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Hydrogen bonds are caught on camera

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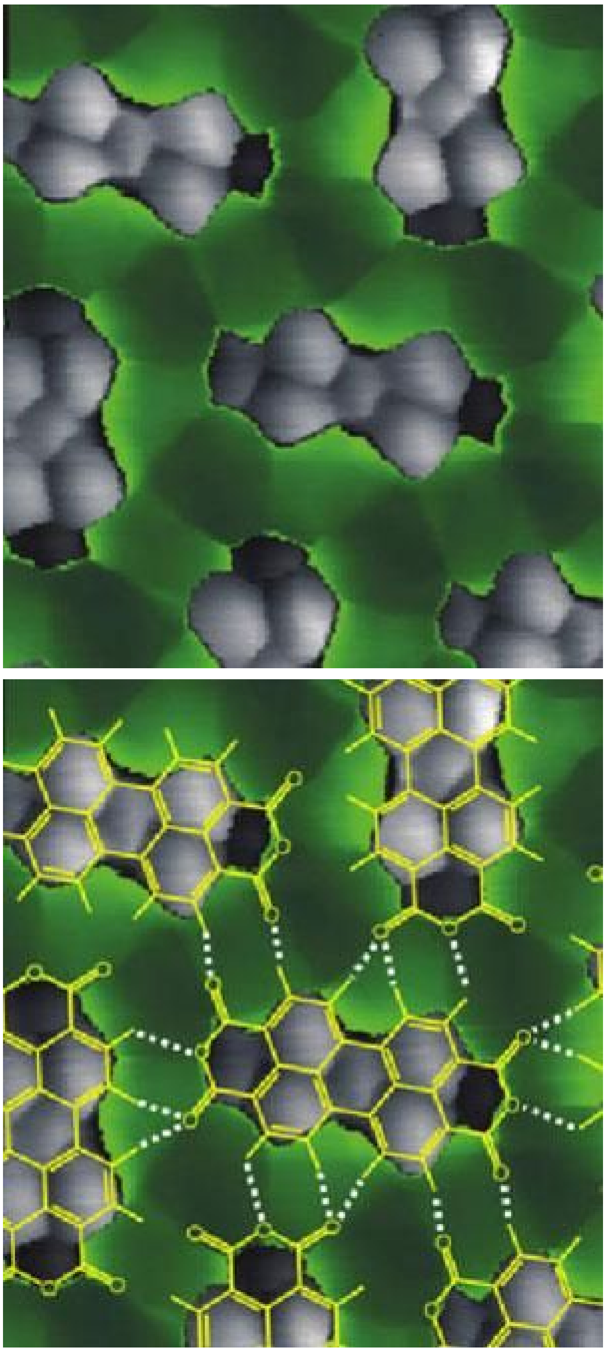

By affecting the way molecules bind to each other, hydrogen bonds are responsible for water's high boiling point, ice's propensity to float and DNA's signature double helix.

Now these life-enabling bonds – essentially the force of attraction between one molecule's slightly positively charged hydrogen atoms, and negatively charged areas on a neighbouring molecule – seem to have been captured on camera.

Individual atoms can be imaged using a scanning tunnelling microscope (STM). As its sharp-tipped probe scans a surface, the extent to which electrons “tunnel” between the tip and surface indicates changes in height caused by the presence of atoms.

In 2008, Stefan Tautz at the Jülich Research Centre in Germany and colleagues found that the resulting images became sharper if cold hydrogen is present between the tip and the surface.

Intricate detail

Now his team has shown that this allows hydrogen bonds to be imaged too. When they applied the technique to a sample of the flat organic molecule PTCDA, not only did the molecules show up in intricate detail, an electrical signal was also detected between them (coloured green in image), at exactly the locations where hydrogen bonds are present.

“We were absolutely stunned to see this,” says Tautz. The next step is to discover what is causing the phenomenon. “It’s an open question, and I don’t want to speculate,” he adds.

Whatever that turns out to be, the imaging technique could have exciting applications. “The images show remarkable intramolecular resolution and greatly advance the investigation of molecular monolayer structures,” says Leo Gross, a surface chemist from IBM Research in Zurich, Switzerland.

Designer nanopores

Peter Sloan, a physicist at the University of Birmingham, UK, says that the ability to image hydrogen bonds could, amongst other things, aid the construction of “designer nanopores”. These are customisable gaps between self-assembled molecules that are held together by hydrogen bonds, and can enhance catalysis.

“The trick is how to design the self-assembled layer,” he says. “Being able to see the hydrogen bonds between molecules will give a better understanding of the 2D bonding and hence allow better, more complex self-assembled structures to be designed and made.”

STM only works on flat surfaces, so imaging the hydrogen bonds between more complex, three-dimensional molecules like proteins is not yet possible.

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