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Cover: Mirsch / Tall Halaf Project
A ceramic bowl with a filigree design, discovered at the Tall Halaf archaeological site. From the 5th millennium B.C., this artefact is impressive evidence of a lost Middle Eastern civilisation.

Matthias Kleiner

Enhancing Productivity from the Inside Out

Science thrives on the fascinating diversity of researchers' ideas and projects. Promoting it requires phases of dynamism and change as much as periods of quiet concentration and productive development

Frequently I'm asked what I find most interesting and exciting about science and research. And whether I respond as the President of the DFG, as an engineering scientist, or as a private individual, my answer is always the same:

What fascinates me most about science and research is its diversity — the diversity of our fundamental thirst for knowledge and of the researchers who seek this knowledge, drawn in by that which has yet to be grasped and conceived. It is the spectrum of ideas and questions that one individual alone would not be able to raise and which get to the bottom of the issues that concern us all: the largest contexts and the smallest details of our life and our world; the countless insights and findings that contribute to our security and welfare.

This diversity – a perpetually changing whole – is something we encounter everywhere within the DFG: in our daily interactions with researchers, during committee meetings, in each new issue of german research. And especially, of course, in the people and projects we actively support.

Just the most recent examples: In late November, the new DFG-funded Collaborative Research Centres (CRCs) and Research Training Groups (RTGs) were approved. The responsible committees, with representatives of the research community as well as of the federal and state governments, are charged with deciding on an ever increasing number of grant proposals. This highlights the enormous interest in our funding programmes, but it also forces us to be even more selective than in the past. By the end of the most recent committee sessions, eleven new CRCs and ten new RTGs were established. Our approval rate is still high by both national and international standards.

The new CRCs and RTGs stand for the highest scientific quality – and for an impressive range of research topics: from spontaneous self-organisation of soft matter to the origin of the Milky Way to more efficient propulsion systems for aircraft; from the regulation of markets to the development of high-temperature superconductors to psychological development risks in children and adolescents.

One week later, in early December, the DFG Joint Committee selected the ten new winners of the Leibniz Prize. At home in disciplines like Egyptology and computer science, experimental solid-state physics and organic geochemistry, quantum optics and cell biology, they are a testament to diversity even at the highest levels of research, which Germany's most important research award is meant to boost, along with the recipients themselves. I'm especially pleased to note that four of the prizes will go to outstanding women researchers.

Looking ahead: For the DFG's New Year's reception in mid-January in Berlin, we have also invited four young scientists who succeeded in last year's Jugend forscht competition for researchers up to age 21. They were honoured with the newly endowed DFG Europe Award and then participated in the European Union Contest for Young Scientists (EUCYS), where they also placed in the upper ranks. These researchers and their work are indications of the diversity of tomorrow's research.

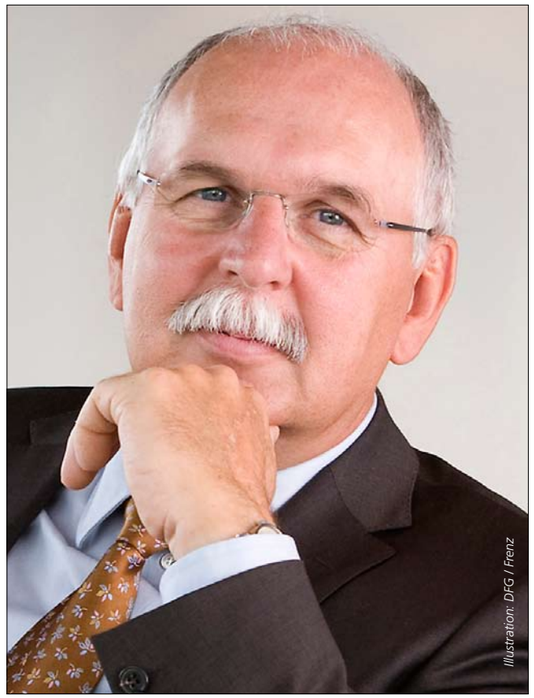


Illustration: DFG / Frenz

Different though these topics and projects – and the people behind them – may be, they have two things in common: All the ideas and queries arise from the research community itself. And they connect and develop under the umbrella of scientific self-government provided by "their DFG", with its wide range of funding opportunities – from financing for large research networks all the way to individual grants, which are sometimes less visible to the public but just as valued by the community. Funding for individual projects is the backbone of research promotion, and we plan to do even more to highlight its successes.

Especially at a time when research policy, for example at the European level, is not exempt from having topics and frameworks prescribed from the top and from the outside, such diversity from the bottom and from the inside cannot be cherished enough. It must be our ongoing challenge and commitment to not only preserve but strengthen it.

Diversity in research can sometimes manifest itself in a single research topic. The most current case in point is biodiversity research, where various disciplines of the life, natural, engineering and social sciences, as well as the humanities, join forces to help us better understand, and consequently protect, the natural foundations of life. For this reason, the DFG announced a call for proposals last autumn for a Research Centre on Integrative Biodiversity Research. This decision was made following an intensive discussion process with the scientific community, during which biodiversity research was identified as an especially pressing research desideratum in Germany. We expect the community to submit numerous high-quality proposals, one of which will be selected in 2012 as the basis of what will be the seventh DFG Research Centre. Here too, the key impulses have been coming from scientists themselves.

With their focussed scientific expertise and innovative collaborations between academic and non-academic research, these DFG Research Centres are role models and reflect the diversity of the German research system. Thanks to innovations such as the Excellence Initiative, with its graduate schools, clusters of excellence and institutional strategies, rapid and profound changes have occurred within a short time. That we have been able to ignite these changes – always in close cooperation with the research community itself – is significant and promising.

But it also shows that science and scholarship – especially in higher education and academic research – need not only stimulation and the freedom to develop, but also regular periods of productivity and concentrated quiet time. Whether additional types of higher education, further differentiation, or ever new forms of cooperation really benefit science and research is at least worth debating. After all, the research community deserves that we have confidence in its independence and capability.

I propose that we give our scientists and academics time to calmly and persistently implement the changes we have helped initiate. The coming year, with its first decisions in the second phase of the Excellence Initiative and the first prioritisations under the new Pact for Research and Innovation, will provide great opportunities for this. Let's take advantage of them.

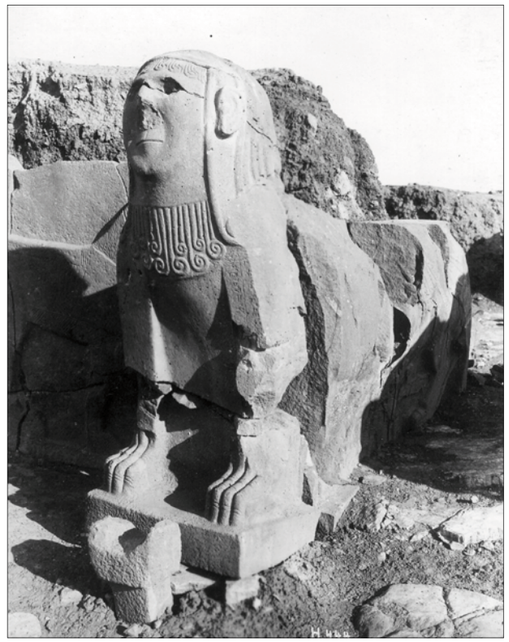
Prof. Dr.-Ing. Matthias Kleiner
is President of the DFG.

Lutz Martin

Still Full of Surprises

The excavations at Tall Halaf remained undisturbed for more than seven decades. Recently, however, German and Syrian archaeologists have resumed work there – and are gaining new and varied insights into the settlements of the Ancient Near East

Illustration: Mirsch / Tall Halaf Project



Illustrations: Archive of the Max Freiherr von Oppenheim Foundation, Cologne

For a long time, it was one of the most prominent sets of ruins in the Near East. It is, however, only in the past four years that Tall Halaf has moved back into the spotlight of archaeological field research. On 5 August 2006, precisely 95 years to the day after the start of the first systematic excavations and 77 years after the last campaign, Syrian and German archaeologists resumed their spadework at the site.

The Tall Halaf ("Tall" means a settlement mound), in which the ruins of the ancient city of Guzana are concealed, lies on the Djirdjib River, one of the sources of the Khabur, in northeast Syria. Around three kilometres east of the Tall is the nearest town, Ras al-Ain. Directly north of the settlement mound lie the tracks of the legendary Baghdad railway, which today forms the border between Syria and Turkey. The ancient settlement is divided into a town complex with an almost rectangular citadel measuring six hectares in area and some 20 metres in height, and another, also almost rectangular, lower town, approximately 60 hectares in size.

It was in the citadel that Cologne banker's son and later diplomat Max von Oppenheim (1860–1946) discovered strange-looking monumental sculptural reliefs during a brief exploratory dig in 1899. Artefacts found during excavations performed in 1911 to 1913 and in 1929 were taken to Germany, where they were displayed in the Tell Halaf Museum in Berlin's Charlottenburg district from 1930 onwards.

Following the destruction of the museum in the Second World War, the remains of the basalt monuments were excavated from the rubble and taken to Berlin's Museum Island, where experts have been piecing them back together as part of a large-scale restoration project since 2001.

What is known about the ancient settlements on Tall Halaf? The first small settlements were established around 8,000 years ago. The brightly-coloured ceramics produced during that time are considered typical of an era during the Late Neolithic period. Today, this era is known as the Halaf period. At the start of the first millennium before Christ, the Aramaic ruling dynasty known as the Bachiani founded their principality's capital on the prehistoric settlement mound. The name of the city, Guzana, was first mentioned in an Assyrian text dating from 894 BC. The most spectacular discoveries at Tall Halaf include the west palace, a building erected by the Aramaic prince Kapara and featuring stone relief carvings from the early part of the first millennium.

Imposing and expressive (left side): The reconstructed entrance to the West Palace in the former Tell Halaf Museum in Berlin, ca. 1930. Next: Embrasure sphinx from the entrance after the 1912 excavation. Right: Tall Halaf in 2008 – topographical map showing excavation trenches. Centre and below: An early Iron Age tomb, before and after opening.

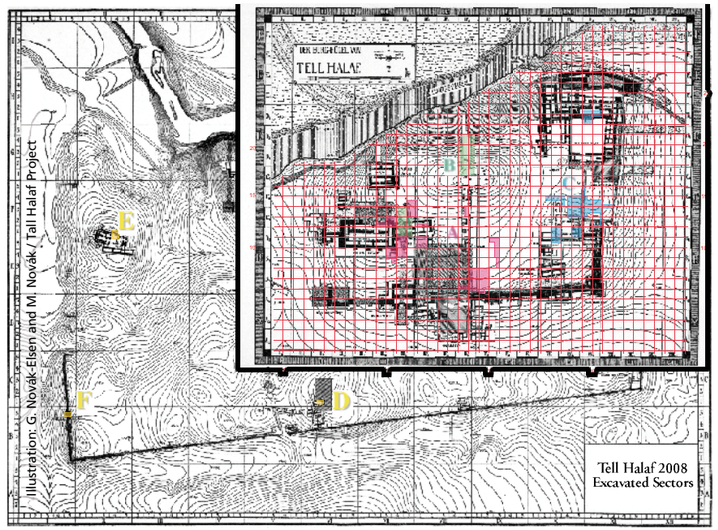


Illustration: G. Novák-Elsen and M. Novák / Tall Halaf Project

Illustrations (centre and below): Simons / Tall Halaf Project

The ten-metre-wide entrance to the building was, according to reconstruction methods suggested by the architects surrounding Max von Oppenheim, divided by three columns depicting gods on animal bases. These are presumed to be the highest deities of the Hurrian pantheon: the weather god Teshup on his symbol animal, the bull; Hebat, the sun goddess of Arinna, on a lioness; and Sarruma, their son, on a lion. Two sphinxes in the embrasures complete the entranceway. To the right and left of the entrance, at the base of the mud-brick walls, are large relief stone slabs known as orthostats. This type of entrance design is, as yet, unique in ancient Near Eastern cultures. To protect them against weathering, the remaining pedestal areas of the palace were also decorated with relief-ornamented orthostats of red-dyed limestone and greyish-black basalt. These orthostats were, however, considerably smaller.

It is assumed that the city finally came under Assyrian rule around 808 BC, when it became the seat of an Assyrian governor. The Bible mentions Guzana in conjunction with the capture of the inhabitants of Samaria by the Assyrian King Sargon II. Cuneiform documents and clay dockets with Aramaic inscriptions found during Max von Oppenheim's excavations serve as evidence of the continuation of the city after the collapse

of the Assyrian empire during the 7th century BC.

The remains of buildings and pits several metres deep and filled with rubble from the Hellenistic period serve as evidence of the town's existence and continuous settlement until into the Islamic period. Today, parts of the citadel are used as burial sites for the neighbouring village of Tall Halaf.

It was the discoverer and excavator of the ruins, Max von Oppenheim, who repeatedly called for fieldwork to be continued after 1929, as there were many fundamental questions about the settlement which remained unanswered. In 1939, however, the final attempts by the then 79-year-old excavator to have work resumed failed. In view of the tense political situation immediately prior to the outbreak of the Second World War, the French administration unexpectedly prohibited any further excavations.

When German archaeologists were able to resume excavations in Syria in the mid-1950s, they focussed on other ancient settlements. The response to the contemporary field work at Tall Halaf was rather muted at the time, which meant that the city and its legends remained merely a popular destination for excursions.

During the restoration project at the Vorderasiatisches Museum (Museum of the Ancient Near East), however, it became clear that archaeological field research was required in order to gain new insights and to clarify chronological questions. Incidentally, the southern part of the citadel had previously been destroyed by construction work carried out by the inhabitants of the neighbouring Tall Halaf village, and the archaeologists' presence enabled the Syrian antiquities authorities to place the area under special protection.

Meanwhile, a joint expedition by the National Museums in Berlin and the Direction Générale des Antiquités et des Musées in Damascus, in cooperation with the Universities of Halle and Tübingen, had launched three excavation campaigns. This added a further 110 local excavators to the around 40 members of the German-Syrian expedition team. Exploratory trenches totalling around 3100 square metres and covering the west palace region, the mud-brick massif to the south of the citadel, the northeast palace and the old test trench at the northern slope, have now been opened. In the now overbuilt lower town, explorations were extended to smaller "sondages", with test trenches being opened near the western city wall, the city temple and the sanctuary.

(1) Tübingen archaeology student Christiane Radovanov drawing ceramics. (2) A female terracotta figure from the Halaf period, 5th millennium BC. (3) A Parthian figure of a rider, created between the 2nd century BC and the 2nd century AD. (4) A round-bellied ceramic vessel from the 7th century BC, discovered in the northeast palace. (5) Restorer Simone Korolnik painstakingly reconstructs a ceramic piece.

The interesting new discoveries included evidence of four (so far) circular prehistoric buildings. Judging by the ceramics found there, these can be dated back to the mid and late Halaf periods. The city was inhabited during the Ubaid period, the 5th millennium BC, up until the Late Chalcolithic period, the 4th millennium BC, before being abandoned for over 2000 years.

As far as the Iron Age is concerned, new excavations have clearly indicated that Kapara's palace was not, as Max von Oppenheim assumed, constructed on top of the remaining walls of an earlier building. In fact, the west palace is an entirely new building, whose massive foundations (up to three metres tall in places) were set into a deep pit.

Before the palace was constructed, however, the area was subject to intensive development and usage. This is evidenced by the existence of mud-brick walls, which were smashed through when the trench for the palace foundation was created.

To the south of the citadel, Max von Oppenheim discovered a large mud-brick terrace, which is, in parts, built over the top of the citadel's southern wall. Recent discoveries indicate that this terrace, already identified by the older excavations as a structure from the Neo-Assyrian period (8th century BC), may have served as a platform for buildings constructed by wealthy citizens. This is evidenced by an impressive inventory of findings. In one house on the mud-brick massif, for example, a clay tablet was discovered, in addition to jewellery in the form of pearls and rings. This clay tablet is a loan document apparently written during the first half of the 7th century, according to which a woman lent out silver at an interest rate of 50 percent.

The trenches at the northeast palace have provided new insights into historical building and architectural methods. It had previously been conjectured that the northeast palace extended further to the south, a hypothesis which has now been confirmed. It is, however, not Kapara's residential palace, as von Oppenheim supposed. Instead, this structure dates from the Neo-Assyrian period. Up until the end of the Assyrian Empire in the 7th century BC, the palace served as the official seat of the Assyrian governors. After the empire collapsed, it was – after many alterations – probably used for residential and commercial purposes into the Late Babylonian period.

Very limited excavations have been carried out so far in what was once the lower part of the town. Follow-up investigations on what's known as the sanctuary in the south of the town, where von Oppenheim found two relief carvings, have shown that no older cultural layers should be expected in this area. These sculptures date this space to the Aramaic period (end of the 10th, beginning of the 9th century BC). Further excavations along the western city walls and at the "city temple" (which has been attributed to the Neo-Assyrian period) served to locate these structures in order to enable future, more detailed investigations of the sequence of construction and chronology to be performed.

In conclusion, the investigations at Tall Halaf are particularly profitable, as they provide insights into prehistory and the period from the early part of the 1st millennium until the end of the ancient Near Eastern empires. New findings on the early Iron Age are eagerly anticipated, as little research into this period has been carried out. Furthermore, the Tall may also serve as an important reference location for the Hellenistic Greek period in Upper Mesopotamia.

Dr. Lutz Martin
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Rembert Unterstell

Trinational, Multilingual and Innovative

German, Austrian and Italian researchers are currently undertaking collaborative studies on the "Political Communication in Europe from the Ancient Times until the 20th Century"; this is just one example of the increasingly international focus of the DFG's Research Training Groups

The history of the Kingdom of Lombardy-Venetia under the rule of the Habsburg Monarchy has researchers from the three countries on the move: Francesca Brunet comes from the small town of Feltre in Venetia. A doctoral researcher in history at the universities of Innsbruck and Trient, Brunet's main interest lies in the legal and political history of Lombardy-Venetia in the 19th century.

Her quest to track down historical sources has taken the 28-year-old to archives in Milan, Brescia, Venice, Vicenza and Vienna. Brunet, who is studying the Austrian Emperor's use of the "legal pardon" in the Vormärz era, is especially interested in court records from the period spanning 1815 to 1848. Since 2007, she has held a scholarship at the International Research Training Group (IRTG) "Political Communication in Europe from the Ancient Times until the 20th Century", which brings together researchers from Germany, Austria and Italy. Francesca Brunet hopes to complete her dissertation in early 2011, but until then she has a lot of ground to cover.

According to Brunet both capital punishment and the legal pardon were "important channels of political communication", and served to convey contemporary notions of governance and justice. The capacity of the Austrian Emperor to override legal norms made him both a correctional instance, at least with regard to individual sentences, and the guarantor of those same legal norms, concludes Brunet.

Debating science at 2000 metres: research fellows meet for their annual seminar at the University of Innsbruck's guest house in Obergurgl.

Illustration: GK 1067

Illustration: Unterstell

Three women, one training group: doctoral researcher Francesca Brunet (left), coordinator Lisa Regazzoni (right) and spokesperson Luise Schorn-Schütte (below).

Illustration: Unterstell

Francesca Brunet, who studied history in Florence and Venice, is supervised in her doctoral research by professors Brigitte Mazohl (University of Innsbruck) and Ottavia Niccoli (University of Trient). Brunet's doctorate will consist of a double doctoral diploma that will be recognised by both universities. Working under the supervision of two experts on the history of Lombardy-Venetia has proven to be a boon for Brunet, enabling her to engage with two national research cultures (and languages), and establish a network of transnational contacts.

Brunet is currently one of nineteen doctoral researchers, who are joined by two post-doctoral researchers at the IRTG. The research partnership enjoys the support of historians from five universities: Bologna, Frankfurt am Main, Innsbruck, Pavia and Trient. This trinational undertaking has received funding from the DFG since October 2004, with the Italian and Austrian partners providing additional scholarships and funding for direct project costs.

As an instrument for the promotion of excellence, national, state and university quotas do not impact on the running of the International Research Training Group, explained historian of early modernity and IRTG spokesperson Professor Luise Schorn-Schütte. Researchers and projects are selected "solely on the grounds of their academic expertise and qualifications", and both are subsequently supervised by two university professors; an approach that enables researchers to gain a binational doctorate.

Early career support in historical politology – according to Dr. Lisa Regazzoni, academic coordinator at the IRTG Head Office in Frankfurt, the research programme has been shaped by two fields: the recurring historical dispute over normative values in political communication, of which Brunet's study is one example; and the role of the past as an argument in contemporary debates. The latter is particularly evident in historiography, which, in Regazzoni's words, "forms part of the political communication of any society".

Illustration: Dt.-Ital. Hochschulzentrum Trient

The spectrum of projects undertaken within the framework of the IRTG ranges from research into political communication in Hellenic Bithynia, Pontos and Cappadocia, to studies of the Anabaptist movement in 16th century political communication and corruption scandals in the Weimar Republic.

However diverse these topics might seem, they share a common research perspective. Luise Schorn-Schütte, a German pioneer of the IRTG, explains that the studies are united by their adoption of "contemporary approaches to the history of political thinking". As a consequence the focal point of much research has shifted from national political history towards an emerging "new intellectual history" of European thought. As Schorn-Schütte notes, this entails a significant change in perspective: while earlier research took a "top down approach" – analysing the thinking of "key figures" in light of the concepts of later historians – researchers are now moving to adopt a "bottom up" approach that is centred on the ideas and concepts drawn on by the historical actors themselves. This shift has also brought the

language(s) of the political into the focus of transnational research.

Managing a trinational research project has its ups and downs, both for university professors and research fellows. Establishing a common perspective "was a learning process that required the good will of all those involved", remembers Schorn-Schütte. While training programmes at the participating universities have become more compatible, German and Italian doctoral training programmes still differ significantly in practice.

To address these differences, the IRTG has developed a cross-sectoral study programme, which provides opportunities for university professors and research fellows to meet regularly to discuss topical issues and methodological approaches – as part of the study programme the IRTG stages an annual, week-long seminar at a different university each year. The programme's research fellows have also established their own networks, explains Regazzoni, including an Internet-based communications platform. Working groups and workshops organised by research fellows also serve to enhance cooperation. The IRTG coordinator is convinced: everyone profits from this approach, which embeds the participants within a larger whole to which everyone can make a valuable contribution.

International early career support: the RTG is the first and only one of its kind to bring together German, Austrian and Italian researchers. Currently sixty International Research Training Groups are funded by the DFG, approximately a quarter of which are dedicated to the humanities and social sciences. The first IRTG was established by the DFG in 1999. According to Luise Schorn-Schütte, DFG vice president from 2004 through to 2010, the groups are "highly effective funding instruments" and were created "for good reasons". The International Research Training Groups provide a research environment that promotes multilingualism; an aspect that Schorn-Schütte considers "elementary to an education in the humanities".

In Schorn-Schütte's understanding, language is a research object in itself, and not merely a medium of historical research. The former vice president is an ardent proponent of both multilingualism and international exchange in early career development, which she considers a "driving force for innovation". It's hardly surprising that she would like to see graduates of the RTG "continue to work at an international level and, with the support of well-trained academic and personal networks", contribute to the development of a nuanced research perspective in European historical studies.

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

www.dfg.de/dfg_profil/geschaeftsstelle/dfg_praesenz_ausland/indien/index.jsp

A Seedbed for New Doctoral Cultures

20th anniversary brochure highlights success of Research Training Groups

Since their establishment in 1990, the DFG's Research Training Groups have pioneered far-reaching changes in doctoral training at German universities, breaking ground in national and international research projects across a broad range of disciplines including the natural, life and engineering sciences and the humanities and social sciences.

A new brochure published on the occasion of the 20th anniversary of the programme's establishment takes an in-depth look at this outstanding success story. Detailing the programme's creation and development over two decades, the brochure features interviews with graduates and current staff, and showcases some of the programme's leading projects.

Print copies of the brochure are available free of charge from the DFG Press and Public Relations Office (Tel. 0228 885-2109, Michael.Hoenscheid@dfg.de). Alternatively, click on the following link to download a PDF of the brochure:

www.dfg.de/en/research_funding/programmes/coordinated_programmes/research_training_groups

A Rising Star

Franz Huber explores philosophy with mathematics

The notion of "Western philosophy" evokes a range of associations – Diogenes and his tub, first and last questions, and profound thinking combined with the desire to explore uncharted philosophical waters. At an early age, Franz Huber's "interest in existential and continental philosophy" led him to study philosophy at the University of Salzburg, where he was introduced to philosophical logic, "a fascinating school of thought for science and everyday life", explains Huber in a voice that still reveals his Austrian origins.

The study of logic led Huber to formal scientific philosophy, a branch of analytical philosophy which explores philosophical issues from a mathematical perspective. The ambitious young philosopher soon made a name for himself in the philosophy of science and the study of epistemology with a flurry of publications. Today, the 33-year-old is a rising star in the discipline of analytical philosophy; a fact that Huber, now the Director of the Emmy Noether Junior Research Group, modestly plays down. Dressed casually, the obviously relaxed Huber merely notes that his works are better known in "international contexts" than in Germany.

Epistemology and the philosophy of science seek to explain how knowledge is created, what knowledge consists of and how it is substantiated (or not, as the case may be). According to Huber, approaching the philosophy of science from a mathematical perspective offers significant advantages, which he succinctly highlighted in his doctoral thesis on the "problem of confirmation". Huber, who was just 25 years old at the time, completed his thesis, titled "Assessing Theories. The Problem of a Quantitative Theory of Confirmation", in 2002 in Erfurt. Huber's central thesis was that the value ("assessment") of a scientific theory lies in the "balance that is struck between its degree of informativeness and its plausibility / likelihood". Huber went on to win the prestigious Wolfgang Stegmüller Award for an essay based on this study.

This award and his later success are the fruit of a remarkably ambitious and consistent academic career. After studying philosophy, German philology, general linguistics and mathematics at the University of Salzburg and completing his doctorate, Huber took up a fellowship at the University of Constance in a research group for "Philosophy, Probability, and Modelling" led by Sofja Kovalevskaja Awardee Professor Luc Bovens. "I owe a lot to this important experience", concludes Huber as he talks of the inspiring work in the research group, which included no less than ten post-doctoral researchers from around the world.


Illustration: Unterstell

In 2005, Huber crossed the Atlantic to take up a position at the California Institute of Technology in Pasadena as Ahmanson Postdoctoral Instructor in Philosophy. On his return to Germany, Huber became the Head of the Emmy Noether Junior Research Group "Formal Epistemology", affiliated with the Zukunftskolleg and the Department of Philosophy at the University of Constance in January 2008. But before Huber's working group of three doctoral researchers could take up its work, Huber was called to temporarily fill Professor Wolfgang Spohn's chair for Philosophy and the Philosophy of Science at the University of Constance. Huber places great value on academic teaching "as an opportunity for philosophical interaction".

Meanwhile, basic research forms the primary focus of his research group. Huber's work explores epistemological questions relating to belief and degrees of belief, metaphysical questions relating to causation and counterfactuals, and meta-philosophical questions relating to normativity and the use of intuitions and formal methods in philosophical methodology; his aim is to arrive at new philosophical insights with mathematical precision. Huber is convinced of the creative potential of formal epistemology, which he feels provides the ideal framework for interdisciplinary work, extending his inquiry into the field of artificial intelligence, for example. The prestigious "Stanford Encyclopedia of Philosophy" has embraced Huber's thinking and invited him to compose the entry on formal representations of belief (http://plato.stanford.edu/entries/formal-belief) – yet another clear sign that Franz Huber is indeed a rising star in his field. **Rembert Unterstell**

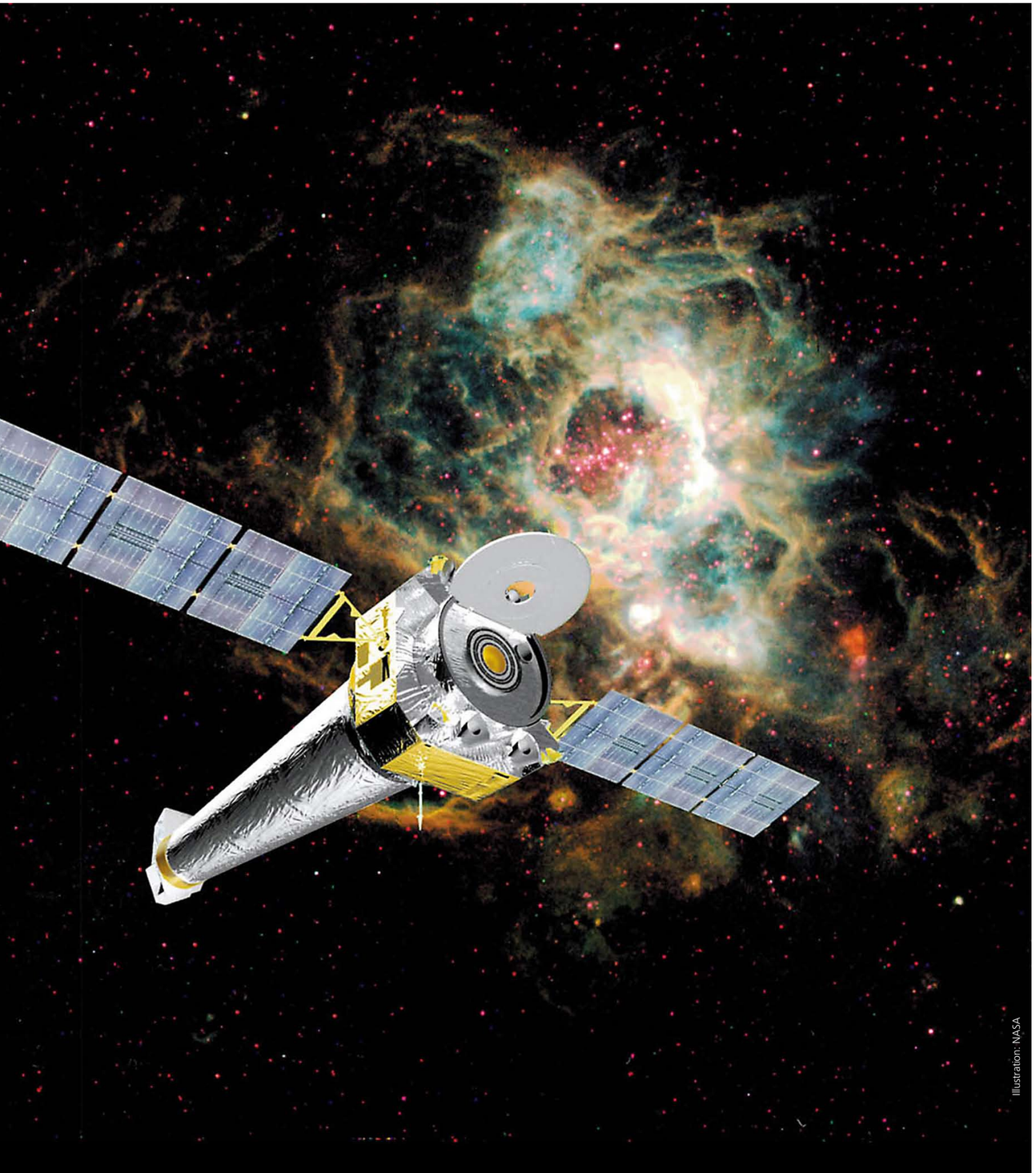


Illustration: NASA

Mikhail Revnivtsev and Helmut Hetznecker

Space, Illuminated

Billions and billions of point sources immerse the entire Milky Way in a diffuse X-ray light. The actual composition of the galactic background radiation was long hidden from observers on Earth. Astronomers have now solved the puzzle

When astronomers point their telescopes skyward, they collect a broad range of radiation from outer space. This includes radiation from stars and galaxies, radiation from hot and cold gas, radiation in the infrared range, and visible, radio or x-ray radiation. The human eye is naturally only designed for visible light waves, which make up just a fraction of the entire radiation spectrum that reaches us from space.

If one were to compare the range of visible light with a musical octave, the width of the entire electromagnetic spectrum would span at least 53 octaves. A piano that could cover such a range of frequencies would be nine and a half metres wide. In fact, the invisible radiation components contain immense amounts of valuable information about the cosmic processes. It is for this reason that astronomers have long endeavoured to make measurements over the largest possible range of the cosmic radiation spectrum.

X-ray radiation forms anywhere in the universe where it is particularly "hot", or energetic. Supermassive black holes in the centre of massive galaxies draw in gas and stars from the surrounding area with immense force. During this process, the material is heated as high as a hundred million degrees Kelvin by its internal friction shortly before it disappears forever. At such temperatures, the thermal energy is irradiated primarily in the X-ray range.

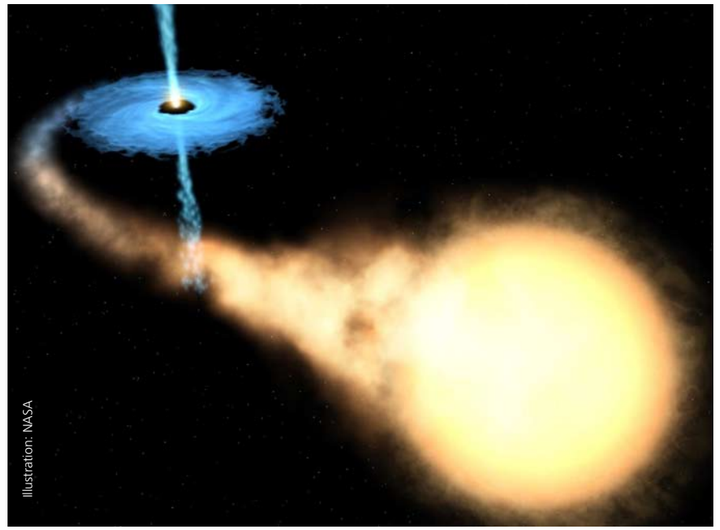
Left: An artistic representation of the Chandra X-Ray Observatory.

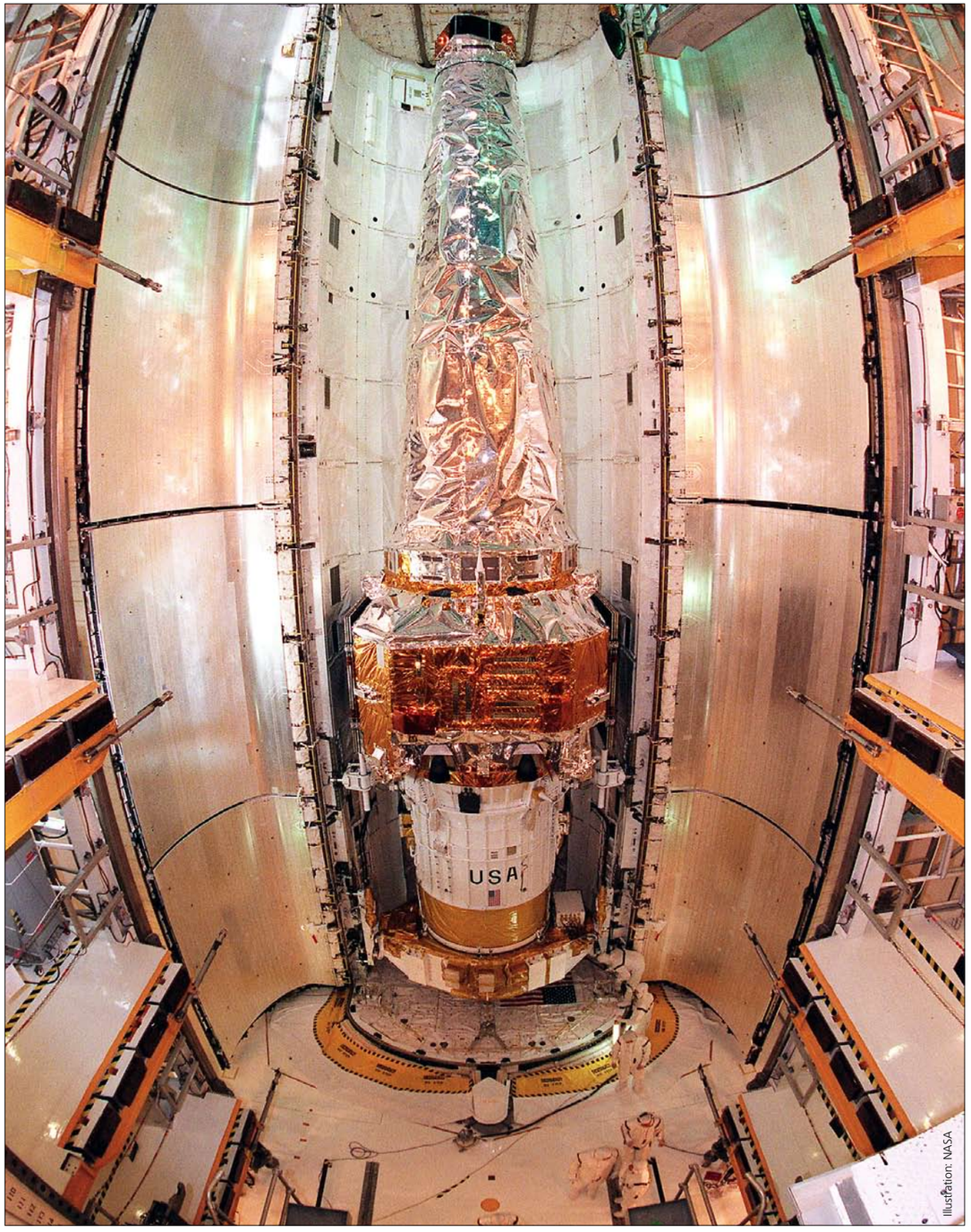
Astronomers observe the illumination of active galaxies located billions of light-years away, including so-called quasars, whose enormous brightness can be attributed to precisely this process. But there are many other X-ray sources in the universe: for example, this radiation is formed in certain binary star systems. If the binary star consists, on the one hand, of a very compact object – a white dwarf or a neutron star – and, on the other hand, a red giant, the material may flow from the giant star to the dwarf. But not only point sources can emit X-ray radiation. Massive galaxy clusters, not seldom home to more than a thousand galaxies, are embedded in a halo of extremely hot gas that illuminates brightly in the X-ray range. Numerous such diffuse sources are spread across the universe over millions of light-years.

In our galaxy as well, the Milky Way, astronomers have found since the 1970s, a large number of X-ray sources, including many of the aforementioned X-ray binaries, but also massive stars whose corona, at temperatures of many million degrees Kelvin, produces this high-energy radiation. At the end of the 1970s, it was possible to verify the existence of diffuse X-ray radiation, i.e. X-ray radiation that is emitted from broad sources, that reaches us from across the galactic plane. Astronomers call this constant illumination the "galactic X-ray background". For years, its source was believed to be the interstellar gas found in large quantities in the plane of the Milky Way.

With this assumption, however, came a difficult-to-solve problem: To produce X-ray radiation with the measured spectral characteristics, the interstellar gas would need to be so hot that its thermal energy would enable it to overcome and escape the gravitational field of the galaxy. No significant quantities of such a gas have, however, been observed in the vicinity of the Milky Way. The astronomers were faced with a puzzle.

The history of X-ray astronomy began in 1949 as X-ray radiation from a celestial body, the Sun, was verified for the first time with the aid of a research rocket. The main problem that this branch of research has fought to overcome is that the Earth's atmosphere very effectively shields against this radiation – much to our luck, as there would be no life on Earth under the influence of the energetic electromagnetic waves. For this reason, astronomers need to place their X-ray detectors high above the atmosphere. Before the start of the





Left: Highly dynamic: an "X-ray binary", an artistic rendering of a binary star. Right: Chandra is the largest satellite put into orbit by a Space Shuttle to date – a length of 13.8 metres and a weight of 4.8 tonnes.

space age, V2 rockets and high-altitude balloons were used for this purpose. It was with the aid of a brief rocket observation in 1962 that the first X-ray source outside of our solar system was discovered: the X-ray binary Scorpius X-1, located 9000 light-years away in the constellation Scorpius.

An important step for X-ray astronomy was the launching of NASA's UHURU satellite in 1970, the first satellite specialised solely on measuring cosmic X-rays. Using what was still a fairly rudimentary sensor, the satellite scanned the heavens for new sources. The yield was considerable: 340 X-ray systems. While UHURU operated with a lead plate filled with holes, the more modern satellites of the late 1970s and 1980s were equipped with sophisticated X-ray telescopes that were capable of bundling the incident radiation in a manner similar to an optical telescope – a quantum leap in imaging quality. Thus, it was possible to identify a newly discovered source using stars or galaxies from optical observations.

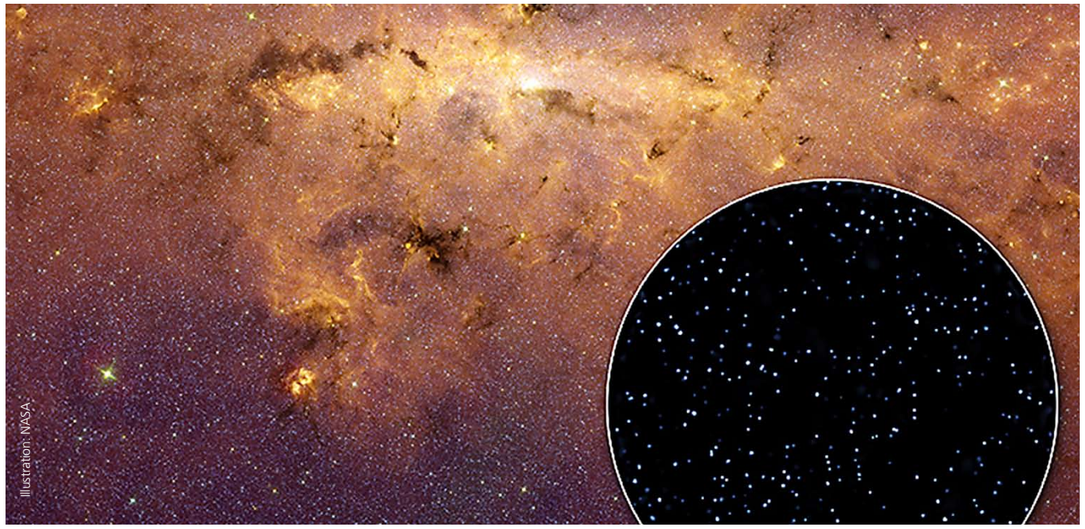
A "star" among the X-ray satellites was the German ROSAT, which was launched into space in 1990. Equipped with a so-called Wolter telescope, which surpassed the power of its predecessors by many times, it revolutionised the X-ray astronomy data pool within just one year. With the new technology, objects with intensity less than one-hundredth of those previously detected became visible. ROSAT was responsible for the discovery of not fewer than 60,000 X-ray sources, including representatives from all types of sources: quasars, X-ray binaries and supernova remnants, as well as galaxy clusters and especially hot – but otherwise normal – stars.

ROSAT continued to perform strongly even after this initial success. Until the conclusion of its operational life in February 1999, it sent data from nearly 150,000 X-ray sources back to Earth. One of its most important contributions to research was, however, in the area of the cosmic X-ray background. The entire cosmos illuminates uniformly in all directions in a diffuse X-ray light. With the help of ROSAT, it was possible to verify that this is the result of billions of superimposed point sources, primarily distant quasars and other active galaxies, that could not be spatially resolved with previous sensors and telescopes.

But ROSAT was likewise unable to shed light on the nature of the galactic background radiation. That the radiation could not be the result of hot interstellar gas was quickly apparent from the aforementioned theoretical reasons: travelling at thousands of kilometres per second, the gas would escape the gravitational field of the Milky Way.

It was known for years that the spatial distribution of the X-ray radiation had a noticeable correlation with the distribution of the infrared (IR) radiation, which originates from the disk and the centre of the Milky Way. The predominant sources of IR radiation are low-mass stars, whose visible light is obscured by the interstellar clouds of the galactic plane; their IR-light, on the other hand, reaches Earth with very little loss in intensity. A clear indicator, therefore, that the source of the diffuse X-ray radiation can be found in these stars. Also "suspicious" was the fact that the intensity of the X-ray radiation from a given region correlates strongly with the star density in that area – a fact familiar from stars located near the Sun.

A team of researchers at the Cluster of Excellence "Origin and Structure of the Universe", the Max Planck Institute for Astrophysics in Munich and other institutions examined these



Amazingly deep and illuminating insights: an image from the Chandra X-ray Observatory of part of the sky near the centre of our galaxy.

indicators in an effort to definitively explain the nature of the galactic X-ray background. For this purpose, they pointed the telescope on the CHANDRA X-ray satellite at a small region near the centre of the galaxy for a period of 11 days, measured the intensity of the emitted X-ray light and corrected the value with the contributions of the extragalactic X-ray background and the damping caused by the interstellar material. They compared their result with a measurement of the IR radiation intensity from the same region, a step that ensured the researchers that the selected region is representative. This was the case because the ratio of the two intensities was the same as the ratio obtained from a comparison of IR and X-ray data from the entire Milky Way.

Thanks to the high imaging quality of the CHANDRA instruments, it was also possible to verify a total of 473 point sources of the radiation in the observed region. In all likelihood, most of these are white dwarfs of binary star systems and stars with high coronal activity.

The measurements could, however, provide an explanation for only a relatively narrow spectral range within the comparably low-energy, soft X-ray radiation. For the assumption that the entire X-ray spectrum originates from discrete sources to prove correct, the distribution of the hard X-ray radiation would also need to match that of the IR radiation. A second stringent criterion would also need to be fulfilled: The generation of thermal radiation through the constant flow of material from a red giant to a white dwarf (or a neutron star) is characterised by a certain energy limit which is directly reflected on the spectrum of the radiation: one would, therefore, expect the intensity of the X-ray radiation to drop off quickly at very high energies. Both predictions could be confirmed by the data collected from the Milky Way by the International Gamma Ray Observatory, INTEGRAL, over a period of four years.

Given the convincing findings, the researchers consider it proven that X-ray binaries and coronally active stars are responsible for at least 80 percent of the diffuse X-ray radiation in the Milky Way. The puzzle of our galaxy's X-ray background, which has been ongoing for three decades, appears to be solved.

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Erich Weichselgartner and Stefan Winkler-Nees

Data for Everyone!

Around the world and in every discipline, data sharing is on the advance. The online archive PsychData shows just how great the benefits can be

Are there particular effects in the living environments of adolescents that promote the consumption of alcohol, tobacco and other drugs, and that increase the risk of abuse? The identification of such risks is of great importance for well-targeted prevention work.

With this in mind, a longitudinal study involving 2000 young people in Berlin recorded a broad range of social and psychological aspects during their development over a period of six years and correlated these with the use and abuse of drugs.

The extensive data collected are now available to all interested researchers through the PsychData data archive of the Leibniz-Institute for Psychology Information (ZPID). This database exists due to the efforts and personal involvement of Rainer K. Silbereisen, director of the Berlin study.

With this project, Silbereisen makes a case for a trend that can be observed in all disciplines and around the world: data sharing. The motivation for this is the desire to make scientific information available to all interested researchers. The ZPID has been addressing this topic in the field of psychology since 2002. PsychData establishes an archive that documents quantitative data from all research areas, stores them long-term and makes them available for future use.

The research community only stands to benefit from this improved data accessibility. In addition to the economic advantages, electronic archives also offer the possibility of "re-analysing" data with new research questions or using other statistical methods. Investigations intended to compare, merge or expand the results of various studies are also supported.

To facilitate the future use of the data, they must be carefully documented. The services provided by PsychData include the documentation of the provided data, which is in line with global documentation standards. Thus, the background of the studies, the samples and the collection methods, as well as the individual variables, are described. Those who provide data also have the option of uploading their data into PsychData online themselves. Data users can concurrently explore the descriptions of the collected studies online and access data sets at no cost from PsychData.

Currently, access to research information in psychology is often cumbersome. Technical or organisational conditions, such as obsolete storage media, result in the data – often collected at great expense – becoming unusable. Not only researchers, but also science policy-makers and research funding have recognised the value of data sharing. For this reason, the Scientific Library Services and Information Systems Division (LIS) also supports the establishment of PsychData. The DFG subcommittee for information management adopted a recommendation for the long-term use of research data; secure storage and accessibility are the primary aspects.

With PsychData, psychology in Germany offers a networked platform for research data. The vision is that, in the future, the generally comprehensible documentation of research data, the joint scientific use of the data and the long-term archiving of the data will become natural parts of research projects in psychology and other disciplines.

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http://psychdata.zpid.de
www.dfg.de/lis

Martin Winter, Miriam Kunze, Alexandra Lex-Balducci

Into a Future of Electromobility

Lithium-ion batteries are already in widespread use in cell phones, laptops and digital cameras. An interdisciplinary research initiative is now using novel combinations of materials to extend the potential of this energy storage technology – especially for use in energy efficient vehicles

It is impossible for us to imagine a world without cars or trucks driven by internal combustion engines. We have become accustomed to unlimited individual mobility, perhaps too accustomed to realise that there are actually limits, after all. One of the main limitations is the limited supply of energy, which is governed by the finite availability of fossil fuels.

Renewable energy is being discussed as an alternative to fossil fuels worldwide, but the sources of renewable energy such as solar or wind power, which are capable of providing an almost unlimited supply of energy, are not always available and are unevenly distributed. On top of this, the electricity generated basically needs to be used straight away. Storing electricity calls for powerful and long-term energy storage solutions.

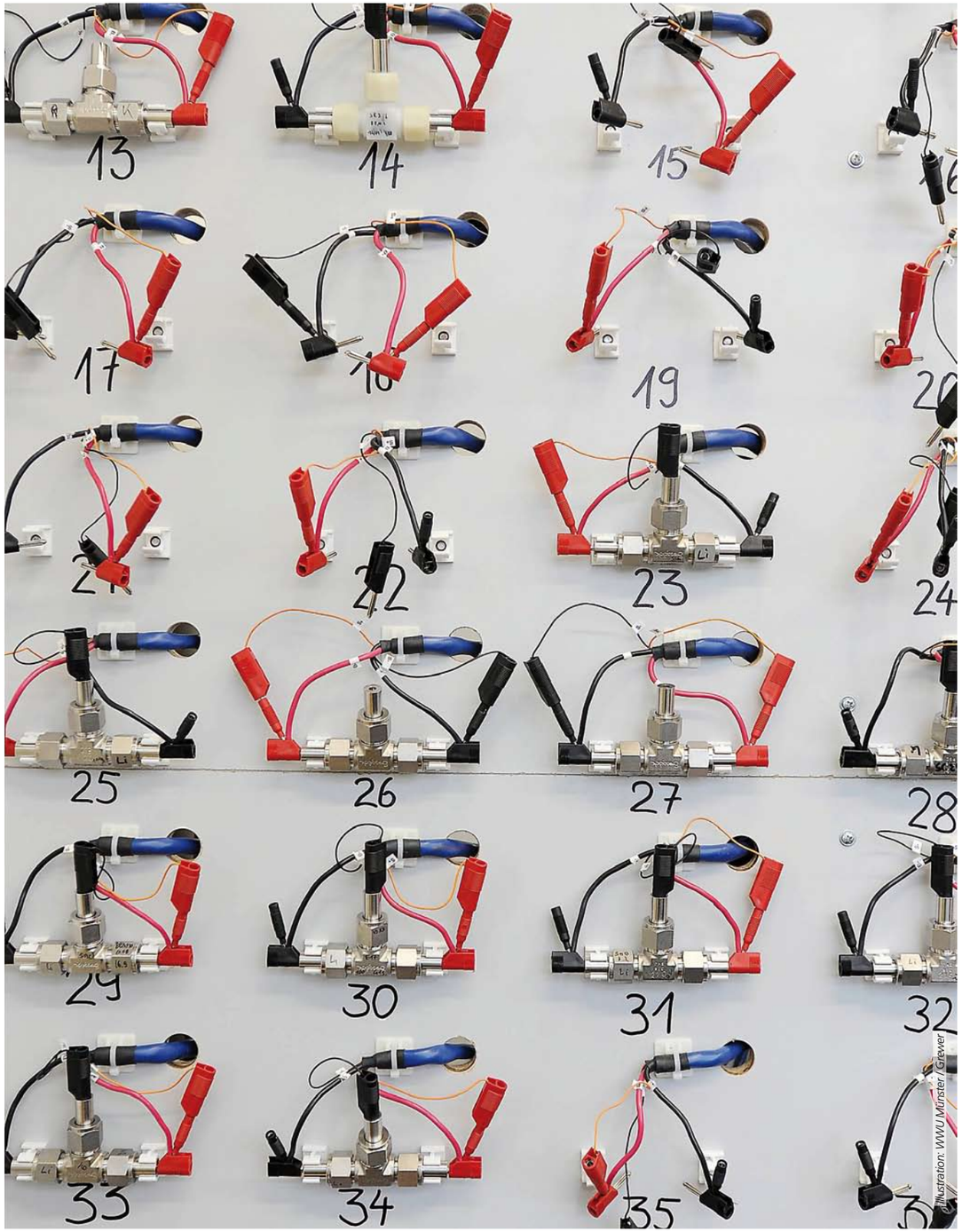
Lithium-ion technology is the most elegant and most efficient form of storing electricity currently available. In principle, the mechanism is very simple: Two mixed conducting intercalation compounds with very different chemical potentials for lithium cations and electrons are used as the negative electrode (anode) and positive electrode (cathode), and an electrolytic salt dissolved in an organic solvent is used as the electrolyte. The charging and discharging reaction causes lithium cations to travel from the cathode to the anode via the electrolyte.

A key advantage of this technology is that lithium-ion batteries – thanks to their modular design principle – allow the use of a wide variety of materials and combinations of materials. This means that the search for new materials is practically unlimited. At a voltage of approx. 3.4–3.8 V (depending on the type of cell and the load profile) lithium-ion cells can achieve energy densities of up to 250 Wh/kg (watt hours per kilogramme) or up to 800 Wh/l (watt hours per litre) – unrivalled by other accumulators.

Lithium-ion batteries are already the dominant energy storage system for cell phones, portable computers (laptops), cordless tools and camcorders, collectively referred to as the 4C market. After all, in comparison to other types of rechargeable batteries, they offer numerous advantages such as a wide variety of shapes and sizes as well as high energy density and power density. However, it is impossible to attain optimum results in terms of energy and power with one and the same system. Rather, it is necessary to tailor the batteries either for high power or high energy, depending on the intended application.

This calls for a comparative approach in order to determine whether the energy content of lithium-ion batteries really is as high as is claimed. This also applies to the current hot topic in the field of batteries: electromobility, or, in other words, vehicles that use batteries and electricity, such as purely electric or hybrid cars, busses and bicycles.

The lithium-ion technologies currently in use in electric vehicles can achieve “approximately” 0.5– 1 kilometres of range per kilogramme of battery weight, “approximately” because there are not only many different lithium-ion technologies, but also a wide variety of vehicle concepts competing against each other. It thus requires about 100 kilogrammes (or more) of battery

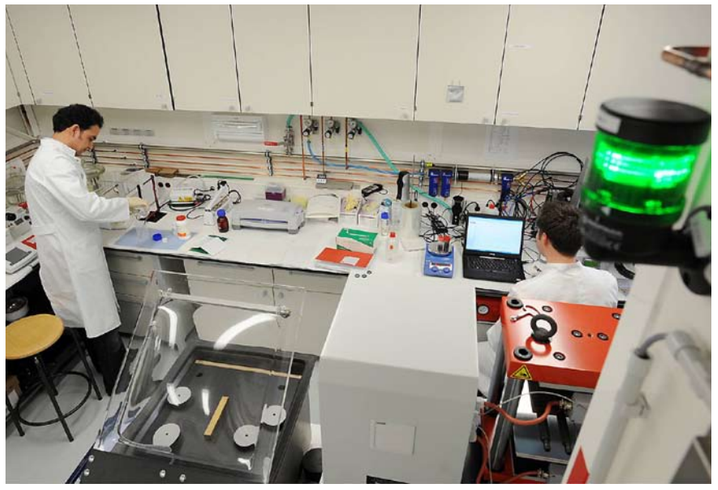


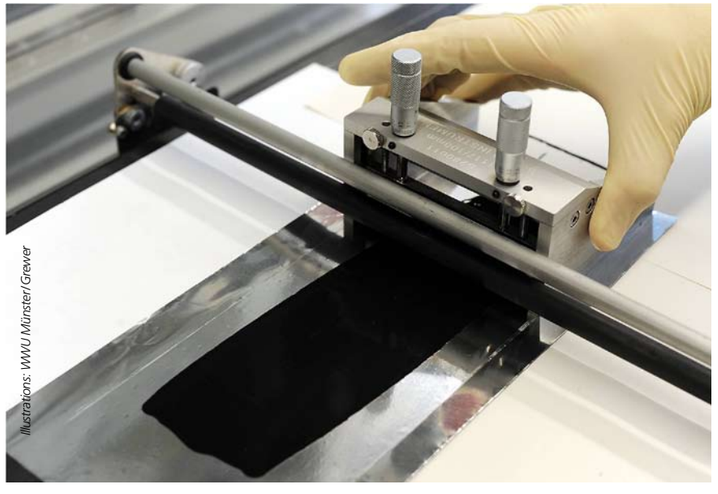
On trial: The performance and operating life of newly developed lithium-ion cells is repeatedly tested using simulated charge/discharge cycles.

© Illustration: WWU Münster / Grewer

weight to travel a distance of 100 kilometres, at present.

There are two approaches to this problem. On the one hand, work is underway to develop and further refine lithium-ion technologies as well as alternative technologies in an effort to increase vehicle range. This approach addresses the electromobility of tomorrow, or even the day after tomorrow. The second approach is to adapt the application to the specific characteristics of the technology chosen. For instance, take a city vehicle that is designed for use around town or for commuting. It needs to be small and lightweight, with sufficient battery capacity to give it a range of 100 kilometres. However, such a limited range does not suit drivers' current habits or meet their demands in terms of personal freedom. The result of this is that the acceptance of electric vehicles is currently poor, even though the average distance travelled by car per person per day in Germany is less than 50 kilometres. To put it bluntly, most "automobiles" are anything but mobile most of the time, as they are normally only in motion for less than two hours a day.





Illustrations: WWU Münster/Grewer

Left: The first step is making the individual components. Here a viscous electrode slurry is being applied to metal foil. Above: Once it has dried, the moisture-sensitive parts are assembled into prototype cells in special rooms where the relative humidity is less than 0.1 percent.

An alternative approach to the problem is to use plug-in hybrids, which combine a medium-sized battery that drives an electric motor with an internal combustion engine with a conventional fuel tank. On short journeys these vehicles run as electric vehicles, and on longer journeys or at higher speeds the internal combustion engine cuts in to assist. The battery can then be recharged by being plugged into a socket, overnight, for example.

Both city and plug-in vehicles can already be built using existing lithium-ion technology. Most electric vehicles on German roads to date belong to trial fleets operated by energy companies, public utilities, taxi companies and car manufacturers. Only a few belong to private individuals. However, this is not only due to their lower speeds or the potential range of a single battery charge, but also due to the cost of the lithium-ion batteries, which remains prohibitively high.

Apart from the aspects of cost and energy content, there are also other issues that need to be addressed such as safety, operating temperature range, fast charging capability and operating life.

Illustration: Car Culture/Corbis

A successful prototype: The Tesla Roadster – with over 6000 rechargeable cells – is the first mass-produced car powered by lithium-ion batteries.

Why are lithium-ion technologies nevertheless the most popular? This is due in part to strategic factors, and in part to technological factors. The strategic factors are obvious. Whereas there is disillusionment about the time it is taking for the commercialisation of fuel cell vehicles, the search has also been on for promising technologies that can be implemented in the near future. An alternative was soon found: The hybrid engine, albeit using nickel metal hydride (NiMH) battery technology, has made unparalleled progress since the 1990s. However, the NiMH battery, with its low usable energy content, is not suitable for use in purely electric vehicles, but can "only" serve as an auxiliary power unit alongside an internal combustion engine. Hybrid operation can save a significant amount of fuel, for instance, by the recovery of braking energy during stop-start driving in city traffic and when driving under conditions where internal combustion engine performance is poor.

To move on from hybrid vehicles to plug-in hybrid vehicles and then on to purely electric ve-

hicles, a battery with higher energy content and power capacity is called for: the lithium-ion battery. In western civilisation, in particular, it is easy to plot the value creation chain for these batteries, both from an industrial point of view – with a strong chemical industry, a large automobile industry and auto supplies industry – as well as from the academic point of view, where scientists and engineers have been quick to pick up on this topic and give it a great deal of attention in R&D.

Limited experience in mass production of the batteries as well as in the power electronics of battery packs remains an Achilles' heel of this technology. A number of technological factors in favour of lithium-ion technology have already been mentioned above.

The conclusion we come to is thus that, at present, there is no other accumulator technology that even comes close to offering as good a mix of energy, power, dynamics and operating life. The trump card of lithium-ion technology, however, is its chemical diversity, which gives it great potential for further development, including both increased performance as well as a reduction in the cost of the anode, cathode and electrolyte solution.

In terms of the interaction between the individual components, the lithium-ion battery is an excellent candidate for short- and medium-range electric cars of the future as well as for plug-in applications.

Lithium-ion technology is promising due to its energy content, power, dynamics and long operating life.

For longer-range applications, other high-energy battery systems known as "super batteries" such as metal-air batteries are considered to have greater potential. Due to its particularly high energy density, the Holy Grail is lithium-air technology, which involves complex chemistry and complex cell structure; numerous problems – a genuine challenge.

It is therefore only realistic to envisage the use of metal-air batteries as being much further off than that of lithium-ion batteries. From a technological point of view they are unlikely to simply replace lithium-ion batteries, as their power and dynamics are not likely to prove suitable for use in cars. The highly dynamic lithium-ion technology will thus continue to play a significant role alongside such high-energy batteries. At the end of the day, "super batteries" also demand compromise.

Electromobility will itself end up having to be a compromise, especially in the early years. How well this compromise is accepted will depend on a number of factors, for example, the price of energy, CO_2 emission reduction regulations, and the acceptance of this new technology by the general public. Will they see the advantages of electromobility, rather than simply focussing on the disadvantages? Will it be possible to demonstrate that generating electricity from renewable sources such as solar and wind power can only make economic sense if it is possible to temporarily (and dynamically) store the electricity once it has been generated?

Batteries have a great future, not only in the field of electromobility, but also in other fields. The course is being – or needs to be – set now, by politicians, industry and, of course, by the research community.

Prof. Dr. Martin Winter
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Dr. Miriam Kunze
is involved in research into innovative electrolyte systems for lithium-ion batteries.

Dr. Alexandra Lex-Balducci
is the leader of an independent junior research group working on "novel lithium gel polymer electrolytes". They both work at the Institute of Physical Chemistry at the WWU in Münster.

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Eva-Maria Streier

Tin Wedding in Beijing

Ceremony and strategy workshop: How the DFG and its partner organisation NSFC celebrated the 10th anniversary of the Sino-German Center for Research Promotion

It was a cold and clear October day in Beijing when one black limo after another pulled up to the Sino-German Center for Research Promotion (SGC) on the northwest side of China's capital. Guests had come from near and far to celebrate the tenth anniversary of the Center, which is one of a kind in its constellation as a Chinese-German joint venture.

Together with its Chinese partner organisation, the National Natural Science Foundation of China (NSFC), the DFG had inaugurated the new building ten years ago to the day, on 19 October 2000. It was the DFG's first international branch, followed by Washington / New York, Moscow, New Delhi and Tokyo. The DFG and the NSFC each provide half of the funding for the Center, which has one German and one Chinese director as well as two vice directors, and supports bilateral collaboration in the natural, life and engineering sciences. It is especially committed to early-career support for researchers.

About 200 invited guests were welcomed by DFG President Matthias Kleiner to this "tin wedding" – the celebration of ten years of marriage – in the SGC auditorium. In his opening address, Kleiner identified three factors as fundamental to this shared success: equality, re-

The building of the Sino-German Center with apartments for visiting researchers.

Illustration: CDZ / DFG

Former and current SGC Directors – f.l.t.r.: Jens Egon Mosch, Robert Paul Königs, Zhao Miaogen (Vice Director), Heike Strelen, Armin Krawisch and Reinhard Rutz.

spect, and peer-to-peer partnership. Since research – beyond geographic or ideological approaches – requires thinking and acting across borders, the major research-funding organisations are charged with a special responsibility to facilitate this, said Kleiner.

Each year, the SGC supports over 1,400 researchers from both countries and funds about 30 symposiums and summer schools. In addition to numerous early-career support programmes, cooperation groups and research projects, the SGC has also underwritten about 250 symposiums so far. Add to that six International Research Training Groups and two Collaborative Research Centres / Transregios. Since 2000, the DFG and the NSFC have invested about 30 million euros in the SGC.

Thus the President of the NSFC, Professor Chen Yiyu, rightfully claimed in his greeting that Sino-German cooperation had become the most important component of his organisation's international strategy.

Michael Schaefer, the German Ambassador to China, struck a political note during the ceremony. He emphasised the importance which the German federal government places on "research collaboration with the world's best minds". The combination of German experience and Chinese dynamism, he said, will guarantee the success of the research so important for the future of both countries.

The anniversary had been kicked off with a strategy workshop, where prospects for the next decade of Sino-German research cooperation were explored. DFG President Kleiner singled out research on energy – especially solar –, food safety, microelectronics and materials as example areas of future cooperation. Moreover, Kleiner said, the combination of traditional Chinese medicine with methods and approaches of conventional Western medicine should be explored, as should joint research into infectious diseases.

Impressive figures were presented in NSFC Vice President Shen Wenqing's speech. The NSFC budget increased exponentially over the last 20 years and now equals about 40 percent of the DFG's annual budget of approximately 2.4 billion euros. NSFC investments in international collaborations rose from 3 million yuan in 1987 to 300 million yuan in 2010. Tasks for the future, according to Shen Wenqing, include the expansion of international cooperation and early career support for researchers.

In his keynote statement, Professor Ernst-Ludwig Winnacker, DFG President at the time of the SGC's inception and currently the General Secretary of the Human Frontier Science Program, picked up where the previous speaker left off. He made it very clear that young researchers don't choose the countries but rather the top institutions where they want to work. According to Winnacker, the three pillars of scientific excellence are the three C's: communication, cooperation and competition. His advice for the next decade of the SGC: "Invest in young researchers and their early independence – both financially and structurally." The Secretary General of the DFG, Dorothee Dzwonnek, seconded his appeal and noted that early career support will be central to calls for proposals under the new framework agreement between the DFG and the NSFC.

Next, an impressive series of short presentations illustrated the wide range of research areas and the vitality of Sino-German cooperation. Professor Liqui Meng, China-born Vice President of the Technical University Munich, talked about some 20 scientists of her institution who regularly travel to China for research. Professor Harald Fuchs, Münster, and his Chinese colleague, Professor Zhan Xi, gave a presentation on their nanoscience-focussed Collaborative Research Centre. Timo Balz (36), the 2009 recipient of the newly-created NSFC fellowship for young researchers from abroad, gave a presentation in his new role as an associate professor and the first permanent foreign employee at Wuhan University. His specialist field is remote sensing, and he plans to remain in China for the time being.

According to Professor Bärbel Friedrich, a microbiologist at the Humboldt University of Berlin and Vice President of Leopoldina, cooperation with China may even inspire the scientific community to issue international statements advising governments on research policy. Professor Volker Moosbrugger and his Chinese colleague, Professor Sun Ge, described in their speech the most comprehensive cooperation project to date, the Tibet Plateau programme.

The Presidents – f.l.t.r.: Chen Yiyu, NSFC President; his predecessor Chen Jia'er; Ernst-Ludwig Winnacker, former DFG President; Zhang Cunhao, NSFC President until 1999; and DFG President Matthias Kleiner.

The Joint Committee of the SGC, which functions as its "board of directors". On the German side it is headed by chemist Ferdi Schüth (centre), DFG Vice President, standing to the right of DFG Secretary General Dorothee Dzwonnek.

During the subsequent reception on the premises of the SCG it became apparent that good and trusting relationships between German and Chinese researchers have developed over the last ten years at all levels. These personal contacts facilitate cooperation and are stable and sustainable. The role of the Sino-German Center for Research Promotion goes way beyond research funding – a factor that, given China's rapid development as a major economic and scientific power, cannot be underestimated. DFG President Kleiner therefore predicted with confidence that the SGC would be around to celebrate its "golden wedding" after 50 years of marriage.

Dr. Eva-Maria Streier
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Markus Huber-Lang and Florian Gebhard

The Trauma After Trauma

High impact injuries not only result in broken bones – the risk from whole-body inflammation and immune system failure is often even greater. Clinical researchers are seeking better methods of diagnosis and treatment

Injuries pose a serious risk at any stage of life, and are by far the most common cause for the need for clinical treatment. Each year, over 8 million people in Germany – or one in ten of the population – is involved in an accident. Over 1.5 million of them are severely injured and require full inpatient treatment. Furthermore, below the age of 45, major trauma is the leading cause of death. Despite the great progress made in surgical and anaesthesiological emergency care, doctors still fear an excessive inflammatory response following trauma. This systemic reaction with its complexity and complications remains a serious challenge for both clinicians and researchers.

In this context, the Clinical Research Unit at the University of Ulm (KFO 200) is using various clinical and experimental methods to investigate the early inflammation response as well as the changes in the immune system following severe tissue trauma. In addition to the surgical and anaesthesiological "damage control", they aim to more precisely measure the immune response and deliver a carefully targeted "immune control" using innovative therapeutic concepts. They plan to improve the posttraumatic cell and organ dysfunction and to finally increase the survival rate.

Bone and joint fractures, soft tissue injuries, and any organ tissue damage normally cause an initially localised inflammatory response. This is the body's way of limiting and healing the damage caused. Immediately after the trauma ("first hit"), and depending on how severe the injury is, endogenous and exogenous mediators are released, and so-called "DAMPs" (referred to by experts as danger-associated molecular pattern molecules) spread throughout the body. These DAMPs are detected by the innate immune system ("danger sensing") and specific danger messages transmitted to the cellular defence system ("danger translation"). This results in the early activation of various protein kinase cascades (complement system, coagulation system) as the early post-traumatic inflammatory response ("danger response") as well as in stimulating immune cells, which in turn release various signalling substances and messengers. This inflammatory reaction is accompanied by a complex neuro-endocrine stress reaction, and is intended to banish the danger ("danger clearance"). In the clinical view, the inflammatory response is no longer considered localised, but rather as a general danger in the form of a whole-body inflammation ("systemic inflammatory response syndrome", or SIRS) if any two out of four clinical variables (body temperature, respiratory rate, heart rate or white blood cell count) changes significantly.

Overall, the inflammatory response after trauma mostly leads to tissue regeneration and ultimately to healing. However, approx. 10–15 percent of severely injured patients with SIRS develop an almost irreversible multiple organ dysfunction syndrome, ending in death. In this regard, so-called "second hits" such as oxygen demand, artificial ventilation, operations or infections can further stimulate and exacerbate the inflammatory answer. If micro-organisms (for example bacteria in the blood) are also found while a patient is suffering from SIRS, these patients are described as having the much-feared blood poisoning (sepsis). Depending on the severity of the SIRS, it is the lungs that are primarily affected as the central target and effector organ, which can lead to a difficult-to-treat lung failure (referred to by experts as "adult respiratory distress syndrome", or ARDS).

For example, one project being conducted by the Research Unit in Ulm is studying the function of the neutrophils and macrophages in the lungs (alveolar macrophages) with regard to their inflammatory response following lung injury typically seen in victims of road traffic accidents (e.g. dashboard injuries). Overall, the trauma appears to result in a loss of control of the body's own regulatory mechanisms and an imbalance of the pro- and anti-inflammatory responses, interfering with the communication within and between the cells, and thus disturbing functioning on a molecular, cellular, tissue, organ and multi-organ level. This may lead to a "danger escalation" within the body.

The immune system plays a particularly important role if a hyperactivation after trauma and SIRS switches to immunosuppression, also referred to as "immune system failure". In autopsies of trauma victims

Illustration: Grass / U Ulm

Emergency Room at Ulm University Hospital: This is where severely injured patients and patients who are in critical condition are given initial care.

with SIRS performed immediately after death, an American research group observed that the organ morphology appeared, at first sight, to largely retain its integrity, which remains unexplained, and which is in stark contrast to the significant clinical organ dysfunction immediately prior to death. A cellular "hibernation" brought on by the trauma as a protective mechanism was hypothetically proposed, as a kind of "survival strategy" by the organs, per se.

One of the project sections belonging to the Research Unit is therefore working on inducing such a "hibernation" using specific medication in order to measure the changes in the inflammatory response under standardised intensive care conditions following experimental trauma. Because this hibernation-like state has so far been observed to be reversible and have negligible effects on cardiovascular function, it is hoped that it will offer a potential new treatment approach in the future.

Interestingly, it was found that the rate of programmed cell death (apoptosis) of certain immune cells (lymphocytes) was enhanced in the autopsy studies mentioned above, following post-traumatic, whole-body inflammation, which may explain the well-known increased susceptibility to infections after trauma.

In contrast to this, the post-trauma lifetime of other white blood cells (neutrophils) is significantly increased, for reasons that are as yet unknown. Neutrophils thus remain in the tissue significantly longer and contribute not only to better defence against infection from invading micro-organisms, but also to significant "collateral damage" to the patient's tissues and organs. It is here that one of the working groups is seeking possible causes for the change in apoptosis of the immune cells following trauma.

However, it is not only the immune cells that are attracting attention, but also the cells that are responsible for regeneration, restoration and maintenance of the tissue. On the one hand, these are the precursor cells in each specific type of tissue, and on the other hand the stem cells from the bone marrow. These are capable to differentiating to form bone cells, cartilage cells or fat cells, and thus play a central role in post-traumatic regeneration. Recent studies have found an increased number of stem cells in the blood following acute trauma. The role of the stem cells in the interaction between the post-traumatic inflammatory response and regeneration still remains largely unknown and is another focus of the Research Unit in Ulm.

The trauma cascade (from bottom left to top right): Following a motorbike accident, a multiple injured patient is taken to the emergency room by helicopter, where he is soon diagnosed as having a fractured pelvis, which means he will need to have a "damage controlling" emergency operation. After this, the patient is transferred to the intensive care unit at Ulm University Hospital for further treatment.

Illustrations: Grass / U Ulm

In joint injuries, an acute cartilage trauma often leads to a barely controllable development of post-traumatic joint degeneration, termed post-traumatic arthrosis. The mechanisms of acute and chronic cartilage destruction are manifold. The trauma response of the cartilage appears to be governed primarily by the cartilage cell damage and local inflammatory response. It has been shown in the body, and especially in bloody joint effusion, that locally released inflammatory factors lead to a reduction in the synthesis of cartilage, to increased cytoskeletal degeneration and, ultimately, to cartilage cell apoptosis. Due to the slow growth rate of cartilage cells, the degree of self-repair by the cartilage is rather limited. According to the latest findings, the cartilage cells appear to be the target and source of certain DAMPs, whose role in the post-traumatic development of arthrosis is currently being more precisely defined by ongoing studies. Blockade of some of these DAMPs and inflammatory factors, which has so far only been successful in vitro, could potentially allow doctors to a positively modify the response of cartilage to trauma and open up new approaches to treating the hitherto almost uncontrollable development of post-traumatic arthrosis.

Serious post-traumatic complications can threaten the patients' quality of life in the long term or impose lasting limitations on them. Apart from the acute therapy of severely injured patients, it is clearly the "danger control" and "immune control" of the inflammatory response that is crucial for a good outcome, in particular in the case of post-traumatic "immune failure".

The studies conducted to date have looked at various organs to investigate molecular approaches to gain a better understanding of our body's capability to cope with danger. One of their key conclusions is that, just like ECG monitoring of the heart, "close-knit" or even "online" molecular and functional monitoring of the danger molecules as well as the corresponding immune response of injured patients will be imperative for preventive treatment in the future. This applies not only to anaesthesiological and surgical interventions, but also needs to include appropriate, targeted and individual "immunomodulation", so that both the early and the late complications associated with the post-traumatic inflammatory response and the danger escalation in the form of "trauma after trauma" can be prevented as far as possible.

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No one had anticipated such an influx. About 170 mainly early career researchers arrived at the German House in New York City on a radiant Saturday afternoon at the end of November to find out about the funding opportunities provided by the European Research Council (ERC). Under the title "Yes, You Can", the DFG, the German Center for Research and Innovation New York (GCRI) and the National Contact Point for the European Research Council (NCP-ERC) hosted the event within view of the United Nations' main building. The workshops and discussions were followed by the first Leibniz Lecture to be held in North America. It was given by Hannah Monyer, who in 2003 was awarded Germany's most prestigious research prize, endowed with €2.5 million. The DFG's purpose in organising the Leibniz Lectures is to increase the international visibility of top-level German research. The event was a success, and all participants had something positive to say about the learning effects. Europe had successfully wooed American research.