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Physics news on the Internet (based on electronic preprints)

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1. Search for new physical effects using optical resonator

Researchers from the University of Düsseldorf, E Weins, A Yu Nevsky, and S Schiller, have obtained restrictions on new physical effects from the stability of the oscillation frequency in an optical resonator that might result in a change in its length. The resonator, 25 cm long, was fabricated from crystalline silicon, and its resonance frequency was determined by the inverse time of electromagnetic wave propagation from a laser. The resonator frequency was periodically compared over a year with the frequency of a hydrogen maser located in the laboratory and with time readings obtained from GPS in which they are established by an atomic clock. This gives a comparison of the stability of the local process frequency in atoms with the stability of the resonator length. The restriction $|\mathrm{d}f/\mathrm{d}t|/f < 1.4 \times 10^{-20}$ s^{-1} was obtained for the relative frequency drift, which is two orders of magnitude stronger than the Universe expansion rate $H_0 \simeq 2.3 \times 10^{-18}$ s^{-1}. The change in the local scales at the H_0 level had already been ruled out in previous experiments. It is known that in the framework of General Relativity the Hubble expansion only proceeds on average on cosmological scales. However, a local expansion of even coupled objects is sometimes formally considered as effect of new physics. The described experiment also gave restrictions on violation of the principle of local spatial invariance (under Earth's motion) and on the magnitude of hypothetical space-time fluctuations with frequencies of $\sim 10^{-6}$ Hz.

Source: https://arxiv.org/abs/1612.01467

2. Local flutter mode in plasma

In an experiment, K Ida (National Institute of Natural Sciences, Japan) and colleagues have confirmed the theoretical prediction that L A Artsimovich made in 1968 concerning the development in plasma of local 'tongue'-shaped deformations at a pressure exceeding the magnetic pressure. This type of instability is due to flute instability. The experiment was carried out in a superconducting stellarator (Large Helical Device). Plasma perturbations were observed by magnetometers and through registration of cyclotron radio emission of ions that increased sharply upon the development of instability. The tongue-shaped deformation of the magnetic surface began 100 μs and reached its maximum 30 μs before the plasma collapse. Furthermore, a deformation of proton distribution was observed in the phase space due to a fast variation of the radial electric field. For flute instability, see, e.g., the book by L A Artsimovich, *Closed plasma configurations* and the review by M S Ioffe and B B Kadomtsev in *Sov. Phys. Usp.* **13** 225 (1970).

Source: *Scientific Reports* **6** 36217 (2016)
https://doi.org/10.1038/srep36217

3. Quasi-liquid layer on the surface of ice

As far back as the 1850s, Michael Faraday proposed that a thin liquid-water layer exists on the surface of ice below the bulk ice melting temperature of 273 K. The hypothesis was based on the fact that adjoining pieces of ice fuse together. The presence of a quasi-liquid layer was later confirmed in many experiments, but its origin and thickness remained the subject of discussion. M A Sancheza (Max Planck Institute for Polymer Research, Germany) and colleagues used spectroscopic methods to study the properties of the quasi-liquid layer within the temperature range of 235–273 K. It turns out that already at 235 K ($-38\,^{\circ}$C) a double molecular layer (bilayer) of liquid water exists on the surface of the ice, and upon heating above 257 K two such bilayers appear. Such a jump-like thickness variation was predicted in theoretical calculations by the method of molecular dynamics. The measurements also showed that in the character of the network of hydrogen bonds the liquid water in the surface layer looks more like ice than overcooled water in the volume at the same temperature.

Source: *Proc. Nat. Ac. Sci.* **117** 203003 (2016)
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4. 'Chip' gravimeter

E M Rasel (University of Hannover, Germany) and colleagues designed a quantum gravimeter located 'on a chip', that is, within one microcircuit and operating in an effective volume of only 1 cm^3, analogous to the atomic Mach-Zehnder interferometer. Approximately 15,000 ^{87}Rb atoms fell from the height of 1 cm and were transferred by laser pulses to different interfering states. The fact that the condensate in the laser wave field was again thrown up was a new element. This prolonged the time of its fall to several dozen ms, which is of great importance for measurements with such a compact device. Atomic interference was observed by the resonance absorption, and free-fall acceleration was found. Although the new gravimeter is an order of magnitude inferior in sensitivity to devices now in use, further development of its compactness is envisaged.

Source: *Phys. Rev. Lett.* **117** 203003 (2016)
https://doi.org/10.1103/PhysRevLett.117.203003

5. Gamma ray emission from the center of the Galaxy

In 2013–2014, the G2 gas cloud passed in close proximity (2200 Schwarzschild radii) to the supermassive black hole in the center of the Galaxy. The gas accretion from the cloud to

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the black hole was expected to induce flare activity in a wide energy range. However, no increase in the level of emission from the center of the Galaxy was observed in the X-ray, IR, or radio ranges upon passage of G2 through the orbit pericenter, because the cloud was not notably destroyed. M L Ahnen (Swiss Federal Institute of Technology in Zurich) and colleagues used the MAGIC Cherenkov telescope to observe the center of the Galaxy in 2012–2015 in the very-high-energy (VHE) gamma-ray range not below 100 GeV. However, as in other ranges, no G2 effect on VHE gamma-ray emission was now observed. Nevertheless, in these MAGIC observations, some concomitant results were obtained, namely, the spectrum of background (continuous) VHE gamma-ray emission from the central region of the Galaxy was measured, and the presence of a gamma-ray source spatially coincident with the $G0.9+0.1$ supernova remnant and the existence of a gamma-ray source near the radio arc in the galactic center were confirmed.

Source: https://arxiv.org/abs/1611.07095

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