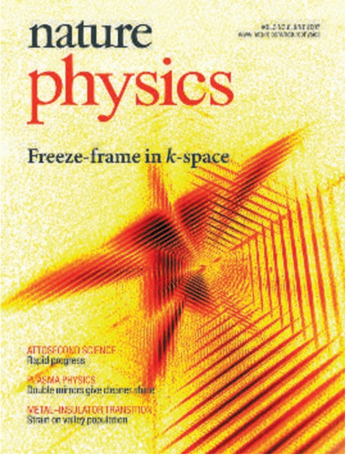


## Cover story

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The dynamic response of a periodic structure to any wave-like excitation — be it optical, acoustic or electronic — is governed by the coupling between the eigenstates of the structure. A complete description of these eigenstates involves not only real space, with which physicists and non-physicists alike are familiar, but the inverse of this space — so called reciprocal- or *k*-space. Although techniques exist to characterize the electronic eigenstates of atomic crystals in *k*-space, the same cannot be said for the optical eigenstates of photonic crystals. Rob Engelen and colleagues have now developed a near-field optical microscopy technique that enables them to track the temporal evolution of a pulse of light in *k*-space from one eigenstate to another as it passes through a complex photonic-crystal structure. **[Letter p401]**

### WELCOME TO THE ATTOWORLD

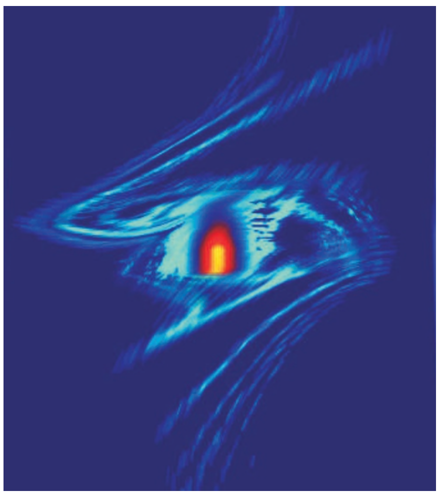
Laser pulses with durations of less than a femtosecond were first produced in 2001. The feat opened up an entire new field of research: attosecond science. Ferenc Krausz and Paul Corkum review the breakthrough in technology that has provided a look at — and a handle on — the real-time motion of electrons on the atomic scale. And they peer into the future of attosecond science, predicting implications well beyond physics. **[Progress Article p381]**

### THE ROLE OF VALLEY POLARIZATION

In two dimensions, any metal, according to weak-localization theory, will become insulating. But experimentally, metallic behaviour does occur. Oki Gunawan and co-workers have investigated the conditions for the metal–insulator transition in a two-dimensional electron gas, using strain to control the population of electrons in the conduction-band valleys. In the unstrained state, the sample is metallic if two particular valleys have equal populations. However, when an applied strain breaks this degeneracy the valleys become unequally populated, or 'polarized'. The samples then show insulating behaviour if the amount of spin polarization, controlled by a magnetic field, is also sufficient. **[Letter p388; News & Views p370]**

### LASERS POLISHED WITH PLASMAS

When a pulse of light from a high-intensity laser hits a polished surface, it produces a train of high-harmonic attosecond X-rays, which could have a variety of uses, from medicine to materials science. Improving this process means increasing the laser power. Unfortunately, as the power of a laser is increased, the noise it emits ahead of its main pulse can carry enough energy to destroy a surface before the pulse arrives. But by bouncing the pulse between a series of 'plasma mirrors', Cedric Thaury and colleagues show that they can remove this noise. Moreover, using these cleaner pulses, Thaury *et al.* have demonstrated that laser-driven high-harmonics are produced by two distinctly different laser–plasma interactions. **[Article p424; News & Views p369]**



Plasma mirrors produce cleaner pulses of ultrahigh-intensity light.

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### DOMAINS OF UNUSUAL SIZE

The fractional quantum Hall state at filling factor 2/3 undergoes a quantum phase transition to a fully spin-polarized state in the presence of a magnetic field. This kind of first-order phase transition is normally accompanied by hysteresis, owing to the formation of macroscopic domains near the transition. But in a microscopic sample such as the electron gas in question, could there be hysteresis as well? The answer is yes, report Basile Verdene and colleagues. By tracking the phase transition as they vary the size of their sample, they show that domains are indeed present and unexpectedly large, at 500 nm. **[Letter p392]**

### BRINGING 2D NMR UP TO SPEED

Two-dimensional NMR spectroscopy — in which the signal is dispersed into two spectral dimensions — is a key technique in obtaining detailed information about the structure and dynamics of molecules. Recording 2D-NMR spectra, however, is painfully slow, traditionally requiring the sequential execution of several experiments and/or signal averaging to overcome the inherent insensitivity of NMR. Lucio Frydman and colleagues have found that two separately developed techniques for boosting nuclear polarization and for getting 2D spectra in a single signal-acquisition step make a perfect couple for 'ultrafast 2D NMR', with the potential to cut the duration of experiments from hours to seconds. **[Letter p415]**

### SIMPLE IMPACT

Many empirical descriptions have been proposed for the dynamics of a low-speed impact of a solid with a granular medium, but none captures all of the complex behaviours of these systems. To address this, Hiroaki Katsuragi and Douglas Durian have developed an experimental technique to measure accurately the velocity profile of a steel ball as it impacts with a bed of glass beads. Using the results, they have arrived at a simple unifying description of this behaviour that treats the interaction between an object and a medium as the sum of two separate components — a velocity-dependent inertial drag and a depth-dependent friction. The success of this description suggests that seemingly complex granular impact phenomena can be easily understood. **[Letter p420]**