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1. Direct observation of Landau levels

K Hashimoto (Tohoku University, Japan) and colleagues have been able to observe for the first time the spatial structure of electron wave functions corresponding to Landau levels, using scanning tunneling spectroscopy. Landau levels comprise the energy levels of quantized motion of electrons across a magnetic field. They studied two-dimensional electron gas in the surface layer of semiconducting InSb. The measurements were performed at 0.3 K in a 6-T magnetic field under ultrahigh-vacuum conditions. Fourier transform of the spectroscopic data made it possible to identify several oscillations of the radial wave functions of electrons for each Landau level. In specific cases, the structure of the wave functions was also discernible in the real space, shaped into one, two, or three concentric rings, although observation of oscillations of wave functions in real space is much more complicated due to the drift and chaotic motions of the guiding centers of electron orbitals. The results of these studies are important, among other things, for applications of the quantum Hall effect.

Source: *Phys. Rev. Lett.* **109** 116805 (2012)
http://dx.doi.org/10.1103/PhysRevLett.109.116805

2. Impact of ions on a surface

The properties of CaF_2 surface defects arising from collisions with this surface of slow, multiply charged Xe^{q+} ions, where the ion charge q in the experiment was varied from 10 to 33, have been studied by A S El-Said et al. at the Helmholtz-Zentrum Dresden–Rossendorf (Germany). The surface topography was investigated using an atomic force microscope. It appeared possible to establish the conditions under which specific types of defects arise and construct the 'phase diagram' of how they form, depending on the kinetic energy of incident ions and their charges. It was found that at low q an ion can cause the formation of a cluster of defects in such a way that the surface remains even, nonetheless. The presence of a triangular-shaped cluster (due to the configuration of the crystal lattice) became noticeable only after chemical etching of the surface. If q was sufficiently high, nanoscale hillocks would form on the surface, in addition to defect clusters; the hillocks were visible even without etching. This growth of hillocks is caused by melting of the crystal lattice around the ion that penetrates into the subsurface layers, by excitation and ejection of atoms. The position of the hillock region on the 'phase diagram' mainly depends on the ion charge and only very weakly on ions' kinetic energy. However, the boundary of the area in which triangular defects are visible after etching depends essentially on both these parameters.

Source: *Phys. Rev. Lett.* **109** 117602 (2012)
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3. Magnetic anisotropy of Fe_4 complexes

E Burzuri et al. (Delft University of Technology, Netherlands) have investigated the magnetic anisotropy of individual Fe_4 complexes consisting of four iron atoms embedded in a nonmagnetic organic molecule. The complexes were placed between three gold electrodes in the field-effect transistor configuration. An Fe_4 complex could capture electrons and the resulting electronic states could be measured by applying an electric potential to the gate electrode. The magnetic properties of Fe_4 varied significantly from one electronic state to another. The current–voltage characteristic of the system was built depending on the electronic state of the Fe_4 complex, the external magnetic field, and the orientation of Fe_4 relative to the direction of the applied magnetic field. The resulting dependence proved to be nonlinear in a certain range of parameters, pointing to the magnetic anisotropy of Fe_4 complexes.

Source: *Phys. Rev. Lett.* **109** 147203 (2012)
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4. Plasma in a spheromak

A team of researchers led by T R Jarboe et al. the University of Washington has conducted experiments on the stable injection of plasma into improved spheromak — a facility for the self-confinement of plasma by the magnetic field it carries. Spheromaks may find applications in thermonuclear power generation. They are not only of interest as such, but can also be used as auxiliary systems for the injection of plasma into tokamaks. The installation consists of a central toroidal chamber incorporating two additional semitoroidal 'mug handles'. Plasma with a self-twisted magnetic field (magnetic helicity) is injected into these handles. This geometry produces a configuration of electric currents and magnetic fields capable of confining plasma without external magnetic field, such that its power requirements are two orders of magnitude lower than those for conventional magnetic confinement. The experiment reported a threefold increase in electric current in the plasma, up to more than 40 kA. The designed facility is merely a prototype: the experiment has shown good results but under conditions far less demanding than the real conditions in a thermonuclear fusion reactor. Larger-scale studies will be required for a more complete assessment of the effectiveness and practical implementation of this technique.

Source: http://www.washington.edu/news/2012/10/11/mug-handles-could-help-hot-plasma-give-lower-cost-controllable-fusion-energy/

5. 'Missing baryons' in the Galaxy

Observations with space X-ray telescopes of the circumgalactic medium around the Milky Way have revealed a massive halo of hot gas which perhaps contains the so-called 'missing baryons'. The problem of missing baryons lies in the fact that direct observations have identified only about a half of the amount of baryonic matter that was produced in the Universe by primeval nucleosynthesis and that is implied by the observations of anisotropy of the cosmic microwave background radiation. A Gupta (Ohio State University, United States) and his colleagues studied nonshifted (with $z = 0$) absorption lines of oxygen ions in the emission of eight active galactic nuclei observed by the Chandra X-ray Observatory. The character of lines is such that they appear to arise when radiation passes through a gas halo greater than 100 kpc in radius with a temperature of 1–2.5 million K. This halo envelops a mass comparable to that of all stars in the galactic disk. It may even comprise the entire local group of galaxies. In addition, Gupta's team utilized the data from the XMM-Newton and Suzaku telescopes which recorded the emission from gases in the halo, allowing more accurate calculation of the mass of hot gas. Earlier observations with the Hubble Space Telescope have already indicated that such massive hot gas halos do exist around very distant galaxies observed in the early Universe.

Source: *Astrophys. J. Lett.* **756** L8 (2012)
http://arXiv.org/abs/1205.5037v4

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