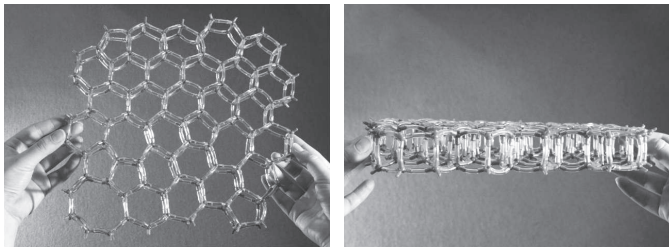
# Clear View into Glass

Researchers in Berlin have analyzed the atomic structure of amorphous silica for the first time

We can look through glass, but what glass itself looks like on the inside has remained a mystery to date – at least when it comes to the exact position of the atoms. Scientists at the Max Planck Society's Fritz Haber Institute in Berlin have imaged, for the first time, the structure of silicon and oxygen atoms – the main components of glass – in a disordered silica film. To do this, they used high-resolution microscopes to look at a thin glass film just two atomic layers thick and whose internal structure can't be examined using conventional methods of structure determination. In doing so, the researchers confirmed that glass consists of a network of different sized rings containing alternate silicon and oxygen atoms. Norwegian-American physicist William H. Zachariasen had already posited this structure as far back as 1932. In other studies, the researchers observed the transition from a crystalline into a disordered structure. Their findings could also help in the search for more powerful catalysts in which amorphous silica is used a substrate.

(Journal of Physical Chemistry C, August 8, 2012)



A model of two-dimensional glass: Measurements taken by the Max Planck researchers in Berlin prove that disordered silica forms a structure in which not only hexagonal shapes, but also pentagonal and heptagonal ones are created.

# Traces of Trauma in Genetic Material

Abuse during childhood leads to epigenetic modifications to the hormone gene

Abused children often suffer their whole life as a result of their experiences, and as adults suffer from depression or anxiety. A victim's genetic predisposition is crucial in determining whether a victim actually becomes ill. The risk of developing post-traumatic stress disorder rose with increasing severity of abuse only in the carriers of a specific genetic variant in the FKBP5 gene. Scientists at the Max Planck Institute of Psychiatry in Munich have now discovered that traumatic experiences can modify this FKBP5 genetic variant epigenetically. A methyl group separates from the gene at this point. This causes a marked increase in the activity of the gene and can permanently disrupt the balance in the victim's stress hormone system, ultimately leading to psychiatric illness. The epigenetic change in the DNA is generated primarily by childhood traumatization and doesn't occur in individuals who are traumatized as adults. In time, these findings could help to identify and treat victims of trauma who are at a particularly high risk of contracting a psychiatric illness.

(Nature Neuroscience, November 3, 2012)

Abused children often suffer from their trauma their entire life. Individuals affected in this way express their fears in drawings.

Photo: Fritz Haber Institute – Markus Heyde (top), MPI of Psychiatry (bottom)

# Inspiration for the Neanderthals

Cultural exchange between modern humans and their relatives

*Homo sapiens* brought art and culture to Europe. A number of scientists reached this conclusion following the discovery of early Stone Age tools and items of jewelry. Some of the scientists believe that Neanderthals created some of these objects. They appear to be correct: According to researchers at the Max Planck Institute for Evolutionary Anthropology in Leipzig, Neanderthals did manufacture complex tools and items of jewelry during the Châtelperronian phase around 40,000 years ago – after they had learned these skills from watching modern humans. Using state-of-the-art radiocarbon dating techniques, the scientists were able to date finds from two sites – the Grotte du Renne and the Grottes de Saint-Cézaire – in France to between 41,000 and 44,500 years ago. A Neanderthal skeleton from Saint-Cézaire dates to 41,500 years ago. The Leipzig-based researchers concluded that Neanderthals had made the objects during the Châtelperronian. At this point, modern humans were already present in Southern France and in Germany and had introduced new behaviors in these areas. Both Neanderthals and modern humans evidently participated in some form of cultural exchange.

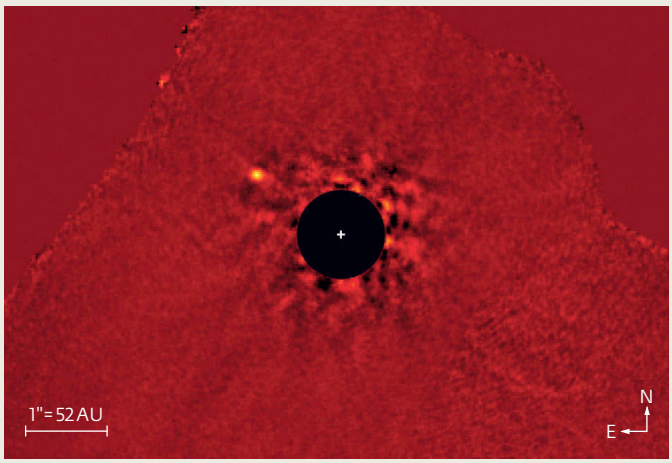
(PNAS, published online, October 29, 2012)


Châtelperronian body ornaments from the Grotte du Renne in Arcy-sur-Cure, France. According to the latest dating information, Neanderthals made the objects.

# Super Jupiter Portrayed

A discovery in the Andromeda constellation sheds new light on the birth of planets

Capturing an image of extrasolar planets is difficult: the celestial bodies are very far away, relatively small and drown in the light of their parent star. Nevertheless, researchers, including several from the Max Planck Institute for Astronomy, have successfully captured an image of a super Jupiter, 13 times the mass of our Jupiter, using the Subaru telescope in Hawaii. It orbits the Kappa Andromedae star, which is 2.5 times the mass of the Sun and, at an estimated 30 million years, is very young. The new exoplanet is located around eight billion kilometers away from its parent star. Astronomers believe it is highly likely the celestial body formed in a similar way to smaller, lower-mass planets: in a protoplanetary disk of gas and dust that surrounded the young star in its earliest stages of development. This makes the discovery of the planet a test case for current models of how planets are born. (Astrophysical Journal Letters, in press)




Astronomical bull's-eye: False color near-infrared image of the Kappa Andromedae system, captured using the Subaru telescope in Hawaii in July 2012. Most of the light from the parent star, on which the photo is centered, was filtered out by image processing. The super Jupiter Kappa Andromedae b can be clearly seen at the top left of the picture.

Photos: Marian Vanhaeren and Michele Julien (top), NAOJ/Subaru/J. Carson (College of Charleston)/T. Currie (University of Toronto) (bottom)

# The Pathways of Epidemics

A new computer model rapidly and accurately assesses who spreads an infection particularly extensively, thus facilitating countermeasures

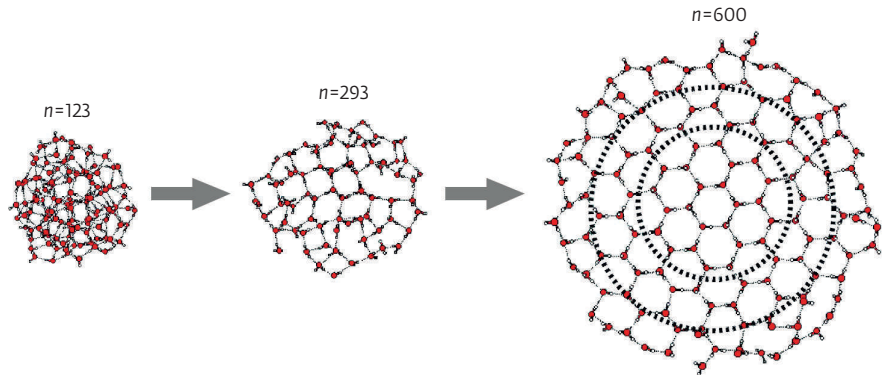
A new computer-aided method developed by researchers at the Max Planck Institute for Mathematics in the Sciences could help to curb epidemics more effectively in the future. Essentially, the new process identifies those individuals in the population who propagate an infection most strongly. The distinguishing feature of this process is that it estimates the actual number of people who can directly or indirectly infect a specific person using significantly less computational effort than comparable precision processes. This property is connected with the structure of the social networks in which an infected person is integrated. Information about how many more people a contagious person infects compared with a less virulent carrier is especially important at times when a vaccine is in short supply. In such cases, doctors need to know which individuals they should preferentially vaccinate to most effectively prevent a pandemic. (EPL, October 5, 2012)

## An Eye for an Eye, a Tooth for a Tooth

Vendettas and blood feuds occur in many societies, sometimes lasting for decades. These occur even though theoretical calculations show that vendettas are costly for the participants from an evolutionary point of view and therefore shouldn't develop. They usually lack any apparent benefits, and the harm for participants is huge. Using common-good games and the "prisoner's dilemma," researchers at the Max Planck Institute for Evolutionary Biology in Plön and the University of Göttingen have now shown that vendettas can arise from conflicts in groups of several individuals. Punishments that are actually intended to sanction misconduct and increase willingness to cooperate regularly escalated in the scientists' experiments to vendettas, especially when the original punishment was unjust or excessive. In relationships between two people, on the other hand, vendettas didn't endure – the disadvantages for the participants are clearly too great. Even if vendettas cause serious problems, according to the researchers, they can ensure justice between two parties in larger groups and protect against unjust or excessive punishment.
(PLOS ONE, September 19, 2012)

## The Smallest Ice Crystals in the World

An ingenious experiment reveals the minimum number of molecules needed before water forms a crystalline structure




At the origin of the perfect crystal: Water crystallizes with a six-fold symmetry that can be seen in every snowflake. This structure already forms in water clusters that have 475 molecules and that don't resemble a snowflake at all.

Graphic: MPI for Dynamics and Self-Organization – Udo Buck

Ice crystals also have small beginnings – smaller than previously believed. Even 475 water molecules can form a real crystalline structure; initial attempts can be discerned with as few as 275 molecules. It was previously believed that around 1,000 molecules were the minimum necessary for a complete crystal. The new lower limit for ice clusters was determined by researchers working with Thomas Zeuch at the University of Göttingen in an experiment developed by Udo Buck from the Göttingen-based Max Planck Institute for Dynamics and Self-Organization. The researchers generated water clusters of different sizes at temperatures ranging from minus 180 to minus 150 degrees Celsius. They discovered the minimum number of molecules needed to form a crystalline structure by irradiating the ice clusters using infrared light. This light shows how the molecules vibrate. The vibration profile changes as soon as the molecules form a crystal. The scientists hope that the result will help climate researchers to gain a more accurate understanding of the formation of ice clouds in the upper atmosphere and to consequently improve their climate models. (Science, September 21, 2012)

# Late Birth, Healthy Life

Children of women aged around 40 are not sicker later in life any more frequently than the offspring of 30-something mothers

A mother's age at the time she gives birth doesn't determine the health of her child in later life. Instead, the determining factors are her education and the number of years that she gets to spend with the child. This was revealed in a study carried out by Mikko Myrskylä at the Max Planck Institute for Demographic Research using data collected from more than 18,000 individuals in the US. The scientists adjusted the health data for other potential contributing factors, such as the mother's level of education and lifespan. They came to the conclusion that children whose mothers were aged between 35 and 44 were not ill any more often as adults than children of mothers aged between 25 and 34. This contradicts the previous assumption that the adult offspring of older mothers are sick more frequently because the woman's body had already degenerated at the time of the birth, for example due to physiological effects like decreasing ovocyte quality or a weakened placenta. However, it is still true that higher maternal age increases the likelihood of miscarriage and conditions like Down syndrome. The researchers aren't exactly sure why the number of years the mother and child spend together has an effect on the subsequent health of the child. It could be that mothers can support their children better the longer they are there for them.

(Demography, August 28, 2012)

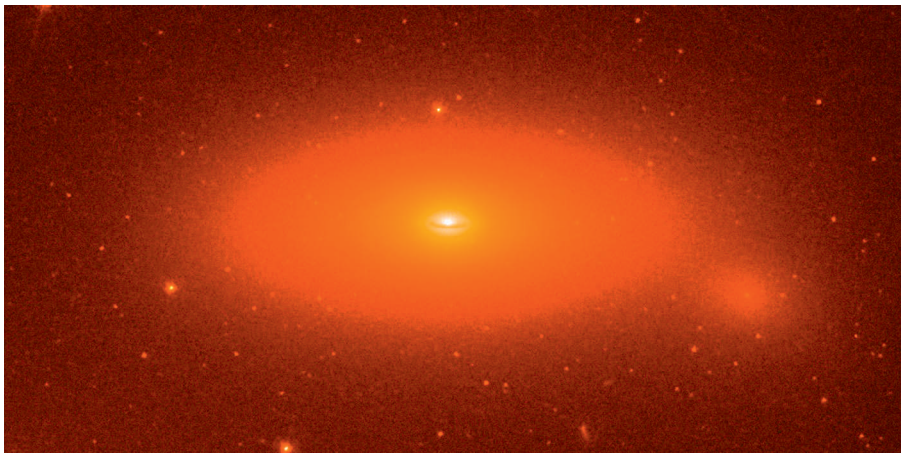
The mother's education and the number of years she survives after giving birth and thus spends with her offspring, rather than her age, are crucial to the health of the adult children.

# Black Hole Upsets Galaxy Models

An unusually massive object in a tiny galaxy challenges theorists

A super-heavy black hole exists at the heart of every galaxy. Its mass usually accounts for approximately 0.1 percent of the total mass of the parent galaxy. This is what the observations have shown, which are in accordance with current galaxy evolution models. Now, an international team working with Remco van den Bosch at the Max Planck Institute for Astronomy has tracked down a black hole that appears to upset this connection. To accomplish this, the researchers used the Hobby-Eberly Telescope in Texas and archived images from the *Hubble Telescope*. In the process, they discovered a gravitational trap with no fewer than 17 billion solar masses in the small galaxy NGC 1277. The object could set a "heavyweight" record: its mass amounts to around 14 percent of the total mass of NGC 1277, or in other words, considerably more than the 0.1 percent mentioned above. The astronomers would have expected this type of gigantic black hole in a galaxy at least ten times bigger than this one.

(Nature, November 29, 2012)



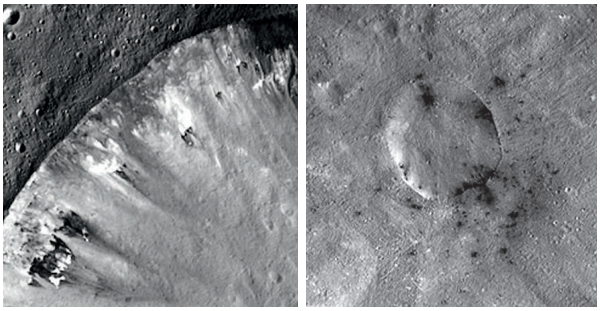
Invisible gravitational trap: The center of the NGC 1277 disk galaxy harbors a black hole with 17 billion solar masses, making it one of the heaviest black holes ever found.

Photo: FrOnline (top), NASA/ESA/Andrew C. Fabian/Remco C. van den Bosch, MPIA (bottom)

# The Shattered Protoplanet

Powerful impacts on Vesta transferred carbonaceous material

With a diameter of approximately 525 kilometers, the protoplanet Vesta has had an eventful past: images captured by the German Framing Camera on board the US space probe *Dawn* show two enormous craters at its southern hemisphere. These were caused by impacts that permanently altered not only the celestial body's shape, but also its surface composition. A team of scientists headed by the Max Planck Institute for Solar System Research have shown that the two cosmic fragments that shattered the southern hemisphere of Vesta between one and two billion years ago brought with them dark, carbonaceous material. This explains the unique differences in brightness, as the dark material, which is located all over the surface, reflects as little light as carbon does. The researchers believe that similar collisions in the early period of the solar system also supplied the inner planets, such as the Earth, with carbon, a basic building block of organic compounds.
(Icarus, Vol. 221, Issue 2, November/December 2012)



Scars from early history: Most of the dark, carbonaceous material on Vesta can be found on the rims of smaller craters (left) or scattered in their surroundings (right). It arrived on the surface of the protoplanet as a result of collisions with cosmic fragments.

# Making Music Together Connects Brains

Nerve cells can be synchronized between individuals

When people make music together, the impulse for their own actions comes from the coordinated activity of the group. In fact – as scientists from the Max Planck Institute for Human Development in Berlin have shown – their brains also synchronize. The scientists used electrodes on the heads of guitarists playing in duets to trace the brain waves. The synchronization process was particularly notable in the so-called delta waves, which are located in the frequency range below four hertz. This occurred not only within the brain of one individual musician, but also between the heads of the duet partners. In the player taking the lead, the synchronization of brain waves was more pronounced and was already present before the duet started to play. The researchers in Berlin attribute the synchronization of the players' brain waves to an active synchronization process and not to the fact that they are both doing the same thing. The guitarists were actually playing in different voices. The scientists assume that this synchronization between brains doesn't happen only when playing music, but also when people coordinate their actions in other ways, such as during sports or when dancing together.
(Frontiers in Human Neuroscience, November 29, 2012)

Electrical activity in the guitarists' brains is recorded via 64 electrodes.

Photos: NASA/JPL-Caltech/UCLA/MPS/DLR/IDA (top, 2). MPI for Human Development – Schulze (bottom)

# More Carbon Dioxide Leads to Less Vapor

The main reason for the anthropogenic greenhouse effect, the increasing concentration of carbon dioxide in the atmosphere, has an unexpected side effect: less water evaporates. Plants, with their billions of tiny leaf pores, are the cause of this apparent contradiction. They open for a shorter time when $CO_2$ levels increase, meaning that less moisture evaporates. This finding was made by an international research team, in which scientists from the Max Planck Institute for Chemistry and the Max Planck Institute for Meteorology participated. The team simulated three scenarios: a doubling of current $CO_2$ levels in the atmosphere, an increase in the global average temperature by 2 degrees Celsius and a combination of both scenarios. In contrast to a scenario where there is only an increase in temperature, evaporation fell with increased $CO_2$ concentration. According to the last realistic scenario, the scientists assume that evaporation will decrease by around 15 percent. A previously unknown feedback mechanism, in which global warming is intensified because fewer clouds form, emerges as a result. (Nature Geoscience, September 2, 2012)

Because more carbon dioxide in the atmosphere inhibits evaporation from plants, fewer clouds may be formed in the future.

# Quantum Stress in Nanofilms

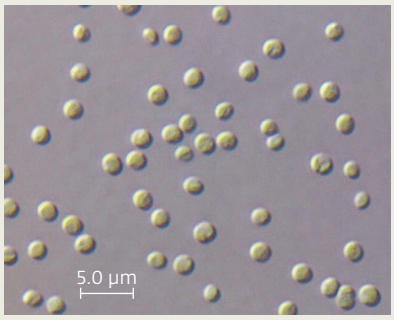
Read heads in hard drives, lasers in DVD players and many other devices contain ultrathin films of metal or semiconductor materials. These devices only work perfectly if the films contain no defects. Yet during their manufacture, stresses arise in the films, causing defects in their structure. Researchers at the Max Planck Institute for Intelligent Systems in Stuttgart have now discovered a previously unknown mechanism that can cause damaging stresses equivalent to up to one thousand times standard atmospheric pressure in films just a few atomic layers thick. This is caused by the wave properties of electrons. The wavelength of electrons corresponds roughly to the thickness of the nanofilm. The result, simply put, is that electrons don't fit into an arbitrarily high stack of atomic layers. According to the laws of quantum mechanics, there is only room for complete wave packets, with the result that the stack is sometimes a little too thin, sometimes a little too thick. The film thus shrinks or expands along the direction of the stack. In response to this, the film is perpendicularly compressed or relaxed to the surface. This mechanism could possibly be used for highly sensitive gas sensors.
(Physical Review Letters, July 27, 2012)

# Bartering in the Ocean

## Symbiosis ensures that nitrogen fertilizes the seas

Nitrogen is a vital nutrient in cell growth. However, only a few organisms can use nitrogen in its gaseous state in the atmosphere or dissolved in water. A recently discovered cyanobacterium, like many other members of this family of microorganisms, has this ability. Unusually for cyanobacteria, the newly discovered single-celled organism can't form carbon compounds through photosynthesis – an ability that countless plankton algae have. It is logical therefore for the two organisms to work together. Researchers at the Bremen-based Max Planck Institute for Marine Microbiology have now demonstrated a symbiosis between the bacterium and single-celled algae in a class known as prymnesiophyte. The bacterium supplies the algae with nitrogen, and in return, receives carbon compounds. The scientists assume that it piggybacks in a hollow on an alga measuring just one-thousandth of a millimeter. While various types of land-based plants, such as peas, beans and clover, benefit from symbiosis with nitrogen-fixing bacteria, this new community is the first of its kind that we know about in the ocean. It plays an important role in fertilizing the world's oceans with nitrogen compounds. It is also a potential model for the first symbioses of cells with cyanobacteria, from which chloroplasts evolve in plant cells.
(Science, September 21, 2012)

Algae of the genus *Nannochloris*. They resemble the species with which some cyanobacteria enter into symbiosis.




Photos: Bart von Stratum (top), Daniel Vaulot, Station Biologique, Roscoff, France (bottom)