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1. Spin Hall effect at room temperature

D Awschalom and his colleagues from the University of California, Santa Barbara and Pennsylvania State University in the US have detected the spin Hall effect at room temperature for the first time. The effect was observed in a nonmagnetic material in the absence of an applied magnetic field and consisted in the fact that an electron spin current flowed in a traverse direction to the charge current — leading to a concentration difference between opposite spin electrons on the lateral faces of the sample. The reason for this phenomenon is that the scattering direction of an electron depends on precisely how the electron's spin is directed when participating in the spin – orbit interaction. The spin Hall effect was predicted by M I Dyakonov and V I Perel in 1971 and first observed by D Awschalom and Y Kato in their 2004 study on GaAs at 20 K. In the new experiment, 1.5-μm thick *n*-type semiconducting films of chlorine-doped ZnSe were investigated using Kerr rotation spectroscopy. As the temperature increased from 10 to 295 K, the size of the spin Hall effect (i.e., crystal-side spin polarization) decreased by about ten times, while still remaining measurable. The task for future research is to increase the spin coherence time and the fraction of polarized electrons at elevated temperatures. The spin Hall effect can find applications in designing spin current sources for spintronic devices.

Source: *Phys. Rev. Lett.* **97** 126603 (2006); prl.aps.org
http://arxiv.org/abs/cond-mat/0607288

2. Quantum cooling

Measuring the quantum state of a system always exerts some perturbing action on the system. Now an experiment on the practical employment of this effect for cooling a microscopic beam of atoms has been performed at the University of Maryland by the team of researchers led by K Schwab. In the experiment, use was made of the fact that the mechanical vibration amplitude of the beam could be put into correspondence with a certain effective temperature. Close to the resonating silicon nitride beam, the team placed a superconducting single-electron transistor (SSET) whose electromagnetic field depended on (and thus allowed measurement of) the level of vibrations in the beam. This quantum measurement could give rise in some cases to smaller vibration amplitudes and thus to the cooling of the atomic beam. The cooling obtained in the experiment was from 550 to 300 mK. The reason for the cooling lies in the asymmetric spectrum of the transistor's quantum noises that exert back-action on the beam being measured. It is believed that this quantum electromechanical technique may in the future be useful for cooling down components of nanoscale mechanical devices.

Sources: *Nature* **443** 193 (2006); www.nature.com
http://physicsweb.org/articles/news/10/9/9/1

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Translated by E G Strel'chenko

3. Superconducting qubits

M Steffen and his colleagues from the University of California at Santa Barbara have for the first time obtained a quantum-correlated (entangled) state of two superconducting Josephson tunnel junctions. The researchers used the method of 'quantum state tomography' when performing the measurement of the quantum state of the system, which confirmed the appearance of an entangled state. Because superconducting elements can store quantum bits (or qubits) of information, creating coherent systems of superconducting elements is promising for the development of quantum computers. In one of the alternative approaches, as many as eight ions in an atomic trap were brought into an entangled state at the same time. Thus far, no fundamental difficulties are known which would prevent creating similar entangled states in the systems comprising more than two superconducting elements.

Sources: *Science* **313** 1423 (2006);
http://physicsweb.org/articles/news/10/9/3/1

4. Superhigh frequency nanotube resonators

Researchers from Lawrence Berkeley National Laboratory and the University of California, Berkeley reported creating a nanoelectromechanical system (NEMS) resonator based on a carbon nanotube. The nanotube is attached to two metallic contacts 300 nm apart, by means of which a high-frequency alternating current is passed through the nanotube, and at a distance of 200 nm from the tube, a third (gate) contact is placed, to which an RF signal of a different frequency is applied. While the electric field of the gate exerts a force on the nanotube, the vibrations of the nanotube, in turn, change the capacity of the capacitor formed by the nanotube and the gate. All the contacts are connected to a radio scheme which allows measuring the amplitude and phase of the vibrations. At room temperature and an air pressure of 1 atm, a resonance occurs between the mechanical vibrations of the nanotube and the electromagnetic oscillations at about 1.3 GHz. That this frequency is somewhat lower than in a vacuum is due to air molecules depositing themselves on the nanotube surface. The dependence of the resonance frequency on the deposited mass allowed supersmall masses ($\sim 10^{-18}$ g) to be measured. The effective resonator Q factor reached 440.

Source: *Phys. Rev. Lett.* **97** 087203 (2006); prl.aps.org

5. Testing general relativity

Of all currently known systems for testing the effects of general relativity, there are a number of reasons why the double pulsar system PSR J0737-3039A/B is the most promising: both neutron stars (A and B) are detectable as radio pulsars, the pair is relatively close to the Sun (500 pc), and its orbital period is only 2.4 hours — leading to large orbital velocities and orbital accelerations and allowing an independent determination of the mass ratio of the stars. PSR J0737-3039A/B has been studied with several radio telescopes since its discovery 2.5 years ago by the Jodrell Bank team. By observing the pulse shape and spacing between the radio pulses from the neutron stars, it proved possible to study such effects as orbit shrinking due to gravitational wave emission by the system; corrections to the simple Keplerian motion of stars due to spacetime curvature, and the effect of a gravitational field on radio signal propagation. All in all, a test of the general theory of relativity was carried out at 10^5 times the solar system's gravitational field (higher than anything else in the Universe, apart from black holes) to an accuracy of 99.5% — a record high accuracy for the high-field range.

Source: http://arxiv.org/abs/astro-ph/0609417

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