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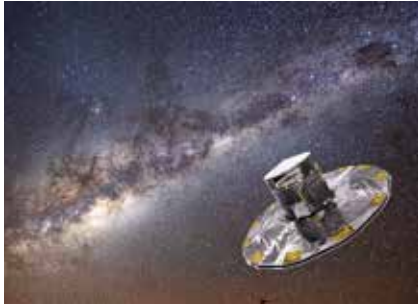
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Cover: Markus Hessinger

Sustaining activity, independence and mobility in daily life: Engineers and orthopaedic technicians collaborate to develop a motorised knee joint orthosis.



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Peter Strohschneider

A Bright Outlook for Research in Germany

The year 2014, in which political conflicts between the federal government, the states and the parties long delayed the conceptual development of the research system, drew to a positive close: Implementing the forward-looking decisions made in mid-December is the task for the new year – in which there will also be reason to celebrate.

The good news came at the end of the year, bringing pre-holiday cheer to German science and research: With their decisions to continue the Higher Education Pact including programme allowances for indirect project costs, the Pact for Research and Innovation, and the Excellence Initiative, the federal chancellor and the states' minister presidents made important and long-awaited strategic decisions for the academic research system in Germany. These finally provide the research community, the research organisations in general, and the DFG in particular with a planning outlook and instil confidence after many months of uncertainty and also some concern.

Credit is due to the heads of the federal and state governments, and in at least equal measure to the ministers for science and research. In late October they agreed in the Joint Science Conference on the policies that have now been confirmed. Consensus on programme allowances for indirect project costs was especially uncertain. For as indispensable as such funding had long become for research at underfunded universities, as threatened was its continuation by the dispute between federal and state governments. The fact that it has now even been increased from 20 to 22 percent, with participation of the states, is a great success, even if this doesn't cover the actual indirect costs of most projects. After all, the political dispute was not about "22 vs. 25 percent", let alone "22 vs. 40 percent", but "22 percent vs. nothing".

No less important are the other two decisions. The third phase of the Pact for Research and Innovation

provides the DFG and non-university research organisations with a reliable framework for the development of their financial resources for another five years, with a growth rate that is remarkable by international standards, albeit at a lower level of three percent vs. a previous five percent. And the fundamental decision to continue the Excellence Initiative ensures the institutions that have been funded since 2012 the chance of a second phase of funding, maintains a research-driven procedure, and makes it possible to uphold the promotion of top-level university research as a priority of science policy.

These decisions brought to a positive conclusion a year in which political conflicts at various levels – between federal and state governments as well as between the parties – had long pushed into the background the conceptual discussions on the future of the research system. Instead of quickly detailing the guidelines – laid down correctly and by consensus, but also rather generically, in the Berlin grand-coalition agreement – for further federal prioritisation of education, science and research, and for closer cooperation with the states, several months were marked by an unproductive standstill. Only resolutions on the distribution of billions in federal education money and on the repeal of the constitutional ban against federal-state cooperation on higher education finally brought a breakthrough in late May, which was followed by the decisions regarding the pacts.



Certainly, some important issues remain unresolved, especially in terms of the fundamental decision to continue the Excellence Initiative. It is all the more important now to quickly concretise the basics and then develop them together with the research community. Nevertheless, the recent decisions are a very important step for the research community, the research system, and research policy.

The DFG's research-policy efforts contributed to this success. In its dual role as the largest funding agency and the central self-governing organisation for research in Germany, the DFG in 2014 also repeatedly articulated the interests, expectations and needs of researchers, as well as their concerns and discontent: in numerous direct conversations with politicians, but also at public events, such as the one with the German Council of Science and Humanities and the German Rectors' Conference at the federal press conference before the decisions in May, or with researchers at the speakers' meeting of the excellence institutions just before the Joint Science Conference session in October.

At the same time, the DFG, building on its 2013 position paper on the future of the research system, has set out its proposals regarding the future consideration of the funding functions of graduate schools and clusters of excellence in a further developed Excellence Initiative. And it has continued – most recently in mid-November at a DFG Senate meeting – to discuss a more systematic and flexible design of its portfolio of grant programmes.

It is not too early to characterise the further development of these foundations, laid in 2014, as a key task of the research community and research policymakers, especially the DFG, in the new year – a year, by the way, that also offers cause for celebration. In 2015 the DFG's Gottfried Wilhelm Leibniz Programme, under which we award the Leibniz Prize, will turn 30. We at the DFG will celebrate this anniversary, together with the research community and all those in politics and society who are interested in research, in a variety of ways: at the presentation of the 2015 Leibniz Prizes in Berlin, at a scientific Leibniz Colloquium and a Leibniz Festival in Bonn, as well as with contributions by or portraits of Leibniz Prize recipients in our DFG magazine.

The Leibniz Programme and the Leibniz Prize should be regarded in two ways: as both the most prestigious German award for researchers with strong international visibility, and as a prominent form of recognition for the inquiring individual, without whose curiosity and imagination there can be no scientific knowledge – and who remains the DFG's first and foremost concern.

A handwritten signature in blue ink, which appears to read "Strohschneider".

Professor Dr. Peter Strohschneider
is President of the DFG.



Illustration: DFG/Lössau

For Better Health Protection: 50th List of MAK and BAT Values

President Strohschneider presents list to the Federal Ministry of Labour and Social Affairs / 65 changes and additions

It was a mandate and a recognition. For the 50th time, the DFG Senate Commission for the Investigation of Health Hazards of Chemical Compounds in the Work Area has submitted a list of Maximum Workplace Concentrations (MAK values) and Biological Exposure Limits (BAT values), laying the scientific foundation for the legislation that governs health and safety in the workplace. The DFG President, Professor Peter Strohschneider, presented the list to Hans-Peter Viethen, under-secretary at the Federal Minister of Labour and Social Affairs, in late July 2014. It includes 65 changes and additions and is available in a digital open access format as well as in a printed version.

When the list was presented at a meeting of the Senate Commission, (photo above), Professor Strohschneider and Mr Viethen thanked the Commission members for their conscientious and important work.

„The suggestions by the Senate Commission form an important basis for German legislation and they are also of great significance for the rest of the world. In providing this list of Maximum Workplace Concentrations and Biological Exposure Limits, the DFG is also fulfilling its statutory mandate to advise on science policy,“ the DFG President said.

At the meeting, Andrea Hartwig, Chair of the Commission and Professor of Food Chemistry and Toxicology at the Karlsruhe Institute of Technology (KIT), described the Commission and its responsibilities and cited examples to illustrate the relevance of its scientific work.

International interest in the work of the Commission is indicated by over 200 000 downloads of the open access version of the “MAK Collection” in 2013, which amounts to almost twice as many as in the previous year. Non-European countries

have contributed significantly to this increase. The list of Maximum Workplace Concentrations (MAK values) and Biological Exposure Limits (BAT values) has been produced in English since 1985. The European Commission frequently consults the Commission’s recommendations and the Commission itself works closely with other international bodies.

The current list includes important changes for dichloromethane, for which the Commission has defined a MAK value of 50 ml/m³ for effective protection from neurotoxicity and an increased risk of cancer. However, pregnant women should not be exposed to this substance at all. Dichloromethane is used as a solvent. Tetrafluoropropene, which could be used in vehicle climate systems, has been given a MAK value for the first time.

The Commission has also defined a MAK value for diacetyl, which aggressively attacks the lungs and has come under discussion since evidence of damage was observed in workers in microwave popcorn production in the USA. Using a procedure established in 2010 to apply the results of animal experiments to humans in order to derive the MAK values, the Commission has reviewed the final two of a total of 37 substances and now concluded this process. As a result, the concentration for diethylexylphthalate (DEHP) has been lowered to 2 mg/m³ and that for diazinon has been retained.

Following the presentation of the 50th List of MAK and BAT Values, the next major event for the DFG Senate Commission will be in 2015 when it will mark the 60th year since its foundation.

For more information about the work of the Senate Commission, a detailed list of all additions and amendments and open access to the MAK Collection of publications, please go to: www.dfg.de/en/mak

Transatlantic Careers

Germany seeks to attract top US-based researchers

At the beginning of September, the meeting of the German Academic International Network (GAIN) in Boston focussed on prospects and career opportunities in the German research system.

The theme of the 14th annual meeting was “Research Careers in Universities and Industry” and provided over 300 German researchers currently based in the USA and Canada with the opportunity to talk to high-profile representatives of German research, government and industry and make contacts to allow them to pursue a future research career in Germany.

“These highly qualified individuals are important bridge-builders between Germany and the USA,” noted DAAD President Professor Margret Wintermantel. DFG Secretary General Dorothee Dzwonnek said in advance of the event: “We warmly invite all participants based on the other side of the Atlantic to come and discover the unimagined possibilities that our research system can already offer.”

A careers fair with over 70 exhibitors allowed participants to make contact with German universities, research institutions and companies and to find out about job opportunities and fellowship programmes.

For more information, please go to:
www.dfg.de/en/dfg_profile/head_office/dfg_abroad/north_america/reports/2014/140926_gain_bericht/index.jsp

Towards More Sustainability

DFG Secretary General calls for more scientific input in policy decisions at UN climate summit

At the United Nations Climate Summit in New York on 23 September, DFG Secretary General Dorothee Dzwonnek called for more weighting to be given to scientific input in policy decisions on sustainability issues.

Dzwonnek attended the 2014 climate summit along with Professor Martin Visbeck, a climate and ocean researcher at GEOMAR Helmholtz Centre for Ocean Research in Kiel, at the personal invitation of UN Secretary General Ban Ki-moon. Visbeck is the spokesperson for the German Committee Future Earth, set up in 2013 as a statutory body of the DFG and supported by the funding organisation through a scientific secretariat based at GEOMAR. The German Committee Future Earth is the national point

of contact for the new international research programme “Future Earth”, the aim of which is to bring together scientific research for global sustainability.

For Dzwonnek and Visbeck, the summit also provided an opportunity to talk to Federal Environment Minister Barbara Hendricks (photo left to right), the Federal Minister for Economic Cooperation and Development, Gerd Müller, and other German government representatives.

Other discussions took place to prepare for an international conference to debate the scientific parameters for the measurement and optimisation of sustainability. The conference is being jointly organised by the DFG and the United Nations University (UNU) and is expected to take place in May 2015 at UN headquarters in New York.

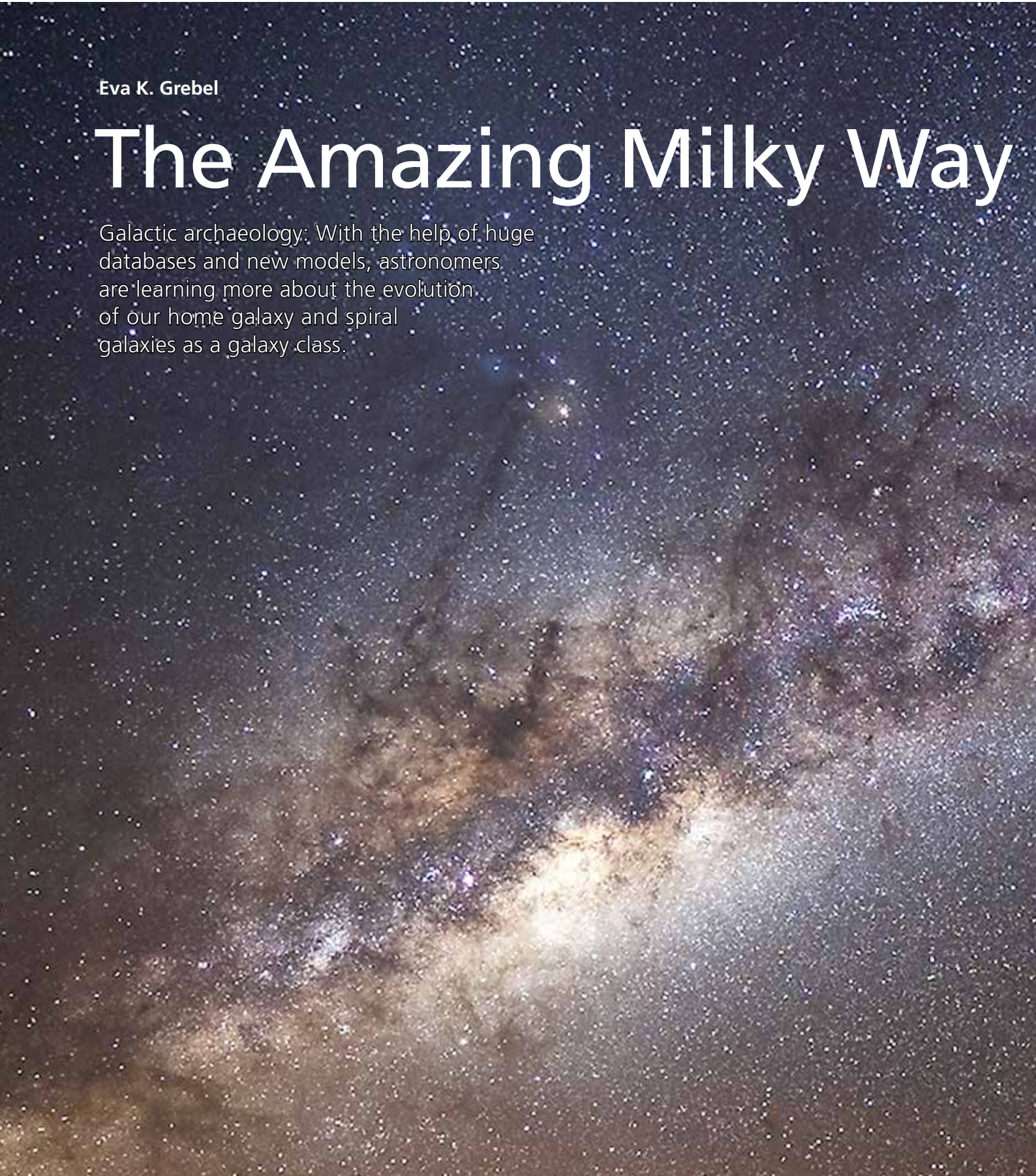


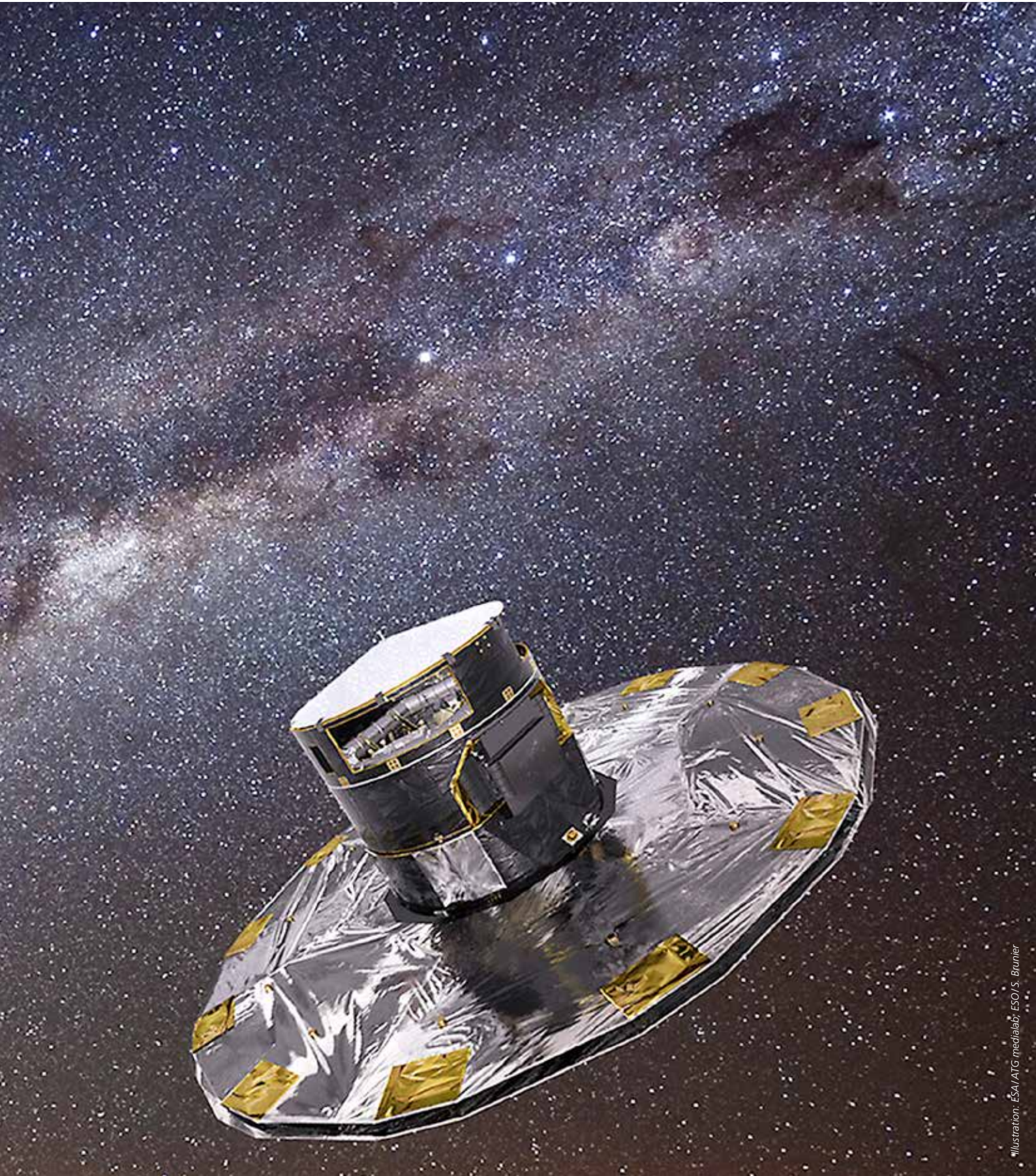
Illustration: Schueler

Eva K. Grebel

The Amazing Milky Way

Galactic archaeology: With the help of huge databases and new models, astronomers are learning more about the evolution of our home galaxy and spiral galaxies as a galaxy class.





The Milky Way is our home galaxy. On a clear night, the glowing band of stars and luminous clouds of gas is visible in the sky. The name “Milky Way” derives from Greek mythology. The milky-coloured band is said to have been created by the milk spilt by Hera, the wife of Zeus, when she pulled the infant Hercules away from her breast. The scientific term “galaxy”, which refers to a system of stars, gas, dust and dark matter held together by gravity, in fact derives from the Greek word for milk. The Milky Way is just such a system, and is often referred to as simply “the Galaxy”.

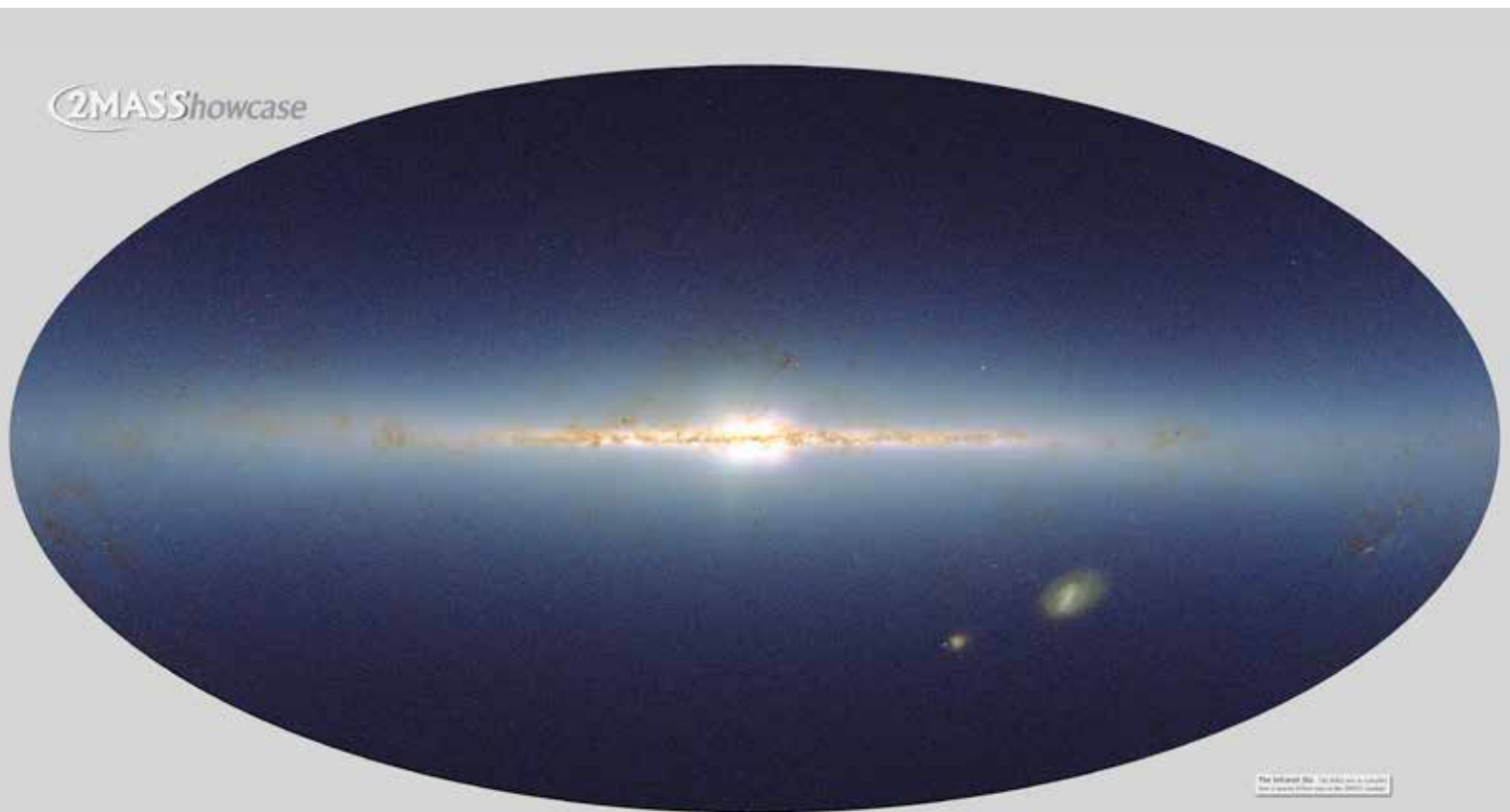
When Galileo Galilei gazed at the heavens through his telescope in 1610, he was able to verify for the first time what earlier astronomers had surmised: that the milky band was made up of countless individual stars. Today we know that this is the disc of the Milky Way. Our solar system lies within this disc, on the edge of one of its spiral arms. From Earth, we see the edge of the disc.

The band of the Milky Way looks irregular to us because it is full of gas and dust and some of the light is obscured by dust clouds. Because we are viewing the Milky Way from a position inside the disc, it was a long time before the

blurry, luminous band was recognised as a flat disc-shaped formation of individual stars. We now know that the disc of the Milky Way is around 100 000 light-years across. Our Sun is approximately 26 000 light-years from the Galactic centre.

While gas and dust restrict our view of the Milky Way in visible light, they do allow new stars to be born in our Galaxy. Stars and planetary systems can form when huge clouds of gas and dust no longer have enough pressure to resist their own gravity and begin to collapse. This usually happens in the dense regions of the Milky Way’s spiral arms. But exactly how

Panoramic view – the sky at infrared wavelengths. The edge of the galactic disc, the central bulge and, bottom right, two small companion galaxies of the Milky Way can be clearly seen.



The infrared view of the Milky Way is a composite of images taken by the 2MASS survey.

Two Micron All-Sky Survey (2MASS) Infrared Processing and Analysis Center/Catalogs © University of Massachusetts

these processes take place is not yet fully understood.

The Milky Way comprises more than just the obvious disc region, with its relatively high concentration of stars and gas compared with the surroundings. In the centre of our Galaxy, which is difficult to observe because of the large amounts of dust present, even higher stellar densities are found. This concentrated gathering of stars in the centre of spiral galaxies is known as a “bulge”. The roughly spherical bulge in the middle of the Milky Way transitions into an elongated bar, making our Galaxy, like about 30 percent of all spiral galaxies, a “barred spiral”.

In the centre of the Milky Way there is a massive black hole, which was detected by measuring star movements using high-resolution infrared data. We now know that virtually all large galaxies contain a very massive black hole at their centres, which presumably formed during the early phase of the galaxy’s formation.

Most of the visible matter in a spiral galaxy is found in the bulge and galactic disc. By observing the movement of stars and gas within the disc we can deduce the presence of additional, non-luminous matter. This requires the existence of additional mass. The question of just what this “dark matter” is made of is a key problem challenging astronomers and particle physicists.

The “normal”, luminous matter in galaxies is embedded in much larger spherical structures, haloes of dark matter. Spiral galaxies like the Milky Way have a sparse halo of visible matter consisting of comparatively few, mostly very old stars



Astronomer Johannes Ludwig beside the semicircular mount of the 4-metre Mayall Telescope at Kitt Peak National Observatory in the USA.

and globular clusters. Because of its low stellar density, this stellar halo contributes little to the overall luminosity of a spiral galaxy. However, it does provide some vital clues as to how the galaxy was formed.

The Milky Way is a typical spiral galaxy, the most common type of massive galaxy. The formation and evolution of these galaxies still present important unanswered questions in modern astronomy.

From our position inside the Milky Way we can study its components up close and with great accuracy. The stars in the Milky Way cover almost the entire cosmic age range, from stars in the process of being formed to the oldest stars that formed shortly after the Big Bang. These stars are witnesses to the evolutionary history of the Milky Way, and have a lot to tell us. By studying the physical properties, composition and movement of stars in the different components of the Milky Way, we can engage in “galactic archaeology”.

Some of this research is being carried out by a DFG-funded Collaborative Research Centre (CRC), “The Milky Way System”, which was set up in 2011 at Heidelberg University. One of the key actors in this project is the University of Heidelberg’s Centre for Astronomy, which consists of three astronomical institutes and is the largest university astronomy facility in Germany. Two non-university research institutes, the Max Planck Institute for Astronomy and the Heidelberg Institute for Theoretical Studies, are also

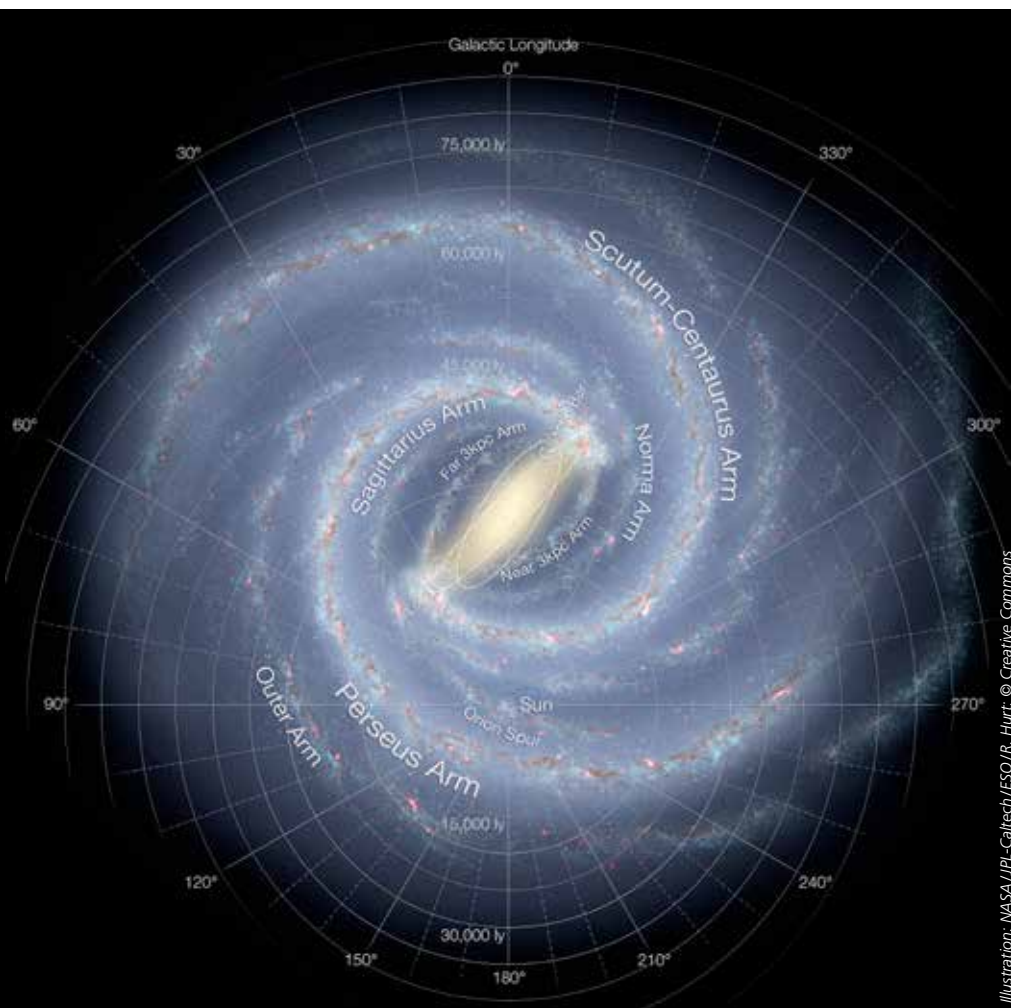
participating. The Haus der Astronomie, which is supported by the Klaus Tschira Foundation, the Max Planck Society, Heidelberg University, and the city of Heidelberg, carries out science outreach for the CRC in the form of school events, lecture series and workshops for teachers.

The study of our home galaxy has a long tradition in Heidelberg. The institutes involved in the CRC play leading roles in major international celestial survey projects, in which the Milky Way is measured in different wavelengths. This includes major projects such as mapping our Galaxy with high-resolution images across large expanses of the sky or performing spectroscopic analysis of hundreds of thousands of its stars. The image data allow scientists to track the position and density distribution of different types of stars. Spectroscopy, on the other hand, provides clues as to the speed and composition of stars.

These data, whose acquisition became possible only in recent years thanks to the development of advanced instruments, form the basis for galactic archaeology in the CRC. The CRC’s experimental component is complemented by theoretical models and simulations, for which the team uses a supercomputer developed jointly by the CRC and Research Centre Jülich.

To understand the evolutionary history of the Milky Way, we use a combined approach. Firstly, we investigate long-term, large-scale processes that shaped the evolution of the Galaxy. This includes the question of the role of accretion in the formation of our home galaxy, i.e. the merging of smaller

Spiral arms – the complex structure of the Milky Way disc.





The "nerve centre" 2000 metres up at the Kitt Peak National Observatory: astronomers in the Mayall Telescope control room.

galaxies into the Milky Way, and when and how often such events occurred. To answer these questions, we try to identify stars that originally came from smaller galaxies by their motion and chemical composition. This primarily involves studying the galactic halo.

Secondly, we study short-term, small-scale processes, such as the preconditions and processes involved in the formation of stars from huge clouds of gas and dust and the enrichment of the gas with heavier elements formed through nuclear fusion inside stars. By studying this enrichment and the relative proportions of different elements, we can work out where stars formed, from what material, and over what time-scale. The combination of these two approaches gives us a detailed picture of star formation, chemical development and the role of inter-

actions in the evolutionary history of a typical spiral galaxy such as the Milky Way.

The European Space Agency's Gaia satellite was successfully launched at the end of 2013, and the Collaborative Research Centre is looking forward to using its data. Astronomers in Heidelberg played a leading role in the preparations for the Gaia mission. Over the next few years, Gaia will measure the positions, movements and distances of up to 1 billion stars in the Milky Way with unprecedented accuracy. By combining these data with the ground-based survey data previously mentioned, we will be able to characterise stars and other components of the Milky Way in eight dimensions: three-dimensional position, three-dimensional motion, elementary composition, and age.

These unique data will usher in a golden decade for basic research into the Milky Way system. The astronomers involved in the mission are anticipating substantial breakthroughs and new insights into the evolutionary history of our home galaxy.



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www.zah.uni-heidelberg.de/de/sfb881/



Julia Block, Jürgen Hielscher, Thorsten Meiß

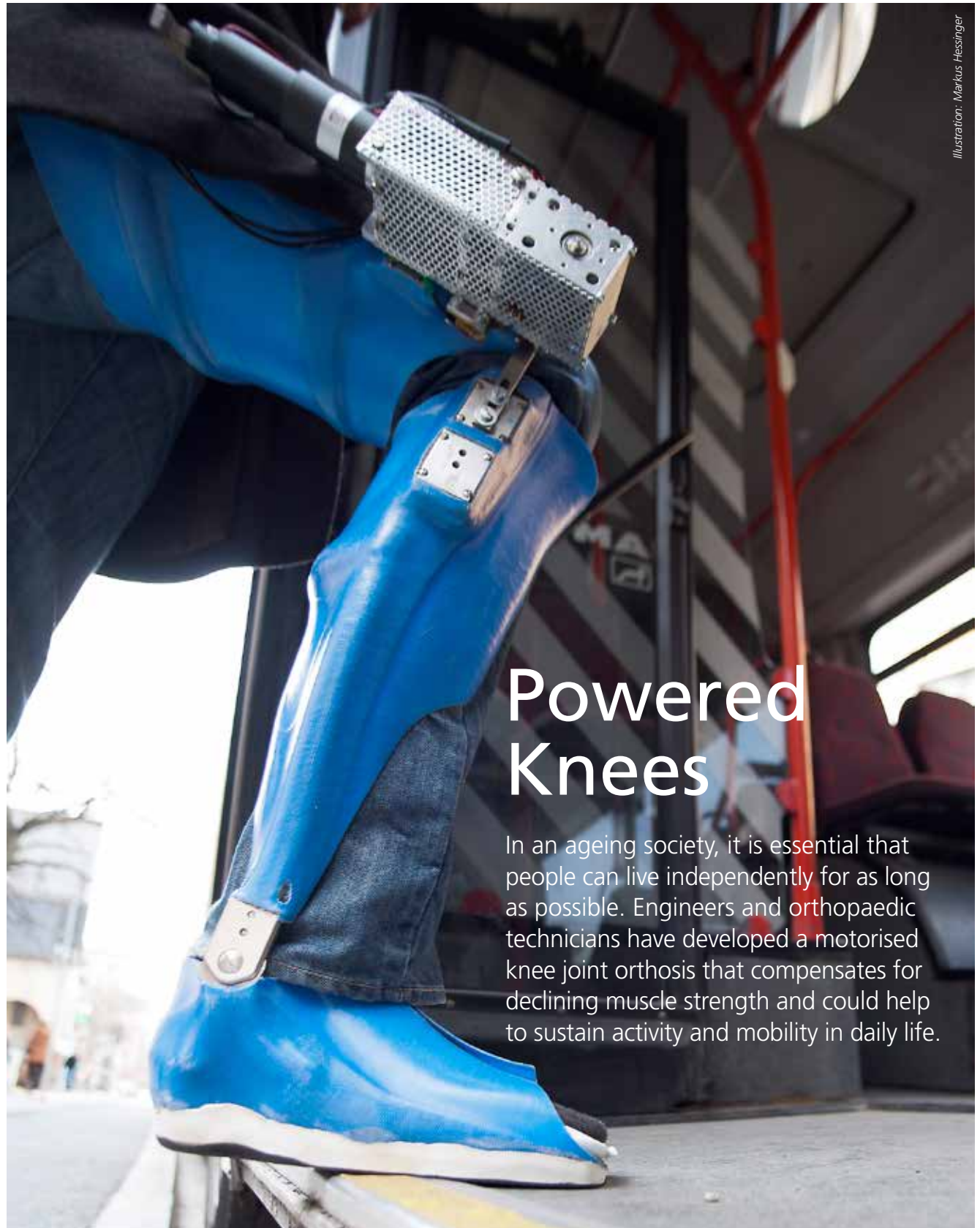


Illustration: Markus Hessinger

Powered Knees

In an ageing society, it is essential that people can live independently for as long as possible. Engineers and orthopaedic technicians have developed a motorised knee joint orthosis that compensates for declining muscle strength and could help to sustain activity and mobility in daily life.

Hilde is setting the table for coffee when she gets a call from her friend Gertrud. "Is your lift working again yet?" – "Hello, Gertrud. No, it's still out of order, I'm afraid." Gertrud's disappointed answer is unexpected: "I'm sorry, Hilde, but I'll have to cancel. You know I can't make it up to the third floor by myself these days." As a result, one woman is sitting at her table set for two, the other in her armchair at home just two streets away, and both are frustrated because of the limitations imposed by old age.

As we get older our muscles lose their strength. According to kinesiologists, the loss of leg muscle strength can be up to 30 percent. This loss of muscle power and the associated physical frailty can cause considerable restrictions in everyday life. In recent years, the leisure industry has very successfully developed Pedelecs, electrically assisted bicycles which make it easier to ride uphill or cover longer distances. Mobility assistance for older people is a key area of concern.

For seniors, age-related changes and frailties often represent limiting factors in everyday life. Walking on the level might still be possible, but climbing stairs or getting up from a seated position demands more than twice as much knee torque, which must be generated by the muscles around the knee joint. Movements like these place particular strain on the knee-extending muscles, mainly a muscle group known as the quadriceps. Declining muscle strength makes it difficult for older persons to maintain the level of independence they desire. There are several aids designed to make standing up easier, such as bath chairs, raised toilet seats, hand rails and riser recliner chairs. Meanwhile, lifts and stairlifts overcome the barrier of stairs. But these aids are stationary

and only available in the home environment. How can we help people by means of mobile aids?

At home in her flat, Gertrud has few problems. When she bought a new sofa, she was careful to choose one that was not too low or too soft. Otherwise she can't get up quickly enough to answer the phone in the hall. But outside her apartment, she faces other obstacles. On the bus, she has got into the habit of getting up a stop early so she can get off in time at her own stop. And to visit Hilde in her third-floor flat, she can usually take the lift.

Stories like Gertrud's provided the reason for developing an assistance system suitable for everyday use. The idea was to compensate for reduced knee torque by means of an orthosis – an orthopaedic aid that usually has a stabilising function. The addition of a motor creates an active orthosis that not only stabilises the joint, but also allows exter-

nal force to be applied, thus assisting a person's movements.

Active orthoses are already used in various fields, for example in the treatment of tetraplegia and the rehabilitation of stroke patients. However, the aim in this case was to use an active orthosis as an everyday aid for older people with limited mobility, particularly in situations where their own strength is no longer sufficient. Standing up from a seated position is a good example – and became one of the first applications. To establish what requirements such an orthosis would need to fulfil, the research team first gathered reference data for the motion of standing up by analysing healthy volunteers in a motion analysis laboratory. Using 3D motion analysis, the movements of a human being can be expressed in joint angles and moments with the help of a camera system, optical markers and a biomechanical

Left: Getting on the bus. An orthosis can help an individual take part in normal everyday activities. Below: In the motion analysis laboratory, the functions of an orthosis are tested and the effects for the user are analysed.



cal model. Force plates embedded in the floor record ground reaction forces under the person's foot. Using these data, it is possible to work out the torques and mechanical forces involved in the motion of the joints.

These reference data were used to design the actuator attached laterally of the thigh brace of the orthosis. The motor torque is linked to the orthosis joints by a reducing gear mechanism. However, the friction of the gear mechanism puts additional load on the user when not compensated for. This problem was solved by incorporating a torsion spring and a newly developed control algorithm. The spring is fitted between

the motor control gear and the orthosis joint, so in mechanical terms the components are connected in series. This series elastic actuator (SEA), combined with the controller, compensates for gear friction and moment of inertia, with the result that the orthosis creates no resistance in non-support situations.

To make the orthosis easy to use for older adults like Gertrud, it uses the principle of power-assisted steering, similar to that found in our cars. The knee torque applied by the user is measured and a percentage of this is provided as additional torque. This makes the system intuitive to use and enables the user to maintain

control of their motion. Because the 3D motion analysis system with stationary force plates cannot be used in everyday surroundings, it was necessary to develop a strategy to determine the target knee torque. The camera system is replaced by angle sensors in the knee and ankle joints of the orthosis. To measure the ground reaction force under the foot, miniaturised force sensors are integrated into the foot plate. With the help of a detailed control model, the data supplied by these sensors allow the control system of the orthosis to determine the exact knee torque being applied by the user at any given moment. The rest of the process is identical to that in the lab: the auxiliary torque is calculated by multiplying the calculated knee joint moment by an amplification factor.

When the musculoskeletal system is supplemented by external forces, it is important to avoid stressing anatomical structures. The knee joint is a pivotal hinge joint, which means that the knee's axis of rotation moves during flexion. When an external torque is introduced to the joint structure, it is important that the anatomical and orthotic axes are congruent. Linking the two sections of the orthosis with a simple hinge joint will cause shear forces in the knee joint and the orthotic braces. So the researchers analysed the progression of the knee axis in various everyday movements. Using these data, they were able to design and build three alternative orthotic joints that were then tested on volunteers.

To reduce shear forces, orthotic joints are tested and adjusted.



Illustration: Julia Block



Building the orthosis with the help of fibre composite technology: a profiled carbon fibre framework is shaped around a plaster model of a volunteer's leg and resin soaks the fibre mesh, forming the braces.

over the muscle to measure the electric signals generated by muscular contraction. In everyday use this procedure is prone to noise and complex in handling, so there was a need to develop an alternative way of detecting muscle activity. A sensor measures the changes that occur in the shape of the thigh when the muscles contract. No direct skin contact is required as the sensor is housed in an elastic cuff wrapped around the thigh. Tests showed positive results – a clear signal from the sensor cuff when the wearer stood up and good correlation between this signal and the EMG data being recorded at the same time.

Tests with healthy volunteers demonstrated that they felt the support of the active orthosis while standing up. The muscle activity of the rectus femoris was reduced by up to 25 percent compared to the reference measurement without external support. In tests carried out so far, the power assistance concept has proved to be very reliable. The orthosis is currently undergoing further development to make it more suitable for everyday use and allow for more extensive test procedures. In particular, researchers are aiming to reduce its weight and size. A battery-based power supply is also being developed for mobile use. The sensor cuff for detecting muscle activity will be integrated in the orthosis braces. These data will be used to detect the user's movement intention. Instead of a large drive mechanism, the team is currently testing a concept involv-

ing several small motors distributed over the leg, which makes the orthosis both smaller and lighter.

Extensive testing must be carried out on volunteers with an improved prototype to check safety aspects for practical use. Developers are also looking at the external appearance of the orthosis, because as with Pedelects, the idea is that users should regard it as a modern aid that fits seamlessly into everyday life.

Thanks to her active orthosis, Gertrud doesn't have to miss the visits she loves to her friend Hilde. The old gentleman across the road has also asked her with great interest about the high-tech device on her leg.



Dipl.-Ing. (FH) Julia Block

works in the Motion Analysis Laboratory at the Heidelberg University Orthopaedic Hospital.

Dipl.-Ing. Jürgen Hielscher and Dr.-Ing. Thorsten Meiß

are research assistants at the Institute of Electromechanical Design in the Faculty of Electrical Engineering and Information Technology at the University of Darmstadt.

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www.emk.tu-darmstadt.de/en/institute/research/inter-lab-research-projects/orthese-adaptive-knee-orthosis/



Integrated shear force sensors measured discrepancies between the kinematics of the orthosis and the joint. These measurements were used to choose the best of the three designs.

The orthosis should be as unobtrusive as possible when in use and should react intuitively and “intelligently” to the user's intentions. Because conscious body movements are always associated with the tensing and relaxing of muscles, the contraction of the quadriceps can be measured to deduce the user's intended movement. The use of electromyography (EMG) to measure muscle activity is a common procedure. With this technique, electrodes are attached to the skin

Peter Boeker

The Search for the “Electronic Nose”

The sense of smell is perhaps the most ignored of the five senses – and extremely difficult to understand. Previous research relied on human volunteers. Now researchers are using integrative approaches in an attempt to analyse smells using engineered sensors.





A dog runs from tree to tree, sniffing as it follows an invisible scent trail. We all know how important smell is to a dog. But what does it mean to humans? Most people give this question very little thought. We are sometimes aware of smells: we like the pleasant fragrance of a rose, and more often we are irritated by the unpleasant smell of manure. Unfortunately, we often fail to appreciate the value of a thing until we lose it. Losing the ability to see or hear is frightening. But what about the sense of smell? Couldn't we afford to lose that?

Smell is one of the five traditionally defined senses, along with sight, hearing, touch and taste. Smell and taste are the two "chemical senses". Rather than detecting physical stimuli, they react to molecules. In evolutionary terms, the chemical senses are the oldest senses. But is it possible that in our times and culture, smell has lost its importance in an environment full of visual and audible stimuli?

By no means, as anyone who has had a bad cold will tell you. Food loses its attraction and going to a fine restaurant would be pure waste – because taste is in fact mainly smell. The tongue can only detect a few qualities, such as sweet, sour, salty and bitter. Flavours are actually detected by the sense of smell when odorants enter the nose through the throat; this is referred to as "retronasal olfaction". The loss of the sense of smell due to injury or disease therefore deprives us of the fine sense of taste and therefore one of life's important pleasures.

Smell has been put to various uses for a long time. Scent marketing is designed to increase sales of a product by using the right fra-



Achieving the dream of an "electronic nose" calls for inspiration and dedication.

grances. Bakeries and bread shops use the scent of freshly baked rolls from a baking machine as part of their marketing strategy. A more subtle use of scent is the special fragrance systems or fragrance oils

added to the air conditioning systems in shops and hotels.

What is noteworthy is that smell awakens unfiltered emotions, many of which are linked to memories, often from a long time ago.

In Marcel Proust's famous novel *In Search of Lost Time*, the trigger for a memory is the aroma of a madeleine. Smells have the power to directly awaken memories and feelings. The consumer industry seeks to use this to its advantage.

But scientific research into the sense of smell also has many facets. The decoding of the genetic basis of smell won the Nobel Prize for Medicine in 2004. Medical scientists study the effects of diseases such as Parkinson's or Alzheimer's on the sense of smell. Olfactory tests could provide an early indicator of these conditions and help with their treatment. For food technologists and flavour manufacturers, odorants are a key component of food quality. Scientific measuring techniques are always required, the development and use of which

demand extensive knowledge of chemistry and physics. Researchers are now looking beyond the limits of specific fields and adopting interdisciplinary approaches in olfactory research. Smell cannot be reduced to pure chemistry, nor can it be described in purely phenomenon-oriented terms.

The question of technical measurability is also just as fascinating as it is relevant: Does a new product, perhaps a new car, smell nice? Is the industrial smell from a nearby factory within a tolerable limit? What's making that stink in the neighbours' new chimney? At present, questions like these can only be answered with human panelists: not trained perfumers, but "average smellers". Naturally, this type of investigation is complex and expensive, and there are doubts as to its objectivity.

How nice it would be to have a convenient device that could analyse an odour and tell you its exact composition – an "electronic nose" in the same way that cameras are electronic eyes and microphones are electronic ears. In fact, researchers all over the world have been pursuing this goal since the 1980s. The inspiration for the design of an electronic nose came from nature. Our sense of smell is based on specialised olfactory cells that are activated by odorants. The olfactory tissue of the nose contains millions of these cells. But there are only about 400 different types of olfactory cell, each of which reacts to a different type of odorant. Obviously this does not mean that the human nose can only distinguish between 400 different smells. The many possible patterns of cell activation are decoded by the brain and assigned to different odours.

Doctoral researcher Jan Leppert working with odour sample bags at the Institute of Agricultural Engineering.



Illustration: Lannert, Bonn

The pioneers in this field have reached a few conclusions by analogy: substances with a smell are gases, olfactory cells are specialised gas sensors, and the brain processes signal patterns like a computer. So the first electronic noses were combinations of gas sensors which produced different signal patterns according to the smell they detected. A computer was able to identify the smell on the basis of the different patterns or recognise variations from a desired standard.

But what may sound like a straightforward success soon proved to be much more difficult than at first thought. The system often failed to make the correct link between smells and signal patterns. At first the designers assumed that

the problem was caused by technical deficiencies, and invested a lot in improving the systems – but failed to find a solution. In fact, the problems were more fundamental and demanded an interdisciplinary analysis.

The evolution of life has affected not only our physical form but also our sensory organs. The founders of evolutionary epistemology, such as Konrad Lorenz, noted the influence of the evolutionary process on the sensory organs. The smells detected by the human olfactory system are not simply pleasant or unpleasant additions to life, but carry important information. To find food it was necessary to be able to smell ripe fruit from a long

distance away. We need the ability to tell whether food has gone off before we eat it, and we recognise this by the characteristically unsavoury smell of rot and decay. In other words, evolution produces efficient solutions, which is why the sense of smell is so selective. Only a small percentage of all the gases in the atmosphere are information-carrying and detectable by the human nose. To the rest we are “smell-blind”.

This has far-reaching consequences for the technical analysis of smell. Gas sensors that measure all gases indiscriminately, whether they have a smell or not, are an inadequate substitute for our biological olfactory cells. This shortcoming cannot be compensated for even with the most sophisticated data processing technologies. So future research into electronic noses will need to focus on the selectivity of the sense of smell and the now decoded repertoire of olfactory receptors. The major challenge here is to establish a lasting connection between biological structures and microelectronic components.

As the handy autonomous odour analyser is still, as yet, science fiction, researchers currently use a combination of measuring technology and the human nose to analyse odours. If a product has a noticeably deviating odour, an “off-odour”, a specialised analytical chemist is called in. First the gases given off by the product are collected. This can be done over a long period with active carbon-like substances known as adsorbents. The adsorbents are then heated and the concentrated gases are released. The gas mixture and the odorants it contains are now separated in order to analyse and smell each substance individually.

What can you smell? Experiment leader Jochen Fischer and test volunteer Alicia Chamarro using a GC olfactometry system.



Illustration: Lannert, Bonn



Illustration: Roger Huchlings / In Pictures / Corbis

Concentrated and in his element: a perfumer in Grasse, the world capital of perfume, in the south of France.

This process, known as gas chromatography, takes place in long, thin glass capillaries. The rate at which the substances pass through the capillaries varies according to their interaction with the coated walls. Each substance emerges from the end of the capillary at a different time. The substances can now be identified using a mass spectrometer, a device which measures the masses of atoms or molecules. For smell tests, some is diverted to an outlet where a trained odour expert describes each odorant and defines its intensity. When comparing products, the experts try to identify the substances that cause the difference in smell. This need not be a single substance; often it is a shift in concentration, or several

different substances that produce a combination unpleasant to the nose, like badly seasoned food.

The pioneers of such odour analyses were, logically, food chemists. Because flavour is more smell than taste, sophisticated methods were developed to investigate the contribution of individual odorants to the perceived flavour, for example a strawberry flavour. This knowledge can also be used to develop synthetic flavourings, which instead of many natural components contain only a few odorants, but when mixed correctly can hardly be distinguished from the genuine article. Unfortunately this has led to a certain amount of flavour standardisation:

for example, a maracuja yoghurt and a maracuja shampoo may taste or smell remarkably similar. Odour research is a broad and inspiring field of work.



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Rembert Unterstell

Satchmo and Superman

American studies scholar Daniel Stein analyses media in transatlantic popular culture by applying principles from cultural studies. The Heinz Maier Leibnitz prizewinner is particularly interested in “intermediality” and “serial narrative”.

When most people see the thin, colourful, stapled pages of a comic, they might think of Superman, the all-American hero, the glamorous Daisy Duck from Duckburg, or the easygoing Lupo the wolf and his antics in the German comic universe of Fix and Foxi. Dr. Daniel Stein, on the other hand, thinks of research – not only because that is his job, but also because he has a weakness for “graphic literature”. Since the autumn of 2013, the 38-year-old specialist in American studies has been working at the John F. Ken-

nedy Institute at FU Berlin, where he is surrounded by picture stories with speech bubbles, motion lines and sound words: comics worlds that have been entertaining their readers for over 100 years. This imaginative world with its characters, settings and plotlines has since migrated to films, television series and computer games, as the comic enters the age of media alliances. “Welcome to Planet Everywhere, Superman!”

“Everyone thinks they know something about comic books,” says Stein in an interview at his institute in Berlin, but in order to move beyond a merely personal interest in comics, you have to “place them in their cultural contexts and understand their social significance”. Stein’s aim is to look behind comics and their aesthetics to explore their content and discourse, their narrative styles and patterns, and their social messages. Stein, who has a special understanding of popular culture in all its creativity, might be a hipster at heart, but with his full beard and black glasses he looks more like a thoughtful intellectual contemplating his chosen world of transatlantic culture and media.

The term “American popular culture” encompasses commercial expressive forms in music, literature, radio, television and comic books, genres such as crime, fantasy, sci-fi and soap, which Stein sees as both a mirror and a product of mass-cultural modernity. He describes the “sphere

of popular culture” as “industrially operated, produced by a division of labour and shamelessly commercial”, adding “but this does make it a very flexible and inventive culture”. His overarching interest is to study the relationship between literature and non-literary media in culture.

He wrote his dissertation on the autobiographical oeuvre of legendary jazz trumpeter Louis “Satchmo” Armstrong, which incorporates both literary and musical expressive forms. Stein drew on Satchmo’s letters, books, music, tape recordings, film roles, interviews and photo collages. In the broad field of autobiographics, the jazz icon always reasserts himself and builds an image from the inside out to world fame. In his study *Music is My Life. Louis Armstrong, Autobiography, and American Jazz* (University of Michigan Press, 2012), Stein shows how music and autobiographical narrative are connected, for example in terms of improvisation and performance. His study was received as a major contribution to “intermediality” and won the Rolf Kentner Dissertation Prize and the 2010 Christian Gottlob Heyne prize.

His work at the interface between literature and music goes back to his earliest interests. Born in 1975 in Mainz, Stein has played electric bass since his youth and grew up in an academic environment, as his father taught British studies. Reading English literature and first visits to England and the USA stimulated his interest in





The characters and action may be trivial, but the genre of superhero comics (some of which are shown here) is as creative as it has remained productive over the years.

the Anglo-American world. He read American studies, sociology and political science in Mainz and at Austin College, Texas before spending two years as a lecturer in the English department at the University of Michigan, Ann Arbor. In 2004 he was appointed a research assistant at the University of Göttingen. After receiving his doctorate he spent three years (2010–2013) as a member of the DFG Research Unit “Aesthetics and Practice of Popular Seriality” (www.popularseriality.de/en/index.html). The group spokesperson, Professor Frank Kelleter, was also his doctoral supervisor.

His interest as a postdoctoral researcher on the Research Unit is now focussed on American superhero comics, a genre that emerged in the 1930s and went on to be globally successful. Under the title “Authorizing Superhero Comics: On the Evolution of a Popular Serial Genre”, he is studying Batman and Spider-Man series with a particular focus on authorship and reader roles. One of his key conclusions is that popular seriality weakens the distinction between author and reader, manifesting itself in a specific series awareness that emerges in letter columns, editori-

als and fanzines. Depending on one’s perspective, serial narrative is “open” or “unreliable”, but it certainly draws in the reader, viewer or listener.

So what is his favourite comic strip? Only after some hesitation does he name *Krazy Kat* by George Herriman, which appeared on a daily basis between 1913 and 1944: a cosmos of ideas, highs and lows and an example, as Stein explains, of how the reiteration, variation, and occasional frustration of a simple formula of dog, cat and mouse can continually strike a spark with readers.

Speaking of bright sparks, Stein was the winner of the 2013 Heinz Maier Leibnitz Prize, the most important funding award for young researchers in Germany. He is delighted at this prestigious accolade and grateful for the respect accorded to his field of work as one that belongs “to the canon of modern American cultural studies”.

Studying this canon includes observing the emergence and change of cultural phenomena, their beginnings and their various manifestations. Stein’s latest research project is on these very lines, focussing on

the early and formative phase of serial popular culture around 1850 through “city mystery” novels. This genre examines the dark side of urbanisation, including crime, exploitation, prostitution and corruption, with a touch that is both creative and sharp-tongued. His interesting thesis, yet to be confirmed, is that city mysteries “not only portray the conflicts of their era, but engage in politics, make politics possible”. Political enlightenment through serial entertainment?

Here in Germany the gap between entertainment and education may yet to be filled in, but the direct and indirect influence of US popular culture on German culture can hardly be overestimated. “What are the USA’s contributions to global culture?” asks Daniel Stein. “Jazz and comic books are definitely among them.”

Dr. Rembert Unterstell

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In October 2014 Daniel Stein was appointed Professor of North American Literary and Cultural Studies at the University of Siegen.

www.uni-siegen.de/phil/anglistik/mitarbeiter/stein_daniel/index.html?lang=de

Natalie Binczek and Cornelia Epping-Jäger



Illustration: edition text + kritik

Towards Audio Poetry

Audio books are enjoying enormous popularity among publishers and the public as an alternative form for printed literature. Now researchers in literature studies are taking a closer look at this successful medium. They see in it a distinct form of expression with an aesthetic all of its own.

During the autumn and winter of 1973, author and poet Rolf Dieter Brinkmann (1940–1975) went walking around his home city of Cologne. Public broadcaster WDR had loaned him a tape re-

corder and a microphone. Brinkmann set off to collect audio material to create a portrait of his life as an author. Most of the time he is in a bad mood, unimpressed by what he sees and concerned by what he

feels. He swears and yells into the microphone as he spends the days walking along the arterial roads and the nights among the decayed neon lights of Cologne's nightlife district; sometimes he interviews strangers

on the street or in the pub. He tells what he sees, directly, as he reflects on himself, life, and his writing. “We won’t get anywhere with literature,” Brinkmann says on the tape. “In no place. On no corner.”

Why is a research project on the topic of poetics and hermeneutics of audio books concerned with these recordings? Firstly, most obviously, because 32 years later the recordings were published as an “audio book” under the title *Wörter Sex Schnitt*. Secondly, because the recorded material throws up important and stimulating research questions.

In what cultural and technical framework do new media forms of literature emerge? Does audio literature – a literature which is not conceived in advance as literature but generated directly through speech with a technical recording medium – follow different criteria from literature which is written down before being published? Is it possible to develop poetics, a logic of literary production, and hermeneutics, a theory for the construction and comprehension of audio

texts, for these new forms of audio literature? Or to express it in more general terms, the key question is that of the elements on which an audio literature produced in and for the audio book medium is based.

If we then consider the publication of the Brinkmann tapes, we can see that the material published in 2005 under the title *Rolf Dieter Brinkmann, Wörter Sex Schnitt, Originaltonaufnahmen 1973* is fundamentally an audio book, but one that deviates from the standard form. “As far as market and usage are concerned, the audio book is the spoken dialogue scene of a narrating voice,” says media scientist Wolfgang Hagen. Indeed, the majority of audio books do offer spoken dialogue scenes featuring a single voice – usually a voice that is already well-known from radio and television.

Audio dramatisation and scenes created by several voices – what might be termed the audio drama, or the literary feature – account for only 10 percent of audio

book productions. Most of an audio book consists of written text that is read out. If this text has already been published in book form, it is abridged by the radio station’s or publisher’s editors for recording purposes. Even “classics” are rarely rendered in full; often the version the listener hears is 30 to 40 percent shorter.

This is where an audio book like *Wörter Sex Schnitt*, comprising five CDs, is fundamentally different: it includes no prepared text and is also not read out from a written source. Rather, what we have here is a person whose voice we have never heard before, and this person is yelling, whining and singing in a voice that, to quote Brinkmann, sounds “like you’ve stepped on to a racetrack and been punched in the stomach”.

These tapes are also not the familiar model of an “audio diary”. Brinkmann does not walk around the city collecting material for a written text to be composed later. He is not interested in such conventional models of writing. When



Illustration: Friedrich / Süddeutsche Zeitung Photo

Underground poet Brinkmann liked to be provocative (left and right). Below: Wörter Sex Schnitt is an audio edition with unedited original recordings, and an experimental audio book.



Illustration: Friedrich / Süddeutsche Zeitung Photo

he talks into the microphone, apparently directly, as he wanders through the grey city of Cologne, he refers to the philosopher and literary critic Fritz Mauthner and his dictum that “contradictions only exist in language”.

In his urban speeches, Brinkmann closely examines this dictum, attempts to radically engage in the “world of things” which he challenges to be “written into” his sensitive view of things. For the listener later in time, this means that the fact of being moved, of being directly addressed by the voice, in short that which is perceived as authentic in the audio book, can be understood as the effect of a poetological strategy. In other words, Brinkmann is presenting that which is not presented, using the spoken word. The project is concerned with analysing the

conditions surrounding the emergence and impact of audio literature, not only through *Wörter Sex Schnitt* but also an extensive corpus of audio books which includes the likes of Peter Kurzeck (*Ein Sommer, der bleibt*), Thomas Bernhard (*Der Hutmacher*), Elfriede Jelinek (*Moosbrugger*), Robert Musil (*Remix. Mann ohne Eigenschaften*), Konrad Bayer (*Goldenberg*), Paul Celan (*Lesung vor der “Gruppe 47”*) and Hubert Fichte (*St. Pauli Interviews*).

For all these authors, the audio book proved to be a medium with more potential than it had previously been credited with in the literature. It is not limited to what has been termed the “narrower” definition of an audio book, that of the audio book as a reading aloud. Even the

“broader” definition, that of audio books as a “change in medium from the visual to the audible book”, as “audio productions with recorded voices, documents, spontaneous speech, music, sound”, is not adequate. Neither of these definitions takes into account the fact that the audio book contributes to the creation of a genuinely audio-based production aesthetic. The question of conditions and the relevance of the orality and audibility of literature is therefore at the centre of the project in Bochum.

Previous research was based on the assumption that the spoken and the written word were two different worlds: on the one hand the ephemeral nature of the voice that is gone as soon as it has spoken, and on the other the thoughts, plans and writing of the author, set down in written form. “Writing means reading yourself,” said editorial theorist Almuth Grésillon.

The Bochum audio book project has shown that this assumption is only true to a limited extent, and that the new audio media present “writing-like” potentials of this notion of Grésillon’s, and do so for the emergence of a new audio poetry too.

Let’s return to *Wörter Sex Schnitt*, but also go beyond Brinkmann. From the audio material published in *Wörter Sex Schnitt*, Brinkmann created an audio drama, a so-called “subjective documentation” with the title *Die Wörter sind böse*. The



The screenshot shows the BRshop website interface. On the left is a navigation menu with categories like 'Startseite', 'Produktseiten', 'Hörbücher / Hörspiele / Lesungen', 'BR-KLASSIK', 'Kochen', 'Rock / Pop / Liedermacher / Jazz', 'Rund um Bayern', 'Spaß & Comedy', 'TV-Kult / Filme / Serien', 'Volksmusik & Blasmusik', and 'Wissen & Sprachen'. The main content area features a highlighted audio book 'Alexander Kluge: Chronik der Gefühle' for 58,00 €. Below it, a detailed description of the book is provided, mentioning its award as 'Ausgezeichnet mit dem Deutschen Hörbuchpreis 2010'. To the right of the book listing are buttons for 'EINKAUFSWAGEN' (shopping cart) and 'KONTAKT' (contact). The shopping cart shows 'Der Einkaufswagen ist leer' and 'Versandkostenfrei ab 35 €'. The contact section provides a phone number (01805/15 17 19), a fax number, and an email address (service@br-shop.de). On the far right, two audio book covers are displayed: 'Ereignisse und andere Prosa' by Thomas Bernhard and 'St. Pauli Interviews' by Hubert Fichte.

Audio books and audio plays are an important part of public broadcasters' schedules – here, Bavarian broadcaster Bayerischer Rundfunk. Right: Cover of two audio books with a distinct aesthetic: Thomas Bernhard's *Ereignisse und andere Prosa* and Hubert Fichte's *St. Pauli Interviews*.

researchers on the audio book project compared the two works and noted that audio productions are freer in the arrangement of verbal and non-verbal structures, the use of titles, mottoes and commentaries, and the creation of section and chapter headings. Furthermore, it is not clear whether pictures of the contributors whose diary entries or interviews are included in the audio book should be considered an integral part of the work. Elements and production conditions of this kind are well researched for the printed book, but in the case of the audio book, this task has hardly begun.

In addition, there is currently no media-specific transcription system that could help to record and signal emotional components of the voice as well as qualities such as "energetic talking", "silence", "reflection", "recollection". The

researchers are developing just such a transcription system, which will make possible a comparative analysis of audio books and audio dramas.

To conclude, let us take another look back. A comparison between passages in the audio book and the audio drama reveals that Brinkmann repeatedly improvised on certain themes and basic motifs, and continually refined these variations down to the smallest phonetic and vocal elements on his urban wanderings. Far from being random repetitions, these passages are therefore a deliberate aesthetic technique, well-known in poetics, but previously underestimated in its significance for audio poetics. This comparison also shows that these passages were inserted at least 82 times into the audio drama, with further variations, enriched

with recorded voices and acoustic special effects, testifying to the occasionally astonishing creativity and wealth of potential of the audio book poet.



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Manfred Schedlowski

The Value of Aversion

The human immune system is capable of learning. To investigate how it communicates with the brain during learning processes, researchers employ the paradigm of classical conditioning. Their aim is to achieve a better understanding of immune responses and to establish learning protocols as supportive therapy for the treatment of diseases.

In 1886, American surgeon John Mackenzie reported a striking observation in the American Journal of Medical Science: when a woman who was allergic to roses was exposed to an artificial rose, she suffered an asthma

attack. She was experiencing a severe reaction of her immune system caused by the previous association of the allergen (roses) and the subsequent allergic immune response, an example of classical conditioning.

Learning and memory are not only established concepts in behavioural science and neuroscience, but also important terms in immunology, where they describe the recognition of antigens by the body's immune cells. Immune



responses can be however also influenced by classical learning processes. These learned immune responses are based firstly on the exchange of information between the brain and the peripheral immune system, which communicate continuously through biochemical and neuroanatomical paths, and secondly on the phenomenon of the classical conditioning of physiological responses, first described by Ivan Petrovich Pavlov over 100 years ago, and still found today in every school biology textbook.

The classical conditioning of immunological responses is best illustrated by the phenomenon of “conditioned taste aversion” in an animal model. Rats or mice are offered a new taste, usually a sweet-tasting saccharine solution, in drinking water as a conditioned stimulus (CS). This taste stimulus is directly combined once or, ideally, several times with the injection of a drug that suppresses immune functions and acts as an unconditioned stimulus (US). When the taste stimulus (CS) is offered again without the injection, the animals avoid the saccharine solution. This is described as a “conditioned taste aversion”.

Conditioned responses can also be observed as immunosuppressive effects that correspond, in a weaker form, to the immunopharmacological effects of the drug used as the US. Based on experimental findings in animals, researchers have identified the communication paths between the brain and immune

Left: In the learning phase volunteers are given the immunosuppressive drug (unconditioned stimulus) together with ...

... an unfamiliar-tasting green drink that serves as the conditioned stimulus. Below: In the lab, researchers investigate whether and how the conditioning process suppresses the activity of T lymphocytes in comparison with the effect of the drug.

system that are activated in the classical conditioning of immunosuppressive effects. They are able to explain what may at first appear to be an astonishing phenomenon: the fact that a taste stimulus can influence immunological processes.

Further experiments with animals have demonstrated that these learned immune responses are not merely interesting laboratory phenomena of no real importance to the organism, but clinically significant response patterns. For example, the progress of a chronic inflammatory autoimmune disease like arthritis can be mitigated by learned immunosuppression and the rejection process of transplanted organs can be delayed.

The classical conditioning of immunosuppressive responses as observed in animal models has also been transferred to humans. Interestingly, the conditioning protocols employed for human subjects are similar to the learning protocols used for laboratory animals. Volunteers take the immunosuppressive drug Cyclosporin A as the US, which is often used in clinical situations where it is necessary to suppress a patient's immune response. As a conditioned stimulus (CS), the volunteers are given a green-coloured strawberry milk with a lavender flavour. In the learning phase, the drug is offered several times together with the taste stimulus. After an interval of one week,



the volunteers are given the same drink, this time with a placebo (a pill with no effect).

Meanwhile a control group goes through the same conditioning protocol, but receives only a placebo during the learning phase instead of the drug. At the end of the learning phase, blood samples are taken. Immunological analysis shows the typical inhibition of T cell proliferation and reduced production of cytokines, the chemical messengers responsible for the activation of T lymphocytes, caused by Cyclosporin A. A similar, although less marked, suppression of the immune response can be produced as a learned immunosuppression by

the consumption of the drink (the conditioned stimulus).

These learned effects on the body's defence system produced by conditioning are a fascinating example of "bidirectional" communication between behaviour, the brain and the peripheral immune system. The model makes it possible to carry out a detailed analysis of this communication network. However, the phenomenon of learned immune response also has clinical implications. In addition to increasing basic scientific knowledge, it is also hoped that this research will make it possible to refine conditioning protocols to

serve as supportive intervention strategies for patients under pharmacological treatment. This would allow drug dosage and undesirable side-effects to be reduced while maximising therapeutic effectiveness for the patient's benefit.

However, a few fundamental questions remain to be answered before these protocols can be employed in routine clinical practice. For example, if the learned immune response is limited to a single event, it still remains a useful model for investigating interactions between the brain and immune system. But in clinical situations in which continuous immunosuppression is required over

Simplified model of conditioned taste aversion in the acquisition and recall phases, tested on rats in the laboratory.

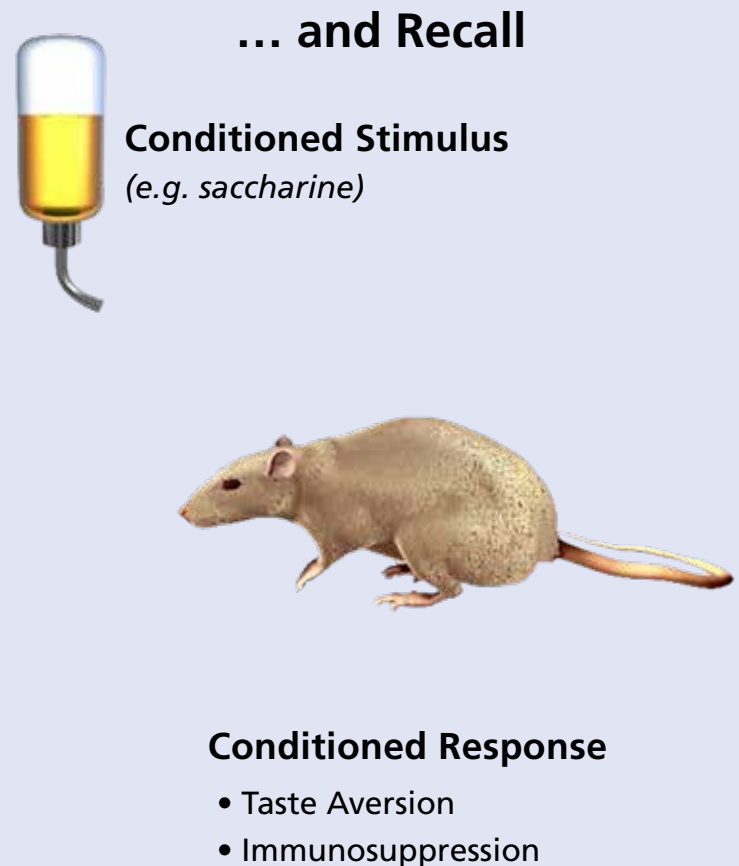
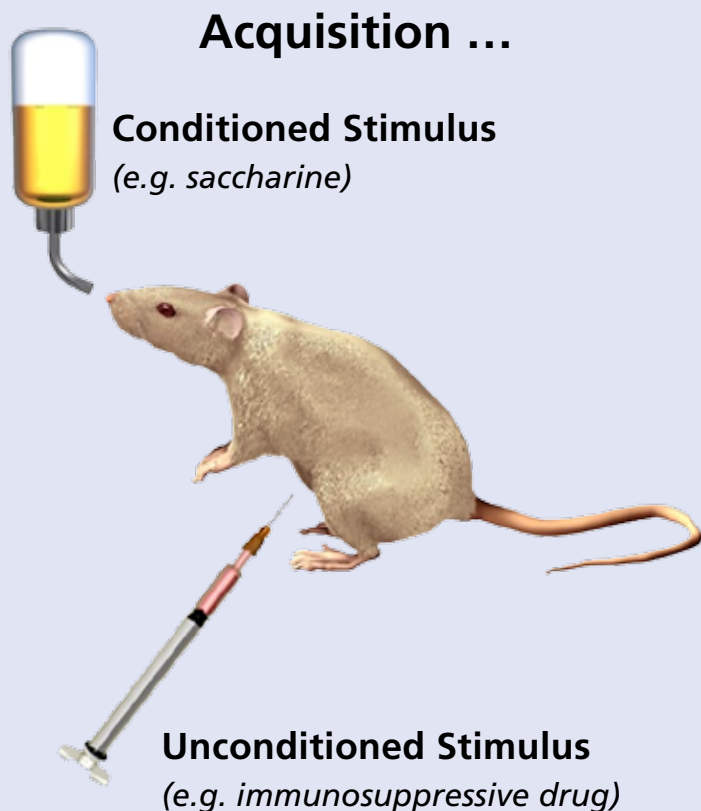




Illustration: Martin Kaiser/Universitätsklinikum Essen

In a human experiment, volunteers are given a green coloured drink with a lavender flavour.

a long (perhaps very long) period, the model would have no value. Recent experiments with human volunteers show, however, that a learned immune response can be triggered again after a long break by consuming the drink (CS).

As with other learning processes, the conditioned immunosuppressive effects subside after a certain time. Research is therefore currently underway to investigate whether the extinction of the learned immune response can be delayed or even prevented altogether.

As with other medical treatments, volunteers react to conditioning with differing sensitivity. Studies have identified psychological and neuroendocrine factors (so-called predictor variables) which are associated with learned immunosuppression and therefore

have predictive value. However, the reliability and quality of these predictor variables needs to be further refined and tested in routine clinical practice.

Even if it is premature to anticipate a clinical application, conditioning protocols can still serve as a useful model because they allow us to investigate whether learned effects on the immune response also occur with other substance classes; it may even be possible to transfer these to other physiological systems such as the hormonal or cardiovascular systems. The research, which has been interdisciplinary from the outset, has led to a better understanding of human biology through the analysis of the mechanisms steering the communication between brain, behaviour and the immune system. In

the long term it could also help us to develop new and promising approaches to the treatment of disease.



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The Deutsche Forschungsgemeinschaft

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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. *CRC/Transregios* 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.

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 focusses 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*. In so called *Reinhardt Koselleck Projects*, the DFG supports especially innovative research undertakings by outstanding scientists and academics.

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