

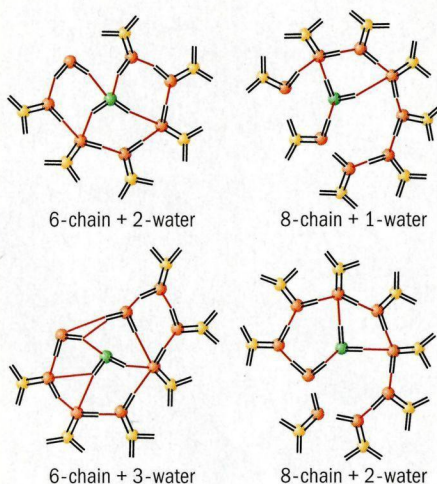
X-ray analysis reveals the wonders of alcohol

Water and alcohol have been found to mix less readily than most people think (perhaps lending support to anecdotal evidence that "artificial vodka", made out of reagent-grade ethanol and fresh water, needs to sit quite a while before it is good to drink).

US and Swedish researchers using the Advanced Light Source at Lawrence Berkeley National Laboratory have used X-ray emission (XE) and X-ray absorption (XA) spectroscopy to study the bonds between molecules of methanol over picosecond and femtosecond timescales. The results not only reveal the incomplete mixing of water and methanol at the molecular level, but also clarify the molecular structure of methanol and cast light on the mixture's thermodynamic properties.

The team has found that liquid methanol consists of both chains and rings of between six and eight molecules. This has reconciled two conflicting views about its structure, both of which had found support in neutron-diffraction studies. When water is added to form an equal mixture, the resulting spectrum is very similar to the added spectra for the two separate liquids.

However, the spectrum of the mixture indicates fewer methanol chains, and further analysis indicates that water molecules bridge the methanol chains to form rings. This, the



Research has shown that methanol chains link up with water to form rings.

researchers say, helps to explain why the increase in entropy is smaller than expected when water and alcohol mix. Certainly there is more to mixing the liquids at the molecular level than is evident in the popular alcohol-water mixtures at the macroscopic level.

Further reading

J-H Guo *et al.* 2003 *Phys. Rev. Lett.* **91** 157401.

Genetic copier is driven by convection

It is always a surprise when a new invention or discovery turns out to have been anticipated by nature, as with the 2 billion year old natural reactor at Oklo in Gabon, Africa.

Dieter Braun of Rockefeller University, New York, USA, and colleagues have shown that the polymerase chain reaction (PCR), which is nowadays used to copy DNA in huge quantities in laboratories around the world, may occur naturally, driven by the simple process of convection.

In the laboratory, DNA is mixed with an

enzyme and cycled through temperatures between 60 and 90 °C. The new idea here is that volcanic vents in the ocean might push chemical mixtures from a hot region near the vent to cooler regions. There, the mixtures' temperature would drop, allowing them to fall back towards the vent, to repeat this motion and form a convection cell where PCR or similar reactions could occur automatically.

The same process could also take place on a smaller scale anywhere that such convection cells form, and could offer an important hint as to how life began.

Further reading

Dieter Braun *et al.* 2003 *Phys. Rev. Lett.* **91** 158103.

Superconductor makes light work

A new pixellated device that could detect not only the position of an arriving photon, but also its energy, has been proposed by Peter Day and Henry LeDuc of the Jet Propulsion Laboratory, together with Jona Zmuidzinas and colleagues at Caltech.

The device exploits the change in kinetic inductance of a small superconductor when some of its Cooper pairs are broken up by an incident photon. The higher the energy of the photons, the more pairs are broken up, and the more slowly a current can respond to outside changes. This effective inductance can be measured with microwave techniques.

While there remains much to be done to make this into a practical imaging device, it could revolutionize astronomy, in particular the measurements of the cosmic microwave background radiation, and lead to many other interesting new applications.

Further reading

Peter K Day *et al.* 2003 *Nature* **425** 817.

Material shows no thermal expansion

A new material made of ytterbium, gallium and germanium has almost zero thermal-expansion coefficient, and, unlike similar substances, conducts electricity.

James Salvador of Michigan State University and colleagues have shown that this intermetallic compound remains the same size between 100 and 400 K. It could have many engineering applications, where high electrical or thermal conductivity is needed in addition to low thermal expansion.

The mechanism is not fully understood, but it seems to be electronic. Electrons move from ytterbium to gallium atoms, making the former shrink while the latter are much the same size. This shrinking just offsets the usual thermal expansion, so the material stays the same size as the temperature changes.

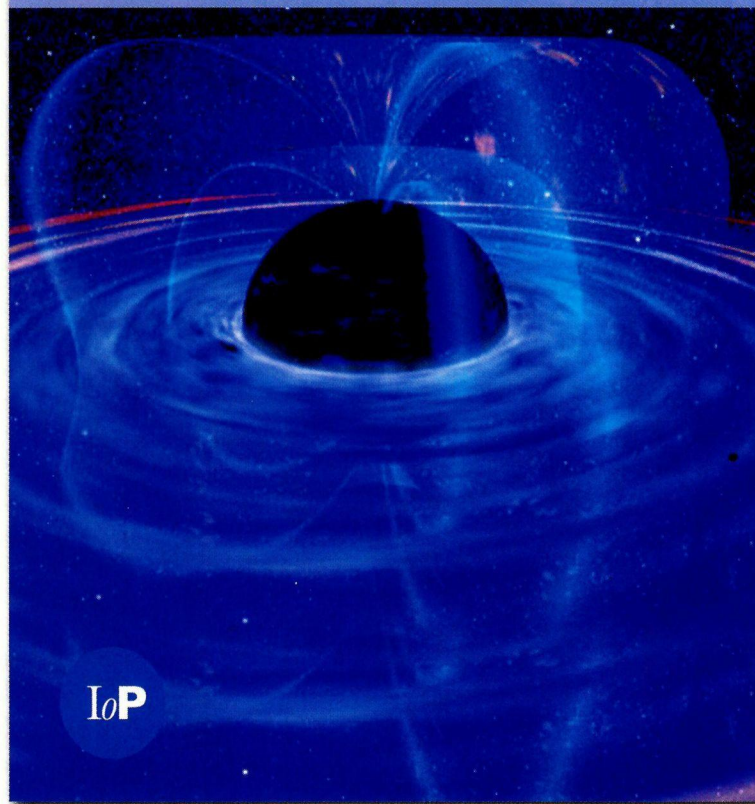
Further reading

James R Salvador *et al.* 2003 *Nature* **425** 702.

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