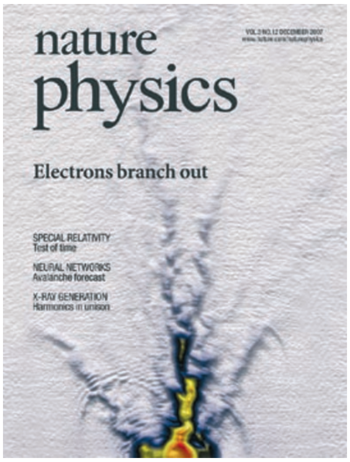

Cover story

Vol.3 No.12 December 2007

Two-dimensional electron gases provide 'mini laboratories' for fundamental physics as well as the basis for the semiconductor industry. Devices are ultimately limited by the flow of electrons, and a direct visualization of their flow could lead to better designs and applications. To this end, Michael Jura and co-workers use scanning gate microscopy to observe the electrons flowing through samples with different levels of disorder. They find that although the electrons flow along narrow branches, as expected, electrons in the cleanest sample — which still include a few scattering sites — show no hard scattering from impurities and defects. Moreover, the trajectories are stable to changes in the initial injection sites and injection angle. This stability is not expected for classical chaotic motion and quantum mechanical simulations are necessary to explain the results. **[Letter p841]**

PRECISE TIMING

The special theory of relativity tells us that a clock watched in a given inertial system ticks faster than an identical clock in any moving inertial system. The effect, known as time dilation, has been observed experimentally — first in 1938. Now Sascha Reinhardt and co-workers report the most precise test of time dilation so far, based on a method combining ion storage and cooling technology with an optical metrology technique that uses frequency combs. Their results confirm the predictions of special relativity, and provide benchmarks for theories of quantum gravity and 'new physics' beyond the standard model. **[Article p861; News & Views p831]**

NEURAL NETWORKS GET ORGANIZED

Neurons can signal to each other through junctions known as synapses, enabling them to build extended networks. Experiments in cell cultures show that stimulating one neuron triggers bursts of activity. The size distribution of these 'neuronal avalanches' can be approximated by a power law, suggesting that the networks operate near the critical point. Anna Levina and colleagues address the question of how these networks can reach the critical point, and argue that no fine-tuning is needed. When factoring in that the efficiency of transmission through synapses depends on the frequency of their use, they find that neural networks self-organize to operate in the critical regime. **[Letter p857; News & Views p834]**

MELT AWAY

Melting is generally a first-order transition. There are many ways to measure it, depending on the substance. For a thin film on a substrate, it's possible to quantitatively characterize the melting using an optical microscope. Placing a monolayer of different solid alkanes (hydrocarbon chains) on silica, Hans Riegler and Ralf Köhler image the domains as a function of temperature. They find reversible melting — that is, the lateral domain size continuously decreases on heating, and then increases again on cooling, which is not first-order behaviour. Owing to 'pre-wetting', a liquid-like film wets the adjacent surface and causes melting to occur at drastically reduced temperatures. **[Article p890]**

The fractal shape of alkane domains indicates an amorphous rather than crystalline structure.

p890

X-RAYS COHERENTLY COMBINED

X-ray sources based on the generation of high harmonics by the interaction of an intense laser with a gas or solid target are a promising alternative to synchrotron sources. Unfortunately, as most of the driving energy is wasted through the production of low harmonics or by passing straight through the target, the efficiency of these sources is low. A seemingly obvious way of improving this is to pass the incident radiation through multiple targets. But because harmonics travel through the targets at different speeds, adding them constructively is a great technical challenge. Jozsef Seres and colleagues present a solution using a quasi-phase-matching technique that enables harmonics from successive sources to be coherently combined. **[Article p878]**

MIND THE TRUE GAP

In a conventional superconductor, the energy gap measured by a scanning tunnelling microscope is the superconducting gap and it scales with the superconducting transition temperature T_c. However, in a high-T_c superconductor, the additional gap ('pseudogap') in the normal state obscures the view. Tetsuo Hanaguri *et al.* make use of the *d*-wave nature of the superconductivity to extract the true superconducting gap by means of the 'quasiparticle interference' effect. Surprisingly, their measurements in $Ca_{2-x}Na_xCuO_2Cl_2$ reveal the same momentum dependence of the superconducting gap as in $Bi_2Sr_2CaCu_2O_{8+\delta}$, whose T_c is three times higher — only some of the electrons take part in the superconductivity in the oxychloride compound. **[Article p865]**

HOLEY ANTENNAS

Central to 'plasmonics' is the idea of manipulating light, at scales well below the diffraction limit, through its interaction with the surface plasmons that are present within any metal. Yuri Alaverdyan and colleagues demonstrate a so-called optical antenna that exploits this interaction to receive and transmit light to the far-field. They show that the production of antisymmetric surface plasmon polaritons by an appropriately spaced finite array of subwavelength-sized holes in a thin metal film leads to a periodic redistribution of positive and negative charges. This distribution of charge behaves in a manner similar to the dipole elements of a conventional radio antenna, enhancing the scattering of light in one direction and suppressing it in another. **[Article p884; News & Views p839]**