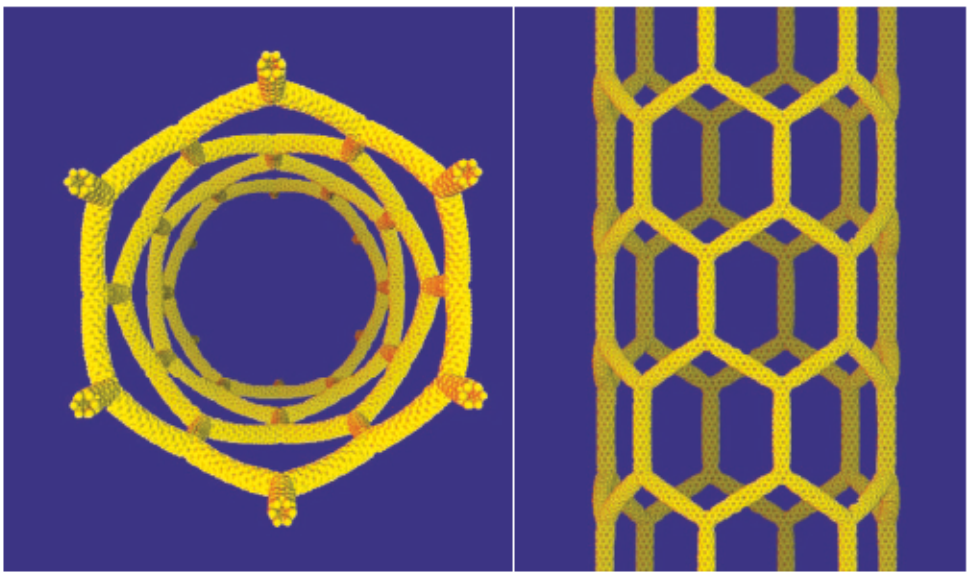
RESEARCH HIGHLIGHTS

Supertubes

Nanotechnology **17**, 617–621 (2006)
First there was just graphite and diamond. Then came fullerenes and nanotubes. Now theoretical physicists in Brazil introduce another form for carbon — the 'supernanotube'.

An ordinary nanotube is made from carbon atoms arranged in a hexagonal grid, in which each atom bonds to three others. The supernanotube proposed by Vitor Coluci of the University of Campinas and his co-workers has a similar structure (pictured), but with nanotubes in place of the bonds, resulting in Y-shaped junctions where the atoms would be. Using supertubes in place of nanotubes would create a supersupertube, and so on, to form ever-larger fractal structures.



V. R. COLUCI

CHEMISTRY

Order of the rings

J. Am. Chem. Soc. doi:10.1021/ja057908f (2006)
One of the great challenges in organic chemistry is developing novel ways to synthesize complex structures. The best reactions work for a range of chemical substrates, and give high yields.

By these criteria, a reaction, discovered by Derek Tan of the Memorial Sloan-Kettering Cancer Center in New York and his co-workers is near ideal. They report a new way to make spiroketals — unusual structures with two oxygen-containing rings that are connected by a single carbon atom.

The team obtained a number of spiroketals by reacting simple molecules with titanium salts. The oxygen atoms in the substrate seem to interact with the titanium in a way that helps to control which isomer is formed.

NEUROBIOLOGY

Some nerve

J. Cell Biol. doi:10.1083/jcb.200509174 (2006)
An evolutionary shift that occurred some 400 million years ago gave the myelin coats around the nerve cells of the central nervous system protective powers, according to a study led by Bruce Trapp at the Cleveland Clinic Foundation in Ohio.

The shift saw protein zero (P_0), which persists in the myelin of the peripheral nervous system, replaced in the central nervous system by the more complex proteolipid protein (PLP). Trapp's team 'reversed' this evolutionary step in mice, so that P_0 was expressed instead of PLP. The swap halved the lifespan of the mice and degraded their motor skills. It also seemed to accelerate the normal age-related degeneration of myelinated nerve fibres.

ZOOLOGY

Record-breaking fish

Proc. R. Soc. Lond. B doi:10.1098/rspb.2005.3419 (2006)
Zoologists have unveiled the smallest free-living vertebrate ever found. Mature females of the fish *Paedocypris progenetica* (pictured below), which lives in highly acidic blackwater peat swamps in southeast Asia, average just 7.9 millimetres in length. Described by Ralf Britz, of London's Natural History Museum, and his colleagues, the miniature species has a larva-like appearance, with a skull that does not form properly, leaving it with a hole in the top. But the specimens' gonadal development shows them to be mature adults — and males possess a unique specialized structure near their genitals thought to be used for clasping the female during mating.

IMMUNOLOGY

Cytokine sound-off

Nature Immunol. doi:10.1038/ni1304 (2006)
Some immune cells shoot to kill, but helper T cells sound the bugle to call in the cavalry. Mark Davis and his colleagues at Stanford University School of Medicine, California, show that they use a two-note alarm.

The cytokines secreted by helper T cells to activate immune cells seem to be distributed in two ways. One transport pathway targets antigen-presenting cells that interact with the helper T cell, the other distributes cytokines more broadly through the surroundings to recruit other immune cells. The pathways are associated with families of transport proteins known as Rabs and SNAREs.

The finding, says Davis, will shape ideas about the role that the delivery method plays in cytokine function.

PHOTONICS

Random sandwiches

Europhys. Lett. **73**, 225–231 (2006)
Distinguishing true randomness from something that just looks like it is hard — yet it can be vital.

To add to the raft of mathematical methods for assessing randomness, Alain Haché of the University of Moncton in New Brunswick, Canada, and his co-workers propose an ingenious approach based on physics.

They simulated light transmission through stacks of material in which the layers had

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different scattering properties. The transmission was strongly sensitive to disorder in the layers' properties. When the scattering properties encoded numbers, random sequences 100 numbers long could be distinguished from pseudo-random sequences with 70% fidelity.

A physical realization of the scheme should be possible using materials with tunable optical properties.

PHYSIOLOGY

Speed demons

J. Exp. Biol. **209,** 433–443 (2006)

Squid propel themselves through water at impressive speeds by relaxing and contracting their mantle — the muscular, tube-shaped structure near their head.

Baby oval squid (*Sepioteuthis lessoniana*) are also fast. But to swim quickly, these small creatures must contract their mantles at a much higher rate than adults of the same species. How do they do it?

Joe Thompson and William Kier of the University of North Carolina find that mantle muscle filaments in baby squid are, on average, 1.5 times shorter than those in juveniles and adults. Unlike vertebrates, which use biochemistry to fine-tune their muscle speed as they age, it seems that squid adjust the filament length.

EARTH SCIENCE

Meet the CHAMP

Geophys. J. Int. **164,** 319–330 (2006)

Earth's magnetic field is dominated by magnetism from the core, but certain minerals, such as magnetite in the planet's crust, or lithosphere, provide an additional contribution to the field. The CHAMP satellite has been measuring the lithospheric magnetic field since 2000. Its latest data highlight magnetic anomalies along subduction zones — where one tectonic plate sinks beneath another —that have never before been seen from orbit.

The image (above) shows the lithospheric magnetic field at an altitude of 50 kilometres, with subduction zones highlighted by thick green lines. Because the magnetic properties of the crust are temperature sensitive, the team of scientists led by Stefan Maus of the GeoResearch Centre Potsdam, Germany, hopes that precisely measuring and mapping the field will help to improve models of tectonic movement.

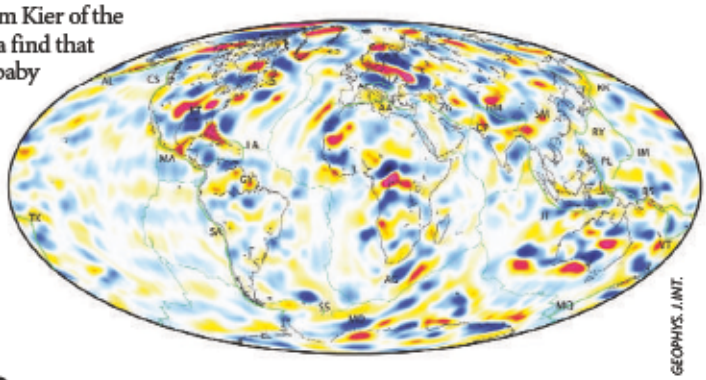
ASTROPHYSICS

Space intruders

Nature Phys. doi:10.1038/nphys214 (2006)

High-energy blasts from space known as short γ-ray bursts (GRBs) are thought to be produced when one neutron star merges with another, or with a black hole. But recent observations show short GRBs coming from above and below galaxies' main disks, where pairs of neutron stars, known as binaries, were expected to be less common.

One possibility is that GRBs originate in globular clusters, dense balls of ancient stars around galaxies' edges. Jonathan Grindlay of the Harvard-Smithsonian Center for Astrophysics in Cambridge, Massachusetts, and his colleagues show that, in clusters, some binaries will form when one neutron star intrudes into another kind of binary, made of a neutron star and a low-mass star. Then neutron star mergers in clusters could be frequent enough to account for 10–30% of all short GRBs.



GEOPHYS. J. INT.

CELL BIOLOGY

Mitochondrial massacre

Proc. Natl Acad. Sci. USA **103,** 1382–1387 (2006)

Researchers in Japan have watched sperm mitochondrial DNA being destroyed in the egg immediately after fertilization.

Offspring inherit almost all of their mitochondria, which provide cells with energy, from their mother. This was long assumed to be because the handful of mitochondria delivered by the small sperm are diluted by the large egg's abundance of these organelles. But real-time observations made by Yoshiki Nishimura and his team back up reports that paternal mitochondrial DNA (mtDNA) is instead actively digested.

By fluorescently labelling the paternal mtDNA in fish, the researchers showed that it is broken down within hours of fertilization. This may prevent the embryo from inheriting paternal mtDNA that was damaged during sperm production.

JOURNAL CLUB

Carl Wunsch
Massachusetts Institute of Technology, Cambridge, USA

An oceanographer charts the ebb and flow of opinion on ocean currents.

Many scientists believe that high-latitude cooling drives the ocean's currents as cold, dense water sinks then flows towards the Equator, creating a convective heat engine.

Since I was a student in the 1960s, when a colleague at MIT, Thomas Rossby, had seemingly shown that such a flow could be set up in the lab, this view has been entrenched.

But a flaw in the heat-engine model was pointed out as early as 1908 by the Swedish meteorologist Johan Sandström.

Heating a saucepan from below causes an instability: lower, warmer fluid rises and displaces the fluid above, leading to a vigorous convection current. In the ocean, heating and cooling both occur at the same level — the surface. Sandström argued that this situation should be stable.

In my student days, Sandström's argument was simply dismissed because he had considered an ideal, non-turbulent fluid.

Recently, however, some of us became interested again — in part because of public concern that the ocean circulation is 'shutting down', and more sensibly because of the need to understand the oceanic energy budget.

In one example, two experimentalists revisit the problem (W. Wang & R.- X. Huang *J. Fluid Mech.* **540,** 49–73; 2005) and find that cooling salty water at or below the level of heating always produces some motion. So Sandström wasn't strictly correct. But the observed flow is so weak that the efficiency with which the ocean converts heat to motion must be vanishingly small.

The circulation in the ocean — and in retrospect, in Rossby's original experiment — depends on details of how cold and warm waters mix. That means the winds and tides are the real drivers of the ocean currents. How long will it be until the literature catches up?