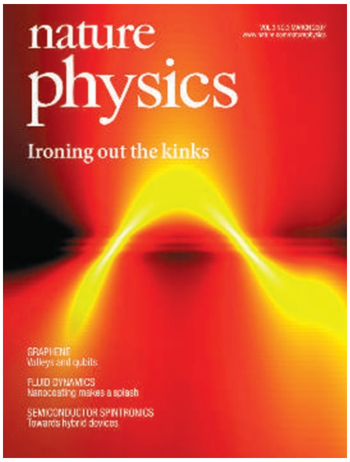



## COVER STORY

**Vol.3 No.3 March 2007**

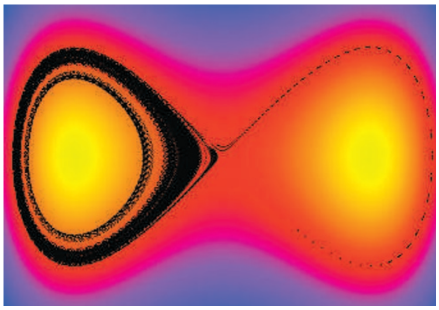
At the 1987 March Meeting of the American Physical Society, thousands attended a special session — the 'Woodstock of physics' — to hear about the new copper-oxide-based superconductors. But the vital question has remained unanswered: what causes the electrons to form pairs? Lattice vibrations or magnetic excitations? In this issue, Baptiste Vignolle *et al.* use neutrons to map spin excitations in unprecedented detail, arguing for magnetically mediated superconductivity; Dennis Newns and Chang Tsuei, however, present a theory based on a two-phonon mechanism. Eschewing both phonons and magnons, Krzysztof Byczuk and co-workers offer an explanation for the origin of the 'kink' in photoemission data, taken as evidence by both sides — they say the kink may have nothing to do with superconductivity.
**[Letter p163; Letter p168; Article p184; News & Views p148]**

## GRAPHENE RIBBONS JOIN THE DOTS

A key challenge in developing graphene-based devices arises from the very property that makes graphene so attractive — the relativistic behaviour of its charge carriers, which allows charge to pass straight through the p-n structures used to control the direction of current flow in conventional silicon electronics. Two reports in this issue propose a solution in the form of graphene nanoribbons. Rycerz and colleagues suggest that the flow of current in a nanoribbon could be controlled by preferentially injecting charge from a quantum point contact into one of its two valley-like conduction bands. And Trauzettel and colleagues suggest that a series of electrostatic gates placed along a nanoribbon could form an array of quantum dots, and hence act as a chain of coupled spin-qubits for quantum computing applications.
**[Letter p172; Article p192; News & Views p151]**

## STEALTH SPLASHES

The description of a solid body hitting an air–water interface traditionally ignores the effects of viscosity and surface tension for high-speed impacts, assuming the surface properties of the object have no effect on the size of the splash.However, Cyril Duez *et al.* see exactly the opposite: depending on the surface treatment of their spheres, they can control the splash size. A hydrophilic sphere produces a tiny 'plop' whereas a hydrophobic sphere — coated with a nanolayer of silane — causes a loud splash. Air entrainment is the key. An air cavity created by the passage of a hydrophobic sphere causes the familiar splash. For a hydrophilic sphere, there is no air cavity, as water rushes in to fill the space behind the sphere, and hence there is no splash.
**[Letter p180; News & Views p145]**



Odd one out — the search for rare physical trajectories. p203

## OF RARE IMPORTANCE

In systems governed by nonlinear dynamics, it's often the odd case that is of prime interest. In nonlinear media, for example, only very specific initial conditions lead to so-called soliton solutions. But singling out such 'rare trajectories' for a dynamical system is difficult. Julien Tailleur and Jorge Kurchan propose an algorithm that, in numerical simulations, biases the dynamics in a way that the probability of rare events is enhanced. They expect that their approach could make the problem of finding atypical trajectories in a wide range of real-world situations amenable to efficient modelling.
**[Article p203]**

## A NEW STATE OF MATTER?

Helium does not solidify at absolute zero in ambient conditions due to its zero-point energy. Rather, both helium-3 and helium-4 exist as superfluids, with no measurable viscosity. At 26 atm, helium-4 does solidify, but it was predicted that at higher pressure, it would become a supersolid: a solid with superfluid properties. In 2004, Kim and Chan tentatively identified a supersolid state of helium-4. However, Philip Anderson believes otherwise. In particular, he argues that the observations are consistent with a different quantum state, in which a tangle of vortex loops fluctuates. Moreover, the same physics could apply to the strange pseudogap state of high-temperature superconductors.
**[Letter p160]**

## SEMICONDUCTOR SPIN CURRENT

A current can be made spin-polarized by injecting it from a magnetized ferromagnetic contact into a non-magnetic metal. When a spin-polarized current attempts to cross from a non-magnetic metal into a second ferromagnetic contact, the resistance it encounters depends on its orientation to the magnetization of the contact. Such behaviour is used to great effect in the magnetic read heads of computer hard disks. But if spin is ever to be used for more complex tasks, such as computation, it is vital that semiconductor-based, rather than metal-based, spintronic devices be developed. To this end, Xiaohua Lou and colleagues categorically demonstrate an all-electrical means to inject and detect spin-polarized currents in an integrated GaAs device.
**[Article p197; News & Views p147]**

## THE LATEST SPIN

Given that a single transistor of a Pentium 4 processor costs less than 2 micropence, it's unlikely that the semiconductor industry will disappear anytime soon. However, other technologies can offer additional functionalities. For instance, the spin degree of freedom of an electron, rather than its charge, can be exploited in memory devices. Such 'spintronic' devices are good for storage, but not for logic (as the spins lack coherence) or communications applications. In their Review Article, David Awschalom and Michael Flatté explore the potential of hybrid devices that combine the attributes of traditional semiconductors with those of metallic spintronics to obtain a semiconductor spintronics device with information processing, communication and storage capabilities. **[Review p153]**