Hyperactive at two thousand years old

For at least two millenia, the Stromboli volcano has exploded up to 20–30 times every hour, launching 'bombs' of molten or semi-molten rock. Fortunately, these explosions are mild, and large explosions rare but unpredictable. Gas bubbles rising through the magma are responsible for the explosions, but it's not clear how they form. To find out, M. Bottiglieri and colleagues have analysed seismic data taken on the volcano (*Europhys. Lett.* 72, 493–498; 2005).

The distribution function of the time interval between events (defined by a threshold amplitude) is exponential, suggesting a Poisson process with a characteristic interval rate of 2.73 minutes. A higher threshold yields 3.98 minutes. Bottiglieri *et al.* assumed that bubbles grow through coalescence, and they obtained a coalescence time and bubble-size distribution function consistent with observations. Moreover, the metre-scale bubbles are most likely two-dimensional. Although more complicated models exist, the authors stress that their simple diffusion model provides a sound starting point for a microscopic understanding of 'strombolian' explosions.

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HOT MOLECULES

In the winter season, the warming of ethanol is to many a familiar process. Treated on a more rigorous level, however, understanding the heat transport through a bulk liquid is far less intuitive, particularly if its constituent molecules experience long-range electrostatic interactions. Modelling the microscopic energy flux on a computer is one way to approach the problem, and Janka Petravic reports how the interactions between many molecules can be factored in efficiently to such a calculation for ethanol (*J. Chem. Phys.* 123, 174503; 2005).

The work extends recent numerical studies of energy transport in ionic liquids to molecules whose total charge is unevenly distributed. By simulating the equilibrium dynamics in an ensemble of 256 ethanol molecules, the experimentally observed decrease in thermal conductivity with increasing temperature could be well reproduced over the range of 0 to 60 °C. However, a systematic overall offset of about 10% indicates residual inaccuracies in the underlying model of the ethanol molecules.

Cascades and crystals combined

The advent of quantum cascade lasers and of photonic crystals have each contributed significantly to our ability to generate and manipulate light, yet rarely have these two concepts been successfully combined. But L. Andrea Dunbar and colleagues now show that photonic-crystal reflectors can be used to improve the performance of a terahertz quantum cascade laser (*Opt. Express* **13,** 8960–8968; 2005).

Terahertz (THz) radiation has myriad potential uses — from surveillance and medical imaging to the monitoring of hazardous chemicals in the environment — but applications have been limited by the need for a compact and efficient means of generating and manipulating radiation in this frequency band. Although quantum cascade lasers are a promising THz source, it is difficult to guide the radiation they emit.

But, by placing two-dimensional photonic crystals that are tuned to reflect THz frequencies at either end of a quantum-cascade-laser cavity, Dunbar *et al.* have demonstrated improved operation compared with cavities formed with simple one-dimensional Bragg reflectors. And, with further work, there is the hope of better focusing of the emitted radiation.

Nanofingers do the walking

Scanning probes have been widely adopted in nanolithography. Typically, a probe tip is used to transfer molecules onto a surface with nanoscale resolution, either directly or indirectly, such that pixel patterns can be deposited to order. The problem, however, is that one probe is often used for both writing and imaging, which introduces the risk of cross-contamination. Although probes can be switched during operation, this is rather cumbersome and inefficient. Ideally, one would perform the patterning and imaging operations sequentially without delay. Now, Xuefeng Wang and Chang Liu have built a machine that can do precisely that (*Nano Lett.* **5,** 1867–1872; 2005).

The 'nanoprinter' consists of an array of seventeen sharp-tipped probes, each capable of performing one of three dedicated functions: nanopatterning, generation of dot patterns and pattern imaging. Each 'nanofinger' acts independently of the others, and can move its tip closer to or further from the surface as required, using thermal expansion modules attached to each probe. The device produces accurate patterns while minimizing the risk of contamination and eliminating the need to change the probe tip.

Stretching Schrödinger's cat

'W states' and 'cat states' are quantum physicists' favourite pets. Both describe forms of quantum entanglement of several particles, and, as these states have strongly non-classical behaviour, they have become invaluable tools in exploring fundamental aspects of quantum physics as well as in practical applications.

But size matters: experiments have so far been restricted to the entanglement of a handful of particles, such that each additional member in the entangled flock plays a significant role. Each step up brings more experimental challenges and establishes a new benchmark for control of a quantum system.

Hence the achievements now reported by D. Leibfried *et al.* and H. Häffner *et al.* are remarkable (*Nature* **438,** 639–642; 643–646; 2005). Using ion-trap setups, they have created and characterized six-particle cat states and eight-particle W-states — four-ion entanglement had marked the record so far. With this leap forward, the experimental investigation of entanglement is ready to go into the next round.

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