Relics of Late Antique prosperity: the Late Antique Little Ice Age in the 6th century A.D. saw settlements in the Near East, like this one in Syria, expand as a result of increasing precipitation and improved water management.

LEARNING FROM PAST CLIMATE

Climate changes throughout history, such as the Little Ice Age between the 13th and 19th centuries, have often been associated with famines, crises and wars. However, there are also many examples of how populations and politicians have been able to use changing climatic conditions to their advantage, or at least to maintain stability. An interdisciplinary research team, which includes scientists from the Max Planck Institute for the Science of Human History, is therefore using a new approach to study how societies react to climate change. This focuses on societal resilience and ensures that climate data and historical facts are analyzed more carefully than was formerly often the case. The team has already used this guideline to put together case studies, e.g. of the Late Antique Little Ice Age that occurred during the 6th century A.D. These climate changes exerted great pressure on some societies, while others used them to their benefit. The inhabitants of the Eastern Mediterranean region, for example, improved their water management and used the increase in precipitation to grow larger crops. Overall, the researchers have identified five strategies for coping with climate change and now plan to explore these in greater detail: the exploitation of new socioeconomic opportunities; the utilization of robust energy systems; the use of trade to tap new resources; ascertaining politically effective reactions to extreme events, and migration.

www.mpg.de/16613100

AWARD-WINNING ✶

PATRICK CRAMER

This year, the renowned Louis Jeantet Prize for Medicine goes to Patrick Cramer, Director of the Max Planck Institute for Biophysical Chemistry, for his groundbreaking work in the field of gene transcription. This copying process enables living cells to produce transcripts of their genes that then serve as blueprints for making proteins. Cramer's research focuses on RNA polymerases, the molecular machines that implement this process.

Patrick Cramer has made the structures of many of these cellular copying machines visible in atomic detail for the first time. He was able to demonstrate how RNA polymerases translate genetic information and how they work as a team with other protein complexes. The award presented by the Swiss Louis-Jeantet Foundation is endowed with 500,000 Swiss francs.

www.mpg.de/16336063

Versatile substance: a newly discovered nickel compound could serve as a catalyst for numerous chemical products in the future.

CATALYST WITH A WIDE RANGE OF APPLICATIONS

Nickel bonded with organic partner molecules serves the chemical industry as a catalyst for the production of numerous chemical compounds. Its uses range from the production of fine chemicals to the synthesis of pharmaceutical drugs, insecticides, and pesticides. A nickel complex containing cyclooctadiene, which was discovered around 60 years ago at the Max-Planck-Institut für Kohlenforschung, has been used for this purpose for many decades. However, it is extremely complicated to use, since it is highly temperature-sensitive and immediately decomposes in air. Scientists at the same Max Planck Institute have now succeeded in developing an innovative series of nickel complexes that remain stable in air for about one month and can withstand higher temperatures than the complex previously used. In terms of their desired catalytic properties, however, they are very similar. This is why industries showed such immense interest following the first publication. The U.S. specialty chemical manufacturer Strem Chemicals has now acquired an initial non-exclusive license to produce the catalyst with the goal of supplying customers in the fields of science and research.

www.mpg.de/16305747

LOW-COST RAPID TEST

As long as vaccine is in short supply, one way of helping to contain the coronavirus pandemic could be to regularly test as many people as possible. Researchers at the Max Planck Institute for Evolutionary Anthropology and the Hospital St. Georg in Leipzig have now developed an improved method of detecting Sars-CoV-2. Known as Cap–iLamp, this method amplifies the desired target sequences of the virus at a constant temperature using minimal technical equipment. Instead of a swab, which many people find unpleasant, all that is required is a gargle lavage sample. The test result can be read visually – orange or red for negative, vivid yellow for positive – or with the help of a free smartphone app half an hour to no more than one hour after the test. This improved testing method outperforms similar tests, since it significantly reduces the number of false-positives. Moreover, it can detect a single infected sample in a pool of 25 uninfected samples. The technical cost of a pool test is approximately one Euro per person.

www.mpg.de/16536940

9

IMAGE: FRANCIS TSENG
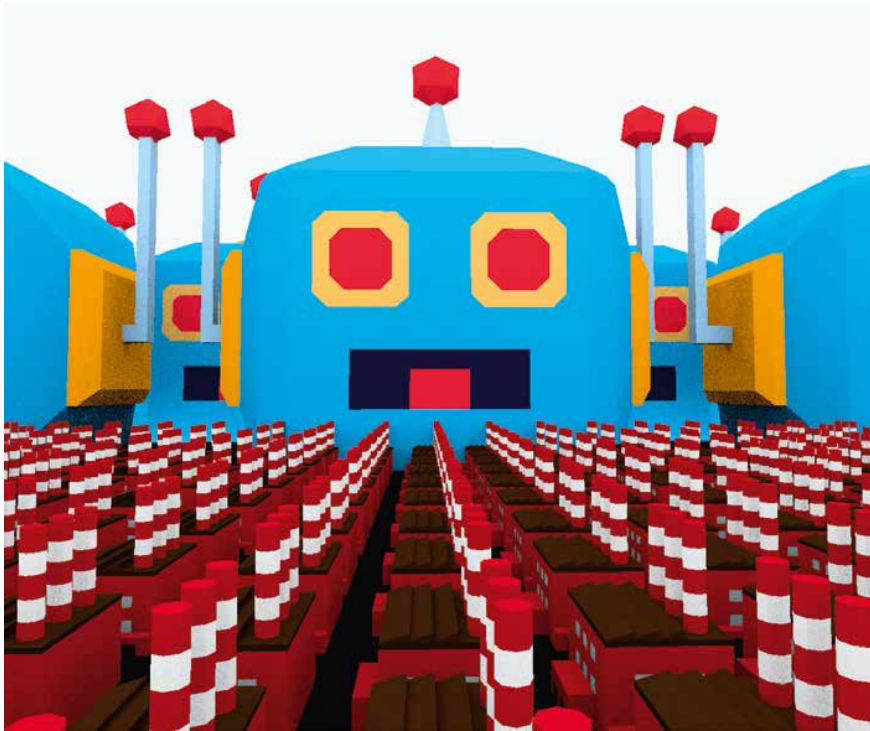
Digital competition: robots are ready to take over the jobs of human employees, both in the gaming world and in reality.

PLAYING THE AUTOMATION GAME

10 We live in a world in which robots are building more and more of our cars, algorithms are trading stocks, and computers are translating texts. Robotics, digitalization, and artificial intelligence are transforming numerous professions. Some jobs are disappearing, while other new ones are being created. The online game *'The Automated Life'* is a chance to practice overcoming these challenges at work. The game was developed in the Center for Humans and Machines at the Max Planck Institute for Human Development. Players start out with a job that is severely threatened by automation. They have to save up for further training and apply for new jobs, which in turn open up new opportunities for further training programs and careers. Meanwhile, automation is advancing relentlessly, and jobs are constantly being eliminated by new technological developments. Keeping an eye on their bank balance and bearing in mind how many more years are still to go before they retire, players have to be able to make quick, smart decisions to win out against digitalization and ultimately enjoy their well-deserved retirement. Anyone who plays this game is also contributing to research: the data from each game is analyzed anonymously with the intention of understanding how humans cope with automation.

www.mpg.de/16578078

UNDER-STANDING SIGNING AS A LANGUAGE

Over 70 million deaf people around the world use some form of sign language. Thus far, however, it has been difficult to identify the parts of the brain that process both spoken and sign language. A meta-analysis carried out by scientists at the Max Planck Institute for Human Cognitive and Brain Sciences has revealed that the Broca area in the frontal lobe of the brain's left hemisphere plays a key role for both types of language. The brain's right frontal lobe, which processes non-linguistic aspects such as spatial or social information about the communicator's counterpart, is also vital for understanding sign language. The hand, facial and body movements of which a sign language consists are in principle perceived similarly by deaf and hearing people; in deaf people, however, the signs also activate the language network in the brain's left hemisphere, which includes the Broca area. Deaf people therefore perceive the gestures as gestures with linguistic content rather than pure movement sequences, as is the case with hearing people. *www.mpg.de/16461250*

PHOTO: SHUTTERSTOCK

Specialized in language: the human brain specializes in processing linguistic information – regardless of whether it is spoken or signed.
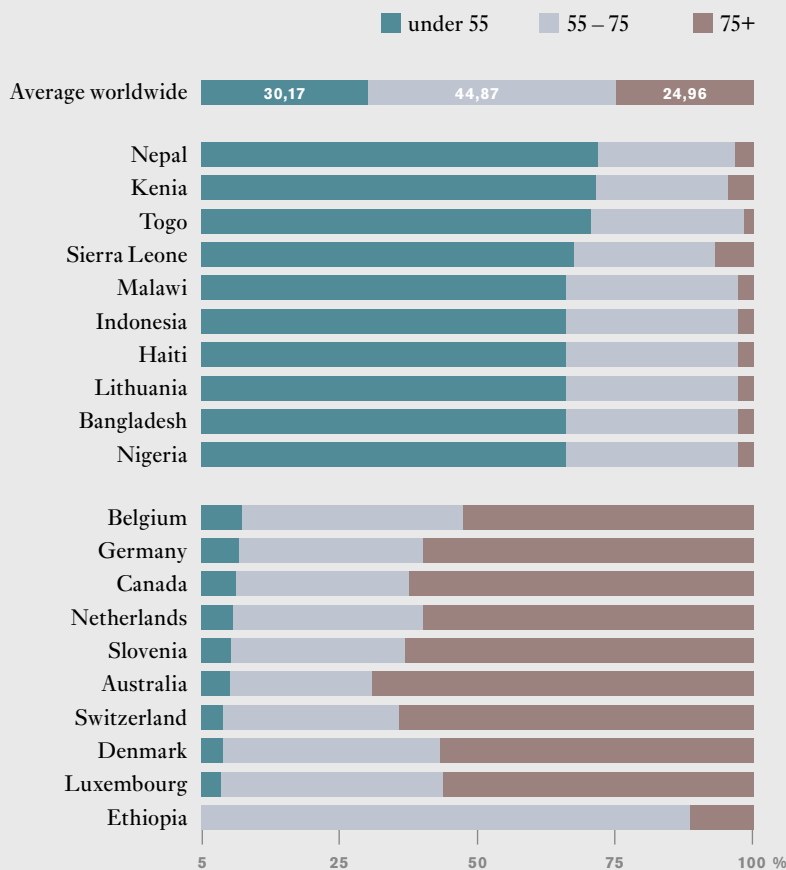
YEARS OF LIFE LOST

In order to make a proper assessment of how the coronavirus pandemic has impacted mortality, an international team of researchers, including scientists from the Max Planck Institute for Demographic Research, has evaluated 1.2 million deaths that occurred in 81 countries between the start of the pandemic and the beginning of January 2021. Their goal was to ascertain the ages of the people who died from COVID-19 and calculate how much their lives were shortened compared to the average life expectancy. Middle-aged people and those of early retirement age accounted for the largest proportion of the years of life lost. A global comparison indicated that three-quarters of the years of life lost impacted people who were younger than 75 years of age. This contrasts starkly with the widely held belief that most people who die of COVID-19 only had a few years left to live in any case. In medium and low-income countries, the proportion of years of life lost is often significantly higher in the youngest population group (under 55) than in the oldest. The picture in high-income countries is quite different: more than half of the years of life lost here are accounted for by the oldest population group (over 75).

www.mpg.de/16447194

PROPORTION OF YEARS OF LIFE LOST ACCORDING TO AGE GROUP

under 55 · 55 – 75 · 75+

Average worldwide: 30,17 | 44,87 | 24,96

Nepal, Kenia, Togo, Sierra Leone, Malawi, Indonesia, Haiti, Lithuania, Bangladesh, Nigeria

Belgium, Germany, Canada, Netherlands, Slovenia, Australia, Switzerland, Denmark, Luxembourg, Ethiopia

Marked differences: in poorer countries, the proportion of years of life lost tends to be highest in the youngest age group (top). In the countries where this age group accounts for the smallest proportion of years of life lost, the living standards are usually significantly higher (bottom). The research team studied 61 other countries in which these figures lay in between these extremes.

11

ARTIFICIAL INTELLIGENCE SUPPORTS COVID-19 PROGNOSES

Estimating the risk of patients dying is arguably one of the most difficult and stressful challenges doctors ever have to face, especially now during the COVID-19 pandemic. In ideal circumstances, they can adjust the treatment and save the patient's life. A team led by researchers at the Max Planck Institute for Intelligent Systems has now developed an algorithm and trained it using machine-based learning methods, so that it can help physicians predict mortality. The algorithm analyzes large volumes of medical data and identifies patterns that are barely discernible to humans. It can also be used to determine the mortality risks associated with other diseases. A similar algorithm analyzes medical data such as pulse, blood pressure, and information about the patient's symptoms to detect patterns indicating that their COVID-19 infection is likely to be severe. The researchers are currently testing this algorithm in a study carried out in cooperation with Tuebingen University Hospital and are still seeking participants in the German-speaking countries who have just tested positive for coronavirus.

ei.is.mpg.de/covid-19-studie (in German)
www.mpg.de/16444031

STELLAR EXPLOSION AT AN UNUSUAL LOCATION
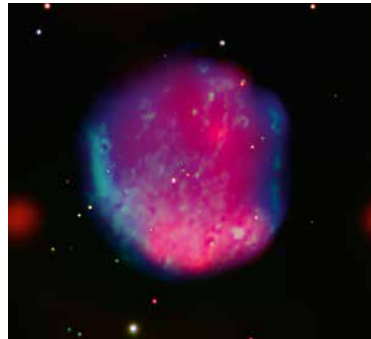
Gaseous relic: this composite x-ray and radio image shows the supernova remnant "Hoinga".

Researchers at the Max Planck Institute for Extraterrestrial Physics have discovered a gigantic, previously unknown supernova remnant in our Milky Way using the German x-ray telescope eRosita. With a diameter of several angular degrees, it is not only its size that is surprising, but also its position in the sky: the scientists have dubbed it Hoinga, which is the medieval name for the town of Bad Hoenningen on the Rhine. The astronomic remnant is located far above the galactic plane – in a region where the birthrate of stars is actually very low and there should therefore be very few suns expiring as supernovas. Most searches for exploding stars actually concentrate on the galactic disc and not on the outlying areas of the Milky Way. To date, astronomers have only discovered around 300 of these stellar remnants in our home galaxy – far fewer than the 1,200 that should theoretically exist there. This means that the researchers have either estimated the number of supernovas incorrectly or simply overlooked the vast majority of them. Incidentally, Hoinga was already visible in data collected by the German x-ray satellite Rosat some 30 years ago; however, the object went unnoticed because of its dimness and its position. *www.mpg.de/16527751*

FROM LONE WARRIOR TO TEAM PLAYER

The transition from single-celled organisms to multicellular ones was a major step forward in the evolution of complex life. Some organisms, such as the slime mold Dictyostelium discoideum, can exist in both states. At home in forest soil, this mold chooses its state according to varying factors such as food supply. If slime mold cells do not find enough to eat, they amalgamate and form a long stalk that can release spores from the fruiting body at its tip. This enables the mold to survive in inhospitable conditions and colonize new habitats that may offer better conditions. Researchers at the Max Planck Institute of Immunobiology and Epigenetics in Freiburg have now discovered that sulfur deficiency is a leading facilitator in the formation of cell clusters. As a component of two amino acids, sulfur is essential to the formation and activity of proteins. If this element is lacking, the cells are no longer able to produce sufficient protein to grow and proliferate. This is how they recognize that there are not enough nutrients in their environment. They then amalgamate and form a fruiting body with spores in order to access new resources. *www.mpg.de/16476527*

WARNING SYSTEM FOR MARKETS

Financial markets will become more predictable in the future: an international team led by scientists at the Max Planck Institute for Mathematics in the Sciences is using mathematical instruments to recognize the early signs of bubbles and crashes. The researchers view a financial market as a network of stocks, and determine the market's dynamism and fragility using certain attributes of this network, or more precisely, using so-called Ricci curvatures. They used this approach to analyze the development of the U.S. S&P-500 and Japanese Nikkei-225 indexes between 1985 and 2016. While securities perform very differently during normal trading periods, their performance during bubbles and imminent market crashes is much more uniform, and this can be detected more efficiently using Ricci curvatures than with any other form of measurement. *www.mpg.de/16597554*
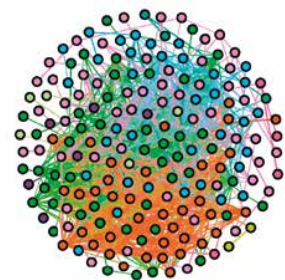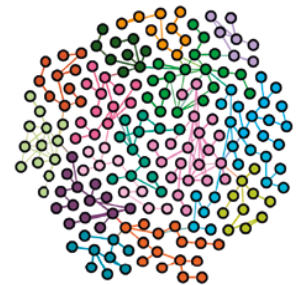
Promising connections: when bubbles develop on financial markets, the correlations in the stock network are much denser (below) than in normal trading periods. The nodes are accordingly more interconnected, as can be seen from the orange coloration.

The European free-tailed bat not only hunts for insects near the ground but also climbs to high altitudes.

PHOTO: ADRIÀ LÓPEZ BAUCELLS

BATS ON THE RISE

Bats are the only mammals that can actually fly. Some species travel over one hundred kilometers on their nocturnal excursions in search of food. A team at the Max Planck Institute of Animal Behavior in Radolfszell has now discovered that European free-tailed bats use updrafts for their ascents. The researchers tracked the bats using mini GPS transmitters and then linked the flight data to weather data. Analysis of the GPS data revealed that the bats often follow the natural contours of the landscape and maintain the same height above the ground. Now and again, however, they shoot upwards and climb 300 to 800 meters; one bat even reached a peak height of almost 1,700 meters above the ground. A close analysis of their flight paths showed that the animals probably use the upward movement of the air that occurs when winds encounter obstacles such as mountains. However, the wings of bats – unlike those of certain birds – are not suitable for extended gliding flights. This is why the bats plummet towards the ground immediately after the ascent. Under their own power, bats can reach flight speeds of up to 135 kilometers an hour – a velocity which in the animal world is only exceeded by nosediving birds. The power for this feat comes entirely from the bats' pectoral muscles, which are only two centimeters long.

www.mpg.de/16371261

13

FORESTS IN DANGER

More than half of Europe's forests are under threat from the impact of global warming. This was the result of a new study performed by an international team including Henrik Hartmann, scientist at the Max Planck Institute for Biogeochemistry in Jena. For this, the researchers used artificial intelligence to analyze satellite data gathered between 1979 and 2018. The results indicated that windthrow, forest fires, insect infestation, or combinations of several of these factors are increasingly endangering Europe's forests. Such events are likely to become more frequent and severe as a result of climate change, while heat and drought are making trees more vulnerable to damage. This knowledge could be used to restructure forests so that they become better able to withstand the impacts of climate change.

www.mpg.de/16501852

Colibactin-producing *E. coli* bacteria (green) damage the DNA (white) of epithelial cells (red) in the intestinal mucosa. The nuclei are shown in blue.
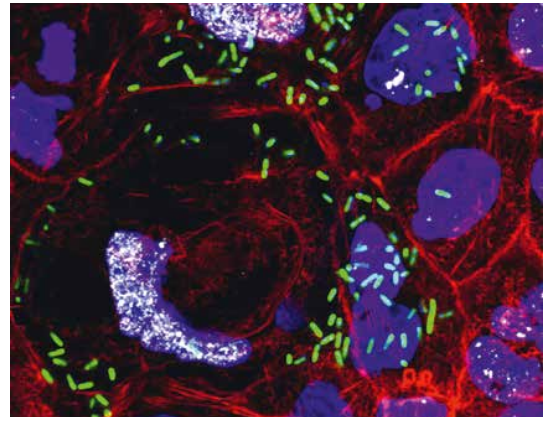
HUMANS MAKE MICE MORE INTELLIGENT

Fans of Tom and Jerry have long since known that if a mouse wants to survive in a house, it has to be particularly intelligent. Researchers at the Max Planck Institute for Evolutionary Biology in Ploen have now proven this scientifically. According to their findings, rodents which have lived close to humans for a long time are better at solving problems than others of their species which live away from human settlements – a phenomenon that has also been observed in birds. The scientists investigated the behavior of three species of house mouse that have lived in human environments for 3,000, 8,000 and 11,000 years respectively and have had to adapt accordingly. The results of their experiments show that the mice that have associated with humans for the longest period were best able to solve problems. These findings cannot be explained by personality traits such as curiosity, motivation or perseverance, but only through differences in cognitive skills. Since the mice investigated have been living in the researchers' laboratory for several generations, the rodents must have inherited this enhanced intelligence.

www.mpg.de/16442871 (in German)

TOXINS FROM GUT BACTERIA

Escherichia coli bacteria occur naturally in the human gut. However, some strains produce a toxin called colibactin, which harms the organism's DNA and is implicated in the development of colorectal cancer. Scientists have not succeeded in proving this connection until now. A team of researchers from the Max Planck Institute for Infection Biology in Berlin has caught colibactin in the act of changing the DNA of colon cells so that they behave like cancer cells. The researchers used colon stem cells to cultivate hollow, three-dimensional mini-organs known as "organoids". In the presence of colibactin-producing bacteria, the cells began multiplying faster after just a few hours – despite the absence of a growth factor without which cells do not normally divide. This uncontrolled proliferation is a precursor of cancer. DNA sequencing of the organoids revealed that colibactin induced numerous mutations in the DNA, including some that led to whole sections of chromosomes being rearranged or lost. *www.mpg.de/16419527*
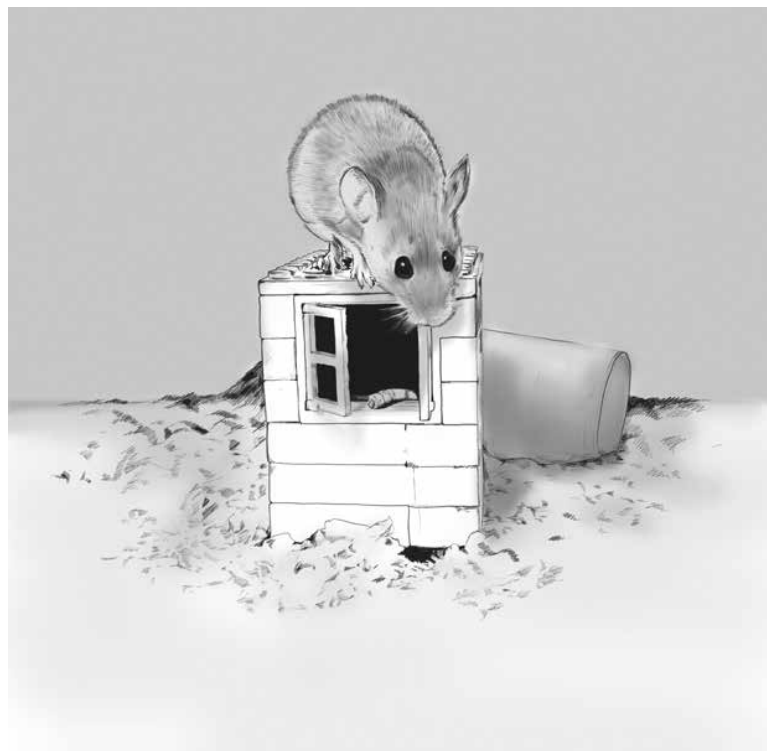
14

A behavioral experiment required mice to open a small window to reach a morsel of food. Animals whose forebears had long lived close to humans performed significantly better.

MAGNETIC FIELDS AT THE EDGE OF A BLACK HOLE

The first image of a black hole went round the world in April 2019. It showed a bright ring with a dark central region at the heart of the M87 galaxy 55 million light years away. The measurement data used for this image were collected by the antennas of the Event Horizon Telescope (EHT) sites located around the globe. The research team, which includes scientists from the Max Planck Institute for Radio Astronomy in Bonn, has continued analyzing this data in recent months – in a sense, they are placing sunglasses with polarized lenses on the data in the computer. In this way, they discovered that a significant proportion of the radio emissions surrounding this monstrous cosmic mass are in fact polarized, i.e. they curve in one direction. This polarization is caused by the magnetic fields immediately surrounding the black hole. The image produced with the polarization filter now shows the course of the magnetic field lines. The region is particularly interesting because it is the source of a high-energy jet, a gas stream several tens of thousands of light years long, the formation of which appears to have been influenced by magnetic fields. The observations should help elucidate the mechanisms behind it.
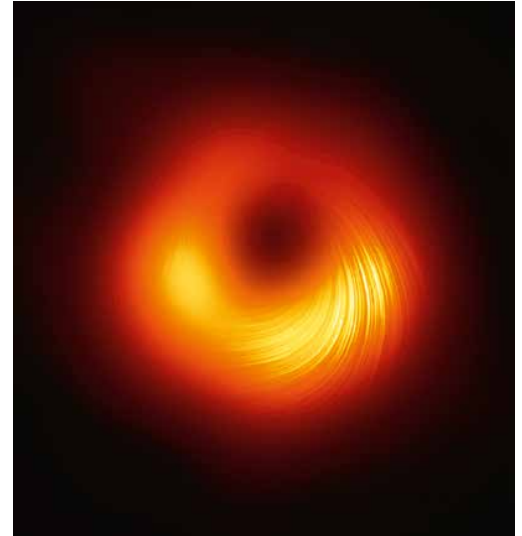
www.mpg.de/16630569

IMAGE: EHT COLLABORATION

Magnetic gravity trap: curved polarization field lines showing the course of the magnetic field have been sketched into this image of the shadow of the black hole at the center of galaxy M87.