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Physics news on the Internet (based on electronic preprints)

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1. Superheavy hydrogen

For over forty years physicists have searched for nuclei of superheavy hydrogen, consisting of four neutrons and one proton. Now, for the first time, these nuclei have been reliably detected in an experiment conducted by Russian scientists from the Joint Institute for Nuclear Research in Dubna and the Russian Research Center 'Kurchatov Institute' in collaboration with their colleagues from France and Japan. Produced in the reaction $^1H(^6He,^2He)^5H$, the nuclei of the isotope ^5H were identified by the kinetics of the decay of ^2He into two protons. The energy spectrum of the protons shows a resonance which, according to calculations, corresponds to the nucleus of superheavy hydrogen as the second reaction product. The discovery became possible thanks to a combination of a cryogenic target, special kinds of detectors, and a unique source of ^6He nuclei developed at Dubna.

Source: *Phys. Rev. Lett.* **87** 092501 (2001)
http://prl.aps.org

2. Cancellation of magnetic moments

H Adachi and his colleagues in Japan have discovered that the compound $Sm_{0.976}Gd_{0.024}Al_2$ may have zero macroscopic magnetization even with all the spins (and intrinsic magnetic moments) of its electrons aligned in a single direction as in a common ferromagnet. Spin magnetization and that due to the orbital motion of atomic electrons are different in their temperature dependence. At a temperature of 67.5 K a perfect cancellation of the two magnetizations occurs, although both above and below this temperature the substance does have a magnetic moment. The alignment of electron spins was approved by studying the Compton scattering of polarized X rays from a sample. The discovered effect was predicted theoretically by the Australian physicist A Stewart in 1972. It may prove useful in experiments which require spin polarization but in which the effect of a macroscopic magnetic field is undesirable.

Source: *Phys. Rev. Lett.* **87** 127202 (2001)
http://prl.aps.org

3. Anomalous acoustoelectric effect

The normal acoustoelectric effect is the appearance in a material of an electric current parallel to the sound wave propagation direction. The study of this effect may be useful in understanding interactions between electrons and the vibrations of the crystal lattice. A collaboration of scientists from Russia (A F Ioffe Physical Technical Institute, St. Petersburg), Ukraine, and Poland studied the propagation of acoustic surface waves in a thin film of $La_{0.67}Ca_{0.33}MnO_3$ laid onto a substrate of piezodielectric material $LiNbO_3$. It was found that, along with the ordinary current, an additional current is generated in the material, which does not depend on the direction of the sound wave and which over a certain temperature range exceeds the current due to the normal acoustoelectric effect. A detailed study showed that the additional current is due to the properties of the piezodielectric substrate and is produced by the electric fields resulting from the compressions and rarefactions in the field of the acoustic wave.

Source: *Physics News Update*, Number 557
http://www.aip.org/physnews/update/

4. Superconductivity in a crystal of fullerene

In a pure crystal of fullerene C_{60} the distance between the molecules is 1.415 nm, and the temperature at which such a crystal becomes superconducting is $T_c = 18$ K. It is known that inducing hole superconductivity (hole injection) and doping the crystal with certain substances may lead to a higher transition temperature. A record high transition temperature of 117 K was achieved by J H Schön, Ch Kloc and B Batlogg from Lucent Technologies by doping a C_{60} crystal with molecules of tribromo-methane (Br_3CH). Placed in the space between fullerene molecules, the Br_3CH molecules increase the lattice parameter to 1.445 nm, causing T_c to rise to a temperature characteristic of high-temperature superconductors.

Source: *Science* **293** 2432 (2001);
www.science.com

5. X-ray burst

For the first time, a short powerful burst of X-ray radiation from the object Sgr A* at the centre of our Galaxy has been detected by the space-based Chandra Observatory. Within a few minutes the source's brightness increased 45 times, then decreased by a factor of 5 within the next ten minutes, and then returned to its normal level over a period of several hours. According to the infrared telescope data on the kinematics of stars at the centre of the Galaxy, the location of the source Sgr A* coincides with the supposed location of the central black hole with a mass of about $2.6 \times 10^6 M_{\odot}$. Previously, only weak constant-brightness radiation at radio and X-ray wavelengths has been observed to come from this object. The burst can be explained either by the infall of a comet head into the black hole, or alternatively by the reconnection of magnetic field lines in the black hole's magnetosphere. Either scenario leads to the formation of shock waves and also involves the acceleration of electrons to subrelativistic speeds — and thereby X-ray radiation. Powerful variable-brightness radiation is characteristic of quasars, where it is due to the intense unsteady accretion on supermassive black holes. Modern galaxies (including our Galaxy) also may have passed through a quasar stage in the dim past, but today their central black holes are calm — except for rare events one of which was presumably detected by Chandra.

Source: http://unisci.com

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