

## Nuclear Magnetic Resonance Scanner for Individual Proteins

The nuclear magnetic resonance scanners we know from hospitals are set to become extremely sensitive. A quantum sensor developed by a team headed by Professor Jörg Wrachtrup at the University of Stuttgart and researchers at the Max Planck Institute for Solid State Research in Stuttgart makes it possible to use nuclear magnetic resonance scanning to investigate the structure of individual proteins atom by atom. The sensor, which the researchers presented back in 2013, consists of a nitrogen atom in a tiny diamond and detects magnetic signals from the atoms in a sample. The researchers have now improved its resolution to such an extent that it can distinguish the signals from different types of atoms. This method could one day help diagnose diseases in the early stages by detecting the first defective proteins. Defective protein molecules are what cause, for instance, Creutzfeldt-Jakob disease. ([www.mpg.de/11383152](http://www.mpg.de/11383152))

## *Homo sapiens* Older than Previously Thought

Modern man lived in Morocco as far back as 300,000 years ago

This find means we have to rewrite the early history of man: in Jebel Irhoud, some 100 kilometers northwest of Marrakesh, an international research team led by Jean-Jacques Hublin from the Max Planck Institute for Evolutionary Anthropology in Leipzig, Germany, and Abdelouahed Ben-Ncer from the National Institute of Archaeology and Heritage in Rabat, Morocco, uncovered remains of *Homo sapiens* along with stone tools and animal bones. The finds are around 300,000 years old, making them the oldest securely dated fossil evidence of our own species.

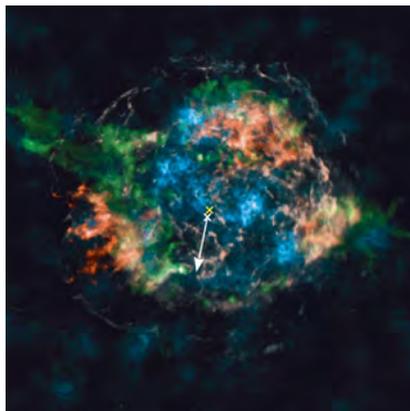
The oldest *Homo sapiens* fossils previously known are from Ethiopia and are around 100,000 years younger. Most researchers therefore as-

sumed that all humans living today descended from a population that lived in East Africa around 200,000 years ago. However, the fossils from Morocco show that *Homo sapiens* had already spread across the entire African continent around 300,000 years ago – long before the out-of-Africa dispersal of *Homo sapiens*.

The Jebel Irhoud site has been well known since the 1960s for its human fossils and stone tools. However, it was difficult to interpret these artifacts due to the uncertainty surrounding their geological age. New excavations since 2004 have uncovered further *Homo sapiens* fossils. There are a total of 22 fossilized remains of skulls, mandibles, teeth and long bones of at least five individu-

## Neutrinos Drive Supernovae

The distribution of radioactive elements in the Cassiopeia A remnant provides insight into the explosion

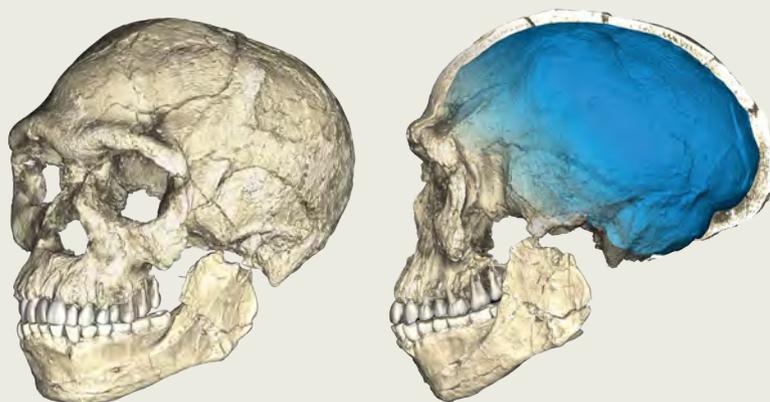


Pronounced asymmetry: Titanium (blue) and iron (white, red) in supernova remnant Cassiopeia A. The yellow cross marks the geometric center of the explosion; a white cross and an arrow indicate the current position of the neutron star and its direction of movement. Computer simulations yield a similar scenario.

Supernovae are an important source of chemical elements in space. When these stars explode, radioactive atomic nuclei are created in the hot interior and can provide information about the invisible processes that cause the explosion. Using elaborate computer simulations, a team of scientists from the Max Planck Institute for Astrophysics and Japan's RIKEN research center were able to explain the recently measured spatial distribution of radioactive titanium and nickel in Cassiopeia A, a roughly 340-year-old su-

pernova remnant. The theoretical scenario is that these elements are created in the hot ejecta near the core. Because of the wild boiling within the star, the neutrino-driven explosion begins aspherically, and the supernova expels the ejected stellar matter with a pronounced asymmetry. In the case of Cassiopeia A, the remaining compact neutron star should therefore be speeding toward the southern hemisphere, while the largest and brightest titanium structures containing most of the matter should be found in the northern half of the remnant. And that is precisely what observations of Cassiopeia A show, thus confirming the simulations. ([www.mpg.de/11368641](http://www.mpg.de/11368641))

The first of our kind: Two views of a composite reconstruction of the earliest known *Homo sapiens* fossils. The shape of the facial skull falls within the variation of humans living today. The archaic-looking brain case (blue), in contrast, indicates that the brain shape, and possibly brain function, evolved within the *Homo sapiens* lineage.



als, documenting an early stage of human evolution. The team working with geochronology expert Daniel Richter from the Max Planck Institute in Leipzig used thermoluminescence dating methods on heated flints found in the deposits to determine the age of the various layers at the site. This method takes advantage of natural radioactivity and measures how much time has passed since the heating took place.

Anatomically, the early *Homo sapiens* were already very similar to modern humans: as the researchers discovered from computer tomography (micro-CT) scans of several original fossils, they had modern-looking facial skulls and teeth. Their brain cases, in contrast, were rather elongated and not round like those in humans living today. This suggests that the shape of the facial bones was already established

when *Homo sapiens* emerged, while the brain shape and possibly also its function only developed later as our species evolved.

As a result of the most recent findings, earlier controversial finds are being reevaluated: scientists now likewise consider an approximately 260,000-year-old skull fragment from Florisbad, South Africa, to belong to *Homo sapiens*. ([www.mpg.de/11322481](http://www.mpg.de/11322481))

## Pointing a Finger at Electronics

Digital devices can be controlled with gestures above the back of the hand

Smartwatches have similar capabilities as smartphones, but they're not exactly easier to use. Anyone who has difficulties, say, selecting a point on a map on their cell phone screen probably won't have an easier time of it on a watch display. An international team working with researchers at the Max Planck Institute for Informatics is now remedying this. The team has presented WatchSense – an input method that converts finger movements on and above the back of the hand into control signals for a smartwatch, tablet or even a PC. To this end, a depth sensor attached to the forearm tracks the tips of the wearer's thumb and index finger moving across the back of the hand and transmits these finger positions to the electronic device. Users can monitor input directly on the device's display. As the researchers discovered, this method enables users to, for instance, select a new sound track or adjust the volume in a music player faster than is possible with conventional input methods.



A new type of remote control: WatchSense enables users to control electronic devices, such as smartwatches, with finger movements on and above the back of the hand by tracking the tips of the thumb and index finger.

## The Amazing Flexibility of the Human Mind

A study among illiterate women provides clues about what causes dyslexia



Writing was such a recent invention in evolutionary terms that there hasn't been time for a dedicated "reading area" to develop in the brain. Instead, brain regions that originally evolved to recognize complex objects, such as faces, are "recycled" to learn to read. In a study conducted with illiterate adult women, researchers at the Max Planck Institutes for Human Cognitive and Brain Sciences and for Psycholinguistics have now shown that this process changes the brain more fundamentally than was previously assumed. As these women learned how to read and write, the scientists registered changes that extend into the thalamus and the brain stem, which are evolutionarily old brain regions. Previously, congenital dysfunctions of the thalamus were discussed as a possible cause of dyslexia. However, this seems doubtful, since it has now been shown that this brain region can be fundamentally modified through just a few months of reading training. ([www.mpg.de/11312849](http://www.mpg.de/11312849))

Profound change: Illiterate women in India learned how to read Hindi, their native language. As they did so, brain regions that were previously assigned to different skills were modified.

## With the Grip of a Gecko

A gripper that resembles a suction cup and is equipped with microscopic nubs grips a variety of objects

Robots will soon likely be able to hold on better when they want to grasp an object: a gripper developed by researchers at the Max Planck Institute for Intelligent Systems in Stuttgart flexibly adapts to objects of different shapes and also holds them securely because its surface is covered with tiny nubs. These kinds of contact surfaces, which are inspired by the fine, extremely adhesive hairs on the soles of gecko feet, did in fact already exist, but thus far only in the form of rigid ma-

terials. They don't adhere to arbitrarily shaped objects. The coin-sized gripper developed by the materials scientists in Stuttgart resembles a suction cup. It uses negative pressure to hug the contours of a variety of shapes and can hold, for instance, a 300-gram glass flask filled with liquid. ([www.mpg.de/11315088](http://www.mpg.de/11315088))

Teacups and tomatoes – the gripper developed by the Stuttgart-based researchers grasps a variety of objects and also holds them securely.



# Gut Bacteria Affect Aging

Microorganisms of young fish increase the lifespan of older conspecifics

It loses its pigmentation, its motor skills and mental faculties decline, it gets cancer – the turquoise killifish struggles with similar signs of old age as many other living creatures. But this African

fish is just a few months old when physical decline sets in. As with humans, the composition of the microbial community in the killifish gut changes with age: in young fish, many different species of bacteria ensure a healthy gut, but this diversity decreases as the fish age, while the proportion of pathogens increases. Scientists from the Max Planck Institute for Biology of Ageing in Cologne

have now transferred the microorganisms of young killifish to middle-aged animals. With the young intestinal microbiota, the fish not only live around 40 percent longer, but at the ripe old age of four months, they are also still as agile as young fish. If young fish receive the gut microbes of older animals, their lifespan, in contrast, doesn't decrease. It's still not clear just how the microbes affect longevity. It's possible that the intestinal flora from a young organism supports the immune system and thus prevents the proliferation of pathogens over the course of the fish's life. ([www.mpg.de/11236218](http://www.mpg.de/11236218))



After just a few months, the vibrant colors of the turquoise killifish begin to fade. The fish's rapid physical decline with age has piqued the interest of researchers on aging worldwide.

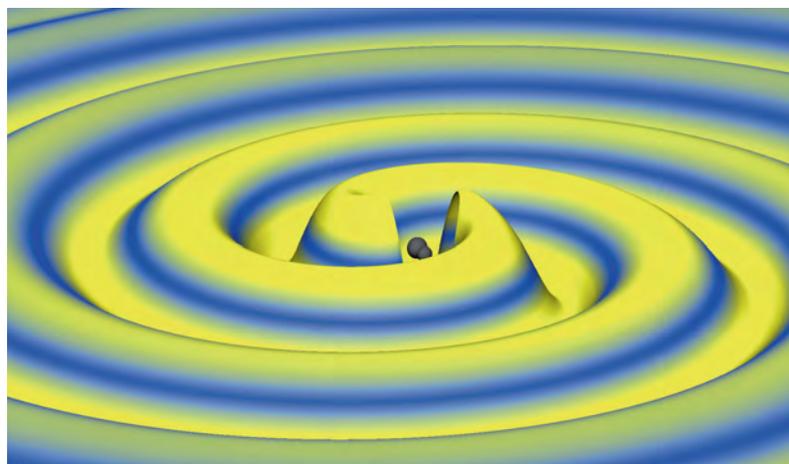
## Gravitational Waves Detected for the Third Time

LIGO detectors observe a signal that is once again discovered at the Albert Einstein Institute in Hannover

For the third time, researchers have detected the gravitational waves that Albert Einstein predicted 100 years ago. The two LIGO detectors in the US signaled a hit on January 4, 2017 at 11:11:58.6 CET. The gravitational wave designated GW170104 reached the detector in Hanford three milliseconds before reaching the one in Livingston – an effect that owes to the source's position in the sky. Two black holes, with 31 and 19 solar masses, had merged into one black hole with 49 solar masses. The signal was first observed at the Max Planck Institute for Gravitational Physics (Albert Einstein Institute) in Hannover. There, Alexander Nitz investigated a few candidates that an analysis system he developed had identified in almost real time. In doing so, the researcher first came across a promising signal in the Livingston detector data, then subsequently also in the Han-

ford data. The newly observed black hole, with its 49 solar masses, fills the gap between the two merged black holes previously detected by LIGO and points to a new class of these objects. ([www.mpg.de/11325825](http://www.mpg.de/11325825))

The source of the wave: This image comes from a numerical simulation of the gravitational wave event GW170104, which was generated by the merger of two black holes. The strength of the gravitational wave is indicated by both the height and the color: blue denotes weak fields, yellow, strong. The black holes were enlarged by a factor of two in order to improve their visibility.



## DNA from Prehistoric Humans Discovered in Cave Soil

A new method enables researchers to detect millennia-old DNA in cave sediments

Tools and other artifacts produced by ancient humans have been unearthed at many prehistoric archaeological sites. It often remains unclear just who the creators were, as archaeologists rarely find human fossils such as bones or teeth in the sediment layers connected with these finds. But researchers at the Max Planck Institute for Evolutionary Anthropology in Leipzig “fished out” tiny DNA fragments from sediment samples ranging from 14,000 to more than 550,000 years old. The scientists were able to identify the DNA fragments as belonging to Neanderthals, Denisovans and modern humans, as well as various extinct mammals. Using these DNA traces in the soil, researchers will soon be able to detect the presence of ancient humans and other mammalian species even at archaeological sites where no more-conspicuous remains were found. ([www.mpg.de/11247830](http://www.mpg.de/11247830))



Researchers found traces of DNA in the sediment layers of the El Sidrón cave in Spain.

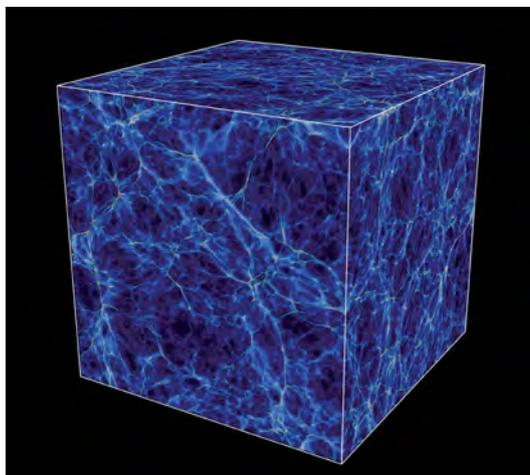
## Shedding Light on the Cosmic Web

Astronomers use the light from twin quasars to survey the structure of the universe

The matter in intergalactic space forms a vast network of interconnected filaments. Nearly all atoms in the universe

– most of them direct remnants of the Big Bang – are part of this cosmic web. Now, a team led by researchers at the Max Planck Institute for Astronomy has surveyed the fine structure of this web some two billion years after the Big Bang – using a new method that takes advantage of pairs of distant, hyperluminous quasars located very close to one another to illuminate space. Quasars are the active cores of young galaxies. In their study of charted regions more than

11 billion light-years away from us, the scientists identified structural differences on scales of just a few hundred thousand light-years – comparable to the size of individual galaxies. The light from two sources (quasars) enabled them to describe these differences quantitatively. The astronomers then compared their findings with supercomputer models that simulate the development of cosmic structures from the Big Bang to the present. To the researchers’ delight, these simulations yield a universe that matches the observation data quite well. ([www.mpg.de/11259384](http://www.mpg.de/11259384))



Snapshot: An image from a supercomputer simulation of the cosmic web 11.5 billion years ago. The researchers created this and other models and subsequently compared them with the quasar observations to draw conclusions about the properties of the young universe. Each side of the cubic section shown here measures 24 million light-years.

## Being Overweight Increases Risk of Alzheimer's

Obesity is associated with fewer connections between regions of the brain

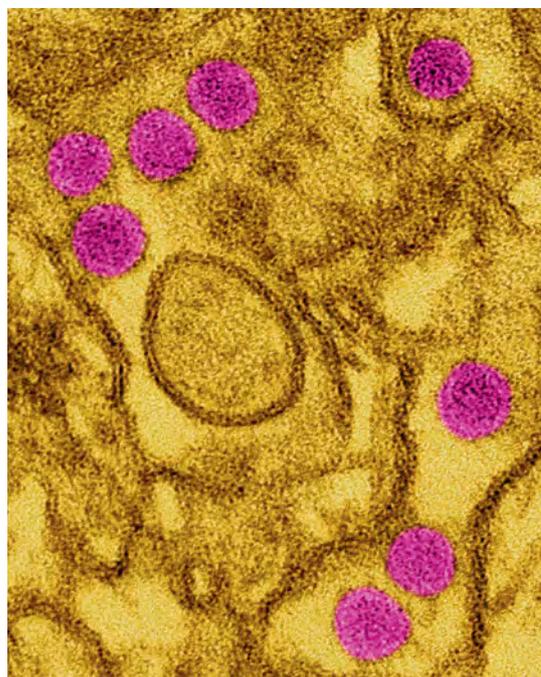
Being severely overweight or obese not only increases the risk of diabetes, heart failure and arteriosclerosis, it evidently also compromises the brain. According to scientists at the Max Planck Institute for Human Cognitive and Brain Sciences in Leipzig, some areas of the brain are less strongly connected in severely overweight people aged 60 to 80. As a result, individual regions are less capable of interacting in the default mode network. This network becomes ac-

tive when we let our mind wander, but also, for example, when we are planning future action or recalling the past. Weaker links within this network, on the other hand, are an early indicator of impending dementia. Older, severely overweight individuals could also be at greater risk for Alzheimer's. The researchers now plan to investigate how changes in diet affect the brain network and mental faculties in general.

## Zika Viruses Produced in the Lab

Scientists fulfill a crucial prerequisite for vaccine production

In the last ten years, the Zika virus, which is transmitted by the yellow fever mosquito, spread from Africa and is now found in around 60 countries. The virus gained notoriety shortly before the 2016 Olympic Games in Brazil, when it became known that an infection during pregnancy can harm newborns. People who live outside of Africa have no natural immunity, so scientists are working to develop a vaccine against the pathogen. Researchers at the Max Planck Institute for Dynamics of Complex Technical Systems in Magdeburg, in collaboration with a research team in Brazil, have now propagated large quantities of Zika viruses in the lab. To that end, they adapted hamster cells to be able to grow in a liquid nutrient medium and infected them with viruses from Brazil. After almost two weeks, the scientists harvested nearly 40 million infectious viruses per milliliter from high-density cell cultures. Thanks to these findings, researchers can now conduct further studies on the Zika virus. ([www.mpg.de/11293337](http://www.mpg.de/11293337))



Colored electron microscopy image of Zika viruses (pink) in kidney cells: The viruses are transmitted to humans by mosquitoes, but they can also be transmitted sexually. If pregnant women contract Zika fever, their babies may exhibit brain growth disorders (microcephaly) after birth.

## Diagnosing Cancer with a Breath Test

Inhale deeply ... and exhale. This is what a test for lung cancer could one day look like. Today, most lung cancer patients die within five years of being diagnosed. One of the main reasons for this is that the disease isn't noticed until it is too late. Scientists at the Max Planck Institute for Heart and Lung Research in Bad Nauheim therefore developed a method that can detect the disease at an early stage. To do this, they analyzed breath samples for traces of RNA variants of the GATA6 and NKX2 genes, which are produced in different amounts in cancerous and healthy cells. Using a newly developed method, they can isolate the RNA molecules that are present in the breath in trace amounts, and usually fragmented. In one study involving healthy subjects and cancer patients, the breath test correctly determined the health status of 98 percent of the participants. With such a high success rate, this method could be used for routine early detection in clinics, as a complement to conventional methods. Together with the technology transfer organization Max Planck Innovation, the researchers are now seeking licensing partners to develop the breath test to maturity and market it. ([www.mpg.de/11237619](http://www.mpg.de/11237619))