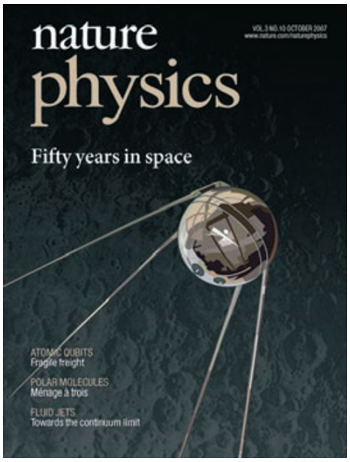


Cover story

Vol.3 No.10 October 2007

On 4 October 1957, the world changed. A series of beeps across the sky confirmed that the Soviet Union had won the first leg of the space race, by putting an artificial satellite into orbit. In his Perspective article, Joe Burns shares his memories of the Sputnik launch, and discusses its impact not only on US politics in a cold-war climate, but also on science: the huge boost in influence and funding for science and engineering; and the subsequent strides in understanding the physics of the cosmos, made possible through space-borne instrumentation. In an accompanying Commentary, as plans are drawn up for a return to the Moon, Mike Lockwood considers the science case for building a base there, and whether a human presence is justified.
[Perspective p664; Commentary p669]

GOOD THINGS COME IN THREES

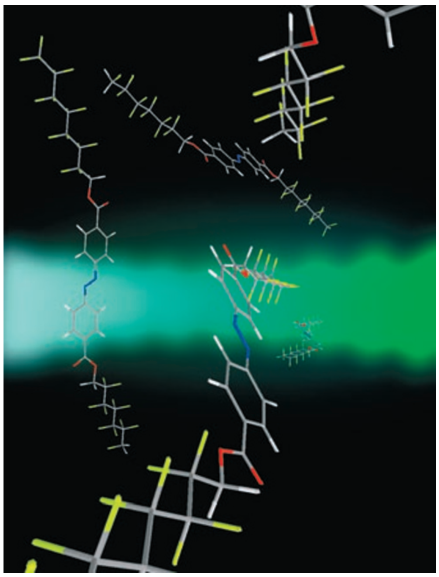
In recent years, cold atoms in optical lattices have become an important tool for simulating the phases of solid-state systems, not least thanks to the ability to precisely control atomic interactions. Hans Peter Büchler and colleagues take the concept further and predict that trapped polar molecules can be manipulated, using microwave fields, such that strong three-body interactions arise between nearest neighbours, whereas two-body interactions can be tuned — and even suppressed — with static fields. Such properties might enable an experimental exploration of 'exotic' quantum phases, such as topological phases or spin liquids.
[Article p726]

EXTREME FLUID FOCUS

If you turn on a kitchen tap to just the right speed, the stream of water stretches ever more thinly under gravity until it breaks into droplets before hitting the sink below. Such behaviour limits the ultimate size of conventionally produced liquid jets to the order of micrometres, and restricts their use in applications such as lithography and biotechnology. But in this issue, Alfonso Gañán-Calvo and colleagues show that stable jets of diameters well below a micrometre can be produced by focusing one liquid jet within a second coaxial liquid jet, which is itself focused by a third jet of gas.
[Article p737; News & Views p679]

HEAVY INTERFERENCE

Electrons, atoms and molecules that pass through a diffraction grating show interference patterns, very much like light waves. The phenomenon is arguably the most startling manifestation of wave–particle duality. But matter-wave diffraction also provides a practical tool to study, for example, the transition between quantum and classical behaviour. However, interactions between the diffraction grating and the particles often limit the approach. Stefan Gerlich and colleagues demonstrate that using a standing light wave in place of a solid grating reduces dispersive interference, and might enable experiments with classes of molecules that could not be studied so far.
[Letter p711]



Azobenzene molecules *en route* to an optical diffraction grating.

p711

INFORMATION TRANSFER

Cold neutral atoms are among the physical systems under consideration as carriers of quantum information. A necessary step in developing a scalable quantum-computer architecture is providing the ability to transfer atoms between different spatial zones, each of which makes a suitable environment for one of the key tasks to be fulfilled by a quantum information processor (such as storage, controlled interactions between qubits, or quantum-state read-out). Jérôme Beugnon and co-workers show that optical tweezers provide a convenient means of transporting atomic qubits without losing the precious information encoded in the internal states of the atoms.
[Letter p696; News & Views p684]

FUZZY CHAOS

Ask a planetary scientist whether the outer Solar System is chaotic and the answer will be either a resounding yes or a resounding no. For non-specialists, the fact that the planets continue to orbit the Sun without crashing into each other suggests a stable situation. But the question is, can we predict the angular position of a given planet within its orbit? For the inner planets, we can do so for about 20 million years. In this sense they are chaotic. As for the outer planets, Wayne Hayes argues that the current observational uncertainty is such that this question remains open.
[Letter p689]

PLASMA GAIN

The key to the extraordinary increase in peak intensity that can now be achieved for high-power lasers is 'chirped pulse amplification' — a technique that spreads (and subsequently compresses) a laser pulse in space and time, so that it can be amplified without destroying the materials from which conventional optical amplifiers are made. The spreading and compression steps require large optical gratings, increasing the difficulty and cost. Jun Ren and colleagues demonstrate a technique that uses the nonlinear optical properties of plasmas to both amplify and compress an input pulse. Because plasmas are immune to optical damage, this could be a cheaper and more convenient route to higher laser intensities.
[Article p732]