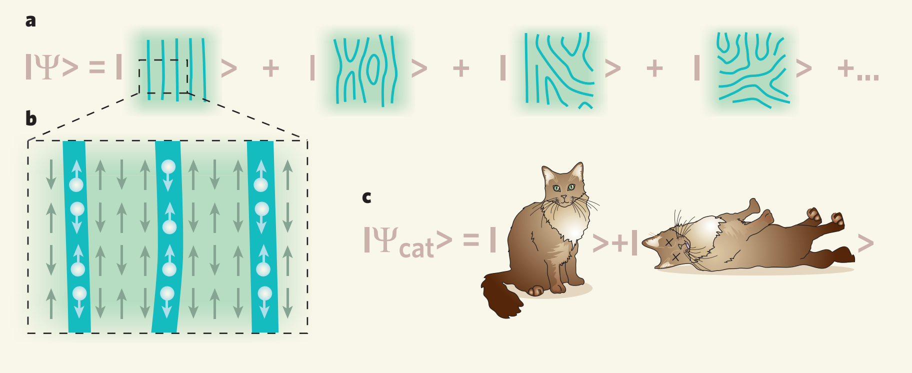

Figure 1 | Hunting the stripes. Electrons in the copper oxide planes of high-temperature superconductors sometimes form non-superconducting static stripe patterns. **a**, These stripes are believed to survive in the superconducting state as part of a quantum superposition of countless disordered stripe states that forms an overall featureless superconducting quantum liquid. **b**, Close up, the stripes are seen to consist of delocalized electrons ('rivers of charge') separated by domains of localized electrons showing a characteristic spin order. **c**, The principle of quantum superposition by which the stripe states are hidden from view in the superconducting phase is also the source of uncertainty over the fate of Schrödinger's infamous cat. Capturing the quantum cat or the quantum stripes in a definitive state requires snapshots taken on a timescale that is short compared with the timescale of quantum fluctuations between the superimposed states (dead or alive; stripy or non-stripy). By exploiting the coupling between high-frequency lattice and collective-stripe vibrations, Reznik *et al.*[1] provide a glimpse of quantum stripes.

therein). So, although taken seriously, quantum stripes have not been seen as a proven fact.

Reznik *et al.*[1] present a new indicator of quantum stripes by exploiting the motions of the ions that form the copper oxide lattice. These motions give rise to quantized lattice vibrations, known as phonons, that can be easily observed, again by inelastic neutron scattering. Electronic stripes must also undergo coherent vibrations, but these cannot be seen directly. When the phonons and the stripe vibrations enter resonance, however, they are expected to interact strongly and cause a characteristic anomaly in the spectrum of the phonons. Reznik and colleagues observe just such a phenomenon in a copper oxide with static stripes.

The key is that these anomalies will occur on a timescale that is shorter than the quantum fluctuation time of the delocalized quantum stripes. The quantum stripes will therefore seem to come to a standstill when viewed through the phonons, and the phonon anomaly should persist even when there is no sign of static stripes. This is exactly what Reznik *et al.* observe[1]: even in the best superconductors, which show no sign of static stripes, the anomaly is blurred, but it is still clearly discernible.

So is this the turning point in the stripe wars? Although quantum stripes are more elusive than nuclear submarines — all signals of them have so far been indirect — the strength of the idea is that this single hypothesis explains a world of strange behaviours. Viewed from that angle, the defenders of the conventional BCS model might seem like medieval defenders of a geocentric cosmos, forced by observations to add ever more epicycles to their already baroque universe. On the other hand, there is no a priori need for electrons in crystals to behave in aesthetically pleasing ways; the epicycles could still be the truth. For one side or the other to win the war, a way of sending a sortie for direct reconnaissance of quantum stripes must be found. ■

Jan Zaanen is at the Instituut-Lorentz,
Universiteit Leiden, PO Box 9506,
2300 RA Leiden, The Netherlands.
e-mail: jan@lorentz.leidenuniv.nl

1. Reznik, D. *et al. Nature* **440,** 1170–1173 (2006).
2. *Nature Phys.* **2,** 138–143 (2006).
3. Tranquada, J. M. *et al. Nature* **375,** 561–563 (1995).
4. Zaanen, J., Nussinov, Z. & Mukhin, S. I. *Ann. Phys. (NY)* **310,** 181–260 (2004).
5. Kivelson, S. A. *et al. Rev. Mod. Phys.* **75,** 1201–1241 (2003).
6. Eremin, I. *et al. Phys. Rev. Lett.* **94,** 147001 (2005).

BIOMATERIALS

Gripping stuff

The aquatic bacterium *Caulobacter crescentus* can come, quite literally, to a sticky end. As Peter H. Tsang and colleagues report (*Proc. Natl Acad. Sci. USA* **103,** 5764–5768; 2006), the bacterium's long, tail-like anchor sticks it so tightly to a supporting surface that it often tears apart when a detaching force is applied, rather than relinquishing its grip. The adhesion is thought to be the strongest of biological origin yet discovered.

When *C. crescentus* (two are pictured here, spawning clones) is in its non-motile (stuck) state, its anchor — appropriately named its 'holdfast' — binds the bacterium to the surface, and a stalk connects the holdfast to the cell body. The authors used atomic force microscopy to record the force needed to detach a non-motile cell from a micropipette by means of a suction pipette oriented perpendicular to the pulling direction. They measured the area of coverage of the holdfast and other dimensions of the bacterium, working out average geometries and finally applying a mathematical technique known as finite-element analysis to calculate the adhesion strength.

The holdfast enables the bacterium to remain stuck to the surface even in strong jets of water, and Tsang *et al.* calculate that, were it to cover an area of 1 cm^2, it could support a weight of 680 kg, even on a wet surface. That exceeds all other known cell-adhesion capabilities — including the sticking power of the much-studied gecko's foot. And because, owing to the geometry of *C. crescentus*, the adhesion often failed through fracture of the cell stalk rather than at the adhesion interface, the true adhesion strength at the interface could be still higher.

Y. BRUN

Polymers of a sugar-based molecule called *N*-acetylglucosamine are known to be present in the bacterium's adhesive plaque. The authors found that when they treated the polymers with an enzyme to break them down, the strength of the bacterial attachment was reduced. However, the detailed physical and chemical mechanisms of *C. crescentus*'s adhesive abilities remain to be revealed. Their elucidation could trigger the development of a new range of synthetic adhesives.

Rosamund Daw