

Cover: Niels Paul Bethe/PRISMA+
An inside view of a cryomodule, which is at the heart of MESA, a superconducting electron accelerator that will be used on completion for basic research in particle physics.

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“We’ve come a long way and accomplished a great deal together”

Katja Becker’s start in her new role as DFG President was unusual to say the least. The infection biologist talked to *german research* about her first year in office, discussing not only the corona crisis and how it has affected her work but also addressing other topics as well.

german research: *In all honesty, Ms. Becker, did there come a point during the past year when you regretted having taken on the position of DFG President?*
Katja Becker: No, not once!

Really?

Not even for a moment. On the contrary, at times I felt it was a fortunate coincidence that somebody with my biomedical background – from the field of infection research – was able to take on this position at the DFG in the year of the coronavirus. I’ve always considered it a great pleasure, and indeed an honour, to work for the DFG and alongside such an outstanding team. Nonetheless, the past twelve months have been very demanding. We’ve had to face enormous challenges that continue to be unpredictable. This applies to all of us of course, but it was certainly a lot to take on in my first year in this position.

You started out with big plans. What have you been able to put into practice?
 First, let me say that I appreciate being able to start off by talking about our accomplishments and not about what didn’t get done. After all, many things turned out differently from what we expected. A lot has gone well, and we’ve seen positive developments in many areas.

What comes to mind?

Let me start with a personal perspective. I spent a long time contemplating whether I’d be able to move out of active research – it was not an easy decision for me. But once I started to see what types of opportunities this presents, my transition from research to research administration with the DFG actually came quite easily. My position covers a diverse range of fascinating topics and offers a high degree of creativity and flexibility. And in my work, I am fortunate to remain involved with top-level academic research, through my committee work and numerous talks at the national and international level. Add to this my involvement in research policy and the position is in fact highly diversified. I’ve found it to be increasingly pleasurable as time has gone by, and I’ve become more and more familiar with all the relevant topics. The same applies to communication ...

... which was a key topic when you were elected. From the beginning, you have aimed at establishing a new style of communication and outreach that fosters a culture of open communication. This extends to the academic research community and research policymakers, to the DFG, its member organisations, committees and Head Office staff through to the public and society at large.

Yes. My aim is to foster a new, more receptive approach. I feel it’s important to promote communication based on arguments – but you have to allow arguments to be put forward from all sides. In my work I believe in putting all the cards on the table and then undertaking a joint assessment to opt for the best solution rather than simply asserting interests for their own sake. This isn’t always common practice in our society and around the world. It’s an approach that requires a lot of time and commitment.

And has the effort been worth it?

Yes, I’ve had positive experiences in a range of different contexts over the past year. I’ve observed positive reactions from many people who are not used to this approach – or those who have not encountered it in a long time. It encouraged them to believe that substantive arguments matter, and that everybody is able and welcome to have a say. This has enabled us to address a whole range of large, complex issues and accomplish a great deal, despite the corona situation.

Can you be more specific?

We took a look at universities of applied sciences (UAS) in Germany and how they relate to the DFG. This has



A year in pictures: Katja Becker in January, giving her very well-received first speech at a New Year’s reception of the DFG – and in July wearing a face mask, together with the new Secretary General Heide Ahrens, after the virtual General Assembly.

been a long-standing issue in the academic research system and in research policy. We started by carefully examining the topic within the DFG from various standpoints. We held five or six workshops, and then we got the UAS themselves involved, along with other stakeholders within the system as well as policymakers at the federal and state levels. The result is a set of measures based on a transparent, honest discussion. We are committed to allowing the UAS fair access, while not changing the DFG’s core task of furthering blue skies research.

You also had plans regarding the DFG itself and its internal structure.

That’s right, and I think we’ve made good progress here too. In a very intense process, we have completely revised the DFG statutes. We have also reviewed our governance structures, which had long been subject to controversial debate. This process is still underway, but I hope we can complete it at our next General As-

sembly and that the DFG will then have truly modern statutes. And, following a long interim period, we were able to fill the position of Secretary General. The DFG is very fortunate to have Heide Ahrens in this role – and so am I.

You were also looking to focus on internationalisation.

Internationalisation is indeed a key topic for me. There are many aspects to it and a lot is happening in this area right now – there’s the Global Research Council, the European Research Area, and we’re also looking very closely at China at the moment. It’s a process that requires many small steps that are all geared towards the overall goal of enabling science and academia – in particular researchers – to cooperate openly and freely at any time and in any place. The COVID-19 pandemic has shown very clearly the true importance of this international component and of promoting a collaborative approach. In this context, it is

vital for the general conditions and prerequisites of any cooperation to be transparent at all times. We need to address topics such as good research practice, ethical standards and dual-use as well as aspects relating to equal opportunity and diversity. I believe it is important to keep an open mind while at the same time ensuring we clearly communicate our boundaries or red lines. This is something else we’ve deliberately addressed in the past year, so I feel there’s a lot we can build on here.

Looking back at 2020, there has been a general tendency to focus on how the coronavirus upended ready-made plans and hindered even the best of intentions. In reflecting on last year, you instead focus on the positive.

That’s true – during these times, it’s important to acknowledge our accomplishments and how we’ve successfully responded to new challenges. But of course there were things that didn’t get done and strong restrictions that impacted our

daily work. For example, I regret having been unable to meet many of my colleagues and stakeholders within the research community in person. Although we were able to quickly adopt videoconferencing and other such technologies, I miss the personal interaction and face-to-face communication. The same is true for personal contact with organisations abroad, as travel has been severely limited. And this applies to the members of our committees and Head Office staff, too. Over the past few months I've been at the Head Office frequently, not least to send out a signal. The same can be said of the many staff members working in the executive-level offices, and those who work at the data centre or in facility management. However, the vast majority of staff have been working from home since March and taking care of the wide range of the DFG's tasks remotely. This is an incredible achievement.

2020 was also an anniversary year: the DFG was going to commemorate the establishment of its predecessor organisation 100 years ago and raise awareness of the importance of knowledge-driven research. The motto of the campaign was "DFG2020 – Because Research Matters". Yes, and of course many activities could not take place, especially larger events and our knowledge expedition. This was very disappointing, especially because everyone involved had worked so hard and we were going to give a fresh, novel look at how important it is for research to be driven by curiosity and empirical findings. But we made the most of the situation with our online campaign and by switching to digital formats. We hope to be able to hold the main event in 2021. After all, our anniversary year and the coronavirus pandemic have shown again and again just how crucial our motto is.

Let's talk about the coronavirus. As an infection biologist, were you tempted to

be more actively involved in research as well?

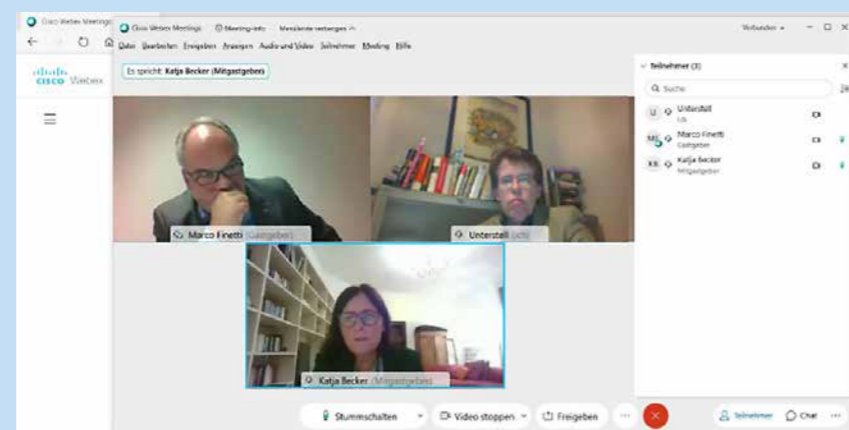
Definitely. Before I took up my current role, I led a DFG Priority Programme and a LOEWE Center in Hesse investigating tropical infectious diseases. In one of our projects we even did research into the function and structure of proteins in coronaviruses. I would have been very interested in working on a crystal structure, for example, and getting involved in identifying the potential weak points of the virus. But it quickly emerged that the coronavirus would have a huge impact on the DFG's work too, and that the DFG would be able to get involved in a variety of ways – and indeed be obliged to do so.

The DFG did in fact adopt numerous measures as early as mid-March, at the start of the first lockdown. What was your main focus here?

I don't think it's possible or even desirable to prioritise these measures.

source-friendly and therefore more sustainable processes in science and research funding management. She continued to say that the so-called Zoom fatigue that is becoming ever more pronounced must not get out

of hand, and will have to be reduced after the corona crisis. Ms. Becker showed no signs of videoconferencing fatigue in her interview with *german research*, and we spent a very enjoyable hour with her. **fine**



Screenshot: DFG

A typical day for Katja Becker in her first year as DFG President: On this Friday in December, she takes part in six video conferences not from her office in Bonn for a change, but from her home in Marburg. Her first meeting with the President of the Chinese partner organisation NSFC starts at 8:30 a.m. At 3:30 p.m. it is time for her final meeting of the day, in which she talks to the editors of *german research* calling from the Head Office and a home workstation in Bonn. Many business trips can be avoided in the future due to the option of holding all types of meetings virtually. Ms. Becker pointed out that this allows for more climate and re-

We had to face many major challenges across various different levels: the first step was to create suitable conditions to allow the DFG's work to continue as smoothly as possible, both at the Head Office and for our reviewers, review boards and committees. Then our goal was to provide support for DFG-funded projects and try to reduce the consequences of the pandemic and the lockdown as far as possible.

And then there was research into the coronavirus itself.

Exactly, and here again on different levels, the long-term perspective on the one hand and very urgent and current problems on the other.

How successful were you?

The transition to working from home and using video conferences or written procedures for virtually all reviews and decisions worked surprisingly well, and I'm very grateful to everyone involved. With our initial administrative and financial support followed by emergency funding of €175 million from our financial backers, we were able to provide the more than 30,000 DFG-funded projects with additional time and flexibility, enabling the work to continue – and indeed many careers, too.

What about measures focusing directly on research into the coronavirus?

The situation is very positive here as well. The response to our interdisciplinary call was tremendous. We received close to 300 funding proposals across the whole spectrum of disciplines, and funding will begin very soon for some of these. We established an interdisciplinary Commission for Pandemic Research, a body that will be able to further the role of basic research in this area; it is

also closely in touch with particularly urgent research issues and able to identify these very precisely. I'm also particularly pleased that we've been able to create a new instrument called Focus Funding. Its lean proposal process allows for work to be taken up at very short notice, and we're already funding a number of projects.

Is it fair to say that handling the corona situation has also been part of the positive track record of 2020?

Yes, I would say so. We've come a long way and accomplished a great deal together in this area, too. This makes me proud of the DFG, its committees and the researchers who receive funding.

The coronavirus has considerably changed the role of science and the humanities in society and policymaking. I don't mean to be cynical, but at the end of the day would you say that the pandemic has actually benefitted the scholarly endeavour?

Benefitted is not the right word given the devastating amount of loss we've experienced due to the pandemic. Nevertheless, science has never played such a prominent role in society as it has over the past few months. It has earned a lot of trust among policymakers and in society as a whole. This is a very positive development, in particular compared to many other countries. However, there are limits to how durable this role and this confidence are. We will have to prove worthy of it in the future, too.

How?

By carefully continuing to pursue what science is all about and what it is able to achieve. This entails using scientific standards and expertise to continue research into the virus, bringing together as many perspec-

tives as possible in this context. This is also going to be important with regard to vaccines and vaccination campaigns. I would say we're in a good position to respond to the challenges and opportunities brought about by the pandemic, but this will remain an enormous task coupled with great responsibility going forward.

Looking at the future from a different angle, what do you hope for in 2021?

I hope that we will find ways to completely overcome the pandemic in our work and in our personal lives. I also hope that once the pandemic is over, we can maintain the positive aspects and the lessons we've learned. The leap we took into the digital sphere, in particular, has been enormous. I'd also be happy to see us tapping into our common experience of this past year to strengthen cooperation and team spirit among people in science and academia and between different countries. After all, we're all in this together – whether we're talking about the climate, the environment or the trend towards political radicalisation – and it would be great for us to realise this sooner rather than later.

And in terms of the DFG in particular?

I hope we can build on and conclude what we successfully started last year. Partly because this will enable us to focus more closely on other pressing topics such as the Excellence Strategy, diversity and sustainability. I also hope we can continue to show the research community and research policy stakeholders – as well as society at large – what the DFG represents, raising awareness of its true value for our country and beyond.

This interview was conducted by Marco Finetti and Dr. Rembert Unterstell.

Coronavirus Vaccine Demonstrates the Long-Term Value of Knowledge-Driven Basic Research

Development of the BioNTech mRNA vaccine stems back to a project in a DFG-funded Collaborative Research Centre on cancer research in Mainz / Funding from 2006 to 2008

The most promising vaccine so far in combating the coronavirus emphasises the long-term value of knowledge-driven basic research and its funding by the DFG. The mRNA vaccine platform – used by the BioNTech company from Mainz for its COVID-19 vaccine developed with the US pharmaceutical company Pfizer – results from preliminary work conducted from 2006 to 2008 in a project at a DFG-funded Collaborative Research Centre (CRC) dealing with cancer research at the University of Mainz. This in turn was already linked to previous DFG funding.

The leader of the project went on to establish BioNTech, where he now holds the role of CEO: Professor Dr. Uğur Şahin, whose name and person are linked closely to the BNT162b2 vaccine. By mid-December, the vaccine had been approved in the UK and the US, among other countries. The European Commission granted a conditional marketing authorisation on 21 December, paving the way for vaccines to start in late December in the EU.

Alongside Şahin himself, his wife Dr. Özlem Türeci, a private lecturer and Chief Medical Officer at BioNTech and also a major contributor to the COVID-19 vaccine, was also involved in a project at the CRC. Spokesperson for the CRC was immunologist and oncologist Professor Dr. Christoph Huber, who was also involved in founding BioNTech and



The CRC project leader who went on to develop the vaccine: Uğur Şahin

is now part of the company's supervisory board.

Şahin denotes the work funded by the DFG as "important contributions" towards exploring fundamental scientific issues on the path to the currently deployed mRNA vaccine platform. "This preliminary work helped lay the foundations for the development of our vaccine," states Şahin.

The CRC at which Şahin's work took place received around €19 million of funding between 1997 and 2008, and was dedicated to researching "Mechanisms of tumor defense and their therapeutic implications". From 2000, Şahin was the leader of an independent junior research

group. Şahin's own project was set up in 2006, in the final funding period for the CRC, and initially led by him as a private lecturer before he was awarded a professorship in experimental oncology. The project received over €300,000 in funds before the CRC ended in 2008.

Under the title "Development of mRNA-based vaccines to induce integrated T and B-cell immune responses against molecularly defined tumour antigens", the project aimed to control and destroy tumours by directly activating the body's own immune system, which is a fundamentally different approach to therapy than radiation or chemotherapy. The so-called tumour antigens on the surface of tumour cells are identified and their genetic information is deciphered. The genetic blueprint obtained in this way can be used as a template or platform for the development and technological production of a vaccine specifically directed to target antigens. Ribonucleic acids (mRNA) are used as a vaccine substance. They inform the immune system about the antigens to be combated and then rapidly degrade, thus leaving no permanent genetic changes in the genome.

This approach of an mRNA vaccination is in turn based on other preparatory work from the 1990s. This included work in another CRC at the University of Tübingen funded by the DFG between 1997 and 2004. Dr. Ingmar Hoerr also

worked at the CRC led by immunologist Professor Dr. Hans-Georg Rammensee on the main topic of "Stem cells and antigen recognition in the hematopoietic system. From hematopoietic stem cells to immunotherapy". Hoerr was awarded his doctorate here and went on to found the biotech company CureVac, which is also currently working to develop a coronavirus vaccine.

Şahin himself continued his work begun in the CRC project with the help of several funding streams from the Federal Ministry of Education and Research (BMBF) and in the Translational Oncology (TRON) research centre, which was also DFG-funded and which he co-founded in 2010 at Mainz University Medical Centre. In 2008 he founded his spin-off BioNTech, where this work has now contrib-

uted to the development of the BioNTech coronavirus vaccine.

"Our early research addressed the question of how we can further improve our immune mechanisms and utilise them to combat cancer cells. Now we've been able to build on this knowledge. Using a vaccine to activate the immune system against SARS-CoV-2 is an easier challenge than overcoming self-tolerance against cancer. We also benefited from the years we spent crossing the borders between basic research and application."

In addition to his activities at BioNTech, the researcher continues to be a professor at the University of Mainz and as a project head in three current CRCs, he continues to receive DFG funding.

DFG President Katja Becker congratulated Şahin and his staff on the

development of their vaccine and emphasised that: "The DFG is very pleased to have had the opportunity of making its contribution to the early findings. These are now being used in the successful university spin-off which developed the vaccine that promises so much hope. Its development reveals the essential nature of research that derives knowledge solely based on scientific curiosity, and whose true value often lies in the very fact that it is unpredictable. No one could have foreseen the coronavirus pandemic when the CRC was established, and yet the research conducted at that time created a pool of knowledge which – years later and in a quite different area – is enabling significant progress to be made in combating this global challenge."

www.dfg.de/en/service/press/press_releases/2020/press_release_no_52

First Decisions on COVID-19 Focus Funding

33 projects addressing urgent issues / A total of €3.6 million for up to one year

The DFG has reached the initial funding decisions for its new COVID-19 Focus Funding. With immediate effect, these decisions will enable 33 research projects on immunity, host susceptibility and pathological mechanisms of infection with SARS-CoV-2. The total funding of €3.6 million is provided for a maximum of one year including a programme allowance for indirect costs arising from the projects.

COVID-19 Focus Funding was set up in August as an individual grants programme for addressing particularly urgent scientific questions on the coronavirus pandemic that need short-term answers. It

follows a simplified procedure in which the description of the funding proposal for each project is limited to a maximum of five pages. Those submitting proposals must be specially qualified and have access to established infrastructure, as well as an appropriate repertoire of research methods and material. Researchers based at universities, universities of applied sciences, non-university research institutions and healthcare facilities are equally eligible to submit proposals.

The new funding instrument is linked closely to the DFG's interdisciplinary Commission for Pandemic Research that was established in

June. Focus Funding is intended to promote projects in subject areas where the Commission identifies a special need for research. Specific calls which are directed at all relevant subject disciplines are published in this context. The first call was issued in August. It resulted in the DFG receiving a total of 89 funding proposals within a month, 33 of which have now been approved.

Three further COVID-19 Focus Funding calls have been issued since mid-December. The next call is scheduled for the beginning of February.

www.dfg.de/en/service/press/press_releases/2020/press_release_no_53

Rembert Unterstell



Illustration: anna.lacloque

“The behaviour of each individual matters”

Physicist, infection researcher, pandemic modeller: Michael Meyer-Hermann relies on data-driven methods for understanding the course of the COVID-19 crisis. His expertise is highly appreciated by policy makers, the media and the field of basic research. We spoke to the pioneering researcher who is part of the DFG's interdisciplinary Commission for Pandemic Research.

german research: Professor Meyer-Hermann, we are having this conversation in mid-December, following the decision to have a second rigorous lockdown amid the second wave of the pandemic. In which way does the current situation differ from the first hard lockdown back in spring?

Meyer-Hermann: Case numbers are much higher than in spring, as we all know. The population no longer took the virus quite as seriously, after having overcome the first wave. The weather in summer was an adverse factor. We are now in a situation where we can

no longer rule out that a triage may become necessary in overburdened hospitals. It was therefore urgently necessary to take strong measures.

The second rigorous lockdown appears to be clear evidence that the “wave breaker lockdown” implemented in

early November has failed. Do you share this view?

Case numbers were stabilised through the soft lockdown and public awareness of the issue was raised once again. So it was not in vain. However, the exponential growth that is currently taking place, shows that these softer measures did indeed not suffice to regain control of the pandemic. It is regrettable that we waited for so long, before implementing a hard lockdown. Back in October, the same measures could have swiftly nipped the second wave in the bud, and have saved many lives, as well as reducing economic and psychosocial consequences.

Will the current, tightened restrictions be enough to control and restrict the spread of the infection?

The measures are not as drastic as they may seem. Schools would soon have closed anyway. The most significant additional measure taken is to close shops. This is certainly going to prevent a lot of contact in the context of Christmas shopping. On the other hand, there will be additional contacts due to family visits over Christmas. The school closures which are intended as a pre-quarantine, will hopefully help to limit the number of new infections among the elderly. In our models we assume an increase of cases ten days after Christmas, along with an overall downward trend. However, these models are based on constant case numbers. We cannot tell for certain, whether this will be enough considering the exponential growth we are currently experiencing as a starting point. We must be very careful!

Every day, we are presented various key figures related to the pandemic. Among these are the numbers of new

infections, of available intensive care beds and of deaths due to COVID-19. You frequently stress the importance of the R value. Why is it so significant? The R value allows for a look into the future. The R value indicates the trend of the development. It has meanwhile become common knowledge that the R value must be lower than 1 for case numbers to decline. It is a quick indicator that shows, whether additional action is required to fight the pandemic.

Another indicator is the 7-day incidence rate. Do you still think that a threshold value of 50 cases per 100,000 people is suitable for determining where restrictions can be eased and where they must be tightened?

I have been urging strongly that this figure should not be subject to debate. Policy makers have demonstrated a good sense of intuition in choosing this figure. The value reflects the goal that health offices should remain capable of tracking

Professor Dr. Michael Meyer-Hermann ...

... has been the leader of the Systems Immunology Department of the Helmholtz Centre for Infection Research (HZI) since 2010. He is also a professor at the TU Braunschweig and a member of the board of directors of the Braunschweig Integrated Centre of Systems Biology (BRICS), a joint facility of the HZI and the TU Braunschweig.

Meyer-Hermann was born in 1967. He studied physics, mathematics and philosophy in Frankfurt/Main and Paris. In 1997 he earned his doctorate in theoretical physics in Frankfurt, with his thesis about quantum field theory and applications in elementary

particle physics (“The Internal Structure of the Nucleon”).

Upon obtaining his doctorate, he established working groups in the field of systems immunology in Dresden, Oxford (UK) and at the Frankfurt Institute for Advanced Studies. In addition to developing new methods in theoretical cell biology, his research is dedicated to understanding the adaptive immune system, in particular in the context of the nervous and hormone system. He uses mathematical methods and models and this has enabled him to provide new impulses for researching antibodies that are optimised in the “germinal centres” of an organism.

Systems immunology ...

... is dedicated to understanding the immune system through the use of mathematics. Medical and biological systems are modelled with theories or simulated using a computer, in order to conduct data-driven research of diseases: the development of infections, control of immune responses that

are adjusted to a particular pathogen, and ageing of an organism caused by chronic inflammation. The repertoire of methods ranges from ordinary and partial differential equations, via agent-based modelling, through to algorithms for control circuits and artificial intelligence.

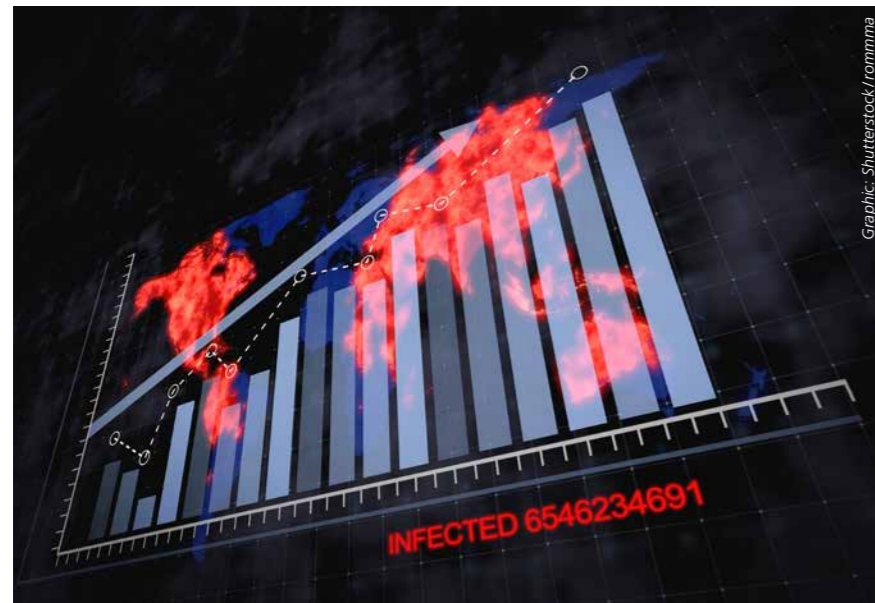
contacts and documenting infection chains. An incidence rate of 50 is just about manageable for the health authorities. However, it is also the tipping point between controlled growth and an unrestricted development that can easily become exponential in its full dynamic.

Can this approach be used in a hotspot strategy?

A hotspot strategy is not relevant at this point, as we are in the middle of a situation that resembles a large-scale blaze. Hotspots will only become visible and relevant after this wildfire has been extinguished. Only then can they be addressed through local and regional measures.

Physical distancing, hand-washing, non-medical face masks – setting these rules is one thing, their acceptance and the behaviour of people is different story. Do you think that it is even possible to overestimate this factor?

The coronavirus pandemic is spreading across the world like a wildfire. The number of infections and deaths keeps rising.



Public acceptance is indeed the decisive critical factor. Our modelling activities have shown changes in the population's contact behaviour even before the start of the actual measures, both in the case of the

We will keep you posted about the impact the coronavirus pandemic has on the DFG's work and about all measures taken to date and in the future on our website www.dfg.de and via Twitter: @dfg_public.

full lockdown in spring and of the partial lockdown in autumn. This is very clear and it shows the power that lies within the behaviour of the general public. Debate of the lockdown made many people realise that the situation is serious and that action is required.

At the state premier conference regarding the coronavirus situation that was held at the Federal Chancellery in mid-October, you issued urgent warnings based on figures and graphs, saying

that we are not approaching a crisis but right in the middle of it. The media even referred to you as the "Merkel Whisperer". How do you understand your role in policy consultation?

My role as a researcher is to provide simulations that act as a database for political decisions; to offer a prospective view of the situation and the development trend. However, I always point out that our forecasts cannot cover a period of more than two to four weeks. One reason for this is that the behaviour of the population adapts to the respective situation within the pandemic. This is why the forecasts should not be overinterpreted: I use data of the pandemic and assess it, and I try to tell which way the situation is headed in different scenarios. This allows me to illustrate the effect of particular measures. It is the job of policy makers to consider these assessments in relation to other issues, such as ethical, social or economic aspects. In my research, however, I have been increasingly focusing on these border regions between the different disciplines. This gave rise to the paper "Shared interests of public health and the economy" by the ifo Institute and the HZI, in which we point out that swift control of the pandemic is vital to allow for a healthy economy and that political containment measures are therefore justified.

Let us talk about your public impact for a moment: In April you coauthored a widely acclaimed analysis of the dynamics of the pandemic issued by the Helmholtz Association. Since June, you have also been a member of the DFG's Commission for Pandemic Research. What are your expectations in this context?



Face masks have become a part of everyday life. They are also a symbol of the restrictions and challenges posed by the pandemic.

The interdisciplinary nature of the commission is a very important factor to me. I find this very rewarding and it is beneficial to decision-making processes and recommendations. One's own perspective is complemented by those of others, especially in the area of basic research. This also allows for an easier implementation of decisions, as other aspects such as behavioural psychology during the pandemic, or legal and economic collateral damage are also taken into account. More to the point: We focus not only on intensive care bed availability, but on a broad understanding of pandemic activity. This is very important and worthwhile in my opinion. Beyond calls and funding for basic research projects, the pandemic commission could also set a trend for communication with the public and the provision of clear information about the pandemic.

Speaking of trends and in the context of your discipline, the field of systems im-

munology: Is my impression correct that even before the pandemic, you advocated the view that in the methodological canon of immunological research, greater importance should be attached to approaches from the areas of physics and mathematical modelling?

Your impression is very accurate. I have been campaigning for a long time for methods from mathematics to become part of the standard repertoire of immunology. My simulations are examples of how this might work, and of how the results can be used in a constructive manner, not only during a pandemic.

Before we come to the end of this conversation, we must talk about the promising prospects of COVID-19 vaccines. Which impact do you expect vaccination campaigns will have on the further course of the pandemic?

First we will have to wait and see how effective the announced vaccines really are, especially taking different age groups into account.

I am thinking about senior citizens aged 60 and up in particular, who are an especially vulnerable group for which the success rate of other vaccines is known to be significantly reduced. It is to be expected that sufficient time and quantities of vaccine will be needed to vaccinate the population at large. Even if a vaccine is highly effective and has few side effects, it will take a while to immunise all those willing to be vaccinated. A vaccine will reduce the problem of the pandemic, but it will not solve it.

Will we still be able to return to our old normality in 2021?

I hope that we will get the pandemic sufficiently under control to allow for normal social interaction without infecting others or getting infected. However, I do not believe that we will achieve this by spring. Maybe we will feel a form of relief by autumn 2021. Nevertheless, I also believe that we will have to face a new form of public culture that is based more strongly on mindfulness and consideration for others. Such a development could be beneficial not only to social interaction, but it may also encourage individual regulation in everyday life. Otherwise, the state will need to keep issuing social distancing orders again and again. The way in which people behave in their different areas of life will continue to be a key aspect of the pandemic.

Interview: Dr. Rembert Unterstell,
Publishing Executive Editor of the DFG magazines *forschung* and *german research*.

Further information about research in the field of systems immunology:
www.helmholtz-hzi.de/en/research/research-topics/immune-response/systems-immunology/our-research



Matthias Neubert, Hartmut Wittig and Renée Dillinger-Reiter

New Insights into Dark Matter

Basic research in particle physics: MESA, an innovative superconducting electron accelerator, is designed to allow precision experiments to be carried out with extremely high beam intensities. This could enable scientists to detect tiny deviations from the predictions of the Standard Model of particle physics.

A graphic (model) view of MESA – in the foreground can be seen one of the cryo-modules, the heart of the accelerator.

These are exciting times for everyone involved. Not only is the study of dark matter one of the most thrilling challenges in 21st-century fundamental physics, but the construction of a new particle accelerator is an extremely ambitious project that demands specialised expertise and know-how. This is the very know-how that physicists at Johannes Gutenberg University Mainz have at their disposal, with plenty of experience in the construction and operation of large particle accelerators on the Gutenberg campus.

They have been operating the MAMI electron accelerator for al-

most 30 years and are already using it to conduct research at the highest international level. But in the future, thanks to an extremely high beam intensity, MESA will enable them to perform precision experiments that previously seemed unimaginable. To achieve this, the accelerator will use the innovative energy-recovery linac (ERL) technology which has even found its way into the name – MESA stands for Mainz Energy-Recovering Superconducting Accelerator.

The search for dark matter and the construction of MESA are key components of the PRISMA+ Cluster of Excellence, granted in 2018.

These two activities intersect in a very exciting way, because the MESA experiments have a special focus on dark matter. Important foundations for this were laid during the funding period of the predecessor cluster PRISMA, which got underway in 2012.

Now, construction work on MESA has begun in earnest: in autumn 2019, heavy specialist equipment arrived on campus to drive 36 foundation piles 34 metres deep into the ground. These will later support an underground extension to house MESA and the associated experiments. This will involve some modification of the existing underground facilities of the Institute for Nuclear Physics, where the MAMI accelerator is currently situated, and the addition of a 600 square metre experiment hall at a depth of around 11 metres. The new underground experimental hall is part of the Center for Fundamental Physics, a research facility that provides the essential infrastructure for the PRISMA+ research programme.

In a particle accelerator, electrically charged particles – electrons in the case of MESA – are accelerated by means of alternating electromagnetic fields. In the actual experiments, the particles are collided with the atomic nuclei in a material sample known as the target. The scattered particles then strike detectors which measure their momentum, energy and other physical parameters.

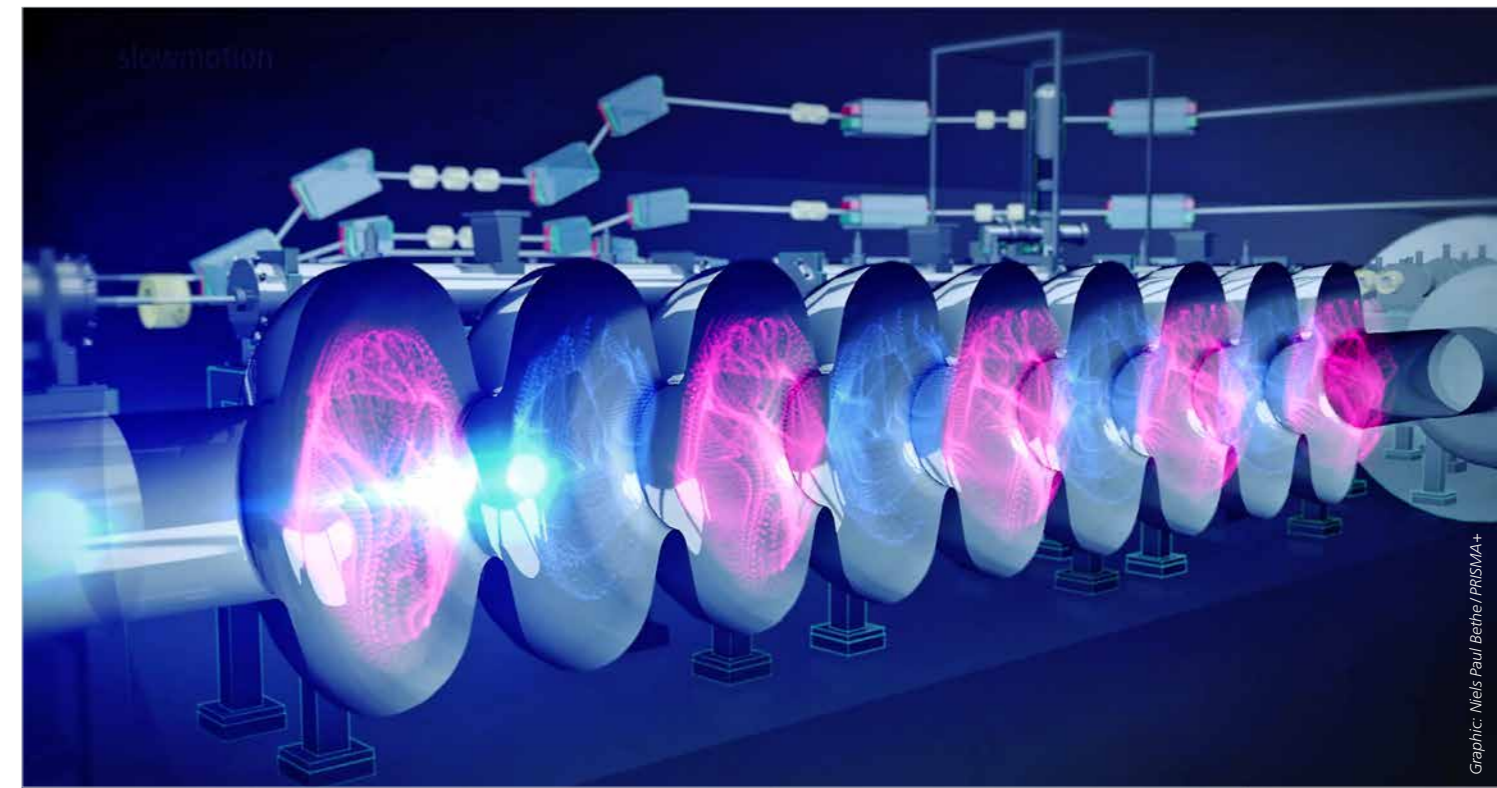
What makes MESA special is the fact that, thanks to the ERL technology which is a kind of innovative energy recycling, the accelerator is very economical in its use of energy. By slowing down the electron beam after it has passed



Above: Testing a cryomodule. Below: Visualisation of the architecture of the planned experimental hall at the Center for Fundamental Physics in Mainz; the envisaged installation of MESA can already be seen.



Model: DGI Bauwerk Gesellschaft von Architekten mbH



Graphic: Niels Paul Bethe / PRISMA+

View inside a cryomodule: inside the “cavities”, standing electromagnetic waves are generated. Through the rapid reversal of polarity, the electrons that move synchronously with the field are continuously accelerated.

through the experiment, around 95 percent of the energy needed to accelerate it is recovered again. This energy is then available to the next set of electrons. MESA is the first to use this new technology for basic research in particle physics.

At the heart of MESA are two “cryomodules”. Each of these consists of two cavity resonators, each with nine cells (known as cavities) made of niobium. This metal has the property of losing all electrical resistance at very low temperatures, making it superconducting. The cavity resonators are cooled with liquid helium to minus 271 degrees Celsius – that’s just 2 degrees above absolute zero. In the completed MESA accelerator, the electrons will pass through the two cryomodules three times

before finally reaching a kinetic energy of 155 mega-electronvolts (MeV).

MESA operates at an energy several orders of magnitude lower than that of large accelerators. Instead of high energy, it uses extremely high beam intensity. This will allow the research team to make extremely precise measurements and search for very rare events. MESA will also offer very high beam quality, another important requirement for the planned precision experiments.

Instead of using extremely high energy to search for new physics beyond the Standard Model of particle physics, MESA physicists are aiming, through precise measurements at low energies, to find tiny deviations from the predictions of the Standard Model or detect

very subtle effects – which could be caused by the mysterious dark matter, for example.

Scientists have known for a long time that dark matter must exist, because without it, many astrophysical observations cannot be explained. What is more, the visible matter we know about makes up only around 1/6 of all the matter in the universe – while over 80 percent is made up of dark matter. Therefore, the search for dark matter touches on the fundamental question of the substance which the cosmos is made of. Yet today, it is still completely unclear what dark matter consists of. It is as if there was a large elephant in the room, and we can’t see it. That’s how physicists often describe the challenge facing them and many colleagues around the world.

Particle physicists are currently discussing and investigating a whole range of possible particles that could theoretically be candidates for dark matter. This is what makes the search for this new form of matter so varied. One much-discussed candidate are weakly interacting massive particles or WIMPs. At the Gran Sasso laboratory in Italy, 1,400 metres beneath the ground, around 160 researchers in the XENON collaboration operate the world's most sensitive detector used to search directly for WIMPs – with important contributions coming from Mainz. The analysis of existing data from the current experiment XENON1T continues to deliver exciting new insights. For example, the collaboration recently

announced a surprising excess signal whose source is not yet fully understood.

At the same time, the researchers are working hard to complete the successor experiment XENONnT. At the heart of it is a cylindrical tank with a volume of 3 cubic metres, filled with just under 9 tons of liquid xenon at a temperature of minus 95 degrees Celsius.

Xenon is very suitable for these experiments because it can be manufactured with an extremely high purity and is very dense in liquid form. If a WIMP collides with one of the many xenon nuclei, it transfers some of its kinetic energy to the nucleus, which then excites other xenon atoms, making them glow. These very weak signals of

ultraviolet light are detected by sensitive light sensors.

In their experiments so far, the researchers have already managed to considerably narrow down the coupling strength for WIMPs in the predicted mass range. Thanks to its greater mass combined with new background suppression techniques, XENONnT will achieve a sensitivity that, at the start of the project, still seemed inconceivable.

MESA will also be capable of searching for WIMPs if they prove to be lighter than previously assumed. In the beam dump experiment DarkMESA – in which the accelerator's beam dump serves as the target – these particles could be generated and detected afterwards.

Testing the gas target of the MAGIX spectrometer in the A1 spectrometer of the MAMI particle accelerator.

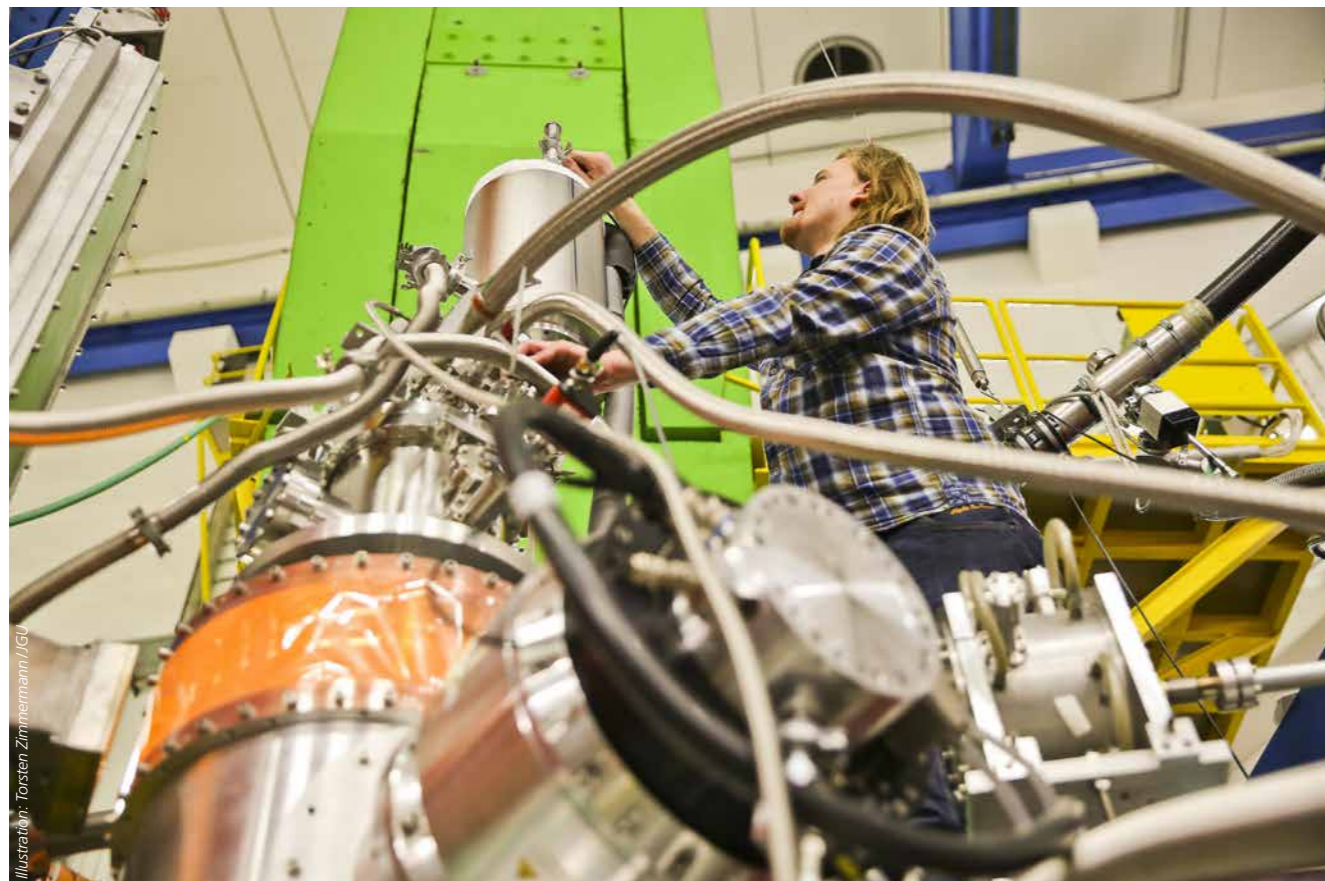


Illustration: Torsten Zimmermann/JGU

extreme accuracy a fundamental physical constant, the mixing angle of the electroweak interaction.

The discovery of dark photons or light dark matter particles, which is what the physicists of PRISMA+ are striving for, would be a scientific sensation. It could explain a whole range of astrophysical observations that are not currently understood, helping us to gradually unravel the secrets of dark matter. The MESA accelerator will enrich research in this field in many ways. But the researchers will need to be patient for just a little while longer: the underground experimental hall for MESA as part of the Center for Fundamental Physics is due to be completed in 2022, and the first experiments could then be performed in 2023.



Illustration: Roberto Corrieri und Patrick De Perio/XENON-Kollaboration

XENON1T experiment at the Gran Sasso underground laboratory in Italy, with a water tank for radiation shielding (left) and service building (right). Last year, researchers here observed the decay of the xenon-124 atomic nucleus for the first time.

It is the enormous intensity of MESA's electron beam that makes this type of experiment possible.

Researchers are also searching for another much-discussed candidate for dark matter – extremely light particles such as axions or axion-like particles. These weigh up to 24 orders of magnitude less than their heavy cousins, the WIMPs. Physicists at PRISMA+ are currently developing several experiments to search for these particles. All are based on the assumption that there is a constant flow of axions that influences the properties of normal matter in very subtle ways. According to theoretical ideas, such influences could be detected using methods such as atomic spectroscopy with caesium vapour, special nuclear magnetic resonance (NMR) techniques, or even antimatter. So far, these experiments have not caused dark matter to reveal itself, but increas-

ingly, they too are enabling us to set limitations in relation to their nature and gradually narrow down the field of search.

Another experiment planned at MESA, the MAGIX experiment, will search for a different clue to dark matter – so-called dark photons. Just as “regular” photons are the messenger particles of the electromagnetic force, dark photons occur in various extensions of the Standard Model as messengers of a new force that acts between dark matter and ordinary matter. The newly designed MAGIX spectrometer is ideally suited to searching for the decay of dark photons into electron-positron pairs and also significantly expanding the search range compared with previous experiments.

The third experiment envisaged at MESA, P2, is designed to reach indirect conclusions about dark photons by determining with



Mainz-based physicists **Prof. Dr. Matthias Neubert** and **Prof. Dr. Hartmut Wittig** are spokespersons for Cluster of Excellence 2118.

Dr. Renée Dillinger-Reiter is responsible for press and public relations for the cluster.

Contact: Johannes Gutenberg-Universität Mainz, Exzellenzcluster PRISMA+, Staudingerweg 9, 55128 Mainz, Germany

www.prisma.uni-mainz.de



Vera Demberg and Tim Schröder



Illustration: Shutterstock/istockphoto

Smart, Articulate and Stress-Resistant

Virtual assistants that are capable of spoken communication are a popular trend – but they are still not well suited to stressful everyday situations such as driving a car. Using eye trackers and a driving simulator, computer scientists are looking for ways to optimise these smart systems.

Dictation software and virtual assistants have been around for many years, but for a long time these digital aids had their teething problems. When a train passed by outside or a drill was buzzing somewhere in the house, they were often unable to understand. All the assistant could say was: “Sorry, I didn’t understand.” There is a good reason why the spoken menus used

by call centres are still very simple. Normally, the required response is “Yes”, “No”, or a number.

So for a long time, virtual assistants failed to excite any real enthusiasm. But now that has changed. Modern interactive loudspeakers like Alexa and Echo from Amazon or the Home Mini Smart Speaker from Google have made voice control very attractive to many people.

Thanks to sophisticated algorithms for speech analysis, these devices can understand the speech of very different people – and respond. Jokesters have even posted videos on the Internet showing a Home Mini Smart Speaker and an Alexa having a conversation with each other.

Without a doubt, after many years of research, virtual assistants have achieved a breakthrough. And

it is safe to assume that more and more new applications will arrive on the market over the next few years. As part of the trend known as Industry 4.0, areas where a lot of manual work is still performed could be combined with voice control – a basic requirement for carrying out dual tasks. Virtual assistants in vehicles, which can already be used to control a car phone, for example, might acquire a range of new features. From dictating letters and e-mails while driving to doing online research, there are many conceivable options.

But in spite of all the advances made, there are still technical hurdles to overcome before a dialogue with an on-board system can become as easy and natural as having a conversation with a passenger. In a dialogue between a human and a technical system, it is not only necessary for the system to understand language and be able to give a meaningful response: it is also essential for

the system’s response to actually be received by the human participant. Whether a human perceives information or not depends largely on their mental state at any given time.

For example, the more attention a driver has to pay to the traffic situation, the less they can concentrate on a conversation – for instance when approaching the narrow entrance to a building site. In the worst-case scenario, they will make a driving error because they were distracted by the conversation. A human passenger can easily adjust their language to the situation, by pausing or using shorter sentences. A virtual assistant is not so sensitive.

So the challenge is to design a virtual assistant that can respond differently according to the situation to avoid causing additional stress to the user. Our team in the Cluster of Excellence at Saarland University is investigating the scenarios in which a dialogue distracts a human

user and places greater demands on them – and how this can be improved. To do this, they are combining various scientific aspects in a new way. The simple question of how much a driver is stressed by traffic has already been examined by many researchers. But our team was the first to investigate in detail the extent to which the complexity of language affects cognitive workload and thus an individual’s driving behaviour.

A well-established test used by psychologists to measure stress is pupil size. One possible indicator is the overall size of the pupil, with a large pupil indicating a raised stress level. Alternatively, the frequency of small twitches of the pupil can be measured. This indicator is known as the Index of Cognitive Activity or ICA. When the brain is required to process more complex information, the nerve cells (neurons) synchronise themselves. One effect of this is that the pupil muscles are

A virtual assistant which is smart and situationally aware – studies in the driving simulator promise new insights reflecting real-life scenarios.



Illustration: Oliver Dietze

innervated, causing an increase in the frequency of small and rapid pupil dilations. Using special cameras known as eye trackers, these rapid dilations can be recorded and analysed. One application of the ICA method is to measure the stress level of fighter pilots.

The research team used ICA in a driving simulator. As the volunteers drive a simulated vehicle along virtual roads, the researchers play back various sentences to them. The complexity of the sentences varies due to the choice of words or changes in sentence structure. For example, a sentence like “While Steve was at a holiday resort, he wrote lots of postcards” is fairly unsurprising. But even a small change will cause a volunteer to cognitively stumble: “While Steve was at a holiday resort, he wrote lots of applications.” The word “application” is

unexpected in the context of a vacation, which increases the workload involved in processing the information. Essentially, the more improbable the occurrence of a given word, the more a spoken sentence requires us to think.

The higher cognitive workload resulting from processing difficulties can be estimated using the ICA. Among the volunteers in the driving simulator, the rapid dilations of the pupil did indeed become more noticeable when unexpected words cropped up. At normal speaking speed, a word lasts only a few tenths of a second. Yet the ICA method appears to be sensitive enough to detect these short-lasting events.

Even more processing workload is placed on the brain when the volunteers listen to more complex sentence constructions with unexpected elements, such as the

following German sentence: “Die Nachbarin, die einige der Mieter auf Schadensersatz verklagt haben, traf sich gestern mit Angelika.” (The neighbour whom several of the tenants sued for damages met Angelika yesterday.)

This sentence contains an unexpected change of meaning. Until they hear the word *haben*, a plural verb, a German speaker assumes that the neighbour is the subject of the sentence and is suing the tenants, and therefore expects to hear the singular verb *hat*. But in fact the verb is plural, *haben*, which changes the meaning of the sentence: it was the tenants who sued the neighbour.

This example illustrates how flexibly the listener’s brain sometimes has to work, and this flexibility becomes all the more difficult the more a person is occupied with other tasks, such as driving.

In the driving simulator, researchers use the Index of Cognitive Activity, which evaluates stress perception by measuring pupil size.



Illustration: Oliver Dietze



Illustration: Shutterstock/Neglia

The virtual assistants available today have their limitations.

From this starting point, a language generation system was developed which can automatically output formulations of varying complexity. A virtual assistant can then use these depending on the situation – simple, short sentences when the workload is high and more complex constructions containing more details and information during relaxed phases.

This is a completely new approach, because currently available dialogue systems do not take account of the difficulty of a generated statement for the human user. In addition, they do not always give the appropriate answer to a user’s question. It will therefore be some time before a virtual assistant can respond with the same variation as a human being. But initially, the aim is to fundamentally understand how much a volunteer’s cognitive workload can be modified by varying the sentence structure and word choice of the dialogue system.

To convey information in the appropriate language at any given time, it is of course necessary to know the situation the user – a driver or a worker on an assembly line – is currently in. Continu-

ously monitoring a user would be technically complex and probably rather unpleasant for the individual in question. It would be more appropriate to equip virtual assistants with technical data from the environment, such as the current driving parameters of a vehicle.

The intention is that this data will feed into a mathematical model that interprets the situation and gives guidelines to the virtual assistant accordingly. It would even be conceivable to use a self-learning system that gradually gets to know the driver and their individual driving behaviour, and continuously improves its interpretation of the vehicle parameters. Does the driver tend to brake sharply on approach to a construction site? Do they have a consistent driving style, or do they tend to react abruptly?

Individual differences between people play an important role when it comes to developing a universal virtual assistant that can interact appropriately with any user. Age is one significant factor: the working group in Saarbrücken found during their experiments that older driv-

ers steer more poorly on average and are more distracted by difficult words than younger people. If the development of virtual assistants capable of language variation is to become reality in the future, then age-specific aspects will need to be taken into account. There is also the fact that older people often have hearing difficulties. The virtual assistant should therefore avoid words that sound too similar or could be misunderstood.

But it’s not just age that makes the difference: there are many factors that affect whether a person becomes consciously aware of information. A driver who goes through a red light at a junction may have perceived the red with their eyes, but the information has been lost on the way to their conscious awareness because they were distracted by high cognitive workload somewhere else. So the universally sensitive virtual assistant of the future needs to be smart enough to prevent this happening, by making sure that the spoken word is received and understood.



Prof. Dr. Vera Demberg

is Professor of Computer Science and Computational Linguistics in the Cluster of Excellence “Multimodal Computing and Interaction” at Saarland University.

Tim Schröder

is a biologist and works as a freelance science journalist in Oldenburg.

Contact: Universität des Saarlandes, Fachrichtung Informatik, Campus, Geb. E1 3, 66123 Saarbrücken, Germany

www.sfb1102.uni-saarland.de



Peter-Henning Clausen

The Parasite with a Few Tricks up its Sleeve

Theileria pose a deadly threat to cattle. Every year, more than a million animals in Africa, the Middle East and Asia fall victim to the rampant East Coast fever and tropical theileriosis. A network initiative is seeking to immunise cattle using attenuated forms of the pathogen – with the aid of a new live vaccine against the disease.



A microscopic view of the reproductive stages of *Theileria* in lymphocytes of cows: macromeronts, also known as "Koch's bodies" (above, between the lymphocytes), and micromeronts (small bodies on left).

Your Excellency, Following my report of the 12th August of this year, permit me to report most dutifully the results of my investigations thus far into the cattle diseases prevalent here... In serious, rapidly fatal cases, I discovered in the red blood cells (of cattle) peculiar forms with a rod-like appearance, such that one might take them for small bacilli. These are often somewhat curved, sometimes so much so that they form a ring, in which case they look very similar to the parasites of tropical malaria... In the most serious cases they are found in an extraordinary quantity; on occasion they are so abundant, that 80–90% of all red blood cells are occupied by them...”, wrote Robert Koch concernedly on 27 October 1897, in a report that he submitted from Dar-es-Salaam to the State Secretary for

the Interior in Berlin on a rife cattle disease in what was then German East Africa, now Tanzania.

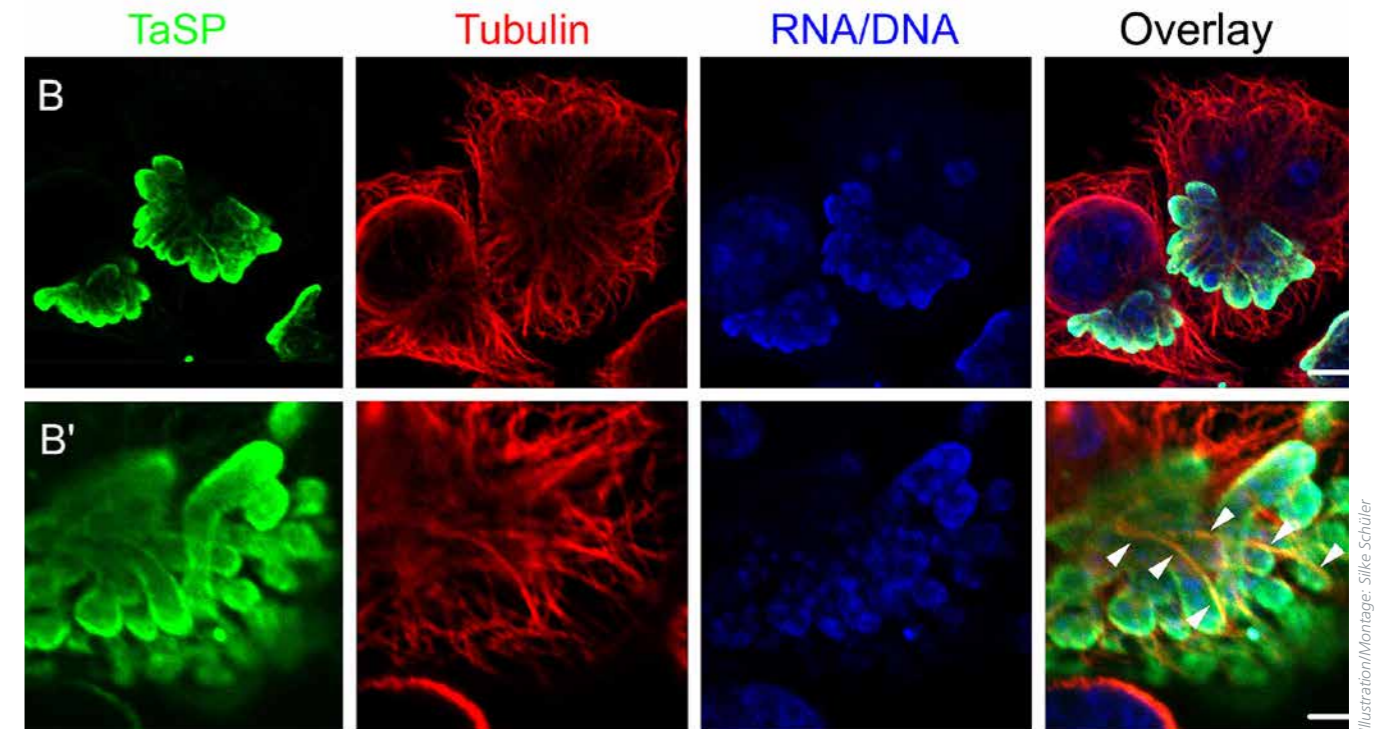
A few years later, the parasites were named “Koch’s bodies” after their discoverer. Sir Arnold Theiler (1867–1936), known as the father of veterinary medicine in southern Africa, subsequently identified hard ticks as the main carriers of the pathogen. In 1906, they were named *Theileria* after him. But it would be another 70 years before parasitologist Eberhard Schein from the Free University of Berlin worked out the complete developmental cycle of the pathogen in the ticks that transmit it. This laid the groundwork for the intensive study of *Theileria* and their carriers.

Theileria annulata, which causes tropical theileriosis or Mediter-

ranean theileriosis, is primarily transmitted by *Hyalomma* ticks. The disease is prevalent from North Africa, southern Europe and the Middle East to India, Central Asia and China. East Coast fever, which is caused by *Theileria parva*, is limited to eastern and southern Africa, the range of the carrier tick *Rhipicephalus appendiculatus*, also known as the brown ear tick.

So what exactly are *Theileria*? They are parasitic protozoa which transform the host cells of the immune system (lymphocytes) and stimulate them to divide uncontrollably. As a result, the whole lymphatic system is flooded with infected cells. These infect the lung tissue and cells of the digestive tract, with lethal consequences: approximately 1.1 million cattle

Left: Bloodsucking ticks (*Rhipicephalus appendiculatus*) on the ear of a cow – carriers of East Coast fever. Right: Intensive work in the laboratory to improve animal health – scientists cultivate the vaccine against *Theileria*.



The parasites attach themselves to the spindle apparatus of the leukocytes. The membranes of *Theileria* mother cells were detected with an antiserum (green signal) and the cytoskeleton of the leukocytes with an antibody (red signal). The DNA was detected using TOTO-3 iodide (blue signal). B shows three leukocytes infected with tropical theileriosis; B' documents overlaps.

die annually from East Coast fever, with 28 million animals being at risk of the disease.

To develop a vaccine it is necessary to understand how the parasite behaves inside hosts and carriers, and how its developmental cycle works. When the carrier – a tick larva or nymph – sucks blood from an infected cow, it ingests red blood cells infected with *Theileria*, known as merozoites. The parasites multiply in the tick’s gut. When the tick moults as it progresses to its next stage of development, the parasites migrate through body fluid to the tick’s salivary gland.

The next time the tick feeds on a host, another asexual reproduction process takes place: infectious stages of *Theileria* known as sporo-

zoites develop, which the tick then transmits to a susceptible animal through its saliva with its next blood meal. The sporozoites enter the host’s lymphatic system (the stage at which Koch’s bodies form) and here the parasites continue to multiply. They form merozoites, which enter the host’s red blood cells and develop into the comma or ring shape described by Robert Koch. This completes the developmental cycle.

Theileria are unique, and they have an array of tricks at their disposal. They attack the host’s immunocompetent cells, such as T and B lymphocytes and monocytes/macrophages, and control their transformation and division. Like tumour cells, these infected cells have unlimited potential for growth and metastasis. The un-

derlying molecular mechanisms, however, are not yet fully understood. Nevertheless, a number of *Theileria* molecules have been identified, for example the immunodominant surface molecule of *T. annulata* (TaSP), which interacts with the microtubules of the host cells. This enables the pathogen to stay connected to the microtubule network of the host cell and trigger the division of leukocytes. In this process, the parasite synchronises its own division with that of the host cell, producing growing parasites (macroshizonts) on each daughter cell. The pathogen also prevents the death of the host cell, resulting in uninhibited, tumour-like growth of both host cell and parasite.

Acaricides are used as a preventive measure to kill the carrier

ticks, but because these pesticides have been used for many years, some tick species are becoming resistant to them. If used carelessly, they can also cause environmental damage. A number of chemotherapy options are available to treat infection with *Theileria*, but as well as being expensive, again, there is a high risk of resistance developing.

Currently, the best measure against Mediterranean theileriosis is to immunise animals with attenuated pathogens. The parasites are weakened such that, although they can still reproduce, they cannot trigger disease in an immunocompetent host. The long-term cultivation of *Theileria*-infected cells in the laboratory can weaken the pathogen.

Investigations by the project team in Sudan and Egypt have shown that the transmission of attenuated *T. annulata*-infected cells to susceptible calves causes a mild fever reaction and a low or undetectable number of pathogens in red blood cells. By contrast, the

transmission of non-attenuated pathogens produces a whole spectrum of symptoms: long-lasting fever phases, infected leukocytes in the lymph nodes, and metastasised infected cells in various organs, particularly the lungs. In many cases, the animal dies.

T. parva infections, the cause of East Coast fever, are still treated using the infection and treatment method (ITM) developed in Kenya in the 1970s. Although it is very effective, this method has so far only been used on a limited regional scale. There is a fear of spreading foreign parasite genotypes, which could lead to further problems. Another reason is that the vaccine-induced immunity may be specific to certain strains of the pathogen, and that local strains could therefore result in breakthrough infections. However, studies in Uganda indicate a substantial genetic match between the pathogens and the vaccine. This establishes an important foundation for the more widespread use of vaccination in Uganda.



A scene seemingly drawn from the Old Testament – two Maasai herders with their cattle, which are essential to life and survival in Tanzania, East Africa.

Important research results have also been achieved in Kenya. Molecular tests have been developed

to perform quality control of the pathogen strains used in the vaccines. To improve the immunisation of animals against *T. parva*, further experiments are planned to produce weakened *T. parva* B cell lines. The reason for attempting to generate *T. parva*-infected B cells is that these cells are less aggressive to the host than infected T-lymphocytes.

The successful experimental immunisation of animals in Sudan has prompted great interest at the ministry of agriculture. Following an information meeting with the agriculture minister, the government expressed its willingness to vaccinate valuable dairy cattle around the capital Khartoum with live vaccines in a field trial. The project team regards this as a

success. Project partners in Tunisia and Egypt are currently working to implement this concept in their countries too.

One overall aim of the project is to improve the use of the vaccine in the field. The lyophilisation of infected cells (preserving them by freeze-drying) would be a significant step in this direction, so this is a measure that should be further investigated. Some promising investigations have already been carried out in Tunisia.

To summarise what has been achieved so far and the likely results in the foreseeable future, the effectiveness of vaccination against East Coast fever and tropical theileriosis has been improved

with the help of the transregional network initiative to promote the use of live vaccines. These are new and important steps in the fight against the dreaded theileriosis – for the benefit of animal health in Africa and beyond.



Prof. Dr. Peter-Henning Clausen researches and teaches at FU Berlin.

Contact: Institut für Parasitologie und Tropenveterinärmedizin der FU Berlin, Robert-von-Ostertag-Straße 7–13, 14163 Berlin, Germany

www.vetmed.fu-berlin.de/en



Left: Iganga, eastern Uganda: Vets and their assistants vaccinate a group of penned-in cattle against East Coast fever. Right: To immunise an animal against the deadly disease, the vaccine is injected into the base of the ear.



Illustrations: Christine Moniag

Illustration: dpa/H. Brehm

From Laboratory to Bedside

Christian Reinhardt, an oncologist and clinician scientist based in Cologne, combines caring for cancer patients with research into targeted and personalised therapies. A deeper molecular understanding of disease could provide new approaches in this field.

For Prof. Dr. Christian Reinhardt, the lab workbench and research are part of a normal day's work at Cologne University Hospital. After dropping off his children, one 5 years of age, the other 2 years old, at the university daycare centre, his working day begins shortly after 7am in the nearby Cologne Center for Genomics with the regular small team meetings in his lab. Around 9am he heads to his second workplace, the oncology and haematology ward in the Department of Internal Medicine I, where his schedule includes ward rounds, ward work and the midday meeting. Then he heads back to the lab; on three afternoons a week he takes part in the tumour board, the expert panel for treatment planning, followed by administrative tasks, from

health insurers' recourse claims to animal experiment applications. Not uncommonly, it's late before his young family sees him in the evenings.

His job demands more than just switching quickly from clinical practice to laboratory. But are the two worlds, each with their own requirements, fundamentally compatible? Reinhardt, 44, a tall and alert figure, says "Yes" – followed by an exclamation mark. "For me it's enriching – it's my dream job, because in addition to raising the standard of patient care, I get to make a difference beyond that too." But as he is quick to point out, this requires "clear agreements and allowances in terms of the time available".

You can't do this job, he says, without high intrinsic motivation

combined with ambition, plenty of discipline and energy. Or without the conviction that a research oncologist may have a better understanding of what is going on in a cancer patient, is familiar with the relevant clinical questions and uses them as the starting point for research. For Reinhardt, studying molecular mechanisms and treating cancer patients are part of one and the same job, that of clinician scientist. Since 2012, he has held a research professorship in clinical and molecular oncology at Cologne University Hospital.

So how did he end up in molecular medicine? After his medical studies in Hamburg, Berlin and most importantly Freiburg, it was his time as a postdoctoral researcher at the Massachusetts Institute of

Technology that guided his choice, or as he puts it was the "point of no return". Effervescent and with the kind, friendly manner people want to see in a doctor, he describes this period as "incredibly intense". In late 2004, a DFG research fellowship enabled him to go to the US east coast, where he remained for five and a half years. The outstanding academic environment, the "collaboration spirit" of the researchers and the strategic research management made a lasting impression on him.

It was here that he found his research area in molecular cancer research: investigating the molecular aspects of the DNA repair mechanism and the cellular signalling cascades that occur in chemotherapy-induced DNA damage. In the search for the causes of therapy resistance, this is an important and tremendously exciting question. Using a combination of experiments and mouse models, he investigated the so-called checkpoint kinase MK2, an enzyme, and its function in tumour development – with results that attracted a lot of attention.

In 2008, Reinhardt completed his habilitation in molecular medicine in Cologne. He was attracted by the considerable, networked expertise in tumour biology and cancer medicine at the university hospital, the university itself and the Max Planck Institutes. His Emmy Noether group, approved by the DFG in 2009, was what he calls "a door-opener" for his return to Germany. The name of the group gives a clue as to the direction his work has taken: "In Vivo Characterization of the Protein Kinase MK2 as a Potential Target Molecule for a New Chemotherapy-Sensitizing Cancer Therapy".

Reinhardt, whose wife is a heart surgeon, determinedly pursued his research work, partly helped by a three-year Lichtenberg professorship from the Volkswagen Foundation. Since 2013, he has been the coordinator and spokesperson of the DFG Clinical Research Unit 286, which investigates molecular mechanisms in chronic lymphocytic leukaemia (CLL), the most common – and still incurable – form of leukaemia.

In his research to improve tumour therapies, Reinhardt looks for ways of treating genetically defined tumours more effectively. He hopes that understanding the "genetic Achilles' heel" of tumour growth will make possible personalised treatment that exploits patient-specific tumour mutations for therapeutic purposes.

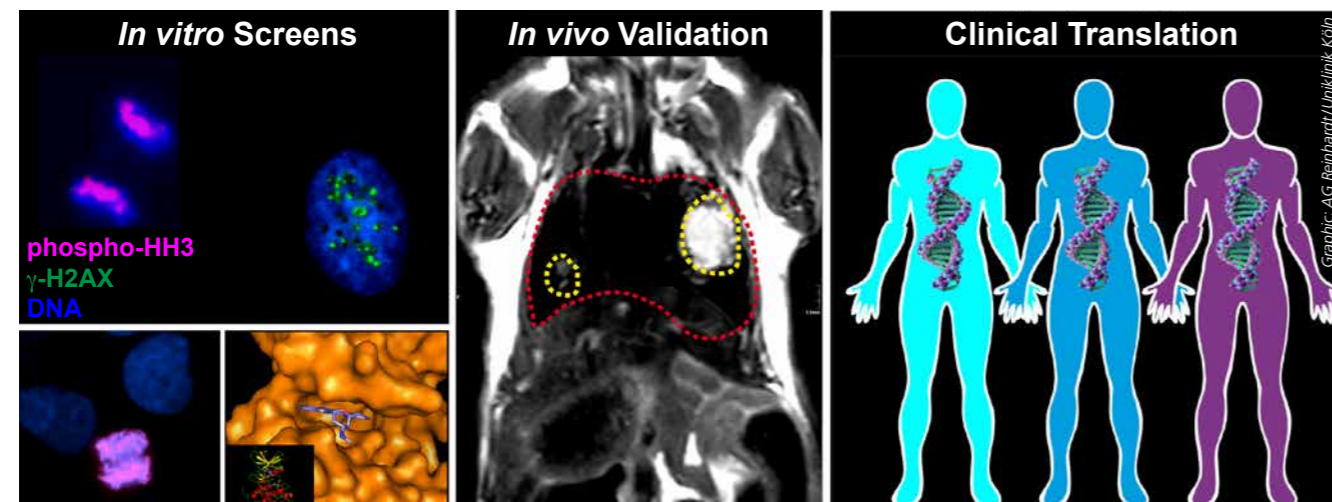
Cologne University Hospital also recently set up a Molecular Tumour Board whose job is to make treatment decisions on the basis of molecular biology findings. To do this, Reinhardt explains, the tumour is genetically profiled and the cancer is classified according to molecular subtypes. This is an example of the interface between basic research and clinical practice.

Reinhardt's work has earned a number of awards, including the €30,000 Theodor Frerichs Prize of the German Society of Internal Medicine in 2016, which recognises "tangible potential for translation". Reinhardt believes that cancer therapy is currently undergoing a fundamental shift – "away from toxic chemo- and radiotherapy towards innovative treatments that specifically target cancer cells and their genetic material". However, in our growing molecular knowledge, the new genetic, immunological and



Illustration: AG Reinhardt/Uniklinik Köln

Translational research projects operate at the interface between basic and clinical research. They bring these two vital elements together to improve patient care on the basis of scientific insights.



bioinformatics methods, he also sees new requirements for young oncologists: "As well as solid clinical training, they need well-rounded training in molecular cancer research." This is where the Clinician Scientist Programmes come in.

For patients and physicians, many hopes in the fight against malignant tumours have not been fulfilled: in Germany, one in three patients still dies from the consequences of cancer. This makes it all the more important to take steps towards new treatment strategies. Research oncologist Christian Reinhardt is one of the people taking those steps – with tremendous passion and dedication.

Dr. Rembert Unterstell
is Publishing Executive Editor of the DFG magazines *forschung* and *german research*.

Irene Götz

Making Do, Getting By

A tight budget, cramped living conditions, health problems: A research project in Munich is illuminating the precarious existence of many female pensioners from a cultural studies perspective.

Just about getting by: Female pensioners who are single or widowed are especially likely to experience a precarious retirement.

There was no mistaking the urgency of the words: “We’re dealing with a poverty avalanche,” said Ulrich Schneider, CEO of the German Parity Welfare Association. He was referring to a recent social study which revealed that poverty among new old-age pensioners was rising significantly and had, in fact, seen the greatest increase out of all age groups since 2006. The issue of an ageing society, and particularly poverty in old age, is a topic which for a long time attracted little notice but in recent years has begun to be regarded in a new light by both politicians and the media.

This cultural studies project, which has just led to a new book (*No Retirement! How Women Cope with Poverty in Old Age*, edited by Irene Götz, published in March 2019 by Kunstmann), began with a highly

ambivalent finding. Reports on later life published by the German government talk about a new generation of “active” and “fit” older citizens who take care of themselves and continue to be useful members of society through voluntary activities. In a labour market struggling with a lack of qualified candidates, the “potential of age” is being recognised as a resource. However, for a growing number of older people, pursuing activities in retirement is less a question of social engagement and more a question of survival in the face of a “precarious retirement”.

According to another study carried out by the Parity Welfare Association in 2017, pension levels have been falling continuously for many years, with the result that between 2005 and 2015, poverty among

new pensioners aged 65 or over increased more than in any other age group in Germany. Bottle collectors and pensioners filling shelves in the supermarket are emerging as new social figures of old-age poverty in our towns and cities.

As the project study reveals, women are particularly at risk of poverty in old age. The average female pensioner in Germany receives approximately €650 per month, a little over half of the pension paid to the average man. Women from a middle-class background are not exempt from the threat of poverty in old age, especially if they are single in the last third of their lives. Statistically speaking, women live longer than men and frequently care for their partners, but ultimately are unlikely to receive the same kind of partner support.

Here, everything has its place: the living room of an older woman as a haven in the midst of everyday life.



Illustration: Petra Schweiger

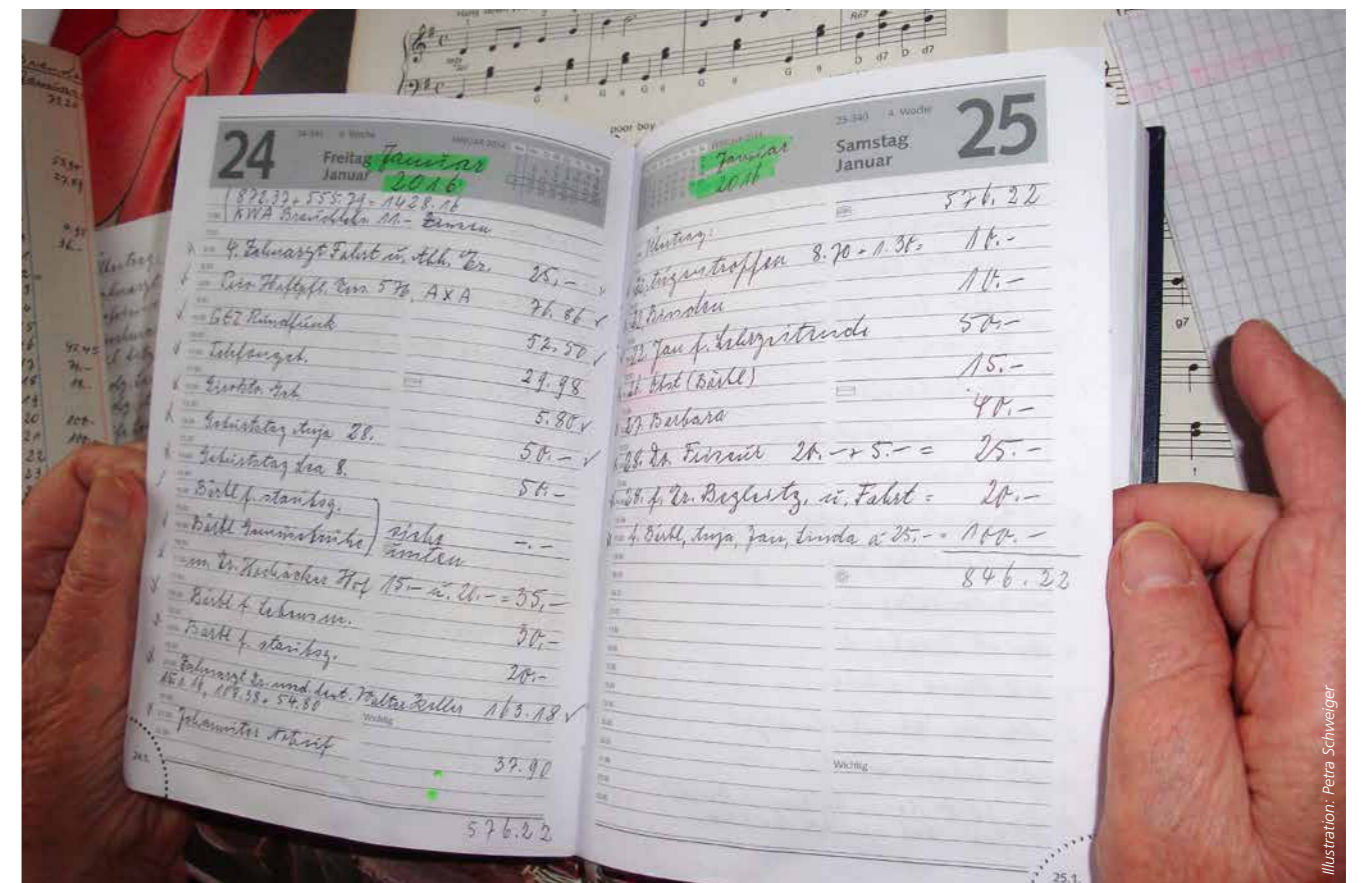


Illustration: Petra Schweiger

Keeping careful accounts: every extra expenditure is noted to keep track of a limited household budget.

The social reasons for vulnerability to poverty are primarily due to the typical earning biographies of women that still hold true to some extent today, but also follow a generation-specific logic. During the Adenauer period with its conservative family policy, the retired women of today were socialised according to a traditional model of womanhood that saw women merely as additional earners in families with a single main breadwinner where the female partner may not have worked or, if she did, worked only on a part-time basis.

Correspondingly little was invested in the education of children born during the war or the postwar years. For many women, the small size of their pensions is due to giving

up work to look after children, or working part-time or taking a break from work while raising a family – engaging in reproductive labour instead of remunerated work. The risk of poverty in old age increases if a woman has been divorced. In statistical terms, single mothers are also at a significantly higher risk of poverty, as are women with a migration background.

Although the specific risks facing women in old age, of being materially and thus often psychosocially precarious and vulnerable, have been known for a long time, there are very few studies that examine the fragilities of day-to-day life for retired women. How do women live and get by in an ex-

pensive city like Munich when the average pension is hardly enough to cover the costs of a one-room flat? This was the starting point for the DFG-funded project “Precarious Retirement. Work and the Conduct of Life of Elderly Women”, in which a team of cultural analysis researchers investigated how women live and get by in an urban environment with the aid of biographical interviews and participatory observation.

How do the women cope with everyday life in spite of money worries and, in many cases, physical limitations? What kind of work do they continue to do, for example “mini jobs” (the term used in Germany to describe part-time work with earnings of less than €450 per month), self-employment well into

old age, or providing support services to others? What strategies do they develop to save money and manage on a small budget? And what kind of support can they count on (be it family, neighbours, colleagues or public services)?

In particular, the team wanted to find out to what extent cultural capital (knowledge, education, qualifications) and social capital (networks) help to compensate for a lack of economic capital, resulting in differences depending on position in the social space and a different distribution of capital types (to borrow from the French sociologist Pierre Bourdieu). And to what extent do life courses that lead to poverty in old age reflect shared experiences specific to gender and generation?

The majority of the women interviewed were between 60 and 75 years old when the interviews were carried out between 2013 and 2017. Most had an income of only around €1,000 per month and little or nothing in the way of savings or a private pension. A large proportion were divorced, a few were widowed, and a small number had new partners earning a separate income, but living in a separate household. The biographical interviews, of which approximately 50 were conducted, provide microscopic insights into the lives and coping strategies of female pensioners in Munich faced with the prospect of dropping down the social ladder. The Bavarian capital serves as a useful example of one of Germany's most expensive cities. The interviewees described practices and attitudes with which they coped with a lack of material resources. The analysis showed that, in terms of the onset of and strategies for coping with poverty, an



Illustration: dpa/Sebastian Gollnow

individual's position in the social space with correspondingly varying amounts of social and cultural capital (Bourdieu) was just as important as gender-specific and generational factors.

The extent to which the interviewees were still able, health-wise, to cope with limited resources, to save, plan ahead, and conserve or divide up any existing resources was crucial. In addition to this sustained reproduction in a context of scarcity, there are also instances of production, for example swapping as part of an informal economy. However, opportunities to organise a clothes swap or make DIY gifts, for example, reveal social differences.

For instance, purchasing and storing fabrics to sew clothes requires sufficient means and storage space. The generation- and gender-specific knowledge from a postwar economy based on thrift and reuse, as well as domestic skills like cooking and sewing, also emerged as essential cultural capital. In most cases, having to budget affects all aspects of everyday life: property, clothes and furniture, and particularly physical wellbeing, which is often a limited resource that needs careful investment and maintenance.

When these forms of cultural capital – practices of self-care and the economical, sustainable use of

personal resources – have not been learned or can no longer be maintained due to health problems, and, most of all, when support networks are lacking, interviewees described the constant “scrimping” as a source of perpetual stress – with which they nevertheless have to cope through self-reliance. This may affect all aspects essential to participation in social life or even to survival, for example being limited to an inadequate diet and unhealthy food, abstaining from buying clothes, or only having the heating on in one room. In cases like these, individuals reported giving up hobbies and cancelling newspaper and magazine subscriptions. “Unnecessary” trips

Getting out of the house is important for older people with limited mobility. It often provides opportunities for social contact that are frequently lacking in day-to-day life.

by public transport are also avoided, often making it impossible to maintain social contacts.

After retirement age, opportunities for gainful employment to increase material resources and enlarge social networks are limited. But some people simply have to keep working, whether in a mini job, as a *Leih-großmutter* (a paid “grandmother”), managing a local exchange trading system, befriending seniors or doing care work. Community activities are regarded as desirable sources of auxiliary income.

Poverty in old age remains a taboo subject. In many cases, feelings of shame and guilt for not having provided for one's old age prevent older people from seeking support from public services. In particular, women in difficult economic circumstances express a desire not to be a “burden” to their families. This ties in with public moral discourse on the “old age burden”.

Anxieties associated with a “precarious retirement” include worries about the costs of illness or the frequently cited, dreaded scenario of being forced to move out of one's own home due to the rent or additional costs becoming too high.

In the interviews, in spite of the women's vulnerability and experiences of situational depression and anxiety – when the rent goes up again or they find themselves no longer able to cope with a mini job – they also revealed contentment and strategies for adjusting to old

age. They did, however, reflect on how these strategies appear fragile with increasing age and the fact that their future is insecure, particularly without any material margin to fall back on.

As people age, social differences, gender differences, and differences in income, education, and the quantity and quality of social networks become more crucial. Even for more skilled mini jobs – the number of over-65s employed in mini jobs is increasing – or voluntary activities, qualifications and contacts are extremely useful. The risk of poverty in old age thus increases if an individual lacks qualifications, has not spent a long time in employment, has little regular contact with children and family, or lacks a network of friends. All in all, the biographical interviews make it clear that being of retirement age, having a working-class or migration background, being female, and being a single-person household make an individual particularly vulnerable to poverty, a vulnerability that also extends to middle-class women. Poverty in old age is still an issue that Germany needs to get to grips with, and it has taken too long for it to be politically recognised as a problem.



Illustration: © Robert Haas

Prof. Dr. Irene Götz

is Professor of European Ethnology and Cultural Analysis at LMU Munich.

Contact: LMU München, Oettingenstr. 67, 80538 München, Germany

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The Deutsche Forschungsgemeinschaft

The Deutsche Forschungsgemeinschaft (DFG, German Research Foundation) is the largest research funding organisation and the central self-governing organisation for research in Germany. Its mission, as defined in its statutes, is to promote “all branches of science and the humanities”.

With an annual budget of around €3.3 billion, the DFG funds and coordinates approximately 31,000 research projects in its various programmes. These projects are carried out by both individual researchers and groups of researchers based at universities and non-university research institutions. The focus in all disciplines is on basic research.

Researchers at universities and research institutions in Germany are eligible to apply for DFG funding. Research proposals are evaluated by reviewers in line with the criteria of scientific quality and originality, and then assessed by review boards, which are elected for a four-year period by the German research community.

For more information, visit www.dfg.de/en

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The DFG currently has 97 member organisations, primarily comprised of universities, non-university research organisations such as the Max Planck Society, the Leibniz Association and the Fraunhofer-Gesellschaft, the Helmholtz Association of German Research Centres, and academies of sciences and humanities. The majority of the DFG's budget is provided by the federal and state governments, and it also receives funds from the Stifterverband.

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The fields of science and academia, research funding and science policy in Germany started the year 2021 like every year: with the DFG New Year's Reception. However, yet another consequence of the coronavirus pandemic was that various established and appreciated aspects had to be handled differently this time. Amid a second, even stricter lockdown in Germany, the DFG had to do without the beautiful atmosphere of the Leibniz Hall at the Berlin-Brandenburg Academy of Sciences and Humanities, without cheerful background music, our champagne reception and generally without the opportunity to meet in person and exchange ideas. Nevertheless, we were able to make virtue of necessity: In line with the DFG's nature as an organisation that has always been dedicated to promoting innovation, the function was held on an online platform on 11 January. In the form of avatars, the guests met around virtual tables to wish each other all the best for 2021, most of all good health, and to follow up on the DFG President's New Year's address she had given via a livestream. In her speech, Katja Becker pointed out the importance and the great long-term benefits of knowledge-driven basic research that have been highlighted throughout the current pandemic. At the end of the day, while the participants of this first ever virtual New Year's Reception regretted not being able to get together in person, they were pleased to be able to meet and talk at the start of the year at all, despite COVID-19.

