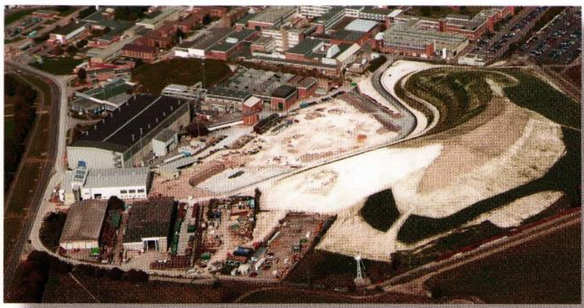
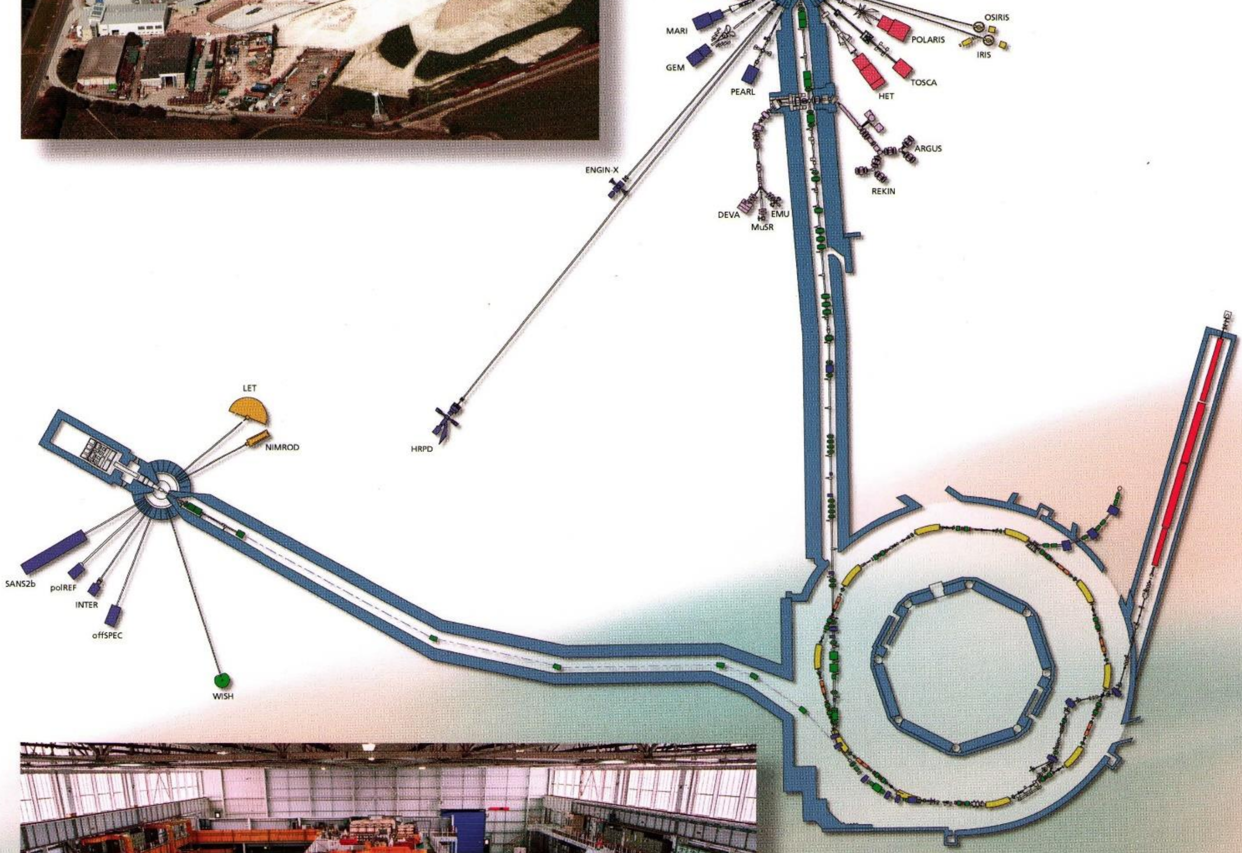
2005

ISIS *2005*

20 YEARS OF EXCELLENCE





On 16 December 2004, ISIS celebrates the 20th anniversary of its first neutron production. As the world's leading pulsed neutron and muon source, and the major research facility at the CCLRC Rutherford Appleton Laboratory, ISIS has been an undoubted success. Crucially, it could not have achieved so much without the unique partnerships that have developed with its world-wide community of users.

Scientifically, ISIS has enabled an international research community to make advances across a continually increasing range of science using the best facilities of their kind. Technologically, it has set the direction for neutron sources of the future.

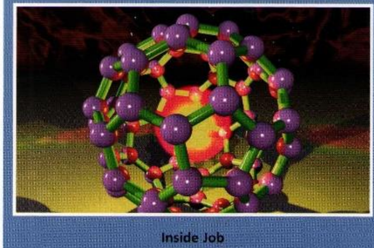
Currently under construction, the ISIS Second Target Station Project will open up new opportunities in bio-molecular science, nanoscale science, advanced materials and soft condensed matter. Expansion of ISIS will ensure that the instrument suite continues to be at the cutting edge of technology, and can adapt to meet the changing needs of our research communities.

Neutron scattering is a unique and powerful way to study the properties of solids and liquids at the atomic level, revealing where atoms are and what they are doing. The representations of science in this calendar can only capture a few aspects of the research taking place at ISIS, but go some way to conveying the striking beauty of the atomic world.

On behalf of everyone at ISIS, I offer you our very best wishes for the year ahead.

Andrew Taylor
Director, ISIS

DECEMBER 2004 - JANUARY

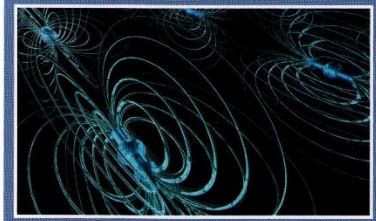


Inside Job

A muonium atom is trapped inside a buckyball.

Sub-atomic particles called muons can be implanted into materials where they exist fleetingly as tiny 'spies' that inform us about the atomic-level details of the material. Here, a muonium atom (a positive muon that has picked up an electron to form an atom resembling hydrogen) is trapped inside a C_{60} cage (a 'buckyball'), something that happens to 10-20% of muons implanted into C_{60} material. However, unlike other atoms that C_{60} might trap, the muonium atom has an unconventional escape plan – muons live, on average, for only two millionths of a second, and decay to form other particles which are fired out at high speed leaving the C_{60} cage empty.

FEBRUARY - MARCH

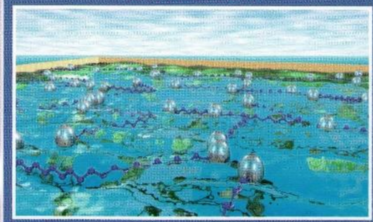


State of Flux

Lines of magnetic force spread between microscopic magnetic features.

When placed together on a regular grid, magnets will interact with each other and form an ordered arrangement with the poles of neighbouring magnets pointing in opposite directions. The strong interaction between magnets means that if one of the magnets is perturbed, a magnetic wave moves across the grid as a result. The magnetic moment of the neutron makes it an ideal probe for magnetism at the molecular level. As the microscopic magnetic behaviour of materials is reflected in their macroscopic behaviour, neutron scattering can contribute to the fundamental physical understanding of materials that are used in the construction of devices of great technological importance, such as computer hard drives.

APRIL - MAY

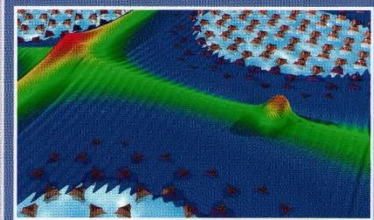


Pressure Drop

Surfactant molecules congregate on a liquid surface.

The surface of water is a very attractive place for many molecules; in particular, those that are used to manufacture soaps or that form biological cell membranes. These molecules, known as surfactants, may be dissolved in water but will rise to the surface and form a thin film at the surface if given the opportunity. The behaviour of such thin films is often dependent on the surface area, pressure, temperature or the salt content of the water. Any changes in behaviour may be particularly important for the efficiency of soap or the properties of a biological membrane. Neutron reflectometry is used to study such thin layers under different conditions and this has led to a much greater understanding of the interactions that drive the behaviour of these complex molecular structures.

JUNE - JULY



Castaway

Neutron reflectivity data reveals a unique multilayer landscape.

Soft lithography is an attractive option for patterning large areas of material in a uniform and cost effective manner. By using the self assembly of polystyrene spheres, it is possible to form highly regular templates that can then be used as masks to deposit metallic multilayer systems. After deposition and characterisation by conventional magnetometry and microscopy, the influence of this physical in-plane ordering on the magnetic structure can be studied by polarised neutron reflectometry to reveal details that cannot be measured by other techniques.

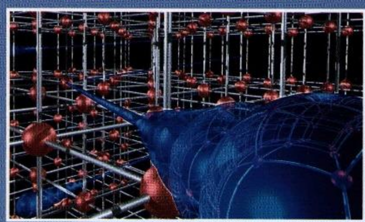
AUGUST - SEPTEMBER

Sphere of Influence

A hydroxide ion imposes structure on surrounding water molecules.

Where there is water, there are negatively charged hydroxide ions. They are very reactive, converting any oily material around them to soap – hence their widespread use in many cleaning processes and chemical reactions. Neutron scattering has been used to map out the arrangement of water molecules surrounding the hydroxide ion in solution. At least two distinct shells of water are found, forming a 'cup and saucer' arrangement, with the inner 'cup' containing about four water molecules. Over the top of the cup is a 'lid' of weakly bonded water molecules. As soon as a proton attempts to hop from one of the existing 'cup' water molecules onto the hydroxide ion, this molecule is replaced by one of the molecules from the 'lid'.

OCTOBER - NOVEMBER

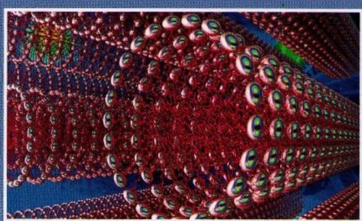


Brief Encounter

Neutrons fly through a crystal lattice.

As neutrons interact with the nuclei of atoms, they 'see' matter as mostly empty space and as a result, they are a highly penetrating probe. However, another consequence of this property is that the majority of incident neutrons pass straight though any sample that is placed in their path and hence neutron scattering from materials is relatively weak. This has a major influence on the design of neutron scattering instrumentation, where the emphasis is increasingly on using large detector arrays to record those small numbers of neutrons that are scattered.

DECEMBER - JANUARY 2006

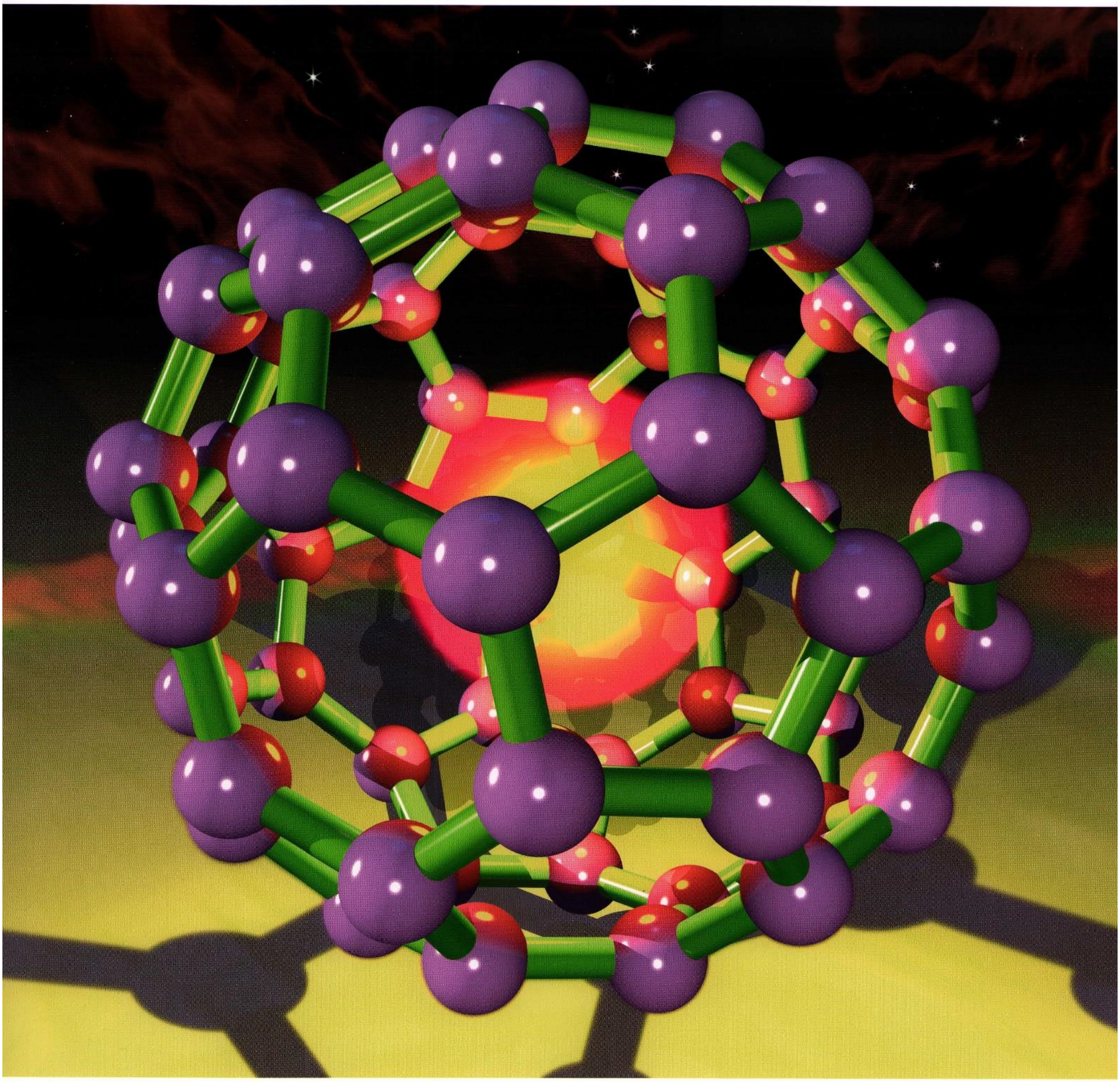


The Gathering

Surface active molecules self-assemble in solution.

Crystals are not always solid. Liquid crystals are in fact soft and have the ability to flow. Whilst most people associate the term 'liquid crystal' with clock displays and watches, there are many other types of liquid crystal that we encounter every day. They are found, for example, in shampoos and laundry detergents, where the active molecules (called surfactants) assemble into a rich variety of aggregate structures such as spheres, discs or, as shown here, long tubes. These aggregates, called micelles, may range in size from a few nanometres to several thousand nanometres. Even the micelles themselves can order into regular arrays, just like atoms in normal crystals. The technique of small-angle neutron scattering is used to examine this ordering and probe the size and shape of the micelles and this has led to improvements in the formulation and manufacturing of a number of surfactant-based products in common use.

All images were created at the ISIS Facility of the CCLRC Rutherford Appleton Laboratory in Oxfordshire, UK by Robert Dalgliesh, with input from Kenneth Shankland and Adrian Hillier. Martyn Bull, Stephanie Presland and Barry Miles contributed towards the text and design. The images were rendered using POV-Ray (www.povray.org) running under the GRIDMP (www.ud.com) distributed computing system. GRIDMP adaptation of POV-Ray by Tom Griffin.



DECEMBER *2004*

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JANUARY

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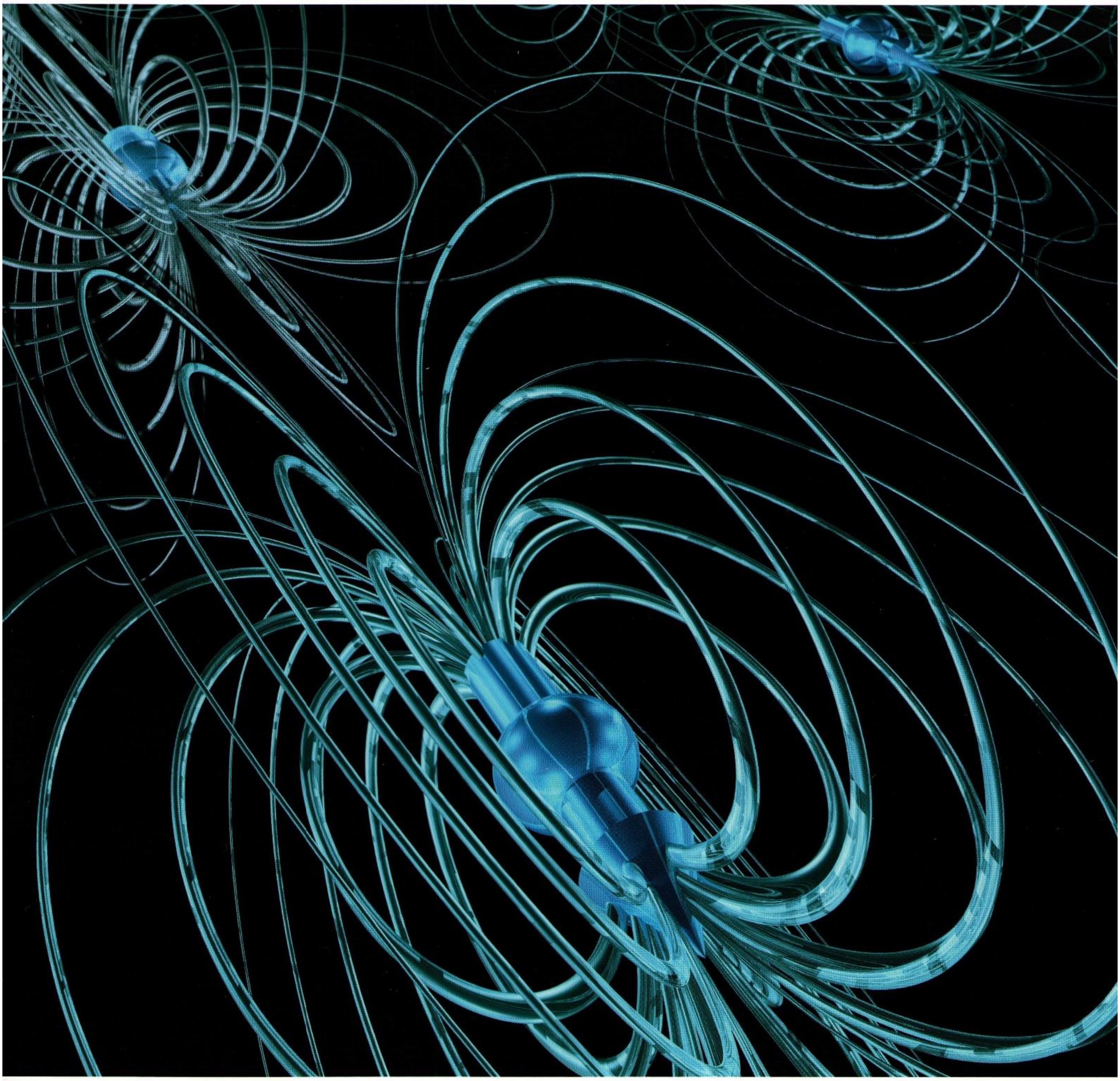

FEBRUARY

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MARCH

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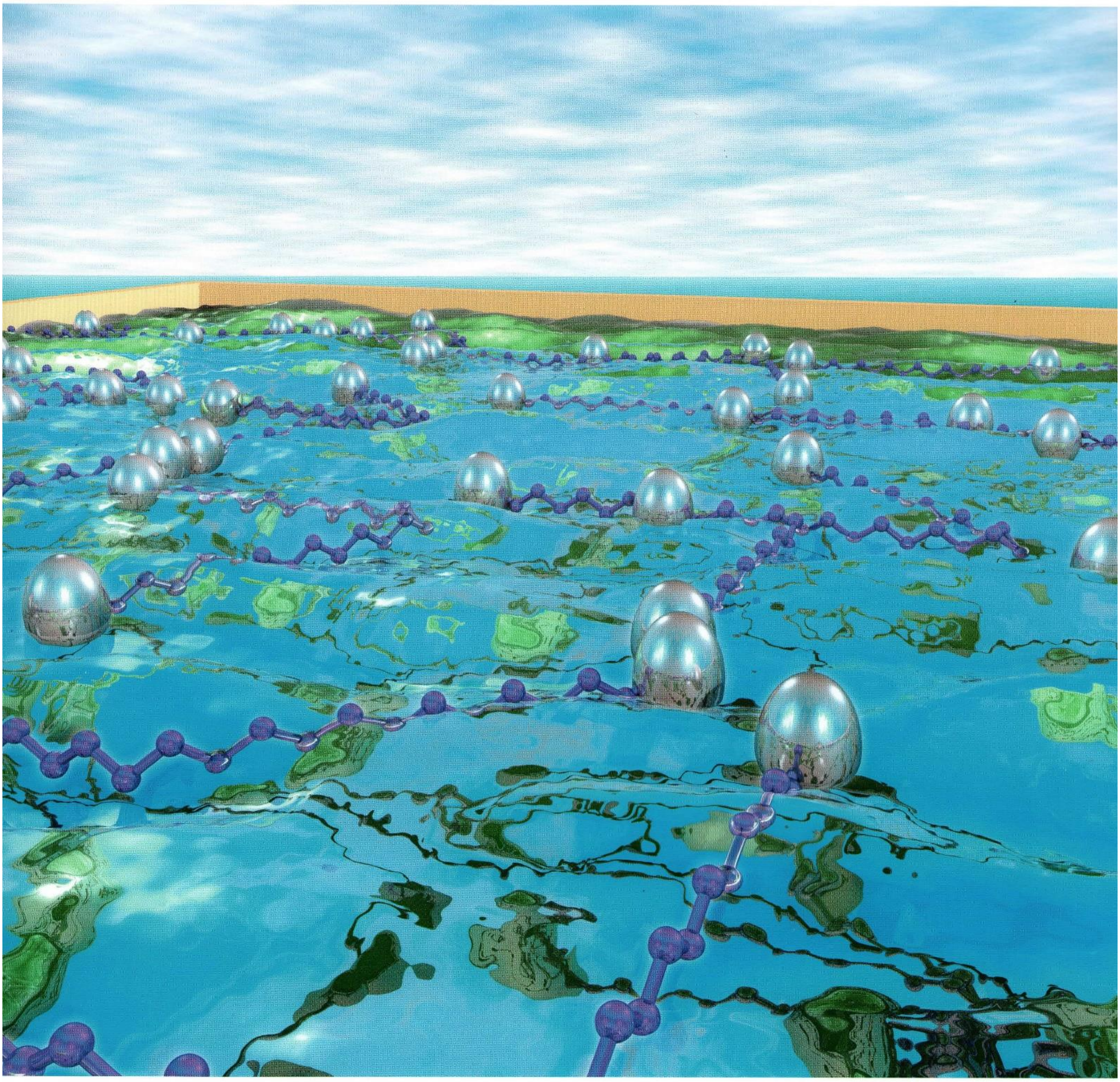

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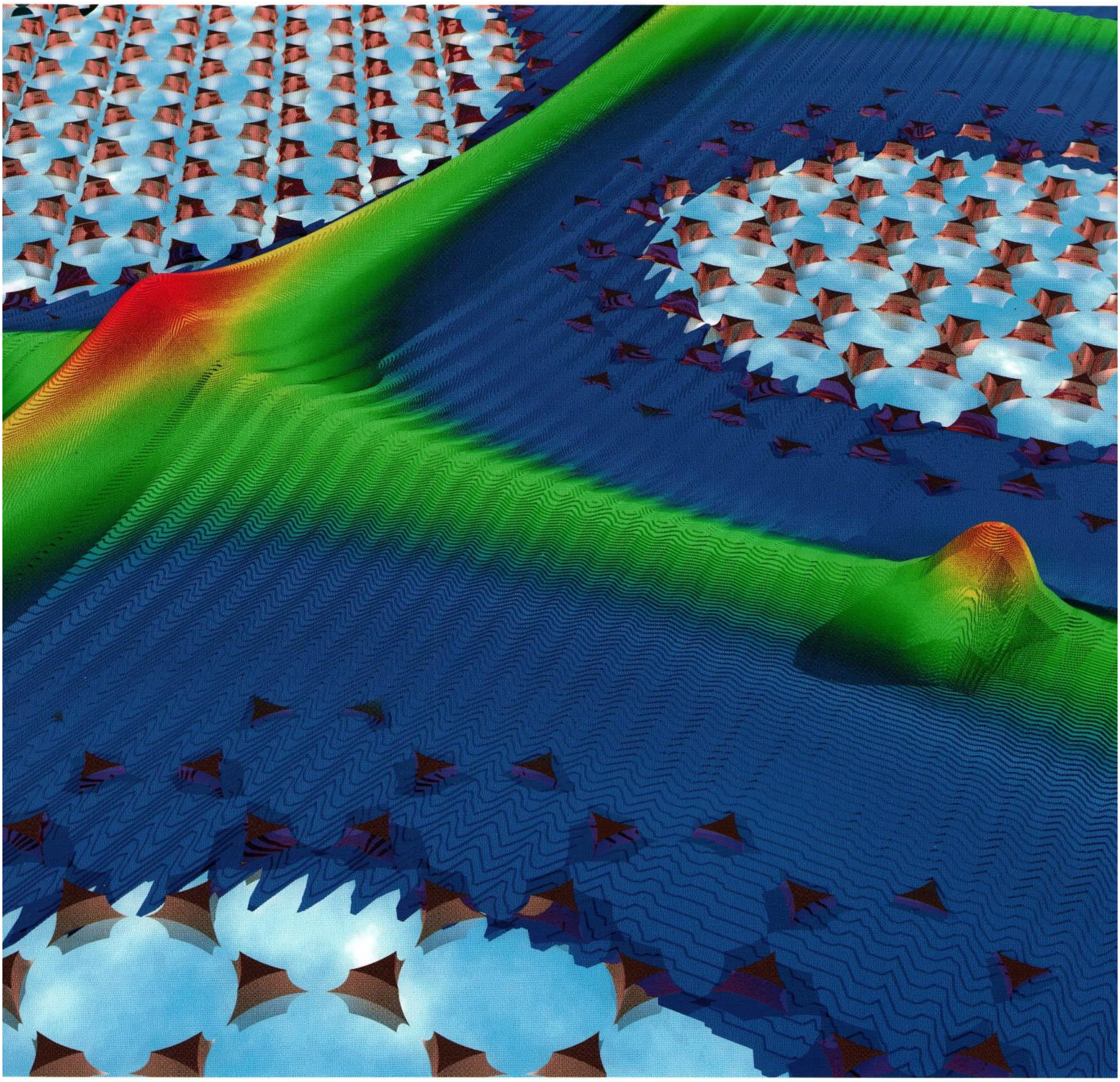

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JULY

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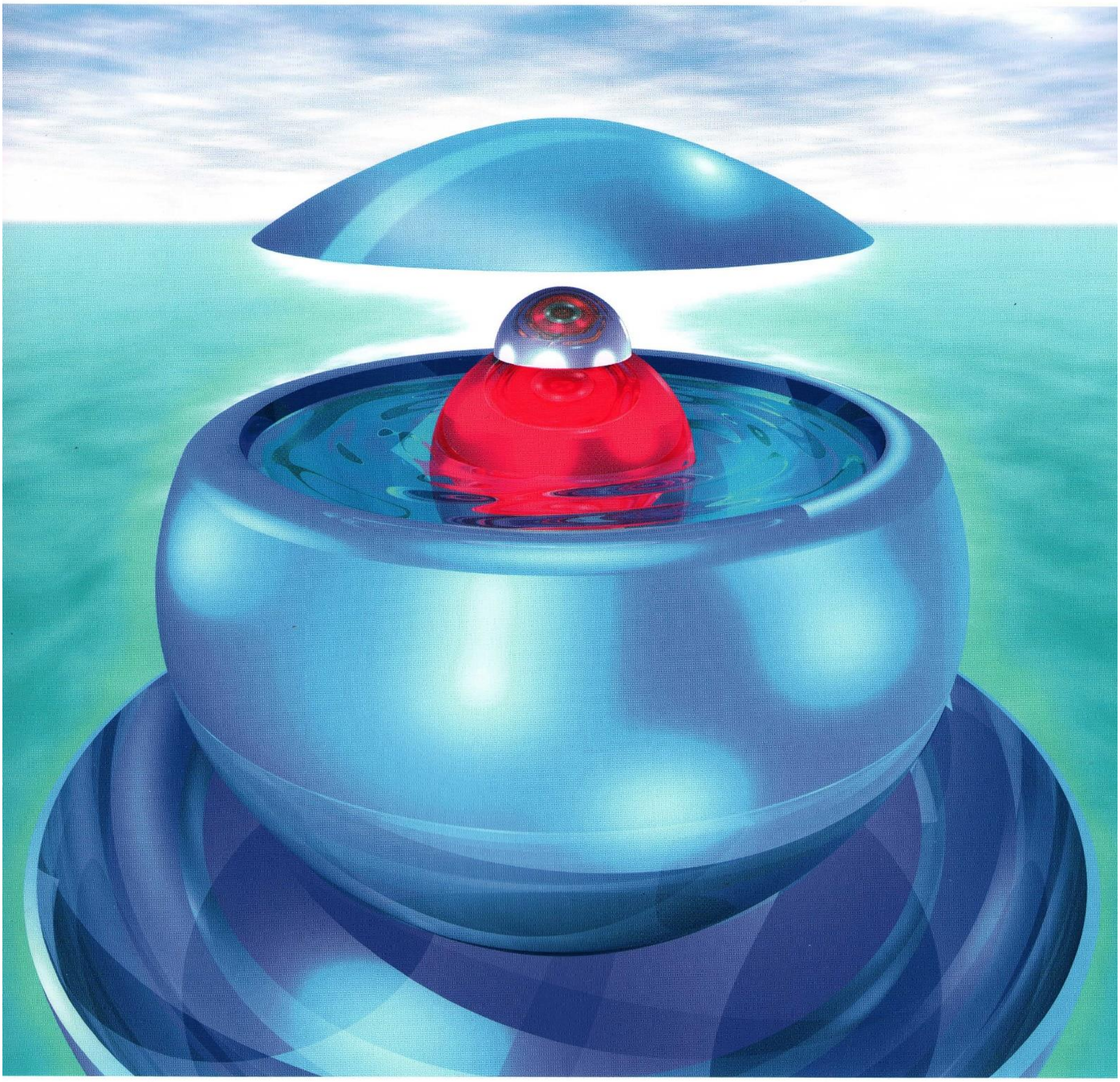

AUGUST

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SEPTEMBER

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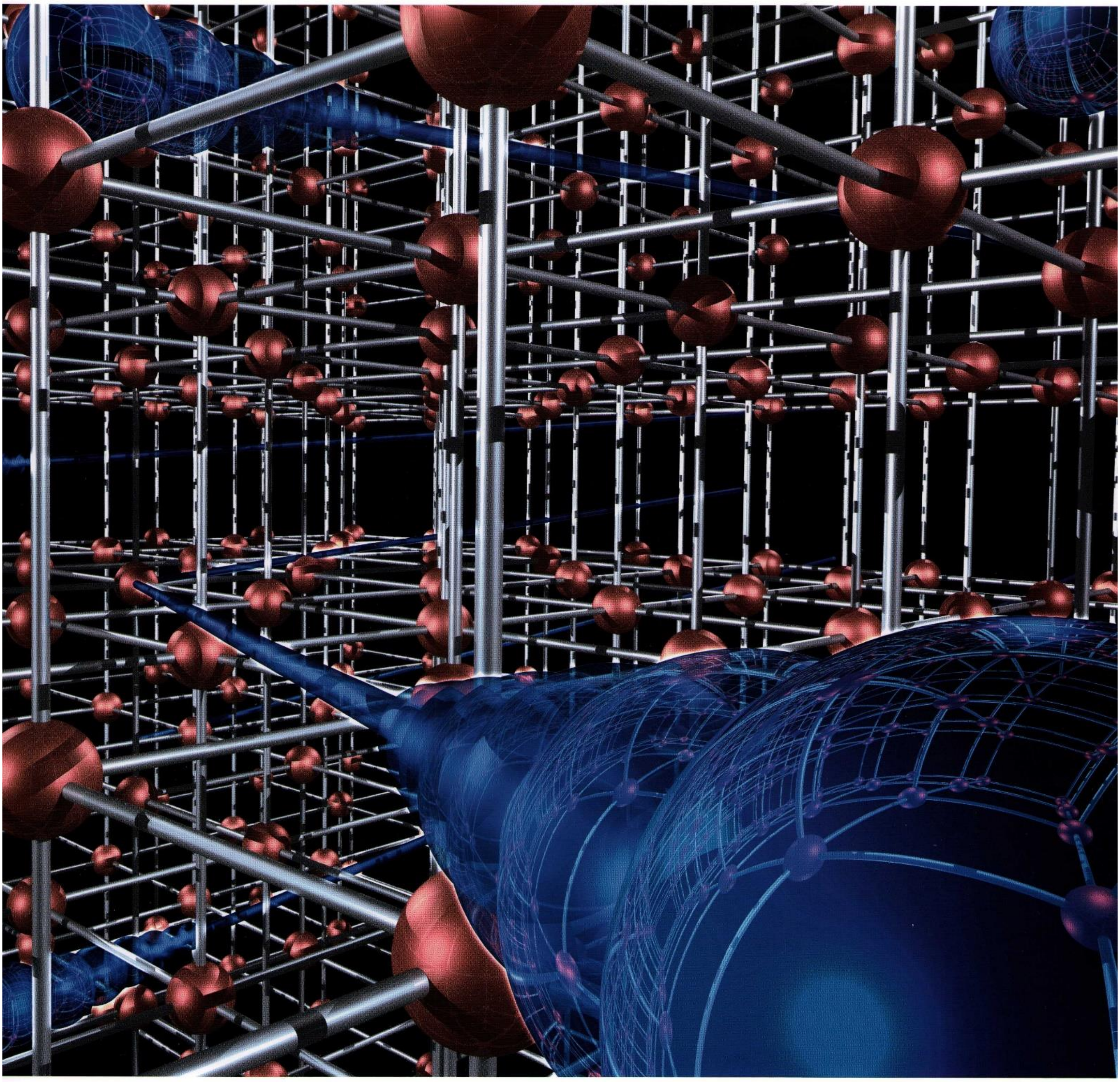

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NOVEMBER						
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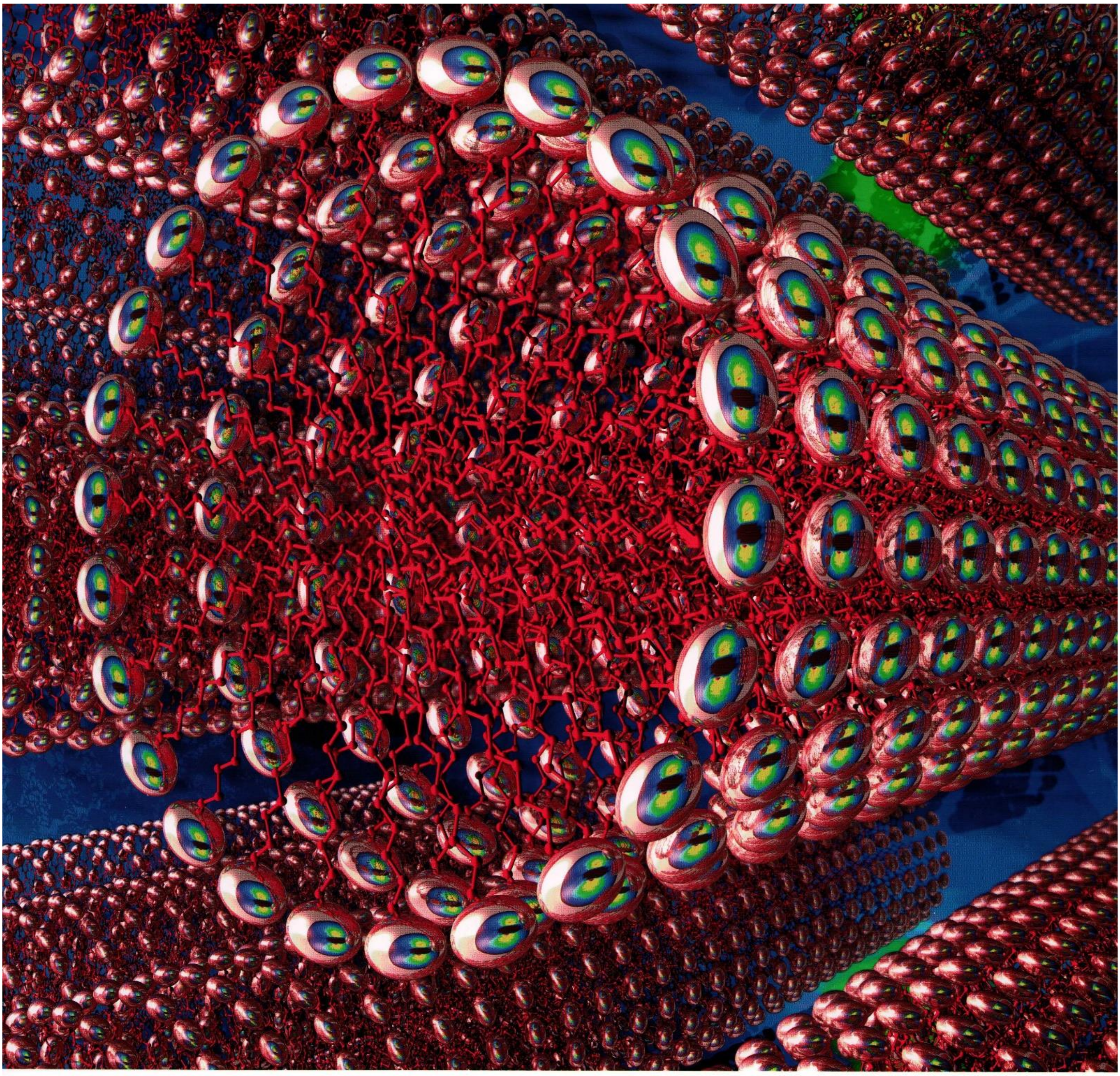

DECEMBER

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JANUARY *2006*

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