# Mine, Mine, Mine!

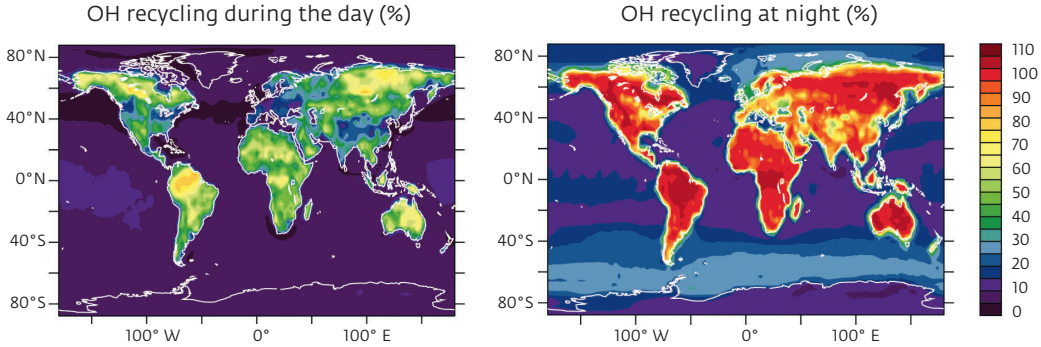
A lack of impulse control prevents children from sharing fairly – even though they understand the benefits of sharing

If children do not share fairly with each other, it may not necessarily be due to a lack of insight. They understand very early on that fairness and generosity can be beneficial. However, according to researchers at the Max Planck Institute for Human Cognitive and Brain Sciences in Leipzig, it takes some time before they possess the neuronal requirements to act in accordance with this understanding. Researchers tested children between the ages of 6 and 13 in various game situations in which the children were expected to share with another child. Most of the older children, like adults, made fairer offers if there was a chance that their counterpart could refuse the offer. If this happened, in this particular game, both parties left empty-handed. The younger children, on the other hand, did not behave more fairly in this game, running the risk that their partner would not accept an unfair offer and they would both end up with nothing. Measurements taken with a magnetic resonance scanner showed that the lateral prefrontal cortex – an area of the brain that, among other things, is necessary for controlling a person's own behavior – was less active in younger children than in older subjects. (Neuron, March 8, 2012)

Sharing fairly at elementary school age – easier said than done: A region of the brain that holds the key to behavior control develops gradually in children.

# Catalyst for Cleaner Air

The atmosphere has a robust capacity to clean itself, thanks to the consistent recycling of its cleaning agents – hydroxyl radicals. These are generated in the atmosphere by UV light, from water and ozone, and break down organic compounds in the air. Scientists at the Max Planck Institute for Chemistry in Mainz have now clarified exactly how the radicals are recycled. According to their findings, the reactive molecules can be produced when isoprene is broken down. As a key component of essential oils, isoprene is emitted into the atmosphere by plants, and is thus produced mainly in tropical rainforests. Until now, it was known only for consuming hydroxyl radicals during its chemical cleaning. This is also the case when there are high concentrations of hydroxyls in the air. At low concentrations, however, isoprene is broken down through a chemical mechanism in which more of the atmospheric cleaning agents are produced than are removed. Isoprene thus acts as a buffer that can diminish the increase in greenhouse gases and other air pollutants. (Nature Geoscience online, February 26, 2012)




The world maps show how efficiently hydroxyl radicals are recycled during the day and at night. During the day, they are formed mainly over forests, while at night, efficiency is generally high over continental regions.

Photo: MPI for Human Cognitive and Brain Sciences; graphics: MPI for Chemistry – Domenico Taraborrelli

# Direct Genetic Exchange

Plants transfer the genetic material in their chloroplasts to contact zones

Grafting is a popular agricultural method for combining plant characteristics. But it is not only humans who enhance fruit trees and garden plants in this way – plants themselves also grow together naturally if they touch. Scientists at the Max Planck Institute of Molecular Plant Physiology in Potsdam discovered that the plants can exchange their chloroplasts together with their genes for photosynthesis. The genetic material in the transferred chloroplasts can even be passed on to the next generation. In their experiments, the researchers grafted two species of wild tobacco onto a cultivated species. Their analyses showed that the cultivated species transferred its chloroplast genome unchanged to the two wild species. Like bacteria, plants can also exchange genes without reproducing. Researchers do not yet know how the chloroplasts leave their original habitat and seek out a new cell.
(PNAS, January 30, 2012, published online)

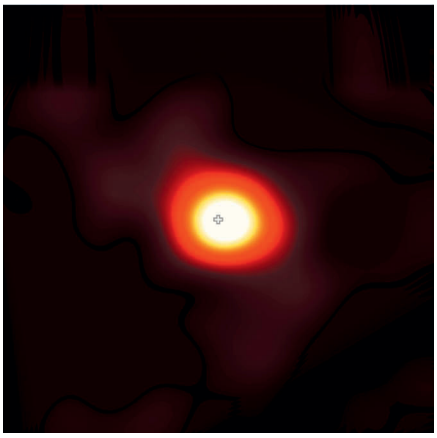
A natural graft between a birch (left) and an oak. At the point of contact, the two species, which cannot be hybridized, can exchange genes.

## Wandering Thoughts

While reading this article, it is highly likely that your thoughts will wander briefly, again and again. Despite this, you will still recall most of what you have read immediately afterwards. According to researchers at the Max Planck Institute for Human Cognitive and Brain Sciences in Leipzig, short-term memory allows humans to perform routine tasks while allowing their minds to wander. As the researchers determined in memory tests, there is a correlation between the mental working memory capacity and an unhindered stream of thoughts: participants in the study who had a greater short-term memory capacity allowed their minds to wander more frequently during routine tasks, yet still managed to perform the tasks without any problems. However, we are not completely at the mercy of the capacity of our short-term memory: by paying more attention to a task, we can compensate for a lower working memory capacity. (Psychological Science, March 14, 2012, published online)

# Powerhouse in the Crab Nebula

Pulsars are some of the most exotic objects in outer space. They are the remnants of burnt-out stars – extremely dense spheres of neutrons with a mass similar to that of the Sun, but with a diameter of just 20 kilometers. These neutron stars rotate on their axes for a period of between one millisecond and ten seconds, emitting charged particles. They move along magnetic field lines and emit radiation in almost the entire electromagnetic spectrum. If one of these beams crosses the line of sight, the star flashes for a moment, just like a signal from a lighthouse. The pulsar in the center of the Crab Nebula is particularly strong. This was confirmed by an international team of researchers that included scientists from the Max Planck Institute of Physics, using two MAGIC telescopes in La Palma in the Canary Islands. They observed the cosmic bundle of energy in the gamma-ray region from 25 to 400 gigaelectronvolts (GeV), a region that was previously difficult to access, and discovered that the pulsar emits pulses lasting approximately one millisecond with a maximum measurable energy of up to 400 GeV – at least 50 times more than theorists thought possible. "In the final analysis, there must be processes behind this that are as yet unknown," says Razmik Mirzoyan from the Max Planck Institute of Physics. (Astronomy & Astrophysics, March 30, 2012)

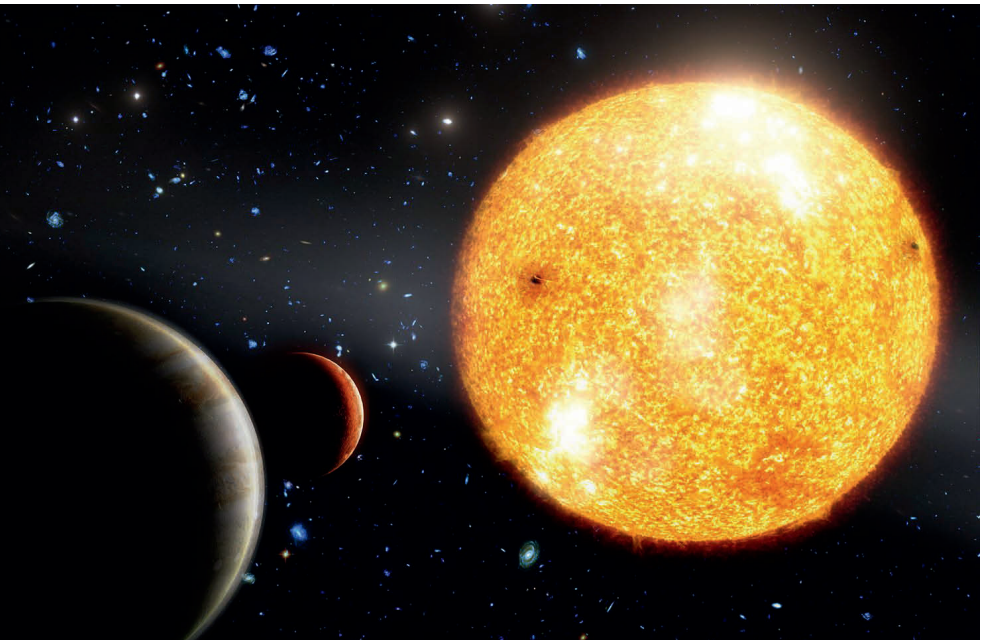


Cosmic lighthouse: The Crab Pulsar emits gamma-ray pulses measuring up to 400 gigaelectronvolts (GeV) – at least 50 times higher than theorists thought possible.

Photos: MPI for Molecular Biomedicine (top), MAGIC collaboration (bottom)

# Fossil Planets

Astronomers discover a solar system from the universe's early days

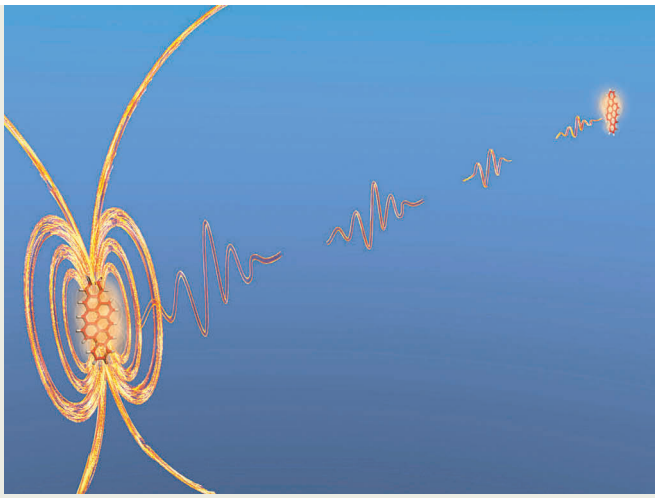


A glimpse into alien worlds: An artist's impression of the star HIP 11952 in the Cetus ("whale") constellation and its two Jupiter-like planets. The two celestial bodies orbit their parent star in 7 and 290 days.

The discovery of planets that orbit distant suns is part and parcel of everyday astronomical life. So the discovery of the new system around HIP 11952, a star with two planets located some 375 light-years away, is itself nothing special. However, HIP 11952 is 12.8 billion years old – in other words, it came into existence just one billion years after the Big Bang. "The planets probably formed when our galaxy itself was still a baby," says Johny Setiawan from the Max Planck Institute for Astronomy. Consequently, the star contains essentially only hydrogen and helium, which were by far the most abundant elements in the early universe. All heavy elements – which astronomers call "metals" – were produced only over the course of billions of years inside stars, and then flung into space as supernova explosions. This, in turn, should favor the formation of planets, since, according to traditional models, planets emerge in metal-rich clouds around stars. This means that the formation of planets around metal-poor stars should be an extremely rare occurrence. However, astronomers discovered another solar system of a similar age just two years ago. They conclude from this that new planets are obviously formed during all periods of cosmic history. Why and how? The researchers want to conduct further observations to find out. (Astronomy & Astrophysics, March 5, 2012)

## Molecules as Radio Stations

Radio communication is now possible at an elemental level: Scientists at the ETH Zurich and the Max Planck Institute for the Science of Light in Erlangen used two molecules as antennas and transmitted signals between them in the form of individual photons, or light particles. Since a single photon usually interacts very little with a molecule, the scientists had to use some experimental tricks to ensure that the recipient molecule registered the light signal. This included, for example, directing the transmitted photon to the recipient molecule using powerful lenses. They also matched the color of the emitted photon very closely with the color that the other molecule can receive. A radio connection communicated through individual photons would be suitable for various applications of quantum communication, such as quantum encryption, or in a quantum computer. (Physical Review Letters, February 27, 2012)



A transmitter molecule of the organic compound DBATT emits a stream of single photons, which are shown as wave packets. The recipient molecule scatters these photons.

Photos: Timotheos Samartzidis (top), Robert Lettow (bottom)

# Followers Foster Democracy

The majority attracts undecided individuals to its side

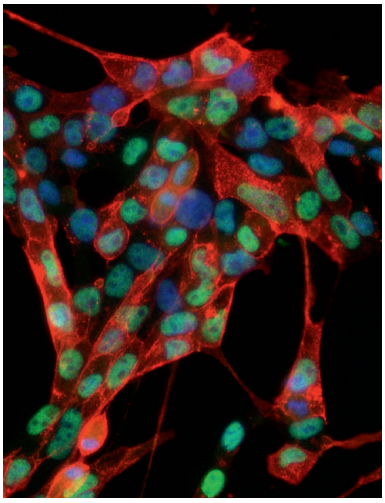
Social beings must reach decisions jointly, regardless of whether they live in a shoal of fish or in human society. In some cases, a small, resolute group may succeed in bending the whole community to its will. The commonly held view is that such groups will always be successful when they are faced with many poorly informed and undecided individuals. Using computer models and behavioral studies of fish, a group of researchers that included colleagues from the Max Planck Institute for the Physics of Complex Systems discovered that poorly informed individuals tend to support the majority rather than a particularly determined minority.

The researchers based their models on just a few generalized assumptions. The results thus apply to all systems in which individuals prefer to follow one another rather than engage in conflict. Applied to humans, this means that uninformed and therefore undecided individuals can facilitate a democratic outcome, as they prevent a minority from taking control. However, the calculations also show that the number of poorly informed individuals must not be excessive. In such cases, the decisions follow a random pattern. (Science, December 16, 2011)

Always following the crowd: Undecided contemporaries, too, can benefit democracy.

## From Specialist Straight to Multitalent

Scientists at the Max Planck Institute for Molecular Biomedicine in Münster extracted somatic stem cells from fully differentiated somatic cells in mice. Using a combination of growth factors in which the factor Brn4 plays a key role, the researchers transformed skin cells into neuronal stem cells. Prior to this, a detour through pluripotent stem cells was required. These cells are capable of developing into any type of cell in the body. However, they have such a degree of plasticity that they can also transform into cancer cells and form tumors. The somatic stem cells generated with Brn4 pose a lower risk of cancer, as they can form only certain types of tissue, in this case nerve tissue. The scientists now want to examine whether human cells behave in a similar way to mouse cells. (Cell Stem Cell, April 6, 2012)



Dyed neuronal stem cells: The cell membranes are highlighted with red dye, and the cell nuclei with green and blue.

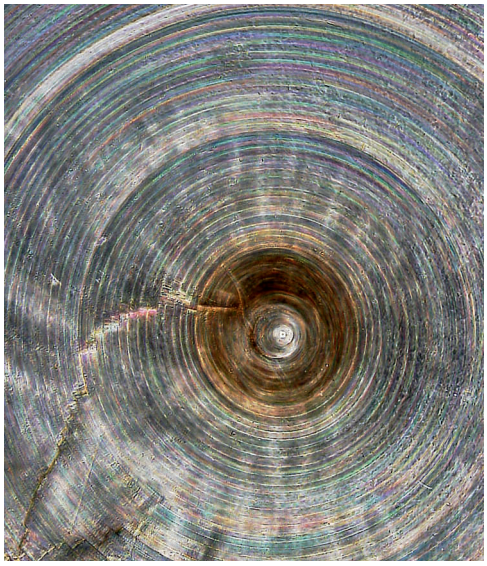
Photo: Rolf Schulten – buchcover.com (top), MPI for Molecular Biomedicine (bottom)

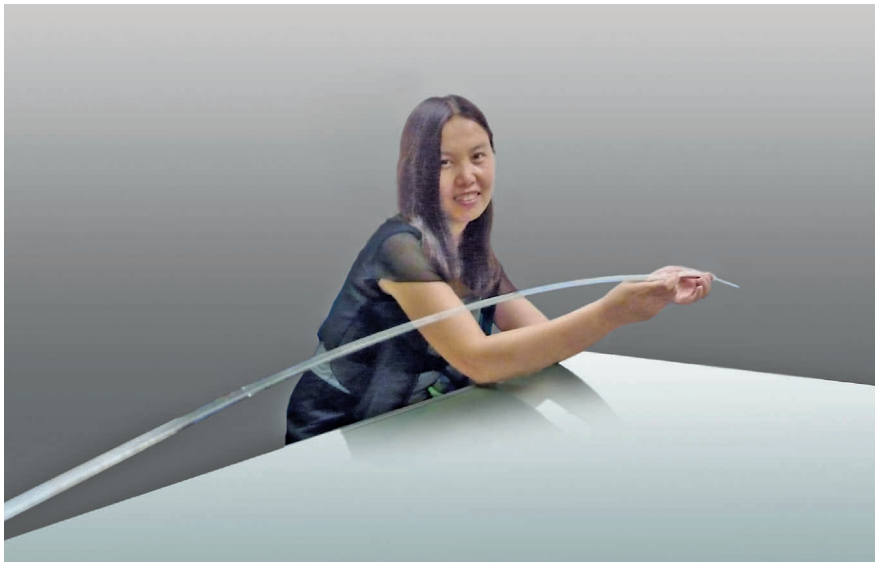
## Sweet against Sugar

It is used as a raw material in licorice, calms the stomach and helps alleviate respiratory diseases: licorice root. The Medicinal Plant of 2012 has been cherished in traditional healing since ancient times. Researchers at the Max Planck Institute for Molecular Genetics in Berlin have now discovered that licorice root also contains substances that have an anti-diabetic effect. The amorfrutins, as they are known, not only reduce blood sugar, they are also anti-inflammatory and are very well tolerated. The health benefits are based on the fact that the amorfrutin molecules dock directly onto a receptor in the cell nucleus called PPAR. This activates various genes that reduce the plasma concentration of certain fatty acids and glucose, which is a sugar. The amorfrutins could possibly be used as nutritional supplements or as mild remedies that are individually tailored to the patient. To find out for sure, the researchers will now have to test the effect of the substances on diabetes patients. (PNAS, April 16, 2012, published online)

# Climate Archive in Glass Sponge

11,000-year-old deep-sea sponge provides a record of previous environmental changes in the sea



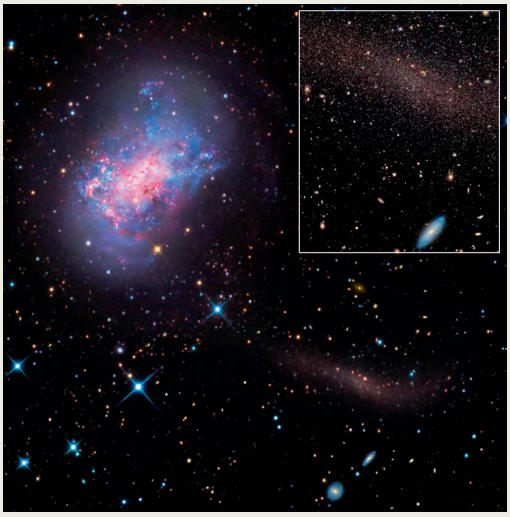


A glass sponge as the subject of a study: The photo on the left shows a one-millimeter-wide cross section through the skeleton of *Monorhaphis chuni*. On the right, researcher Xiaohong Wang holds the silicon dioxide skeleton, which measures more than two meters long and is reminiscent of a glass fiber rod.

Climate researchers have discovered a new archive of historical sea temperatures. Using the skeleton of a glass sponge belonging to the *Monorhaphis chuni* species that lived in the East China Sea for 11,000 years, an international team of researchers headed by scientists from the Max Planck Institute for Chemistry were able to show that the deep-sea temperature changed several times in recent millennia. The skeleton, which is one centimeter thick and two meters long, resembles a glass fiber rod. The sponge, whose cells surrounded the glass rod during its lifetime, constantly formed new layers of silicon dioxide. Based on isotopic and elemental analyses, the researchers concluded that the sea temperature in the sponge's environment increased at least once from just under two degrees Celsius to between six and ten degrees Celsius. These changes in temperature were not previously known about and can be traced back to seamount eruptions. (Chemical Geology, March 18, 2012)

# Hungry Dwarf Galaxy

The little ones always grow up. This is no less true of the universe: tiny galaxies merge to become impressive galaxy systems. But how do dwarf galaxies grow? In a similar way, it seems: through cosmic cannibalism. Two groups from the Max Planck Institute for Astronomy discovered a mini-galaxy that is currently "eating" another one. They found that a small companion of the NGC 4449 dwarf galaxy in the Canes Venatici constellation is actually an even smaller galaxy system that is just about to be swallowed up by NGC 4449. The researchers also studied the shape of the distortion, analyzed the star types and searched for structures that trace the orbit of the galaxy that is about to be devoured. (Nature, February 9, 2012)

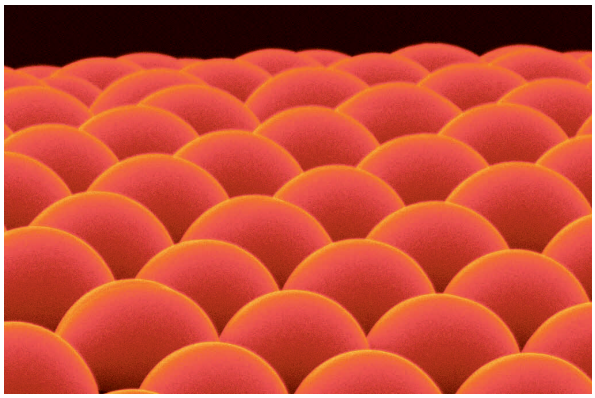


Cosmic meal: The NGC 4449 dwarf galaxy (top left) is in the process of devouring an even smaller galaxy (bottom right). The inset came from the 8.2-meter *Subaru* telescope and resolves the smaller galaxy into individual stars.

Photos: Universitätsmedizin Mainz – Werner E.G. Müller (top, 2), R. Jay GaBany (Blackbird Observatory) in collaboration with David Martinez-Delgado (MPIA). Small photo: R. Jay GaBany (Blackbird Observatory). Aaron Romanowsky (UCSC) and Jacob Arnold (UCSC) in collaboration with David Martinez-Delgado (MPIA) and the National Astronomical Observatory of Japan (NAOJ) (bottom)

# Microlenses – Formed Naturally

Materials scientists can sometimes learn from very simple organisms. Scientists at the Max Planck Institute of Colloids and Interfaces are manufacturing simple, inexpensive and top-quality microlenses from calcium carbonate. Their work is inspired by the brittlestar *Ophiocoma wendtii*, a relative of the starfish, whose skin is studded with such lenses. Like the brittlestar, the Max Planck researchers are using just one organic substance – in this case a surfactant – with which the tiny crystal lenses form on the surface of a calcium-saturated solution with the carbon dioxide in the air. Such microlenses are of technological interest in the processing of optical signals, for instance in telecommunications. Until now, it has been possible to manufacture these types of lenses only in very complex processes, for example using semiconductor technology. (Nature Communications, March 6, 2012)



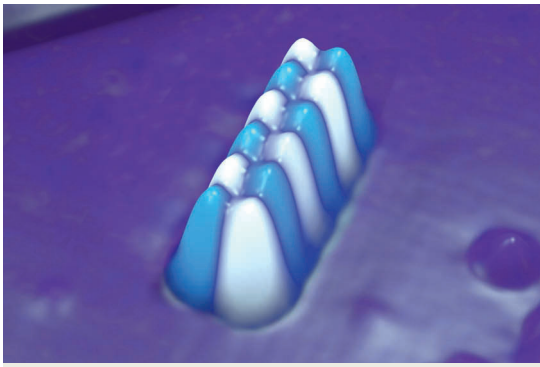
Microscopic lenses made from calcium carbonate: Regularly aligned hemispheres of calcium carbonate form an array of high-quality optical lenses.

# Nasal Spray for Panic Attacks

Anxiety-reducing substance can reach the brain through the nose

Tablets that are intended to have an effect in the brain must overcome the blood-brain barrier. This can mean that a lot of the original active substance is lost. Using mice, Max Planck researchers have now demonstrated that the anti-anxiety substance neuropeptide S can also be absorbed through the nasal mucosa and deliver its effect in the brain. Scientists from the Max Planck Institute of Psychiatry in Munich succeeded in visualizing the path taken by the intra-nasally administered substance to special neurons in different regions of the brain. Neuropeptide S reached the brain just 30 minutes after administration through the nasal mucosa. The anxiolytic effect of the substance was achieved after four hours. Neuropeptide S clearly influences the transmission of signals between neurons in the hippocampus, an important brain structure for learning and memory. The substance will have to undergo a battery of tests before it can be used on humans. (Neuropsychopharmacology, January 25, 2012, published online)

Help in a little bottle: An anti-anxiety spray is still a long way off, but Max Planck scientists are working on it.



An atomic storage unit. Researchers from IBM and the Max Planck Society store one data bit in just 12 iron atoms on a copper nitride base. The alternating blue and white coloring illustrates the antiferromagnetic arrangement.

## Smallest Data Storage Unit in the World

New opportunities in magnetic data storage are opening up to the IT industry. Scientists working in IBM's research division in San Jose, California, and a research group from the Max Planck Institute for Solid State Research at the Center for Free-Electron Laser Science in Hamburg developed an antiferromagnetic data storage unit. Conventional magnetic storage units use ferromagnetic storage points. In such units, the magnetic moments of all atoms, which can be visualized as tiny bar magnets, align themselves in the same direction. They thus generate a magnetic field and require a minimum distance between them. In antiferromagnets, the magnetic moments arrange themselves alternately in opposing directions and therefore don't generate a disruptive magnetic field. Prior to this, it was impossible to generate, in a controlled way, two states that could stand for the zero and the one in a data bit. The scientists have now succeeded in doing this in an extremely small storage point: the team accommodated one data bit in just 12 iron atoms that were positioned on a copper nitride surface. This means that information can be packed 100 times tighter than in current standard hard drives. (Science, January 13, 2012)

Photo: MPI for Solid State Research – Sebastian Loth (top), MPI of Colloids and Interfaces – Kyu-Bock Lee (middle), fotolia (bottom)