

PHOTO: SOUTH AFRICAN RADIO ASTRONOMY OBSERVATORY (SARAO)



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Tuned in to space: the MeerKAT radio observatory currently consists of 64 telescopes, with 20 more to be added.

LISTENING TO CELESTIAL RADIO

It is the largest, most sensitive radio telescope in the southern hemisphere: 64 individual, dish-shaped antennas – each 13.5 meters in diameter – are tuned in to space from South Africa to allow researchers to investigate distant radiation outbursts with the same precision as pulsars or interstellar clouds in our own Milky Way. One of the important receiver systems for this gigantic “ear”, which goes by the name of MeerKAT, comes from

the Max Planck Institute for Radio Astronomy in Bonn. The Max Planck Society is providing a further EUR 20 million for the construction of 20 additional antennas. Max Planck President Martin Stratmann believes that the MeerKAT project is “a milestone in radio astronomy”. This branch of astronomical research uses radio waves emitted by objects in space as a means to explore the universe. Here the sensitivity of the tele-

scopes is a vital factor in the quality of the observations. Factors such as the accessibility of various celestial regions, time and frequency resolution, and the speed at which the firmament is mapped also play an important role. Thanks to its unique location in a semi-desert region of Karoo, the system is only slightly affected by terrestrial interference radiation, which means that its sensitivity can be fully utilized.

www.mpg.de/15382572

Under observation: a team in Bochum has investigated which words activate the language assistants in the networked loudspeakers produced by major manufacturers.



EAVESDROPPERS IN YOUR LIVING ROOM

It appears that networked loudspeakers with language assistants from Google, Amazon and Apple send snippets of conversation to the manufacturers more often than they should. A team from the Max Planck Institute for Cyber Security and Privacy Protection and the Ruhr-Universität Bochum has identified more than 1,000 English, German and Chinese words that unintentionally activate these language assistants and establish a connection with an Internet server. They are only supposed to react to “OK, Google”, “Alexa” and “Hey Siri”, but the networked loudspeakers were also activated by the words “OK, cool”, “on Sunday” and “daiquiri”. The systems are always listening, but only store the audio data locally for a brief time unless the applicable terms are used, prompting them to answer a question by accessing the Internet. If the systems mistakenly think they are being addressed, they transmit a brief sequence of what has been said to the respective manufacturer. The companies then search these audio segments for phonetic sequences that unintentionally start their systems – sometimes without the user’s knowledge – in order to make the speech recognition more reliable.

www.mpg.de/15183736

PHOTO: MAXIMILIAN GOLLA/MPI FOR CYBER SECURITY AND PRIVACY

A SPARKLING RING IN SPACE

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In the center of the giant galaxy Messier 87 lurks a gigantic black hole. The image of this mass monster, obtained using the Event Horizon Telescope (EHT) in 2017 and published last year, went around the world. The EHT team, which includes researchers from the Max Planck Institute for Radio Astronomy, has now analyzed a quantity of archive data, some of which have not yet been published. Observations dating from the years 2009 to 2017 show that the black hole in M 87 meets expectations: the shadow remains constant, and its diameter is consistent with the predictions set out in Einstein’s general theory of relativity for a black hole of 6.5 billion solar masses. Nevertheless, the data were hiding a surprise. This relates to a region farther away, where the shadow is surrounded by a disc of hot gas. In the EHT image, it appears as a bright ring – which over time seems to glitter. This appears to be caused by matter that falls onto the black hole, heats up to several billion degrees, and then becomes turbulent due to the presence of magnetic fields.

www.mpg.de/15424512

Snapshot images of the black hole in galaxy M 87 based on observations and geometric modeling. While all the rings are similar in diameter, the location of the most powerful radiation emission varies.

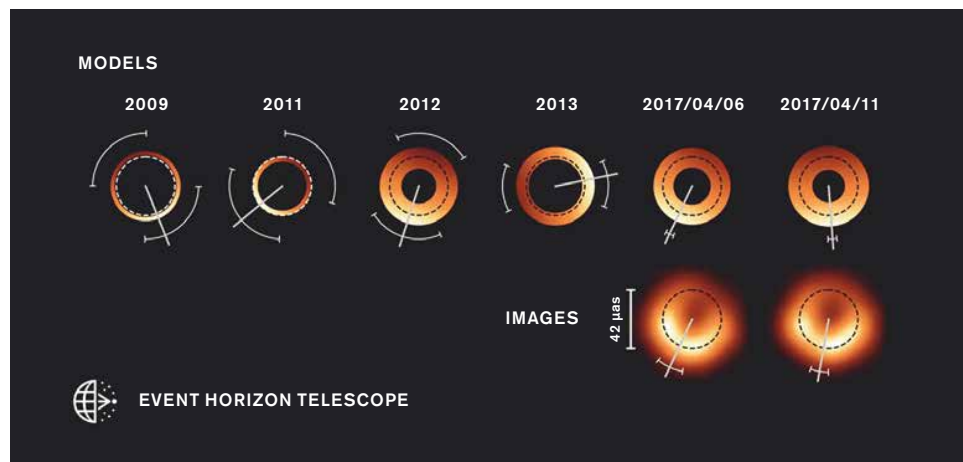


IMAGE: M. WIELGUS & EHT COLLABORATION

ANIMALS WITH A SIXTH SENSE

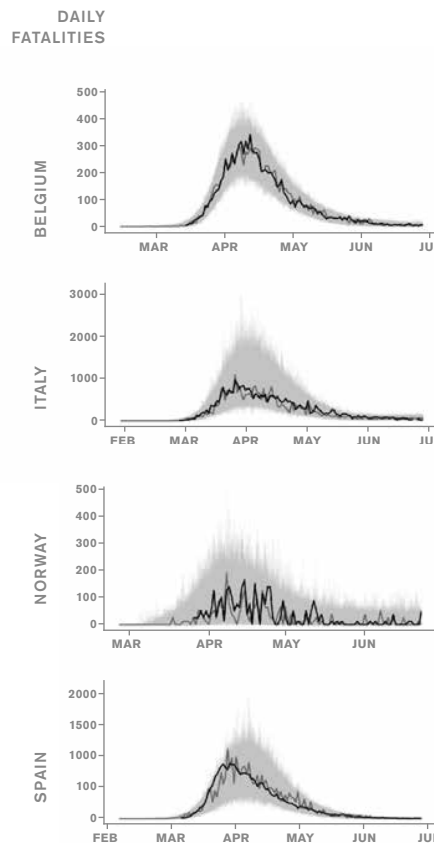
PHOTO: MPI OF ANIMAL BEHAVIOR / MACCINE / USCHI MUELLER

Throughout history, earthquakes have repeatedly wreaked havoc on humanity and wiped out entire civilizations. Even today, nobody can reliably predict when and where the next earthquake will occur. However, researchers from the Max Planck Institute of Animal Behavior and the University of Konstanz have now proved that domestic animals can detect even early signs of earthquakes. In an earthquake-prone region of Northern Italy, they fitted cattle, sheep and dogs with accelerometers and recorded their movements over several months. During this period, there were twelve earthquakes measuring four or higher on the Richter scale, as well as numerous small, barely perceptible quakes. In some cases, the researchers observed unusual behavioral patterns among the animals as early as 20 hours before a quake. Moreover, the closer the animals were to the epicenter of the impending quake, the earlier they changed their behavior. However, these behavioral changes were only statistically significant when the researchers evaluated all the animals collectively. In other words, their abilities are more easily recognized when studied collectively than when each animal is studied individually. It is still unclear how animals sense impending earthquakes. They may sense the ionization of the air caused by the intense rock pressure in earthquake zones through their fur. It is also conceivable that animals smell gases released from quartz crystals before a quake. A system that evaluates real-time data measured since December 2019 shows what an animal earthquake early warning system could look like. An alarm is triggered as soon as the sensors detect a marked increase in animal activity over periods of 45 minutes or more. This system has already issued one warning: a small quake shook the region three hours later.

www.mpg.de/15126191



A living early warning system: sensors on collars like that worn by the cow in front measure the motion profiles of farm animals and pets. Restlessness indicates that an earthquake is imminent.



Reality and simulation of the coronavirus pandemic: the black line shows the actual daily fatalities, while the dark gray line traces a single prediction. The predictions determined by the model are shown in light gray.

FLU INCREASES SUSCEPTIBILITY TO COVID-19

The flu epidemic this coming fall and winter will intensify the coronavirus pandemic. This conclusion was drawn by researchers at the Max Planck Institute for Infection Biology and the Institut Pasteur in Paris. They used a mathematical model to investigate the first months of the coronavirus pandemic in Europe and model its progression in Belgium, Norway, Italy and Spain – four European countries that experienced the pandemic with differing degrees of severity during the first half of the year. The simulations showed that the decrease in the number of Covid-19 cases in the spring was not only the result of countermeasures but also coincided with the end of the flu season. Influenza thus increased the coronavirus transmission rate by an average of 2.5 times. Based on these results, the team has concluded that flu vaccinations could reduce the risk both of influenza and of Covid-19 infection.

www.mpg.de/15373608

GRAPHICS: MPI FOR INFECTION BIOLOGY

LIVE LONGER IN SOUTHERN GERMANY

People in Baden-Wuerttemberg and southern Bavaria are most likely to live to a ripe old age. This has been shown in calculations made by Roland Rau and Carl Schmertmann from the Max Planck Institute for Demographic Research. Average life expectancy varies by more than five years in men and almost four years in women depending on the district in which they live. In the Salzland district of Saxony-Anhalt, for example, women only reach an average age of 81.8 years, while in the Starnberg region they live to be 85.7 years. There is also a marked north-south divide among the men: in Bremerhaven, they only live to be 75.8 years on average, while on the rural out-

skirts of Munich, they reach the age of 81.2 years. In all, most of the regions with lower life expectancies are located in eastern Germany. Yet even in western regions of Germany, particularly in the Ruhr district, there are areas where people are more likely to die at a younger age. According to the study, life expectancy in any given region is most affected by the unemployment rate and percentage of Hartz IV (unemployment benefit) recipients. In contrast, frequently debated factors such as average income, population density and the number of doctors per 100,000 inhabitants play a much less important role.

www.mpg.de/0320201en

COVID-19 RISK GENE COMES FROM NEAN- DERTHALS

One of the factors that influences the severity of a Covid-19 infection is the individual's genetic predisposition. Patients with a certain variant of a multi-gene cluster on chromosome 3, for example, are three times more likely to be treated in hospital and to require artificial respiration. Researchers from the Max Planck Institute for Evolutionary Anthropology in Leipzig have now discovered that the DNA sequence in these patients is similar to that in the Neanderthals. The scientists say that modern humans inherited the sequence from the Neanderthals when they interbred around 60,000 years ago. It is not yet clear why people with this gene variant are more severely affected by the disease. The risk variant is most widespread in South Asia, where around half of the population carry the Neanderthal variant in their DNA. In Europe, on the other hand, it is carried by only one in six people.

www.mpg.de/15451493

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FERTILIZATION ACCELERATES CLIMATE CHANGE

So far, too little attention has been paid to an important aspect of climate protection: agriculture also contributes significantly to the emission of greenhouse gases. The concentration of nitrous oxide (N₂O) in the atmosphere, for example, has risen at an ever-increasing rate in recent decades. According to an extensive study conducted by an international team including Sönke Zechle, Director of the Max Planck Institute for Biogeochemistry, it is now around 20 percent higher than pre-industrial levels. This is more than climate researchers had assumed in even their most pessimistic forecasts. One important factor in this increase is the growing use of nitrogen fertilizers worldwide. In Europe, however, nitrous oxide emissions from agriculture are declining because European farmers are using fertilizer more efficiently. The greenhouse effect of nitrous oxide is about 300 times stronger than that of carbon dioxide. This means that despite its relatively small proportion in the composition of the air, nitrous oxide currently contributes about seven percent to hu-

man-induced global warming. Current scenarios indicate that if the global community does not succeed in curbing the rise in nitrous oxide emissions, restrictions on emissions of other greenhouse gases will have to be tightened even more than currently planned if the agreed climate goals are to be achieved.

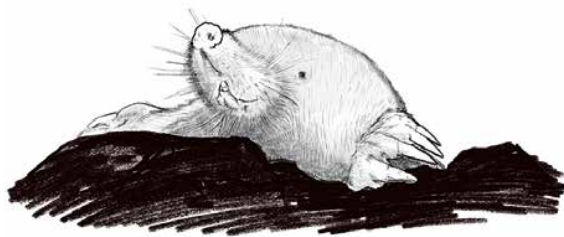
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Agriculture as a climate factor: nitrous gas emissions have risen worldwide in recent decades, primarily due to increased fertilization.



PHOTO: PICTURE ALLIANCE / DPA | ULI DECK

ILLUSTRATION: HENNING BRUER



The Iberian mole (*Talpa occidentalis*) is common in Spain and Portugal. Elevated levels of male sex hormones cause the females to develop powerful muscles and testicular tissue.

GENDER DEBATE AMONG MOLES

Moles may look cute, but they are true powerhouses and remarkably aggressive towards other members of their species. They also have an extra digit on each front paw that enables them to burrow more efficiently. Female moles have yet another anomaly: they are intersexual, i.e. they possess characteristics of both sexes, and have both ovarian and testicular tissue. The testicular tissue does not manufacture sperm, but produces almost as much testosterone as in the males. This natural “doping” helps the females burrow deep into the earth and fight for scant resources underground. Re-

searchers from the Max Planck Institute for Molecular Genetics in Berlin working with colleagues from the Charité and the Helmholtz Association have now identified the genetic sequences and mechanisms for the production of testicular tissue and male sex hormones in female Iberian moles. Regulatory sequences for the gene *CYP17A1*, which is responsible for hormone production, are for example present in triplicate. This enables the females to produce more testosterone. These findings testify to the wide spectrum of sexual phenotypes that occur in nature.

www.mpg.de/15476613

Unique diversity: the exhibit displays the skulls of various mammalian species that settled in southeast Asia 100,000 years ago as the tropical forests spread across the region.



PHOTO: JULIEN LOUYS

SAVANNAH INSTEAD OF TROPICAL FOREST

Southeast Asia, which is now known for its lush rainforests, was for some time covered by vast expanses of grassland. According to a study by the Max Planck Institute for the Science of Human History and the University of Griffith (Australia), during the early part of the Pleistocene era, rainforests dominated the area extending from modern-day Myanmar

to Indonesia but gradually began giving way to grassland some 1.25 million years ago. The grassland reached its maximum extent around one million years ago and became the habitat for numerous species of large grazing mammals, such as the elephant-like stegodon, which was hunted by hominins closely related to homo sapiens and thus played a significant

role in their survival. However, this change didn't last long. The rainforest began to return around 100,000 years ago, as numerous species of megafauna died out. Early humans such as *Homo erectus* were also unsuccessful in adapting to the tropical forest as a habitat.

www.mpg.de/15479583



A female specimen of the deep-sea anglerfish species *Melanocetus johnsonii* has a male fused to her belly. While the female is around eight centimeters in size, the male only grows to a length of two-and-a-half centimeters.

HOOKING UP WITH FOREIGN BODIES

Searching for the right partner is not always easy – especially if you live in the vast expanses of the deep ocean. Anglerfish have found a unique solution to this problem: once one of the tiny males has found a female, it permanently attaches itself to its much larger mate. The male's body taps into the female's bloodstream, which from then on supplies him with nutrients. Until now, it was not known how the male managed to circumvent the female's immune system, which ought to reject it as a foreign body. Researchers from the Max Planck Institute of Immunobiology and Epi-

genetics in Freiburg and the University of Washington in Seattle have now found out that the fish only use one of the two available immune defense mechanisms: they have no acquired immune response, instead protecting themselves against infection by means of enhanced innate defenses. In humans, loss of acquired immune response would lead to a fatal immunodeficiency. Knowledge of the immune system of anglerfish could help strengthen innate immunity in humans and thus help patients with immunodeficiency.

www.mpg.de/15212439

TURBO CHARGE FOR PHOTO-VOLTAICS

At present, the material of choice for solar cells is silicon, yet that could soon change. Researchers are working on replacing the element in photovoltaic components with perovskite compounds to make photovoltaic systems more efficient and cost-effective. An international team led by Stefan Weber from the Max Planck Institute for Polymer Research in Mainz has now observed that an electrical charge moves more than 50 percent faster when it is flowing parallel to the striated microstructures in perovskite crystals than when it is moving perpendicular to them. Purposeful alignment of these electron highways, known to specialists as ferroelastic twin domains, with the electrical contacts of perovskite solar cells could make the cells even more efficient. These cells are already generating energy more efficiently in the laboratory than conventional solar cells made of silicon. However, perovskite solar cells currently contain the toxic heavy metal lead, and are not yet sufficiently moisture-resistant for practical use. Scientists are attempting to remedy these defects as well.

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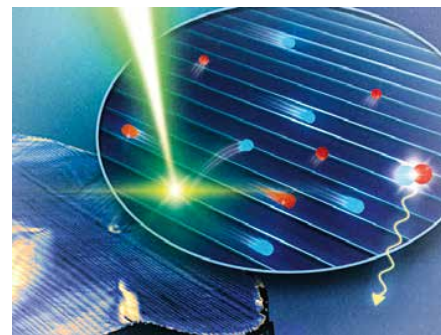


IMAGE: MPI FOR POLYMER RESEARCH

Charges generated by light are transported more quickly when they move parallel to striated microstructures in perovskite solar cells than when they are perpendicular to them.

CRYOVULCANISM ON CERES

Until around one million years ago, the dwarf planet Ceres – the largest body in the asteroid belt – was home to active ice volcanoes. Brine surged up from layers deep below the Occator Crater and erupted onto the surface. The water then evaporated and left behind bright, salty deposits. This process is probably still ongoing, albeit no longer in the form of violent eruptions. A team led by the Max Planck Institute for Solar System Research came to this conclusion after evaluating images from the American space probe Dawn. The surprising discovery thereby: the chunks in the asteroid belt are commonly believed to be simply structured, waterless, in-

active bodies, but Ceres, with a diameter of approximately 950 kilometers, turned out to be an exception. The findings indicate that remnants of a global, salty ocean are located around 40 kilometers below the Occator Crater. But why does the water rise to the surface in that area? This is probably due to the impact that once formed the crater. It caused a release of pressure, and the gases dissolved in the water and bubbled up in a manner similar to the opening of a champagne bottle. However, researchers are still puzzled as to why the water has remained liquid and relatively warm to this day.

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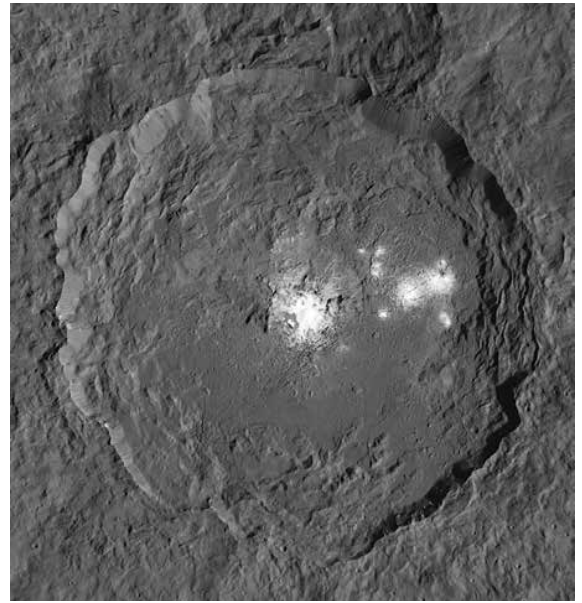
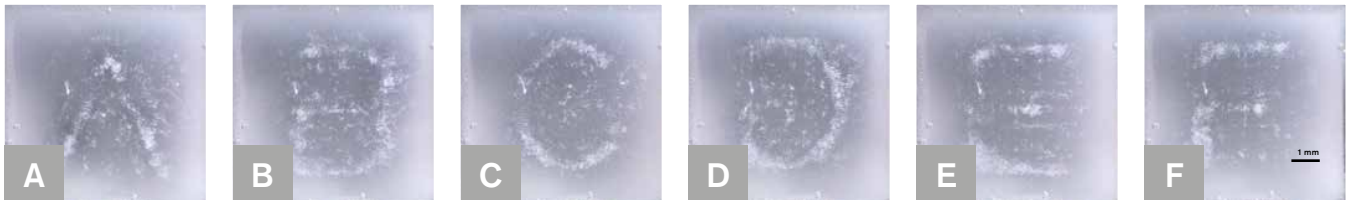


PHOTO: NASA / JPL-CALTECH / UCLA / MAX PLANCK INSTITUTE FOR SOLAR SYSTEM STUDIES / GERMAN AEROSPACE CENTER / IDA / PLANETARY SCIENCE INSTITUTE

A long history: brine erupting from deep within the dwarf planet Ceres over millions of years gave the Occator Crater its modern-day shape.



A slide show with ultrasound: researchers in Stuttgart are making ultrasound profiles visible by using sound pressure to capture microparticles. This enables them to write the alphabet using microparticles and sound, for example.

USING ULTRASOUND TO FIGHT TUMORS

Ultrasound is widely utilized as a diagnostic tool in medicine and can also be used to treat tumors. In doing so, the diseased tissue is specifically targeted and heated to destroy the cancer cells. The sound pressure profile has to be precisely shaped to avoid damaging healthy tissue. Researchers worldwide are using ultrasound to combat tumors and other pathological changes, for example in the brain. This is more difficult in the brain, since the cranium distorts the sound wave. A team from the Max Planck

Institute for Intelligent Systems and the University of Stuttgart has now developed a projector that can flexibly model three-dimensional ultrasonic fields with comparatively little technical effort, while forming more intensive sound pressure profiles with higher resolutions than is possible with the technology commonly used at present. For this purpose, the team has constructed a chip with 10,000 individually-controlled electrodes upon which they can electrolytically produce any desired pattern of hydro-

gen bubbles within a thin film of water. The gas bubbles block the ultrasonic waves, which means that the bubble pattern serves as a mask for the ultrasound. This means that when an ultrasonic wave passes through a chip that is partially covered with gas bubbles, a corresponding ultrasound profile is created. The bubbles can easily be removed and a new pattern generated. In the future, this could make it easier to tailor ultrasound profiles to individual patients.

www.mpg.de/15488241