

PACS number: **01.90.+g**

Physics news on the Internet (based on electronic preprints)

DOI: 10.3367/UFNe.0185.201507e.0784

1. Search for dark photons and dark Higgs bosons

The Belle Collaboration has implemented a search for hypothetical massive dark A′ photons and Higgs h′ bosons at the KEKB electron–positron collider in Japan. These particles were proposed as an extension of the Standard Model, and A′ might be carriers of the interaction between dark matter particles. If A′ and h′ decay immediately after production, they can, in principle, be registered via the products of decay into ordinary particles. The researchers investigated possible $e^+e^- \to A'h'$ and $h' \to A'A'$ channels with the subsequent decays. All the data collected during the Belle work were utilized in the analysis, but no statistically significant signal was detected above the background level. This negative result imposes a restriction from above to the A′ and h′ production probability and on the interaction strength of these particles with ordinary particles in the Standard Model. The restrictions obtained by Belle are more rigid than those established earlier in other experiments and cover wider ranges of A′ and h′ particle masses.

Source: *Phys. Rev. Lett.* **114** 211801 (2015)
http://arXiv.org/abs/1502.00084

2. Delayed-choice experiment with an atom

In 1978, J Wheeler suggested the idea of a quantum interference experiment in which the decision to carry out measurements comes after a particle has passed through the interferometer slits. This method excludes the possibility of the information on the measurement somehow being transferred to the particle before its passage. An experiment of this type was performed with photons in 2007 (see *Usp. Fiz. Nauk* **177** 314 (2007) [*Phys. Usp.* **50** 329 (2007)]). A G Truscott (Australian National University) and his colleagues were the first to conduct an analogous experiment with a single atom. Metastable helium atoms fell one by one from an optical dipole trap filled with an ultracold gas and were exposed to laser pulses. The first two pulses changed atomic phase by π and $\pi/2$, playing the role of a mirror and a splitter in an analogous experiment with photons and brought the atom to a superposition state of two motions in opposite directions. A third $\pi/2$ pulse emitted by the signal of a random-number quantum generator could induce interference of these states. For each experimental cycle, the interference in about 1000 atoms was examined. With the third pulse, a clear interference pattern was observed. In this case, the detection probability versus the phase difference of two atomic states had the form of a sinusoid. And in the absence of a third pulse, no interference occurred. This experiment, the just as the delayed-choice experiment for photons, confirmed the prediction of quantum mechanics and ruled out the possibility of hidden parameter transfer to the atom before the measurement.

Source: *Nature Physics* **11** 539 (2015)
http://dx.doi.org/10.1038/nphys3343

3. Volume-varying magnetostriction

In 1842, J Joule discovered the effect, subsequently called *Joulian magnetostriction*, consisting in the fact that, upon switching on an external magnetic field, magnetoactive substances are anisotropically strained without changing their volume. This rule has been followed for all the substances studied till now. It is most often explained by the behavior of magnetic domains in a magnetic field. However, H D Chopra (Temple University, USA) and M Wuttig (University of Maryland, USA) have revealed for the first time that, along with anisotropic strain upon magnetic field strengthening, the iron–gallium alloy changes its volume, elongating simultaneously in all directions. This unusual behavior was referred to as *non-Joulian magnetostriction*. Chopra and Wuttig investigated the magnetic structure of Fe – Ga samples by the fringe contrast method by depositing a colloidal composition onto their surface. The magnetic structure turned out to have the form of a periodic two-dimensional array of microcells several μm in size. These microcells, which had never been observed earlier, are formed after sample quenching — its heating and then fast cooling. According to the authors, their origin is most likely due to elastic gradients caused by charge/spin density waves.

Source: *Nature* **521** 340 (2015)
http://dx.doi.org/10.1038/nature14459

4. Abraham force in a liquid

H Minkowski in 1908 and M Abraham in 1909 proposed theories describing the interaction of light with a transparent medium (see, e.g., the review by V L Ginzburg and V A Ugarov in *Usp. Fiz. Nauk* **118** 175 (1976) [*Phys. Usp.* **19** 94 (1976)]). If light enters a liquid from the air, then, according to Minkowski, it affects the liquid with a force opposite to the beam direction, whereas the Abraham theory predicts the inverse direction of the force. In the former case, the surface of the liquid becomes convex, and in the latter case concave. The shape of the surfaces was actually examined in a number of experiments to show agreement with the Minkowski theory. However, U Leonhardt (Weizmann Institute in Rehovot, Israel) and his colleagues from Sun Yat-sen University in Guangzhou (China) performed a new experiment confirming the validity of the Abraham theory. The concavity of the surface was demonstrated for water and mineral oil. It was found that the light beam width and the depth of the liquid-filled vessel are essential. If these are large enough, the liquid, when affected by light, begins moving, and a stationary vortex flow sets in with time. In the neighborhood of the beam inlet into the liquid, the surface becomes

Uspekhi Fizicheskikh Nauk **185** (7) 784 (2015)
DOI: 10.3367/UFNr.0185.201507e.0784
Translated by M V Tsaplina

concave, and the effect of light on the liquid is described by the Abraham theory. And when Leonhardt and colleagues used a narrower focused beam in their experiment, no stationary motion of the liquid was observed and a convexity occurred on the surface, i.e., Minkowski's theory held true.

Source: *New J. Phys.* **17** 053035 (2015)
http://dx.doi.org/10.1088/1367-2630/17/5/053035

5. Measurement of ray velocities of a gravitational microlens

Microlensing event shows itself as an effect of star brightness amplification due to the gravitational focusing of star light by a star or another object passing through the line of sight. In 2012, a star from the galactic bulge was lensed, the lens being a binary system, OGLE-2011-BLG-0417, which is at a distance of ~ 1 kpc from us. Using the UVES spectrograph mounted at the VLT telescope of the European Southern Observatory, I Boisse (Aix-Marseille University, France) and colleagues measured with high accuracy the radial velocity of the bright star in the binary system OGLE-2011-BLG-0417 and compared the data obtained with the theoretical predictions. It turned out that the results of measurements at a level of 3.7σ did not agree with the calculations: instead of an increase with time (due to the orbital motion of the pair), the line-of-sight velocity remained nearly constant. This difference can be explained by the fact that the main lens might not be the OGLE-2011-BLG-0417 system but the neighboring star which is occasionally located in the vicinity of the line of sight or rotates around the pair along a wide orbit.

Source: http://arXiv.org/abs/1506.02019

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