of a magnetic field, the rotation was sustained solely by the surrounding plasma, without external action. Numerical simulation reproduced the observed rotation and showed that a key role in it was played by the formation of an ion wake — a region of excess positive charge — behind one of the particles. Previously, rotation had been observed experimentally of only asymmetric individual particles and more complex clusters. The rotation of a particle pair discovered by D.A. Kolotinskii et al. [5] demonstrates a new mechanism of self-organization and synchronization in dusty plasmas

and may find application in controlling the motion of microparticles in complex media. For more details see the *UFN* website: https://ufn.ru.

5. A supermassive black hole in Abell 2744-QSO1

In 2023, the galaxy Abell 2744-QSO1, which belongs to the 'little red dot' class, was discovered with the James Webb Space Telescope at a redshift $z = 7.04$. The mass of its central black hole (BH) was estimated from the virial relation to be $4 \times 10^7 M_\odot$, but the applicability of the virial approach remained uncertain. I. Juodzbalis (University of Cambridge, Great Britain), and their co-authors have made the first direct measurement of the BH mass in Abell 2744-QSO1, confirming the earlier estimate [6]. Narrow H_α lines were observed with the NIRSpec spectrograph of the James Webb Space Telescope; these data were used to determine the ray velocities and velocity dispersion of the hydrogen clouds depending on the distance from the centre of the object. This yielded the BH mass $5 \times 10^7 M_\odot$ and exclude a dense central star cluster. The observations have not yet revealed a stellar component in Abell 2744-QSO1 and placed the limit $m_* < 2 \times 10^7 M_\odot$ on the total stellar mass. This BH may have appeared in a starless galaxy through a direct collapse of a gas cloud, or it may be a primordial BH. The origin of little red dots, which amount to 15–30% of all galaxies hosting active nuclei at $z > 2$, remains unknown.

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