

# Formula for Preventing Power Outages

Search for weak points in grid to become easier

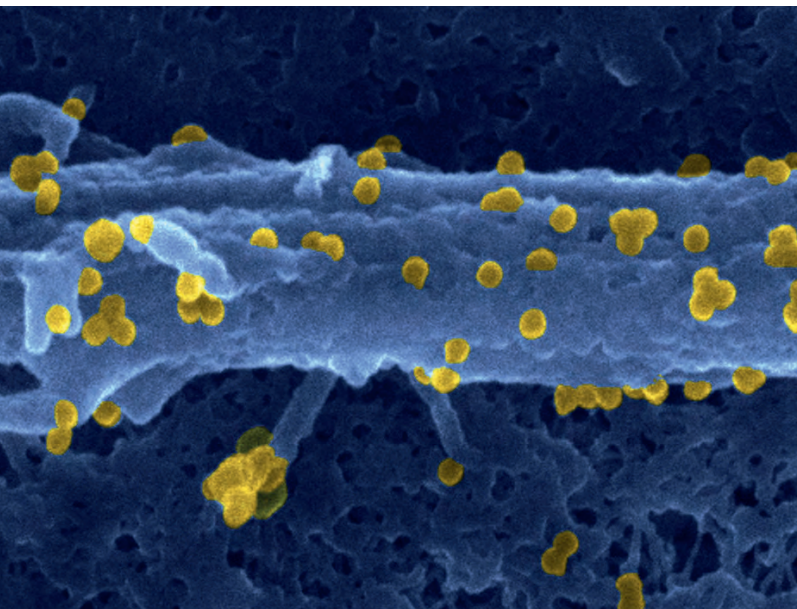
The risk of power outages will soon be easier to assess than before. A team of researchers headed by Marc Timme at the Max Planck Institute for Dynamics and Self-Organization have developed a simple formula for identifying power lines whose failure can cause the lights to go out in an entire region or city. Their formula takes into account not only how much electricity a line transports but also whether the surrounding electricity network can compensate for the malfunction of the heavily used line. Until now, several thousand complicated simulations were needed to determine this. ([www.mpg.de/10447869](http://www.mpg.de/10447869))

A simple formula can predict whether the failure of a power line will cause a regional power outage.



# Old New Weapons against Viruses

Existing drugs could soon be used to fight Chikungunya infections



Chikungunya viruses (yellow) are transmitted by mosquitoes. Once it has survived the infection, the body has lifelong immunity to the virus.

The mosquito-borne Chikungunya virus has been spreading in South America and the Caribbean since 2013 and is now threatening southern Europe and the southern states of the US. It causes flu-like symptoms with fever and joint pain that can last for months, with occasional fatalities. As the process for the development of new drugs is expensive and protracted, scientists at the Max Planck Institute for Infection Biology in Berlin have developed a new strategy that should make the development of a treatment more effective. Up to now, researchers targeted primarily the pathogen's proteins in the fight against infections. The scientists in Berlin, however, target the proteins the virus needs to be able to infect humans. They want to prevent the reproduction of the pathogen with the help of substances that specifically affect these proteins. The scientists have identified two substances – including, surprisingly, a widely used anti-psychotic drug – that inhibit the Chikungunya virus in mice without triggering side effects. According to the scientists, human host cells have several proteins that are needed not only by the Chikungunya virus but also by other viruses. These could provide a starting point for the development of broad-spectrum antiviral drugs. ([www.mpg.de/10500598](http://www.mpg.de/10500598))

## Children of Older Mothers Do Better

A study by Mikko Myrskylä, Director at the Max Planck Institute for Demographic Research in Rostock, and Kieron Barclay from the London School of Economics proves that the biological risks associated with pregnancy in later life are more than compensated by the positive social developments in the corresponding period. The health and educational opportunities of people in industrialized nations are improving from year to year. In their study, the scientists analyzed data from more than 1.5 million Swedish women and men born between 1960 and 1991. The researchers discovered that children born in the later years of this period performed better at school and were more likely to attend university than those born in the earlier years. Clear differences were even observed among children in the same family: the children of older mothers attended school or college for one year longer on average than their 20-year-old

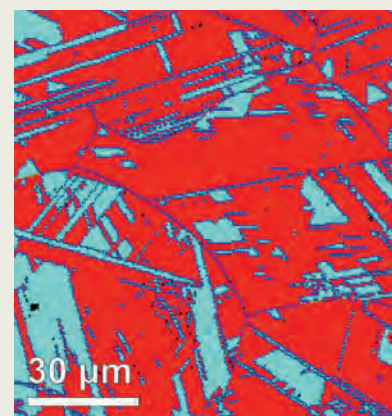
siblings. "So whether a woman had a child at 20 or 40 makes a huge difference for the child," says Myrskylä. ([www.mpg.de/10411999](http://www.mpg.de/10411999))



The blessing of a late birth: Children born today have better opportunities.

## Strength and Ductility for Alloys

For the steel industry, there may be a way out of a dilemma that has been around for as long as people have been processing metal. Scientists from the Max-Planck-Institut für Eisenforschung (iron research) in Düsseldorf have presented a new type of metallic material that is extremely strong but also ductile. Up to now, one of these material properties could be improved only at the expense of the other. The researchers in Düsseldorf changed this by combining the advantages of steel with those of high-entropy alloys. High-entropy alloys contain similar volumes of five or more metals. They can be particularly strong but, unlike steel, they are also brittle. Steels, in contrast, consist mainly of iron and are particularly ductile if the small crystals from which they are formed can change their structure. The researchers in Düsseldorf have now also made this kind of structural change possible in high-entropy alloys, despite it having previously been considered to be unfavorable in such alloys. In this way, they are helping to enable metal components to be designed with thinner sheets, thus conserving resources. ([www.mpg.de/10536074](http://www.mpg.de/10536074))



An alloy made of iron, manganese, cobalt and chrome becomes ductile because it can have two co-existing crystal structures, and one structure can transform into the other. The two crystal structures can be identified by the two different colors in this cross-section of the material, which was produced using electron backscatter diffraction.

## Suspense in the Movie Theater Air

Exhaled breath of moviegoers reveals the scene playing on screen

With some movies, the air is heavy with suspense – quite literally. Scientists at the Max Planck Institute for Chemistry and the Johannes Guten-

berg University Mainz analyzed the air in movie theaters during various movie screenings and determined that each movie leaves a characteristic pattern in the air. The concentrations of carbon dioxide and isoprene in the air increase during particularly tense moments in movies, probably because the audience tenses up during such scenes and breathes faster. With these tests, the researchers aim to establish whether human breath has a significant impact on the concentration of trace gases in the atmosphere. Despite the detectable traces of these gases in movie theater air, their findings to date indicate that this is not the case. ([www.mpg.de/10508367](http://www.mpg.de/10508367))



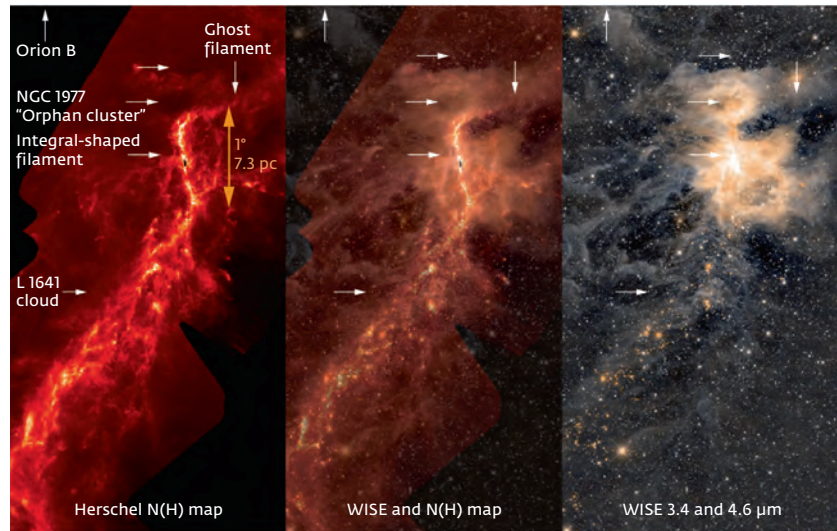
When the tension in the movie rises, breathing changes and the concentrations of carbon dioxide and isoprene increase. Researchers analyzed this phenomenon among moviegoers.



## The Secret Life of the Orion Nebula

The interplay of magnetic fields and gravitation in the gas cloud leads to the birth of new stars

Stars and even entire star clusters are constantly being born in space. According to the standard models of star formation, this occurs inside gas clouds that collapse under their own gravity. Amelia Stutz and Andrew Gould from the Max Planck Institute for Astronomy in Heidelberg have now proposed another mechanism. The researchers came up with it when they investigated an integral-shaped filament of gas and dust, which also includes the Orion nebula. In their scenario, the filament is a flexible structure that undulates back and forth. The interplay of magnetic fields and gravitation should allow instabilities to arise, some of which are known from plasma physics and which could enable the formation of one star cluster after another. Protostars would be found only along the dense spine of the filament, and infant stars would arise primarily outside the filament – as is observed in reality. ([www.mpg.de/10515222](http://www.mpg.de/10515222))



Birthplace of suns: The integral-shaped filament, the two star clusters above the filament, and cloud L1641 in the south can be seen on these images of the Orion A star formation region. The image on the left shows a density map compiled from data from the *Herschel Space Observatory*, the image on the right an infrared image taken by the *WISE* space telescope. The photo in the center is a combination of the two images.

## Other People's Happiness

Inequality can reduce satisfaction in the better-off

$$\text{Happiness}(t) = w_0 + w_1 \sum_{j=1}^t \gamma^{t-j} CR_j + w_2 \sum_{j=1}^t \gamma^{t-j} EV_j + w_3 \sum_{j=1}^t \gamma^{t-j} RPE_j + w_4 \sum_{j=1}^t \gamma^{t-j} \max(R_j - O_j, 0) + w_5 \sum_{j=1}^t \gamma^{t-j} \max(O_j - R_j, 0)$$

The unequal distribution of happiness reduces well-being – even among those who are favored by fortune. Scientists from the Max Planck UCL Centre for Computational Psychiatry and Ageing Research in London carried out a study involving games of chance. Participants were informed whether the other players had won or lost in the same games. During the experiment they were asked at regular intervals how happy they felt. It emerged that the winners were happier on average when their co-players also won. This could be attributed to guilt. However, some losers were happier when other

players also lost, which in turn could be attributed to envy. In another test, the same participants were asked to share a small sum of money anonymously with another person. People whose happiness was particularly affected by receiving more than others handed over 30 percent of their money, while those who suffered more from the disadvantage they faced gave only 10 percent. As a result, a link was established for the first time between people's generosity and the extent to which inequality impacts their happiness. ([www.mpg.de/10604496](http://www.mpg.de/10604496))

# When Foes Become Friends

A few modifications in the genome transform a fungal plant pathogen into a potentially beneficial organism

Sometimes it doesn't take much to turn foes into friends. Researchers at the Max Planck Institute for Plant Breeding Research in Cologne discovered that modifications to 13 percent of the genes of a soil fungus that is harmful to *Arabidopsis thaliana* (thale cress) can transform the fungus into a beneficial organism. To do this, the scientists compared the genome of the beneficial fungus with that of a closely related harmful species. The analysis showed that the beneficial fungus had lost many genes that its

harmful cousin uses to circumvent the plant's immune system. Moreover, in some cases, the pathogenic genes it still possesses are no longer read. The plant relies on its immune system to decide whether or not to allow the fungus access to its roots: while *Arabidopsis* plants growing in low-phosphate soil reduce their immune response so that the beneficial fungus can supply them with vital phosphate, their immune system blocks the fungus in phosphate-rich soils. (www.mpg.de/10433805)

## The Effect of Bacterial Ice Nuclei

Microbes induce the formation of ice crystals by changing the order and dynamics of surface water molecules



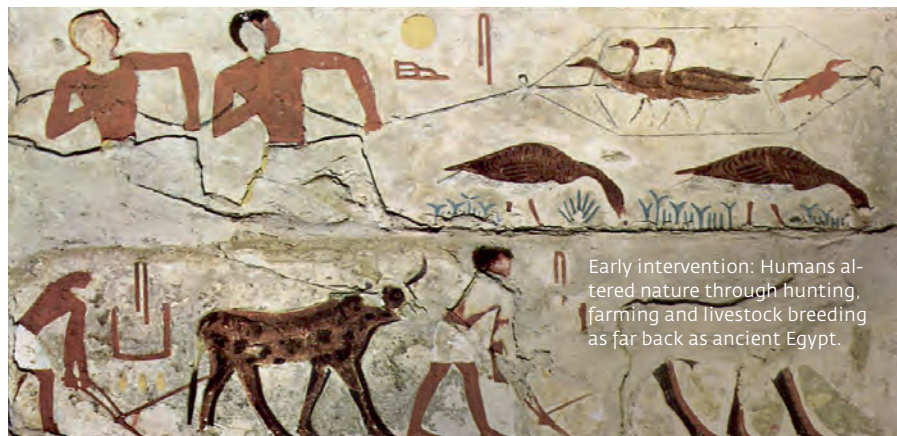
Ice crystals: Max Planck researchers have discovered that certain bacteria affect the ordering and dynamics of water molecules in water droplets.

The freezing point of water is anything but cut-and-dried. Small droplets of the purest water don't freeze until the temperature reaches minus 37 degrees Celsius. Crystallization nuclei, such as bacteria with ice-forming proteins on their surface, are needed for ice crystals to develop at just below 0 degrees Celsius. Researchers at the Max Planck Institutes for Chemistry and for Polymer Research have now explained the molecular mechanism by which proteins cause water molecules to solidify. According to their research, the proteins generate ordered structures in the water and dissipate heat. These findings aid in better understanding the conditions under which frost damage occurs in plants, but that's not all: as the bacteria also occur in the atmosphere, where they likewise promote the formation of ice crystals, they also play a role in the formation of clouds and precipitation – a major factor behind the uncertainty of weather and climate forecasts. (www.mpg.de/10470442)

## Humans Have Influenced Ecosystems for Thousands of Years

Humans have been shaping the Earth's landscapes for many thousands of years. A review of archeological data collected over the last 30 years reveals the extent of this intervention. The study, which was headed by Nicole Boivin, Director at the Max Planck Institute for the Science of Human History and a scientist at the University of Oxford, identifies four major phases in which human activity caused far-reaching changes in the Earth's ecosystems. Fossil evidence from the period between 50,000 and 10,000 years ago shows that around two-thirds of the 150 megafauna species that existed at the

time became extinct with the spread of modern humans. The emergence of agriculture and cattle breeding then gave rise to new evolutionary pressure on plants and animals, and resulted in the number of wild vertebrates becoming "vanishingly small" compared with the number of domesticated animals. Moreover, the human colonization of islands involved such extensive species resettlement that the archaeologists refer to "transported landscapes." The emergence of early urban societies and extensive trade relations gave rise, in turn, to a period of intensive agriculture. (www.mpg.de/10558677)



Early intervention: Humans altered nature through hunting, farming and livestock breeding as far back as ancient Egypt.



# Mommy's Darlings

Female rhesus monkeys form closer bonds with their daughters than with their sons

Many mammals develop close ties with certain members of their species. Whether males or females form closer bonds with each other most likely depends on which sex leaves the birth group on reaching sexual maturity and establishes new relationships in a different group. Observations by scientists from the Max Planck Institute for Evolutionary Anthropology in Leipzig also confirm this. In the case of rhesus monkeys, the males leave their birth group at the age of four. Females, on the other hand, remain with their birth group and rely on strong ties with other group members for their survival. The aggressive behavior of the mothers toward their male offspring in the first year of life appears to prevent the latter from forming close relationships with their group. Although the mothers provide the same care and attention to their offspring of both sexes, they are considerably less aggressive toward their female young and allow closer contact with them.

Rhesus monkey mothers are more aggressive toward their sons than toward their daughters in the first year of their lives.



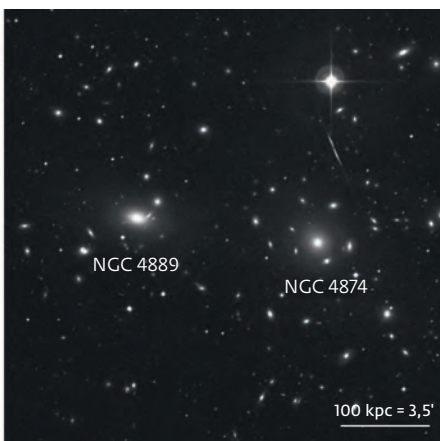
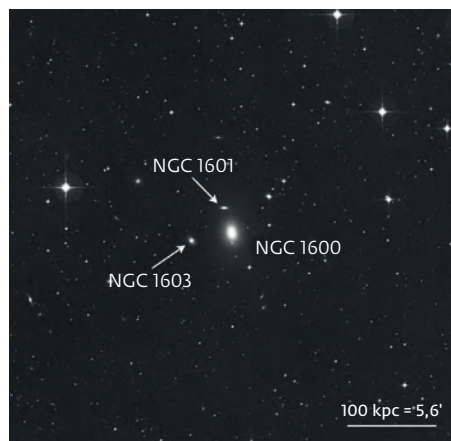
# Black Hole in a Lonely Galaxy

Astronomers find a cosmic object with unusual characteristics

The growth of massive black holes isn't confined to large galaxy clusters. An international team of astronomers from the Max Planck Institute for Extrater-

restrial Physics and from the US and Canada have found a black hole with a mass of around 17 billion solar masses – one of the most massive black holes

found to date – at the center of NGC 1600, an elliptical galaxy that is relatively isolated in space. "Other galaxies that harbor extremely massive black holes are typically located in dense regions of the universe populated by many other galaxies and clusters," says Jens Thomas, an astronomer in Garching. Equally remarkable is the fact that the center of NGC 1600 appears to be unusually diffuse – as though it were missing billions of stars. They may have been ejected during an earlier collision with one or more other galaxies. ([www.mpg.de/10431399](http://www.mpg.de/10431399))



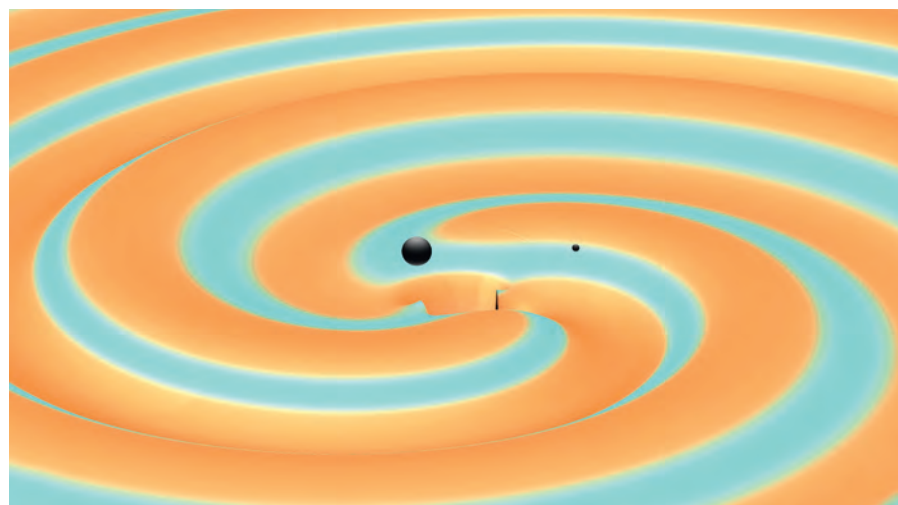
The elliptical galaxy NGC 1600 harbors an extremely massive black hole with a mass 17 billion times that of the Sun. The core is highly diffuse and lacks many stars – probably the result of a previous galaxy-galaxy merger.

## Gravitational Waves 2.0

Researchers again observe signal originating from two merging black holes

Scientists working at the two American LIGO instruments detected a second gravitational wave. The signal was recorded on December 26, 2015 and named GW151226. It originates from a pair of black holes of around 14 and 8 solar masses. The two black holes merged at a distance of some 1.4 billion light years from Earth. The researchers also discovered that at least one of the black holes had previously rotated about its own axis. The merger then emitted the equivalent of around 1 solar mass in gravitational wave energy, leaving behind a rotating black

hole measuring 21 solar masses. The second event was much weaker than the first one detected in September 2015 and was buried in the detector noise. "With this second observation we are truly on the way to genuine gravitational wave astronomy," says Karsten Danzmann, Director at the Max Planck Institute for Gravitational Physics in Hannover. The researchers at the Institute contributed significantly to the discovery by providing highly accurate wave models and advanced detector technology, among other things. ([www.mpg.de/10600416](http://www.mpg.de/10600416))



Cosmic dance of death: The simulation shows how two black holes with solar masses of 14 and 8 circle each other. The researchers measured 27 orbits before the black holes merged. The colors reflect different gravitational fields: cyan represents weak fields, and orange, strong ones.

## Bearded Dragons Sleep Deeply

The brain's sleep phases developed early in vertebrate evolution

Sleep is ubiquitous in the animal kingdom: from insects and worms to mammals and humans – they all regularly take time out. Measurements carried out by researchers at the Max Planck Institute for Brain Research in Frankfurt have now shown that primeval vertebrates such as reptiles have sleep phases that resemble those of mammals in many respects. For example, the neuroscientists observed regular low-frequency and high-amplitude waves in the brains of bearded dragons during one phase of sleep. During two other phases, the neurons fire in strong pulses (delta phase), similar to the waking state, accompanied by rapid eye movements (REM sleep). The researchers also observed some differences: the lizards' sleep cycle is extremely fast, lasting only 80 seconds, while in humans it lasts between 60 and 90 minutes. The major similarities would suggest that the REM and delta phases of the brain are at least as old as the common ancestor of reptiles, birds and mammals, which lived around 320 million years ago. ([www.mpg.de/10477322](http://www.mpg.de/10477322))

## Kids Also Gossip

Five-year-olds judge the behavior of others, thus influencing their reputations

"It's better to play with Anna, Daisy always cheats!" The gossiping so typical of, and often criticized in, adults starts relatively early in childhood development: children as young as five judge the behavior of their peers and so help other children choose a suitable playmate. This is the finding of a behavioral study carried out by researchers at the Max Planck Institute for Evolutionary Anthropology in Leipzig. As part of the study, three- and five-year-old children were

asked to collect tokens and share an agreed number of them with a playmate. The researchers observed that the five-year-olds warned other children about tight-fisted participants. Although the three-year-olds also helped out with information, they didn't judge the behavior of their playmates. Thus, even preschool children can exchange information about others through gossip and so identify cooperative partners. ([www.mpg.de/10484061](http://www.mpg.de/10484061))