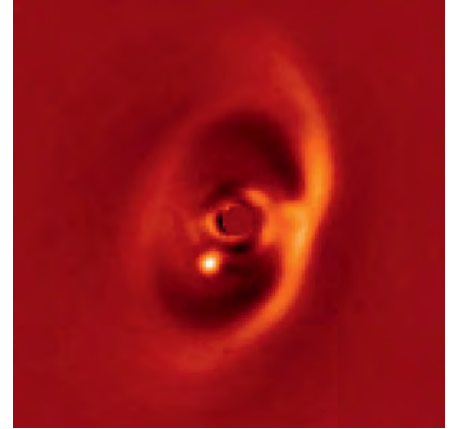


Birth of a planet

A detailed image shows the young celestial body PDS 70b in the midst of a circumstellar disk

Researchers have so far identified more than 3,800 exoplanets orbiting alien suns. Now, they have discovered an extremely young member of this class of planets: the object PDS 70b is located in the gas and dust disk surrounding its mother star, PDS 70 and thus in the environment where it was born. The planet therefore offers a unique opportunity to test models of planet formation and to learn about the early history of our solar system. Located some 370 light years from Earth, the celestial body was tracked down by a team working with doctoral student Miriam Keppler of the Max Planck Institute for Astronomy using an instrument at the Very Large Telescope in Chile. The images show an extended gap in the circum-

stellar disk of the star PDS 70: presumably, the young giant planet is still accumulating material and, over time, clearing a vast area as it orbits its mother star once every 120 years. With several times the mass of Jupiter, PDS 70b is encircled by clouds and has a temperature of just under 1,000 degrees centigrade. Furthermore, the separation of 22 astronomical units (equal to 22 times the distance between the Earth and the Sun) confirms the theory that gas giants such as Jupiter are formed at a relatively large distance from their central star. (www.mpg.de/12136833)



Cosmic birth: this image, captured using the Very Large Telescope, shows the protoplanetary disk around the star PDS 70. The young exoplanet PDS 70b is clearly visible as a bright spot at the inner edge of the gap (dark area). The emission from the central star is not shown.

Neutrino from a remote galaxy

MAGIC telescopes have detected the origin of a particle that appears to come from the black hole of a blazar

Astrophysicists from the Max Planck Institute for Physics and colleagues have succeeded for the first time in locating the source of a high-energy cosmic neutrino. It is very likely that it comes from a blazar, an active black hole in

the center of a distant galaxy in the constellation of Orion. Neutrinos are difficult to detect. The largest detector in the world, which goes by the name of IceCube, only detects about 200 of these particles per day, most of them originating from the Sun. On 22 September 2017, IceCube detected a neutrino that was special: its very high energy of roughly 290 teraelectronvolts indicated that the particle might have traveled here from a distant source. Moreover, scientists were able to identify its incoming direction with a high degree of precision, demonstrating that the particle originated from the blazar TXS 0506+056, which is approximately 4.5 billion light years away. The object also emits gamma rays in the very high energy region of at least 400 giga-electronvolts, according to observations made using the two MAGIC telescopes on the Canary Island of La Palma. This is another indication that the neutrino captured by IceCube actually came from the blazar. (www.mpg.de/12131369)



Eyes into space: the two MAGIC telescopes provided valuable information about the course of a high-energy neutrino, which originated from the distant blazar TXS 0506+056.

An eye for character

A new computer system uses artificial intelligence to identify people's personality traits based on their eye movements

Computers are gradually learning to interpret human behavior – and can now also do so by analyzing the way people use their eyes. A team led by researchers from the Max Planck Institute for Informatics has developed a software system that can recognize a person's character traits by using artificial intelligence to evaluate their eye movements. The technique analyzes how neurotic, agreeable, extrovert, and conscientious the test subjects are. These four factors are an essential part of how psychologists gauge a person's character. In addition, the software determines how curious a person is. People also tend to make subconscious assessments of character on the basis of visual behavior. The character studies produced by the Saarbrücken researchers' software are not yet reliable enough for practical applications. However, with more extensive training data, they should become significantly more accurate and could then help to make cooperation between humans and computers more social, efficient, and flexible. (www.mpg.de/12185266)

Self-healing seed pods

In plants of the Australian genus *Banksia*, special waxes seal small fissures in the fruit wall

Some Australian plants need a lot of patience when it comes to propagation – and their seed pods must be able to repair themselves. Seeds of some species of *Banksia* remain in their lignified two-part pods for up to two decades before being released during bush fires. *Banksia* is a genus of evergreen plants that are only found in Australia. Some species use their fiery opening mechanism to ensure that the seeds encounter the perfect conditions for germination. In order for the seeds to remain intact over the long period beforehand despite changing weather conditions, it is possible that a self-healing mechanism prevents permanent damage to the seeds. Researchers at the Max Planck Institute of Colloids and Interfaces in Golm, Potsdam, suspect that this may be the purpose of waxes found at the seam between the two halves of the pod. Their analyses show that the waxes are irrelevant once the pods open. However, they melt at temperatures of 45 to 55 degrees centigrade, which are reached in some areas of Australia in summer. The researchers therefore hypothesize that the waxes patch up small fissures in the pods. (www.mpg.de/12123073)

Photo: MPI for Evolutionary Biology/M. Schwarz

Egg cell seeks sperm

Female gametes prefer sperm cells with different immune genes

Through clever selection of a particularly suitable partner, animals can increase the future success of their offspring. In some species, this selection process appears to continue even after the sex act: researchers at the Max Planck Institute for Evolutionary Biology in Ploen have discovered that the egg cells of a stickleback have a say in which sperm fertilize them. They seem to make their decision based on the sperms' immune genes – or rather based on the major histocompatibility complex (MHC). A complex consisting of many different gene variants leads to a strong immune system. For a highly varied gene complex, an egg cell must therefore merge with a sperm that possesses complementary gene variants. Indeed, the researchers' experiments show that sperms whose MHCs differ from that of the egg cell have the highest chance of fertilization. Researchers do not yet know how the egg selects the sperm. Given that selecting the correct immune genes has played an important role in human evolution, it is also possible that human egg cells are involved in choosing their partner during fertilization. (www.mpg.de/12308867)

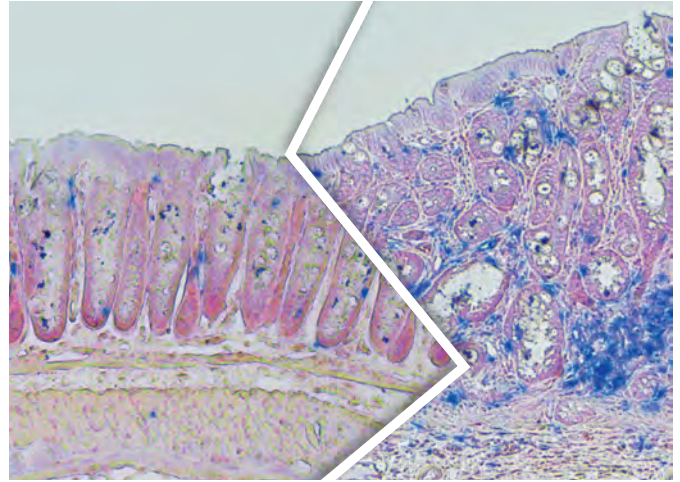


A male stickleback displaying courtship colors. In this species, the females choose their mating partners carefully. However, a female stickleback cannot be sure that her offspring will receive the best immune genes, because each sperm contains only one of the two gene variants of a fish. The egg cells have therefore found a way to select a sperm with suitable immune genes.

Fatty tissue causes stress

Researchers clarify the relationship between excess weight and bowel cancer

Overweight people have a higher risk of developing bowel cancer. According to scientists from the Max Planck Institute for Metabolism Research in Cologne, this may be partly due to a stress response in fatty tissue when the body is required to store an ever-increasing amount of excess fat. Persistent excess weight therefore puts the body in a permanent state of stress. This raises the alarm for the body's immune defenses, which trigger inflammation in the fatty tissue and ultimately throughout the body. As a result, the immune cells are reprogrammed so that they no longer combat the cancer cells repeatedly developing in the body, but rather aid their survival and thereby support tumor growth. The researchers also tested potential new treatment approaches on mice: they eliminated some of the immune cells and modified the animals' genetic make-up so that immune cells could no longer be reprogrammed despite a fatty diet. In both cases, the inflammation subsided in the mice's fatty tissue, and the immune system began to combat the cancer cells again. (www.sjf.mpg.de/1871353)



Colon tissue from thin (left) and overweight mice (right). The latter shows more immune cells (blue) and tumors.

Early dentistry for horses

More than 3,000 years ago, Mongolian herders removed problematic teeth from young animals

Members of a Mongolian pastoral culture from the period between 1300 and 700 BC are thought to have been the first people to practice dentistry on horses. This is the con-

clusion reached by an international team of researchers working under William Taylor of the Max Planck Institute for the Science of Human History in Jena. By analyzing rem-

nants of skulls from almost 30 archaeological sites associated with this culture, the scientists showed that the herders began removing painful teeth from young animals in around 1150 BC. Dentistry for horses appears to have emerged in parallel to the introduction of bronze and iron snaffles, which allowed humans to achieve more nuanced control of horses as animals used for riding. However, the use of these mouthpieces led to pain in what are known as the "wolfteeth" – vestigial teeth that develop in the jaws of some horses. This led the herders to develop a method for removing these problematic teeth – similar to the way veterinary surgeons remove them today. The ability to treat this problem was an indirect prerequisite for the settlement of new areas of Eurasia by horse-mounted peoples from the first millennium BC onward. (www.mpg.de/12120068)



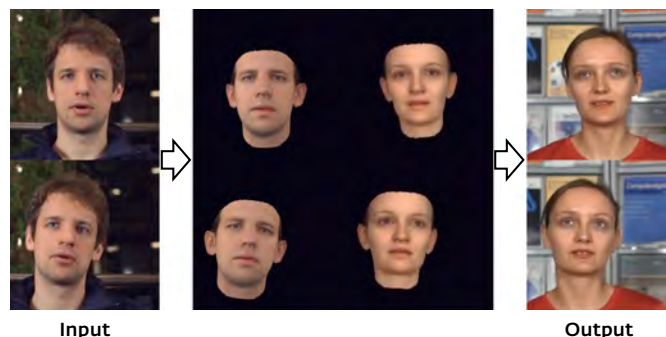
The root of the problem: a healthy set of teeth is important in horses so that the mouthpiece of the bridle does not cause the animals pain.

A puppet show with facial expressions

A new piece of software adapts the facial expressions of people in videos to match a translation dubbed over the film

Dubbing films could become significantly easier in the future. A team led by researchers from the Max Planck Institute for Informatics in Saarbruecken has developed a software package that can adapt actors' mouth movements and complete facial expressions to match the film's translation. This removes the need to coordinate the spoken words with the video. To synchronize an actor's facial expressions with the sound, the researchers use a 3D model of the face and artificial intelligence (AI) methods that allow the software to derive realistic movements of the actor's face that correspond to the dialog. The technique could save the motion picture industry a considerable amount of time and money when it comes to dubbing films in the future. It can also boost the impression of a natural conversation setting in video conferences. People in these meetings typically look at their own screen and not into the camera, and the software can correct for this. Given the potential for misusing video footage with this technology, the scientists are

researching methods for automatically detecting such modifications in videos and advocate that edited material should be watermarked. (www.mpg.de/12226519)



A person's facial expression, lip movements, gaze direction and head pose (input) can be transposed onto another individual (output) using the *Deep Video Portraits* technique, which works using 3D face models (center).

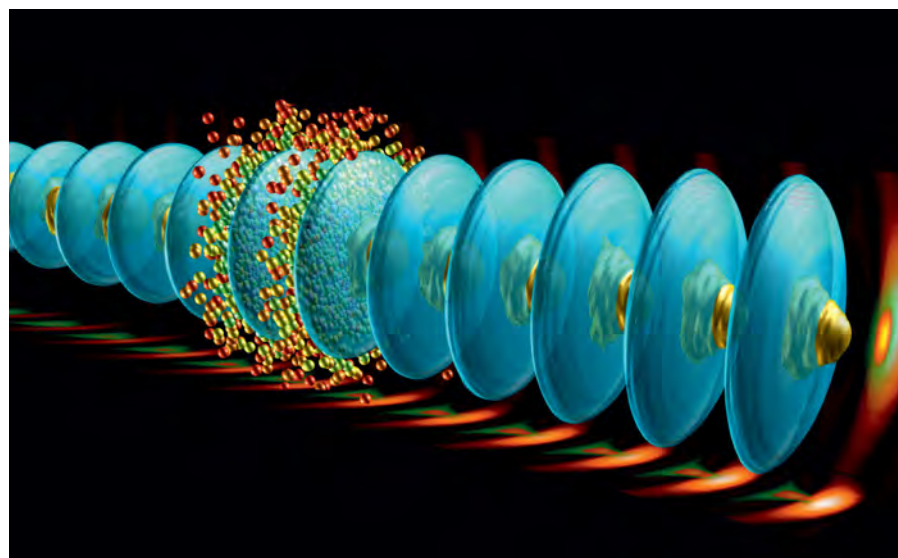
Electrons ride plasma wave

First successful test of a new concept for the particle accelerators of the future

There is a good chance that a new door will soon open to physicists, offering them fresh insights into the mysteries

of the universe. The international AWAKE collaboration, which also involves scientists from the Max Planck

Institute for Physics, has made a breakthrough in its efforts to build a new type of particle accelerator. For the first time, the researchers have accelerated electrons by letting them surf on a plasma wave – a wave of positively charged atoms and negatively charged electrons. They expect that particles in future accelerators operating according to this principle will gain as much energy in 1 meter as they would in 50 meters in the Large Hadron Collider at CERN in Geneva. Physicists could therefore cause particles to collide with significantly more energy than has been possible to date – and gain new insights into the Big Bang and the structure of matter by studying the traces of the collisions. (www.mpg.de/12240838)



Surfing particles: in the AWAKE experiment, protons (bullet-like structures) form a plasma wave (ellipsoidal structures) that accelerates electrons (small spheres) to high energies.

In the gravity field of the black hole

Astronomers conduct successful test of Einstein's general theory of relativity in the galactic center

The black hole at the heart of the Milky Way is an ideal cosmic laboratory for all kinds of physical tests. Its extremely strong gravitational field influences the surrounding area and has an im-

act on the motion of stars passing nearby. Now, scientists at the Max Planck Institute for Extraterrestrial Physics have recorded an effect that Albert Einstein predicted with his gener-

al theory of relativity over 100 years ago. The researchers used all four mirrors of the Very Large Telescope in Chile to observe the galactic center. They turned their attention to a star called S2 and followed it on its orbit around the black hole. In May 2018, S2 came particularly close to this gravitational giant at a distance of approximately 14 billion kilometers. The star was moving at a speed in excess of 25 million kilometers per hour. The measurements clearly showed an effect known as gravitational redshift: light from the star S2 was stretched to longer wavelengths by the enormously strong gravitational field, making it appear red. This change in wavelength agreed precisely with Einstein's prediction. (www.mpg.de/12146084)

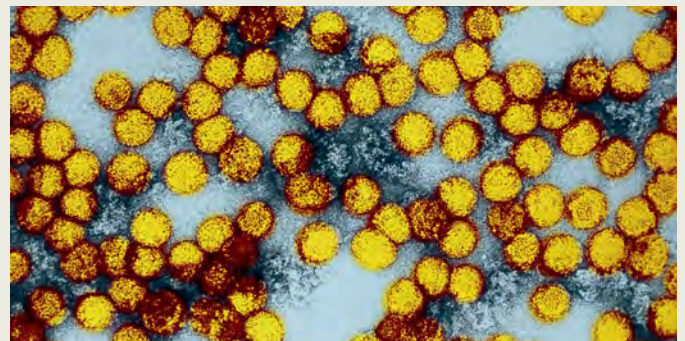


Relativistic color change: this illustration shows the star S2 passing the black hole in the galactic center. The gravitational redshift caused by the extremely strong gravitational field is clearly visible.

Vaccines without eggs

Highly concentrated reproduction of some flaviviruses in bioreactors will be possible in the future

Vaccines against some life-threatening infections could become more readily available in the future. A team led by researchers from the Max Planck Institute for Dynamics of Complex Technical Systems in Magdeburg has now used bioreactors containing cultures of duck cells to produce yellow fever and zika viruses such as those used for live vaccines. By combining various approaches, they achieved higher concentrations than were previously possible with any other method. For example, they optimized the viruses so that they would multiply particularly well in the duck cells. They also used what are known as perfusion reactors, which allow the efficient supply of fresh nutrient solution to the host cells. Last of all, they monitored the cell concentrations constantly and adapted the supply of nutrient medium accordingly. The production of vaccines currently requires about half a billion chicken eggs per annum, leading to continual bottlenecks as this type of production cannot be ramped up flexibly according to demand. Now, the Magdeburg-based research-



Yellow fever viruses under an electron microscope.

ers are investigating whether other viruses, such as the influenza pathogen, can also be multiplied using their method. (www.mpg.de/12300448)

Parrots think in economic terms

The birds forgo an immediate benefit if they expect a greater reward in the future



Sometimes, it pays to wait – for example, when it comes to choosing between an immediate, but small, reward and a greater reward at a future date. Parrots have clearly grasped this concept: contrary to the saying “better a bird in the hand than two in the bush”, they are capable of learning when it is better to wait for a greater reward. Researchers at the Max Planck Institute for Ornithology in Seewiesen taught parrots to exchange tokens for food, with different tokens representing cereals, sunflower seeds, and walnuts – foods of a low, medium, and high nu-

tritional value for birds. The parrots were then invited to choose between an immediate reward and a token that they would later be able to exchange for food of a higher nutritional value. The results show that the parrots generally only forwent an immediate reward in favor of a token if it represented a higher nutritional value than that of the immediate reward. Parrots are therefore capable of making a rational decision and maximizing the benefit to themselves. The birds perform just as well as chimpanzees in similar experiments. (www.mpg.de/12250812)

An African gray parrot facing the decision “food or token”. The bird generally chooses the token if it can later exchange it for food of a higher nutritional value.

Our fractured African roots

Diverse in form and culture, our ancestors lived scattered across the entire continent of Africa

It is generally accepted that the origins of modern humans lie in Africa. For a long time, it was assumed that the early ancestors of *Homo sapiens* were a single, relatively large demographic group. Now, an international study led by Eleanor Scerri, a researcher at the University of Oxford and the Max Planck Institute for the Science of Human History in Jena, has called this view into question. According to the study, stone tools and other artifacts suggest that a similar process of cultural development took place in various regions independently. Human fossils also show a complex mix of archaic and modern features at multiple locations and at different times. Genetic findings also support this picture. The researchers believe that this was caused by climatic changes and a resulting shift in habitable zones. As suggested by a detailed reconstruction of Africa’s climate zones and habitats over the past 300,000 years, the individual groups of people experienced many phases of isolation. This likely led to corresponding local adaptation, the development of unique cultures, and specific biological features – followed in turn by periods of genetic and cultural mixing. (www.mpg.de/12131917)



The puzzling history of humankind: archaeological finds, fossils, genetic data, and insights into habitats are painting a new picture of human development.

Rendezvous in the Stone Age

Different forms of humans have interbred more often than previously assumed



Until around 40,000 years ago, two forms of humans inhabited Eurasia: Neanderthals in the west and Denisovans in the east. Together with the Neanderthals, the also extinct Denisovans are the closest relatives of modern humans. The two groups of early humans probably didn't encounter one another very often, but when they did, they must have mated fairly frequently. Otherwise, there would be no way to explain why the small number of early humans that researchers have studied so far includes a direct offspring from a union between Neanderthals and Denisovans: researchers at the Max

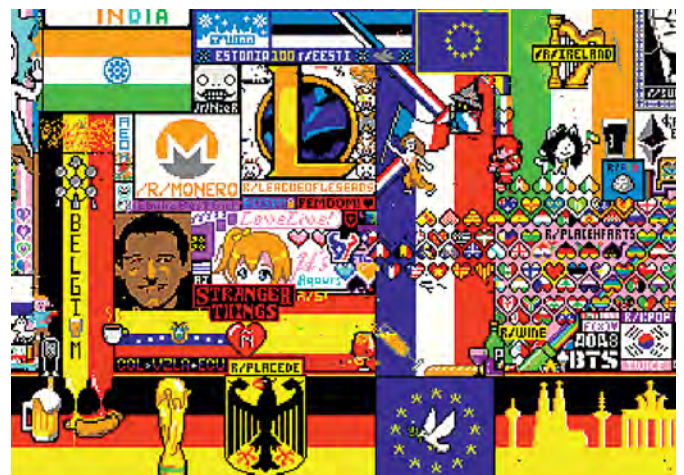
Planck Institute for Evolutionary Anthropology in Leipzig analyzed the genetic make-up of a prehistoric woman and discovered that her mother was a Neanderthal and her father a Denisovan. This union was not the first of its kind, for the woman's father counted at least one Neanderthal among his ancestors. The analyses also indicated that the mother was more closely related to Neanderthals living in western Europe than to Neanderthals from the Denisova Cave. The Neanderthals must therefore have migrated between western and eastern Eurasia before their disappearance. (www.mpg.de/12208106)

The bone fragment found in the Denisova Cave in Russia in 2012 is just a few centimeters in size. It comes from a woman whose parents belonged to different hominin groups.

Art in the midst of competition and cooperation

An online project shows parallels with the dynamics of cultural evolution

Scientists from the Max Planck Institute for the Science of Human History in Jena have used an art project on the popular web platform Reddit to explore how culture evolves. Over the space of three days, Reddit opened up a digital canvas on which every user could place just a single pixel in a given period of time. More than a million users took part. As the canvas filled up quickly, small groups had to learn to work together or drive out rival teams in order to place an element, such as the flag of their home country, in the picture. For Thomas Müller and James Winters from the Institute in Jena, the project provided an opportunity to test the dynamics of cultural change. The striking thing was that the elements became increasingly dependent on one another for survival – especially as the canvas ran out of space. These findings corroborate the view that cultural change follows a similar logic to that of biological adaptation: the success of individuals manifests itself in the skillful defense of their territories, but cooperation is ultimately the key to lasting success. (www.mpg.de/12251403)



Joint work: a section of the 1,000 by 1,000 pixel canvas at the end of the art project on Reddit. Max Planck researchers used the initiative to understand mechanisms of cultural development.

Gene. mix up

A disease is considered «rare» if only 5 out of 10,000 people suffer from it – often making it difficult for medics to come up with an accurate diagnosis. The Foundation supported Stefan Mundlos at the Max Planck Institute for Molecular Genetics. His technology enables the genetic data of patients to be specifically compared to data relating to rare diseases, thereby increasing the effectiveness of diagnosis and therapy.

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