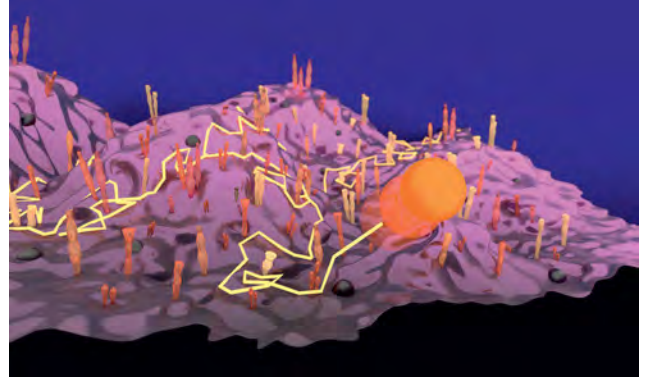


## 3D movies from cell membrane

A new microscopy technique is making it possible to watch membrane proteins at work

A research group from Erlangen is shedding new light on cell functioning and thus opening up new possibilities for developing therapeutic drugs. Vahid Sandoghdar and his team from the Max Planck Institute for the Science of Light and the Max-Planck-Zentrum für Physik und Medizin have developed a method known as iSCAT (short for interferometric scattering) to such an advanced level that they can now use it to film proteins in a cell membrane in 3D and nanometer resolution. To do so, the team marks the molecules with individual gold nanoparticles. The gold scatters irradiated light, thus enabling the scientists to pinpoint the proteins. Since cell membranes are involved in numerous cellular processes, studying their movements and behavior can reveal a lot about the way in which cells function. This knowledge is important in medical terms, as the proteins in cell membranes are susceptible to a considerable number of active ingredients.

([www.mpg.de/0220191/en](http://www.mpg.de/0220191/en))



Road movie with membrane protein: a protein molecule marked with a gold particle (orange circle) can be tracked on its path across the cell surface (light yellow line) since the nanoparticle scatters light in a characteristic pattern.

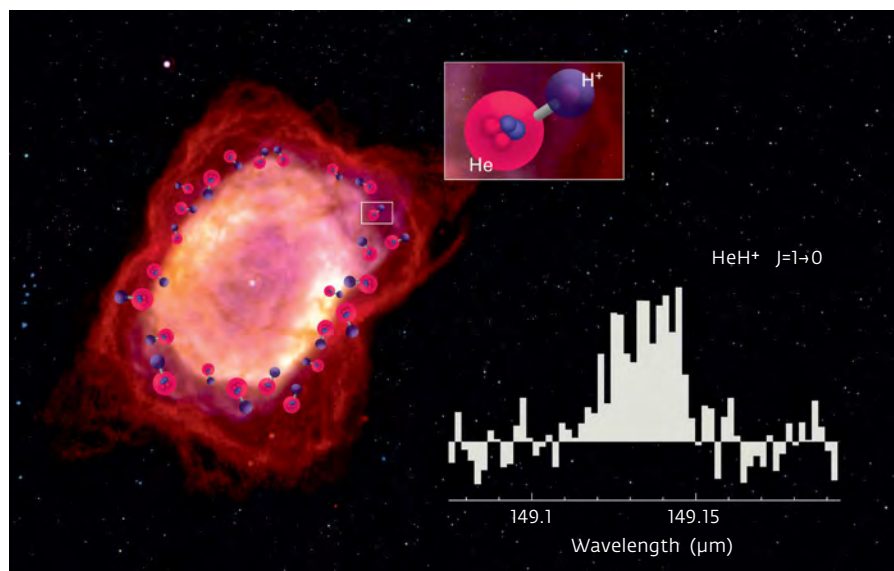
## Molecule from the early universe

Astronomers find helium hydride in a planetary nebula

Immediately after the Big Bang 13.8 billion years ago, the universe was unimaginably dense and hot. It was only after a certain time that falling temperatures allowed the first chemical reactions between the newly formed light

elements to take place. During this process, ionized hydrogen and neutral helium atoms combined to form the helium hydride ion ( $\text{HeH}^+$ ) – the first molecule ever. For a long time, researchers tried in vain to find this substance in

space. Using the far infrared spectrometer GREAT on board the flying observatory SOFIA, an international team led by Rolf Güsten from the Max Planck Institute for Radio Astronomy has now succeeded in detecting this molecule in the planetary nebula NGC 7027. Planetary nebulae are gas envelopes ejected by sun-like stars during the final phase of their lives. At their center sits a spent white dwarf star with a surface temperature of more than 100,000 degrees; this emits energy-rich radiation that drives ionization fronts into the ejected envelope. Model calculations predicted that this was where the  $\text{HeH}^+$  molecule forms, and the astronomers did indeed strike gold. ([www.mpg.de/13392365](http://www.mpg.de/13392365))



Early molecule: the spectrum of the helium hydride ion  $\text{HeH}^+$  seen on board the flying observatory *Sofia* in the planetary nebula NGC 7027. The underlying image was obtained using the Hubble telescope; the sharp transition zone between the hot gas (white-yellow) and the cooler envelope (red) is clearly visible. This is where  $\text{HeH}^+$  is formed.

## Diet influenced the development of languages

Changed dietary habits encouraged the development of new sounds

The phonemic inventory of human speech is incredibly diverse, ranging from common sounds such as “m” and “a” to rare click consonants. This range of sounds is generally thought to have become established with the emergence of *Homo sapiens* around 300,000 years ago. An international team of researchers including scientists from the Max Planck Institute for the Science of Human History and the Max Planck Institute for Psycholinguistics is now shedding new light on the evolution of verbal language. The study shows that labiodental consonants such as “f” and “w”, which now occur in numerous languages, have only become widespread over the last 2,000 years – as the result of a change in dental bite. In earlier times, adult humans had edge-to-edge bites in which the incisors met exactly, thus enabling them to chew tough food. As softer food became more widespread towards the end of the Stone Age, this formation was superseded by a dental bite in which the upper incisors were positioned slightly in front of the lower ones. ([www.mpg.de/13189521](http://www.mpg.de/13189521))

## Lower pension, shorter life

Income and social status are having an increasing impact on life expectancy

On average, men who receive small pensions die five years earlier than male pensioners who are better off. This was the conclusion drawn by scientists at the Max Planck Institute for Demographic Research from their analysis of data provided by the German Pension Fund. Between 1997 and 2016, life expectancy increased in all income brackets. However, at 1.8 years, the life expectancy of the poorest 20 percent in West Germany increased by only half the time gained by the highest income group. In the East, the lowest income group gained three years, while the highest gained 4.7 years. In addition, some of the older population of the former GDR were able to collect hardly any pension entitlement points after the reunification of Germany because they became unemployed or had to resort to marginal employment. This caused pensions in the East to shrink significantly after 1997. Lead author Georg Wenau warns against interpreting pension size as a causal factor affecting life expectancy. Small pensions are frequently the result of poorly paid jobs and periods of unemployment. Income also correlates strongly with health habits and level of education. ([www.mpg.de/13326414](http://www.mpg.de/13326414))

## On the trail of the Denisovans

In 2010, when scientists from the Max Planck Institute for Evolutionary Anthropology in Leipzig analyzed a tiny finger bone from the Denisova cave in Russia, they hit upon a scientific sensation: the genetic material it contained was distinct from that of Neanderthals and modern humans. The bone must therefore have come from a previously unknown hominin. Known as Denisovans, these early hominins must have mixed with modern humans, as traces of their DNA are still found in Asian, Australian and Melanesian genomes even today. Analyses of the genomes of people living in Indonesia and New Guinea have shown that they inherited DNA from not one but two different Denisovan lineages. The two lineages are so divergent that these two groups may have been completely separate. Denisovans may even have lived in the region until around 30,000 years ago. This means that they may have been one of the last surviving groups of hominins.

The Denisovans must therefore have once been widespread; however, fossils of these mysterious archaic humans are still rare. After the bone from the cave in Russia from which the Denisovans got their name, researchers at the Max Planck Institute in Leipzig have now matched another fossil to a Denisovan hominin: a mandible from a cave in Tibet. This primitive man lived at least 160,000 years ago. The place where the mandible was found is located more than 3,000 meters above sea level, thus proving that the Denisovans had adapted to life in this low-oxygen atmosphere long before *Homo sapiens* arrived in the region. Earlier genetic studies have shown that the Denisovans passed on a gene to the people now living in the Himalayas that enables them to survive at these high altitudes.

([www.mpg.de/13386452](http://www.mpg.de/13386452), [www.mpg.de/13329072](http://www.mpg.de/13329072))



Fragment of a Denisovan's lower mandible found in the Baishiya Karst cave in Tibet. Compared to *Homo sapiens*, these prehistoric hominins had powerful jaws with unusually large molars.

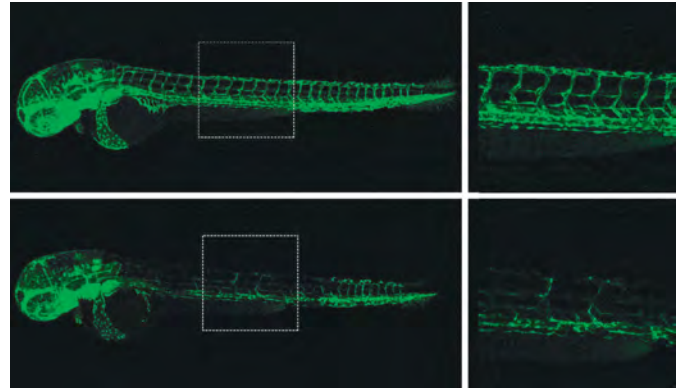
# Genetic defects without consequences

The messenger RNA of defective genes can ensure that other genes compensate for the defect

Defective DNA sequences are responsible for a number of serious diseases. The severity of a disease can vary from patient to patient, as related genes become more active in some of them to compensate for the defect. It appears that a key role is played by messenger RNA molecules (mRNA), which transport the information from the mutant gene out of the cell nucleus to the location where the protein is formed. With the help of genetically modified zebra fish, scientists from the Max Planck Institute for Heart and Lung Research have discovered that the mRNA of a mutant gene sends signals for related genes to take over the task. According to the researchers, these then form more mRNA to compensate for the loss. For several diseases, this could be the reason why some patients have milder symptoms. In the next phase, the researchers aim to compare patients with symptoms of varying de-

grees of severity. This may enable them to identify genes for new treatments. The study also makes it clear that it is extremely difficult to predict the consequences of manipulating the genome. ([www.mpg.de/13336233](http://www.mpg.de/13336233))

The vascular system (green) of two-day-old zebra fish embryos. Absent mRNA in a defective gene prevents the vessels from developing properly (bottom).



## Are fish aware of themselves?

The animals appear to recognize themselves in a mirror

Chimpanzees, dolphins, crows and magpies perceive their reflections as images of their own bodies. Until now, passing this mirror test was seen as an indica-

tion that the species in question possess self-awareness. Scientists at the Max Planck Institute for Animal Behavior in Konstanz have now discovered that

cleaner wrasse also react to their reflections. The fish attempt to remove spots painted onto their bodies when they see them in the mirror. However, the fish show no interest in invisible spots or spots on others of their species. The behavior of these fish meets all the criteria required to pass the mirror test. However, according to the researchers, it is not yet clear whether the results constitute evidence that the cleaner wrasse possess self-awareness. Instead, they are more inclined to interpret the results as an incentive to critically examine the mirror test and consider whether it should continue to be used as the standard test for verifying the existence of self-awareness in animals. ([www.mpg.de/12704402](http://www.mpg.de/12704402))



Self-critical scrutiny: cleaner wrasse (*Labroides dimidiatus*) live in the sea and feed on parasites on the skin of other fish. They recognize in the mirror when a spot has been painted on their bodies.

# Life-saving turnaround in energy policy

Harmful substances released when burning fossil fuels currently cost millions of human lives every year

A rapid withdrawal from the fossil-fueled energy industry would not only benefit the climate, it would also prevent more than three million premature deaths caused by air pollution every year. This was the conclusion reached by an international team of researchers led by Jos Lelieveld, Director at the Max Planck Institute for Chemistry. The scientists have been investigating how air pollution from various sources affects human health. Their study utilizes epidemiological data and a model of the globe's atmospheric chemistry. These allow conclusions to be drawn as to which diseases are the result of contamination with noxious substances and how they shorten statistical life expectancy. It has accordingly been found that emissions from the global combustion of mineral oil, mineral gas and coal are responsible for around 65 percent of the premature



Wind power instead of coal: a shift from fossil energy sources would significantly reduce the health hazard posed by air pollution.

deaths caused by air pollution. Fine dust particles are particularly harmful, as they significantly increase the risk of cardiovascular and respiratory diseases.

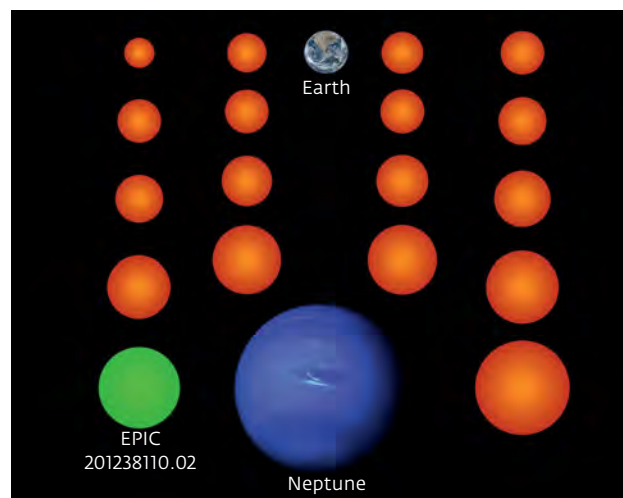
Human health could therefore benefit significantly from switching to renewable energy sources.

([www.mpg.de/13275159](http://www.mpg.de/13275159))

## 18 Earth-sized exoplanets discovered

A new method is being used to detect small celestial bodies that previous searches had overlooked

At present, astronomers are aware of a good 4000 planets orbiting stars outside our solar system. Around 96 percent of these exoplanets are significantly larger than our Earth. However, this percentage is unlikely to reflect actual conditions in space, as large planets are significantly easier to pinpoint than small ones. Yet these small worlds are also the most fascinating, as they give reason to hope that a "second Earth" may be found elsewhere in the universe. Scientists at the Max Planck Institute for Solar System Research, the Georg August University of Göttingen and the Sonneberg Observatory have now discovered 18 Earth-sized exoplanets. All these strange worlds have one thing in common: they are so small that previous searches overlooked them. One of the new exoplanets is among the smallest discovered to date, while another may turn out to have conditions that could support life. The researchers analyzed some of the data from the NASA space telescope *Kepler* using a significantly more sensitive method developed by themselves. The astronomers conjecture that their method may be able to identify more than 100 relatively small exoplanets from the entire body of data collected during the *Kepler* mission. ([www.mpg.de/13505027](http://www.mpg.de/13505027))



Gallery of planets: almost all of the exoplanets known to date are larger than the Earth and are typically the size of the gas planet Neptune. The 18 newly discovered planets (here in orange and green) are significantly smaller; EPIC 201238110.02 could be hosting liquid water.

## Monkey hunting ensured survival in the rainforest

Early settlers in Sri Lanka specialized in hunting small mammals

Tropical rainforests are actually a hostile environment for humans: diseases, limited resources and the indigenous animal species make the jungle less

than attractive for colonization. Agile arboreal monkeys and squirrels, for example, are much more difficult to capture and provide smaller quantities of

protein than large animals that live in open savannas. However, finds made in Sri Lanka prove that modern humans were already living in the local rainforest 45,000 years ago. An international team led by the Max Planck Institute for the Science of Human History has gained new insight into how *Homo sapiens* adapted to this environment. They have found that early settlers actually specialized in hunting small, agile mammals such as monkeys. Their hunting strategy was sustainable – only full-grown animals were killed to ensure that the natural environment was not exploited excessively. “The use of this difficult-to-catch resource is another example of the behavioral and technological flexibility of *Homo sapiens*,” explains Michael Petraglia from the Max Planck Institute for the Science of Human History, one of the study leaders. ([www.mpg.de/12746043](http://www.mpg.de/12746043))

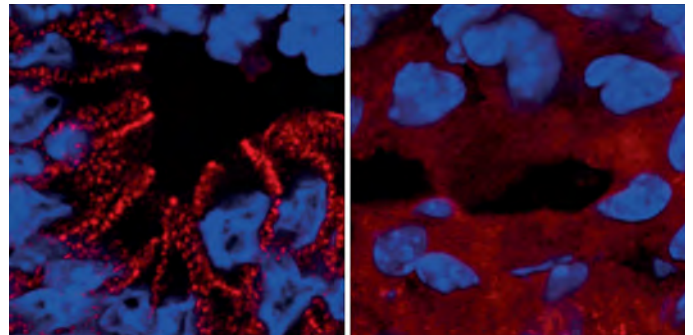


At home in the rainforest: stone and bone tools used by humans 45,000 years ago have been found in the Fa-Hien cave in the Sri Lankan jungle.

## Insulin protects against colorectal cancer

Signaling pathway in the intestinal mucosa strengthens the intestinal barrier

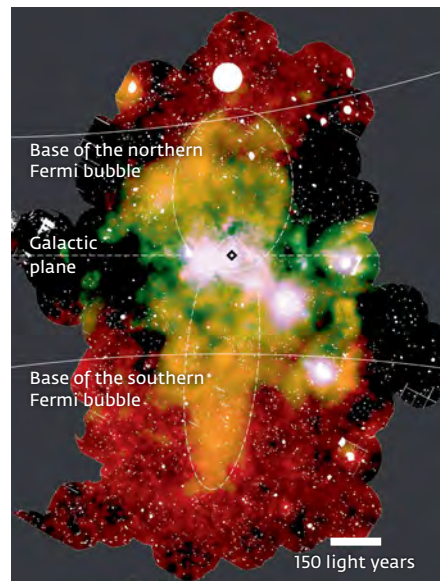
Excess weight can stop insulin receptors reacting to the hormone. This is why overweight people commonly develop so-called "insulin resistance". They are also at greater risk of colon cancer. Scientists at the Max Planck Institute for Metabolism Research have now found out how these two diseases are linked: insulin receptors on the cells in the intestinal mucosa activate genes that are responsible for the formation of zipper-like connections between the cells and thus keep the intestine impermeable. Patients with insulin resistance have greater difficulty in reconstructing these connections following injuries to the intestinal wall. This makes it easier for bacteria to penetrate the intestinal wall and trigger inflammation in the intestine, which in turn encourages the development of colon cancer. ([www.mpg.de/12791681](http://www.mpg.de/12791681))



In healthy mice, connections (bright red) are formed between the intestinal cells (left). These are absent in mice with malfunctioning insulin signaling pathways (right).

# Chimneys in the Milky Way

Researchers discover unusual structures on a new x-ray map of the Galactic Center



Our Milky Way is a comparatively tranquil galaxy. Gigantic outbursts of energy from its center, the site of a supermassive black hole, are rare. Nevertheless, astronomers have long since detected bipolar bulges close to the Galactic center. These wings or lobes show outflows from the center that only extend to distances of up to around 50 light years. Moreover, scientists have long since been familiar with the so-called Fermi bubbles, each of which stretches far beyond the galactic plane but begins some considerable distance from the center. Astron-

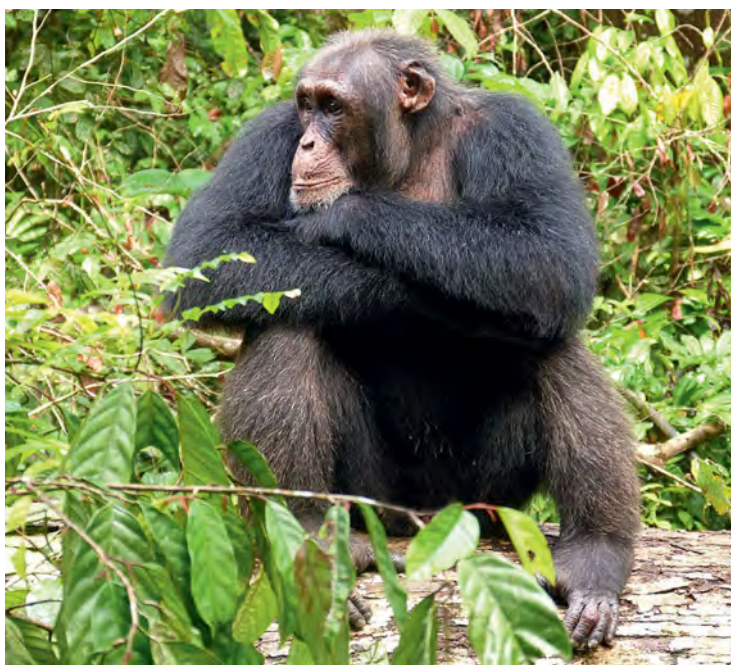
omers led by the Max Planck Institute for Extraterrestrial Physics have now discovered a new structure in x-ray images: two wide gas chimneys that connect inner regions of the center of our Milky Way north and south of the galactic plane with structures much further out. These appear to extend from the wings in the innermost regions of the Galactic Center to the base of the Fermi bubbles. The chimneys apparently blow energy and mass out of the vicinity of the black hole and transport them to the Fermi bubbles. ([www.mpg.de/13261062](http://www.mpg.de/13261062))

A look into the heart of our galaxy: this false-color image shows the x-ray emissions from the central region of the Milky Way. Elongated structures – the recently discovered chimneys – are clearly visible north and south of the galactic plane.

## Social uncertainty also puts chimpanzees under stress

Male animals are less aggressive if social relations in their group are unstable

For species that live in groups, higher status has many advantages but also comes at a cost. An international research team from the Max Planck Institute for Evolutionary Anthropology in Leipzig observed the behavior of male chimpanzees in the Taï national park on the Ivory Coast and measured the stress hormones in their urine. The results show that the male chimpanzees' hormone levels are higher in times of social instability and increased competition. This means that the animals were more stressed than in stable periods – despite showing less aggressive behavior among themselves during these times. The stress appears to be psychological rather than physiological. The males are stressed by the social uncertainty that arises when they are competing for status within the group. As with humans, chimpanzees appear to suffer particularly when their social relationships are unstable. ([www.mpg.de/13295691](http://www.mpg.de/13295691))



Male chimpanzees behave less aggressively in times of social instability in order to prevent the escalation of conflict and maintain the coherence within the group.

## Fruit bats are reforesting African woodlands

800 hectares of new forest could grow every year from the seeds scattered by the fruit bats

Intact ecosystems are not only a joy for nature lovers, they are also useful in financial terms. However, it is usually difficult to calculate how much money they actually bring in. Scientists from the Max Planck Institute for Ornithology in Radolfzell and colleagues from Sweden and Ghana have now calculated the ecological and financial benefits of straw-colored fruit bats in Africa for the first time. Every night, these bats fly long distances to their feeding grounds while scattering the seeds of the fruit they consume. According to the researchers, a colony of 150,000 bats can scatter more than 300,000 seeds in a single night. This means that 800 hectares of woodland could be reforested every year in Ghana alone – by just one colony. However, the number of straw-colored fruit bats in Africa is on the decline. The animals are at risk from hunting and the logging of large trees. Both forests and humans would benefit from better protection. ([www.mpg.de/13271542](http://www.mpg.de/13271542))



Straw-colored fruit bats love fruit more than anything.

## The roots of apple trees

The history of the apple is closely linked with that of humankind. However, it seems likely that humans were not the first to make apples a big thing. As Robert Spengler from the Max Planck Institute for the Science of Human History in Jean reveals in a new study, there is fossil and genetic evidence to indicate that apple trees developed large, fleshy, sweet fruits millions of years before they were domesticated. These were an attractive food source for large mammals, which were classified as megafauna and also distributed the apples. However, most species of megafauna became extinct at the end of the last Ice Age. As a result, populations of wild apple trees became isolated until humans began transporting the fruit, particularly along the Silk Road. Thus the lineages once again came into contact and produced hybrid varieties that bore even larger fruit. Humans then reinforced this characteristic by refining and planting seedlings from the most popular trees, thus laying the foundations for the wide variety of apples available today. ([www.shh.mpg.de/1321592](http://www.shh.mpg.de/1321592))

## A leap towards superconductivity at room temperature

Fewer power plants, fewer greenhouse gases and lower costs: if scientists were to discover superconductivity at room temperature, this could drastically cut electricity consumption. This is because superconductors transport electricity without loss. A team at the Max Planck Institute for Chemistry has moved one step closer to this goal. The researchers led by Mikhail Erements have been synthesizing lanthanum hydride. This hydrogen-rich bond with the metal lanthanum loses its electrical resistance at minus 23 degrees Cel-

sius and at pressures of less than 1.7 megabar, i.e. 1.7 million times atmospheric pressure. Until now, the record for high-temperature superconductivity was minus 70 degrees Celsius; since 2015, this has been held by hydrogen sulfide, which also has to be subjected to extremely high pressure. ([www.mpg.de/13512517](http://www.mpg.de/13512517))

The pressure is on: more than one million bar can be generated between two conically cut diamonds in an anvil cell not even the size of a fist. This makes lanthanum hydride superconductive at relatively high temperatures.

