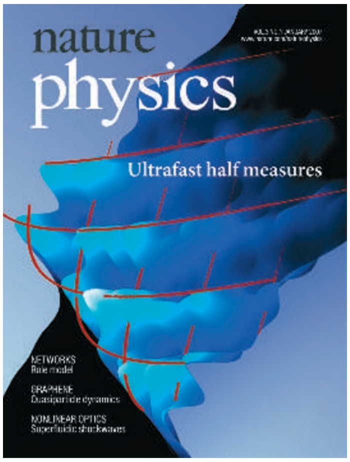


COVER STORY

Vol.3 No.1 January 2007

When a medium is irradiated with a laser pulse so intense that it forces the medium's electrons to move in synchrony with the laser's electric field, the exact phase of this field with respect to the pulse envelope — known as the carrier-envelope phase (CEP) — plays an important role in determining how the medium responds. Measuring the value of this phase is challenging, and usually requires averaging over many pulses. In this issue, Charles Haworth and colleagues show that by analysing the high harmonics generated by the interaction of an intense femtosecond laser pulse with a gaseous medium, they can determine the CEP of a single pulse. Moreover, they suggest that such an approach could soon enable individual attosecond pulses emitted during a particular optical half-cycle of the driving field to be isolated. **[Article p52; News & Views p16]**

GRAPHENE QUASIPARTICLE COMPLEXITY

The relativistic nature of the Dirac fermions that carry charge in graphene is a consequence of graphene's unique electronic structure. Angle-resolved photoemission spectroscopic measurements of this structure conducted by Aaron Bostwick and colleagues reveal an unexpected degree of complexity in the many-body interactions that these quasiparticles undergo. Specifically, they find that electron–electron, electron–plasmon and electron–phonon processes distort the otherwise perfect conical shape of graphene's conduction and valence bands. As well as providing new insight into the properties of graphene, the strength of such interactions could have important implications for our understanding of superconducting and other exotic states of related systems. **[Article p36]**

BEYOND THE LOOKING GLASS

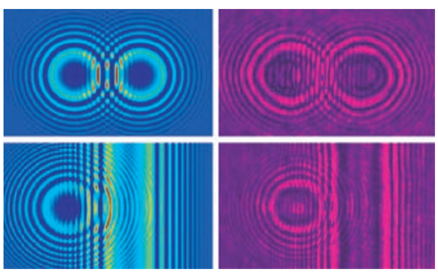
Near the glass transition of a glass-forming liquid, the dynamics slow down to such an extent that the system is unable to equilibrate with its surroundings. As a structural glass ages, two forms of relaxation take place: a fast one corresponding to the local fluctuations of particles within their 'cages', and a much slower one involving the breakdown of those cages. Horacio Castillo and Azita Parsaeian concentrate on the slow relaxation process that involves local fluctuations in the age of the sample. Their simulation shows that such local fluctuations could give rise to the observed dynamical heterogeneities, which, until now, have lacked a clear physical origin. **[Letter p26]**

ROLE PLAY

Complex systems of interacting agents can be represented by networks, making them amenable to statistical analysis. 'Real-world' networks from such dissimilar areas as biology, technology and social sciences share several global properties. However, the relevance of these properties hinges on the homogeneity of the networks. But most real-world networks have a marked modular structure, that is, there are distinct groups of nodes that are densely connected within. In modular networks, nodes can be classified into different roles. Roger Guimerà and colleagues demonstrate that, by focusing on the patterns of connections among nodes with different roles, structural features are revealed that global properties fail to capture, and networks with different functional needs and growth mechanisms can be discriminated.
[Article p63; News & Views p18]

ALL-OPTICAL SUPERFLUID SHOCKWAVES

The absence of viscosity in Bose–Einstein condensates and other superfluid systems makes them respond to shockwaves in a qualitatively different manner from classical fluids. As well as providing means to probe the underlying physics of such systems, shockwaves can produce intriguing new phenomena in their own right. Taking advantage of the fact that the response of certain nonlinear optical crystals to laser light is governed by similar equations to those that govern superfluids, Wenjie Wan and colleagues demonstrate an all-optical system that makes it much easier to study how superfluid shockwaves propagate and interact.
[Article p46; News & Views p13]



Superfluid-like shockwaves collide in a nonlinear optical crystal.

p46

PREMIER QUANTUM PHASE TRANSITIONS

Being at zero temperature, quantum magnetic phase transitions are difficult to study, particularly if the sample is under pressure. In this respect, muons are an ideal probe, as they can go through the pressure cell and are highly sensitive to local magnetic fields. Tomo Uemura *et al.* have used muon spin relaxation measurements to probe both dynamic and static magnetic properties in MnSi and $(Sr_{1-x}Ca_x)RuO_3$. They find direct evidence for the presence of spontaneous phase separation and suppressed critical fluctuations near the quantum magnetic phase transitions — evidence for first-order or discontinuous phase transitions. Through comparisons to other strongly correlated electron systems, they argue that first-order transitions may be generic, and not second order as many believe.
[Article p29; News & Views p15]

SILICON VALLEYS

Interactions with the environment cause a quantum state to evolve. This decoherence is a particular problem for quantum computing, where the state represents information. Now, Srijit Goswami and colleagues have shown that it is possible to increase the coherence time of electron spins in Si–Ge quantum wells. Such states are known for their resilience, but they have a weakness. The electronic band structure of Si has a number of valleys. If the energy splitting of these is too small, electrons can tunnel from one to another and the state is lost. The team show that this energy splitting can be increased by controlling electron confinement, paving the way for silicon-based quantum information systems.
[Article p41]