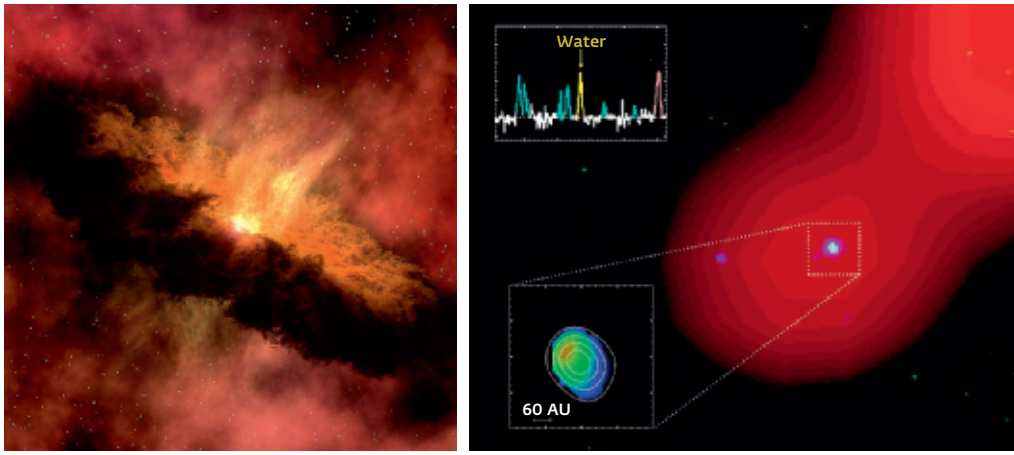
The Elixir of Life in Space

Scientists find large quantities of water in the disk that surrounds young stars

Water is the elixir of life – and space is full of it. Scientists have now found the substance in a disk surrounding a star of the same type as our Sun. Ewine van Dishoeck from the Max Planck Institute for Extraterrestrial Physics and the Leiden Observatory, and Jes Jørgensen from the University of Bonn's Argelander Institute and the University of Copenhagen used the IRAM interferometer to search for heavy water molecules ($H_2{}^{18}O$) in the vicinity of the young star NGC 1333 IRAS4B, which is between 10,000 and 50,000 years old.

The scientists discovered that most of the water vapor is to be found in the rotating disk at a distance of 25 astronomical units (AU) from the star, roughly equivalent to the distance from the planet Neptune to the Sun (1 AU is the distance from Earth to the Sun).

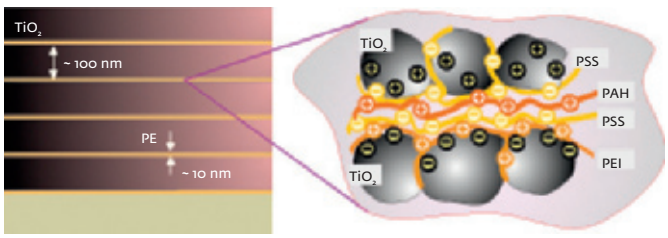
Earlier observations of NGC 1333 IRAS4B had revealed that the water might be drizzling mainly from the surrounding molecular cloud onto the disk in the form of gas and collecting there. The IRAM data now show that the star's disk contains 100 times more water than the models of this scenario predicted – equivalent to 100 times the amount of water in the Earth's oceans. (The Astrophysical Journal, February 10, 2010)



An artist's impression of the young star NGC 1333 IRAS4B (left). Scientists believe that the planets of a solar system are being created in the disk. They have shown for the first time that it also contains large quantities of water (right).

Mother-of-Pearl Sets the Standard

It sometimes pays to look at nature when searching for the right proportions – and this applies equally to materials scientists. At the Max Planck Institute for Metals Research, scientists found that bivalves (mussels), for example, layer proteins and calcium carbonate in mother-of-pearl in exactly the right proportions of thickness, making the mother-of-pearl particularly strong. Using mother-of-pearl as a model, the scientists created a composite from titanium dioxide and a polymer, and varied the thickness of the layers. But they found it impossible to improve on nature's ratio: the titanium dioxide/polymer composite proved to be most stable when the inorganic layer was ten times as thick as the organic layer – exactly the proportions in mother-of-pearl. (Nano Letters, November 6, 2009)



A stable sandwich: Nanolayers of titanium dioxide and a polymer arranged in a ratio of 10:1 make a particularly robust composite.

Older Generation With More Entrepreneurial Spirit

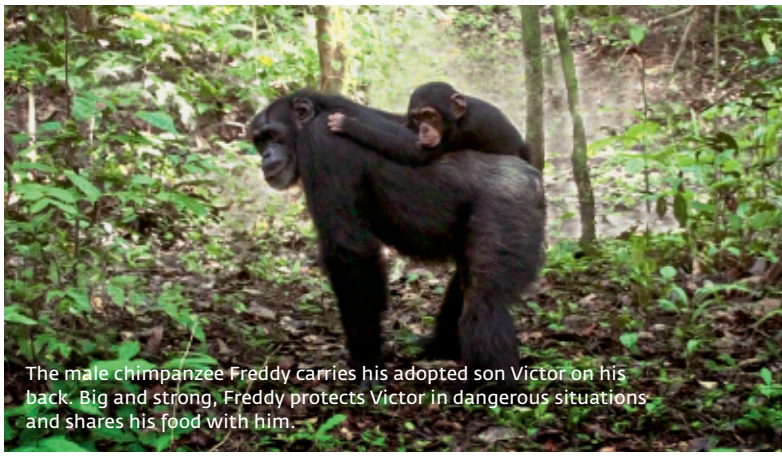
In the future, older people will probably take on more risk than the younger generation – at least when it comes to setting themselves up in business. This is the finding of a study into the effects of demographic change on free enterprise, conducted by researchers at the Max Planck Institute for Economics. The study revealed that people born in years with a high birth rate were more likely to start up a company than people born in years when the birth rate was lower. As the baby boom years are receding further into the past, the people who are more likely to venture into self-employment are also older. The Max Planck researchers think that people born in these years are more entrepreneurial because they are supported by a closer social network. The social environment of the succeeding generations, on the other hand, becomes less closely knit as the result of demographic change. Stronger encouragement of entrepreneurial spirit in younger people will thus be needed in the future.

Graphic: MPI for Metals Research (bottom), photos: NASA/JPL-Caltech/R. Hurt (SSC), Ewine van Dishoeck/Jes Jørgensen (top)

Chimpanzees Help Orphans

In the wild, chimpanzees will adopt young who have lost their parents

What distinguishes humans from animals? For some it is language, for others it is the altruistic willingness to help other members of the species. However, this kind of altruism seems to exist in the animal world, as well. Researchers working with Christophe Boesch at the Max Planck Institute for Evolutionary Anthropology in Leipzig observed that West African chimpanzees adopt orphaned young even though they are not related to them. Several animals lavished care on a juvenile for several years. Surprisingly, half of these adoptive parents were male. This behavior is thought to be encouraged by the presence of leopards with whom the West African chimpanzees share their habitat. The constant threat from the big cats seems to have encouraged cohesion and solidarity within the group. Accordingly, the scientists observed more chimpanzee adoptions in West Africa's Taï National Park than in East Africa. Wild chimpanzees appear to be more prepared to help than those living in captivity. In zoos, chimpanzees cooperate with other members of the group to only a very limited extent. "Our observations show that altruism in wild chimpanzees is much more widespread than studies of chimpanzees in zoos would suggest," concludes Christophe Boesch. (PLoS ONE, January 26, 2010)



The male chimpanzee Freddy carries his adopted son Victor on his back. Big and strong, Freddy protects Victor in dangerous situations and shares his food with him.

Photos: MPI for Biological Cybernetics (bottom), MPI for Evolutionary Anthropology/Deschner (top)

He Who Shoots First Loses

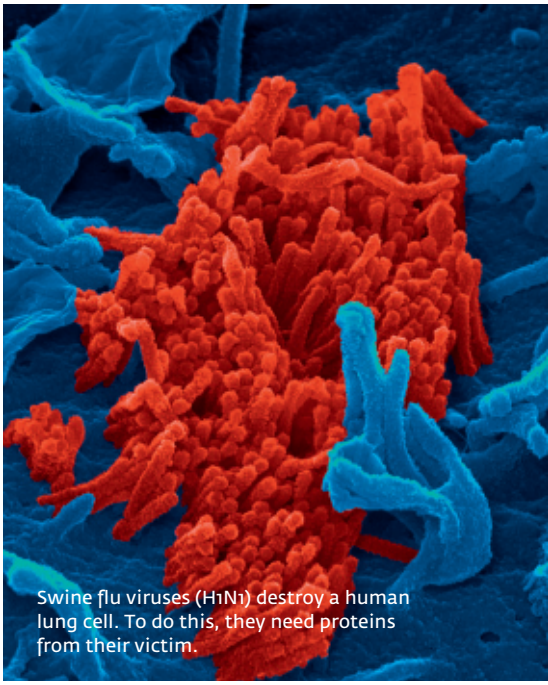
In duels in old Westerns, the cowboy who draws first always comes off worse. This observation intrigued Nobel laureate Niels Bohr and led him to assume that the brain can react faster than it can act. Allegedly, Niels Bohr and a colleague even dueled with toy pistols to prove the theory. Scientists from the Max Planck Institute for Biological Cybernetics in Tübingen have taken a new look at this issue and set up a harmless "shoot-out" in a laboratory. Two research participants were asked to compete to press buttons on a control panel faster than the other. There was no starting signal, so they either had to act on their own initiative or react faster than their opponent. The result confirmed Bohr's assumption: the reacting participants were 21 milliseconds faster, on average, than those who initiated the duel. The brain can indeed react faster than it can act. This seems to make sense, because fast reaction times can be important for survival, to avoid a rapidly approaching vehicle, for instance. (Proceedings of the Royal Society B., February 3, 2010)

High noon in the laboratory: Waiting for one's opponent to act is usually a winning strategy. This is because the brain can react faster than it can act.

Genes Working in the Service of Others

Flu viruses use their host cells for their own reproduction

Our bodies are permanently under siege – viruses and bacteria are constantly trying to get past the defense systems that protect us from infection. Scientists at the Max Planck Institute for Infection Biology in Berlin have now discovered that flu viruses use 287 of the approximately 24,000 human genes to invade the body's cells and reproduce in them. They benefit from the circumstance that small RNA molecules can inhibit individual genes (RNA interference). In the future, this microRNA could take the form of medications, opening up new opportunities for treating infections. Thomas Meyer, head of the research group at the Max Planck Institute, is convinced that, "The strategy of temporarily switching off certain genes in humans will soon play a key role in fighting infectious disease." Furthermore, it is very unlikely that viruses could become resistant to such medication. As a next step, the researchers want to examine whether these genes can be blocked in the body without any significant side effects. (Nature online, January 17, 2010)

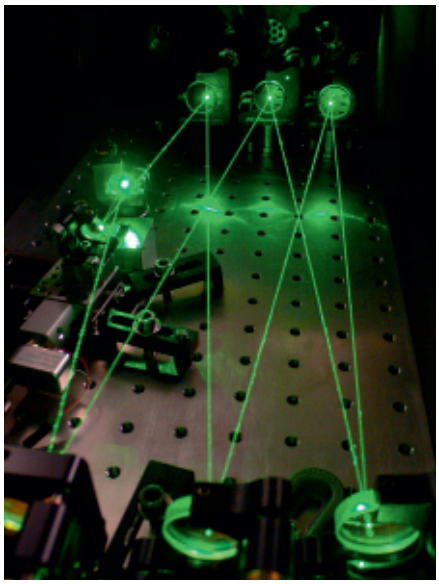


Swine flu viruses (H1N1) destroy a human lung cell. To do this, they need proteins from their victim.

Precision Scale for Atomic Nuclei

The map of our world no longer shows any unexplored islands, but physicists think they might have found one in the periodic table of elements. They suspect that there are stable laboratory-created elements that are heavier than uranium – making them an island of stability among the superheavy artificial elements, which often decay within milliseconds. Help might be at hand in the search for this island in the form of a highly accurate scale for weighing superheavy atomic nuclei. The scale was developed in a project headed by the GSI Helmholtz Centre for Heavy Ion Research, with the collaboration of the Max Planck Institute for Nuclear Physics in Heidelberg. In the apparatus, atomic nuclei run on a helical path that forms a closed ring similar to the end of an electric milk foamer. The mass of the atomic nuclei can be determined from the frequency with which the atomic nuclei move through the spiral and the ring. The mass of a nucleus reveals to physicists how strongly its components – neutrons and protons – are bound to each other, because its mass is less than the sum of the masses of its components. Applying Einstein's formula $E = mc^2$, the missing amount represents the binding energy of the nucleus, which is released when the nucleus is formed. The physicists can now use the results of these measurements to determine which of the various theories predicting the island of stability for different proton/neutron combinations is the correct one. (Nature, February 11, 2010)

Help in the Search for Chemical Traces



Searching for trace gases: Green laser light is reflected between mirrors in a resonator and penetrates the gas sample several times. This increases the intensity of the measured signal.

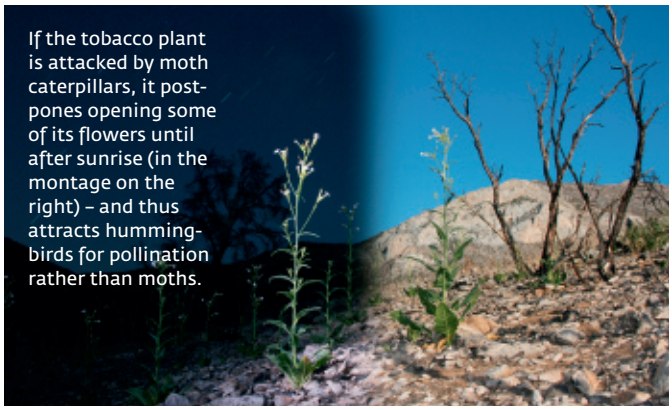
It is now easier to identify traces of chemicals. Scientists at the Max Planck Institute of Quantum Optics in Garching, working with colleagues from France and Japan, have developed a device that detects gas traces very quickly and with great accuracy. These gases play a major role in air pollution and climate change, as well as in investigating the atmospheres of other planets. The gas molecules can be identified by their spectra when they absorb light. In order to detect them quickly even when they are present in very small quantities, the new apparatus combines two frequency combs that contain spectral lines positioned at very regular intervals with an amplifying resonator. The researchers use one frequency comb to screen the sample, and use the other like a light ruler to read the absorbed frequencies quickly and accurately.
(Nature Photonics, January 2010)

Photos: MPI of Quantum Optics (bottom), MPI for Infection Biology/Volker Brinkmann (top)

Plants Spurn Insects

The flowers of the wild tobacco plant become invisible to moths when they have been attacked by their caterpillars

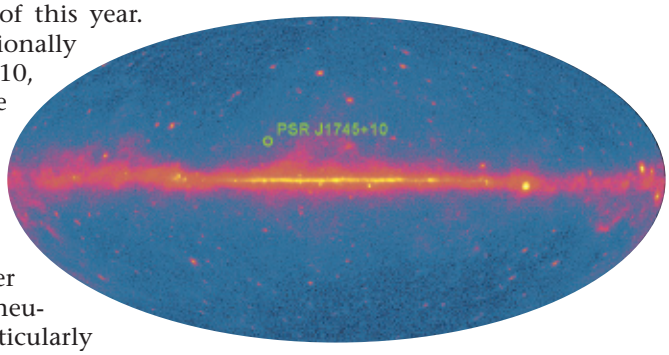
What happens when a friend becomes an enemy? According to scientists from the Max Planck Institute for Chemical Ecology in Jena, some plants can form new alliances under these circumstances. One of them is the wild tobacco plant in the Great Basin Desert in the western USA. It is pollinated by the night-flying five-spotted hawk moth, which is attracted by the scent of the plant's flowers. However, the tobacco plant must pay dearly for the moth's services: the females lay their eggs, from which the voracious caterpillars emerge, on the leaves. But the affected tobacco plants react promptly: alerted by substances in the saliva of the tomato hornworm caterpillars – the hawk moth's offspring – and in the plant hormone jasmonate, they postpone blooming from night to the early morning, when the flowers attract other, less harmful visitors: hummingbirds, which also feed from the nectar, but otherwise leave the plants alone. Nevertheless, it appears that the wild tobacco plant needs the five-spotted hawk moth in order to reproduce. The scent of the flowers attracts moths that come from many kilometers away, unlike the hummingbirds, and they pollinate a large number of plants in a wide area. It may thus be due to the mobility of the moths that the tobacco plants propagate particularly quickly – for instance as the first plants to colonize large areas of burnt ground after a fire. (Current Biology online, January 21, 2010)



If the tobacco plant is attacked by moth caterpillars, it postpones opening some of its flowers until after sunrise (in the montage on the right) – and thus attracts hummingbirds for pollination rather than moths.

The Black Widow in the Sky

The "Fundamental Physics in Radio Astronomy" team at the Max Planck Institute for Radio Astronomy in Bonn was just set up in 2009, but it already has a reason to celebrate: Just a few weeks after the launch of a pulsar search program using the 100-meter telescope in Effelsberg, the researchers were able to detect the first millisecond pulsar in January of this year. The object, provisionally named PSR J1745+10, was found at the site of a gamma-ray point source discovered with the Fermi space telescope and is interesting for a number of reasons. It is a neutron star with particularly rapid rotation, turning about its own axis once in just 2.65 milliseconds – equivalent to almost 23,000 times per minute. The neutron star, a supernova that was created in the explosion of a massive sun, is also part of a double star system. The companion star seems to be extremely light. This leads the researchers to suspect that highly energetic radiation from the pulsar will eventually cause it to vaporize completely. Astronomers have a fitting name for this kind of neutron star – a "black widow."



The position of the millisecond pulsar newly discovered with the Effelsberg radio telescope is marked on a map of the universe showing the gamma radiation measured with the Fermi satellite.

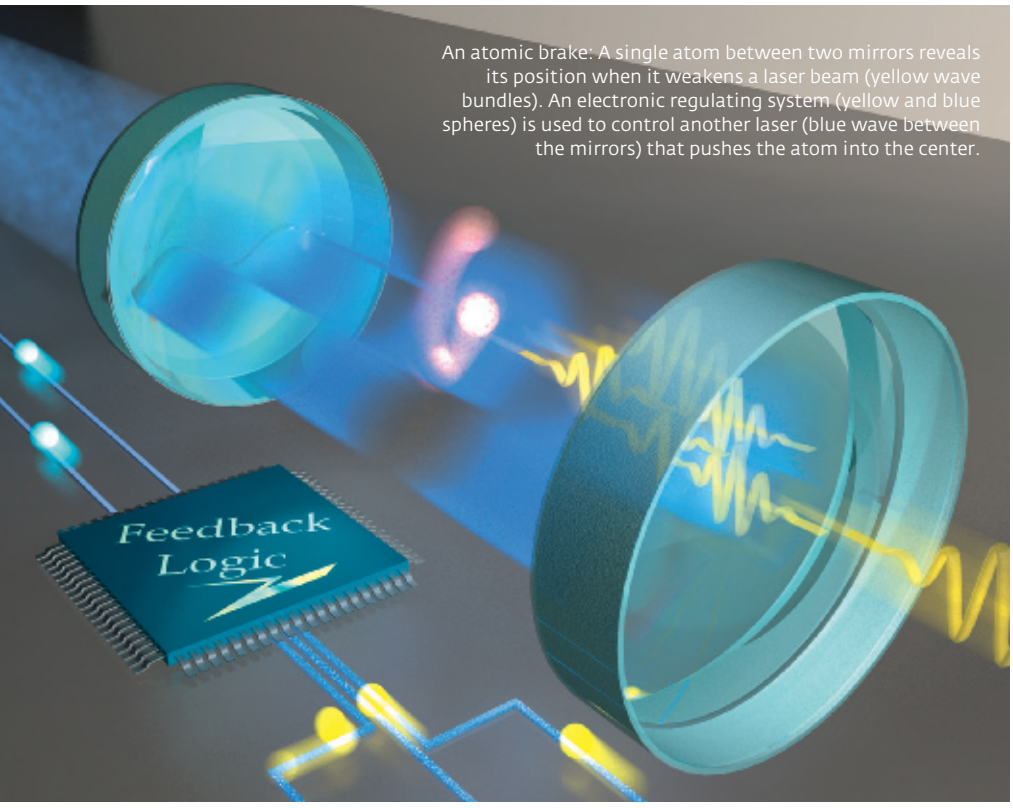
Photos: NASA/DOE/Fermi LAT Collaboration (bottom), Danny Kessler (top)

Reading Helps Hearing

Anyone who wants to understand Scottish, Australian or Texan accents better would be well advised to watch films in English – preferably with English subtitles. Researchers from the Max Planck Institute for Psycholinguistics and Radboud University in Nijmegen have shown that it is possible to use films to improve aural understanding of foreign languages if the subtitles reflect the spoken language. They also help listeners become more familiar with accents in the foreign language. Subtitles in the audience's native language, which are common in some European countries, are not as beneficial because they distract from the dialog. Scientists thus advise watching English films on DVD with English subtitles as often as possible. (PLoS ONE, November 11, 2009)

Atoms in a Quantum Swing

Physicists slow down a single atom using optoelectronic feedback in real time



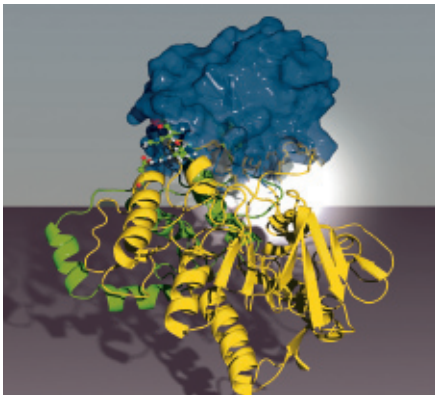
An atomic brake: A single atom between two mirrors reveals its position when it weakens a laser beam (yellow wave bundles). An electronic regulating system (yellow and blue spheres) is used to control another laser (blue wave between the mirrors) that pushes the atom into the center.

Reminiscent of many a scene at the playground, researchers at the Max Planck Institute of Quantum Optics manipulate an atom to slow it down in the same way a father uses gentle pushes to propel his child on a swing and then stop it again. The scientists use intense laser beams with innumerable photons to exert a force on the atom. They control the lasers with a very fast feedback mechanism, according to the direction in which the atom is moving, which they determine with a sort of light gate. In this way, they hold the atom up to four times longer than without the feedback in a resonator formed by two mirrors facing each other.

The physicists' experiment opens up the possibility of bringing an atom to a standstill for as long as the laws of quantum physics permit. Because atoms are subject to Heisenberg's uncertainty principle, they still oscillate very slightly even at the absolute zero of temperature. (Nature, December 17, 2009)

Enzyme Design with Far-Reaching Effects

Engineers are hardly likely to tinker with the cooling system when they want to increase the size of an engine. Yet chemists at the Max Planck Institute of Coal Research have adopted an approach similar to this in their efforts to optimize an enzyme for practical applications. They substituted two amino acids at a site relatively distant from the biocatalyst's binding pocket, the location where the chemical reaction takes place. This modification alters the overall structure of the enzyme in such a way that it can now convert a larger number of different chemical compounds. In addition, it preferentially produces one of two possible enantiomers, which occur as what is known as a racemic mixture during traditional synthesis. Although they are chemically identical, the enantiomers differ in terms of their structure in the same way that a right and a left hand differ. Only one of the two versions is usually suitable for use as a pharmaceutically active agent. The Max Planck researchers are pointing the way to a new approach that will enable the conversion of enzymes tailored to the needs of the chemical and pharmaceutical industries. (Proceedings of the National Academy of Science, early edition, January 27, 2010)

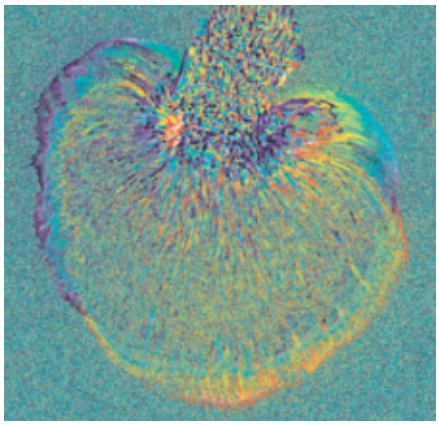


An enzyme becomes more versatile: Using genetic modifications, Max Planck chemists have altered this monooxygenase in such a way that it converts numerous starting substances. Two domains (blue and yellow) are drawn together through the substitution of two amino acids (left, red dots) with the result that the remote binding pocket enlarges (right, white).

Graphics: MPI for Coal Research (bottom), MPI of Quantum Optics (top)

Speedy Offroaders

White blood cells can move with speed and agility

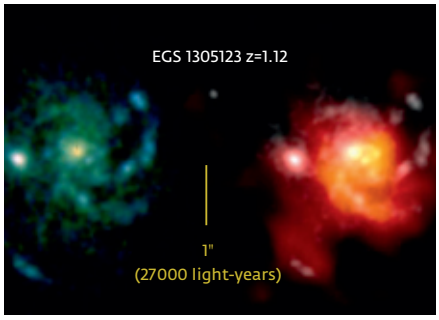


The cell skeleton (marked in color) of an immune cell can form finger-like protuberances to create forward movement.

The analogy is surprisingly apt: like cars, the defense cells in the immune system have an engine, a clutch and wheels, allowing them to penetrate infected tissue and eliminate pathogens. A network of protein chains that pervades the cell and forms the cell skeleton plays an important role in all of this. In order to move around, the cell skeleton creates finger-like extensions that it retracts at another location. Integrins act as wheels – anchors on the cell surface. The link between the cell skeleton and the integrin is equivalent to the clutch, and the connection between the integrins and the external world is like the grip of the wheels," explains Michael Sixt from the Max Planck Institute of Biochemistry in Martinsried. The immune cells adjust their engine output to the slipperiness or grip of the surface beneath them. If the cell anchors fail to grip on a slippery surface, the engine works harder – the cell skeleton changes more quickly and the cell speed remains the same. (Nature Cell Biology, November 15, 2009)

The Fruitful Universe

Stars are created from gigantic gas clouds in galaxies, but their birth rate has changed over time: many more stars were born early on in the life of the universe. Scientists from the Max Planck Institute for Extraterrestrial Physics and colleagues from other institutes now have an explanation for this phenomenon. A few billion years after the Big Bang, normal galaxies contained between five and ten times more gas than galaxies do today, so there was more raw material with which to create stars. The IRAM interferometer allowed the researchers to directly observe the cold gas in young galaxies. They measured its properties spectroscopically in normal, not exceptionally bright galaxies – at a time when the universe was only about 40 percent and 24 percent as old as it is now. Earlier, it was mainly rare, very bright objects that were observed, such as merging galaxies or quasars, which are the nuclei of young, active galaxies. (Nature, February 11, 2010)

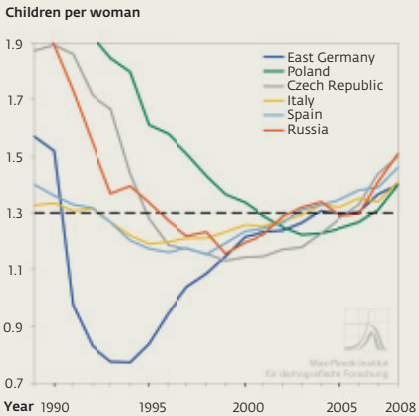


Two views of a typical galaxy 5.5 billion years after the Big Bang. On the left, a picture taken by the Hubble Telescope in optical light. On the right, the combination of an IRAM interferometer image (red/yellow) and a photo in the optical range (gray). The galactic disk contains around ten times more cold gas than galaxies today.

Graphic: Joshua R. Goldstein, photo: MPI for Extraterrestrial Physics-IRAM (bottom), MPI of Biochemistry-Michael Sixt (top)

Birth Rates Rising Again

It appears that the era of low birth rates of less than 1.3 children per woman is over. Scientists from the Max Planck Institute for Demographic Research in Rostock have shown that the trend toward very low and falling birth rates has reversed throughout Europe. This is mainly because the extremely low birth rates are proving to be a transitional effect: parents were not necessarily having fewer children, they were simply having them later. The number of births, which is calculated for a given moment and is generally referred to as the birth rate, thus fell. The average number of children a woman bore in her lifetime, however, was higher. Now that the tendency toward giving birth later is on the wane, the birth rate figures have recovered. The Max Planck researchers expect them to continue to rise. Whether and when parents finally fulfill their postponed wish to have children depends very much on the state of the job market. At least in Spain and Poland, good job prospects manifested themselves in a higher birth rate. In contrast, births fell in eight countries at a time when unemployment was rising. (Population and Development Review, December 2009)



Rising trend: The birth rate is rising throughout Europe; In 2008, it was 0.63 percent above its minimum in Eastern Germany.