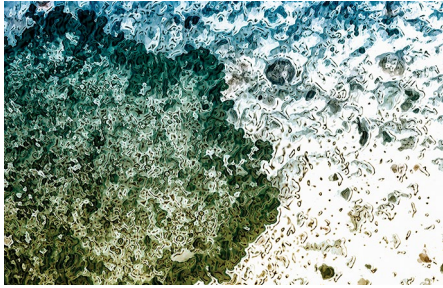


PERCOLATION THEORY

Live transmission

Cell Syst. **7**, 137–145 (2018)



Credit: GiroScience/Alamy Stock Photo

When a bacterium in the middle of a biofilm feels starved of nutrients, it releases a potassium signal that impacts nutrient uptake in its neighbours, starting a chain reaction that propagates all the way to the edge of the film. The peripheral cells respond by reducing consumption so the interior cells have access to nutrients. This display of altruism incurs a high cost to the individual — and cell-to-cell heterogeneity makes it a nontrivial problem in signal transmission. Now, Joseph Larkin and colleagues have shown that the benefit outweighs the individual cost when the system is poised near a percolation threshold.

The authors' model predicts a power-law decay in the distribution of cluster sizes and puts the fraction of cells required for signalling connectivity at a little less than half. By incorporating excitable dynamics into their framework, they found a minimum in the cost–benefit ratio near the percolation threshold. Experiments placed *Bacillus subtilis* biofilms near this threshold, whereas mutant strands with modified structure

and dynamics strayed away, suggesting the biofilm's spatial heterogeneity is tuned to ensure efficient transmission. AK

<https://doi.org/10.1038/s41567-018-0321-7>

TOPOLOGICAL OPTICS

Light on skyrmions

Science **361**, 993–996 (2018)

Best thought of as topological excitations that share the same topology as a set of magnetic moments wrapped around a sphere, skyrmions are widely thought to be promising for magnetic storage and spintronics applications. Shai Tseses and colleagues have now brought skyrmions into the arena of optics. By controlling the interference of plasmon polaritons on a patterned metallic surface, they have succeeded in creating a lattice of optical skyrmions. The authors were able to image this pattern of evanescent electromagnetic fields using a phase-resolved near-field optical microscope.

In contrast to their magnetic analogues studied in solid-state systems, these optical skyrmions can be continuously tuned from a so-called bubble- to Néel-type structure. However, in common with many such topological excitations, the lattice of optical skyrmions displays a remarkable robustness to imperfections. The extent to which light can be manipulated and processed in photonic systems has already given us countless technologies. Few would bet against a few more popping out following this discovery of photonic skyrmions. AT

<https://doi.org/10.1038/s41567-018-0322-6>

2D MATERIALS

Mapping the moiré

2D Mater. **5**, 041008 (2018)

Understanding the nanoscale structure of materials has always been an important problem, but recent observations of superconductivity in twisted bilayer graphene with a moiré pattern make it particularly urgent for this material. A substantial advance has been made by Oleg Ovchinnikov and collaborators by combining very sensitive electron microscopy techniques with computational modelling to obtain a three-dimensional map of the crystal lattice.

Crucially, they were able to determine not only the lateral position of all the atoms from the electron microscopy, but also the height of the ripples from density functional theory calculations. This complete characterization of the material means that local relaxation induced by the bilayer moiré pattern can be distinguished from large-scale strain effects. The former may be vital in understanding the superconductivity, while the latter are important because they have a detrimental effect on conventional transport properties. DA

<https://doi.org/10.1038/s41567-018-0323-5>

QUANTUM COMPUTING

Let's get practical

Proc. Natl Acad. Sci. USA <https://doi.org/ctvz> (2018)

We keep hearing about the tough problems that quantum computers will allow us to crack. As tantalizing — and potentially useful — as they sound, our experimental capabilities still relegate them to a distant future. Many have thus turned towards the more immediate goal of finding tasks beyond the reach of classical machines, but the utility of these tasks is rarely a priority. Andrew Childs and colleagues have now taken a more practical look at what lies between these extremes.

Through circuit optimization, Childs et al. characterized truly useful computations whose hardware requirements are not too far out of reach. They specifically considered the full quantum dynamics of 1D spin chains — a notoriously difficult system to simulate for any more than 20 or so spins, which is often too few to fully reveal phase transitions. The authors showed that digital quantum simulation of a 50-spin chain could be achieved by current algorithms with fewer than 100 qubits executing around 10^8 gates — orders of magnitude below the number needed for factoring large numbers or simulating quantum chemistry. FL

<https://doi.org/10.1038/s41567-018-0324-4>

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PARTICLE PHYSICS

Charmed life

Phys. Rev. Lett. **121**, 092003 (2018)

In the particle zoo, the charm baryon crew has a pretty clear pecking order when it comes to particle lifetime: theory predicts that the Ω_c^0 baryon, consisting of a charm and two strange quarks, has the shortest lifetime of the bunch. But predictions are made to be tested, right? And now, the LHCb Collaboration has published a new measurement of the Ω_c^0 lifetime, which finds a value four times larger than the current world average.

The lifetimes of charm mesons, containing a quark and another antiquark, are known with a much higher precision than those of charm baryons, and these measurements have long provided valuable information on higher-order corrections for calculations. The news that Ω_c^0 baryon lifetimes are not as short as we thought substantially jumbles the lifetime hierarchy — with Ω_c^0 overtaking both the Λ_c^+ and Ξ_c^0 baryons. The result hints at the possibility that either smaller interference effects or additional higher-order corrections need to be considered in the theoretical predictions. SR

<https://doi.org/10.1038/s41567-018-0325-3>