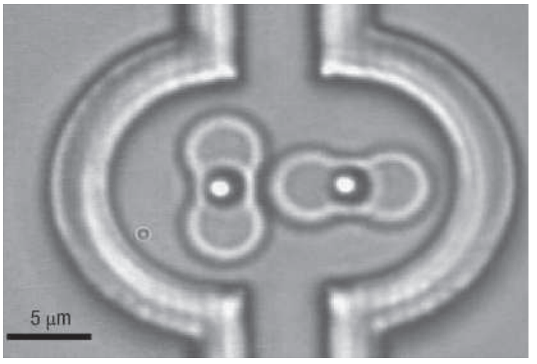
Pump it up

The field of microfluidics offers the potential to process minute amounts of fluids for a variety of chemical and analytical applications (and as a platform for studying new physical phenomena, as demonstrated on page 743 of this issue) on an inexpensive, disposable, plastic chip. At present, the most efficient way to pump fluids through the channels of such a chip is with an external pump, which limits the precision and independence with which their flow can be controlled.

To improve such control, Shoji Maruo and Hiroyuki Inoue demonstrate the operation of a microfluidic pump consisting of two interlocking peanut-shaped propellers held in place by independent axels within a microfluidic channel (*Appl. Phys. Lett.* **89,** 144101; 2006). Driving the rotation of the propeller with optical tweezers forces fluid along the channel, causing a tracer particle within it to move at a speed proportional to their rotation. The smallness and simplicity of the pump itself could provide a useful alternative to larger and more complex designs that have been proposed.



NOT A CLEAN BREAK-UP

When an air bubble detaches from an underwater nozzle, it pinches off from a thin neck of air. For any fluid at the pinch-off point, including water droplets from a tap, the neck approaches a singularity. A level circular nozzle produces a neck with cylindrical symmetry. However, tilt the nozzle by as little as 0.07° from normal and this symmetry is lost, find Nathan Keim and co-workers, following a series of experiments caught on film (*Phys. Rev. Lett.* **97,** 144503; 2006).

Surprisingly, the nozzle's shape, size and tilt angle are preserved as the bubble detaches. Even the number and trajectory of the bubbles are determined by the initial conditions. And for large asymmetries, the neck ruptures instead of pinching off cleanly.

The authors suggest that hydrostatic and Bernoulli pressures rather than surface tension, which tends to restore symmetry, dominate break-up dynamics. With so much physics near singularities left to explore further, don't be too eager to get that leaky tap fixed.

Environmentally sensitive

The diffusion of proteins in the lipid membranes of cells can be described in the framework of two-dimensional brownian motion. To explain experimental data, models need to include effects such as membrane dimensions. The situation becomes even more complicated when the membrane is close to a rigid substrate. Yaroslav Tserkovnyak and David Nelson argue that in such a setting an additional friction term has to be factored in to describe protein diffusion appropriately (*Proc. Natl Acad. Sci. USA* **103,** 15002–15007; 2006).

The friction is assumed to be mediated by a layer of viscous liquid between the membrane and the substrate. Under normal conditions, the friction force plays no significant role, according to the model of Tserkovnyak and Nelson. But when the temperature approaches the critical value for phase separation (when raft-like structures emerge from the initially nearly uniform lipid mixture) the diffusion coefficient starts to depend strongly on the distance between membrane and substrate. This might imply that in the near-critical regime diffusion is very sensitive to the cell's environment.

Pure entanglement

The behaviour of two quantum objects can be correlated even when they are spatially separated; what happens to one particle has immediate consequences for the other one. The phenomenon is known as quantum entanglement, and features as an important ingredient for emerging technologies such as quantum communication or quantum computing. In these applications, an entangled pair is typically prepared in one place and then the constituents are moved apart. In the separation process, the quality of the entanglement — and thus its potential value for later uses — tends to deteriorate. But Rainer Reichle and colleagues show that the degraded entanglement can be purified again, and that at least some of its initial usefulness can be restored (*Nature* **443,** 838–841; 2006).

Reichle *et al.* use atomic ions as carriers of quantum information and implement a purification scheme that uses entangled pairs of low quality to distil a smaller number of high-purity pairs. Unlike earlier experiments, this protocol offers a great deal of flexibility; most importantly it leaves the entangled pairs intact, making them available for applications, or for further rounds of distillation.

Red and dead

Stars in massive galaxies tend to be older than their counterparts in low-mass galaxies, so we must look further back in time (at high redshift galaxies) to study their formation. Not only are such galaxies far away, a star being born lies at the centre of a collapsing ball of dust and gas, which absorbs visual light. But as the dust warms up, it emits infrared radiation that does reach Earth — at least, in principle. Mariska Kriek and collaborators use the Gemini Observatory to reveal a class of galaxies with surprisingly little or no star formation activity (*Astrophys. J.* **649,** L71–L74; 2006).

The authors surveyed 20 bright galaxies with high spectroscopic redshifts ($2 < z < 2.7$) corresponding to younger days of the Universe, about a quarter to a third of its present age. Nine of them failed to show the hydrogen ionization lines characteristic of star birth. Such a low birth rate in the most massive galaxies could be suppressed by black holes. Or, the signal could be obstructed by dust.