No voodoo

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"What's that? Voodoo!" "No, it's feedback." Such was the conversation between John Lennon and his fellow Beatles when Lennon first produced, accidentally, audio feedback with his acoustic-electric guitar. The year was 1964 and the pronounced note eventually made it into the intro to 'I Feel Fine', now known as the first example of feedback sound used on a rock 'n' roll record.

Clément Sayrin and colleagues have explored feedback to quite a different end. They have implemented a real-time quantum feedback scheme in which a superconducting microwave cavity is prepared and stabilized in a quantum state of a well-defined (and user-defined) number of photons.

Controlling quantum systems is, if not voodoo, at least a tricky business; measurement processes typically provoke random back-action on the system. To tame this randomness, Sayrin *et al.* deploy a stream of Rydberg atoms through the cavity to gather information about the photon-number distribution therein. This information is fed back to adjust the cavity field. In this way, the target number of photons is reached five times quicker, compared with preparing the state using an optimized trial-and-error method. Through further monitoring of the cavity field, decoherence-induced quantum jumps can also be detected and corrected. *AT*

Excitations blocked

Phys. Rev. Lett. (in the press)

Rydberg atoms are atoms that have one or more electrons in a highly excited state. The outermost occupied electronic orbital of such an atom can be micrometres wide, producing a strong dipole moment that enables Rydberg atoms to interact over much longer distances than atoms in their ground state. Such interactions can cause the laser-driven excitation of one atom to shift the resonant frequency of neighbouring atoms, which prevents their excitation by the laser that excited the first — a process known as Rydberg blockade.

Andrew Schwarzkopf and colleagues have developed a technique to image the location of many Rydberg atoms in a cold rubidium gas. Autocorrelation functions obtained from these images enabled them to determine the radius and shape of the region over which Rydberg blockade occurs for different excitation states. For the highest measured state, the blockade radius was about 5 μm — 100,000 times larger than a rubidium atom's ground-state radius.

The authors also saw unexpected periodic structures at distances beyond this radius. The large distance of such interactions, and the fact that the atoms involved in Rydberg blockade are quantum entangled, could be useful in building the logic circuits of a quantum computer. *EG*

Perfect heat

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An ideal absorber and emitter of thermal radiation — a black body — could be used to increase the efficiency of thermophotovoltaic devices. But in reality, thermal emission from a natural material is lower than in this perfect case. It now seems, however, that artificial materials can be almost ideal. And what's more, they can be designed to emit at a selected wavelength with a bandwidth much narrower than a black body at the same temperature.

Metamaterials are engineered structures made up of a repeated pattern, or unit cell, with dimensions smaller than the wavelength of interest. The optical properties of a metamaterial can be selected by altering the dimensions of this unit cell. Xianliang Liu and colleagues constructed a metamaterial of gold crosses separated from a metallic ground sheet by a dielectric spacer. They then measured the infrared radiation given off by their metamaterial at various temperatures up to 300 °C. The emitted light was a spectrally narrow peak centred on a wavelength of 5.8 μm. Impressively, the peak emissivity was 98% of the theoretical black-body limit. *DG*

Too close

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It's called Swift J164449.3+573451, and is a lot more exciting than it sounds. In March this year, NASA's Swift satellite picked up this transient source of radiation, which has since been recognized to coincide with the position of a galaxy, at a redshift of 0.354. Follow-up observations at γ-ray, X-ray, ultraviolet, optical and near-infrared wavelengths (D. N. Burrows *et al.*) and at radio wavelengths (B. A. Zauderer *et al.*) have revealed a suggestive pattern of brightening: Swift J164449.3+573451 is the result of the unleashing of a relativistic jet from a supermassive black hole at the galaxy centre.

It's an amazing moment to have captured. Moreover, the data suggest that the turn-on of the jet is probably the consequence of a transient period of accretion onto the million-solar-mass black hole — that is, the tidal disruption of a star unfortunate enough to wander too close. *AW*

Under the microlens

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A focused laser beam can perforate the membrane of a single cell, but the same spatial localization that permits such precise ablation prohibits application of the technique to multiple cells. Mitsuhiro Terakawa and Yuto Tanaka offer a solution to this problem, demonstrating the enhanced optical field generated when polystyrene microspheres bound to cells are excited by a femtosecond laser pulse.

The spheres, it turns out, act as microlenses, localizing laser power and extending focused intensity more than 2 μm beneath them — well within range of the underlying cells. Simulation results accompanying the experimental study suggest that the intensity under each sphere exceeds the ablation threshold of the cell membrane, increasing the probability of transfection. And that's exactly what Terakawa and Tanaka saw in their experiments: fluorescent molecules taken up by the cells indicated a clear boost in membrane permeability on irradiation.

Although the underlying physics is not yet clear, the approach presents a high-throughput analogue to single-cell perforation, with implications for drug delivery. *AK*

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