Ears Tuned to Water

To a bat, flat, horizontal surfaces sound like water

Sounds like water: A greater mouse-eared bat tries to drink from a metal sheet.

Bats can detect streams, ponds and lakes with their ultrasonic sounds because the water surface acts like a mirror: it reflects their calls in such a way that they receive hardly any echo at all. According to Stefan Greif and Björn Siemers from the Max Planck Institute for Ornithology in Seewiesen, bats interpret flat horizontal surfaces as water. When the researchers simulated water surfaces with sheets made of metal, wood and plastic, the 15 bats in the experiment still tried to drink from them.

Although they also use their sight and their senses of smell and touch for identification, echolocation appears to dominate all of these other senses. The researchers now want to find out how the countless numbers of man-made flat surfaces, such as skylights, car roofs and greenhouses, affect bat behavior.

(Nature Communications, November 2, 2010)

The Technical Tricks of a Quantum Key

Commercial suppliers of quantum cryptography close a security loophole

It is possible to encrypt data so that it is absolutely safe – in principle. Quantum cryptography foils anyone who tries to hack into a data line: the hacker can intercept the signals, but can't pass them on without errors. This is because, when the quantum signals are both received and sent, they retain a random characteristic signature. Researchers at the Max Planck Institute for the Physics of Light and the Universities of Trondheim and Erlangen-Nuremberg, however, have shown that existing systems still have a technological weakness: the current signal detectors do not distinguish between weak quantum signals and the bright light pulses on which classical physics is based. This means that a hacker can dazzle the recipient's signal detector with commercially available devices – a process that goes unnoticed. But the researchers have already developed countermeasures, in a joint venture with the manufacturer ID Quantique. (Nature Photonics online, August 29, 2010)

Hackers on a security mission: Nitin Jain (left) and Christoffer Wittmann test devices that use quantum cryptography to transmit data.

A Spray to Replace Injections

In the future, it might be possible to administer insulin as a spray via the lungs, rendering inconvenient injections superfluous. A team of researchers, including those working with Helmuth Möhwald at the Max Planck Institute of Colloids and Interfaces, has produced loosely packed microspheres of uniform size and shape from insulin and other proteins used in medicine. The microparticles are thoroughly absorbed by the body, where they release an accurate dose of proteins. To produce these transport vehicles, the researchers first created porous grains of calcium carbonate, the main constituent of chalk. These were mixed with a protein solution and the protein molecules allowed to penetrate the cavities in the chalk. When the researchers varied the pH value, the proteins in the pores flocculated out, the chalk matrix dissolved and the protein shrank into microspheres. (Angewandte Chemie, October 22, 2010)

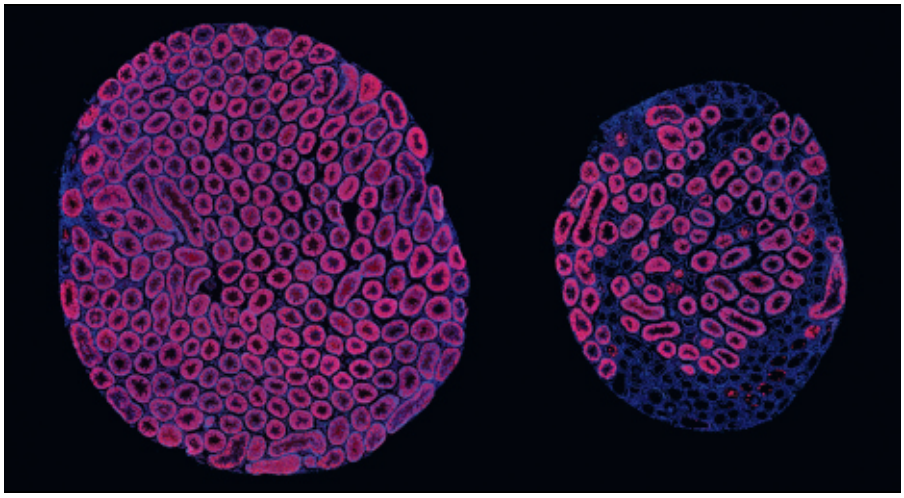
Image: MPI for the Physics of Light (bottom), Dietmar Nill (top)

Be Smart and Multiply

One gene influences both brain size and fertility

Compared to other animal groups, mammals have large brains – something that might be an accompanying effect of their fertility. Max Planck researchers from Dresden and Leipzig have now found a link between brain size and the size of the reproductive organs. It appears that one gene controls both brain development and the function of the testicles and ovaries. Mice with a defective variant of the Aspm gene develop a smaller brain, and in some cases, their ovaries and testicles are drastically undersized. This gene, which is responsible for the correct arrangement of the cell division spindle apparatus, also affects brain growth in humans. Humans with a defective Aspm have a significantly smaller head and a smaller brain. The researchers do not yet know whether those affected also form fewer reproductive system cells. It is possible that not only brain growth, but also higher rates of reproduction have caused evolutionary changes to Aspm.

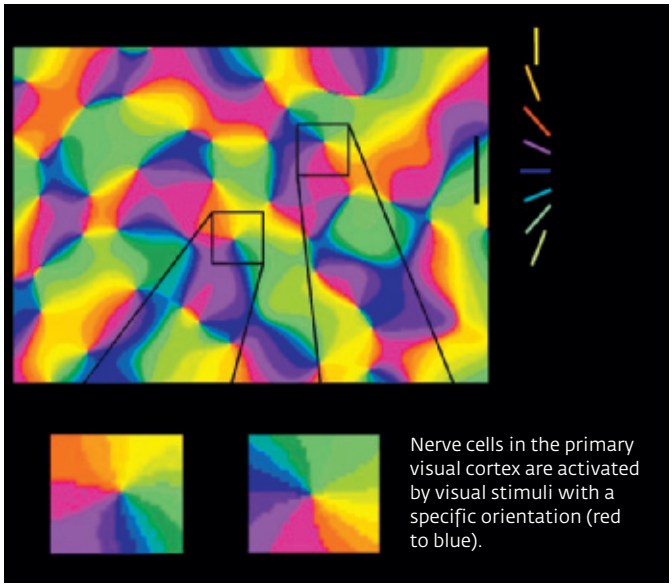
(PNAS, September 6, 2010)



A cross-section through testicles: In a mouse with a functioning Aspm gene (left), they contain sufficient sperm-producing cells (red). A genetically altered mouse with a defective Aspm gene, in contrast, has significantly smaller testicles and produces less sperm (right).

A Head Full of π

Nerve cells in the brain are arranged in accordance with mathematical rules



Nerve cells in the primary visual cortex are activated by visual stimuli with a specific orientation (red to blue).

π has fascinated humans for millennia. This mathematical constant occurs not only in mathematical and physical formulas, but also in our brains, in an arrangement of "pinwheels" in the primary visual cortex. Each blade of the pinwheel contains nerve cells that are activated by stimuli with the same orientation, such as the sight of vertical beams. The average pinwheel density per unit area is exactly π, presumably because every orientation from 0-360 degrees is represented equally in the pattern. Furthermore, scientists at the Max Planck Institute for Dynamics and Self-Organization in Göttingen have proven that a pinwheel pattern of this kind always occurs when the nerve cells are wired together according to certain rules. Genes and environmental influences thus don't play much of a role in the creation of the orientation map. Rather, the nerve cells organize themselves largely on their own, which explains why the neurons are organized as pinwheels in most mammals with well-developed visual systems. In many mammals with poor eyesight, cells with different orientation preferences are scattered randomly throughout the visual cortex.

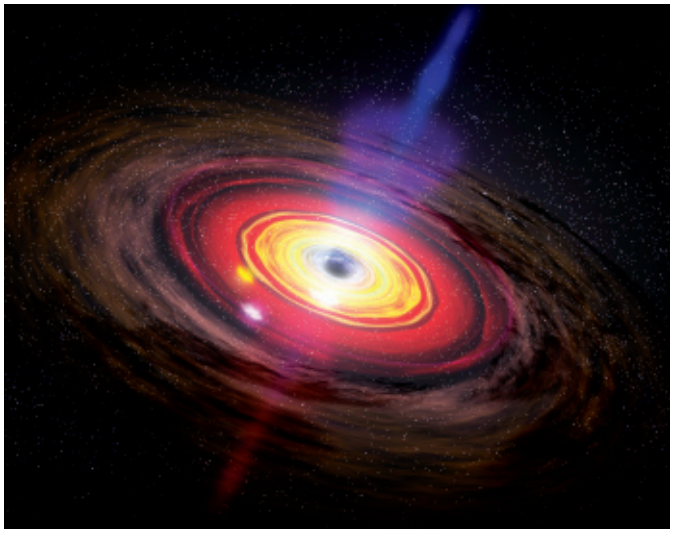
(Science, November 19, 2010)

Photos: MPI for Molecular Cell Biology and Genetics (top), MPI for Dynamics and Self-Organization (bottom)

"Last Scream" from a Black Hole

Researchers create plasmas similar to those surrounding exotic objects

Black holes are voracious feeders: they devour neighboring gas clouds and stars in huge quantities. As the "food" is caught and spirals ever faster into the gullet, it becomes increasingly dense and heats up to millions of degrees Celsius. Before the material finally disappears, it emits an enormously intense X-ray into space. This "last scream" in the form of characteristic spectral lines comes from iron as it sheds electrons. Researchers at the Max Planck Institute for Nuclear Physics, working with colleagues at the Synchrotron X-ray source BESSY II in Berlin, have reproduced this process in the laboratory. They heated iron atoms to temperatures similar to those in the interior of the Sun – or those surrounding a black hole. The spectral lines they measured perfectly matched those detected at X-ray observatories. It emerged in the process that most theoretical computations do not reflect the line positions accurately enough. For example, scientists have long puzzled over the interpretations of the data from the active galactic nucleus NGC 3783. The researchers in Heidelberg, however, identified, among several model calculations, a theoretical procedure that makes the most accurate predictions – and thus created a new way to understand the physics of plasmas surrounding exotic objects. (Physical Review Letters, October 27, 2010)



Exotic structure: Matter swirls turbulently around a black hole. What exactly is going on here?

Turning Over a New Leaf

A new technique allows filigree structures to be created in metal carbides

Chemists from the Max Planck Institute for Colloids and Interfaces have, quite literally, been copying nature. Using a new process, they transformed the skeleton of a leaf almost completely into magnetic iron carbide. To do this, the researchers treat the leaf with iron acetate, nitrogen and heat. The technique allows them to create metal carbides from every carbonaceous structure. But there are more benefits to this than just making attractively shaped objects. For example, the filigree biological structures could provide catalysts and electrodes with a large surface, thus making them particularly efficient.
(Angewandte Chemie, August 16, 2010)

A magnetic leaf: A simple chemical process transforms the leaf into iron carbide, which is magnetic and conducts electricity.

The Genes of Others

Every human being is unique and yet similar in many respects to other humans. This is also reflected in our genes. On the one hand, there are over 16 million variations in the human genome. At the same time, the genomes of all humans are 99.5 percent identical. In comparison, humans and chimpanzees share 96 percent of their DNA. Scientists working on the 1,000 Genome Project, a team that includes Hans Lehrach and Ralf Sudbrak from the Max Planck Institute for Molecular Genetics in Berlin, have analyzed the full genomes of 179 people, and the protein coding genes of 697 people "letter by letter." According to this study, each person has from 250 to 300 mutations that prevent the genes in question from functioning normally. Furthermore, each of them has from 50 to 100 gene variants that are associated with an inherited disease, and 60 new mutations that were not present in their parents. (Nature, October 28, 2010)

Image: MPI for Colloids and Interfaces (bottom), illustration: NASA/Dana Berry, SkyWorks Digital (top)

Successful – Thanks to Mother

To mate successfully, bonobo males need high social ranking and help from their mothers

Success is sexy – this apparently applies not only to humans, but also to pygmy chimpanzees. Scientists working with Gottfried Hohmann from the Max Planck Institute for Evolutionary Anthropology in Leipzig have found that the more often a bonobo male can mate with females, the higher his social status. But even less successful chimps can rack up some points with the ladies. The presence of their mothers helps bonobo males achieve better results in the mating stakes. As mature male bonobos remain with their group, mothers and sons are inseparable, even when the sons have reached adulthood. The high dominance status of the females helps their male offspring in conflicts with other males. However, they do not provide such help to unrelated males. In this way, the mothers increase the number of future grandchildren. (Proceedings of the Royal Society B: Biological Sciences, September 1, 2010)

Behind every strong man there is a strong woman: Camillo is the highest-ranking bonobo male in the study group. He is often to be found near his mother.

Jupiter from Another Galaxy

An exoplanet orbits an immigrant red giant

Astronomers have discovered the first exoplanet from another galaxy. The planet's host star was part of a dwarf galaxy that was swallowed up by our galaxy billions of years ago and that expanded into a red giant at the end of its life. The exoplanet, named HIP 13044 b, has a minimum mass of 1.25 times the mass of Jupiter. The researchers from the Max Planck Institute for Astronomy suspect that the currently very small orbit of HIP 13044 b – it circles its sun in just 16.2 days at an average distance of 18 million kilometers – was originally considerably larger; apparently it shifted toward its star during the red giant phase. Any planets that once orbited between HIP 13044 b and their star presumably also moved closer to their sun – and were consumed by it. The days of HIP 13044 b also appear to be numbered: in the next phase of its evolution, the star will expand so much that it will engulf this planet, too. A similar fate awaits the Earth and its sibling planets in a few billion years. (Science Express, November 18, 2010)

Photos: Bonobo Project – Caroline Deimel, Lui Kotale (top), iStockphoto (bottom)

Not Skill, but Luck

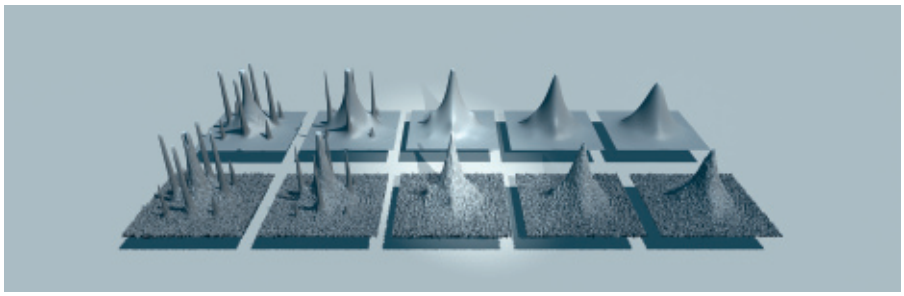
Sports betting is addictive

The announcement of the winning lottery numbers is preceded by a warning: "Gambling can be addictive." Does that also apply to games of skill, such as sports betting? Indeed it does, say Emanuel Towfigh and Andreas Glöckner from the Max Planck Institute for Research on Collective Goods in Bonn. In fact, they say, they present an even greater risk than games of pure chance. In order to find out whether a gambler's skill is a factor in betting successfully on sporting events, they asked over 200 people to bet on the outcome of soccer matches. Soccer aficionados calculated that they had a better chance of winning than was actually the case. The researchers in Bonn showed that people who were knowledgeable about soccer did only slightly better than those with no knowledge of the sport if they predicted the result no more than three days before the game. With a longer prediction horizon, the bet on the outcome of the match became a complete gamble. Precisely because skill plays some role, people overestimate their influence on the result. The more control players believe they have over the outcome of a game, the higher the potential for addiction. The scientists are therefore of the view that bookmakers should be subject to governmental regulation. (Juristen-Zeitung, November 8, 2010)

Because soccer fans in Germany frequently overestimate their ability to make accurate assessments, sports gambling can easily become addictive.

Test Run for a Quantum Simulator

Modifying atoms in an optical lattice controls their state



When the sharp tips in these diffraction pictures disappear (third section from the left), the trapped atoms change their state.

Answers to some of the big questions in physics will soon be within closer reach. A team of researchers including physicists working with Immanuel Bloch at the Max Planck Institute for Quantum Optics has made a big step toward the quantum simulator. An instrument of this type simulates an unfamiliar quantum system with a familiar one. It could be made up of atoms that lie in an optical lattice of overlaid laser beams, as if in an egg carton. The atom ensemble is intended to imitate materials such as those that become superconductive – that is, lose their electrical resistance – at relatively high temperatures, but still well below zero degrees Celsius. An understanding of the details of this change of state would help in the search for materials that conduct electricity without resistance at more normal temperatures. A precondition for this is that the physicists have detailed knowledge of the properties of atoms in the lattice and can control them. Bloch and his colleagues have thus observed how rubidium atoms change their state in response to the temperature and the strength of the optical lattice that results from the intensity of the lasers. The observations correspond to extremely complex calculations with traditional computers, leading the researchers to expect that the quantum simulator also correctly imitates the physical processes where conventional computers fail. (Nature Physics, October 3, 2010)

Artificial Light Confuses Birds

Light pollution is a factor in blue-tit reproduction

Humans frequently turn night into day. This is confusing for birds: for example, the males of some songbird species start singing earlier in the morning if they live at the edge of a wood that is exposed to street lighting. A study by scientists working with Bart Kempenaers at the Max Planck Institute of Ornithology in Seewiesen has shown that robins start to sing 80 minutes before other members of the species that sleep in the dark. Female blue tits lay their eggs one and a half days earlier where artificial light shines at night. In turn, street lights encourage male blue tits to be unfaithful; they have twice as many young with other females compared to males whose territory is dark at night. Under artificial light, the females choose the wrong – meaning unfaithful – partner more often. The researchers now want to find out whether these behavioral changes influence the chances of survival in the offspring. (Current Biology, September 16, 2010)

Less Steam in Earth's Greenhouse

Despite climate change, less water is evaporating from the ground and from plants

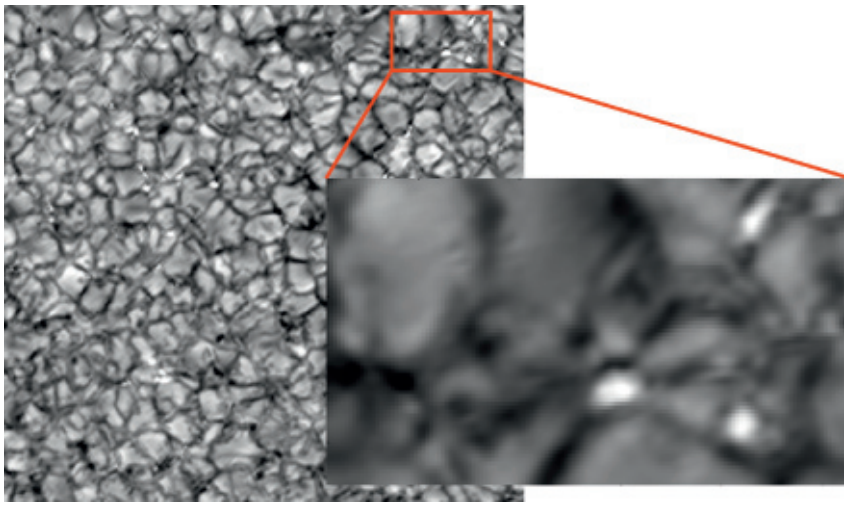
The climate system is a pump that no one has yet fully understood. Researchers working on the Fluxnet initiative with Markus Reichstein at the Max Planck Institute for Biogeochemistry in Jena have now discovered another anomaly: using satellite data and 250 measuring stations spread around the globe, they found that less water evaporated worldwide between 1998 and 2008 than global warming would have led them to expect. Climate researchers previously assumed that climate change is accelerating the global water cycle. However, particularly in southern Africa, Australia and South America, the ground has become increasingly dry, so that less moisture has been able to evaporate. Why the land surface in the southern hemisphere has become drier and whether this trend will continue remains unclear. According to the researchers, it is not necessarily a consequence of climate change. (Nature, October 10, 2010)

Photo: MPI for Quantum Optics

The Magnetic Building Blocks of the Sun

The *Sunrise* balloon telescope reveals tiny structures on the visible surface

The Sun is a turbulent place: hot plasma wells up out of the interior, cools and sinks back again. On the visible surface, called the photosphere, the bubbling streams form a pattern similar to grains of rice, called granulation. The Sun's plasma streams are closely linked with its magnetic properties, because the kinetic energy of the flows is converted to magnetic energy. Some magnetic fields can be seen in the dark sunspots that can be as large as the Earth, but there are also much smaller structures. Tiny areas of brightness between the granules are an indicator of their presence. This is where the strong magnetic fields of the plasma force themselves outward, allowing a view deep inside the interior of the Sun. These structures, called bright points, have been made visible for the first time by the *Sunrise* balloon telescope. Scientists from the Max Planck Institute for Solar System Research report that the magnetic fields within these areas, which are just a few hundred kilometers in size, are 3,000 times stronger than the Earth's magnetic field. (The Astrophysical Journal Letters, October 15, 2010)

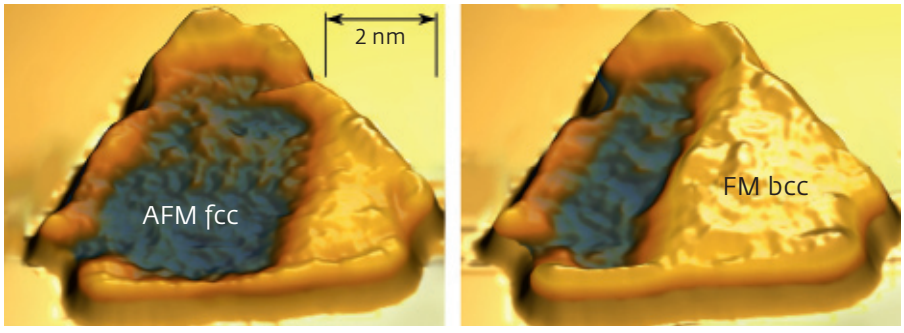


Bubbling grains of rice: This image from the *Sunrise* balloon telescope shows the granules in the photosphere, measuring several thousand kilometers in size. Between them shine bright points of just a few hundred kilometers in size. These are clearly visible in the magnified image.

More Room on Microchips

Magneto-electric coupling makes it possible to drastically increase the density of data on storage media

A new storage technology may soon make it possible to pack data up to 400 times more densely than before. For the first time, a team of researchers has written information into data points with an electrical field. The data points are a mere two nanometers long and one nanometer wide, and store the zero or one of a bit in two different magnetic orientations of the material. Traditional hard drives also record data magnetically, but they are also written onto and read from magnetically. Ingrid Mertig, Fellow at the Max Planck Institute for Microstructure Physics, and her colleagues at the University of Halle have calculated that it is possible to use magneto-electric coupling to invert the magnetic polarization of a very thin layer of iron in a much finer resolution than with a magnetic head. Physicists at the Karlsruhe Institute of Technology have confirmed this in an experiment with a scanning tunneling microscope that works at very low temperatures. (Nature Nanotechnology, October 31, 2010)



An electrically written magnetic data point: Before an electrical field is applied, the antiferromagnetic region (left) dominates, blue in the scanning tunneling microscope image. Afterward, the yellow, ferromagnetic region dominates.

Image: Wulf Wulfhekel/Karlsruhe Institute of Technology (bottom), photo: MPI for Solar System Research (top)