Late Risers Are Cheated On More Frequently

Daily rhythm influences fatherhood in great tits

A transmitter on the back of the great tit tells the researchers when the animal wakes up in the morning.

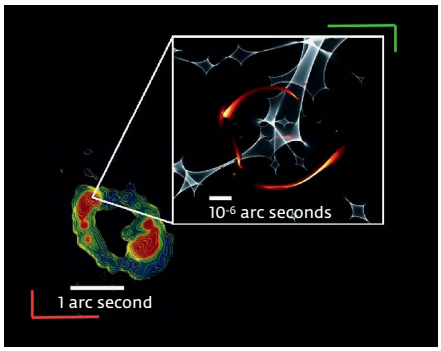
Sleeping in is more enjoyable, but it also lowers reproductive success – at least if you are a great tit. Researchers at the Max Planck Institute for Ornithology in Seewiesen and Radolfzell discovered that male great tits that rise later than their conspecifics are cheated on more frequently by their female mates. The researchers used mini-transmitters to monitor when the animals wake up in the morning. Also, under the skin of some of the males, they placed a small implant containing melatonin, a hormone that plays a major role in regulating the internal clock. As a result, birds that received a melatonin implant woke up later. Thus, instead of waking up early and defending their female against competitors, the males with the implant were still sleeping soundly while their mates amused themselves with other males. Many of the chicks in the nests were therefore the offspring of other males.

(Functional Ecology, June 3, 2015)

A Black Hole under the Gravitational Lens

Turbulent processes take place close to supermassive black holes, which lurk in the centers of nearly all galaxies. These massive monsters swallow up matter flowing in from the outside while at the same time producing gas jets that shoot out into space in two opposite directions. Researchers at the Max Planck Institute for Physics in Munich and the University of Geneva have now succeeded in localizing the origin of the high-energy gamma radiation in such a jet. To achieve this, the researchers observed an active galaxy known as PKS 1830-211, in which one of the two jets happens to be directed toward Earth. In addition, roughly half way between this blazar and Earth, there is a galaxy that acts as a gravitational lens, amplifying the light. The scientists conclude from the effects they observed that the registered gamma radiation originates from a compact region measuring just a few billion kilometers, and is generated very close to the black hole, or essentially at the foot of the jet.

(Nature Physics, published online, July 6, 2015)



Looking at a distant galaxy: The radio chart (bottom left) shows the image of the blazar PKS 1830-211 distorted by the gravitational lens effect. The detail on the right is a simulation of the micro-gravitational lens effect in the gamma ray region; direct observation of the orange ring – it also represents images of the blazar – isn't possible due to its small size.

Alzheimer's Spares Long-Term Musical Memory

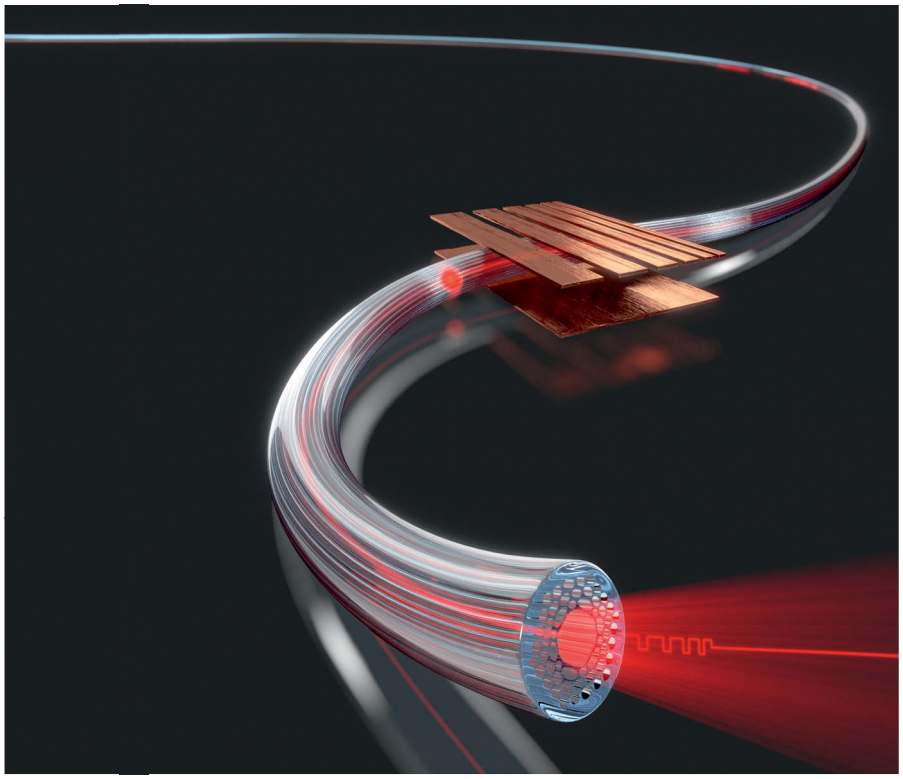
Alzheimer's erases a large part of patients' memory. The disease seems to spare only musical memory, as Alzheimer's patients can often recall musical pieces even when other memories have already faded. In some cases, they are able to sing lyrics of songs even when speaking has become almost impossible for them. Scientists at the Max Planck Institute for Human Cognitive and Brain Sciences in Leipzig wanted to know why musical memory is less affected by Alzheimer's. To this end, they first had to locate the seat of musical memory in the brain. The researchers played top-10 hits, children's songs, oldies and well known classical pieces to Alzheimer's patients while using magnetic resonance imaging to measure their brain activity. In this way, they identified the so-called supplementary motor cerebral cortex as the seat of long-term musical memory. Analyses of the brains of Alzheimer's patients show that this region is less affected by the disease: it loses fewer neurons than the other brain regions, and its metabolism doesn't decline as much.

(Brain, June 3, 2015)

Photos: Timothy Greives (top), Patnaik et al. 1994, Liege Conference on Gravitational Lenses and the Universe/Vovk (bottom)

A Multi-Purpose Sensor

A flying microbead in a hollow glass fiber measures temperature, vibrations and electric fields with high spatial resolution



Glass fibers can do more than transport data. A special type of glass fiber can also be used as a high-precision multi-purpose sensor, as researchers at the Max Planck Institute for the Science of Light in Erlangen have now demonstrated. The researchers sent a tiny glass bead through the interior of these photonic crystal fibers. The movement of the bead is influenced by different physical quantities, such as electric field, temperature and vibrations, and a laser is used to measure how the bead's path changes. The flying particle detects the quantities to be measured over long distances with high spatial precision, even under harsh conditions. The sensor fiber, which currently has a length of up to 400 meters, could help detect damage to high-voltage lines. (Nature Photonics, published online, June 8, 2015)

Measured in flight: A microbead that flies through the hollow channel in the interior of a photonic crystal fiber measures different physical quantities, such as the electric field of electrodes.

The Neanderthal in Us

A bone found in Romania reveals interbreeding among early modern humans in Europe

Neanderthals became extinct about 40,000 years ago, but they contributed on average 1 to 3 percent to the genomes of present-day humans from Europe and Asia. The two types of humans probably mixed with each other in the Middle East around 50,000 to 60,000 years ago, when modern humans left Africa and spread into the rest of the world. However, the intermingling could also have taken place in Europe, as modern humans and Neanderthals lived together there for up to 5,000 years. An international team of scientists that includes researchers from the Max Planck Institute for Evolutionary Anthropology have now found 6 to 9 percent Neanderthal DNA in a 37,000- to 42,000-year-old human mandible from Oase Cave in Romania. That's more than for any other human sequenced to date. Because large segments of the chromosomes are of Neanderthal origin, this individual must have had a Neanderthal in his family tree as recently as four to six generations back. However, the human from Oase Cave evidently has no direct descendants in present-day Europe. Consequently, some of the first modern humans mixed with the local Neanderthals in Europe, but then became extinct.
(Nature, June 22, 2015)

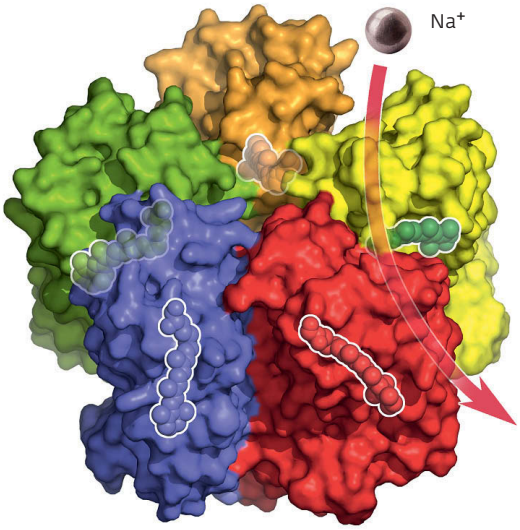
Part modern human, part Neanderthal: The 40,000-year-old mandible belonged to a modern human with Neanderthal ancestors.

Photos: Luca Fiorentini (top), MPI for Evolutionary Anthropology/Svante Pääbo (bottom)

A Switch for Neurons

The light-driven ion pump KR2 transports sodium ions out of neurons

Sometimes, the path from ocean floor to tool for brain research is a short one. A case in point: the ion pump KR2, which scientists discovered two years ago in the cell wall of the marine bacterium *Krokinobacter eikastus*. KR2 is a light-sensitive protein that transports positively charged sodium ions out of the cell. Scientists can integrate these ion transporters into the neuronal membrane, making it possible to control their activity using light impulses – a neuroscientific method that is known as optogenetics. A pump such as KR2 is a feature that was previously missing in the optogenetics toolkit. An international team of researchers has now uncovered the atomic structure of KR2. Together with researchers at the Max Planck Institute of Biophysics in Frankfurt, they also discovered that exchanging one amino acid turns KR2 from a sodium pump into a potassium pump. Neuroscientists could thus use the protein as a very effective off-switch for neurons, as outflowing potassium ions deactivate neurons. In combination with Channelrhodopsin-2, a light-activated channel through which sodium and calcium ions flow into the cell, the potassium pump would form a perfect pair of tools for precisely switching neurons on and off. (Nature Structural & Molecular Biology, April 6, 2015)

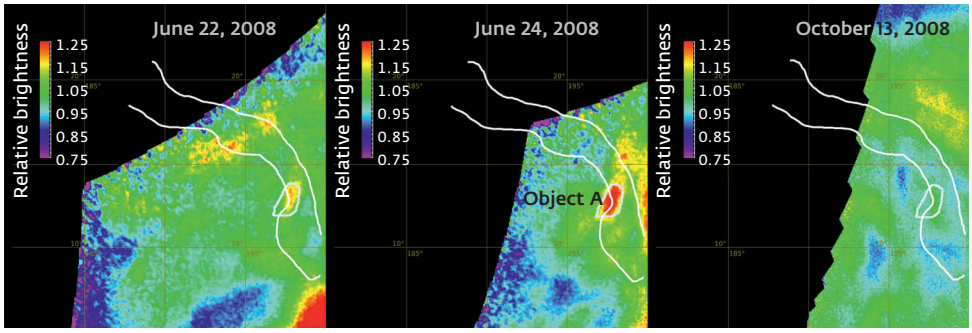


The KR2 complex, viewed from the side. Each of the five KR2 molecules binds and transports a sodium ion (purple). The pump activity is controlled by the small, light-activated retinal molecules (outlined in white).

Hot Lava Flows on Venus

Using a camera on board the *Venus Express* space probe, scientists discover strong evidence of active volcanism

Venus is considered to be Earth's sister: the two planets are nearly identical in size and have similar interior compositions. Scientists thus consider it likely that our neighbor has a hot core. This heat has to escape somehow, and one possibility is that it does so in the form of volcanic eruptions. For instance, a cataclysmic flood of lava may have completely changed the surface of Venus around 500 million years ago. But is the planet still volcanically active today? An international team headed by the Max Planck Institute for Solar System Research has now presented the best evidence to date that it is. The scientists analyzed measurement data from the ESA's *Venus Express* space probe and identified, on photos taken in 2008, four regions whose temperatures had increased drastically within just a few days. The team estimated that the smallest of these hotspots measures approximately one square kilometer and has a temperature of around 830 degrees Celsius. For comparison, the global average surface temperature is 480 degrees Celsius. (Geophysical Research Letters, published online, May 2015)



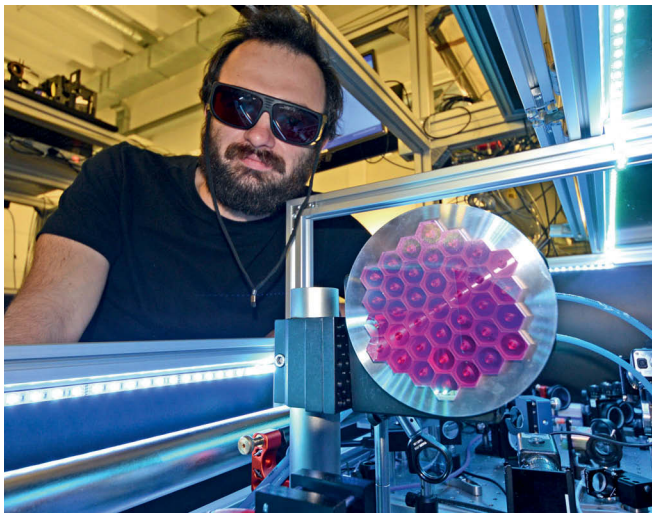
Tracks on the surface: The maps show changes in relative brightness in the Atla region, where the Ganiki Chasma rift zone is located. The images were captured on three different days. Red and orange indicate an increase, blue and green a decrease in brightness. One area, "Object A," shows a distinct increase on June 24, 2008.

Photos: Forschungszentrum Jülich/IBS Grenoble (top), E. Shalygin et al. (2015) (bottom)

A New X-Ray Source for Medicine

A light source for hard, brilliant X-rays makes even tiny structures in material visible

Bone fractures, tumors or arteriosclerosis – doctors today use X-ray examinations to detect numerous diseases. And X-ray images could soon provide even more information. Physicists at Ludwig-Maximilians-Universität (LMU) in Munich and the Max Planck Institute of Quantum Optics are now producing particularly brilliant X-ray light with sharply defined but variable wavelengths in a relatively compact device. They use extremely intense laser pulses to force electrons from gaseous hydrogen atoms onto a wave band, causing the particles to emit the desired light. This X-ray radiation makes it possible to resolve structures measuring little more than 10 micrometers and having various compositions – and this can be done not only in the field of medicine, but also in biology and materials science. Previously, radiation of the quality needed for this could only be produced in large and expensive synchrotron facilities. (Physical Review Letters, May 14, 2015)



Using laser light to produce X-ray flashes: Konstantin Khrennikov and his colleagues use the ATLAS laser system at Ludwig-Maximilians-Universität to produce brilliant X-ray light.

Shorter Lives for the Bold

Differences in personality influence survival in field crickets

A cricket in front of its burrow. For identification, the researchers marked it with a painted spot on its back.

Humans have a distinct personality: they are fearful, bold, cautious or adventurous. Animals have these traits, too. Researchers at the Max Planck Institute for Ornithology in Seewiesen have now found differences in risk behavior, and thus potentially different personalities, among individuals in a population of wild field crickets. They marked all crickets within a fenced-in meadow area and studied their behavior. One criterion for risk tolerance was the minimum distance at which the animals initiate escape when a potential threat approaches. The analyses showed that the crickets vary widely in their individual flight initiation distance and how far they are willing to venture from their burrows. It's not yet entirely clear whether boldness offers advantages with regard to searching for food or a partner, but it definitely also has disadvantages: bold field crickets die younger than less daring individuals, as predators such as shrews and birds prey on them more frequently. (Behavioral Ecology, April 22, 2015)

In Sync with the Leader

A person who says the right thing at the right time frequently becomes the leader of a group

Great leaders are often also great communicators. A special connection develops between leaders and their followers: according to scientists at the Max Planck Institute for Human Cognitive and Brain Sciences in Leipzig, the leader's so-called temporoparietal junction between the temporal and parietal lobes of the cerebral cortex begins to synchronize with the same brain region in their followers. In other words, the rhythms of the leader's and the group's brain activity begin to match.

The temporoparietal junction is important for empathy and for understanding others' mental states. Based on the brain activity, the Max Planck researchers even predicted who a group would elect as its leader, and when. According to their findings, the synchronization of the brain activity is based more on leaders' communication skills and less on how much they talk. The researchers therefore conclude that, among a group of peers, the individual who says the right thing at the right time usually emerges as the leader. (PNAS, March 23, 2015)

Photos: Thorsten Naeser (top), MPI for Ornithology/ P. Niemelä (bottom)

Diversity in Bloom

The forests of the Indo-Pacific region are as rich in tree species as the tropics in the Americas

There may be more species in the tropical forests of the world than previously thought, namely between 40,000 and 53,000. This was determined by an international team, of which Florian Wittmann, a researcher at the Max Planck Institute for Chemistry, was also a member, through counts at 207 locations in 43 countries, and subsequent extrapolations. Various estimates of the number of tropical tree species previously ranged between 37,000 and 50,000 species. The new result thus ranges in the upper end of these assumptions. What surprised the researchers most in the current study was that they found just as many tree species – 19,000 to 25,000 – in the tropical forests of the Indo-Pacific region as in the forests of Central and South America. They had previously assumed that the number of species there would be much lower. By comparison, there are just 124 different tree species in Central Europe. Florian Wittmann assumes that the current survey can serve as the basis for protection programs.

(Proceedings of the National Academy of Sciences, June 1, 2015)

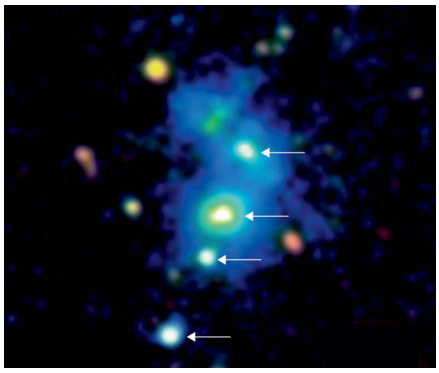
Riverbanks in the Brazilian rainforest are characterized by many different tree species. The forests of the Indo-Pacific region are just as rich in species as the American tropics.

Quasar Quartet Puzzles Scientists

Astronomers must rethink models of the development of large-scale cosmic structures

A quasar is like a cosmic power plant that is driven by the impact of matter on a massive black hole. The active stage lasts only about 10 million years. In this phase, such a galaxy nucleus is among the brightest objects in the universe. Now, using the 10-meter Keck telescope, astronomers working with Joseph Hennawi from the Max Planck Institute for Astronomy have discovered not just one, but four quasars in direct proximity to one another. The quartet resides in one of the most massive structures ever discovered in outer space, and is surrounded by a giant cloud of cool gas – the Jackpot Nebula. Its properties don't match at all with how scientists imagined the early universe. For instance, the models predict that massive structures from that time should be filled with extremely rarefied gas and have temperatures of around 10 million degrees. The gas in the Jackpot Nebula, by comparison, is a thousand times denser and a thousand times colder.

(Science, May 15, 2015)



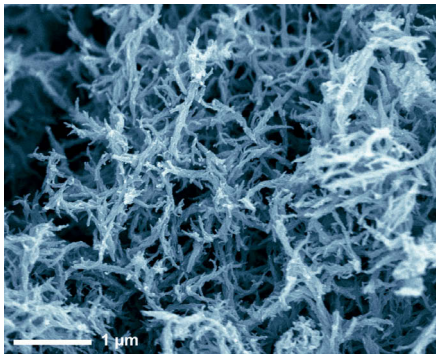
Rare find: This image shows the region in space with the quadruple quasars. The four quasars are indicated by arrows. The nebula in which the quasars are embedded is visible as a hazy, bluish structure. It has an expanse of around one million light-years. The quasars and nebula are so far away that their light takes about ten billion years to reach Earth.

Photos: Michael Welling/MPI for Chemistry (top), Arrigoni-Battaia & Hennawi/MPI for Astronomy (bottom)

Customized Carbon

Nanoparticles made from carbon could be used to store gases, or to produce hydrogen – scientists at the Max Planck Institute of Colloids and Interfaces in Golm, near Potsdam, can now give them the appropriate form and chemical composition for these uses. The researchers selectively produce nanoparticles having a spherical, sheet-like or fibrous structure by injecting various organic – that is, carbonaceous – liquids into a hot salt melt, such as zinc chloride. If necessary, they can incorporate metal or other foreign atoms into the particles by introducing appropriate substances. For technical applications, the versatile recipe is useful for synthesizing the nanoparticles, because their properties are highly dependent on their structure and composition. Until now, carbon nanostructures were produced by carbonizing solid substances, but this produces only spherical particles. Carbonizing liquids was deemed to be impossible. Initial tests showed that nickel-containing nanostructures created in this way are useful as catalysts for the electrolytic production of hydrogen from water. And they're more cost-effective than the noble-metal-based catalysts currently used for this. In some nanostructures, the researchers were also able to store large quantities of gas in relation to the mass of the nanoparticles.

(Angewandte Chemie International Edition, published online, March 4, 2015)

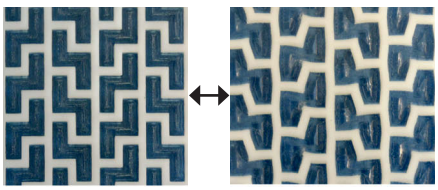


Fibrous and other nanostructures can be selectively produced by carbonizing various organic solvents in hot salt melts.

Actuators That Mimic Ice Plants

Engineers developing moveable robot components may soon take advantage of a trick that plants use. Researchers at the Max Planck Institute of Colloids and Interfaces in Potsdam and Harvard University in Cambridge (USA) have now presented a polymer material with a cellular structure that could be used as an actuator – that is, an actively movable component. The cells are designed in such a way that, when they are swelled by a liquid or compressed air, the structure expands in only one direction. In this way, the researchers mimic the purely physical mechanism by which the coverings of ice plant seed capsules open and close. The researchers at the Max Planck Institute of Colloids and Interfaces had clarified this movement mechanism in 2011. Movable components based on a similar design as the newly presented actuators could give robots particularly natural movement properties.

(Advanced Materials Interfaces, June 26, 2015)



The actuator developed by the Max Planck researchers consists of polymer cells made of non-swellable walls and a swellable interior. When the chambers absorb a liquid, the structure expands in one direction.

Gene Pattern Betrays the Culprit

After an infection with *Helicobacter pylori*, gene activity in the gastric cells resembles the activity of cancer cells

Around half of the global population is chronically infected with the stomach bacterium *Helicobacter pylori*. Around 1 percent go on to develop gastric adenocarcinoma – one of the deadliest forms of cancer. *Helicobacter pylori* can contribute to the development of stomach cancer. Scientists at the Max Planck Institute for Infection Biology in Berlin have now analyzed the genetic changes that occur in the genome of gastric cells soon after a Helicobacter infection.

Whereas cancer-causing radiation or chemicals cause random DNA damage, according to the scientists in Berlin, this pathogen damages the genome in a specific pattern. Over the course of the infection, *Helicobacter* turns off several genes that repair DNA segments. The researchers also determined that particularly active genes and genes located in regions near the edges of chromosomes are more likely than other genes to be damaged after infection. This mutation pattern resembles that of stomach cancer, underscoring the fact that *Helicobacter* plays a role in the development of this form of cancer.

The only other cancer that shows a similar genetic fingerprint is prostate cancer. The development of this type of cancer also involves a bacterium, *Propionibacterium acnes*. Genetic fingerprints of infections may thus even provide indications for bacterial pathogens as the cause of other cancers.

(Cell Reports, June 11, 2015)

Photos: MPI of Colloids and Interfaces (top), Acvanced Materials Interfaces / MPIKG (bottom)