WEATHER PREDICTION

Turbulent rain

New J. Phys. **20**, 023001 (2018)

Credit: Matthias Scholz/Alamy Stock Photo

One reason that weather forecasting is so frustrating is the breadth of scales involved, from global weather patterns to microscale processes affecting, for example, raindrop formation. Connecting these domains remains a substantial challenge in numerical weather prediction. But progress is underway, including the development of a 'cloud microphysics simulator', reported by Izumi Saito and Toshiyuki Gotoh.

Saito and Gotoh introduced a computer model that simultaneously resolves turbulent motion in cumulus clouds (pictured) and the evolution of droplets to raindrops therein. To do so, they had to take into account a broad range of small-scale processes, from condensation and evaporation to collisions and coalescence of droplets. By covering large spatial and long temporal scales simultaneously, the pair ensured that they could capture the interplay between turbulence and droplets.

The model reproduced a number of known features, such as turbulence-induced collisions accelerating rain initiation and droplets modifying turbulence. The ability to see such effects in direct numerical simulations — rather than simply relying on general assumptions — should help to refine the tools that determine whether or not we need to carry an umbrella. *AHT*

https://doi.org/10.1038/s41567-018-0084-1

GRAVITATIONAL WAVES

Control from above

Phys. Rev. Lett. **120**, 061101 (2018)

In the wake of LIGO's success, we are now turning to the skies for the next generation of gravitational-wave detectors. LISA, the Laser Interferometer Space Antenna, involves an interferometer comprising three space crafts — each hosting two free-falling test masses that work as the reference bodies at the end of each arm. Detection of gravitational waves requires fine control of the relative acceleration of these masses. Verifying the feasibility of such control has been the objective of the LISA Pathfinder mission, which launched in December 2015 and was completed in June 2017.

Michele Armano and colleagues have now reported the latest figures for the differential acceleration noise measured aboard LISA Pathfinder. The reduction of the residual gas pressure and improvements in the systematics arising from the electrostatic actuation force and the inertial influence of the spacecraft led to noise levels that would in principle allow LISA to detect gravitational waves at frequencies as low as 20 μHz. Such low-frequency waves are emitted by coalescing objects days before the actual event, so we can be well-prepared to detect them in all their glory. *FL*

https://doi.org/10.1038/s41567-018-0086-z

BIOPHYSICS

Ultrarapid microquakes

Proc. Natl Acad. Sci. USA **115**, 861–866 (2018)

Elasticity is key to a cell's function and vitality, but measuring it requires non-invasive techniques that offer high spatial resolution, while being quick and flexible. Unfortunately, standard methods tend to be invasive or slow, or instead require unfavourable cell fixation. Measuring elastic waves propagating through cells might be one way of circumventing these issues. Shear waves, for example, are easily inducible and linked to elasticity by their propagation speed. Now, Guy Cloutier and co-workers have exploited these properties to devise a non-invasive method for rapid imaging of cell elasticity.

Cloutier and colleagues launched elastic shear waves in living cells held by pipettes, thus effectively inducing kilohertz 'quakes' in the cytoskeleton. They observed the sample through a standard optical microscope equipped with a high-speed camera and, using data analysis inspired by seismology, they obtained elasticity information about the cell — and even about its internal structures. With spatial resolution on the order of a few micrometres — and sub-millisecond temporal resolution — 'cell quake elastography' enables dynamic imaging of the mechanical properties of entire living cells in real time. *JPK*

https://doi.org/10.1038/s41567-018-0087-y

2D MATERIALS

Stretch it and see

Nat. Commun. **9**, 516 (2018)

Two-dimensional materials are often very bendy and can withstand strains larger than 10%. But it can be difficult to measure the local deformations experimentally, either due to optical resolution issues, or because microscopy techniques can be destructive. Now, Lukas Mennel and co-workers have shown that it is possible to map the local strain of two-dimensional crystals non-invasively — by probing their nonlinear optical response.

Second harmonic generation is a coherent process in which a material absorbs two photons, then emits one with twice the frequency and a polarization that is linked to the symmetry of the crystal lattice. Applying strain to the crystal will break these symmetries, and so monitoring the polarization gives access to the strain tensor. Crucially, this approach can resolve all the components of the strain tensor, providing more information than other techniques.

Mennel et al. demonstrated that this can work for molybdenum disulphide with sub-wavelength spatial resolution of a few hundred nanometres, but the approach might also be used on a sub-picosecond timescale to probe transient crystal deformations. *DA*

https://doi.org/10.1038/s41567-018-0085-0

INTERFEROMETRY

Polaronic spectacle

Phys. Rev. B (in the press); preprint at https://arxiv.org/abs/1701.01454

The technique of interferometry — using interference to extract information — provides us with the ability to 'see' on incredibly small scales. Various applications, ranging from single-photon sensing to gravitational-wave detection, are based on the same idea that small changes in length, for example, can be converted into a relative phase. Now Yuto Ashida and co-workers have proposed a new one: using interferometry to probe magnetic polarons.

The scheme involves a system containing an impurity atom immersed in a two-component Bose–Einstein condensate. The interaction between the impurity and bath atoms gives rise to the formation of magnetic polarons, whose presence in turn slightly modifies the spin-wave excitations inside the condensate. Applying interferometry to the bath atoms, these spin-wave excitations are converted into spin dephasing. In this way, the tiny impact caused by the polarons can be determined from the interference fringes. The scheme offers an alternative route to observe few-body physics beyond conventional spectroscopy. *YL*

https://doi.org/10.1038/s41567-018-0088-x

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