In the frame

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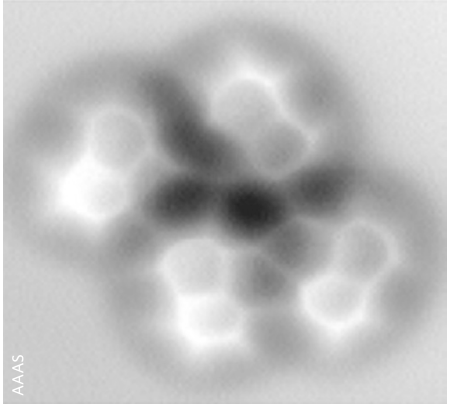

AAAS

A hydrogen bond is the attractive interaction between a hydrogen atom and a highly electronegative atom — such as fluorine, oxygen or nitrogen — in the same or another molecule. Weaker than covalent bonds but stronger than van der Waals interactions, hydrogen bonds act both inter- and intramolecularly — stabilizing ice, for example, or giving proteins their complicated three-dimensional structure.

Hydrogen bonds are, however, notoriously difficult to 'capture' in experiments or in first-principles calculations. Yet Jun Zhang and colleagues have now succeeded in directly visualizing the hydrogen bonds formed in assemblies of 8-hydroxyquilonine molecules on a Cu(111) surface. The 8-hydroxyquilonine molecule comprises, among several carbon and hydrogen atoms, one oxygen and one nitrogen atom — perfect conditions for hydrogen bonds to develop.

Zhang *et al.* used atomic force microscopy to obtain cluster images such as the one pictured here. The imaging process is far from trivial — what you see is not always what you get — however the backbones of the molecules are resolved, as are the hydrogen bonds; there are three of them around the dark hexagonal 'void' in the centre of this image. The technique should also enable more quantitative analyses, such as measuring hydrogen bond lengths for different types of substrate or different temperatures. *BV*

Walk the line

Proc. Natl Acad. Sci. USA http://doi.org/pbd (2013)

Treading a one-dimensional path might sound easy, but the mechanics of getting from A to B in a cell are far from straightforward. Michael Hinczewski and colleagues have developed an analytical model capable of fully characterizing the complex dynamics of myosin V, one of the motor proteins tasked with transporting cargo along biopolymer filaments.

The protein comprises two filament-binding heads connected by a pair of lever arms. As the motor trades chemical energy for mechanical output, the conformations of these arms are modified, effecting a hand-over-hand dynamics as the heads detach and rebind to move along polar biopolymers. Large loads oppose the forward bias, increasing the likelihood of the motor stepping backwards, and giving rise to the 'foot stomping' behaviour seen in single-molecule studies — whereby one of the heads detaches from the filament, only to reattach moments later to the very same site.

Hinczewski *et al.* encoded the polymeric nature of the lever arms in their theory and solved the associated first-passage problem, examining the effects of a backward load, forward bias and preferential binding. The theory reproduces experimental data, suggests that the mechanism is robust to variation in motor design and predicts the load dependence of the foot-stomping dynamics. *AK*

What's in a number?

Phys. Rev. Lett. **111,** 135302 (2013)

In the quantum Hall effect conductivity is quantized, having either integer or certain fractional values. The integer values are topological quantum numbers — also known in mathematics as Chern numbers — that characterize different topological insulating phases. This well-known phenomenon is now also being explored in the physics of ultracold atoms, where the quantum Hall effect can be reproduced in a Fermi gas trapped in a two-dimensional optical lattice.

Topological phases can be explored in ultracold atom experiments using artificial magnetic fields. To characterize the phases, Alexandre Dauphin and Nathan Goldman have proposed a method of extracting the Chern numbers from the time evolution of the centre of mass of the atomic cloud: the ultracold gas is initially prepared in a topological phase and is driven by a constant force; tracking the dynamics of the atomic gas through its sudden release from the trapping potential then reveals information about the topological order.

The idea is a general one, so in principle it could be applied to any cold atom experiment and would also mean that different higher-order topological phases could be distinguished. *IG*

Cloud control

J. Geophys. Res. Planets **118,** 1945–1954 (2013)

How do you catch a Martian cloud and pin it down? A full understanding of the CO_2 and water cycle of Mars would be impossible without studying the formation of clouds. Given the difficulties in sampling one of the cirrus clouds in the Martian atmosphere, Daniel Cziczo and colleagues travelled to Karlsruhe, Germany, where a former nuclear reactor has been converted into an aerosol and cloud chamber. The three-storey-high facility is called the Aerosol Interactions and Dynamics in the Atmosphere (AIDA) Chamber.

The authors introduced Mojave Mars simulant dust (MMS) — mechanically ground olivine basalt — into a nitrogen atmosphere in the cold chamber, with water vapour frozen onto the walls. By varying the MMS pressure (the number of cloud 'seeds' to nucleate ice crystals) and the temperature, they grew ten clouds, using lasers to measure the number, density and composition. At the lowest temperature, 189 K, the relative humidity for forming a cloud is 190%, confirming previous experiments that used different techniques. Further studies that grow CO_2 clouds at lower temperatures are needed to complete the picture. *MC*

A microscale accelerator

Nature http://doi.org/pcn (2013)

High-energy beams of electrons are a sensitive probe of matter, although the size and cost of accelerators often limit the availability of these invaluable tools. Edgar Peralta and his colleagues have now created a microscale electron accelerator that takes advantage of intense laser fields.

Peralta and the team fabricated optical gratings with an 800-nanometre period on two fused silica wafers. A large-amplitude field was set up in the 400-nanometre gap between the gratings using pulses of light from a Ti:sapphire laser, incident on the top of the structure. A relativistic electron passing along the gap can pick up some of this optical energy as long as it is in phase with the grating.

Peralta *et al.* fired a 60-MeV electron beam, generated in a conventional linear accelerator, into the side of their light-irradiated device. The microstructure broadened the energy spectrum of the particle beam, increasing the energy of some electrons at the expense of others. The team measured a maximum acceleration gradient of 250 MeV m^{-1}. *DG*

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