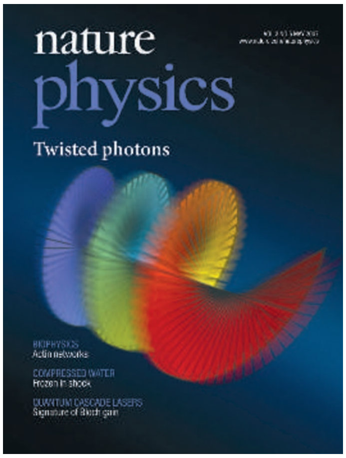

Cover story

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All physicists know that light carries both linear and angular momentum. What is perhaps less well known, however, is that its angular momentum can be broken down into spin and orbital components. Spin angular momentum is associated with polarization, whereas orbital angular momentum arises from a more complex combination of the phase and amplitude profiles of an optical field. Although the spin momentum is the predominant property used in optical-based quantum information applications, orbital momentum is potentially more powerful for encoding and processing such information in high-dimensional quantum spaces. In this issue, Gabriel Molina-Terriza and colleagues review progress in the generation, understanding and use of the orbital angular momentum of light.
[Progress Article p305]

FLASH-FROZEN FLUID

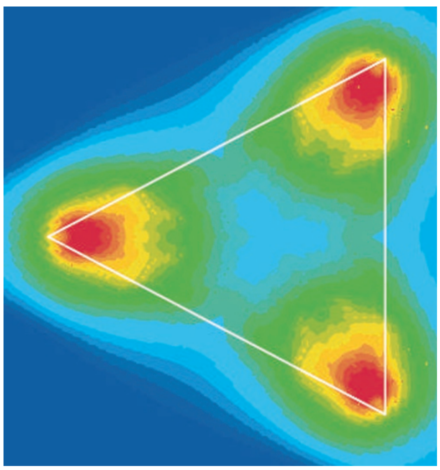
Despite the importance of water we still do not understand all of its phases and phase transitions, particularly at elevated temperatures and pressures. And although it may seem counter-intuitive that heating water to high temperatures will cause it to freeze, Daniel Dolan and co-workers have found that extreme compression does create frozen water. They used the Z machine at Sandia to compress a sample of water magnetically. At 7 gigapascals, the water underwent a first-order transition to ice on a time scale of nanoseconds, without the need for any nucleation centres. The most likely phase is ice VII. [**Letter p339**]

QUANTUM CASCADE LASER HOTS UP

Quantum cascade lasers (QCLs) are one of the most promising compact sources of terahertz radiation. But their electrically unstable nature and the need to drive large currents through them to achieve population inversion for lasing, means terahertz QCLs have only been able to operate at temperatures of around 100 K. To overcome this, Romain Terazzi and colleagues have developed a QCL structure that induces electrons to undergo 'Bloch oscillations', which relaxes the population-inversion condition. The device can therefore operate at temperatures well above those of conventional terahertz QCLs.
[**Letter p329; News & Views p298**]

PLASMONS RESOLVED

Surface plasmon polaritons (SPPs) are composite quasiparticles arising from the interaction of light with electronic excitations that exist at the surface of a conductor. SPPs could hold the key to photonic devices that operate at nanometre scales, as they are much smaller than optical wavelengths, and their properties can be controlled by patterns etched into the surfaces they travel across. Yet their small size makes them difficult to study. By improving the energy resolution of a transmission electron microscope's energy loss spectrometer, Odile Stéphan and colleagues demonstrate a technique for mapping surface plasmons directly, at a resolution well below that of optical imaging techniques. [**Article p348**]



Surface plasmon modes of a silver nanoprism mapped in an electron microscope.

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ACTIN NETWORKS

Biological cells are supported by a 'cytoskeleton', a crosslinked network of filaments made of the protein actin. Paul Dalhaimer and colleagues note that these networks and liquid-crystal elastomers have similar behaviour. Using the principles of polymer and liquid-crystal physics in simulations of actin networks, they arrive at a fuller understanding of their mechanics and phase behaviour. For networks with long filaments, and for varying length and connectivity of the crosslinking proteins, they identify three regimes of nematic phase behaviour — 'loose', 'semi-loose' and 'tight', the latter resembling the cytoskeletal structure of hair cells in the ear, and having properties appropriate for directed sound propagation. [**Article p354**]

BREAK IT UP

Paired electrons (or holes) are responsible for superconductivity. Break up those pairs — by changing the magnetic field, temperature or carrier density, for instance — and long-range phase coherence disappears. In reduced dimensions, pairs can exist well beyond the confines of the superconducting state. Lu Li and colleagues investigate how such pairs are destroyed in the low-density region of the phase diagram of a high-temperature superconductor, where superconductivity, magnetism and glassiness compete for ground-state dominance. Their sensitive magnetization measurements reveal that quantum phase fluctuations break up the pairs, but that short-range superconductivity survives in the vortex-liquid state in which spontaneous vortex creation occurs. [**Letter p311**]

GENTLE PROBE

The quantum properties of Bose–Einstein condensates are typically probed by releasing the constituent atoms from their trap, and letting them interfere. Igor Mekhov and colleagues propose that combining ideas from the physics of ultracold quantum gases and cavity quantum electrodynamics could provide a much less destructive approach. They show that when a quantum gas is placed inside a high-*Q* cavity, different quantum phases — such as the superfluid state or the Mott-insulator phase — have characteristic signatures in the transmission spectra of the cavity. This might provide more detailed information about quantum phase transitions than has been possible so far. [**Letter p319**]