RESEARCH HIGHLIGHTS

PARTICLE PHYSICS

Reality check

Phys. Rev. Lett. **98,** 201801 (2007)

Are axions for real? These hypothetical particles, proposed originally in theories of the nuclear strong force, are now candidates for dark matter. Malcolm Fairbairn of Stockholm University in Sweden and his co-workers have put forward a new way to look for them.

Theory predicts that, in a strong magnetic field, photons convert to axions and back again. This conversion could happen in the Sun, the authors suggest, making it transparent to some forms of radiation. If axions with certain properties exist in the Sun, about 2% of high-energy γ-rays falling on the Sun's surface should travel right through.

Telescopes might detect this effect when the Sun passes in front of a distant γ-ray source. Current observations are not conclusive, the team says, but a more sensitive γ-ray satellite currently under construction — called GLAST — could resolve the issue.

ATMOSPHERIC SCIENCE

Cloudy skies ahead

Geophys. Res. Lett. **34,** L09811 (2007)

Early results from NASA's CloudSat (pictured below) are helping to clarify details of how clouds are distributed around the planet and vertically within the atmosphere. Such information is important for building accurate global climate models.

The first three months' worth of data collected after the probe's launch in April 2006 show that clouds over the tropical oceans fall into two main categories, report John Haynes and Graeme Stephens of Colorado State University in Fort Collins. These comprise clouds whose tops are about 2 kilometres above the Earth's surface, and those that top out at around 12 kilometres. In addition, a layer of cloud in between those two heights was found to be common over the western Pacific ocean.

NASA/JPL

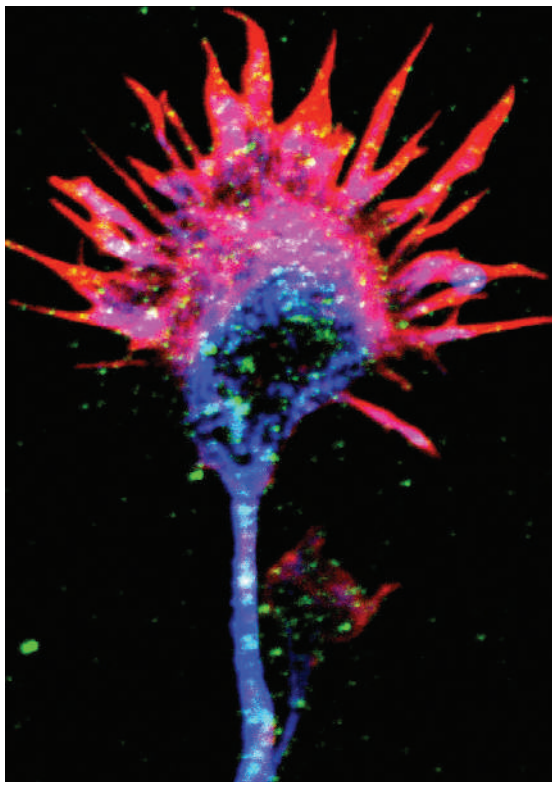
Trippy tips

Science **316,** 1212–1216 (2007)

Cannabinoids may be best known as the active ingredient in marijuana, but their endogenous forms — made naturally in the brain — have a different role. New work suggests they help to guide developing nerve fibres.

Tibor Harkany of the Karolinska Institute in Stockholm, Sweden, and his team tracked the cannabinoid receptor CB_1R in neurons in cell culture (pictured). They found that CB_1Rs (green) were recruited to the growing tip (pink) of the fibre (blue). Activation of CB_1Rs repelled the nerve fibres, encouraging them to grow away from the direction of the cannabinoid signal.

Deleting CB_1Rs in specific neurons in live mice changed the pattern of connections between axons. The authors speculate that in pregnant women, taking marijuana may interfere with the fetus' cannabinoid signalling, affecting neuronal development.



SCIENCE

Clouds that produced rain — 18% of those detected — were markedly thicker than clouds that didn't.

PHYSICS

Best served chilled

Phys. Rev. Lett. 98, 200801 (2007)

A device that can map tiny magnetic fields more precisely than existing techniques has been created from a quantum form of matter known as a Bose–Einstein condensate.

Physicists at the University of California, Berkeley, made a Bose–Einstein condensate by chilling a gas of rubidium atoms, held in place by laser light, to close to absolute zero. By imaging its response to magnetic fields, they could measure and map low-frequency fields with much greater sensitivity than today's best magnetometers. The device could be used to study inert materials or the magnetic fields produced by living tissues.

DEVELOPMENTAL BIOLOGY

Nose left from right

Cell **129,** 787–799 (2007)

The worm *Caenorhabditis elegans* has 'gap junctions' to thank for the asymmetry of its olfactory system, researchers report.

Cornelia Bargmann from the Rockefeller University in New York and her colleagues have found that more than 10% of developing neurons in the worm are temporarily connected into a network by gap junctions. These are channels that let small molecules and electrical signals pass between neurons.

Similar transient networks have been seen in embryos of other organisms, but their function was unclear. In the worm, the gap junctions help to organize the asymmetric olfactory system, which has different receptors for food-related smells in neurons in its left and right side. The transient connections also shape the arrangement of synapses in the final neural network.

METHODS

Sugar on the brain

Nature Chem. Biol. doi:10.1038/nchembio881 (2007)

A new technique can spot proteins that have been modified by the addition of the sugar β-*N*-acetyl-D-glucosamine (*O*-GlcNAc).

Linda Hsieh-Wilson of the California Institute of Technology in Pasadena and her colleagues have used the method to show that *O*-GlcNAc modification may be important in neuronal communication.

The technique combines labelling of the protein of interest and the sugar group to make the modified proteins quantifiable by mass spectrometry.

Hsieh-Wilson's group studied a set of

neuronal proteins. For several, the method could pin-point the position of the added sugar. They also found that some proteins showed more *O*-GlcNAc modifications if they were taken from an intact brain shortly after its neurons had been stimulated than if they were taken from unstimulated brain tissue.

ASTRONOMY

Universal dust-up

Astrophys. J. **661,** L9–L12 (2007)

The most distant γ-ray burst ever seen has cast its light on dust in the early Universe.

Giulia Stratta of the ASI Science Data Center in Frascati, Italy, and her colleagues studied the radiation from a 12.8-billion-year-old burst over three days. The emission was fainter at certain wavelengths than expected from the burst's initial brightness, suggesting that dust in the early Universe is different to that found in the Universe today.

Dust is produced in the dying explosions of stars, so the amount of dust present at this early time and its composition could provide clues about how the first stars formed.

CHEMISTRY

The simplest link

Science **316,** 1172–1175 (2007)

It is now possible to join certain ring-shaped molecules together without resorting to chemical tinkering to make them more reactive. This provides a simple way to perform 'cross-coupling' reactions, a type of reaction widely used in the drug industry.

David Stuart and Keith Fagnou from the University of Ottawa, Canada, used a palladium and copper catalyst system to build carbon–carbon bonds between benzene and two-ringed molecules known as indoles.

Cross-coupling reactions have previously required several steps, with the starting materials first being converted into more reactive analogues. In the new scheme, the catalyst activates a carbon–hydrogen bond on the indole, making it reactive enough to form a bond with one of the benzene's carbon atoms. There are no unwanted side products.

CANCER BIOLOGY

Stem cells fished out

Genes Dev. doi:10.1101/gad.1545007 (2007)

A model of a common and often fatal childhood cancer — embryonal rhabdomyosarcoma (ERMS) — may have helped researchers to identify the stem cells that mediate the disease.

Leonard Zon of the Children's Hospital Boston in Massachusetts and his colleagues induced ERMS in zebrafish by activating a signalling pathway that is mediated by the Ras protein. This pathway is commonly activated in human ERMS, the researchers found.

They identified genetic pathways that drive progression of the disease in both zebrafish and humans, and found that tumour development in the zebrafish depends on a population of cancer stem cells. These cells triggered tumour development when transplanted into healthy animals. The human counterparts may be 'activated satellite cells', found in muscle. Gene-expression studies showed these to have similar self-renewal mechanisms to the zebrafish cancer stem cells.

T. BLACKALL

NITROGEN CYCLE

Seabirds add ammonia

Geophys. Res. Lett. **34,** L10801 (2007)

Seabird colonies are the world's largest point sources of atmospheric ammonia, according to new calculations.

Trevor Blackall, now at King's College London, and his colleagues travelled to two Scottish islands — the Isle of May, home to a colony of Atlantic puffins, and Bass Rock (pictured above), which houses thousands of Northern gannets — to measure how much of the gas is released by bird droppings.

Globally, birds' ammonia emissions are outstripped by those from livestock, synthetic fertilizers and oceans. But the researchers estimate that, in the relatively pristine Southern Ocean below 45° S, penguins account for almost 20% of ammonia emissions. The largest colonies may produce up to 6,000 tonnes of ammonia per year, more than even the biggest poultry farms.

JOURNAL CLUB

Iwao Ohmine
Nagoya University, Japan

A theoretical chemist compares love to hydrogen bonds.

Water molecules assemble into ice "palm to palm", like Romeo and Juliet on their first encounter. Each molecule reaches out to four neighbours, forming hydrogen bonds that lock the molecules into a tetrahedral network. And like the love of Shakespeare's pair, water's hydrogen bonds are resilient. Ice contrives to keep its network, even in the tightest of spaces.

Researchers recently predicted that ice constrained by a carbon nanotube's wall will form either tubular structures or intricate arrangements of double- and quadruple-stranded helices, depending on temperature, pressure and nanotube diameter (J. Bai *et al. Proc. Natl Acad. Sci. USA* **103,** 19664–19667; 2006).

I have spent many years studying the structure and dynamics of water, but am still amazed by these luxuriant ice structures. Had computer simulations not shown how strenuously ice's network can adapt for its molecules to keep their four hands touching, we could hardly have imagined such structures would be possible.

Simulations have also predicted that confined ice can have two symmetrically different phases, which become deformed and indistinguishable when put under pressure (K. Koga *et al. Nature* **412,** 802–805; 2001). So we expect that one type of ice will easily transform into the other through collective motion of its hydrogen bonds.

My prediction is that confined liquid water, which has a disordered network of hydrogen bonds, will undergo similar structural rearrangements. Molecular mechanisms may cause large changes to the network structure of water trapped in proteins or at membrane surfaces, for example. These studies could therefore help us begin to understand another intimate relationship — the relationship between water and life.

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