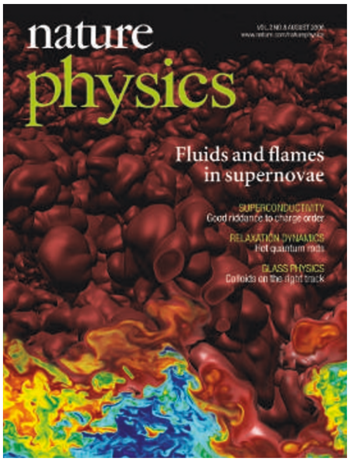


COVER STORY

Vol.2 No.8 August 2006

In systems ranging from our unpredictable weather to flame acceleration of a supernova, the Rayleigh–Taylor instability is the underlying mechanism; liquids of different densities mix in such a way as to lower the energy of the system. For a fluid, the Reynolds number is a measure of whether the flow is laminar or turbulent, with turbulence — and eddies of varying scales — setting in above 2,300 or so. These eddies will affect flame propagation in type Ia supernovae, the ‘standard candles’ used to estimate the expansion rate of the Universe. As it is not possible to measure the dynamics of turbulent combustion in a supernova, William Cabot and Andrew Cook use the largest-to-date direct numerical simulation to study the self-similarity, scaling and growth rate of thermonuclear flames. **[Article p562; News & Views p505]**

QUANTUM RODS STAY HOT FOR LONGER

The manner and speed with which excited charge carriers relax can have a significant impact on the performance of semiconductor devices. Consequently, over many decades, much effort has been devoted to understanding the mechanisms that mediate carrier relaxation. Most involve the transfer of energy from carriers to phonons. But in this issue, Marc Achermann and colleagues report a contribution from an unexpected mechanism. They find that at high illumination intensities in quantum nanorods, the interaction of two low-energy electron–hole pairs through Auger annihilation causes the generation of one higher-energy pair. The result is that it takes much longer for the carrier population to cool down, which could have both advantages and disadvantages for future quantum-rod devices. **[Article p557; News & Views p513]**

TUNE INTO SUPERCONDUCTIVITY

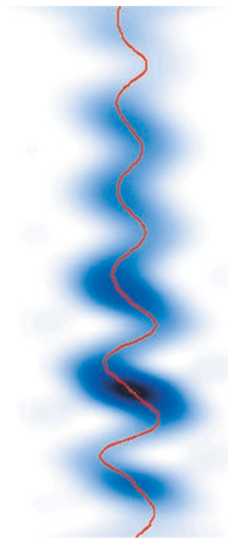
In low-dimensional systems, strong electronic correlations means there are many competing states at low temperature, some having exotic properties. These include superconductivity, in which the electrons pair up and form a condensate, and charge-density waves, in which the density of conduction electrons follows a periodic modulation. Both electronic rearrangements minimize the total energy and introduce an energy gap to the system, but their mutual relationship is unclear. Emilia Morosan and co-authors offer fresh insights. Starting with $TiSe_2$, which exhibits charge-density waves, they systematically intercalate Cu between the $TiSe_2$ layers and suppress the charge-density-wave state. When the Cu content reaches 4%, superconductivity appears. Up to 6% doping, the two states coexist and then superconductivity takes over completely. **[Article p544]**

COLLOIDS AGE AT EQUILIBRIUM?

Above a critical density, colloidal particles suspended in liquid will slow down and undergo a glass transition. The relaxation, or ageing, of the colloidal glass is similar to that in other non-equilibrium systems, such as spin-glasses and jammed granular matter. Despite being out of equilibrium, the concept of timescales for observables to reach equilibrium at different temperatures is useful. Ping Wang *et al.* test this idea experimentally. They track the motion of magnetic particles within the colloidal system to determine the temperature for various modes of relaxation. And though the mobilities and diffusivities of the tracers depend on the age of the glass, they find an effective temperature, higher than the bath temperature, that controls the relaxation dynamics, as for systems at equilibrium. **[Article p526]**

NANOTUBES OUT OF HARMONY

Conventional Raman spectroscopy is a powerful technique for studying the vibrational modes within nanoscopic structures. But because it probes these modes in terms of the frequencies at which they occur rather than how they evolve with time, it is difficult to study how the modes interact. To overcome some of these shortcomings, Alessio Gambetta and colleagues demonstrate the use of a pump–probe spectroscopic approach for observing the coherent vibrational dynamics of single-walled carbon nanotubes in real time. Their results reveal an unexpected anharmonic coupling between the radial and longitudinal modes of the nanotubes, which simulations indicate is caused by the emergence of corrugations in their structure. The authors suggest their technique could be used to develop new ways to optically monitor the structure of nanoscopic materials. **[Letter p515]**



Nanotube vibrations observed in real time.

p515

DIRECT ROUTE TO EVOLUTIONARY SUCCESS

Evolution drives biological systems to adapt to their environment. Similar evolutionary approaches are explored in complex optimization problems for engineered systems — software, for example, or reconfigurable hardware. Panos Oikonomou and Philippe Cluzel now show that the success of evolutionary algorithms — that is, the time taken to find the optimal design for performing pre-determined tasks — is governed by the topology of the underlying network (of logic gates, for instance). They find that networks of a certain architecture, called ‘scale-free’, reach the target particularly quickly, and that the process of finding a solution is remarkably robust. These findings might also aid understanding of why scale-free networks are present in a broad range of natural systems. **[Letter p532]**

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