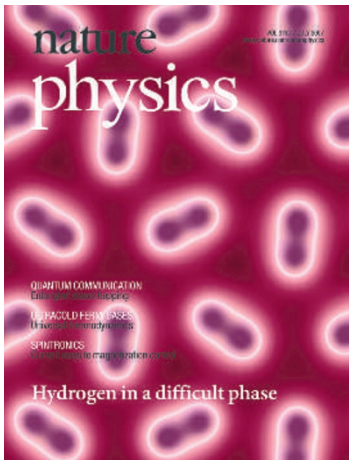

Cover story

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In the laboratory, under the highest currently attainable pressure, hydrogen solidifies but remains insulating even though theoretical calculations suggest it should be metallic (and perhaps superconducting). Higher-pressure studies will settle this question. In the meantime, the actual atomic structures of the high-pressure phases of hydrogen are the subject of debate. Part of the problem is the paucity of experimental data to constrain theoretical calculations, for which huge tracts of phase space must be searched for possible structures. To reduce the effort, Chris Pickard and Richard Needs have come up with a computational approach that optimizes the enthalpy as a function of the atomic configuration. Their candidate structure for phase III hydrogen is not only stable and insulating but agrees with available experimental evidence, thus revising the phase diagram of the simplest element. **[Letter p473; News & Views p452]**

UNIVERSAL FERMI-GAS BEHAVIOUR

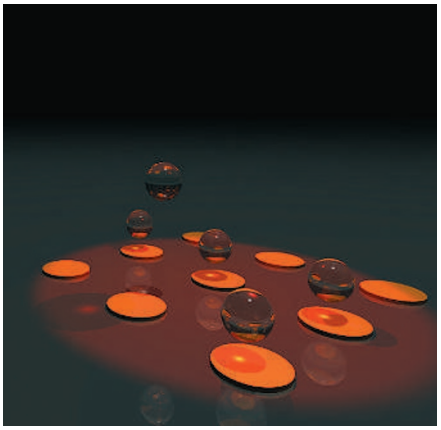
The ability to produce and study strongly interacting degenerate Fermi gases of ultracold atoms promises new insight into many other important fermionic systems — from neutron stars to the quark–gluon plasma of the early Universe — that are otherwise inaccessible. Detailed analysis by Hui Hu and colleagues of the results from three independent ultracold Fermi-gas experiments reveals a remarkable degree of universality of behaviour. Despite different trapping arrangements and the use of two different atomic species, the authors show that the entropy versus energy relations of all systems precisely follow a single curve, derived with no free parameters. **[Letter p469]**

SPOOKY ISLANDS

Quantum communication typically uses entangled photons for transmitting messages, in theory with absolute security. In practice, however, sending information over long distances is challenging, owing to losses in optical fibres, or atmospheric variations when transmitting through free space. Rupert Ursin and colleagues have mastered the challenges of free-space transmission, and, using a telescope at the optical ground station of the European Space Agency as one of the bases, connected two parties residing on different islands in the Canaries via a quantum channel spanning 144 km — comfortably breaking the previous record for free-space quantum communication of 23 km. **[Article p481]**

GOLD ATTRACTION

The manipulation of cells, or micrometre-sized particles suspended in a liquid, is often tackled using optical tweezers. But these devices, which exploit the fact that particles can be attracted to a focused light field, are bulky and often tricky to set up. Maurizio Righini and colleagues take a simpler approach. They show that the locally enhanced optical field generated when a gold microdot is illuminated by unfocused laser light can be used to trap a microbead of similar size. Moreover, using an array of microdots they simultaneously and selectively trap multiple microbeads of one specific size from a suspension containing two different sizes. **[Letter p477]**



An illuminated array of gold dots traps particles in the same manner as an array of optical tweezers.

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PRACTICAL WITHOUT FIELD

Devices that explicitly use the electron's spin degree of freedom have already won their spurs in hard disk drives and magnetic random access memory. A different arena in which spintronics components could offer advantages is that of nanoscale microwave sources. So-called spin-torque nano-oscillators have been demonstrated before, but their operation required relatively strong magnetic fields, limiting the practical usefulness of the devices. Two independent works — by Olivier Boulle *et al.* and Vlad Pribiag *et al.* — now demonstrate that spin-torque nano-oscillators can generate microwave signals also without any external magnetic field. **[Article p492; Article p498; News & Views p447]**

DISORDER LEADS TO ORDER

Competing interactions within a solid often lead to frustration, which prevents one kind of order from dominating at low temperature and results in a degenerate ground state. Such systems are usually sensitive to changes in chemical composition, pressure, magnetic field and so forth. High-temperature superconductors, for example, exhibit complex phase diagrams as a result. But a simpler case is the diamond-lattice antiferromagnet. Doron Bergman and co-workers propose a model for such compounds. They use thermal fluctuations — whose entropic origins usually lead to disorder — to reduce the degeneracy. The resulting spiral spin-liquid might explain the behaviour of $CoAl_2O_4$ and $MnSc_2S_4$. **[Article p487]**

SCANNING ELECTRON LENS

Scanning probe microscopy is a powerful tool for studying the behaviour of electrons within mesoscopic structures. Katherine Aidala and colleagues use it to image the path of coherent electron waves focused by a magnetic field in a 2D electron gas (2DEG). The authors used a similar technique in previous work to image electron waves emerging from a single quantum point contact, by monitoring how much the waves back-scattered from a fully depleted spot beneath a scanning probe tip. But in a magnetic field, bending of the scattered electrons causes the image signal to disappear. By only partially depleting the 2DEG, and using an appropriate device geometry, they now find that the signal can be recovered. **[Letter p464]**