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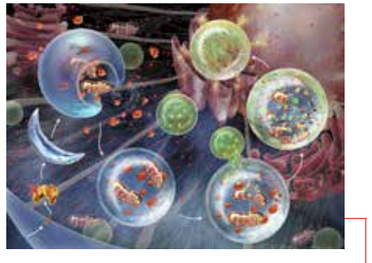
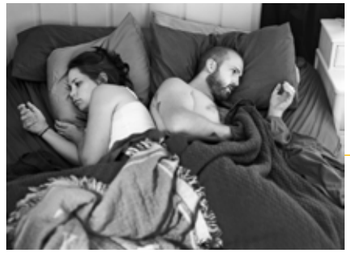
Cover: Press Office U Kassel

A component is carefully handled within the electron beam process. Using optimised local process design, scientists are seeking to achieve tailored material properties.





Peter Strohschneider

Europe? Europe!

What will serve as the foundation for the European research funding of tomorrow? For its next framework programme, the European Commission is focussing on open science, citizen involvement and missions. Reason enough for the research community to keep a close and critical eye on developments.

Today is tomorrow's yesterday: At the beginning of June the European Commission presented its proposal for a ninth research and innovation framework programme, Horizon Europe, to be launched in 2021. A proposal of this nature is the outcome of a lengthy process that starts while the predecessor programme is still ongoing. Until such time as the new programme has actually been adopted as an EU regulation, and under changing presidencies of the European Council, the member states, the European Parliament and various interest groups will make their influence felt. This influence will affect the details of the programme, participation guidelines, work programmes and indeed the overall volume: Since the first framework programme, not only have the programme durations been extended from three to seven years, moreover under the Commission's proposal the financial framework of Horizon Europe is set to be increased to €94 billion.

There are two main reasons why this ninth framework programme is attracting particular attention. One has to do with the general crisis currently affecting the European Union. Since 1984, the EU Framework Programmes have supported cross-border research cooperation within a common legal framework. However, the reliability of this framework can no longer be taken for granted. At the time of the interim evaluation of the current programme, Horizon 2020, in 2016, few could have imagined in what manner and how quickly the idea of a steadily growing and financially secure European funding programme would be put under pressure.

The second factor has to do with the functionally differentiated structure of European research funding itself. It is based on the idea of a common European Research Area and relies on the scientific weight and diversity of a dense, dynamic and internationally interconnected research system in a variety of institutions throughout Europe. The integrated EU research programmes are only one component of European public research funding and must remain subsidiary to the national research systems.

At the same time they have resulted in many national research agendas being adapted to the requirements of the framework programmes in the name of "alignment". In the wake of this, and partly as the result of a strict cost-cutting policy and not just on the part of less economically strong member states, we have witnessed a weakening of the autonomous function of national research funding organisations. As a result, European research institutions and funding organisations are growing increasingly dependent on a relatively small EU funding budget.

This makes the question of the budget for Horizon Europe all the more urgent – particularly as internal tensions are likely to make the next EU budget the subject of extremely difficult negotiations. And in the process, the funding allocated to research is unlikely to take centre stage compared with other policy areas.

Amid the European legitimacy crisis and the declining competitiveness of many member states' research systems – in the face of growing competition from the USA and Asia – the new framework programme will need to prove its strength. The European Commission is calling for a direct legitimation of research from citizens. "Citizens' involvement" is thus one of the key ideas describing an important change in the new framework programme: the introduction of "missions".

Missions are intended to address priority problems in a high-risk manner and deliver focussed, measurable solutions within well-defined time frames. For politicians, missions may be attractive as showcases for research. But while the function of missions would seem to be clearly defined in this respect, there is still no definition of their form or essential structural elements. Missions differ from the discursively well established "global challenges" in areas such as environment, health and energy. But how they differ is not made systematically clear on the basis of individual, frequently cited examples, such as ridding our oceans of plastic or reducing the societal burden of dementia. Even more unclear is how research funding could be coordinated along with the responsibility for other policy areas.

Illustration: DFG/Ausserhofer

Missions promise to make knowledge production something that can be planned in advance, while this is only possible in exceptional cases. Scientific findings are rarely completely unambiguous or achievable on predefined schedules. They are subject to intellectual dispute and the principal condition of methodological scepticism, and: practical, applicable results of knowledge-driven research are often the result of unpredictable discoveries that took a long time to achieve or were made a long time ago. If the scientific community is to be held solely responsible for achieving mission targets and if the participating researchers cannot deliver on promises of quick success, then missions will be more likely to foster public loss of trust in science than to reduce it.

The political steering of missions is unlikely to remedy this assumed loss of trust by simply raising expectations of direct economic impact and immediate societal relevance from projects that have not yet even begun, and equally unlikely to increase their innovational strength.

Responsible research is another principle of Horizon Europe designed to address the public relationship between science and society. Indeed, citizen participation in the form of traditional lay science, for example in local history or the collection of environmental data, is understood and important as is now the critical discussion of calls for public co-design of research under the ideological label of "open science". After all, whom do we mean by "the public" and how do its interests relate to the productive openness of the pursuit of knowledge guaranteed qua the freedom of research?

The claim that open science is by its very nature "excellent science" is simply a categorical mistake. Research driven by the free pursuit of knowledge must – and can – be societally justified, and its processes, findings and limitations must be fully and openly communicated to the public. But it doesn't follow from this that we may confuse science communication and the legitimacy of publicly funded research.

The DFG is one of the most important research funding organisations in Germany's diverse and balanced research system and indeed in Europe as a whole. Foremost in the Alliance of Science Organisations in Germany and in association with its European partner organisations in Science Europe, it advocates a principle of funding that in fact does not fail to recognise the power of knowledge-driven research and its own productivity.

Prof. Dr. Peter Strohschneider
is the President of the DFG.

See also "Benefiting from Horizon Europe?" on p. 4.

Benefiting from Horizon Europe?

At the KoWi conference in Bremen, questions and viewpoints on the EU's next research and innovation framework programme were the focus of discussion

Illustration: Rehling/U Bremen

It was an obvious choice of topic, being of such current relevance: Horizon Europe, the EU's Ninth Framework Programme for Research and Technological Development. At the 30th national conference of the European Liaison Office of the German Research Organisations (KoWi) in Bremen, it provided plenty of material for discussion. At the beginning of June the European Commission published its proposal for Horizon Europe, which is scheduled to be launched in 2021.

It raises numerous questions: Is the Commission's proposed budget of around €100 billion sufficient for a seven-year period? How does the Commission envisage the design of the new topic clusters and missions? And why does the Commission now speak of "open science" rather than "excellent science" with respect to basic research? These and other questions were debated by a panel of high-ranking contributors during the conference.

For Dr. Wolfgang Burtscher (second from left in photo), Deputy Director-General of the European Commission's Directorate General for Research and Innovation, Horizon Europe represents a balanced mix of proven and innovative elements. As one new feature, he notes for example that the Societal Challenges identified in Horizon 2020 have now been grouped into five clusters. It remains to be decided how the mission targets of the individual clusters should be defined.

"For the ninth framework programme, the conditions have changed," said Burtscher in response to criticism of the proposed budget of €100 billion. He explained that Brexit had resulted in the loss of an important net contributor as well as the research nation that so far has financially benefited the most from the framework programme. He also noted that the budget increase of 30 percent was very positive news compared to the current programme, Horizon 2020. "The glass is definitely half full and not half empty," he said.

Dr. Erik Hansalek (on right in photo), head of section for EU research policy and programmes at the German Federal Ministry of Education and Research, was satisfied overall: "Horizon Europe is not a paradigm shift, but a sensible further development of functioning research funding instruments."

DFG Secretary General Prof. Dorothee Dzwonnek (centre) reserved some criticism for the European Commission's omission of the term "excellence", pointing out that the first pillar is entitled Open Science rather than the previous Excellent Science. Finally, Dr. Jens-Peter Gaul (second from right), Secretary General of the German Rectors' Conference, argued in a similar fashion, when remarking that regarding open science as "good science" in itself was problematic. Burtscher did not wish to overemphasise the term, noting that the concept of open science is also primarily concerned with excellent research.

Dzwonnek expressed satisfaction that national research funding in Germany harmonised well with funding at European level and that the two could complement each other. For this reason – and this was the conclusion of the discussion – research in Germany is well set up for the future and can only benefit from Horizon Europe.

www.dfg.de/dfg_magazin/internationales/kowi_bundestagung (available in German only)

Illustration: Nicole Glass

Full meeting agenda for DFG Secretary General Prof. Dorothee Dzwonnek on her visit to New York City and Washington, D.C.: At an evening presentation at the DFG Office North America (in photo with director Rainer Gruhlich), she addressed a hundred guests on "The Internationalisation of Excellence: German Science Policy and Perspectives for German-American Cooperation" and called for a transatlantic partnership that leveraged and continued the impetus of Germany's Excellence Strategy. In a series of research policy meetings, including meetings with the other research organisations in the German House and the director of the National Science Foundation (NSF), France Córdova, she discussed issues relating to early career support, equal opportunity and the special importance of international cooperation in research.

Research Marketing

Two-day forum in Berlin and four award-winning proposals in ideas competition

What are the ingredients of good international research marketing? At the end of May 2018, 140 practitioners came together in Berlin at the invitation of the DFG and the Research in Germany initiative. "In a dense research landscape like Germany, with nearly 450 universities and more than 1,000 public research institutions, it's difficult for an individual institution to build a unique profile," said DFG Secretary General Prof. Dorothee Dzwonnek, highlighting one of the basic problems.

Illustration: DFG/Himsel

The four deserving winners in the ideas competition not only succeeded in projecting an individual profile but also offered a coherent overall proposal. The winning ideas, which were awarded €100,000 each, were submitted by Forschungszentrum Jülich, the University of Münster and the University Alliance Ruhr. The special start-up prize of €75,000 went to the German Sport University Cologne.

www.dfg.de/dfg_magazin/internationales/180529_foma_forum (available in German only)

Alexander Beck, Ulrich Klein and Harald Lesch

Messages from the Universe

Astrophysics: Our home galaxy, the Milky Way, and all other galaxies possess huge magnetic fields. To understand their formation and development, researchers are using a combination of radio telescope observations and numerical computer simulations. This approach is pushing the frontiers of knowledge.

An impressive core station, known in Dutch as the "Superterp". Installed here are antennas for the low-frequency range of 10 to 80 MHz (scattered squares) and the higher frequency range of 120 to 250 MHz (geometrically arranged dark squares).

Illustration: ASTRON, Dwingeloo/NL

The luminous matter in our universe, and therefore all stars and galaxies including our Sun and the Milky Way, are made up almost entirely of charged particles: negatively charged electrons and positively charged ions. This ionised gas is known as a plasma. The ancient Greeks identified the four basic elements as water, air, earth and fire. Plasma corresponds to fire because it is hot, gives out energy, and constantly changes its shape. For astronomers, plasmas are especially important because their magnetic fields accelerate charged particles in a way that causes them to emit radio signals. These signals can be detected on Earth with the help of huge radio antennas.

One such receiver, the Effelsberg radio telescope in Germany's Eifel region, measures an incredible 100 metres in diameter. By tuning in to the cosmic electrons, we can listen in to the unencrypted news headlines from space. They have stories to tell about mysterious, powerful fields beyond the Earth. For instance, we have discovered that all galaxies, including our home galaxy the Milky Way, possess their own huge magnetic fields measuring thousands of light-years across. The desire to understand the origin of these fields has led scientists into unexplored abysses of space and time and to the very limits of knowledge. Cosmic magnetism is a very young area of research.

The development of galactic magnetic fields agrees with the well-known laws of electrodynamics. But how do galaxies turn electric currents into magnetic fields? Astrophysicists believe that the laws that hold true on Earth apply everywhere in the universe. In this sense, astrophysics is "Earth-based" physics applied to the cosmos as a whole. If galaxies really do have large magnetic fields, then they must represent a kind of giant electric circuit, huge electric motors in which magnetic fields are generated.

Continuing with this metaphor, humans are like cosmic electrical engineers. In fact, complicated movements of plasma within a galaxy produce extremely intricate electrical pathways and therefore swirling, interwoven magnetic fields. This process, which partially converts the kinetic energy of the plasma

Measuring 100 metres in diameter, the Effelsberg radio telescope in the Eifel is one of the largest radio telescopes in the world.

Illustration: WikiCommons / Schmitz

Radio signals from the active galaxy M87, detected with LOFAR (Low-Frequency Array) at 140 MHz. Two jets of relativistic particles are being ejected from the centre of the object, which contains a massive black hole.

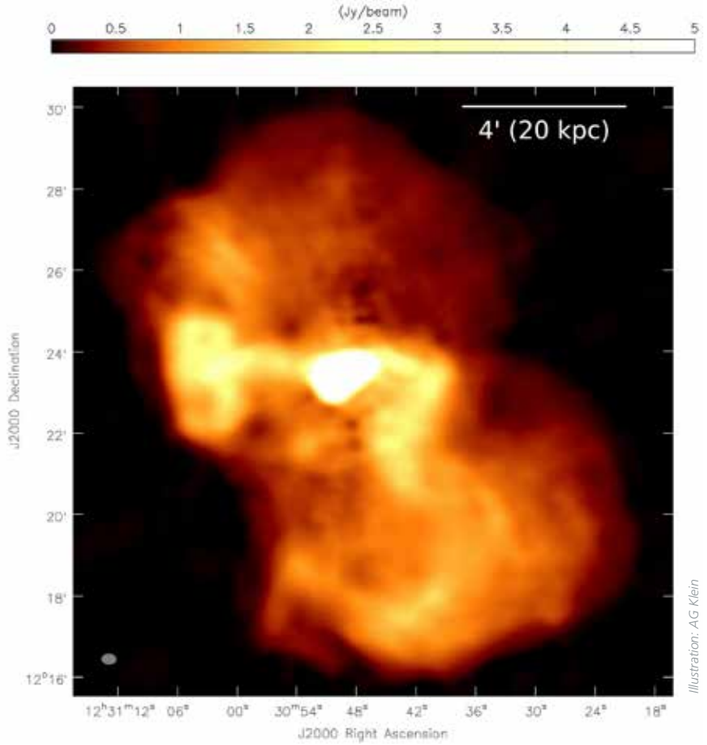


Illustration: AG Klein

into magnetic energy, is known as a "galactic dynamo". But the magnetic field lines seem to have a will of their own – they resist movement and appear to writhe in protest. As a general rule, the greater the magnetic energy, the more resistant the field lines become until they start to subdue the plasma. Like an animal trainer, the magnetic field tames the unruly gas.

The development of the fields can be described using equations from magnetohydrodynamics. The plasma is viewed as a fluid of charged particles, saturated with electromagnetic fields. On Earth, one application of this theory is the design of nuclear fusion reactors. Magnetohydrodynamics is so good that in 1970 the Swedish physicist Hannes Alfvén received the Nobel Prize for Physics in recognition of it.

But why are the movements of plasma so complicated? The answer involves gravity, the "queen of forces", which always exerts attraction. Gravity calls the tune to which all matter in the universe must dance. It determines the movement of planets around stars, of stars within galaxies, and even of galaxies within galaxy clusters. The cosmic plasma must also obey this force, which draws it out of the depths of space into the galactic maelstrom. In the process the plasma becomes so fast that it rolls over itself, becoming turbulent and creating apparently chaotic eddying patterns.

Magnetic fields play an essential role in the development of the universe, for example in the birth of new stars. Only quite recently did physicists begin investigating the low-frequency radio range, and it was only in the early 1990s that new observation stations went into operation. The most successful project of this type is the Low-Frequency Array (LOFAR) designed in the Netherlands, which is now networked with stations in other European countries.

LOFAR observes in the lowest frequency range of 10 MHz to 240 MHz and is fundamentally different from traditional radio telescopes in that it consists of thousands of electronically connected antennas installed in the ground. Instead of rotating and tilting the antennas, the direction of observation is controlled by varying the phase between the various dipole fields. The signals are transmitted via broadband Internet link to a central computer installed in Groningen (Netherlands).

You might wonder how particles, in our case electrons, can achieve such high energy levels that they move at close to the speed of light. This happens because of the shock waves of supernovae and their remnants, which propagate at high speed through our galaxy. This propagation continually takes place at different points in the interstellar medium, such that the basic components of cosmic radiation, electrons and protons, are constantly

accelerated back and forth, becoming faster all the time. Due to their greater mass, the protons produce little radiation; the radio signals are emitted by the electrons.

Another diagnostic tool is the direction of oscillation of the radio waves. By measuring the oscillation direction, radio astronomers can determine the orientation of the magnetic field. To this is added another physical effect known as the Faraday rotation. When a polarised wave passes through a region with a magnetic field which also contains a plasma, the wave's direction of oscillation is rotated. When this happens, the receivers need to be adjusted to achieve maximum amplitude, just like the antenna of a traditional portable radio.

This enables us to detect magnetic fields in the vast expanse of the universe over a wide frequency range of the radio astronomy "window", from about 10 MHz to around 40 GHz. LOFAR makes it comparatively simple to detect the radio waves, which are very intense at low frequencies, and also reacts very sensitively to the Faraday effect due to the long wavelengths. These fields are millions of times weaker than the fields produced by bar magnets.

Armed with this new perspective, in 2010 a DFG Research Unit was set up to investigate "Magnetisation of Interstellar and Intergalactic Media – The Prospects of Low-Frequency Radio Observations". The research group brought together the expertise of eight university and non-university institutes in Bonn, Bochum, Garching, Hamburg, Munich and Tautenburg.

However, LOFAR is not the easiest instrument to use. At LOFAR frequencies the strongest radio sources are so bright that they contaminate weaker ones. Some very clever algorithms are needed to eliminate this effect. Once a clean radio map of the target object has been produced with the help of LOFAR, the next step is the analysis and astrophysical interpretation of the data. Young and experienced researchers work together to create numerical simulations which are then compared with the observed objects.

This is where things start to get really interesting. The researchers compare the observations from the radio sky with the "observations" generated by the numerical simulations performed by powerful computer clusters. They try to incorporate "as much physics as possible" into the simulations. This means firstly the matter that occurs in different forms: the predominant

Comparison of the observed (left) and simulated (right) radio maps of the colliding galaxy system NGC4038/39. The magnetic field orientations are shown in each case, indicated by the yellow and black lines respectively. The similarity between the observed and simulated data is striking.

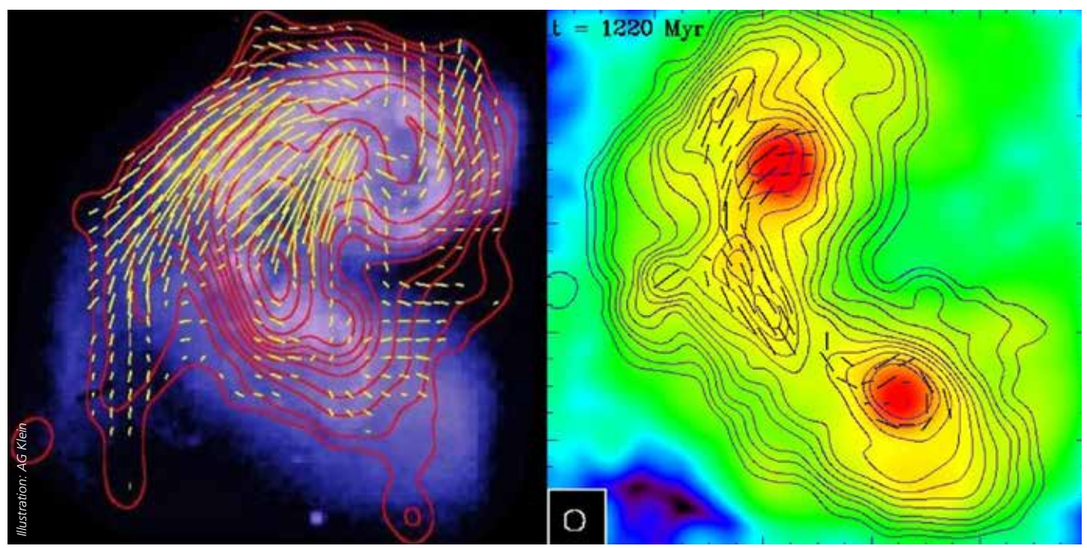


Illustration: AG Klein

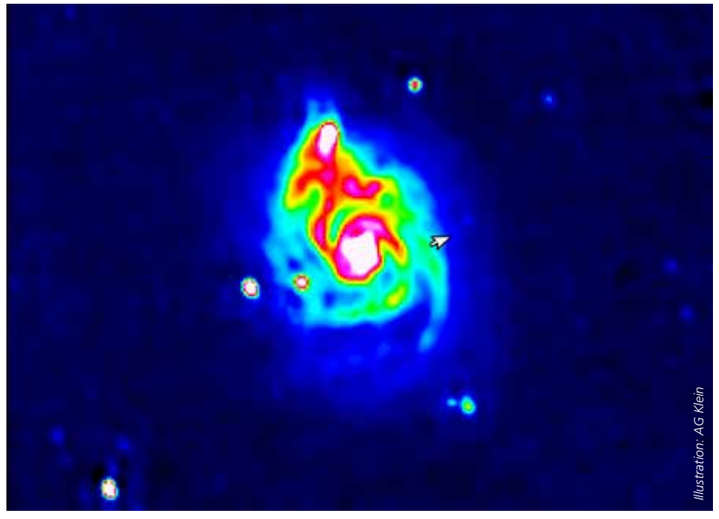


Illustration: AG Klein

Spiral galaxy M51, imaged at a frequency of 151 MHz with LOFAR. The strongest radio signals (white) are emitted from the centre of the galaxy and its satellite galaxy (north).

dark matter, the nature of which is not yet understood; the 100 billion or so stars in the Milky Way and other galaxies; the interstellar matter (the gas between stars) dominated by neutral and molecular hydrogen; the ionised gas in areas of star formation; and cosmic radiation, the high-energy protons and electrons moving at close to the speed of light. Next, the interactions between the different types of matter must be taken into account, which involves reproducing diverse heating and cooling processes as realistically as possible. In this way, astronomers can "construct" individual galaxies together with their radio emissions and compare them with real observations.

This technique makes it possible to create large magnetic field configurations which are then compared with observations. Like stars, dark matter – which scientists believe does not interact with "normal" matter (baryons) – only obeys its own gravitational field. But the gas, and especially the magnetic fields, experience the electromagnetic force, and this is where the magnetic fields play a very special role. Because they are associated with the gas which is widely distributed in galaxy clusters, they act as a "moderator" for structure formation.

Current research into cosmic magnetism is still forging ahead into the unknown darkness of space. Magnetic fields seem to abound even in plasma and between galaxies. The origin of these fields is an enigma, because so far we have found no sources for magnetic fields at these unimaginably large scales. Where do the field lines come from? No one yet knows.

In recent years the DFG Research Unit has made new contributions to this question, partly through active involvement in LOFAR and partly through pioneering work with numerical simulations that model magnetic field structures and radio emissions of galaxies and galaxy clusters. This research also lays the foundations for effective use of the Square Kilometer Array (SKA), a planned network of thousands of different telescopes with stations in Australia and South Africa. This revolutionary technology will add further to our scientific understanding and open another window on the magnetic cosmos, allowing experimental and theoretical astrophysics to advance hand in hand into the unexplored vastness of space. Cosmic magnetic fields are an area of research with immensely promising future prospects.

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Prof. Dr. Harald Lesch
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www.astro.uni-bonn.de/en

Thomas Niendorf, Florian Brenne and Johannes Günther

Endless Possibilities

From plastics to ceramics, additive manufacturing – better known as 3D printing – is possible with almost any material. For various metals, materials scientists are now demonstrating that the possibilities are even greater than previously thought. Using optimised local process design, they are seeking to achieve tailored material properties.

Nowadays, everything begins with the computer. By using specialised software, designers and engineers can develop the shape of a component such that it is perfectly adapted to the application requirements. The engineers are of course also keeping an eye on technical properties and costs of production. However, in traditional manufacturing processes such as turning, milling, drilling and casting, the product design is always subject to the constraints of the particular production process. Now, thanks to 3D printing processes, these constraints can be overcome. The principle of "design for manufacturing" is now being replaced by "design for function" – a huge innovation.

Solutions to known or new engineering problems no longer have to be a compromise between manufacturability and functionality. As a result, new solutions can be achieved, creating products with minimal weight, maximum resource efficiency or additional functionality. The products may even turn out to be cheaper than their conventionally produced counterparts. These new possibilities are in demand in many areas of industry: not only the biomedical and aviation sectors – currently the main drivers for application of printed components – but also the automotive and jewellery industries are showing great interest in 3D printing technologies.

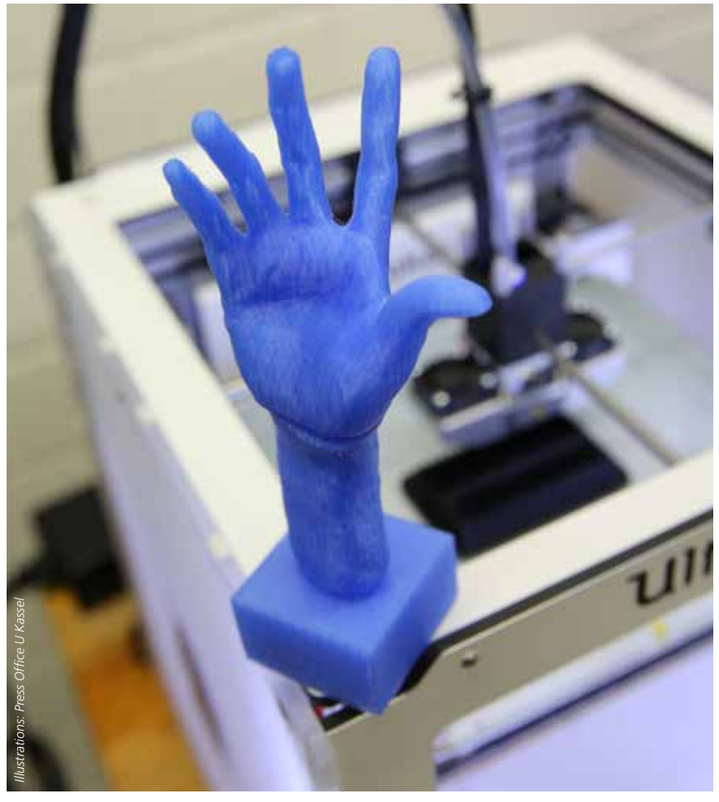
This gives wings to the imaginations of researchers, prompting them to create an almost unlimited range of geometries from the very large to the minuscule, on a scale smaller than millimetres. All that is required is a 3D printer. With this, almost any material can be used, from plastics to metals and even ceramics. However, a specialised technology and a specialised system has to be used for each material. In particular, the technologies of metal processing have recently progressed by leaps and bounds. Once the system capabilities for the additive processing of metal powders were enhanced, further applications emerged.

This is the point at which engineering research in materials technology comes into play. The fact that geometry and material are created simultaneously during the printing process, and both influence one another, is a challenge and likewise an opportunity. In consequence, the quality and reliability of a printed structure are related to the material state and geometry in a much more complex way than is the case with conventionally manufactured parts. Due to the very small local melt pool, the metal powder melts and solidifies extremely quickly, resulting in material states which are not possible in conventionally produced structures. The energy source used to melt the powder is a crucial factor – in addition to the widespread laser technology, printers equipped with electron guns are also employed. This enables researchers to create new, special material states.

In order to influence and evaluate the properties of a component, the researchers must take into account every stage of the 3D printing process. From the quality of the precursor powder to the process parameters used for melting and any post-treatment that may be needed, they must be able to track the impact of every factor on the overall structure. The "human factor" is one of these. The processes involved in additive manufacturing still demand minute attention to detail and in-depth expertise – with the result that the properties of the finished part may bear the "fingerprint" of the human operator.

The Emmy Noether independent junior research group "Functionally Graded Structures from High Manganese Iron Based Alloys – From TWIP Effect to Superelasticity"

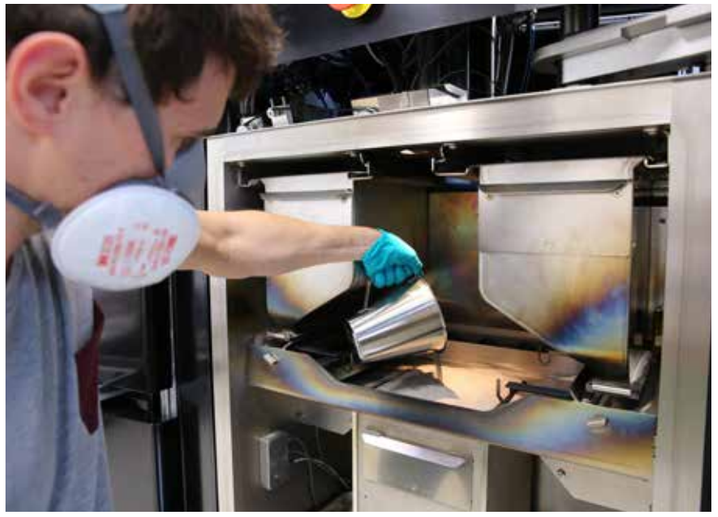
Left: After the electron beam melting process, components are normally removed by hand. The often highly complex structures must be released from a pre-sintered powder cake using blasting processes. Below: This hand was made from a polyamide using fused deposition modelling.



Illustrations: Press Office U Kassel

focusses on the interactions between process parameters in the 3D printing process, the microstructure (the internal structure of the metallic material) and the mechanical properties of the component. One of these properties is the strength of the material, which determines for example the maximum resilience in the event of a crash. Another mechanical property of interest is the so-called damage tolerance, the resistance of the material to the propagation of cracks.

The researchers use a wide range of methods to study the microstructure and mechanical properties of the metals in detail. The internal structure of the materials is examined with different microscopes. This provides information about the structures down to a scale of nanometres, much smaller than the diameter of a hair. These structures are crucial to the fundamental properties of a component on the macroscale – the level of the actual component size. Studying the microstructure of additively manufactured parts gives researchers valuable information about the expected properties. Thus, for example, by controlling the process parameters in additive manufacturing it is possible to control precisely the solidified structure of the materials. A range of structures is achievable, from fine-grained states of very high strength to almost single-crystalline, temperature-robust structures.

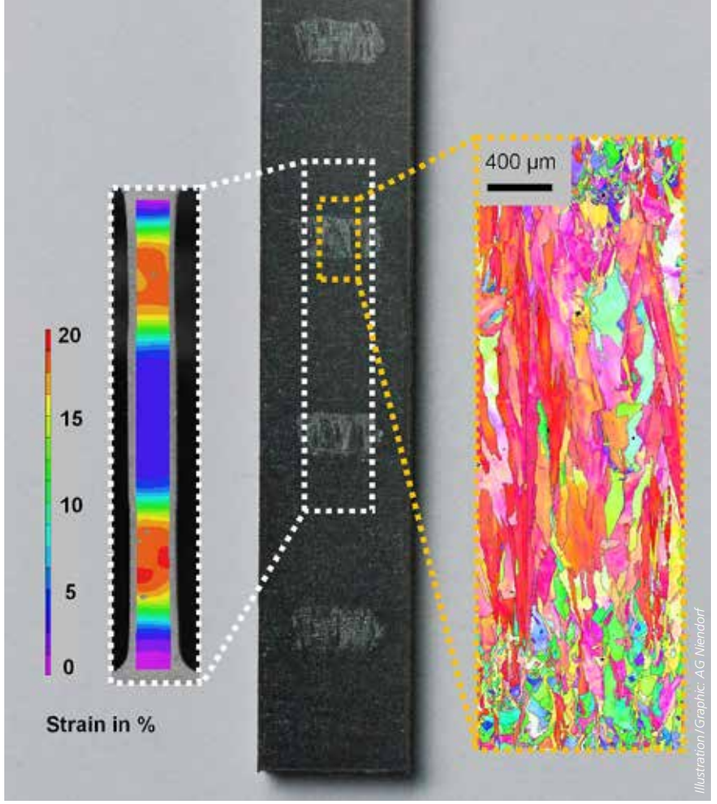


In many additive manufacturing processes, very fine metal powders are fused to form highly complex structures (above). This makes it possible, for example, to create extremely light support structures for aircraft or custom-made implants for a patient (below).

Illustrations: Press Office U Kassel

This allows the properties of a metallic alloy to be tailored to the specific application. Because all microstructural conditions can be obtained on the basis of just one powder and using a single printer system only, different microstructures can be adjusted in specific locations of the part. A component can even be given a microstructural barcode which is not visible from the outside. This makes it possible to integrate copy protection features in a component, which are only detectable if the customer knows exactly where they are located.

By applying this kind of "microstructural grading", strength and ductility can also be locally adjusted, so that in the event of a sudden impact the component is deformed like a concertina without failing. To investigate this, the researchers use a deformation apparatus combined with imaging techniques. This allows them to understand in detail how the material and component behave under deformation, enabling them to then implement a weight-optimised adaptation of the structures, for example.



Illustration/Graphic: AG Niendorf

A metal bar (centre) manufactured with different laser sources, featuring multiple transitions between a fine and a coarse microstructure (right). Under loading, greater elongation occurs in areas of the coarse microstructure than in those of the fine microstructure (left).

For materials scientists, the numerous possibilities of additively manufactured and highly complex geometric structures aren't enough. Their aim is to design and realise materials with specific property profiles which can only be achieved with additive manufacturing. These could be "smart materials", which are generated from mixed powders. Because melting and solidification occur in split seconds in additive manufacturing, it is also possible to create entirely new composite materials. Thus, for example, a joint interdisciplinary research action produced the first iron-silver alloy, which could be used for a new generation of bioresorbable implants. As the alloy gradually dissolves in the body, additional surgery would not be needed, thereby avoiding any unnecessary risk for the patient.

Engineering with smart materials is a highly promising field of research. These materials make it possible to create highly complex, highly efficient actuation components, for example based on the "shape memory effect" – an effect which enables parts to switch in a controlled manner between two different forms. After deformation, these alloys can be transformed back to their original shape by simply heating them. Integrating smart materials of this type in established high-performance alloys is expected to significantly increase their damage tolerance. Although researchers do not yet have definitive evidence in support of this thesis, the first steps to making the vision a reality have already been taken. As an interim conclusion, it may already be said that not only the processing of shape memory alloys by additive manufacturing but also that of functionally graded structures has been successfully achieved. These successes promise more exciting years in basic research and open up the prospect of wide-ranging applications for new materials made by additive manufacturing.

Prof. Dr.-Ing. Thomas Niendorf
leads the Metallic Materials group,

Dipl.-Ing. Florian Brenne
and
Johannes Günther, M.Sc.
are project team members.

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www.uni-kassel.de/maschinenbau/institute/institut-fuer-werkstofftechnik/fachgebiete/metallische-werkstoffe/forschung-aktuell.html

Brigitte Benz and Benedikt Kranemann

Mourning in Public

Disaster rituals: Commemorations following attacks or catastrophes have their own dramaturgy. Varying enormously depending on place, form and message, they are directly and indirectly connected with zeitgeist, religions and worldviews. New forms of remembrance and leave-taking have now become a topic of liturgical research.

Illustration: dpa / DB Meyer pool

An attack on a train near Würzburg on 18 July 2016, a bombing a few days later in Ansbach, and a mass shooting at Munich's Olympia shopping centre left Germany in shock. These tragic events represent a new dimension of violence in the public arena. Here, as well as in other countries, it has been irrefutably confirmed that no society is safe from devastating acts of violence and disasters that claim human lives. Train accidents, plane crashes, large-scale natural disasters, shootings and terrorist attacks confront us with the limits of what is feasible and controllable. They repeatedly raise the question of how such events should be handled publicly and in the media. And they make us ask how grief and hope can be articulated when we are faced with horrifying circumstances. How do states and societies mourn the dead and grieve with those who are bereaved by disaster?

In recent decades, the character of commemoration following disasters in Germany has changed. German society has become more plural, due not only to a growing Muslim community but above all to the growing number of people who profess no religion and follow various worldviews and beliefs. Media coverage of disasters – and therefore the extent to which large sections of society are affected – and also of the mourning of the dead has grown considerably, especially on TV and on the Internet. Because large sections of the population are affected after a disaster, state

Mourning the victims of the Erfurt school shooting: On 3 May 2002, thousands attended the central memorial service in the shadow of the cathedral. The service of remembrance took place beneath a large cross, visible from a distance.

and society are called upon to agree on appropriate forms of mourning and remembrance that can find social consensus. In particular, new reflection is required on the role played by churches and faith communities.

These questions are being investigated as part of a DFG-funded liturgical research project in the Theological Research Seminar at the University of Erfurt. Behind such memorial services, usually imperceptible to the public, is a system which has been established since the school shooting at a secondary school in Erfurt on 26 April 2002, involving emergency counselling, the Federal Ministry of the Interior's office for crisis care and support for victims and families (NOAH) and the various state chancelleries. The latter normally ask churches to participate in the organisation of a memorial service, comprising a state ceremony and a religious service, in which the churches are responsible for arranging the religious element. This is not a service of worship for church members, but rather a service of remembrance designed for the members of a plural society.

Why are churches assigned this responsibility? With what rites and rituals do we remember the dead today? How are different worldviews and beliefs reflected in such services? And what theology is actually applied here? There is no universal script for these "disaster rituals". The act of remembrance takes a different form each time according to the social situation. The order in which the religious service and state ceremony take place, the manner in which biblical texts are selected and incorporated, how Christians, Muslims and those of no faith are involved – all of this varies by town or city and region. Whether a specific basic model for such events emerges in Germany remains to be seen.

The form of disaster rituals depends to an extent on the relationship between state and church. While in the Scandinavian countries, the long tradition of state churches until recent times has meant that these churches bear the responsibility for public mourning; in the Netherlands, secular memorial services have become more firmly established. Examples from the USA testify to a separation of church and state, but little distinction is made between spoken contributions and ritual acts by representatives of the state and of faith communities. In Germany, when a central memorial service takes place consisting of a state ceremony and a church service, there is a clear distinction between the two parts throughout the event: After the religious service is concluded, the church representatives leave the focal area of the church, and the state ceremony is then led by representatives of the state. The change of role and performance is clearly marked.

In the Church of Our Lady in Dresden: Memorial service for the victims of the shooting in Munich. Symbolically used ceremonies with burning candles also play a prominent role in secularised society.

Illustration: Sebastian Widmann / www.bundespraesident.de

Between candles in front of the Albertville school in Winnenden, the scene of a mass shooting by a 17-year-old boy, a handwritten note reads: "Why must something like this happen???? Weapons should be destroyed!!"

Illustration: dpa / Bernd Weißbrod

Unlike the church services of a parish, services of this type cannot rely on a fixed repertoire of symbols, songs and texts. What kind of communication do we see in response to a disaster in a plural society? A theological research project is especially concerned with how religious beliefs, including notions of God and the problem of theodicy, hope, grief and lament are expressed for a heterogeneous public. The researchers on the project are studying the ritual forms and language in which different views of the world are expressed and investigating the reasons for success or failure.

One symbol, evidently capable of finding social consensus, has become especially dominant in recent decades: candlelight. Candles are usually lit for individual victims and then burn as a symbol for the dead. The burning candles may be arranged in very different ways: frequently opposite the mourners, so that the dead are remembered as it were in the view of the living, or, as in Cologne Cathedral at the service for the victims of a plane crash, in the middle of the church, making clear the community of the living and the dead. The individual is free to choose how to interpret this light: as a symbol of remembrance, an expression of presence, or perhaps an experience of light in a dark situation. These interpretations represent the openness of such rituals, which may be understood in different ways. They are therefore especially well suited to public memorial services.

However, tensions remain. Can and should a candle be lit for those who are directly or indirectly responsible for a disaster? So far, different choices have been made in different places. On the one hand, it is emphasised that a perpetrator does not lose their humanity as a result of their act, but on the other hand there is respect for the relatives of the victims, who generally oppose such a symbol for the perpetrator. Theologically, the belief in the unchanging acceptance of every individual by God plays a role. Here, another feature of these rituals can be observed: Although they make use of recurring elements, they are ultimately negotiated locally and depend on the specific situation.

For such services, people seek symbols and rites that permit a sense of community in mourning. The places used for acts of remembrance are also significant. Church

Illustration: Carschten / Wiki Commons

At the 2010 Love Parade in Duisburg, 21 people died and 541 were injured, some seriously. The shock and grief remained publicly visible for a long time.

spaces are normally chosen, from small local churches to the cathedrals in Cologne or Berlin. This held true even after the train accident in January 2011 near Hordorf in Saxony-Anhalt, in an area where most of the population has no religious affiliation. The dead were commemorated in Halberstadt Cathedral. One exception was the memorial service in Erfurt, which was attended by 100,000 people and took place in the cathedral square in view of the Cathedral and the church of St. Severi. The square itself has symbolic significance: Although the two church buildings are the most dominant features, it is also a public space at the interface between church and local community. At the same time it is a place used for very different types of events. The location itself illustrated the complexity of remembrance.

At these services an important role is played by the media, especially television. Through TV, viewers far away from the locality of a disaster can be part of the community of mourners. This enables a society to experience solidarity in the face of a disaster. Without broadcasting, the reality of public memorial services would be completely different. The televised image also presents a highly filtered impression. There are good reasons for this. For example, grieving relatives are not shown and camera operators and photographers can only move within a defined radius.

However, the commentary places emphasis on selected actions or participants. A person in situ and the television viewer gain different impressions of a memorial service. For example, many people in Cologne Cathedral would not have realised that a short prayer was given by a Muslim woman. However, this inter-religious moment was brought out by the television commentary, without which it would not have been particularly visible. In Cologne, the sermon given by Cardinal Woelki and a cross were combined using image technology, significantly altering the effect of the address.

In other words, these are memorial services for the public for which the churches take responsibility. For a theological research project, these services are interesting in that they show churches in a new role and as actors within and for a religiously plural society. In this respect, disaster rituals reflect the way in which not only churches, but also society and state understand their own roles.

What will such memorial services look like in years to come? "Rite design" is not part of the remit of a research project, but the accurate description and systematic analysis of various ceremonies in the present and from a historical perspective can raise awareness of both opportunities and problems for society and faith communities. The aim is to develop criteria which must then be critically examined and further developed in collaboration with scholars in the humanities and social sciences. In an increasingly diverse society, reflection on disaster rituals is of growing importance.

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Illustration: Shutterstock

Tackling the Tower of Babel

Medical informatics and digitalisation: The Portal for Medical Data Models, a DFG-funded research infrastructure, makes a set of 15,000 medical questionnaires available online, contributing to improved transparency and standards in medical research.

What symptoms are you experiencing?", "How long have you had the pain?", "Are you taking any medication?" We've all answered questions like these at one time or another, whether at the doctor's office or in a hospital. Some of them might have you scratching your head in puzzlement. Why is Mr. Müller, who arrives in the emergency department with a torn ligament, asked about the gender and age of his four children?

Often, the medical history forms filled out by doctors and nurses also contain too many questions and take up too much time. The format, content and length of documentation forms vary from one institution to another, even in routine documentation, and for the same conditions and patient groups. An average of 200 to 500 data items are collected per patient, and even more in clinical studies. And even if hospital A collects the same information as hospital B for, say, a particular type of cancer, there is no way of automatically combining and evaluating this data, because the questions are worded differently. For example, does the word *Größe* refer to the patient's height or the size of the tumour?

"A good metaphor to illustrate this problem would be the Tower of Babel," says Prof. Dr. Martin Dugas from the Institute of Medical Informatics in Münster. "Advances in medical research are being held back because a lack of standardised data models and different information systems are failing to exploit the potential for growing digitalisation. We need more transparency and we need standards."

In the Portal for Medical Data Models (MDM), standardisation is achieved by coding the content of individual forms. This is done using the Unified Medical Language System (UMLS) developed by the U.S. National Library of Medicine. For example, the data element "height" is given the code C0005890, which applies regardless of language or system.

With the help of clinicians, a team in Münster has painstakingly annotated over 15,000 forms containing some 370,000 data elements with 1.5 million UMLS codes and entered them into the portal. Most of the content is available in German and English, some of it in up to 50 languages, and it can be exported in 18 different technical formats.

For the first time, it is now possible to compare frequently used data models for particular areas of disease, not only nationally but internationally. This allows the content of questionnaires to be reduced to a minimum while establishing standards.

"The future development of health research and patient care will depend on the extent to which we can exploit the enormous possibilities offered by digitalisation," says Dugas. "This will only happen if we can share research and clinical data across institutions. The MDM portal is a good example of this strategy in action." **RU**

https://medical-data-models.org/?lang=en

Rembert Unterstell

#Smartphone Communities

WhatsApp, Snapchat and Pokémon GO: Konstanz-based media researcher and Heinz Maier-Leibnitz Prize recipient Isabell Otto is studying modern digital media from a cultural studies perspective / Media and participation between demand and entitlement

Illustration: Unterstell

If we were in an airport, this would be the "passenger lounge with a view". In fact we're on the outside terrace of the cafeteria at the University of Konstanz, which offers a magnificent view over Lake Constance. There are wooden benches and tables at which to linger and behind the terrace rises the modern concrete building, once a Reformuniversität and now a University of Excellence. It's a pleasant spot for conversation.

But the contemplation of the view down to the island of Mainau will have to wait, because on this summer's evening I have an interview with media researcher Prof. Dr. Isabell Otto. Wearing a white cotton shirt and a blue blazer, with shoulder-length red hair worn in a braid, she plunges straight in. She knows how to talk snappily about her work. For her it's the end of a long day at the summer school of the DFG Research Unit "Media and Participation". A recipient of the Heinz Maier-Leibnitz Prize in 2016, with a way of speaking that is at once focussed and straightforward, she represents an approach to media studies which is strongly influenced by cultural studies. As she emphasises later, she is not intimidated by the fact that she is engaged in "radical contemporary research"; on the contrary, she sees the dynamism and openness of her objects of research as a bonus.

It's soon apparent that this is someone who can juggle several things at once – with skill yet with no hint of showing off. At the moment she is juggling names like Facebook, Twitter, Snapchat, WhatsApp, selfie technologies and Pokémon GO. Otto studies digital apps and social media platforms as a component and an expression of digital media culture. She is primarily interested in smartphone communities and "participation as a promise and an imposition". It's obvious that she feels strongly about her topic.

Promise and imposition? The ubiquitous smartphone is far more than just a digital phone: for many, it's a window on the world. For digital natives, to use a cautious formulation, it's a major part of their lives. A smartphone promises community life, with likes, Facebook friends and followers, but also presents the threat of cyberbullying and hate speech. But how do "mobile, digital communities form via smartphone operations and the sharing of messages, photos, videos and geodata?", asks Otto. For her, smartphone communities are not social structures that can be empirically mapped, but temporary communities that form, transform and dissolve. Essential to this perspective is a process-based understanding of community. She therefore analyses interactions between smartphone and user and between users and community.

"Social Network" – installation by sculptor Peter Picciani in the exhibition "Hamster Hipster Handy. Im Bann des Mobiltelefons", shown at the Museum Angewandte Kunst, Frankfurt/Main, 2014

Illustration: dpa/Christoph Schmidt

Born in 1976 in Freiburg, Otto's first interest was in theatre, acting and directing. In 1997 she began studying theatre, film and television studies in Cologne and Paris, before going on to write a master's dissertation on "Games Without Boundaries" (Entgrenzte Spiele). She became a research assistant at the University of Cologne, collaborating on a number of projects in the research group "Media and Cultural Communication" and the Research Training Group "Locating Medias" in Siegen. She earned her doctorate in Cologne in 2007 with a study drawing on discourse analysis. In 2010 she was appointed junior professor in Konstanz and in 2015 she accepted a professorship in the Research Unit "Media Participation in Digital Cultures".

In her ambitious dissertation "Aggressive Media. The History of Knowledge of Media Violence" (Aggressive Medien. Zur Geschichte des Wissens über Mediengewalt), she tackled the controversial issue of whether portrayals of violence in the media can contribute to violence in society – a question that always prompts speculation after any attack or mass shooting. Reviewers have praised her use of discourse-analytical methods to reconstruct lines of development and argumentation in and through various media, namely television.

Isabell Otto is obviously a networker, both as a researcher and as an individual. For example, she established the DFG network "Media of Collective Intelligence" and chose for her habilitation thesis the topic "Age of Networking". For this she opted for a process-philosophical approach to decode "Orders of Time Under the Condition of Digital Media" (Zeitordnungen unter der Bedingung digitaler Medien).

Networking and temporality, participation and community, cooperation and distributed intelligence have been the cornerstones of her work so far. In the winter semester 2017/18, her research professorship became a full professorship following an offer from Freiburg. This, too, she reports matter-of-factly. She explains how, in her habilitation lecture, she dealt with the topic of "Migrant Smartphone Communities", addressing the role played by smartphone communication for refugees and family members left behind. – Now we have a little time left to contemplate the view over Lake Constance.

Otto quotes a dictum by Claus Pias, a media theoretician at Lüneburg, who said that the media researcher's job is "not to look at the picture, but at the frame". That's how she sees her job, she explains – understanding the "interaction between framing and unframing" and gleaning new insights from it with reference to complex media practice and the conditions in which it takes place. You don't have to be clairvoyant to know that the digital age will bring more major transformations. Ten years ago, no one predicted the triumph of the smartphone and certainly no one anticipated that it could become a motor of the digital transformation. Looking through the lens of cultural studies, Isabell Otto shows us how digital media "configure" and "are configured" in a broader and a deeper sense – and thus shape the everyday lives of many of us.

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

Dieter Willbold and Silke Hoffmann

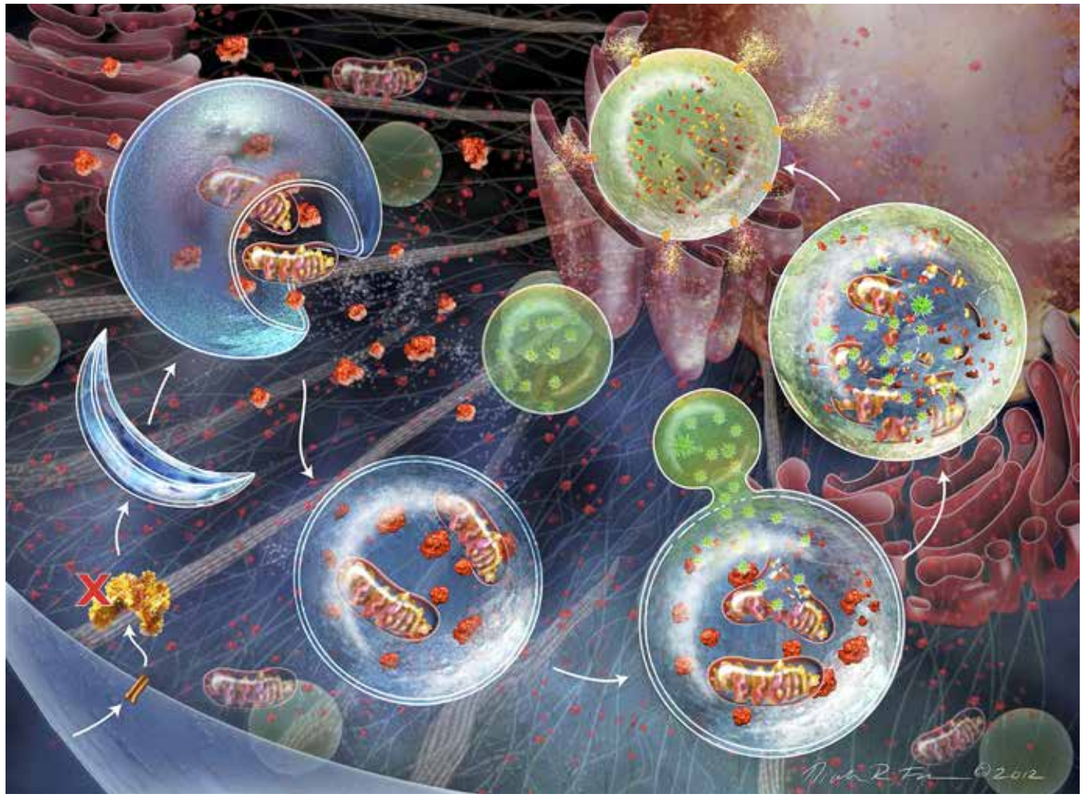


Illustration: Science Photo Library/Nicolle Fuller

Unravelling the Secrets of a Virus

By studying HIV infection, structural biologists are seeking to understand the interactions between the disease-causing virus and its host. Will this result in new treatments? At the very least, it is shedding new light on fundamental cell mechanisms.

Viruses are masters of manipulation, accomplished shapeshifters, and true minimalists. Although they are capable of being extremely successful, they do not have their own metabolism or the ability to replicate by themselves. They are minuscule organisms, measuring from around 20 to a few hundred millionths of a millimetre across, and they live as parasites. When they infect a host, the host involuntarily makes up for what the virus itself lacks. For the host, a virus may be not just a severe annoyance but even deadly.

But viruses are choosy, and they normally only attack particular types of cell. For example, the human immunodeficiency virus type 1 (HIV-1) requires special "markers" in the form of surface molecules such as CD4 on the target cells. These are found on certain immune system cells. You might be tempted to think that HIV-1 mostly only damages the cells it can infect – but you'd be utterly wrong. This is because immune cells are "talkative" and in constant communication with their surroundings by releasing substances called messengers. They are also highly mobile, circulating throughout the entire organism. An acute HIV-1 infection causes a "mass panic", destroying immune cells that cannot be directly attacked by the virus. This develops into acquired immunodeficiency syndrome (AIDS), which is associated in the later stages with neurocognitive disorders.

A virus-host interaction refers to the points of contact between a virus and its host and vice versa. When we consider the small number of components that the virus brings to the relationship, we might expect a straightforward, easy-to-understand network of interactions. But once again the truth is a good deal more complicated. There is a good reason why there is still no cure in sight even so many years after HIV-1 was first described in 1983. Around the world, 37 million people are currently living with HIV-1. Only around half have access to antiviral treatments, and in 2016 alone HIV claimed approximately 1 million lives.

The HIV-1 genome, which consists of just nine genes, contains the information for less than 20 proteins – about a thousandth of the protein molecules encoded in the human genome. These include the proteins needed to build the virus particle and catalytically active molecules that mediate reactions for which the host does not provide the cellular molecular machinery. The "viral construction kit" is completed by an array of regulatory and accessory elements, which among other things possess a varied range of strategies to withstand the host's cellular defence mechanisms.

In cell culture model systems, the accessory proteins are not necessary to viral replication. Here, the virus only has to cope with a single infected cell rather than the whole host organism and its immune system. However, the accessory proteins play a crucial role in successfully infecting the host organism. One of them is known as the negative factor or Nef. Patients who carry virus isolates with an absent or faulty Nef gene belong to the group known as "long-term non-progressors" (LTNPs), who may be infected with HIV-1 for decades without developing the symptoms typical of AIDS. Nef is therefore essential to the pathogenicity or disease-causing effect of HIV-1.

In terms of its structural biology, Nef is a flexible, transformable protein, adapted for interaction with a variety of other proteins. This multifunctional protein is therefore often described as a "master manipulator". Equipped with a lipid

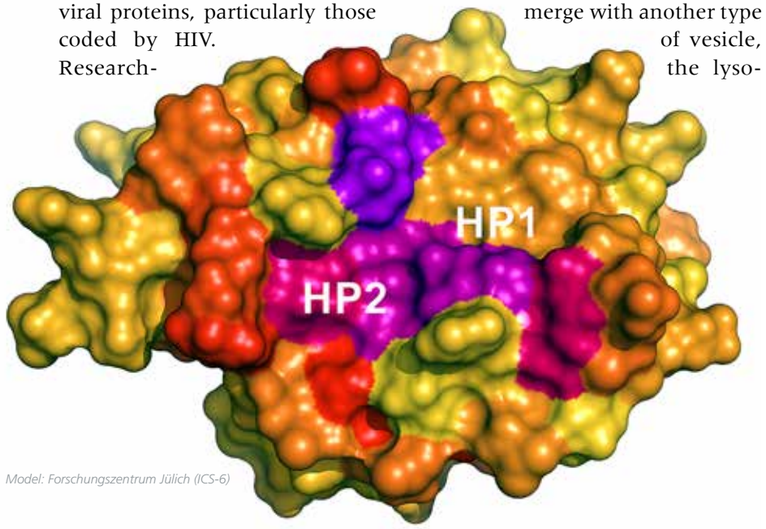
Illustration: Forschungszentrum Jülich (ICS-6)

Left: Artificially coloured illustration of autophagy, the cellular waste and recycling system. Right: 900 MHz NMR spectrometer at the Biomolecular NMR Center in Jülich.

anchor, it has a tendency to dock to membranes. What is especially interesting is the changes that Nef triggers in the surface receptors covering the plasma membrane and the immense increase in the release of extracellular vesicles (exocytosis). These lipid-encased packages are also absorbed by cells that cannot be infected by HIV, taking Nef and its building instructions, the Nef-coding messenger ribonucleic acid (mRNA), to all other cells. This causes various surface molecules to disappear and fools the host organism's immune defences.

The basic molecular mechanisms involved in this process are not yet well understood. How does Nef efficiently reach the plasma membrane to exert its intracellular effect? How does it trigger the exocytosis machinery? These questions prompted one of the projects in CRC 1208, a research group funded by the DFG since the beginning of 2016, "Subversion of Host Cell Vesicle Trafficking: Hijacking of Autophagy-related Proteins by HIV-1 Nef". For a long time, we have been interested in accessory viral proteins, particularly those coded by HIV. Researchers at our institute, which focusses on structural biology, have also become particularly interested in neurodegeneration and autophagy. This was what gave them the idea of searching for new interaction partners of HIV-1 Nef in the brain. The idea was to identify interactions that may be linked to the development of HIV-1-associated neurocognitive disorders. So the researchers docked Nef to a membrane in a special yeast cell system and, in each yeast cell, this membrane-associated Nef was offered a different human protein as a partner. If the two proteins interacted, this was indicated by a particular stain in the yeast colony.

In this experiment, the team found a protein that could serve as a Nef interaction partner, known as GABARAPL2 (from "GABARAP-like 2"). This was an intriguing discovery, since GABARAPL2, like GABARAP, belongs to a group of proteins involved in the process of autophagy. In this process, small membrane-encased sacs (vesicles) known as autophagosomes form continuously in the cell plasma and proceed to envelop cell components which are defective or no longer required. They then merge with another type of vesicle, the lysosomes. Lysosomes contain enzymes that break down the contents into their components, making them available to the cell again in a kind of cellular recycling process.



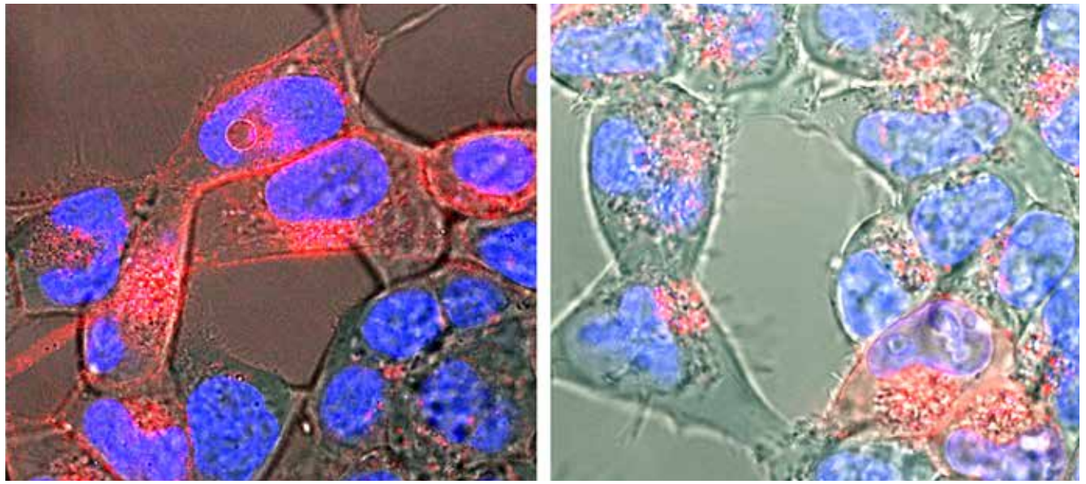
Model: Forschungszentrum Jülich (ICS-6)

Surface view of the GABARAP protein (in yellow). The positions of the "sticky" ligand-binding pockets HP1 and HP2 are labelled. The surfaces where HIV-1 Nef has made contact are colour-coded: the most affected areas are shown in magenta and the least affected in orange.

Autophagy is essential to survival. In the body's cellular production sites, new biological molecules are continuously being produced, and this results in a lot of waste: malformed, clumped or surplus proteins, defective mitochondria, products of metabolism, and lots more besides. Unless this rubbish is cleaned up, it can cause damage. It would seem that autophagy is more than just a clever recycling system. In fact, it appears to play an important role in many diseases. It is also significant as a cellular component of the immune response.

Put simply, when invaders like bacteria or viruses get past the body's first line of defence and enter the cell, the recycling system can detect them and neatly remove them from circulation. Some pathogens have evolved strategies to evade the cellular cleaning crew, for example by blocking it, and HIV-1 is among them. It affects autophagy in different ways depending on the cell type to ensure its own survival within the cell.

But there's more: HIV-1 actually hijacks parts of the autophagy machinery and exploits them. This is where the interaction between Nef and GABARAPL2 and its relatives



Illustrations: Forschungszentrum Jülich (ICS-6)

Comparison of intracellular localisation of HIV-1 Nef (in red) in the presence of GABARAPs (left) and after knockdown of GABARAPs (right).

(known collectively as GABARAPs) comes in. Once the researchers spotted this interaction, they turned their attention to the molecular mechanisms underlying it. The team had already worked out the three-dimensional structure of GABARAP using nuclear magnetic resonance (NMR) spectroscopy. They also knew what the molecule's interaction partner needed to contribute to the interaction in order to fit into its two "sticky" (hydrophobic) pockets. Since the 3D structure of GABARAP and the associated data were already available, it was a relatively simple matter to identify the contact point for Nef on GABARAP. In the cell culture system, they demonstrated that Nef needs at least one of the GABARAPs to locate the inside of the cytoplasmic membrane.

Plenty of questions still remain to be answered. How exactly do the GABARAPs help Nef to locate the plasma membrane? How does this affect what surface receptors the membrane possesses? Can Nef find its way out of the cell without the help of GABARAPs? And how exactly are the "export" packages for Nef, the extracellular vesicles loaded with the protein, formed? Do the two processes even use the same mechanism in some ways? One possibility is that the GABARAPs couple the vesicles involved in the process to the exact "mini express trains" that move along the cellular rail system, the microtubules, from the inside to the outside.

To find answers to these questions, the research team is using an interdisciplinary approach involving a range of methods from atomic-resolution 3D imaging (NMR, X-ray crystallography and cryo-electron microscopy) to cellular techniques (optical microscopy and biochemistry) and even genome editing and proteomic analysis. The findings are then evaluated in the biological system by working closely with virologists. People often ask whether this work is likely to produce new treatments for HIV-1. It may, or it may not. But what is certain is that by studying HIV-1 we can acquire fundamental new knowledge about human biology and in particular, detailed insights into the process of autophagy.

Illustration: FZJ/W.P. Schneider

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www.sfb1208.hhu.de/gruppen-und-projekte.html

Christian Montag

Illustration: © Eric Pickersgill / www.removed.social

Giving It Up

Warning, danger of addiction: nine out of ten people in Germany are now online. But the constant use of smartphones, laptops and tablets can become a problem – and not just for digital natives. Psychologists are now seeking to understand the molecular genetic background and reasons for Internet-dependent behaviour.

In our brave new digital world, the Internet and smartphones have become an integral part of our daily lives in a way which few could have imagined. They have revolutionised not only the way we communicate, but the speed with which we communicate – as well as helping us to find our way around in a strange place or find information in a flash. In spite of the many benefits of digital technologies for individual users, the economy and society as a whole, the darker side of constant Internet use is becoming increasingly visible. An academic debate has emerged as to whether there is an excess of digital consumption and how this excess impacts on the psyche.

One key question confronting researchers is this: Can excessive Internet use be understood as a form of addiction in its own right? Or would it be more appropriate to speak only of "problematic Internet use"? This term is used by psychologists and psychiatrists to refer to the symptoms recognised from traditional addiction research: constantly being occupied by thoughts of the drug (the Internet in this case), loss of control in front of the screen or withdrawal symptoms when deprived of Internet access. In addition, immoderate Internet use can lead to problems in private and professional life, including relationship issues if an individual spends more time on Facebook than with their partner or when their performance at work suffers.

In psychological diagnosis it is very difficult to speak of problematic Internet use in general terms. Studies have shown that it is necessary to draw a distinction between a generalised form of problematic Internet use and other, more specific forms. In view of this, many researchers prefer the term "problematic Internet use", as the classification as an addiction has, as yet, not been officially recognised. In this article we will use the two terms synonymously.

So what constitutes the kind of Internet use that can develop into a problem? It seems to be influenced by whether users spend their online time excessively on one or more digital channels. The specific forms of problematic Internet use are associated with addiction-like behaviour in the distinct use of social networks like Facebook and YouTube, but are also seen in the use of online pornography, excessive computer gaming or "pathological gambling" on the web. Attention has also been drawn to addictive online shopping, which is being discussed as a new issue. Generalised Internet addiction would be associated with excessive use of many of the reported channels. Another face of the problem is smartphone addiction, primarily the excessive use of apps such as the ubiquitous messaging service WhatsApp. Strikingly, Internet addiction appears to be more of a "male" phenomenon, while in the

Images from the project "Removed" by US photographer Eric Pickersgill: The absence of smartphone, tablet or game console reveals how digital devices command our attention in everyday life, even coming between partners or family members.

Illustration: © Eric Pickersgill / www.removed.social

use of WhatsApp on smartphones and social media in general, women are equally represented or perhaps even more numerous than men.

What causes Internet-related addictions? One important approach to understanding this phenomenon comes from personality psychology, where researchers are studying the traits that make a person prone to excessive Internet use. Personality traits which indicate a disposition to substance-associated addictions also appear to play an important role in problematic Internet use. One instance of this is self-control ability, which, if low, is associated with increased Internet addiction levels. Personalities with less self-control are manifested in low self-esteem, personal dissatisfaction and a lack of willpower; lower conscientiousness and negative emotions are also associated with Internet addiction.

Another approach to understanding Internet addiction takes its starting point from quantitative genetics and molecular genetics. In quantitative genetics, twin studies are used to assess the extent to which genetics and environment influence individual differences in Internet addiction. Results indicate that, although estimates of genetic predisposition vary and are influenced by numerous factors, there does seem to be a certain genetic component involved in problematic Internet use – just as with "pathological gambling" or addictions to habit-forming substances such as nicotine or alcohol.

By using techniques from molecular genetics, scientists are attempting to localise segments of the DNA to explain differences in Internet addiction. Traditional variants recognised in psychiatric (addiction) genetics also appear to play a role in Internet addiction. These are variants of genes which influence messenger substances in the brain associated among other things with emotional and cognitive processes.

One result of molecular genetics research is especially interesting: in Asia, scientists have found a genetic variant which is associated with a reduced dopamine receptor

Skype, Facebook, Twitter or WhatsApp? People feel the need to constantly choose between and "check" their digital communication channels.

Illustration: pixabay/MikeRenpening

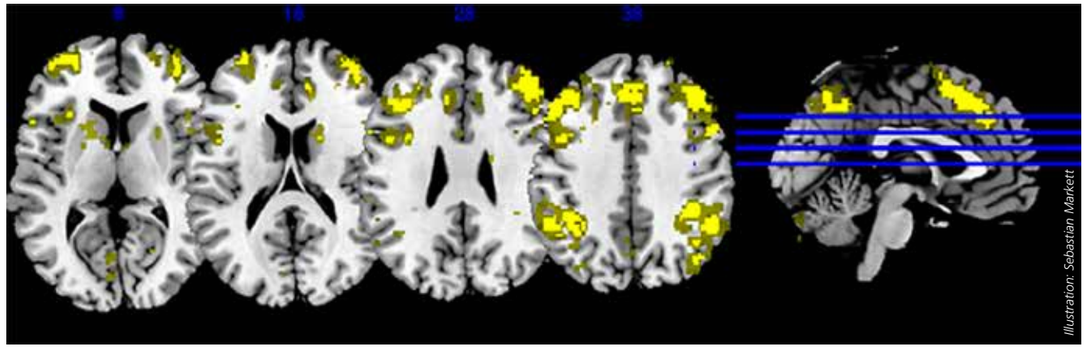

Illustration: Sebastian Markett

MRT images make it possible to track activation or inhibitions in individual areas of the brain.

density in areas of the brain that process rewards. This same variant is more frequent in individuals with Internet addiction. Dopamine is an important messenger chemical which can bind to dopamine receptors in the brain, and which is enormously relevant in addiction research. This gene variant is also known from research into alcoholism. Interestingly, another study, which used positron emission tomography (PET), suggested that people with an Internet addiction have a reduced dopamine receptor density in the relevant area of the brain. PET is a brain imaging technique that provides information about the molecular mechanisms of brain functions.

Another imaging technique, known as functional magnetic resonance tomography (fMRT), revealed overactivity in the brain's reward system when an individual was exposed to Internet-related stimuli, such as computer settings or recurring motifs in a favourite computer game. Brain areas which normally suppress the overactivated reward system show impairments while performing this task. These dysfunctions in the brain may partly explain Internet addiction.

If we combine the empirical evidence from the various areas of Internet addiction research, it becomes clear that people with problematic Internet use exhibit central dysfunctional processes in the brain. This evidence points to problematic Internet use being an addiction. However, it is still too early to reach a final assessment. There are clear overlaps between Internet addiction and conditions such as depression and ADHD, and in some individual cases the use of medication to treat patients with ADHD/Internet addiction or depression/Internet addiction has shown that, in addition to an improvement in ADHD or depression, an improvement in Internet addiction can also result. But how are these different problems connected? And is the diagnosis "Internet addiction" even necessary and relevant for treatment purposes?

When it comes to treating Internet addictions, as with other addictions, most psychotherapists currently opt for cognitive behavioural therapy. With this approach, patients are helped to break dysfunctional thought patterns. An example of such a thought pattern would be the belief "In the offline world I'm a loser, but online I'm an amazing person". However, there are also differences between the treatment of Internet addiction and traditional (recognised) addictions such as alcohol and drug dependence.

For example, total abstinence from the Internet (compared to the treatment of alcoholics) may not be the aim of therapy, as people nowadays cannot play a full part in (cultural) life and the world of work without access to the online world. So the goal of the psychotherapist is not to enable the patient to achieve complete abstinence but to learn a healthy way of interacting with the online world.

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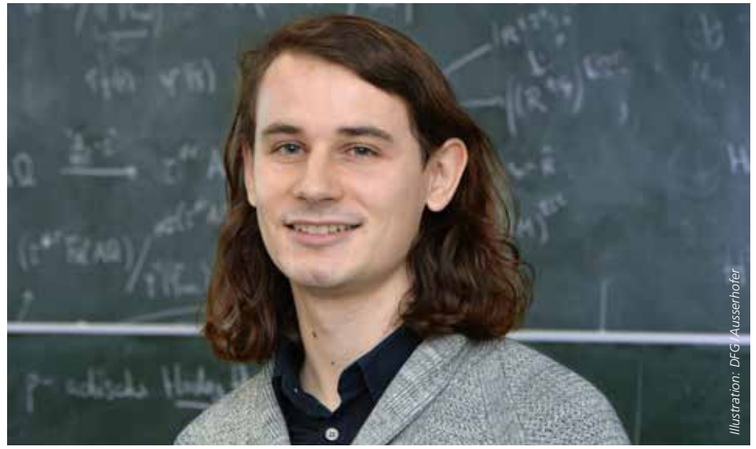

Illustration: DFG/Ausserhofer

Highest honour: Peter Scholze, a professor of mathematics at the University of Bonn and director of the Max Planck Institute for Mathematics, was awarded the Fields Medal at the 2018 International Congress of Mathematicians in Rio de Janeiro. The medal, which is regarded by many as the Nobel Prize for mathematicians, was presented to Scholze in early August "for his fundamental contributions to arithmetic algebraic geometry". DFG President Professor Dr. Peter Strohschneider congratulated the 2016 DFG Leibniz recipient, adding that the awarding of the Fields Medal confirms that "the university research landscape in Germany offers outstanding opportunities to encourage talent and scope to pursue new ideas". At 27, Peter Scholze was the youngest researcher in the more than 30-year history of the Leibniz Prize to be presented with Germany's most prestigious research award. Scholze, now 30, is one of the youngest ever to receive the Fields Medal.

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