Tell-tale oxygen

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One of the most iconic representations of the struggle physicists went through to understand quantum mechanics is a series of black-and-white pictures showing Albert Einstein locked in an animated scientific discussion with Niels Bohr — walking, sitting and smoking (pictured). A famous paradox the pair debated is embodied in the recoiling double-slit experiment.

Although arguably less romantic than old pictures, the newest chapter in the history of this thought experiment takes place in the lab, where Xiao-Jing Liu and co-workers have now tested it using resonant X-ray photoemission from molecular oxygen. Each of the two oxygen atoms in the molecule served as a slit, and the Auger-ejected electron played the role of the particle.

By tuning the energy of the exciting X-ray photons, the electron could be emitted with or without dissociating the O_2 molecule. In the latter case, the two oxygen atoms recoiled together — yielding no information about the atom from which the electron was emitted — and spectral bands exhibited an interference pattern. In the former case, only one of the atoms recoiled, and the availability of path information destroyed any interference, in full agreement with Bohr's complementarity. So far, it seems, he is still winning the argument. *FL*

Ripple effect

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A single ripple in a floor carpet is easily smoothed out by applying a bit of sideways pressure. A wrinkled carpet, though, is more difficult to flatten. Similar situations arise on the nanoscale, as Akihiro Kushima and colleagues discovered when studying surface defects in molybdenum disulphide (MoS_2).

The surface of a stack of MoS_2 layers is prone to structural defects because the layers are held together only by weak van der Waals forces. Narrow linear ripples, forming due to a line of excess atoms in the top layer, are particularly common. They are similar to dislocations in bulk crystals — Kushima *et al.* call them ripplocations. The authors probed the mobility of ripplocations following electrochemical lithiation or mechanical edge compression. *In situ* high-resolution transmission electron microscopy revealed that ripples can easily move around, merge or cancel out, whereas wrinkles don't migrate.

The experiments were complemented by density-functional theory calculations, confirming that it is energetically favourable for nearby ripplocations to combine into one. Further numerical work showed that the electrical conductance is reduced across a ripple, which acts as a barrier for electrons. *BV*

Spike the ball

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The status quo is logical enough: hydrophobic particles flock together in water, as do hydrophilic particles in oil. But what if there were a way to create stable dispersions of hydrophobic and hydrophilic particles in a range of different solvents? There are myriad chemical techniques to do so, but none quite as visually stunning as the topological trick recently reported by Joong Hwan Bahng and colleagues.

The authors fabricated microscale particles and covered them with nanoscale spikes — creating what looked like a population of tiny hedgehogs. The particles seemed averse to locking spikes with one another, and this tendency had the effect of reducing their contact area, and in turn diminishing the attractive forces acting between them. Particles made with highly hydrophilic materials formed stable dispersions in heptane and hexane when fashioned into hedgehog particles. Hydrophobic hedgehog particles were similarly found to form dispersions in water.

By modifying the conditions under which the particles were grown, thereby changing the size and density of the nanospikes, the authors were also able to tune their topology. *AK*

Hungry giant

Astrophys. J. (in the press); preprint at http://arxiv.org/abs/1412.3120 (2015)

The collision of two galaxies is a dramatic event — all the more so when they host supermassive black holes in their centres. Such an event is taking place 134 million light years away, where two galaxies, collectively known as Arp 299, are moving towards each other, causing an overflow of gas that enhances star formation and fuels the black holes. The mechanism triggering a black hole to start feasting on the gas is still unknown, so Andrew Ptak and colleagues combined the data from NASA's NuSTAR high-energy X-ray observations with visible-light images from the Hubble Space Telescope to expose the gluttonous black holes.

The NuSTAR telescope can identify the origin of X-ray emissions, so the observations could be used to pinpoint which of the two black holes is releasing more high-energy X-rays following gas consumption. It turns out that one of the black holes is either inactive or obscured by dust and gas. The other one, however, is very actively feeding on the gas and releasing energetic X-rays. *IG*

Spin control

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The basic building block for logic that uses the electron's spin rather than its charge is the spin analogue of the transistor: a device whose spin-flow between two terminals can be modulated. Although several methods have been developed to inject spins into non-magnetic materials, which would form the channels, techniques for manipulating spin currents are scarce. Estitxu Villamor and colleagues now show that magnetic gating can provide such manipulation.

In the original proposal for the spin transistor, spin control occurs by tuning the spin–orbit interaction with electric fields. Most materials that are good for spin transport, however, have spin–orbit interactions too small for this to be viable. By fabricating a lateral spin valve on top of a ferromagnetic insulator whose magnetization could be tuned with small magnetic fields, Estitxu Villamor *et al.* demonstrated a magnetically controlled modulation of the pure spin currents in a non-magnetic channel.

This magnetic gating arises from the interaction of the spins at the interface between the channel and the substrate, providing access to a far-reaching yet perplexing parameter of spintronics: the spin-mixing conductance. *LF*

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