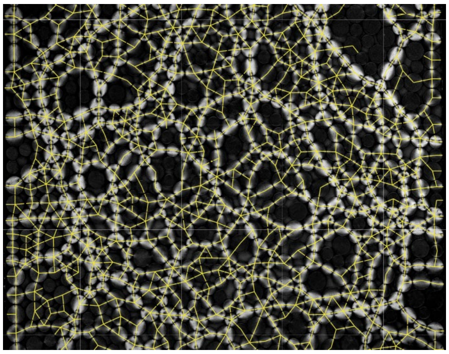
DISORDERED MATERIALS

Network failure forecast

Proc. Natl Acad. Sci. USA https://doi.org/c9ct (2019)



From cell monolayers to modern architecture, two-dimensional disordered structures confer remarkable robustness and flexibility. But mitigating the effects of failure in these materials is a task complicated by their heterogeneity. Now, Estelle Berthier and colleagues have taken inspiration from network science to forecast failure locations by comparing the importance of connections within the disordered lattice.

The geodesic edge betweenness centrality quantifies the extent to which a node or edge of a network features in the shortest paths of the structure, offering a proxy for its importance. Berthier and colleagues computed this property for a network defined by the contacts formed in a real granular packing (pictured). They then laser cut an acrylic sheet in the shape of their measured contact network and tested its response to loading. The team found that failure occurred primarily where geodesic edge betweenness centrality exceeded the mean of the network — providing a test for predicting vulnerability. *AK*

https://doi.org/10.1038/s41567-019-0658-6

THERMOELECTRICS

Cheap as chips

Science **365**, 495–498 (2019)

Thermoelectric materials convert an electric potential into a temperature difference, and so hold great promise for solid-state cooling devices that can be integrated into electronic devices, including computer chips. However, the current state-of-the-art materials for room-temperature applications — alloys based on Bi_2Te_3 — are expensive as they contain large amounts of tellurium. Jun Mao and collaborators have now demonstrated that a cheaper alloy of Mg_3Bi_2 has similar thermoelectric performance to Bi_2Te_3.

In its stoichiometric form, Mg_3Bi_2 is a semimetal with relatively poor thermoelectric performance because the contributions from holes and electrons partially cancel each other out. Doping with additional magnesium adds electrons to make the material n-type to counter this, and alloying with antimony increases the Seebeck coefficient by turning the material into a semiconductor. This produces a material with a thermoelectric figure of merit of approximately 0.9 at 350 K, only slightly smaller than the best Bi_2Te_3 alloys and at a fraction of the cost. *DA*

https://doi.org/10.1038/s41567-019-0659-5

SOLAR PHYSICS

Heat swirls up

Nat. Commun. **10**, 3504 (2019)

Despite their name, quiet Sun regions harbour a mess of magnetohydrodynamic waves and temperature gradients of millions of degrees. Understanding what drives these gradients between the middle and the upper solar atmosphere has kept solar physicists busy for decades. Jiajia Liu and colleagues have now provided observational evidence of localized swirls in the photosphere generating energy fluxes that reach the upper chromosphere. These may provide a mechanism for supplying heat to the corona.

The team applied an automatic swirl detection algorithm to 765 high-resolution chromospheric intensity maps generated by two telescopes, and identified more than 3,000 swirls. By analysing the temporal correlations between swirls in the different atmospheric layers, they established that photospheric swirls generate Alfvén pulses that propagate upwards, leading, in turn, to chromospheric swirls. The amount of energy channelled upwards and the number of swirls detected are in line with expectations for coronal heating mechanisms. *FL*

https://doi.org/10.1038/s41567-019-0660-z

PARTICLE PHYSICS

Photons in the periphery

Phys. Rev. Lett. **123**, 052001 (2019)

Maxwell's electrodynamics forbids light-by-light scattering, but scattering one photon off another is allowed in quantum electrodynamics. However, light-by-light scattering is challenging to measure in experiments — even with current state-of-the-art lasers. An alternative is to use lead–lead collisions at the Large Hadron Collider, where evidence for elastic light-by-light scattering has already been seen, albeit with limited certainty.

Now, the ATLAS Collaboration has analysed a larger dataset from ultra-peripheral lead–lead collisions, where electromagnetic interactions dominate, confirming elastic light-by-light scattering with a significance of 8.2σ over the background-only hypothesis. The update relied on refined analysis techniques, including improved photon identification based on neural networks. These findings constrain models of physics beyond the standard model — for example those predicting axion-like particles. *SR*

https://doi.org/10.1038/s41567-019-0661-y

QUANTUM GASES

Polaron imaging

Nature https://doi.org/c9gv (2019)

Polarons are quasiparticles resulting from the coupling between a single impurity, usually an electronic charge carrier, and a surrounding bath of particles. The impurity repelling or attracting nearby particles modifies the background potential, which, in turn, affects the physical properties of the impurity. Although the presence of polarons has been inferred from macroscopic transport and spectroscopic measurements of various materials, their microscopic details, such as the internal structure, have never been confirmed experimentally.

This goal has now been achieved by Joannis Koepsell and co-workers who have reported a direct observation of magnetic polarons in a doped Fermi–Hubbard system realized by an ultracold-atom quantum simulator. The full single-site spin and density resolution on the lattice allowed the tracking of a local distortion of the magnetic correlations upon impurity doping, yielding a kind of real-space image of the polaron. The authors were able to derive the size of the polaron based on the range within which the impurity retains its impact on the environment. *YL*

https://doi.org/10.1038/s41567-019-0662-x

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