Sand dunes sing in tune

Sand can be made to sing as you walk or slide along the surface. The music produced by a sand dune has been likened to the sound of thunder or a beating drum, and can be heard up to 10 km away. It's understood that the sand grains are generally dry, uniform in size with rounded edges and covered by a layer of silica gel. But besides this, the underlying dynamic mechanism responsible for the sound is a bit of a mystery. By measuring the sound and motion of the ground during avalanches, B. Andreotti (*Physical Review Letters* **93**, 238001; 2004) has found that the surface of the sand dune acts like an elastic membrane of a loud speaker, emitting a maximum of 106 dB of sound (somewhere between an underground train, 100 dB, or rock concert, 110 dB). These elastic waves are excited by the collisions of the sand particles during granular flow, and the resulting vibration of the sand bed tends to synchronize the collisions. This kind of feedback is similar to a phase-locked loop, and suggests wave-particle mode locking as the mechanism behind singing dunes, determined by the intrinsic properties of grain dynamics rather than dune geometry.

All in a spin

The conventional Hall effect — a potential drop across a sample when an electron moves perpendicularly to an applied magnetic field, leading to charge accumulation at the sample edges — is used in materials characterization as a tool for studying charge-transport properties in the solid state. It has been proposed that a similar effect exists in paramagnetic systems, when a spin current is generated transverse to an applied electric field, even in the absence of applied magnetic fields. However, to date, this so-called spin Hall effect has not been observed experimentally. But now, consistent with predictions, David Awschalom and colleagues in Santa Barbara describe the use of scanning Kerr rotation — an optical technique that measures the degree of electron spin polarization in a sample — to demonstrate the accumulation of oppositely polarized electron spin at the edges of narrow semiconducting channels of GaAs and InGaAs (Y. K. Kato, R. C. Myers, A. C. Gossard and D. D. Awschalom *Science* http://dx.doi.org/10.1126/science.1105514). The spatial separation of electrons based on their spin polarization opens new avenues in the development of 'spintronics' — the construction of electronic devices that operate by manipulating spin as well as charge.

MULTICOMPONENT MIXTURES — THE CRITICAL POINT

A quartz plate installed at the bottom of a stirred high-pressure vessel has been used to explore the phase boundary and find the critical point of multicomponent fluid mixtures (J. Ke, P.J. King, M. W. George and M. Poliakoff *Analytical Chemistry* http://dx.doi.org/10.1021/ac048970i). This knowledge is crucial to carrying out chemical processes in super- or near-critical conditions, which have environmental and practical advantages over traditional processes. Experimental determination of the critical point — defined by the pressure and temperature at which the concentration of each component is identical in both the gas and liquid phase — is not straightforward because phase separation is a complex process and the phase boundary may look featureless in the critical region. Martyn Poliakoff and colleagues at the University of Nottingham have used a piezoelectric quartz sensor that changes its mechanical resonance frequency according to the density and viscosity of the fluid in contact with the sensor surface. The system is versatile (thanks to the chemical inertness of quartz), small and easy to install, and the authors, after having validated it on mixtures of two components are already trying it out with three.

Nanocrystals in the clear

Nanocrystal quantum dots are widely used as flourophores and cellular labels in biotechnology and medical applications. However, despite advantages in terms of their tunable emission wavelengths and stability against photobleaching, there are still many questions about the potential cytotoxicity of quantum dots in mammalian cells. However, Akiyoshi Hoshino and colleagues have now determined that the surface coatings are the cause of the cytotoxicity, rather than the nanocrystals themselves. They conducted a detailed study of several widely used surface-modified ZnS/CdSe core–shell nanocrystals (*Nano Letters* **4**, 2163–2169; 2004). Of the different surface caps used, the researchers found that only nanocrystals capped with COOH or TOPO (tri-*n*-octylphosphine oxide) induced cell death by damaging the DNA, whereas nanocrystals coated with NH_2, OH, OH/COOH and NH_2/OH had no significant effect.

Colourful assemblies

One of the dreams of nanotechnologists is to find ways to construct functionally complex structures from relatively simple nanoscale components, with little or no active direction. In the launch issue of *Small*, Charles Lieber and colleagues demonstrate one such 'bottom-up' approach by assembling an array of different colour light-emitting diodes from an assortment of semiconductor nanowire building blocks (Y. Huang, X. F. Duan and C. M. Lieber *Small* **1,** 142–147; 2005). The authors begin by depositing an array of parallel p-type silicon nanowires from solution onto an insulating substrate, using a patterning technique previously developed by the authors (Y. Huang, X. F. Duan Q. Q. Wei and C. M. Lieber *Science* **291,** 630–633; 2001). They then repeat this to deposit a second array of n-type nanowires, each on top of and aligned perpendicular to a silicon nanowire. The intersection between each silicon and subsequently deposited nanowire forms a luminescent pn-junction — or light-emitting diode — and by passing a current across each junction they can be made to light up. The colour of the light depends on the bandgap of the material from which the n-type nanowires are made — GaN for blue, CdS for green, CdSe for red.