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Physics news on the Internet (based on electronic preprints)

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1. Superfluidity of a Fermi gas

It has already been reported in *Usp. Fiz. Nauk* **174** 564 (2004) [*Phys. Usp.* **47** 531 (2004)] about the possible observation of a superfluid fermion gas in an experiment by J Thomas and colleagues on the vibrations of a magneto-optically trapped gas cloud. An independent, methodologically different experiment by R Grimm and his colleagues at the University of Innsbruck, Austria, also discovered a superfluid fermion gas. The gas under study was that of ^{6}Li atoms, cooled down to a temperature of 500 nK in a magnetic field. The atoms first formed Cooper pairs and made a transition to the molecular BEC state. Varying the magnetic field strength caused the condensate to transform into a strongly interacting Fermi gas — until the Cooper pairs ultimately broke up under the action of a radio-frequency radiation. Measuring the frequency of the radio waves absorbed by the gas provided the calculated magnitude of the energy gap (i.e., the pair binding energy) and made it possible to trace its growth with temperature. The presence of a gap is important evidence of the superfluidity in the fermion gas. The results of the experiments are in good agreement with theoretical calculations.

Source: http://physicsweb.org

2. Glowing nanotubes

In 2003, P Avouris and his colleagues at the IBM's Watson Research Center in New York saw carbon nanotubes glowing when an electric current was passed through them. The reason was that the counterpropagating flows of electrons and holes (electron vacancies) recombined in the narrow transverse layer. Now, in their new experiment, the same team has used a microscope and an infrared camera to monitor the position of the bright spot, and a control electrode to move the spot along the tube. The current was passed through the tube (about 50 μm in length) by means of two electrodes attached to its ends. A third, control (or gate) electrode lying beneath the tube was separated from the nanotube by a thin insulating layer, making the entire device similar to a field transistor. To the gate electrode, a voltage of 0 to 40 V was applied. Because electrons and holes travel diffusively from nanotube ends, the gate voltage turned out to have an affect exactly where the charges meet to recombine and thus to produce a glow. Varying the potential allowed the bright spot to be moved along the entire length of the nanotube between the electrodes. With this technique, T Hertel of Vanderbilt University in Nashville, Tennessee suggests that the surface defects of nanotubes can be explored by observing the way the bright spot passes through the defects.

Source: *Phys. Rev. Lett.* **93** 076803 (2004)
http://prl.aps.org

Uspekhi Fizicheskikh Nauk **174** (9) 1028 (2004)
Translated by E G Strel'chenko

3. The origin of peaks in laser spectra

Dye lasers or random lasers are terms referring to devices that use ground liquids or suspensions instead of a single crystal with reflecting faces. Such lasers emit light in all directions and over a wide range of frequencies. A moot question, until recently, was why high-intensity peaks of unpredicted frequencies appear in the emission spectra of such lasers. D Wiersma of the European Laboratory for Nonlinear Spectroscopy in Florence, Italy and the Italian National Institute for the Physics of Matter and his colleagues were able to find an answer after a number of experiments and numerical simulations. Their laser had as its active medium an alcohol solution of the dye to which the light-scattering powder of zinc oxide was added. To excite the laser, short pulses from a pumping flashlamp were used. Of those photons forming the radiation continuum, most underwent only a very few scatterings in the medium. As it turned out, a small part of the photons underwent 100 to 1000 scatterings before escaping from the medium. It is precisely these photons which stimulated powerful peaks at certain frequencies.

Source: *Phys. Rev. Lett.* **93** 052903 (2004)
http://prl.aps.org

4. Controlling the state of individual atoms

Researchers from Switzerland and Sweden have developed a technique with which single electrons can be added to or removed from individual gold atoms. The manipulations were performed with the tip of a scanning tunneling microscope (STM) at temperatures from 5 to 60 K. Gold atoms were absorbed on the surface of insulating film of sodium chloride just two or three atomic layers thick on top of a copper single crystal. When the STM tip potential of +0.6 V gave rise to a tunneling current, a gold atom gained an additional electron and thus became an ion — as the STM image clearly showed. Under a potential of −1 V, an atom lost an electron and returned to its initial state.

Source: http://physicsweb.org

5. Determining the mass of a single star

Ground-based and NASA's Hubble Space Telescope observations have provided the first high-precision measurement of the mass of a single star (other than the Sun). The year 1993 witnessed a microlensing event in which a star in our galaxy gravitationally focused light from a background star in the Large Magellanic Cloud. At that moment, however, the source and the lens were both along the line of sight and impossible to resolve spatially. After several years of its travel through the galaxy, the lensing star moved a large enough angular distance from the background star for both objects to be seen as separate stars by a telescope. In addition, it proved possible to measure the parallax of the lensing star — and so to place it at about 1,800 light years from Earth. Also, from the way the microlensing event took place, it was established that the lens is a single star, rather than a member of a multiple star system. By combining the microlensing and parallax data, the lensing star mass was calculated to have a value of 0.097 ± 0.016 times the mass of the Sun, making it a class M dwarf red star.

Source: http://hubblesite.org
http://arXiv.org/abs/astro-ph/0405124

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