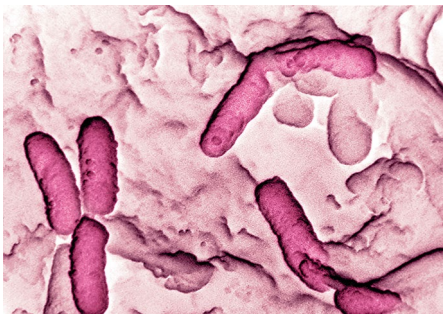
MICROBIOPHYSICS

Filmmaking in the family

Proc. Natl Acad. Sci. USA https://doi.org/10.1073/pnas.1720071115 (2018)



Credit: Cultura Creative (RF) / Alamy Stock Photo

Bacteria have to communicate with one another in order to form a biofilm. And now, Calvin Lee and colleagues have found that they can spread information temporally too — influencing the surface-attachment properties across generations of cells.

Pseudomonas aeruginosa (pictured) is a type of bacterium that attaches to surfaces via feedback between hair-like pili surrounding the cell and a signalling molecule that triggers pilus growth. Their first encounter with a surface is typically uneventful, with slim chances of attachment. But by tracking single cells and monitoring their family trees, Lee et al. found that once cells had seen one surface, they attached strongly to a virgin surface — and their progeny had a similar response.

The team showed that this adaptive state was associated with coupled oscillations of the signalling-molecule levels and pilus activity, which they described using a stochastic Turing model consistent with the surface-sensing framework. The results suggest that surface-sentient cells retain a memory of the surface that is sustained across their lineage — leading to rapid growth of the biofilm. *AK*

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GRAVITATIONAL WAVES

The background story

Phys. Rev. X (in the press); preprint at https://arxiv.org/abs/1712.00688

Two and half years after the first detection of gravitational waves, these observations remain preciously rare. Six gravitational-wave events have been reported so far, five mergers between pairs of black holes and one between binary neutron stars. Such mergers are much more frequent though; a stellar-mass black-hole merger happens every 2–10 minutes somewhere in the Universe, and neutron-star mergers up to a few times every minute. But with current technology only a few of those can be resolved, whereas the vast majority contributes to a stochastic background.

To tap into the rich information contained in the gravitational-wave background — for example about the population properties of far-away black holes — Rory Smith and Eric Thrane developed a new method to search for unresolved events. In place of the currently used cross-correlation approach, they employ Bayesian parameter estimation. They expect that with their method the stochastic background can be determined within a day or so, whereas it takes around one year with the cross-correlation approach. *AHT*

https://doi.org/10.1038/s41567-018-0118-8

MILLISECOND PULSARS

Power of crowdsourcing

Sci. Adv. **4**, eaao7228 (2018)

Millisecond pulsars are old neutron stars that spin hundreds of times per second and appear to pulsate when their emission beams are radiating towards their observers. Most of them emit radio waves and can be detected by radio telescopes. However, others — so-called radio-quiet pulsars — can only be sensed at higher unknown pulsation frequencies. Colin J. Clark and co-workers have performed 'blind' searches in the data obtained from the Large Area Telescope, the main instrument on the Fermi Gamma-ray Space Telescope launched in 2008, and discovered two isolated millisecond pulsars.

Without prior constraints from other observations, a completely blind search is computationally demanding. The analysis involves hundreds of thousands of sky locations covering the gamma-ray source localization region. Clark et al. split the search volume for each source into smaller regions, and distributed them among the computers of tens of thousands of volunteers participating in the Einstein@Home distributed-computing project. Using the aggregated power from these computers located across the globe, gamma-ray pulsations from two sources, identified as two millisecond pulsars, were finally revealed. YL

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SPINTRONICS

Turn it off and on again

Nat. Electon. **1**, 172–177 (2018)

Ferromagnetic materials exhibit an anomalous Hall effect, a current-driven transverse voltage that arises without the need for an external magnetic field. In principle, the effect could be used for data processing and storage, if it weren't for the fact that ferromagnetism is so robust — the 'off' switch being somewhat difficult to locate. But now, Zhiqi Liu and co-workers have demonstrated that the non-collinear antiferromagnet Mn_3Pt also exhibits an anomalous Hall effect, and the magnetic order is fragile enough that it can be destroyed by applying a small strain.

The authors made a device by stacking a thin film of Mn_3Pt on top of a piezoelectric layer. Applying an electric field made the piezo layer expand, which in turn generated strain in the Mn_3Pt and caused the magnetic phase transition. The electric field could thus be used as an external control to turn the anomalous Hall effect on and off, providing an all-electronic method of writing and reading a bit. *DA*

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ULTRAFAST SPECTROSCOPY

Multidimensional scrambling

Phys. Rev. Lett. **120**, 103401 (2018)

2D infrared spectroscopy is an optical analogue of NMR spectroscopy, using photon echoes instead of spin echoes. The technique dispenses with the need for magnetic fields, and offers sub-picosecond resolution, but the ultrafast dynamics can give rise to complex line shapes due to environmental interactions. Such interactions are easily controlled in gases, so the approach is well suited to quasi-free molecules, for which it can resolve rotational contributions and separate intra- from intermolecular contributions. Now, Larry Ziegler and co-workers have used it to show that a rotational substructure can equilibrate in just two intermolecular collisions.

Ziegler et al. temporally resolved the two rotational sub-bands of an infrared transition in a dilute gas, showing that these contributions give rise to new spectral features and dynamics. Using rotational spectral diffusion occurring on a picosecond timescale, the authors resolved an efficient way in which the molecule redistributes energy — so-called *J* scrambling — that is unresolvable in condensed-matter samples. *JPK*

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