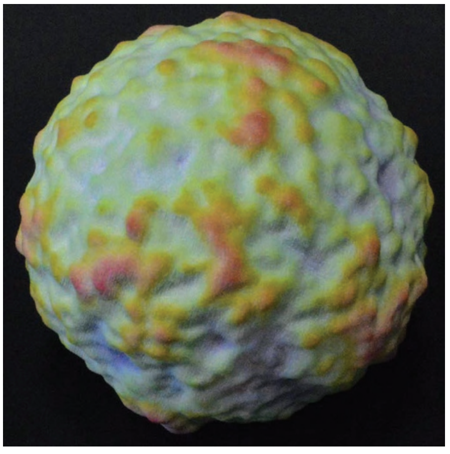
COSMOLOGY

Printed Universe

Eur. J. Phys. **38,** 015601 (2016)



IOP

The skies are filled with the Universe's oldest light: a relic of when expansion and cooling first enabled electrons and protons to form hydrogen and for photons to travel freely through space. Analysing the features in this cosmic microwave background (CMB) has been — and continues to be — crucial to understanding the early Universe and the origin of cosmic structure. David Clements and colleagues have now shown how 3D printing can provide a new way to visualize the CMB.

As the resolution of instruments improves, finer details have to be included in the all-sky map of the CMB, which is usually projected onto two-dimensions with colour used to represent the temperature. By converting data from the European Space Agency's Planck collaboration, which is available online, into CAD files, Clements *et al.* used 3D printing to produce a solid three-dimensional representation of the CMB (pictured), using both colour and topography to represent variations in the temperature. They hope that this approach, which could be applied to other astrophysical or cosmological data sets, will be useful for outreach and teaching — and possibly even research. *LF*

ULTRACOLD ATOMS

Bound together

Nature **539**, 259–262 (2016)

A drop of water is held together by the interplay between attractive and repulsive forces stemming from inter-particle interactions. But what would happen if you could play around with these interactions? Matthias Schmitt and colleagues did just that, but instead of water they used a dilute magnetic quantum liquid: a condensate of dysprosium atoms.

This is no ordinary condensate. Dysprosium has a very large magnetic dipole moment so the atoms interact strongly through the long-range dipole force. They also experience a repulsive short-range contact interaction, which is tunable by a magnetic field using Feshbach resonances. Schmitt *et al.* were able to adjust it such that the balance between the two forces allowed droplets to form. The droplets remained stable when the optical trapping of the condensate was switched off.

Interestingly, the droplets can only form if they contain enough atoms: below a critical number of atoms they simply evaporate. These self-bound droplets are quite dilute, but they still bear intriguing similarities with helium droplets or atomic nuclei. *IG*

BIOMECHANICS

Optimal backpacking

J. Biomech. http://doi.org/bs27 (2016)

Attaching a backpack elastically, rather than stiffly, to its carrier is known to reduce peak forces and loads on joints. But whether that comfort comes at an additional energy cost when walking has been less clear, with experimental results seeming contradictory. Based on a simple model, Dejun Li and colleagues have now found that although there is a difference for rigid and flexible packs, it is smaller than previously predicted.

Li *et al.* showed that for typical walking speeds and pack masses of 5–35 kg, the difference in energy cost between stiff and elastic suspension can be positive or negative, depending on suspension stiffness, load and walking speed. For realistic scenarios the differences are, however, always less than 10%.

These findings are in qualitative agreement with earlier models, but the predicted quantitative changes in energy cost to the walker are significantly lower, and closer to experimental results. The improvement, the authors say, is due to their taking into account the efficiency of the muscle performing mechanical work, which is greater for downward motions than it is for upward ones. *AHT*

QUANTUM GASES

Cold-atom assemblers

Science http://doi.org/bs3b (2016)
Science http://doi.org/bs3c (2016)

Trapping single atoms at low temperatures using optical potentials has become routine. However, creating ordered, defect-free arrays of cold atoms is another story. It's possible to create a regular array of optical tweezers serving as placeholders for the atoms, but achieving 100% filling of the prepared sites is difficult. The nature of the loading process is non-deterministic, which leads to unfilled sites — that is, defects.

But Daniel Barredo and colleagues have found a way to get defect-free 2D cold-atom arrays. Starting from a half-filled array of rubidium atoms, they imaged the occupancies with a CCD camera, then moved the atoms around by repositioning the tweezers. They calculated the sequence of atomic displacements needed to convert the initial random structure into a defect-free array with a pre-defined structure.

Meanwhile, Manuel Endres and co-workers worked out how to create defect-free linear chains of cold rubidium atoms. They too started with a stochastic loading of their array and then visualized the occupancies. Atoms were moved, along a fixed direction, to fill up vacancies. Different orderings were realized, including equally-spaced chains of only a few atoms. *BV*

ACTIVE MATTER

Spin city

Proc. Natl Acad. Sci. USA **113,** 12919–12924 (2016)

Quite apart from the stampeding herds that have captured the imagination of the active-matter community, there lies a wealth of non-equilibrium phenomena in systems of particles that don't move anywhere at all — or so Benjamin van Zuiden and co-workers found, when they set out to predict the behaviour of an ensemble of self-spinning dimers. Immobile, and yet actively rotating, the dimers experienced a range of unique non-equilibrium steady states that looked just like crystals, liquids and glasses — but were driven by entirely different forces.

Using simulations and theory, the team examined a system of active spinners with orientation-dependent repulsive interactions. They found that when the density was low, the dimers self-organized into a triangular lattice and phase-locked their orientations into a pattern that varied periodically. When the density increased, the crystal melted as the active torques competed with the interactions. Emergent edge currents heralded a non-equilibrium transition to the active spinner liquid, and disappeared again when the system arrested at higher densities. *AK*

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