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Physics news on the Internet (based on electronic preprints)

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1. New superconductors

Nanotubes. P Sheng and his colleagues at the Hong Kong University of Science and Technology have for the first time detected intrinsic superconductivity in carbon nanotubes below a temperature of 20 K. Nanotubes possess unique electrical and mechanical properties and are hollow microscopic cylinders with walls just one carbon atom thick (see *Usp. Fiz. Nauk* **167** 945 (1997) [*Phys. Usp.* **40** 899 (1997)]). Previously, physicists had seen only the so-called 'weak superconductivity', due to the tunneling effect in nanotubes placed in a narrow gap between two superconductors. In the Hong Kong experiment, three intrinsic superconductivity effects — supercurrent, the Meissner effect, and the energy gap — were observed in nanotubes.

Source: *Science* **292** 2462 (2001); www.science.com

Boron. Superconductivity in boron has been discovered by a research team led by R Hemley at the Carnegie Institution of Washington. Under normal conditions, boron is a semiconductor. Compression to 175 GPa at room temperature turns it into a metallic phase. If the compression is carried out at $T = 6$ K, boron becomes superconducting even at $P = 169$ GPa. The intriguing result is that, unlike other superconductors, increasing the pressure increases the superconducting transition temperature of boron; for example, at $P = 250$ GPa, $T_c = 11$ K. This effect has not yet been explained theoretically.

Source: *Science* **293** 272 (2001); www.science.com

Iron. At pressures $P \geqslant 10$ GPa iron loses its ferromagnetic properties and makes a transition to a non-magnetic state. Researchers at the University of Osaka in Japan have for the first time identified a transition in iron, from a non-magnetic state to a superconducting phase at $P = 15$ GPa and $T = 2$ K.

Source: *Nature* **412** 316 (2001); www.nature.com

2. Neutrino oscillations

The first SNO (Sudbury Neutrino Observatory) results provide evidence for the existence of neutrino oscillation, a phenomenon in which neutrinos change from one type to another. The SNO detector, which began operation in 1999, is a 12-meter diameter spherical vessel containing 1,000 tonnes of super-pure heavy water DO_2 and surrounded by an array of photomultipliers. The detector is located in a mine 2 km deep in Ontario, Canada. The detector is currently capable of independently measuring the electron neutrino flux and the total flux of all neutrino types. It is found that the total flux exceeds the observable ν_e flux but equals the ν_e flux calculated from the standard model of the Sun. In the interior of the Sun, ν_e neutrinos form as a result of ^{8}B decays. The discrepancy in the observed neutrino fluxes may indicate that ν_e neutrinos transform into other neutrino types during their joumey from the Sun to the Earth. Neutrino oscillations are possible if neutrinos have a non-zero rest mass. According to the Sudbury data, the sum of the masses of the three neutrino types is in the range 0.05 – 8.40 eV, implying that cosmological neutrinos may account for 0.1 – 18.0% of the mass in the Universe.

Source: www.sno.phy.queensu.ca/sno/first_results/

3. New optomechanical effect

It is known that some polymer materials change their shape when heated or cooled. Now a team of German and British scientists has shown experimentally for the first time that certain polymers change shape in response to light as well. The polymer they studied was a rubber-based one containing light-sensitive molecules. Light causes these molecules to change their bonding configuration, thus reorganizing the structure of the sample as a whole and leading to its compression. When the light was switched off, the polymer expanded and returned to its initial state. While shape changes currently occur on a time scale of tens of minutes, the researchers believe faster polymer response to light will be achieved in the future.

Source: *Phys. Rev. Lett.* **87** 015501 (2001)
http://prl.aps.org

4. Gravitation-induced signal delay

The pulsar J0437-4715 is a member of a binary system (the other member being a white dwarf) and is 450 light-years from Earth. Such a close proximity allows high-precision measurement of the binary's orbital parameters and the pulsar and companion masses. The existence of a parallax makes it possible to observe radio pulses which the pulsar emitted at different angles to the binary orbit plane and which therefore have travelled through regions with different gravitational fields on their way to Earth. According to the general theory of relativity, gravitation is a curved-spacetime phenomenon, and it was pointed out by I I Shapiro in 1964 that electromagnetic pulses should experience a certain time delay when travelling through a curved space. Now W van Straten and his colleagues have found the measured delay to be in precise agreement with general relativity. Indeed the precision of their measurements is so high that, the team hopes, gravitational waves coming to the pulsar from external sources may be detected by changes they produce in its radiation — thus making the pulsar a gravitational wave detector.

Source: *Nature* **412** 158 (2001); www.nature.com

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