 

PACS number: **01.90. + g**

# Physics news on the Internet (based on electronic preprints)

## 1. CP-violation

Further evidence for the violation of CP-invariance at a more fundamental level than previously believed has been found at Fermilab. This violation was first discovered in 1964 in experiments with neutral kaons. In 1998, the violation of $T$-invariance in accordance with the CPT-theorem was observed almost simultaneously at CERN and Fermilab [see *Usp. Fiz. Nauk* **168** 1249 (1998)]. In new experiments on kaons, a surprising phenomenon of 'direct CP-violation' was observed. A neutral kaon is a quark-antiquark system whose wave function, theory says, is a combination of two states, K1 and K2, of which K1 corresponds to $CP = 1$ and decays into two pions, whereas K2 ($CP = -1$) has always been believed to decay into three pions. If a kaon travels through matter, a small number of K2 states transform into K1 which then decay into two pions. While previous experiments showed such transformations and decays and provided indirect evidence for CP-violation, in the new work the direct two pion decay of K2, with no transformation into K1, was also observed. This testifies against the so-called Superweak theory, in which CP-violation is only associated with the K2 to K1 transformation and which does not allow any asymmetry in decay composition. The authors report important quantitative results which imply that instead of two, only one free parameter is now needed in the theory of CP-violation. An innovative particle detector constructed of cesium iodide crystals and more sophisticated filtering and data collecting techniques made the discovery possible.

Source: http://www.fnal.gov/pub/hep_news.html

## 2. Nonlinear atom optics

A well known laser optics phenomenon is the mixing of several light fields in a nonlinear medium (one in which the refractive index depends on the intensity of the field) to produce a coherent light of a new frequency. It now turns out that this is also possible with recently invented matter-wave lasers, in which coherent atoms are extracted from a Bose-Einstein condensate. In the reported experiment, three sodium matter waves of different momenta were mixed without an additional nonlinear medium being used. As a result of nonlinear atom-atom interaction, a new matter wave, with a new momentum, is produced, the occurrence of mixing following from the fact that the properties of the new wave depend on the densities of the three input ones. An analog of this effect in nonlinear optics is known as the four-wave process. Nonlinear atom optics was first treated theoretically in 1993, and in 1995 the possibility of four-wave processes involving coherent atoms was suggested. A difference of principle between the atomic and photon versions of nonlinear optics is that while photons involved in a nonlinear process are absorbed and emitted, the number of atoms is always the same.

Source: http://www.nature.com/
*Nature* **398** 218 (1999)

## 3. Electron thermometer

A unique IR detector capable of recognizing a single photon in the range 3 – 10 μm and producing up to 25 billion pulses per second has been developed by the Moscow State Pedagogical University (Russia) – University of Rochester (USA) collaboration. At the heart of the device is a thin layer of superconducting niobium nitride. An electron that absorbs a photon hitting the layer becomes highly energetic and transfers energy to other electrons, thus causing a kind of cascade process in the material. As a result, the material loses its superconducting properties for a very short period of time, which is reflected in a change in its electrical resistance. Unlike other IR detectors, in this one the absorbed light heats only electrons but not the crystal lattice, so that the detector can return very rapidly to its initial state — hence its speed. Applications in astronomical instruments and computer technology are suggested.

Source: http://unisci.com/

## 4. Molecular foundations of friction

A detailed understanding of the force of friction at the molecular level was for the first time attempted at the Berkeley Laboratory. One of two rubbing bodies, an atomic force microscope probe, was used to study the molecular structure of the second rubbing surface, whose elongated organic molecules are normally oriented perpendicular to the surface. When acted upon by the probe, the molecules tilt to assume a new position, and it is the energy spent on this reorientation which is released as a result of friction. Depending on the magnitude of the force exerted by the probe, the molecules tilt at discrete angles, implying that at the molecular level the force of friction is discrete in nature.

Source: *Physics News Update*, Number 418
http://www.hep.net/documents/newsletters/pnu/
pnu.html#RECENT

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*Uspekhi Fizicheskikh Nauk* **169** (4) 418 (1999)
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