Fatal Fling

Flies become easy prey for bats during mating

Mating in the animal world can be a dangerous proposition, as the mating game quickly attracts the attention of predators. Researchers at the Max Planck Institute for Ornithology in Seewiesen have now observed how risky copulation is for flies in a cowshed. Natterer's bats dine with relish on mating pairs of houseflies. In the fervor of the fray, the flies give themselves away through their loud flapping. It is only thanks to the characteristic humming noise that the insects make on the ceiling or walls that the bats can locate them at all. Normally, the flies are invisible to the bats' echo location, as the insects' echo mixes with those from the rough ground below. The excited humming from the fly couples is so enticing to the bats that they even attack loudspeakers that simulate the noises of the flies in the researchers' experiments. (Current Biology, published online, July 24, 2012)

Fatal humming: Copulating pairs of flies attract the attention of bats with the noisy beating of their wings.

Photos: Guido Gerding/Wikipedia (left); MPI for Ornithology – Stefan Greif

Solar Plasma at a Slow Pace

New observations challenge our understanding of stellar interior dynamics

The Sun is a seething gaseous sphere. Its outer third resembles a pot of boiling water: driven by the powerful heat of the interior, hot plasma rises, then cools further up and sinks down again. This convection transports energy outward and affects the structure and activity of the Sun. Scientists at the Max Planck Institute for Solar System Research have been successful in deriving these processes in the convective layer for the first time from direct observations of the solar surface. They used data from NASA's Solar Dynamics Observatory for this, and helioseismology techniques, which resemble the seismology used to study the Earth. Researchers observed the oscillations at the surface and derived from them features such as currents in the interior of the Sun. The result: plasma flows at a relatively slow pace, at less than a meter per second. Models of the plasma flow, in contrast, predict that the plasma should be moving at the speed of a jet. There is no explanation as yet for the immense difference. (PNAS, June 4, 2012)

Ripe Fruit

Fruits react differently to the phytohormone ethylene

Ethylene is a ripening hormone that lets some fruits, such as bananas, apples and tomatoes, ripen after they have been harvested. This is the reason why green bananas become yellow more quickly if they are stored next to apples, which give off ethylene. On other fruits and vegetables, such as peppers, grapes and strawberries, the gas has no effect. These must be harvested in a ripened state and used as quickly as possible. Researchers at the Max Planck Institute of Molecular Plant Physiology in Potsdam have now discovered why ethylene induces continued ripening in some fruits and not in others. According to their findings, ripening tomatoes produce large quantities of ACC synthase and ACC oxidase. The ethylene level continues to climb as a result and activates various genes that cause the fruit to ripen. In peppers, which don't continue to ripen, ethylene has, in contrast, no influence on genetic activity and cellular metabolism. The re-

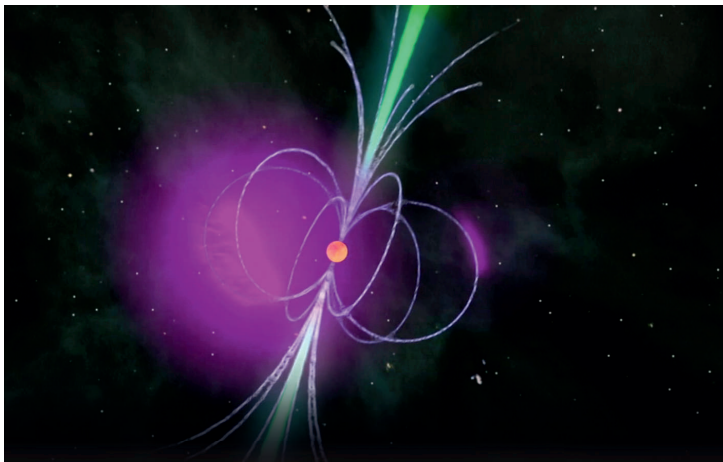
A Volatile Pulsar

Max Planck scientists discover a young neutron star with an unusually restless rotation

Pulsars are exceptional cosmic lighthouses. Compact neutron stars rotate several times a second about their own axes, making them appear to flash. In an international cooperative study, researchers at the Max Planck Institute for Gravitational Physics and the Max Planck Institute for Radio Astronomy have fished out a highly unusual pulsar from NASA's Fermi Gamma-ray Space Telescope data. The very young object, around 5,000 years old, known as PSR J1838-0537 and located in the constellation Scutum, experienced a glitch in its rotational motion during the observational period – the strongest that has been observed in a pure gamma pulsar thus far.

The glitch also explains why the pulsar suddenly disappeared for a time after its discovery. Pulsars can be detected only with the aid of laborious mathematical analysis of the measurement data. As the glitch accelerated PSR J1838-0537 by 38 millionths of a hertz, the neutron star became invisible to these analyses. Once the researchers took the rotational change into account, the pulsar reappeared again in the measurement data. The cause of such a glitch is suspected to be a stellar quake in the neutron star's crust, or interactions between the stellar interior and the crust.

(The Astrophysical Journal Letters, in press)



Lighthouse in space: If a compact neutron star with its extremely intense magnetic field accelerates charged particles to nearly the speed of light, gamma rays (violet) are produced over the surface and radio waves (green) at the magnetic poles. The rotation swings the emission fields through the line of sight to Earth, and the pulsar flashes periodically in the sky.

Photos: NASA/Fermi/Cruz de Wilde (top); Photocase (center)

Tomatoes change in color, aroma and nutrient content also after harvest. The ripening process is induced by the phytohormone ethylene. In this process, the green chloroplasts are transformed into colored chromoplasts, new sugar molecules are formed, and hard components in the cell wall are broken down.

searchers don't yet know what initiates the ripening process in fruit that doesn't ripen after harvesting.

(Plant Physiology, August 2, 2012)

Quantum Memory as Brilliant as a Diamond

Quantum information preserved in an artificial diamond at room temperature for longer than a second

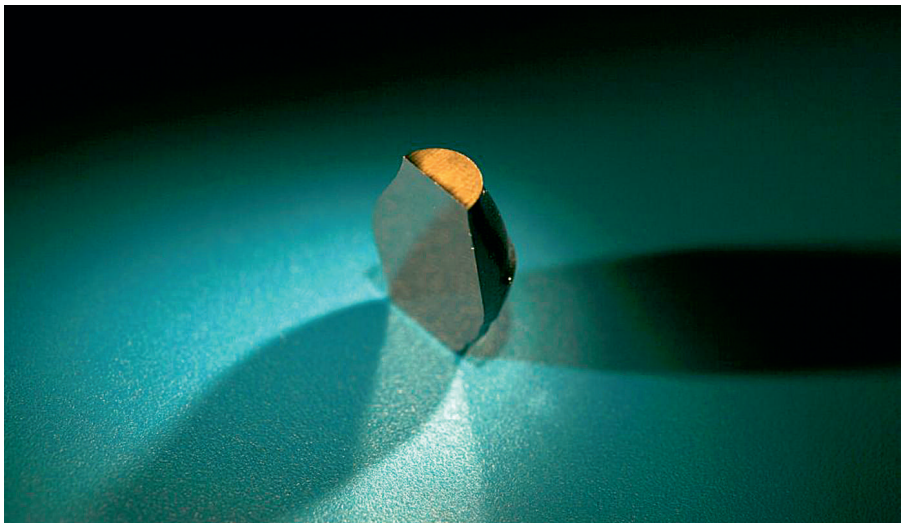
Absolutely fraud-proof credit cards and IDs that can't be counterfeited: quantum memory would make both of these possible. This is because the quantum mechanical state of a particle, such as an atomic nucleus, can neither be copied nor accurately read without additional information that is available only to the authorized user. An international team of researchers at the Max Planck Institute of Quantum Optics in Garching has now stored such a quantum state, which physicists call a qubit, in an artificial diamond for more than a second – and that at room temperature. They stored the qubit in the nuclear spin of a heavy isotope of carbon, C_{13}. Up to now, quantum states could be stored only at slightly above absolute zero (-273.16 degrees Celsius), or the stored quantum information was lost after a few milliseconds. If the technology that is necessary to write quantum information to memory, preserve it, and read it out can be significantly reduced in size, quantum storage has a future not just in counterfeit-proof documents, but also in quantum communications. They could also set new security standards, for instance for banking transactions.

(Science, June 8, 2012)

Iron Trumps Precious Metal

An iron-aluminum compound could replace palladium as a catalyst and make the production of plastics less expensive

Chemists don't like precious metals – at least when they need the expensive materials as catalysts to accelerate or steer reactions in the desired direction. And that is often the case, as with an important step in the production of polyethylene for making plastic bags light, flexible and stable. For this, a team working together with researchers at the Max Planck Institute for Chemical Physics of Solids in Dresden and the Fritz Haber Institute of the Max Planck Society in Berlin has developed a reaction promoter from iron and aluminum that works as well as the usual palladium catalyst, but is much less expensive. The researchers identified the inexpensive alternative by systematically clarifying what properties the material has to have.
(Nature Materials, June 10, 2012)

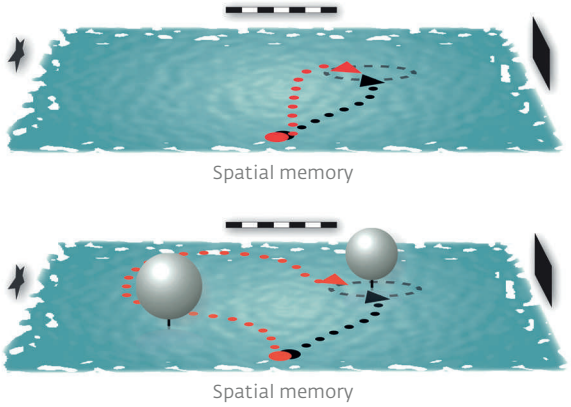


An alternative to precious metal: Max Planck researchers utilized this crystal of an iron-aluminum compound to catalyze an important step in the synthesis of polyethylene plastic. Currently, industry uses a material containing palladium for this.

Decision in the Hippocampus

NMDA receptors facilitate correct decisions in complex orientation tasks

Learning alters the synapses. Previously, scientists believed that a special form of synaptic plasticity in the hippocampus of the brain was responsible for learning spatial relationships.



It is based on a type of receptor for a neurotransmitter called glutamate, known as the NMDA receptor. Researchers from the Max Planck Institute for Medical Research in Heidelberg and the University of Oxford have now observed that mice are still able to orient themselves even when the synaptic plasticity mediated by the NMDA receptor was switched off in parts of their hippocampus. If, however, these mice are required to resolve a conflict during orientation, they no longer complete the task: in a swimming test, the genetically altered mice can't differentiate between a platform that is hidden beneath the water's surface and marked with a balloon, and a second location marked with a balloon, although they found the platform previously without any difficulty by using orientation points on the edge of the pool. Apparently the NMDA receptors in the hippocampus are necessary for recognizing or resolving conflict.
(Nature Neuroscience, July 15, 2012)

Mice with dysfunctional NMDA receptors in the hippocampus locate a platform beneath the water's surface using external orientation points just as well (illustration above, red route) as mice with NMDA receptors (above, black route). However, they are unable to differentiate between two balloons, one of which marks the hidden island (below, red route). Unlike the normal mice (below, black route), they no longer pay attention to the outer orientation points.

Photo: MPI for Chemical Physics of Solids (top); graphic: MPI for Medical Research – Rolf Sprengel

There's No Center of Consciousness

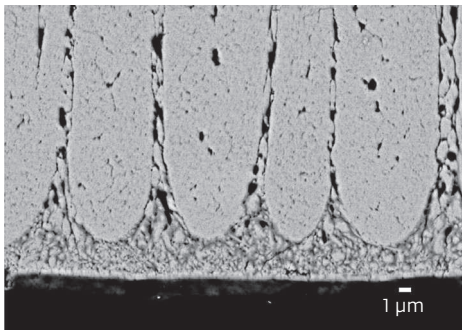
Conscious perception triggers various regions of the brain

Much of what we see, hear, feel or smell is registered only unconsciously. Although these stimuli are processed in different regions of the brain, they don't penetrate into our consciousness. Nerve cells in the temporal lobes of the cerebral cortex determine which visual impressions we consciously perceive. But apparently it's not just these cells: according to measurements by scientists at the Max Planck Institute for Biological Cybernetics in Tübingen, the nerve cells in a part of the frontal lobe known as the lateral prefrontal cortex are also active when a visual stimulus is consciously perceived. The decision as to which sensory impressions reach our consciousness is not made in a single region of the brain. It appears to be more an interaction involving participation of nerve cells from different regions of the brain. (Neuron, June 7, 2012)

Hard as a Shark's Tooth

Teeth of different shark species and those of humans resemble one another in their material properties

Shark's teeth aren't as exceptional as some scary legends would have us believe – at least not in terms of their material. Thanks to a particular structure, human teeth are just as hard as those of the feared predator, even though they are made of hydroxylapatite and sharks' teeth of fluorapatite, which is harder. This is the result of a study in which scientists at the University of Duisburg-Essen and the Max-Planck-Institut für Eisenforschung GmbH (iron research) investigated the teeth of the tiger shark and shortfin mako shark. According to this study, both the two sharks and humans bite with teeth whose material properties resemble one another very closely. The technique with which the two sharks bite differs significantly as well: while the tiger shark cuts pieces from its prey with teeth that are serrated like saw blades, the shortfin mako shark rips off pieces of its prey with its dagger-like teeth. The researchers concluded that it is exclusively the form of the teeth rather than their material that is optimized for a highly specialized application.
(Journal of Structural Biology, June 2012)



Optimized for biting: The shortfin mako shark rips pieces from its prey with dagger-like teeth (left). The tiger shark, in contrast, cuts its meat with saw-blade-like teeth. Oval-shaped bundles of fluorapatite crystals form in the enamel of both sharks (right image). The outer layer (lower half of the image) consists of random crystals that give the teeth their luster.

Photos: MPI for Evolutionary Anthropology (top right), University of Duisburg-Essen (bottom, 2)

Genotype of a Prehistoric Human

New genetic data from the Denisova Cave

The Leipzig-based researchers prepare the gene analyses in protective clothing to prevent contamination.

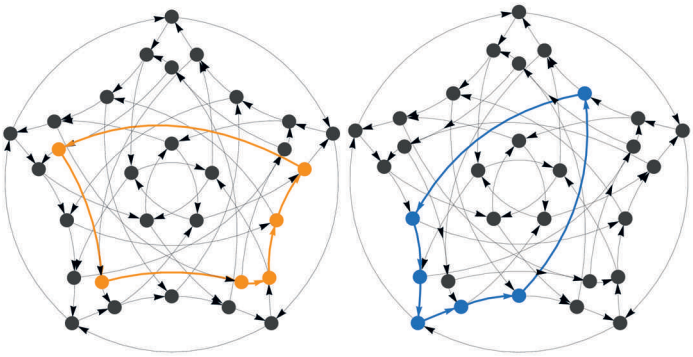
Thus far, a tiny finger bone and two back teeth in a cave in the Altai Mountains are the only known remains of the Denisovans – a humanoid that Max Planck researchers identified two years ago solely through their genetic material. Scientists at the Max Planck Institute for Evolutionary Anthropology in Leipzig, together with an international team of researchers, have now analyzed the genome of the Denisovans with previously unattained precision, and compared the genotype to humans living today. The scientists were able to detect 100,000 alterations, of which only 260 lie in regions that carry information for proteins. A few of them affect genes that influence development of the brain, skin, eyes and dental morphology. The researchers were able to determine from their data that the genetic diversity of Denisovans was smaller than that of today's humans. The results finally confirm that three percent of our contemporary genotype originated from Southeast Asia and that the two anthropoids thus mixed with one another.
(Science, August 30, 2012)

Computers Gather Momentum

A system of coupled oscillating elements could speed up computers

It will soon be possible to process information according to a completely new principle. Scientists at the Max Planck Institute for Dynamics and Self-Organization in Göttingen have introduced the complex network computer, which no longer works with the binary code and transistors of today's computers. Their design is based, instead, on a large number of coupled, oscillating elements, such as lasers and pulsating current loops. The elements can oscillate in different choreographies, each of which represents a system state. If one of the oscillating elements is disturbed, the entire system changes the oscillatory choreography multiple times until it finally settles in a new state. The intermediate states it transitions through and the final state it lands in depend on the kind of disturbance. This thus corresponds to the input signal for the computer, and the result of the computing operation is the entire path from the initial to the final state. The researchers in Göttingen proved that the complex network computer can solve several tasks considerably faster than its conventional counterpart.

(Physical Review Letters, July 2, 2012)

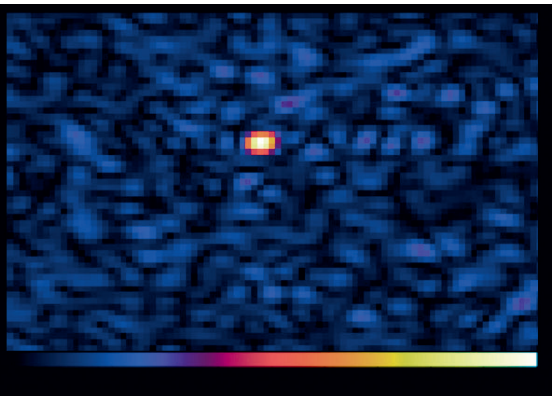


A system composed of, for example, coupled lasers can oscillate in different choreographies that correspond to possible states of the complex network computer. These states can be represented as a network. Disturbing a laser corresponds to the input signal of a computational operation. Depending on the kind of disturbance, the system seeks another path through the network of states. Two of the possible paths, each corresponding to a result of a computation, are shown in the illustration in orange and blue.

Close-Up of an Active Galactic Nucleus

The first interferometer signals between the radio telescope in Effelsberg and the *Spektr-R* Space Telescope have been recorded

The distance from the Earth to the moon is 384,000 kilometers. The antenna of a new radio telescope is almost as large, though it is virtual. To achieve this, researchers at the Max Planck Institute for Radio Astronomy in Bonn and at the Astro Space Center in Moscow combined the 100-meter dish at Effelsberg and the *Spektr-R* Space Telescope. In this process, known as interferometry, the signals are electronically superposed. During their successful observations, the antennas were directed at the object called BL Lacertae, the nucleus of an active galaxy located approximately 900 million light-years away. The project, named *RadioAstron*, provided an angular resolution of around 40 millionths of an arc-second; for comparison, the size of the full moon in Earth's sky corresponds to 1,800 arc-seconds. Astronomers want to study, among other things, the acceleration of particles in the vicinity of massive black holes at the centers of active galaxies, as well as neutron stars and pulsars, dark matter and dark energy.



In the heart of a milky way: The central area of the active galaxy BL Lacertae. The *Spektr-R* Space Telescope helps achieve high-resolution observations.

Graphics: MPI for Dynamics and Self-Organization (top). MPIfR – J. Anderson (bottom left). MPIfR/N. Junkes/Lavochkin Association (bottom right)

Climate Change Despite Sun Screen

Several measures in geoengineering could indeed cool the earth, but they would create an entirely new climate

No sun umbrella can help against climate change, no matter how gigantic. Some climate researchers suggest enriching the atmosphere with sulfur on a grand scale, or positioning countless mirrors in space. They want to screen out the sunlight and cool the earth. However, the pre-industrial climate can't be brought back in this manner. As scientists at the Max Planck Institute for Meteorology have now calculated, these forms of geoengineering would indeed lower the average global temperature, but they would create a new climate with less rainfall. This is because sulfur-laden clouds and masses of mirrors would only reflect the short-wavelength light that vaporizes a lot of ocean water particularly in areas having a high incidence of solar radiation, like the tropics, and mixes the air masses. As a result, it would rain 20 percent less in the tropics and up to 15 percent less in northern Europe, as well as in large parts of North America. This effect wouldn't exist if the concentration of greenhouse gases in the atmosphere were to drop. Carbon dioxide and methane namely capture a part of the radiation reflected from the earth's surface in the atmosphere, and do so evenly across the entire spectrum, so they influence the development of precipitation in sunny regions less.

(Earth System Dynamics, June 6, 2012)

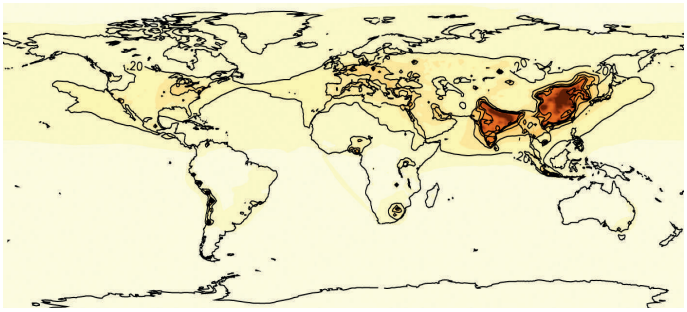
Volcanic eruptions, as in this illustration, spew large amounts of sulfur dioxide into the atmosphere, forming airborne particulates that reflect part of the sunlight. Geoengineering imitates this effect. However, with this type of artificial cooling, it would rain significantly less in large parts of the world than was the case in pre-industrial climate conditions.

Breathing Is Becoming Less Healthy

By 2050, a large portion of the world's population will live in highly polluted air

Researchers at the Max Planck Institute have gazed into the future of our breathable air and seen little that is positive. Air pollution will increase so much, especially in South and East Asia and in the Middle East, that today's limits for pollutant loads will be significantly exceeded by 2050. The scientists calculated this using an atmospheric model. They assumed in their calculations that emissions of harmful compounds will climb at the same rate as the growth of the population and the economy, as in the past. In addition, the researchers assumed in their forecast that there will be no additional measures to counter the emission of hazardous substances – a pessimistic but realistic scenario, in their opinion. Under these conditions, especially in several of today's emerging and third-world countries, air quality will be as poor everywhere as it currently is in only a few highly populated areas. In the industrialized nations of Europe and North America, in contrast, the air quality will hardly deteriorate at all.

(Atmospheric Chemistry and Physics, August 1, 2012)



Air quality of the future: The map shows how high the pollutant load of the atmosphere will climb worldwide by 2050. Pale yellow stands for little additional air pollution, while the redder an area is colored, the heavier the pollutant load will be here in the air we breathe.

Photo: iStockphoto (top); graphic: MPI for Chemistry