COLLECTIVE PHENOMENA

Honeybee house-hunt

Phys. Rev. E (in the press); preprint at http://arxiv.org/abs/1611.07575


DAVID WOODS / ALAMY STOCK PHOTO

How does a swarm of honeybees (pictured) decide on the best site for its nest? To find the answer — or at least part of it — Andreagiovanni Reina and colleagues cast the problem into a mathematical model.

The authors described the situation with a set of coupled differential equations, in which the time-dependent variables are the subpopulations of bees committed to different nest sites, and the remaining set of uncommitted bees. The system contains various parameters, such as the commitment and abandonment rates of subpopulations, describing spontaneous transitions of individual bees. Interactive transitions are accounted for as well: 'recruitment' (positive feedback of scout bees to uncommitted bees, via the waggle dance) and 'cross-inhibition' (negative feedback, in the form of stop-signals, to bees committed to another option).

Reina *et al.* identified the ratio between interaction and spontaneous transitions as a key control parameter — its biological meaning being the prospensity of scout bees to deliver signals. A high ratio helps to resolve decision deadlocks, if there is a choice between nests of equal quality, but low values worsen decision accuracy. *BV*

TOPOLOGICAL MATERIALS

Top of the hour

Sci. Adv. **3,** e1602415 (2017)

Topological insulators have bulk valence and conduction bands that are connected by conducting surface states characterized by a linear dispersion, hosting Dirac-like fermions. These surface states are topologically non-trivial and are protected by a discrete symmetry. Junzhang Ma and colleagues have found evidence that a certain type of crystal symmetry can protect a new type of surface state with an hourglass-shaped dispersion.

All topological insulators discovered so far have relied on time-reversal and/or mirror crystal symmorphic symmetry. But a class of material has been predicted whose band topology relies on non-symmorphic symmetries, which involve translations that are a fraction of a lattice period. Crystalline KHgSb is one of the materials predicted to belong to such a class, with a glide mirror symmetry protecting the surface states.

Using photoemission experiments, Ma *et al.* looked at the electronic structure in crystals of KHgSb. They found support for the idea that these crystals host surface fermions whose dispersion relation is shaped like an hourglass — making KHgSb potentially the first example of a non-symmorphic topological insulator. *LF*

COMPLEXITY

Minority report

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Much has been said about how collective intelligence emerges in a group — be it a flock of birds or a scientific community — but recent events have highlighted our inability to optimize this wisdom. In particular, existing theories have proven insufficient for forecasting key financial and political changes. And the reason behind it may be a lack of diversity, which is known to be essential for the emergence of collective intelligence. Now, Richard Mann and Dirk Helbing have looked at how diversity might be enhanced in complex systems, and built a case for favouring minority viewpoints.

Mann and Helbing constructed an evolutionary model of collective prediction based on game theory, and built in an incentive scheme rewarding agents for making accurate, if unpopular, predictions. The model gave rise to an optimally diverse system capable of making shrewd collective decisions and predictions. The idea that accurate minority opinions should take precedence over wayward majority views may apply to scientific rewards structures, the authors argue, as favouring conformity by funding low-risk studies compromises diversity. *AK*

SPECIAL RELATIVITY

Ticking clocks

Phys. Rev. Lett. (in the press); preprint at http://arxiv.org/abs/1703.04426

Special relativity assumes that laws of physics are the same in all reference frames, a principle known as Lorentz invariance. This principle has been subject to numerous experimental tests, but no sign of Lorentz violation has yet been spotted: either a reassuring or disappointing revelation, depending on your stance. These results are now reinforced by a new test using a fibre network of optical clocks, which pushes the existing bound on Lorentz violation in experiments measuring time dilation.

Pacôme Delva and colleagues used strontium optical lattice clocks located at the LNE-SYRTE, Observatoire de Paris in France, the National Metrology Institute in Germany and the National Physical Laboratory in the UK and connected via state-of-the-art optical fibre links. Looking at the frequency difference between the clocks, they were able to test whether time dilation varies between the reference frames of the three geographically remote locations. This approach improves on previous tests — including other atomic clock comparison experiments — by two orders of magnitude. Moreover, it is only limited by technical noise sources, so further improvements are certainly possible. *IG*

ULTRACOLD GASES

Search for the seed

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When a periodic waveform is subjected to small perturbations to its amplitude and phase, any nonlinearity in the system can lead to its fragmentation — a so-called modulation instability. The phenomenon often results in the formation of solitons — self-reinforcing solitary wave packets — aligned in a train. This has been observed in both optical systems and atomic Bose–Einstein condensates. In the latter, it has long been debated whether the noise or the self-interference of the condensate order parameter serves to seed the modulation instability.

Jason Nguyen and colleagues have now addressed the problem with ultracold ^{7}Li atoms. In their system, the modulation instability was boosted by suddenly switching the interactions from repulsive to attractive. A nearly non-destructive imaging technique allowed them to monitor the subsequent dynamical formation of the soliton train. Nguyen *et al.* found that solitons developed first in the centre of the condensate rather than at the edges, suggesting that the seed for the modulation instability is dominated by noise, which may be technical, thermal or quantum in origin. *YL*

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