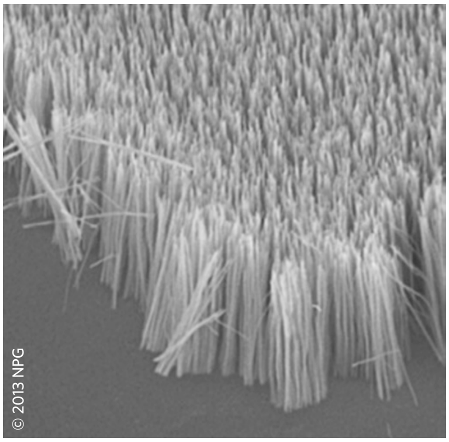
Field of fire

Nature Photon. http://doi.org/nsx (2013)



It is not hard to imagine the consequences of setting a field on fire. But what happens when an intense femtosecond laser burns though a micrometre-sized field — an array of nanowires? Michael Purvis and colleagues have done the experiment and found that it's a good way of producing dense, ultra-hot plasmas, rivalling those created in the pursuit of thermonuclear fusion.

Purvis *et al.* used few-micrometre-long nickel and gold nanowires (pictured) closely packed together at distances smaller than the wavelength of the laser. The femtosecond pulse penetrates deeply into the array, where it is completely absorbed. Numerical simulations show that as the energy is sucked in, the nanowires heat up and explode, generating a plasma of highly ionized atoms. The plasma expands rapidly, filling up all available space — but because the laser pulse is very short, its energy is efficiently absorbed before the critical density is reached. Using this technique, it might be possible to produce laboratory-made plasmas that approach the density and temperature conditions found in the centre of the Sun. *IG*

Close call

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A decade ago, experiments at CERN's Large Electron–Positron (LEP) collider came up with a strange result: the ratio of the lifetimes of the Λ_b^0 baryon and the $\bar{B}^0$ meson, expected to be close to one, was coming out quite a bit lower. A baryon comprises three quarks and a meson is a quark–antiquark pair, so it might seem odd that such different particles should be expected to have similar lifetimes. However, when any of a particle's quarks is a *b* (or bottom) quark, that quark's lifetime is a dominant factor in determining the lifetime of the particle. Hence, calculations — made using the favoured heavy-quark expansion (HQE) — indicate that the ratio of Λ_b^0 and $\bar{B}^0$ lifetimes should be close to, but not quite one.

Now that LEP is no more, the baton has passed to the Large Hadron Collider, and one of its experiments, LHCb, has a new measurement of this lifetime ratio. The LHCb collaboration has already worked a large amount of data into the analysis, and they claim a ratio of $0.976 \pm 0.012 \pm 0.006$ — close to, but not quite one, just as the HQE calculations suggest. *AW*

Beam split on chip

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In the famous Stern–Gerlach experiment, silver atoms beamed through an inhomogeneous magnetic field become spatially separated — a manifestation of intrinsic angular momentum, a purely quantum-mechanical property. Originally a corroboration of the Bohr–Sommerfeld theory (which introduced quantization of the '*z*-component' of angular momentum), the experiment also marked the beginning of the field of matter–wave interferometry.

A present-day device for matter-wave interferometry is the atom chip, using which ultracold atomic Bose–Einstein condensates (BECs) can be created, moved around and manipulated on the microscale. Now, Shimon Machluf and colleagues have used an atom chip to split a BEC of rubidium atoms into a superposition of spatially separated wave-packets of different momenta — a matter–wave beam splitter. The key trick is the creation of a momentum-selective force using the magnetic-field gradients on the chip.

Subsequently stopping the relative motion of split wave-packets and letting them interfere creates a fringe pattern, which can be observed when the spatial separation between the beams is small enough (on the micrometre scale). The repeatability of the interference-fringe formation demonstrates the coherence of the splitting process. *BV*

Collective dynamics

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Nanoscale mechanical resonators have recently reached the quantum regime: laser-induced cooling can prepare such a device in its quantum ground state of just a single phonon. Max Ludwig and Florian Marquardt now demonstrate that arrays of such oscillators could be a convenient solid-state system with which to study phase transitions in complex many-body dynamics.

Ludwig and Marquardt consider a two-dimensional optomechanical lattice driven by a radiation pressure. Photons and phonons are able to move between neighbouring resonators. Their theoretical analysis shows that the collective mechanical motion of this system can change from an incoherent state — when quantum noise prevents the mechanical modes from synchronizing — to an ordered state in which dissipation enables self-induced oscillations to establish themselves. This transition can occur when the optomechanical amplification rate exceeds the intrinsic mechanical damping.

This is not the only way to investigate the dynamics of dissipative systems, but the beauty of the optomechanical approach is that it provides both tunability through optical control and a robust solid-state platform. *DG*

Ghostly glows from the past

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Planetary nebulae come in various shapes and sizes, the most striking of them resembling colourful butterflies or glowing cat's eyes. They are actually stellar remnants, each one the ghostly leftovers of the atmosphere ejected from low- to medium-mass stars as they died. Only a minority of these ionized gas clouds is spherically symmetric; most are elliptical or bipolar. All morphologies result from the particular properties of their progenitor stars, which are independent, so the orientations of the nebulae are expected to be randomly distributed. However, Bryan Rees and Albert Zijlstra have found that the bipolar ones — that is, the hourglass and butterfly nebulae — tend to have their long axis (the one bisecting the wings) aligned with the Galactic plane.

What makes the bipolar nebulae different? The authors argue that stellar magnetic fields would be too weak to shape the nebulae, and that angular momentum carried by binary stars must be the key. Working backwards, they propose that the progenitor binary stars formed within the Galactic bulge in the presence of a strong magnetic field aligned along the Galactic plane. Therefore, the characteristics of bipolar planetary nebulae should encode information from the early Universe that created the conditions under which our Galaxy was formed. *MC*

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