COVER STORY

Vol.2 No.12 December 2006

Free-electron lasers are an exciting development for fields ranging from structural biology to nanotechnology. These lasers produce an intense and extremely short burst of X-rays, which could enable the structure of individual organic molecules to be collected without the need to first form them into a crystal (as is the case in conventional X-ray analysis). But the intensity of these pulses is such that they obliterate any sample they irradiate. In this issue, Henry Chapman, Janos Hajdu and colleagues report a proof-of-principle of a technique that reconstructs the image of a sample using scattered X-rays at the beginning of a pulse. Using a single 25-femtosecond soft X-ray pulse generated by the recently completed FLASH free-electron laser, they imaged two micrometre-sized stick figures patterned into a silicon nitride film — just moments before it evaporated at a temperature of 60,000 K. **[Letter p839; News & Views p799]**

A STEP CLOSER TO QUANTUM NETWORKS

Large-scale exchange of quantum information will require some form of network. These are likely to involve nodes, distributed over remote locations, that host quantum objects such as atoms, ions or molecules for the storage and processing of information, and quantum channels to transmit information between the nodes, typically in the form of photons. In a practical quantum network, synchronized operations on states stored in separated nodes must be possible — Daniel Felinto and co-workers have now implemented this essential ingredient. In their two-node set-up they make, in real time, the evolution in one node conditional on what happens in the other one. Such a level of control could lead to a large increase in the probability of success for network operations, and to favourable scaling properties when the network is expanded.
[Article p844; News & Views p801]

LINEAR RESISTIVITY EXPLAINED

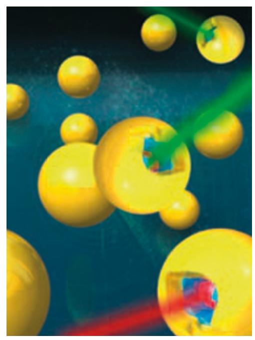
The electrical resistance of high-temperature superconductors is remarkably linear in temperature — a straight line from the melting temperature down to the precipitous drop to zero at the superconducting transition temperature. This simple property is as puzzling as it is ubiquitous, and many consider the normal state to be even more anomalous than the superconducting state. Although various explanations for the linear resistivity have been proposed, theories have been hampered by an absence of precise measurements of the transport scattering rate. To address this, Majed Abdel-Jawad and co-authors use magneto-resistance measurements to determine the angular dependence of the scattering rate. They reveal two different scattering mechanisms: the usual isotropic electron–electron interaction, and an additional anisotropic component, with the same anisotropy as the superconducting d-wave gap, and a linear temperature dependence.
[Letter p821; News & Views p809]

CORRELATIONS STRONG AND LIGHT

Strongly correlated behaviour is responsible for the emergence of many exotic and important physical phenomena, including superconductivity, colossal magnetoresistance and Bose–Einstein condensation. But because of the short time- and length-scales over which the elements of most strongly correlated systems interact, studying their behaviour at this level can be challenging. Two studies in this issue propose that an array of high-quality optical cavities containing appropriately resonant atoms and driven by a laser could provide a more accessible analogue for such systems. The analyses presented in these studies suggest that the polaritons — composite quasiparticles formed of both electronic and optical modes — which populate such an array give rise to rich quantum phase transition behaviour. Moreover, owing to the relatively large distance over which polaritons in adjacent cavities interact, it should be possible to individually probe and even directly control each with much greater ease than in a conventional strongly correlated system.
[Article p849; Article p856; News & Views p803]

QUANTUM-DOT ONIONS

With a controllable number of confined electrons, quantum dots are similar to artificial atoms. An electron spin (which can point either up or down) isolated in a semiconducting quantum dot is a tantalizing candidate for storing one bit of information, or qubit. But to perform any useful operation, the quantum dot must be coupled to another one, at the very least. Jesse Berezovsky and co-workers bypass the need for wires by growing an onion-like quantum dot structure: the core is separated from a shell layer by a barrier layer. Using optical means, the core and shell states can be individually manipulated, meaning that the localized spin states can be initialized and read out at will. Scaling up the approach will be the next major challenge. **[Letter p831; News & Views p807]**



Know your onions: coupling quantum dots.

p831

GOING CRITICAL

The atomic nucleus is a complex entity; understanding its structure in terms of its constituent protons and neutrons is an ongoing challenge. The equilibrium shapes of nuclei are now known to undergo quantum phase transitions, as a function of their nucleon content. In this issue, Rick Casten describes how the concept of 'critical point symmetries' has been brought to bear on the description of nuclear structure at such phase transitional points. **[Review p811]**

ERRATUM

THIS ISSUE

Nature Physics **2,** December 2006

There are three incorrect page numbers in the print version of the This Issue page. The correct numbers are as follows:
“Linear resistivity explained” News & Views p809;
“Correlations strong and light” first Article p849;
“Quantum-dot onions” News & Views p807.