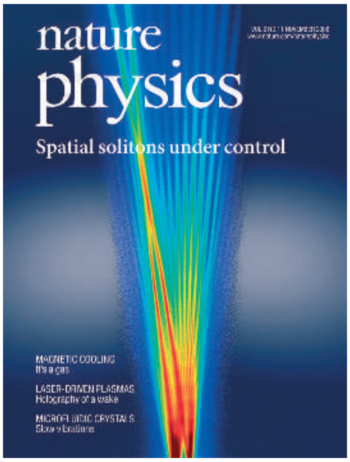


COVER STORY

Vol.2 No.11 November 2006

Following a flurry of activity in the 1990s, there is now a resurgence of interest in optical solitons: three papers in this issue present diverse insights into their manipulation, behaviour and potential practical use. First, Marco Peccianti and colleagues show how to control the path of spatial solitons travelling through a nematic liquid crystal by electrically altering the refractive index of different regions of the material. Carmel Rotschild and colleagues report an extremely long-range interaction between spatial solitons — which usually only interact when they're less than a few beam widths apart — travelling within a heat-sensitive nonlinear medium. And finally, Joe Mok and colleagues demonstrate the ability to tune the speed of gap solitons, slowing them to a sixth of the speed of light in vacuum by launching them near the band edge of a fibre Bragg grating. **[Letter p737; News & Views p729; Article p769; Article p775; News & Views p735]**

MAGNETIC REFRIGERATOR GOES GASEOUS

Cooling by adiabatic demagnetization — first suggested in the 1920s by Debye and Giauque — is a key technique for reaching sub-kelvin temperatures in solid samples. The method converts kinetic energy into magnetic work, but this requires a sizeable coupling between spin and motion. In gases, this coupling is typically too weak to make the approach useful. But Marco Fattori and colleagues demonstrate that, in a dipolar gas, demagnetization cooling does work. They apply the method to a gas of high-spin atoms, chromium-52, in which inelastic collisions drive the demagnetization. Compared with other approaches used to produce cold gases, evaporative cooling in particular, this 'new old' method has the advantage of very little atom loss, and might therefore provide, for example, an alternative route to the Bose–Einstein condensation of dipolar gases. **[Article p765]**

CAPTURING A LASER WAKE

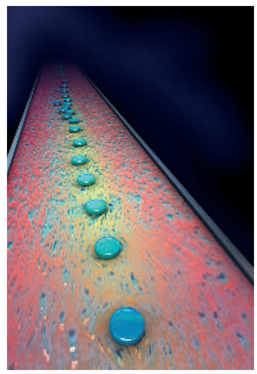
Electrons, protons and even ions can be accelerated using the extreme electric fields generated when a high-power laser is focused into a plasma. But the structure of the so-called laser wakefields that are driven through the plasma at almost the speed of light — analogous to the wake produced behind by a boat as it travels on water — has until now only been discernable through simulations of the process. Nicholas Matlis and colleagues have produced the first direct images of a laser wakefield, by using a holographic technique that reconstructs an image of the wake structures from the way in which they perturb the interference of two coherent light beams passing through the plasma. The technique provides a new tool for studying laser–plasma interactions and potentially improving the performance of laser-driven particle accelerators. **[Letter p749]**

THE QUANTUM IN STATISTICAL MECHANICS

Statistical mechanics describes the thermodynamic properties of macroscopic ensembles very successfully. But when it comes to the foundations of the field, deep conceptual puzzles remain. Why is it, for example, that physical systems that are always in some definite state and evolve deterministically, show statistical behaviour? What is the meaning of the statistical averages for individual states? It has been suggested before that the uncertainty underlying the definition of thermodynamic properties such as entropy has something to do with the fundamental uncertainty in quantum mechanics. Sandu Popescu and colleagues take the approach further, and establish in great generality that the (subjective) ensembles of statistical mechanics can be indeed thought of as reflecting objective quantum-mechanical probabilities. Thermalization, then, would be a result of the entanglement between the system and its environment. **[Article p754; News & Views p727]**

SLOW FLOW OF PHONONS

Although originally intended to provide practical solutions for chemical processing and analysis, the field of microfluidics offers a rich assortment of exotic phenomena for physicists to explore. A case in point is presented in a study by Tsevi Beatus and colleagues of the collective behaviour of a one-dimensional crystal of water droplets injected into a stream of oil flowing through a quasi-two-dimensional microfluidic channel. By tracking the seemingly random short-range motion of the droplets, they identify the emergence of normal vibrational modes whose properties are directly analogous to the acoustic phonon modes of an atomic crystal. The phonon-like waves associated with these modes travel at speeds a million times slower than the speed of sound in the fluid itself. Moreover, the conceptual framework developed for describing phonons in conventional crystals could help simplify our understanding of the complex hydrodynamic interactions that occur in this and other dispersive systems.
[Letter p743; News & Views p733]



A one-dimensional crystal of water droplets in oil supports slow-moving phonon-like modes.

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ATTOSECOND MIDWIFERY

Success in the use of attosecond pulses of light to manipulate the behaviour of atoms, molecules and solids requires more than just the ability to generate these pulses but to accurately and reliably measure their properties too. This is usually carried out well after the pulse generation process, but Nirit Dudovich and colleagues have developed a technique that enables the spatial and temporal profiles of attosecond pulses to be measured at the moment they are created. Moreover, with slight adjustment their approach can be adapted to exert control over the generation process, enabling the high harmonic content of the emission spectrum to be manipulated. **[Article p781]**