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2/2008 ▶ The Top of the World as a Climate Sensor ▶ The Long Road to Visible Atoms ▶ The King's Discipline and its Master ▶ When Dead Stars Emit Signals ▶ The Secret of the Green Skin ▶ The Price of Death

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In this issue

Environmental History

The Tibetan Plateau, which covers some 1.5 million square kilometres, has had a significant influence on the global climate over the past fifty million years. A Sino-German team of researchers is searching for new insights into the far-reaching climate and environmental changes of the past in the sediment of the Nam Co. **Page 4**

Robust Biocoenoses

Because they are able to defy even the most inhospitable of habitats, microalgae are ubiquitous. The algal biocoenoses often appear as a "green skin". Depending on the humidity of the substrate, the biofilm can vary between being moist and slimy or powdery and dry. Bioscientists are on a quest to better understand how microalgae live and how they adapt to such different environmental conditions. **Page 16**

Funeral Cultures

Changes in religious convictions and ideologies also result in adaptations in burial customs. On the basis of the burial and grave rituals in the United States, researchers have demonstrated that the economic interests of undertakers and funeral parlours play a major role that has so far received little attention. **Page 22**

Cover: Mugler

Research Site: Tibetan Plateau

German and Chinese scientists use lake sediments to investigate and trace the climate and environmental history of the region and its global impact. **Page 4**

Ulrike Beisiegel

A Question of Integrity

The DFG's recommendations for ensuring good scientific practice are still current, even ten years after they were published – and yet they have still not really arrived in everyday science

A decade has passed since the DFG's white paper on "Safeguarding Good Scientific Practice" was published, and nine years since the DFG ombudsman, the independent committee on good scientific practice and scientific misconduct, was established. The conclusion of the ombudsman's work so far is that the white paper remains just as relevant now as it was when it was published – and that it is still not sufficiently familiar or established in the minds of the scientific community.

Despite the fact that it was universally accepted, a decade ago, the white paper and the recommendations it contained could only achieve their intended objectives by being implemented as widely as possible and by becoming as self-evident and present in the scientific community's consciousness as possible.

The case of Herrmann/Brach in 1997 had revealed just how vulnerable the scientific system was to abuse. After this case, which was probably the most serious case of scientific misconduct in German history, the scientific community – with the DFG at its forefront – sought ways to establish rules for good scientific practice and how to deal with scientific misconduct. It was specifically intended that this should be done by the scientific community itself, as a form of self-regulation and as the "main aim of self governance of the scientific community".

The DFG white paper also marked the first time that the critical areas that lead to violation of the rules of good scientific practice were clearly identified and recommendations made on how to address these problems.

Probably the most fundamental recommendation is for researchers to exercise strict honesty, both with themselves and with others. This applies not only to the presentation of research findings, but also to the contributions made by partners, predecessors and competing researchers. The white paper also called for diligent documentation of all results, and the retention of all primary data for a period of ten years as well as dealing with issues such as authorship and the ever-increasing problem of plagiarism. Other recommendations relate to scientific cooperation and leadership responsibility, the promotion of young researchers and the obligation of absolute confidentiality of peer reviews. To facilitate the implementation of these recommendations, and to provide a source of advice and support to researchers and scientists, the white paper recommended the installation of the DFG ombudsman and independent, local ombudsmen.

The system of ombudsmen that was subsequently established on the basis of this recommendation reveals the significance of the DFG white paper. Since that time, every researcher and scientist in Germany has been able to turn either to a trusted person at their own institution or to the DFG ombudsman if they suspect a violation of the rules of good scientific practice. We – here I will explain the process as we have established it for our work – then check the suspected violation and request a statement from the person about whom the issue has been raised. Of course, to ensure confidentiality, this is only possible if the person who informed us agrees to us doing so. If there is any disagreement between the two statements, we invite both parties concerned to a hearing. Ideally, this allows us to solve the problem immediately by rectifying the violation of the rules, for example by publishing an erratum if there was a case regarding authorship. These cases are closed by presenting a written statement about the matter to both parties. However, if a serious case of scientific misconduct is suspected, we pass the matter back to the committee at the institution affected. This committee – also called for by the white paper – then checks the information provided again, to assess whether further measures are required.

The enquiries received by the DFG ombudsman reveal the most serious threats to good scientific practice. Allow me to mention two, in particular – along with ideas for how to solve them.

Publications are the most important "currency" in our scientific system. This makes honesty with respect to the work done by each contributor to a publication particularly important. "Honorary authorship" by lead researchers who did not actually contribute to the work is out of the question, for instance. In my opinion, the ever-increasing pressure to perform that exists in the scientific community demands more detailed evaluation of performance. It is simply not fair for the director of an institution to be credited for the number of publications currently generated by the institution in the same way as younger, more active researchers. Perhaps the issue of honorary authorship could be solved by no longer assessing the quality of well-established leadership figures by the number of recent publications of which they were the last author, but by the quality and overall performance of the institution of which they are in charge.

Illustration: private

Many queries we receive relate to issues of a lack of leadership responsibility and insufficient promotion of young researchers. This is a matter of particular concern, since it is the quality of young researchers and scientists that determines the future of our scientific system. In spite of excellent programmes established by the DFG and other funding bodies to promote young researchers, we see time and time again that those affected are neither given the necessary working conditions, nor afforded the independence that they need. Especially in medicine, cases of obstruction instead of promotion of research are frequent, due to the clinical work that takes priority. In such cases it is very important to create the necessary structural conditions for good scientific practice to be put into practice.

One terribly sad fact is that people who report their suspicions can be put at a serious disadvantage as whistleblowers. In order to develop an efficient ombudsman system where self-regulation by scientists and researchers is a matter of course it is thus extremely important that all information is treated in strict confidence. University lecturers who are exposed must not be allowed to make the matter public in order to obtain the support of colleagues and university management.

All in all, after ten years of "ensuring good scientific practice", we can conclude that the DFG succeeded in drawing up a very good set of guidelines on self-regulation in science with the publication of the white paper, and that it has also been able to formally introduce these guidelines at all German research institutions. Nevertheless, their message has yet to be accepted in everyday practice in the scientific community. In this respect, everyone actively involved in the scientific system is obliged to play their part, be it those submitting funding proposals, peer reviewers, or staff at research institutions, as well as doctorate students.

Particular importance needs to be given to integrating "good scientific practice" in the teaching given to all undergraduate students. It is necessary to establish a specific curriculum, but also to integrate the topic of scientific conduct in all regular teaching activities. Graduate schools and other research groups ought to offer seminars on the subject, and this needs to be given much greater priority by scientific institutions, and it must be discussed by departments and committees. First and foremost, the university administrations need to be made more sensitive to the issue, because so far there has been a tendency to play it down and not follow cases up, rather than to actively promote good scientific practice and take serious action against those who violate the rules.

Adherence to the rules of good scientific practice has been given increasing prominence at an international level recently. In this debate, the German ombudsman system which is independent of state control is envied by other countries, which have state-run monitors. We need to recognise the benefits of this autonomy that science in Germany enjoys in having a scientific system that is characterised by honesty and integrity, and do everything in our power to implement the recommendations even more consistently and effectively than we have done in the last ten years. Otherwise, we run the risk of ending up in a situation where this system proves to be ineffectual.

Prof. Dr. Dr. h.c. Ulrike Beisiegel has been the spokesperson of the DFG's ombudsman committee since 2005 and was a member of the international commission which the DFG white paper on securing good scientific practice brought into being. She is the director of the Institute for Molecular Cell Biology at the University Hospital Hamburg-Eppendorf and is also the chair of the Scientific Commission of the German Science Council.

By Antje Schwalb et al.

The Top of the World as a Climate Sensor

Illustrations: Krömer (left page centre), Sachse (all other images)

At 1.5 million square kilometres, the Tibetan Plateau is the largest plateau on Earth. This makes it a key region for providing fundamental information on the formation of mountains and plateaus as well as how these features interact with changes in climate and the environment on the Earth's surface. Over the past 50 million years, the formation of the plateau has had a decisive influence on global climate and put the monsoon system into motion. Because the plateau also responds as a sensitive sensor to changes in the environment, global change can result in drastic changes to the sensitive ecosystems on the plateau.

Together with the Himalayas, the plateau forms the source area for large rivers which are fed primarily by meltwater from glaciers. These rivers supply nearly half of the world's population with drinking water, water for irrigation and water for generating power. Over the past two decades, however, a drastic retreat of the glaciers has been observed. With continuation of global warming, an increase in the production of melt water is to be expected, followed by a drastic decrease which will jeopardise the water supply in the future and reduce crop yields. The intensive pasture farming further stresses the geo-ecosystems on the plateau.

Climate changes in the past and the role of man in shaping environmental history are the focus of the studies in Tibet

During the course of the international cooperative research project "The Tibetan Plateau – Geodynamics and Environmental Evolution", focus was placed on climate development over the past millennia as well as on the role of man in shaping environmental history. Special attention was given to the development of and changes to the monsoon system, and the question asked as to what processes played a crucial role here.

This research work was initiated by a memorandum between the Deutsche Forschungsgemeinschaft (DFG, German Research Foundation) and the Institute of Tibetan Plateau Research of the Chinese Academy of Sciences, which was founded in 2004. The Chinese-German fieldwork began on the Tibetan Plateau in August 2005. The target area was Nam Co, the second largest saltwater lake on the plateau after Lake Qinghai. Nam Co is located about four hours by car north of Lhasa, approximately 70 kilometres long and nearly four times larger than Lake Constance. Projecting from the southern shore like an alpine wall are the Nyainqentanglha mountains, with peaks reaching over 7000 metres.

Lake sediments have the great advantage that they store climatic and environmental changes in the lake and its catchment basin in high temporal resolution. Climatic and environmental indicators buried in the lake sediment such as micro-organisms, algae, grains of pollen and micrometre-size rock and plant remnants are like newspapers which, when analysed, offer a detailed journey into the past. These climatic and environmental indicators are used to search for clues to past changes in monsoon and glacier dynamics.

The collaboration with the Chinese colleagues was prepared during workshops held in Peking and Lhasa. Anyone who considers China to be an emerging nation will know after a visit that this is no longer true. New laboratories with state-of-the-art equipment demonstrate that the advancement of science clearly has priority in China. The Chinese cooperation partners had also organised the permits for fieldwork and constructed a research station at Nam Co, a 120 square metre container with laboratory, seminar room, two bedrooms, a kitchen with dining area as well as a latrine.

The researchers from Germany were among the first guests who set up their tents there to explore the southern shore of the lake from the station. After a few days, the work was relocated to a tent camp in a protected bay near the north-eastern end of the lake. From here, the work programme could be continued on land and water.

The scientists experienced a lesson in applied meteorology their very first night: Heavy showers beat down on the tents, which were covered in white by the next morning. Afterwards it was clear that the tent entrances should not face west if at all possible, since the Southwest Asian monsoon generally arrives from the west. Annual precipitation at Nam Co can reach up to 500 mm, though evaporation is five times as high. In summer, the Southwest Asian monsoon brings the lion's share of precipitation to Nam Co; the area receives very little precipitation from the East Asian monsoon. In winter, the Asian winter monsoon brings arid weather. Moist west winds reach only the northern parts of China. It is known that in the past, extreme fluctuations of the Southwest Asian monsoon led to flooding and droughts and were eventually responsible for the collapse of entire cultures.

Illustration: Sachse

Muddy roads. The destination of the German-Chinese research team is Nam Co, a saltwater lake on the Tibetan Plateau which is nearly four times as large as Lake Constance. Its sediments provide new insight into past climate changes.

This brings up questions on the relationship between air masses and how and through what processes precipitation and evaporation have changed in the past. Of particular interest are the questions as to whether the effects of individual air masses can be detected in the sediments, whether the dominance of a specific air mass played a role for glacier advances and when and how man intervened in the system and with what consequences. Knowledge and understanding of the modern system are necessary in order to answer these questions. The examination of the modern system yields special datasets which can then be used to decipher the climatic and environmental information archived in the sediments.

The work programme also included the collection of soil samples. The pollen contained in the samples was used in experiments to determine what traces modern vegetation leaves behind in the ground. A particularly exciting question in this regard is whether there were phases in the past during which the catchment basin was forested.

Another workgroup determined the position of old shore lines from cliffs and bluffs as evidence of past high lake levels and also located terminal moraines, which serve as indicators of past glacier expansion. On the lake, seismic methods were used to examine the Nam Co sedimentary basin, which extends over 200 square kilometres, as well as the lake bottom. The collected data show that Nam Co is divided into multiple basins with a maximum depth of approximately 100 metres and that these basins are filled with sediment packages ranging from 10 to 20 metres in thickness. Sediment cores up to 5 metres long were taken from water depths ranging from 24 to 31 metres. The temperature of the surface water was 12 degrees Celsius; at depths between 20 and 25 metres, the temperature dropped down to 5 degrees Celsius. In Lake Constance, even though the surface temperature is about 10 degrees Celsius warmer during the summer, the temperature drop occurs at a comparable depth. Although summer is quite short on the plateau, the lake apparently has enough time to form a relatively warm layer of surface water thanks to the intense solar radiation.

A first look at the sediment cores shows a sandy layer, a possible indicator of a low lake level. The job now is to determine when this low level occurred, if it occurred quickly and abruptly or rather slowly and continuously as well as how fast the lake refilled after this low level phase. Is this a sign of reduced monsoon activity over a specific period of time? Using so-called isotope signals from plant remnants as well as shells from micro-fossils, work will be performed to determine the composition of the lake water in the past. Various research approaches will be combined to determine the source of the precipitation and to trace the monsoon and meltwater dynamics into the past.

The German-Chinese collaboration was very productive. During a reciprocal visit to Germany, it was clear how intensely the Chinese partners had familiarised themselves with Germany, particularly German geography and history. During visits to several German laboratories, the Chinese scientists were surprised about the old age of some of the lab equipment, but were likewise surprised about how well the old equipment still functions.

In the first phase of the collaboration, samples were initially analysed both in Germany and in China in parallel in order to ensure the comparability of the analyses and the laboratories. In the future, the sample analysis will be efficiently divided between the two groups. A future spatial expansion of the work programme is intended to provide a better understanding of the spatial distribution pattern of the monsoon system. In a subsequent step, the results which are obtained will be compared with climate models in order to better decipher the processes which drive and control the monsoon system. If this is successful, models will be able to more exactly predict the regional effects of the expected climate warming and will allow man to better adapt to the changing environment.

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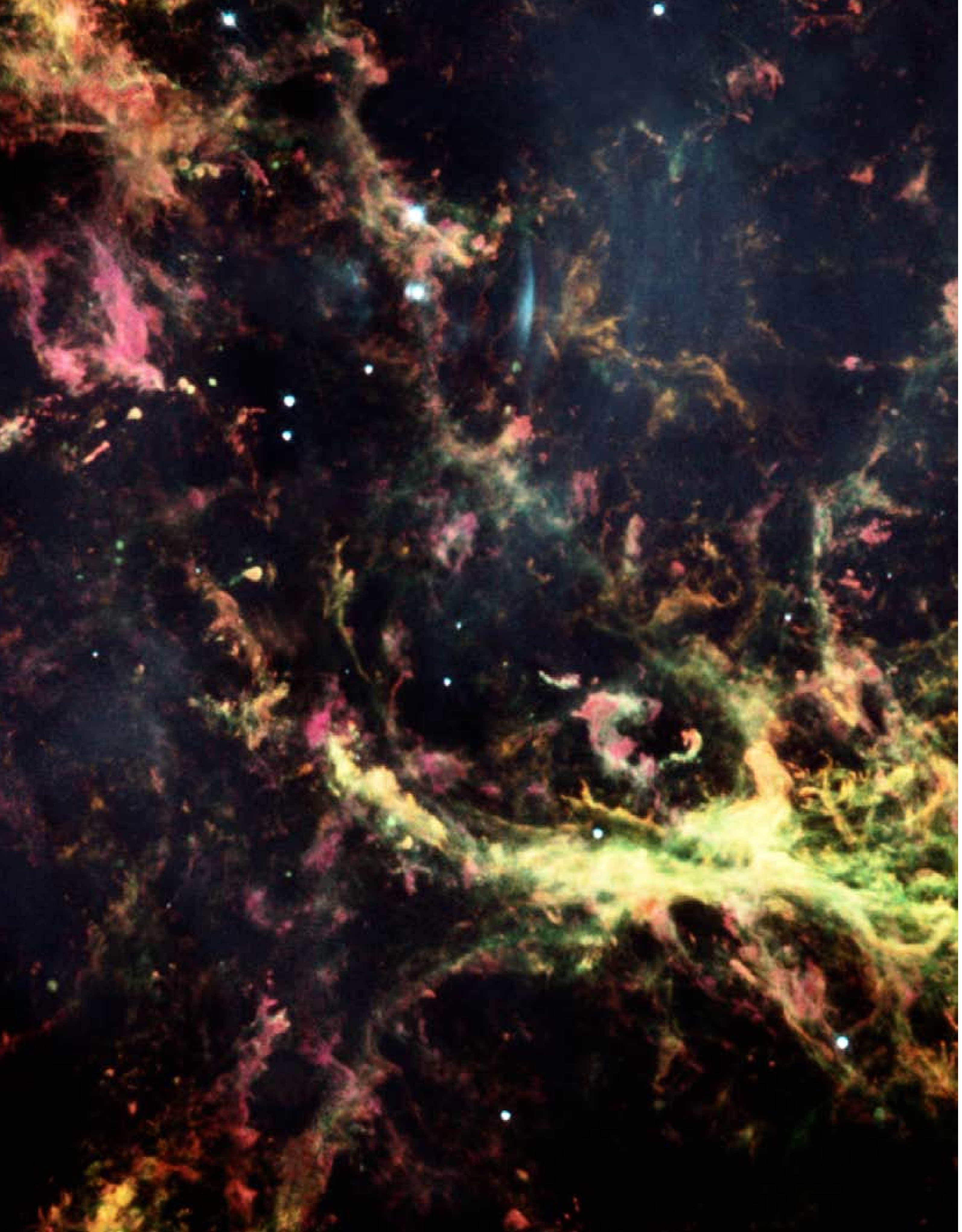


When Dead Stars Emit Signals

Cosmic electronic engineering: Pulsars emit more intense radiation than any other object in the universe. Astrophysicists have found confirmation that the laws of nature that apply on earth also hold true at the boundaries of matter

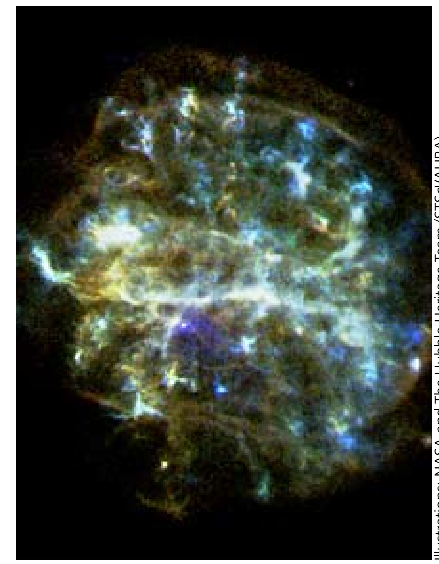
By Harald Lesch and Axel Jessner

About once every 50 years the Milky Way witnesses a monumental event: the explosion of a star. In much the same way as when a bomb explodes, the outer layers of gas surrounding the star are blown off and expelled into space, illuminating the universe. The star's inner core, which is about one and a half times as massive as the sun, survives the explosion, but collapses under its own weight. What is left is an intriguing remnant of the old star, consisting of one of the most extreme forms of matter in the universe, which is as dense as an atomic nucleus.

Whereas the exploding gas shell spreads out into space and the radiation it gives off weakens, the corpse of the star that is left behind frequently signals its presence in the universe by emitting very strong pulses of radio waves. Radio astronomers are able to deduce the nature of this corpse from these pulses. They are only a few tens of kilometres across and spin rapidly around their own axis at up to 650 times a second. At the same time they behave like a cosmic lighthouse, emitting very intense radiation – each second they generate as much energy as the entire population of the earth would use in ten billion years.

They are highly-magnetised, filled and surrounded by a magnetic field a trillion times stronger than earth's. And, what is more, a piece of this material the size of a sugar cube would weigh as much as every person on the planet combined.

They are ambassadors from the very boundaries of perceptible, material reality. If they had been any heavier, they would have fallen entirely victim to their own mass, becoming black holes, from which no radiation can escape.



Illustrations: NASA and The Hubble Heritage Team (STScI/AURA)

Left: Part of the Crab Nebula in the constellation Taurus. The radiation emitted by the pulsar heats the nebula and is also responsible for the blue glow surrounding it. Above: According to calculations performed by astronomers, the Crab Nebula was brought into being by the explosion of a supernova in the year 1054.

The objects in question are pulsars, which were discovered in 1967 as pulsing sources of radio waves in space. Even now, most new pulsars are discovered by observations in the radio band. They are among the brightest objects in the Milky Way. In view of their tiny size, the question arises as to why these objects emit such exceptionally intense pulses of radiation in this band of the electromagnetic spectrum and do so with such extreme precision. Their pulses keep time even more accurately than atomic clocks here on earth.

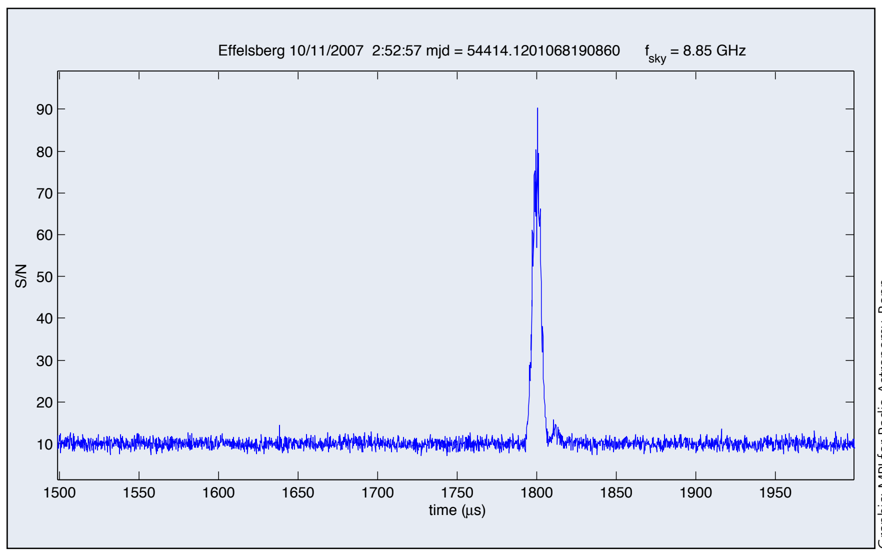
In addition to the remarkable regularity of their radio pulses, they also repeatedly emit bursts of radiation, which, in their most extreme form, can be as brief as just a few billionths of a second. Multiplying the duration of such a burst of radiation by the speed of light, 300,000 kilometres per second, gives the size of the area from which the radiation emanates. The result is astounding. Radio astronomers have observed areas of radiation that are just a few metres in size, but a quintillion metres (a thousand light years) away from us. Translated into more terrestrial proportions, this would be equivalent to being able to clearly see the nucleus of individual hydrogen atoms in the water on the sea bed at a depth of ten kilometres.

For such minute areas of radiation to be at all visible at such a distance, the radio signals emitted by pulsars need to be extremely strong. There is no other object in space that has the ability to generate such intense radiation. Comparing the radio signals emitted by pulsars to the normal radiation given off by a star is something like comparing the light emitted by a laser to that of a light bulb. The light from a light bulb shines in every direction, filling the whole room with a ball of light. The amount of light given off is simply the sum of all of the individual particles in the filament that are excited. In a laser beam, on the other hand, the light given off is concentrated within a very small area. Inside a laser, a large number of electrons are forced to give off precisely the same amount of energy simultaneously by means of technical trickery. The power of a laser is thus proportional to the square of the number of particles excited.

Precise calculations have shown that the radio waves have to be "coherent". This means that, in terms of their spatial and temporal propagation, the electromagnetic waves all share a fixed phase relationship that is constant over time. This enables them to overlap, allowing them to reach very high intensities. For coherent radiation to come about, it is necessary for as many particles as possible to emit the same amount of energy simultaneously. Lasers are a terrestrial source of coherent radiation, whereas the light bulb is a source of incoherent radiation. The power of the radiation observed from pulsars in the radio band can only be explained by several quadrillion electrons that all emit exactly the same amount of energy at exactly the same moment. From a technical point of view, generating coherent light such as that emitted by a laser is no problem nowadays. Lasers are used all around us, from ophthalmic medicine to laser pointers. But there is no high tech wizardry in a pulsar, so what trick does it use to naturally achieve intensities as high as those emitted by lasers on earth?

To answer this question, it is necessary to take a look at the pulsar's immediate vicinity. Researchers assume that pulsars are surrounded by a magnetic field that is anchored to the surface of the rotating pulsar and resembles that of a normal bar magnet. As we all learned at school, the motion of a magnetic field generates electric fields. This is just the same in the case of a pulsar, where the rotation of the magnetic field also generates an electric field. Except that here, the magnetic field is so strong that the field strength of the electric fields generated is so great that they rip charged particles out of the pulsar surface. These particles are then only able to move along the lines of the magnetic field, meaning that

The 100-metre radio telescope belonging to the Max Planck Institute for Radio Astronomy in Bad Münstereifel-Effelsberg. This telescope has been used to observe pulsars, including the highest frequency pulsars, for over thirty years. Below: Plot of a giant pulse from the Crab Pulsar, which is more than 6,000 light years from earth; it lasted just 10 microseconds.



Graphic: MPI for Radio Astronomy, Bonn

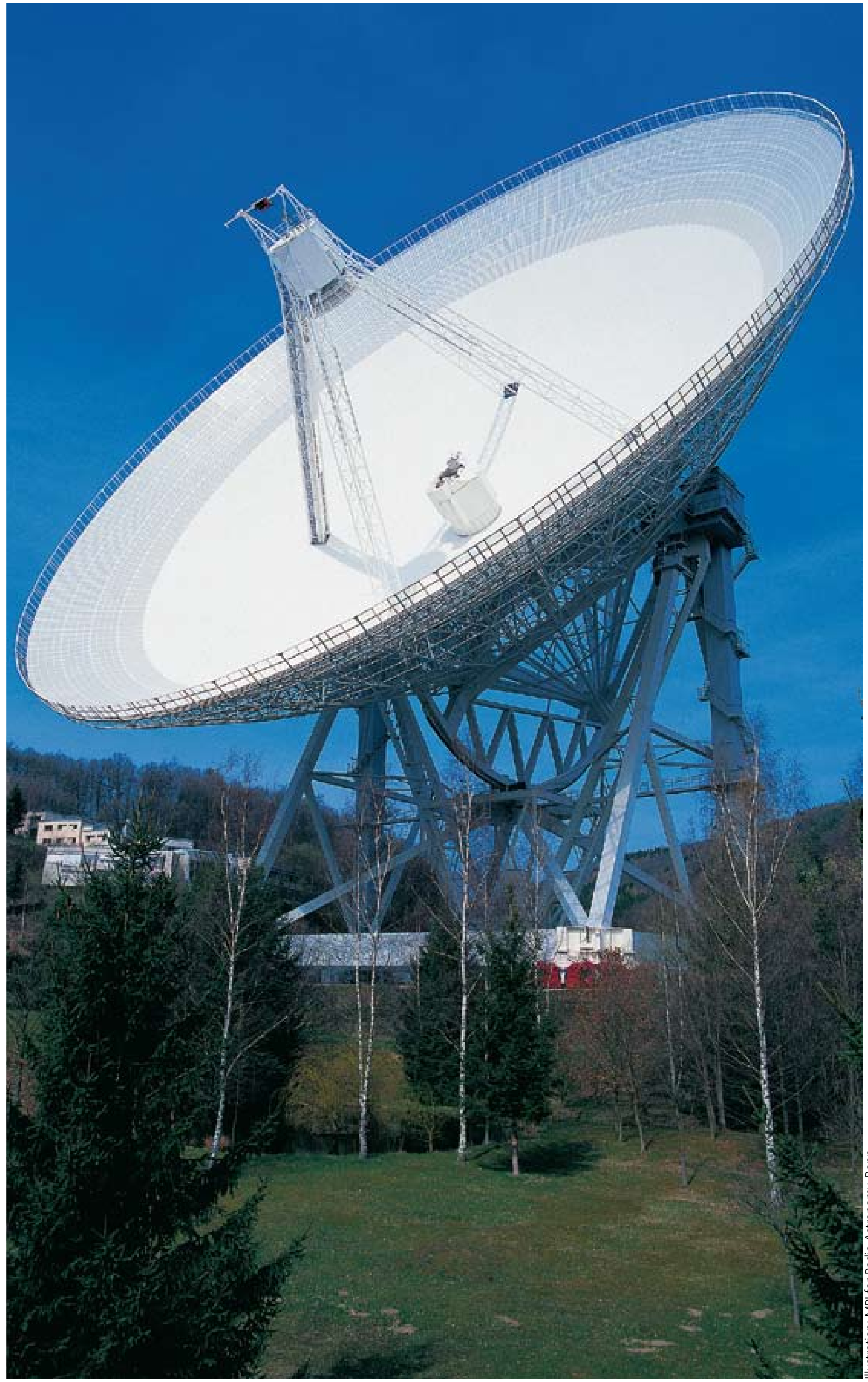


Illustration: MPI for Radio Astronomy, Bonn

there is a constant stream of electrically charged particles originating from the pulsar, which flows out into space along the pulsar's magnetic field. These are the particles that give off the high intensity radio signal. But how?

Let's come back to the laser. Here we have a source of coherent radiation in the form of visible light. But there are also sources of coherent radiation in the radio band on earth too. Every radio transmitter is such a source of coherent radiation. In radio transmitters, intense radio signals are generated by passing electric current along a conductor in such a way that it generates specific charge fluctuations. The higher the strength of the current, the stronger these fluctuations can be, and, of course, the higher the power of the radio signal.

This method, which is familiar from electronic engineering, can also be applied to a pulsar. There, the high electric current is generated by the rotation of the magnetic field anchored to the pulsar. But how is it possible to generate charge fluctuations in the current that are transmitted as coherent radio waves?

An electric current is the flow of electrically-charged particles in a specific direction. The strength of the current depends on the number of particles moving and the speed at which they are moving. The maximum speed at which the particles can move, however, is the speed of light. Even the particles emitted from a pulsar cannot travel faster than the speed of light. This soon results in "particle jams" along the magnetic field lines over the surface of the pulsar.

And now for the big surprise: The fresh particles, in other words those that are just arriving from the pulsar, are slowed down by the particles that have accumulated along the field lines, because all of the particles carry the same electrical charge. Many of them are even reflected and hurtle back towards the pulsar again. However, there is an uninterrupted flow of new particles coming from the pulsar, constantly moving back and forth along the field lines, because the strongest source of current is, of course, the surface of the pulsar itself. It is continuously "squeezing" particles, and thus electrical current, out to the perimeter of the magnetic field, and there are fluctuations in density along the magnetic field lines. The particles are "rocked to and fro" as they flow away from the pulsar at almost the speed of light. Calculations of the current circuit model of pulsar radio emissions have shown the right magnitude of these fluctuations, the right power and the right frequency of the radiation emitted in the radio band.

Most importantly, however, the model provides a reliable explanation for the phenomenon of pulsar radio signals, because it does not rely on any "exotic" physics. The basic equations of electrodynamics first formulated by the Scottish physicist James Clerk Maxwell in the mid-19th century, along with the theory of relativity developed by Albert Einstein between 1905 and 1915, are fully sufficient.

The explanation of the radio signals from pulsars provides remarkable confirmation of the hypothesis behind all astrophysics that the laws of nature we observe here on earth do indeed hold true throughout the universe. The principles we rely on are applied on a daily basis in a multitude of fields of technology, including lasers and radio. In other words, even the corpses of stars that emit pulsating signals from the most remote outskirts of the universe can be understood with the same physics that is put to profitable use back on earth. Now if that isn't convincing evidence, then what is?

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The King's Discipline and its Master

Algebraic topology: Leibniz Prizewinner Wolfgang Lück is studying fundamental problems that are even too theoretical for some mathematicians

By Rembert Unterstell

In conversation he is relaxed, communicative and friendly. Dressed casually in jeans and a sporty sweatshirt, he is nothing like you might expect a dizzy and potentially quixotic mathematician to be. Professor Wolfgang Lück, the winner of the Leibniz Prize 2008, comes across as being down to earth and is very adept at speaking about his work on theoretical mathematics, with a keen sense for how to make it approachable with graphic examples.

The interview with him is so captivating that I am not even tempted to look out of the fifth-floor window of his office at the Münster Institute of Mathematics and admire the roofs of the beautiful cathedral city. He enjoys admiring the panoramic view from his desk once in a while, as he points out, but in general he does not have much time for relaxing these days.

The Leibniz Prize, which he describes as "a great accolade and recognition, but also an obligation", has resulted in him being in great demand for interviews, as a peer reviewer and, last but not least, as a cooperation partner for research projects. And then there is the "Year of Mathematics 2008". As the Vice President of the German Association of Mathematicians (DMV), Lück is a coorganiser of the year of science and is actively involved in a number of events taking place during the year, thus being not only a top-flight researcher, but also a "maths communicator".

His research focuses on the field of algebraic topology or, put simply, the study of geometric shapes. It attempts to describe complete geometric structures on the basis of just a few points. "Take the universe, for example", Lück says, "we are all in it and unable to look at it from the outside, but would nevertheless like to know what shape it is." Topologists study the properties of objects which they possess regardless of their size or proportions. These properties are known as "invariants". They allow mathematicians to comprehend topological spaces

Illustration: Querbach

by assigning algebraic objects to them. "Creatively exploring an enclosed thought construct – algebraic topology is just as much a fundamental theory as it is emissive – fascinates me", Lück stresses. And he adds, in an unpretentious tone, "I am very happy to have found a subject that I am passionately interested in and that I like – and which apparently likes me too." Lück was awarded the Max Planck Research Prize for his groundbreaking research in the king's discipline of mathematics in 2003.

Wolfgang Lück was born in Herford in 1957. His interest in mathematical problems started at an early age, although it was not unrivalled initially. At secondary school his sole passion was football ("for years I fancied the idea of a career in football"), but then his extraordinary talent for mathematics reared its head when, at the age of 15, he won a national mathematics competition. "After this encouragement that changed the course of my life" he went on to study mathematics and physics in Göttingen, where he proceeded to obtain his doctorate in 1984 and later qualified as a university lecturer in 1989. At the age of 33 he became an Associate Professor and subsequently took up a tenure track position at the University of Kentucky, Lexington, USA, before returning to Germany in 1991 to take up a chair at the University of Mainz. Since 1996 he has held a chair as a professor ordinarius at the University of Münster, conducting research and teaching.

As a topologist, Lück is a magnet for young mathematicians, not just in the context of his Research Training Group "Analytical Topology and Metageometry". Lück, a father of four children, hopes to reach school pupils and the general public more broadly during the "Year of Mathematics" through local maths projects by cooperating with schools, with the national support of the Deutsche Telekom Foundation. In Münster his plans include a "Night of Mathematics" as well as entertaining films and workshops. Lück is sure of one thing, "mathematics is far more necessary nowadays than many people are aware, be it in MP3 players, computers or CT scanners". And, he adds, "if we manage to keep the initiatives that have been kicked off now going on beyond 2008, then we stand a real chance of improving the negative, one-sided image of mathematics in the long term. After all, maths is a very versatile subject that can be real fun."

Author: **Dr. Rembert Unterstell** is Publishing Executive Editor of "german research".

Discussion at the electron microscope: Professor Knut Urban (centre) analyses the image of a specimen together with members of his group.

The Long Road to Visible Atoms

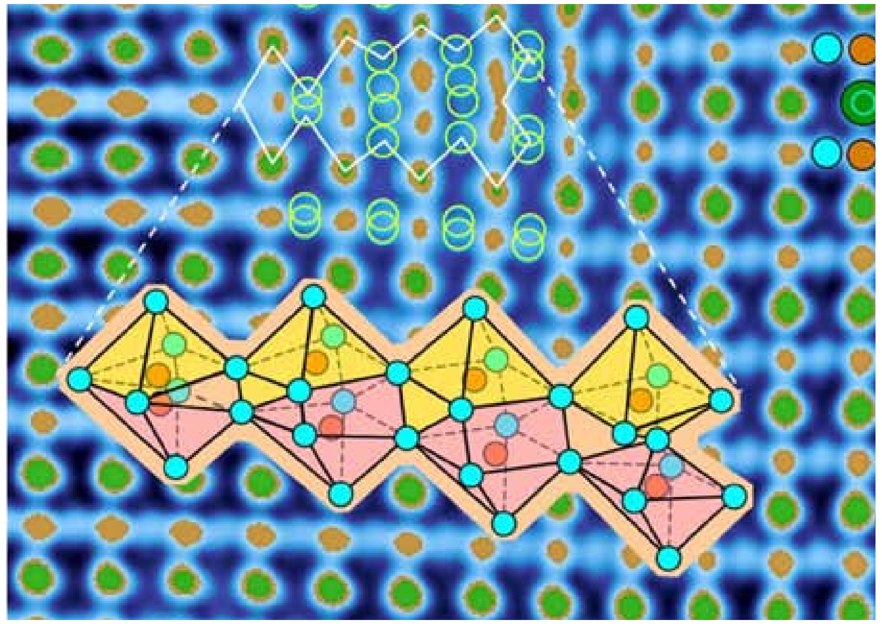
For centuries, physicists and engineers have been battling image aberration in microscopes. With high resolution transmission electron microscopes they have minimised the flaws yet further – allowing the progress of research and technology to continue

By Knut Urban

At first, the view provided by microscopes was a mere curiosity. When the first microscopes came out, they were presented at fairs, where they attracted great public interest. But researchers were also enthusiastic at an early stage about the potential of the first primitive light microscopes, which appeared in the early 17th century. Demand from the scientific community for more powerful microscopes grew rapidly and spurred on a constant stream of new developments. But the road to today's modern, high resolution electron microscopes was a long one – and inextricably linked to the solution of some fundamental questions in physics.

One of the milestones on the way to high-resolution optics, with its aberration-corrected lens systems, which enable the sharply focused images delivered by research microscopes and by state-of-the-art digital cameras, was an invention by the physicist and optician Ernst Abbe (1840–1905). By carefully combining convex and concave lenses, so that single lens imperfections compensated each other, the path was cleared for the development of a microscope lens that surpassed everything that had gone before.

This followed the insight by Isaac Newton, and subsequently Carl Friedrich Gauss, that imperfections were physically inevitable using spherical lenses. The two main forms of lens imperfections are spherical and chromatic aberration. Spherical aberration causes a lens to have a greater refracting power, and thus a shorter focal length, for rays of light that have a large angle of incidence and pass through the edge of the lens, than for rays that have smaller angle of incidence and pass through the centre of the lens. As a result, a sharply focused image of a point source in an illuminated object is produced in the image plane by rays of light that are close to the lens axis, whereas blurred, overlapping images are formed by rays that pass through the edge of the lens.



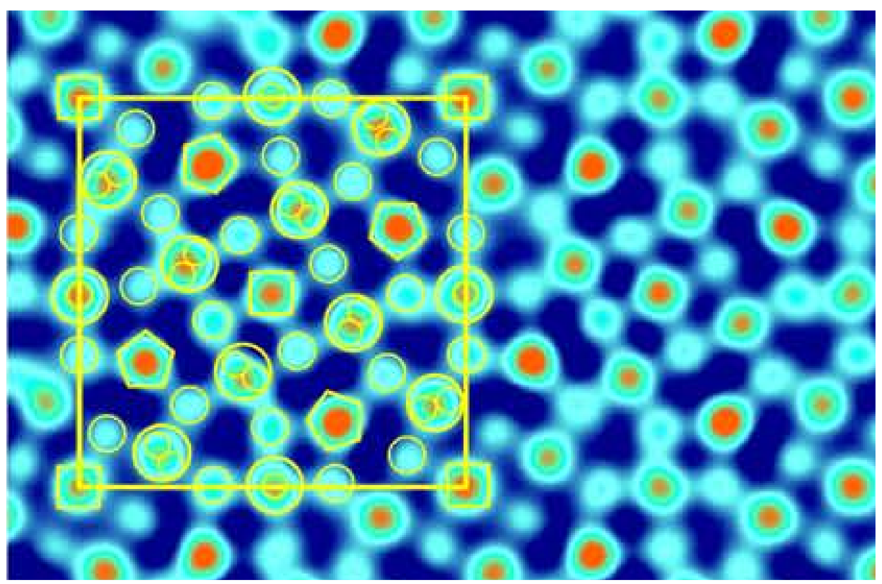
The obvious solution would be to place an aperture between the object and the lens to stop the rays at the edge. But this improvement in the image quality is achieved at the price of poorer resolution. Due to the refracting power that depends on colour, in other words on the wavelength of the light, chromatic aberration also causes the lens to have different focal lengths, and consequently leads to an overlapping of focused and blurred images.

In the early 1930s, Ernst Ruska and Max Knoll became the first to successfully construct an electron microscope. The lenses they used for the electron rays were ring-shaped magnetic fields created using coils of wire through which an electric current was passed. From the wavelength of the electrons, the two researchers were able to work out that it should be at least theoretically possible to image the atomic structure of solid state materials. However, their lenses had such a high rate of imperfections that it was impossible to even conceive of actually realising the goal of atomic resolution electron microscopy.

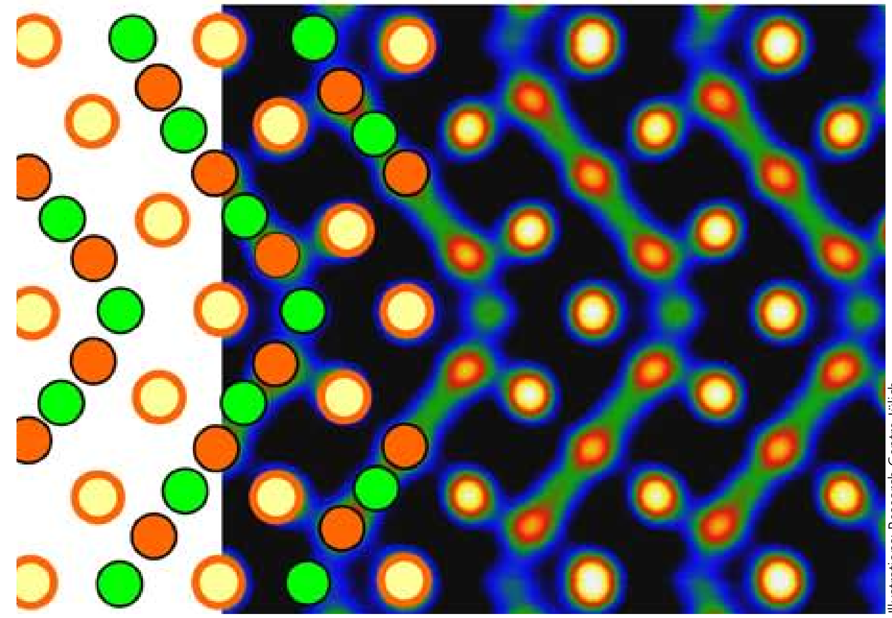
In fact, it was more than 60 years before a way of constructing aberration-corrected electron lenses was discovered. The reason it took so long to develop state-of-the-art high-performance electron microscopy is that while it is possible to make convex lenses using cylindrical magnetic fields, concave lenses cannot be made the same way. This seemed to mean that the solution proposed by Abbe, which had proven so successful for light optics, was excluded for electron optics. Indeed, in the late 1980s a panel of experts in the USA concluded that aberration correction in electron optics was not the way to achieve higher resolution.

At around the same time, however, three German physicists, Harald Rose from the Technical University of Darmstadt, Maximilian Haider from the European Molecular Biology Laboratory and Knut Urban from the Research Centre Jülich set about the task of doing just that. Shortly beforehand, Rose had managed to work out how to build a concave lens that would theoretically be able to correct the spherical aberration of the objective lens in an electron microscope.

Haider's group in Heidelberg went on to actually build and successfully test such a correction lens. This lens was installed in a commercial microscope which had an electron source that generated electrons with such a low energy distribution that it was possible to do without any additional chromatic correction. The first images produced using this microscope were heralded as a sensation. Although the breakthrough had been made, there were several more years of hard work ahead before the world's first aberration-corrected transmission electron microscope could be put into operation at the Research Centre Jülich in the year 2000.



High-resolution electron microscopy makes it possible to see individual atoms. Here we can see calcium barium niobate ($Ca_{0.28}Ba_{0.72}Nb_2O_6$). The blue dots are oxygen atoms (small circles in the model); the red and blue areas of contrast represent Ca (squares), Ba (pentagons) and Nb (large circles) cations.



Tracking down the structure of matter. Left: Strontium titanate ($SrTiO_3$) with a common crystal structure defect that is due to the convergence of two rows of atoms that were originally separate. Right: A "twin grain boundary" in barium titanate ($BaTiO_3$). Barium is shown in yellow, titanium in red, and oxygen in green.

Illustrations: Research Centre Jülich

So what is the principle behind this state-of-the-art method of electron microscopy? Many people think that it must be similar to light microscopy, where the details of a specimen are made visible by shining light through it, and that the local absorption of electrons is stronger or weaker, resulting in an image consisting of light and dark areas.

In fact, none of the electrons are actually absorbed. The interactions between the electrons and the atoms are far more complex and can only be described by quantum physics. The waves of electrons undergo a phase rotation in the electrical field surrounding the atoms. This is easiest to imagine as being like the hand of a clock turning. The closer the electrons are to the atomic cores, the faster the hand turns. Since these phase rotations cannot be observed directly, it is necessary to convert this "phase contrast" into a visible image of light and dark contrast. This is achieved by defocusing the objective lens by a set amount. Because this deviation from the ideal focus results in a loss of image focus it is necessary to arrive at a compromise between contrast and resolution. This was calculated more than 60 years ago by the theoretical physicist Otto Scherzer, and the focus conditions named after Scherzer have remained the standard in high-resolution electron microscopy ever since.

Even during the first few months that the new electron microscope was in use at Jülich, it was clear that a new era had dawned for what had come to be known as phase contrast microscopy. This was thanks to the discovery of a new, previously unthought-of imaging method, which involves setting the correction lens in such a way that the aberration of the objective lens is overcompensated by a few percent, so that it becomes slightly negative. This setting not only allows a significantly higher resolution than in classical Scherzer mode, but also makes it possible to increase the contrast so much that it is possible to image atoms, such as oxygen, which only scatter the electrons weakly because of their low atomic number. In 2005, the first commercial transmission electron microscopes, put up for sale at costs between three and four million euros, came onto the market. In the light of this, the Research Centre Jülich and the RWTH University Aachen established the Ernst Ruska Centre for Microscopy and Spectroscopy with Electrons. Based in Jülich, it is the first user centre for ultra-high resolution electron microscopy in Germany. It currently operates two new latest generation transmission electron microscopes, which went into service in early 2007. These research microscopes are available for use by German researchers.

At present, the most remarkable results being achieved by the high-performance electron optics are in the investigation of oxides, one of the largest classes of materials. It is now possible, for the first time, to see the most important element for the oxide properties of these compounds, oxygen, at firsthand and to measure its concentration at the atomic scale.

Other studies are looking at the properties of ultra-thin films and film systems which are expected to play a major role in the micro- and nanoelectronics of the future. In this field, it has now become possible to measure minute atomic shifts with the previously unimaginable precision of just a few hundredths of the inter-atomic distance. This puts our progress into perspective: regardless how inconceivably small these dimensions may seem, they determine the properties that materials have at the macroscopic scale.

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The Secret of the Green Skin

They are everywhere: Microalgae colonise house walls, soil and trees. Even inhospitable environments hardly bother these algal communities. The way in which biofilms protect themselves and constantly adapt to their habitat is also of interest to basic researchers

By U. Karsten, R. Schumann, L. Gustavs and Th. Friedl

Illustrations: Karsten

A wooden fence completely covered in green algae. Depending on the surface humidity of the substrate, the biofilm may be damp and slimy or powdery and dusty. Inset: Microalgal cultures help us to reach a better understanding of the way these organisms live.

If you look carefully as you walk through a recently built or re-developed area, you'll often see that the walls and roofs of the buildings are speckled with some kind of green substance. What is this green coating that seems to get everywhere? It has, in fact, a lot to do with the insulation of buildings, which is often implemented as an additional façade of insulating boards covering the walls in compliance with new energy efficiency legislation. This method of insulation, however, often results in the formation of "green skin" on building façades after a few years. In many towns, it has been observed that up to 80 percent of the buildings with external wall insulation are affected by this troublesome greening.

A look through the microscope reveals the culprit responsible for these green blotches. They are primarily caused by single-cell microalgae belonging to a variety of different taxonomic units. Microalgae are lower plants that are just a few thousandths of a millimetre large and typically occur as phytoplankton in the oceans and other aquatic environments. There, the aquatic microalgae play a crucial role in fixing carbon dioxide and producing oxygen. A perhaps astonishing fact is that half of all the oxygen present in the earth's atmosphere was produced by algae. The high-value substances they contain and the low cost of cultivating them make microalgae a potentially interesting source of raw materials.

Microalgae can also be found far from the water in manmade habitats, not only on building façades, but also on transformer stations, road signs, lamp posts, and a multitude of other locations that appear, at first sight, to be devoid of the water that the algae need to survive. They also occur in the soil, on the bark of trees and on stones, where they form so-called biofilms that are typically blue-green to black, and occasionally reddish-brown. Depending on the amount of moisture on the surface they inhabit, referred to as the substrate, the algae communities have a consistency that ranges from damp and slimy to powdery and dusty. These organisms, which are described as "aeroterrestrial", actually live at the interface between the substrate and the air.

The microalgae responsible for turning buildings green are probably present all around us in the atmosphere as "aeroplankton". They are either blown on the wind or carried in the rain. The initial growth often consists of algae with a slimy layer of mucus that enables them to stick to even the smoothest of surfaces and stay there. These pioneers then make it easier for other new arrivals to colonise the substrate, forming a community in the biofilm that provides protection against drying out or the effects of bright sunshine.

Most of these green algae have only a few morphological characteristics. The fact that these organisms have such a uniform appearance may be interpreted as a way of adapting to the specific locations they colonise. Perhaps there are only a few structures (ball shaped, thick cell walls) that are suited to survival in biofilms, which frequently dry out. These similar structures seem to have evolved completely independently in entirely different lines of green algae, as has been revealed by molecular genetic studies. The biodiversity that has been shown to exist by molecular genetic data is thus far greater than was initially assumed, although it is often hard to identify under the microscope.

The growth of algae on the surface of buildings is not uniform, but depends on the direction in which the walls are facing. North- and west-facing façades generally have more algal growth. This phenomenon is due to microclimatic conditions such as the duration and intensity of the sunlight a wall is exposed to. On walls with additional insulating boards, the heat flux from the inside to the outside of the wall is also significantly reduced. This means that the surface of the building dries far more slowly, allowing layers of moisture to remain on the surface for longer. This effect is reinforced by the low heat storage capacity of the insulating materials, which allows the building to cool down at night so much that condensation is able to form on the surface.

The façade of a block of flats covered in algae. The extra layer of insulation facilitated the unintentional coloration. If sufficient water is available, what starts off as a gradual colonisation by microalgae can rapidly turn into a "green skin", as seen on the stone statue below.

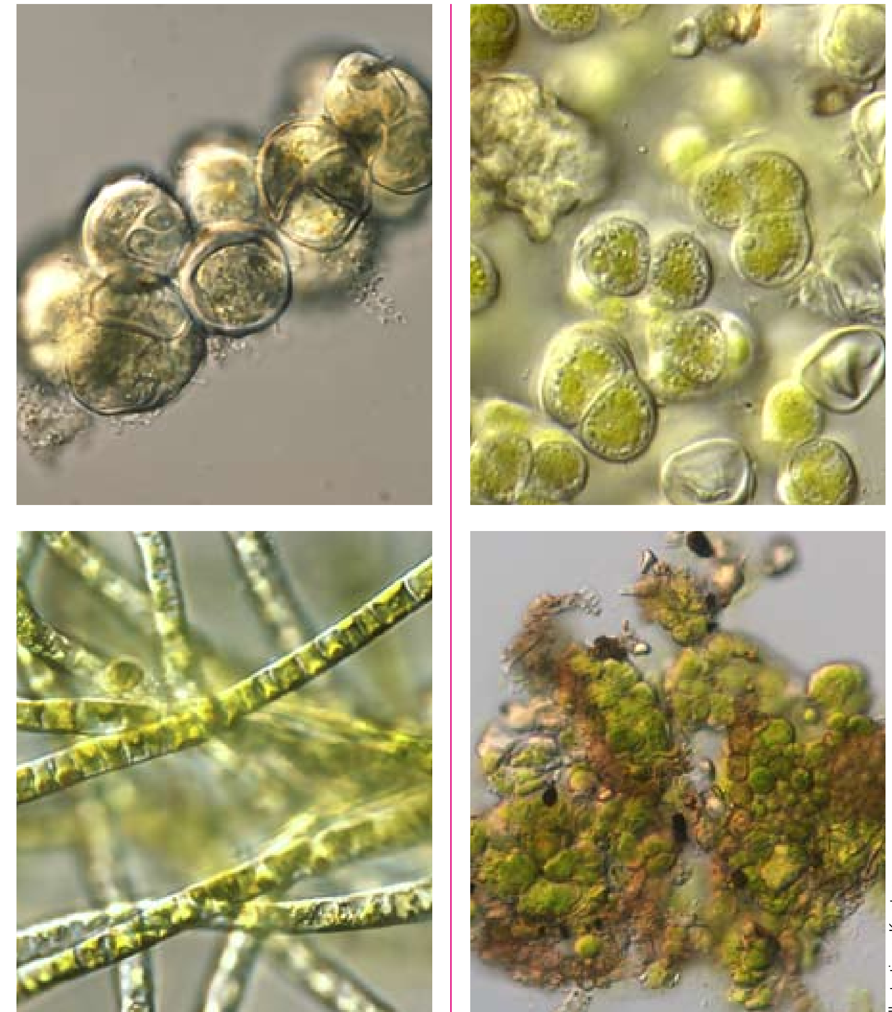
The availability of water is almost certainly one of the key ecological factors governing microalgal colonisation. In addition, the growth of algae in this part of the world is favoured by climatic factors such as mild winters with fewer days of frost and higher levels of rainfall during the main growth periods in the spring and summer.

Nevertheless, the green algae have adapted especially well to the environmental conditions on the surfaces of buildings, which are comparatively extreme. For instance, the water availability ranges from the plentiful drops left by rain showers to prolonged periods of complete dryness. Furthermore, in this climate, the temperature differences between day and night can be up to 15 °C, and the temperature of roof tiles can fluctuate by more than 50 °C in the summer.

The algae deal with the frequent dry periods by forming extremely thick cell walls or layers of mucus that are intended to provide protection against loss of water through evaporation. Spores form during long periods of drought. They are characterised by their thick, impregnated cell walls, which allow them to survive for many years in a dry environment. As soon as they come into contact with water, the spores soon germinate and begin to grow again.

In addition to having these external protective structures, ecophysiological studies have shown that the aeroterrestrial green algae are also capable of growth and photosynthesis without the presence of liquid water if the relative humidity is 100 percent. This is assisted by the biochemical ability to synthesise and store high concentrations of unusual organic substances. Sugar alcohols, in particular, are used to perform a number of metabolic functions simultaneously under adverse conditions. These carbohydrates counteract the threat of a rise in salt concentration due to drought stress, they stabilise sensitive proteins, protecting them from high temperatures, and they supply energy for essential metabolism and repair processes.

Apatococcus is the commonest green alga. Thick cell walls (top row) make the algae very resilient. Bottom left: A filamentous green alga that is also protected by thick cell walls. Bottom right: Green algae stick together with fungi and dead cell tissue to form a biofilm.



Illustrations: Karsten

Along with "drought stress", microalgae sometimes have to cope with excessive sunlight, especially in the summer months, which can impede photosynthesis and damage their photosynthetic apparatus. This means that in very strong light, sensitive parts of the photosynthetic system are shut down and protective mechanisms activated. This allows excess radiation absorbed from the sunlight to be dissipated in the form of biologically-harmless heat. Protective pigments, for instance ß-carotene, are also used to absorb and dissipate the excess energy from the sun's radiation. Incidentally, these carotenoids bring about the easily-visibly coloration of these otherwise green algae to bright yellow and red. In addition to dissipating heat, the oxidation processes, which are associated with strong sunlight and which cause cell destruction, also need to be suppressed. This is achieved by the formation of a number of different antioxidants and the activation of antioxidant enzymes.

In central Europe, another ecological problem is posed by the increase in the amount of "hard" ultraviolet radiation (UV-B). UV-B radiation has a strong mutagenic effect and damages numerous biological molecules in the cells, having a negative effect on many of the algae's vital functions. However, microalgae are able to protect themselves from this stress factor using specific substances that act as sunscreen. The substances used as protection against the harmful effects of UV radiation are special mycosporine-like amino acids (MAAs), which have long been known to act as natural UV sunscreens in many marine organisms. Increased MAA concentrations in the cells allow physiological processes such as photosynthesis and growth to have a broader range of UV-tolerance.

In comparison to the marine microalgae, the aeroterrestrial algae are subject to environmental factors with a much higher stress potential. However, the broad range of abilities displayed by the microalgae in various situations has barely been investigated to date. Fully understanding the complex adaptive skills exhibited by these specialists is a challenging task. Only when the properties and the ecological significance of aeroterrestrial microalgae are better understood will it be possible to address questions relating to their biotechnological exploitation or the development of selective strategies for preventing and combating them. This would be a step towards victory in the battle against that troublesome greening of walls and buildings.

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Between Two Different Worlds

A visit to the DFG's Office in Delhi

By Magdalena Schaeffer

There are two things that are essential to survival in India, as any visitor notices as soon as they arrive, patience and flexibility. Patience is certainly called for on arrival at Delhi's airport, where an Indian customs officer slowly looks you over and takes your passport in slow motion. Impatience or, heaven forbid, insisting that you need to get through customs quickly would certainly be out of place here. So it takes half an eternity until the customs officials have finished scrutinising your papers and you are finally free to leave. A lack of flexibility, on the other hand, would make it impossible to cope with the plethora of contrasting impressions.

Day 2: We head from Delhi to Kanpur, where an Indo-German scientific conference is being held at the Indian Institute of Technology (IIT). We leave Delhi by train before later continuing our journey by car. The scenery could hardly be more varied. From our comfortable compartment on the train we see endless rows of dilapidated houses and huts whiz past our window, which are followed by kilometre after kilometre of green countryside.

Changing from the calm of the air conditioned train to travelling by car is also a bit of a shock. Mopeds rattle past in between the cars and busses, and bicycles, tractors and handcarts nudge their way through the traffic. We are surrounded by noise, dust, scents and smells, heat and no end of people. On the IIT campus we suddenly find ourselves back in the civilised world. Carefully tended paths weave their way through the peaceful atmosphere, with abundant fresh air, flowers and peacocks. Life in India – at least for Western visitors – is a constant state of being between two different worlds.

Patience and flexibility – they are also among the wherewithal Gernot Gad and his staff of five at the DFG's Delhi Office need on an everyday basis. They have been on the subcontinent since November 2006, providing advice and information about the DFG and its programmes as well as the German science and higher education system and supporting Indian and German scientists who are interested in collaborating or working on joint projects. They are based in the German House in the middle of the embassy district of New Delhi, which was the former embassy of the GDR and is now home to the German Academic Exchange Service (DAAD) and the Alexander von Humboldt Foundation (AvH) as well as the DFG. The Delhi Office also has a branch office in Hyderabad. The DFG representatives are frequently on the road too, however, visiting universities or attending conferences such as this meeting for chemists at the IIT in Kanpur. About 15 German scientists have come to the "Frontiers of Chemistry" conference, and there are about the same number of Indian scientists too. "There has been good contact between India and Germany in chemistry for quite a long time, but the exchange is still rather unbalanced, with far more Indian chemists visiting Germany than vice versa. This is not least due to the fact that Germans are not sufficiently familiar with the scientific landscape in India", explains Gernot Gad during his opening speech at the conference.

Illustration: DFG Office India

This imbalance in the level of interest is confirmed by a number of conversations I have on the fringe of the conference. Almost all of the Indian professors present had spent at least a year or more living and researching in Germany with a Humboldt fellowship, and one had even qualified as a university lecturer and started a family while living in Germany. The Indians are also very familiar with some typical German traits, for instance their tendency to be very frank and speak their mind.

The Germans at the conference are rather less familiar with Indian research and culture. For example, that evening they show very little restraint while waiting for the buffet to open, eagerly sampling the starters, so that by the time the buffet is finally opened they are all almost full up already. In India it is customary to make conversation before supper and leave promptly afterwards. It would be considered impolite to stay on after the meal.

All in all the chemists are very successful at making contact with each other. At the conference in Kanpur plans are made for future projects and reciprocal working visits, and Gernot Gad is in high demand. Most of the resulting research collaboration will take place in Germany, however, which is not least due to the German doctoral students, very few of whom are interested in spending part of their degree studying in India.

In contrast, the professors are overwhelmed with applications from Indian students, leaving them faced with the difficult job of selecting successful applicants. Gad and his staff are on hand to assist with this too. "One of the main tasks performed by our office is to provide a detailed overview of the Indian science system. This enables us to give German scientists precisely the right information on departments and institutions that they need."

The reports by the members of the DFG Commission on IT Infrastructure after they paid a visit to Delhi as part of their tour of Asia struck a similar chord. One of the German scientists said, being very self-critical, that "we are amongst the best in our subject, yet here we are visiting India for the first time. We Germans need to become far more proactive!"

The comparatively new DFG Office in Delhi is thus faced with a large number of challenges, especially as India has 28 states with powerful federal legislative powers, and thus has a very heterogeneous scientific landscape. Last, but not least, there is the fact that Germany is just one of many countries that India is interested in cooperating with. Cooperating with German partner organisations is especially important in this respect, Gernot Gad emphasises. "Indian applicants are unfamiliar with what the DFG, the AvH and the DAAD offer and need help in finding the right form of funding to meet their personal needs. Cooperation in this area is far more worthwhile than trying to advance your own interests."

The team in Delhi has already achieved a great deal. For example, they have reached funding agreements with the Department of Science and Technology and the Indian National Science Academy. And a group of Emmy Noether fellows was able to spend several months at highly respected Indian departments at the invitation of the DFG, making contact with their Indian counterparts. As well as that, the team in Delhi has received a number of German and Indian science delegations, taking care of them and providing them with advice and information. The DFG also hopes that a project being run in Delhi by the Lindau alumni group, which aims to get Indian schoolchildren interested in a career in science, will have a broad impact on the next generation. It may seem hard to believe, but despite its immense population, India is suffering a shortage of young scientists, as rising salaries in industry attract the best minds away from academia.

All this has been achieved by the DFG staff in India with the support of the DFG Head Office in Bonn. From Germany it is hard to imagine how time-consuming and nerve-wracking even seemingly trivial things can be. The instructions given on an invoice or buying a train ticket are anything but trivial in India, and the native speakers employed at the office are absolutely essential, because using English all too frequently leads to misunderstandings. But the Delhi team is well equipped with the most important things that you need in India, plenty of patience and flexibility!

Illustration: Schaeffer

Welcomed by an elephant: When German Chancellor Angela Merkel visited Delhi in October 2007, the DFG drew her attention in a typically Indian manner. Right: In addition to the DFG a number of other German research funding organisations are at home in the German House. The close proximity benefits everyone.

Magdalena Schaeffer visited the DFG Office India for two weeks last autumn during her traineeship at the DFG's Press and Public Relations Office. Since April 2008 she is the press officer at the Institute for Advanced Studies in the Humanities (KWI) in Essen.

Rural burial ground with a past: Ingalls Cemetery in Ticonderoga, New York. Entire family dynasties were laid to rest here between 1800 and 1950.

The Price of Death

Religious rituals are assumed to be long lasting and all but unchangeable. Yet funeral culture in the United States shows that they are actually in constant flux – especially due to commercial reasons

By Oliver Krüger

Loud and colourful: Puerto Rican flags and artificial flowers adorn a burial plot in The Evergreens Cemetery in Brooklyn, New York. Graves like this express strong ethnic pride.

What causes rituals to change – for example when it comes to the culture of public mourning and funerals? This question may sound surprising to religious ears. From a religious point of view it is often claimed that rituals have changed very little throughout the centuries. However, recent cultural studies, from sociology to comparative religion, demonstrate that rituals are constantly undergoing a dynamic process of adaptation to social and cultural change. The obvious shifts in Germany's funeral culture – as exemplified by natural burials in forest cemeteries or the trend toward anonymous inurnments – graphically illustrate this finding.

Ritual research used to largely ignore economic factors as drivers of change. The underlying reason can be found in Christianity's taboo on the material aspects of rituals, especially when it comes to funerals. After all, burying the dead is the "seventh act of charity" according to Christian doctrine. This twofold taboo makes the highly commercialised mortuary culture in the United States an intriguing topic, which also brings the economic interests of the funeral industry into view.

Funeral and grave culture in the United States, in spite of the country's religious diversity, was quite homogenous over a long period. Only recently did things begin to change. The "average" American funeral, for Christians as well as non-Christians, is the interment of the body. But the share of cremations in the US, which was only 2.7 percent in 1961, is now as high as 31 percent (2004). Over 90 percent of burials and even 25 percent of cremations currently involve the American custom of embalming and cosmetically preparing the entire corpse.

After the embalming, the deceased is dressed in festive clothes, from underwear and shoes to a fine dress or suit, made by specialised fashion houses. Then the body is laid out, usually in a funeral home, for several hours (up to three days) in a half-open casket for the wake or viewing, before it is buried after a short ceremony. Surprisingly, the vast majority of believers across all Christian churches and denominations, as well as most Jewish funerals, follow this pattern. Even the small Protestant community of the Amish, otherwise known for its seclusion from the world, hires external undertakers to handle embalming.

Denominational biases are reflected especially in people's attitudes toward cremation. Southern Baptists (the largest of the free churches in the US) are opposed on principle to burning a person's mortal remains as they want to keep the body intact in anticipation of its physical resurrection. Significant differences between religious communities can also be seen in the details of the funeral service and the design of the grave.

How could this unique funeral culture emerge – the first one since ancient Egypt to practice embalming on a mass basis? In addition to urbanisation and the rise of a middle class – changes that also happened in Europe – there were three main reasons that lead to the lavish funerals we see in the US. First, the American Civil War (1861–1865) popularised embalming, because the corpses of fallen officers had to be preserved so they could be shipped home. War heroes, for example, were embalmed and publicly displayed. Furthermore, the desire to safeguard the physical integrity of the deceased led to a wide acceptance of embalming in the late nineteenth century, because embalmed corpses were of no use to so-called "body snatchers", who stole corpses on a grand scale for anatomical studies in colleges and universities. Finally, the comprehensive standardisation of American mortuary culture can be attributed to the commercial interests of the funeral industry. By increasingly professionalising and optimising its sales and marketing strategies, it was able to monetise culturally latent demands, such as the desire to preserve corpses.

A "traditional full-service funeral", including embalmment, ceremony, casket, and flower arrangements, runs about 8,000 to 10,000 dollars these days, in addition to the cost of the grave. But cemeteries under private, church or municipal ownership are increasingly being bought up by the funeral industry itself. A plot can cost up to 30,000 dollars. For the average US household, this makes burying a loved one the biggest expense item after buying a home or car.

The impact of the funeral industry on mortuary culture can be observed in a remarkable development in the United Kingdom. As recently as forty years ago, embalming and open-casket viewing were considered downright weird in this country. But after a major American funeral company entered the UK market in the early 1990s, the percentage of deceased persons who undergo embalming shot up to currently over 30.

High funeral costs provoked resistance early on. In 1910, individual cooperatives entered agreements with undertakers who offered lower rates to members. After the People's Memorial Association was founded in Seattle in 1939, memorial societies sprang up in the mid-1950s in all major US cities, and a bit later also in Canada. In 1963, these local groups joined forces to form the Continental Association of Funeral and Memorial Societies. When the funeral industry began to designate commercial associations as funeral societies, the memorial societies, both locally and nationally, sought to prevent misunderstanding by changing their name to Funeral Consumers Alliance (FCA) – an organisation that numbers about 400,000 members across the United States.

Illustrations: Krüger

Bottom left: An imposing tombstone with Chinese characters. Top left: In The Evergreens Cemetery in New York City, we find traditionally built mausoleums as well as ones with a more modern design (above). Right: This plain Amish cemetery near Lancaster, Pennsylvania, was established around 1880.

In many cases, memorial societies grew out of religious lay movements, particularly on the Protestant side, but they also have roots in the union and labour movement. During that period, a major emphasis was placed on popularising cremation. The reform movement gained momentum when civil rights activist Jessica Mitford (1917–1996) caused a stir with her book "The American Way of Death" (1963), in which she revealed the sales strategies employed by the funeral industry, and bluntly described the preparation techniques used in embalming.

Suddenly, funerals became a political issue. The American Intelligence Service, a private organisation devoted to the relentless fight against "un-American activities", disseminated pamphlets and brochures that warned of memorial societies. They condemned advocacy of cremation and criticism of American funeral directors as mere communist propaganda to undermine the traditions, values, and moral community of Americans. Nonetheless, the representatives of memorial societies were ultimately able to push through comprehensive consumer protection legislation, the Funeral Trade Rule of 1984. It made it illegal, for example, for funeral directors to tell their customers that embalming and inhumation are required by law. Since that time, legal aid services have been available, and numerous test cases involving violations of the Funeral Trade Rule have been brought before the courts.

The culture of funerals and public mourning in the United States underwent drastic changes at the end of the 20th century

But in addition to educating consumers and issuing recommendations for legitimate funeral directors, some local FCA chapters have entered agreements with select undertakers to obtain discounts. There is much controversy within the movement whether its mission should be to secure benefits for members or to campaign for a more equitable and transparent funeral culture in general.

The new legal framework that was ultimately created by the various parties made it possible for America's funeral culture to become more diverse toward the end of the 20th century. Cremation has become a popular alternative to traditional burial funerals with embalming and viewing. In addition, more people choose alternative funeral forms, such as home burials and green burials – all of which indicates a ritual culture in flux.

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▸ www.ritualdynamik.uni-hd.de

The Deutsche Forschungsgemeinschaft

The Deutsche Forschungsgemeinschaft (DFG, German Research Foundation) is the central self-governing organisation responsible for promoting research in Germany. According to its statutes, the DFG serves all branches of science and the humanities. The DFG supports and coordinates research projects in all scientific disciplines, in particular in the areas of basic and applied research. Particular attention is paid to promoting young researchers. Researchers who work at a university or research institution in Germany are eligible to apply for DFG funding. Proposals will be peer reviewed. The final assessment will be carried out by review boards, the members of which are elected by researchers in Germany in their individual subject areas every four years.

The DFG distinguishes between the following programmes for research funding: In the *Individual Grants Programme,* any researcher can apply for financial assistance for an individual research project. *Priority Programmes* allow researchers from various research institutions and laboratories to cooperate within the framework of a set topic or project for a defined period of time, each working at his/her respective research institution. A *Research Unit* is a longer-term collaboration between several researchers who generally work together on a research topic at a single location. In *Central Research Facilities* there is a particular concentration of personnel and equipment that is required to provide scientific and technical services.

Collaborative Research Centres are long-term university research centres in which scientists and academics pursue ambitious joint interdisciplinary research undertakings. They are generally established for a period of twelve years. In addition to the classic Collaborative Research Centres, which are concentrated at one location and open to all subject areas, the DFG also offers several programme variations. T*ransregional Collaborative Research Centres* allow various locations to cooperate on one topical focus. *Cultural Studies Research Centres* are designed to support the transition in the humanities to an integrated cultural studies paradigm. *Transfer Units* serve to transfer the findings of basic research produced by Collaborative Research Centres into the realm of practical application by promoting cooperation between research institutes and users.

DFG Research Centres are an important strategic funding instrument. They concentrate scientific research competence in particularly innovative fields and create temporary, internationally visible research priorities at research universities.

Illustration: Querbach

Research Training Groups are university training programmes established for a specific time period to support young researchers by actively involving them in research work. This focuses on a coherent, topically defined, research and study programme. Research Training Groups are designed to promote the early independence of doctoral students and intensify international exchange. They are open to international participants. In *International Research Training Groups,* a jointly structured doctoral programme is offered by German and foreign universities. Other funding opportunities for qualified young researchers are offered by the *Heisenberg Programme* and the *Emmy Noether Programme*.

The *Excellence Initiative* aims to promote top-level research and improve the quality of German universities and research institutions in the long term. Funding is provided for graduate schools, clusters of excellence and institutional strategies.

The DFG also funds and initiates measures to promote scientific libraries, equips computer centres with computing hardware, provides instrumentation for research purposes and conducts peer reviews on proposals for scientific instrumentation. On an international level, the DFG has assumed the role of Scientific Representative to international organisations, coordinates and funds the German contribution towards large-scale international research programmes, and supports international scientific relations.

Another important role of the DFG is to provide policy advice to parliaments and public authorities on scientific issues. A large number of expert commissions and committees provide the scientific background for the passing of new legislation, primarily in the areas of environmental protection and health care.

The legal status of the DFG is that of an association under private law. Its member organisations include research universities, major non-university research institutions, such as the Max Planck Society, the Fraunhofer Society and the Leibniz Association, the Academies of Sciences and Humanities and a number of scientific associations. In order to meet its responsibilities, the DFG receives funding from the German federal government and the federal states, as well as an annual contribution from the Donors' Association for the Promotion of Sciences and Humanities in Germany.

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A fascinating sea of stars sparkles in the sky above the DFG's Head Office in Bonn. The night sky is full of unsolved scientific questions. The DFG's Annual Report 2007 has answers to many questions relating to research and research funding. Its 264 pages contain examples of research funding projects as well as current facts and figures about Europe's largest research funding organisation and its priorities and prospects. A copy of the report can be ordered by e-mail from the DFG's Press and Public Relations Office (Michael.Hoenscheid@dfg.de).