

PACS number: **01.90. + g**

Physics news on the Internet (based on electronic preprints)

DOI: 10.1070/PU2005v048n01ABEH002318

1. Collisions of Bose – Einstein condensate clouds

An experiment to study the scattering and interference of colliding clouds of Bose – Einstein condensate was performed by C Buggle and his colleagues in the Netherlands. In this experiment, an ensemble of 3×10^9 atoms of ^{87}Rb was cooled by rf evaporation to a temperature of 6 mK and then subjected to a rotating magnetic field, whose role was to split the ensemble into two clouds. On further cooling, the clouds transformed into a Bose-condensed state, both of them preserving 10^5 atoms with a condensate fraction of approximately 60% by that moment. Next, using a magnetic field the physicists accelerated the clouds to a relative velocity of about 20 cm s^{-1}, compared to the previously achieved velocity of only 1 mm s^{-1}, which is several times less than the speed of sound in the condensate. The large relative velocity allowed a detailed study of the interference and scattering of atoms in s- and d-waves to be made, in which complex scattering amplitudes, including their imaginary parts, were determined completely for the first time.

Source: *Phys. Rev. Lett.* **93** 173202 (2004)
http://prl.aps.org

2. Thin film superconductivity

The superconducting transition temperature T_c of ultrathin lead films containing only 10 to 30 atomic layers was measured by Y Guo and his colleagues from China and the US. Superconducting films are called thin if their thickness does not exceed the coherence length. The films used in the experiment were grown on a silicon substrate at a temperature of 145 K. It was found that if the number of atomic layers is less than 21, only films with an odd number are stable. As the number of layers increases to 22, T_c also grows, but beyond this value it starts to oscillate. In this oscillation region, the T_c of even-layered films is found to be higher compared to odd-layered ones. From the theoretical point of view, the oscillations are related to the shape of electron wave functions in the thin film. According to calculations, the density of states near the Fermi surface should be higher for odd-layered films. Importantly, oscillations are also exhibited by the electron – phonon coupling which is another factor to determine T_c.

Source: *Science* **306** 1915 (2004); www.science.com

3. Search for new particles

Axions. These are the elementary particles which were suggested to explain the absence of CP violation in strong interactions and which are as yet undiscovered. It is believed that they form profusely in the core of the Sun when thermal photons are scattered by electromagnetic field fluctuations in the solar plasma. In a strong magnetic field, axions should again decay into X-ray photons in what is known as the Primakoff effect. It was to search for the decay of axions flying from the Sun that the CERN Axion Solar Telescope (CAST) was built. The telescope's key component, a powerful superconducting cryogenically cooled magnet, creates a magnetic field of 9 T. The absence of positive results in terms of detecting axions allows a new limit to be set on the axion – photon coupling constant. At a confidence level of 95%, $g_{a\gamma} < 1.16 \times 10^{-10}$ GeV^{-1} for the axion mass $m_a < 0.02$ eV.

Source: http://arXiv.org/abs/hep-ex/0411033

Dark matter particles. The first results of the search for weakly interacting massive particles of dark matter (or hidden mass) at the Soudan Underground Laboratory have been announced. The Cryogenic Dark Matter Search collaboration utilized four germanium and two silicon detectors in its search for nuclei with recoil momentum from interaction with dark matter particles. No such event was detected above the background level, and from the condition of the absence of scattered nuclei a new limit on the interaction cross section of dark matter particles with nucleons has been established. The most severe limitation was obtained for particle masses of about 60 GeV, for which the cross section should not exceed 4×10^{-43} cm^2 at the 90% confidence level, according to the team.

Source: *Phys. Rev. Lett.* **93** 211301 (2004)
http://prl.aps.org

4. A pulsar in the 3C58 nebula

Detailed observations of the gaseous nebula 3C 58 (which is about 10^4 l.y. from Earth) surrounding the pulsar PSR J0205 + 6449 have been made using NASA's Chandra X-ray Observatory. The pulsar was created by the 1954 supernova explosion and, based on its X-ray characteristics, the surface temperature of the neutron star does not exceed 1.02×10^6 K. The neutrino emission, believed to be largely responsible for the cooling of the pulsar, fails to account for the fact that the pulsar has cooled so fast from the time of the supernova explosion to the present — suggesting that additional cooling channels may be involved. For example, pion condensate at the core of the pulsar may play a role in speeding up the cooling. Chandra observations also gave insight into the interesting gaseous structures that surround the pulsar, such as a toroidal structure around the equator of the pulsar and a jet ejected along its axis of rotation. The loop-like filaments which were earlier discovered in radio images are one further feature observed in the gaseous nebula 3C 58.

Source: *Astrophys. J.* **616** 403 (2004)
http://chandra.harvard.edu/press/04_releases/press_121404.html

Compiled by *Yu N Eroshenko*

Uspekhi Fizicheskikh Nauk **175** (1) 104 (2005)
Translated by E G Strel'chenko