HELMHOLTZ PERSPEKTIVEN

THE HELMHOLTZ ASSOCIATION MAGAZINE | NO 01 | 2015

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The fight against MRSA

Resistant germs are conquering hospitals. Now scientists are preparing their counterstrike

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The Helmholtz Association with 37,000 employees in 18 research centres is Germany's largest scientific organisation and has an annual budget of approximately 3.99 billion euros.

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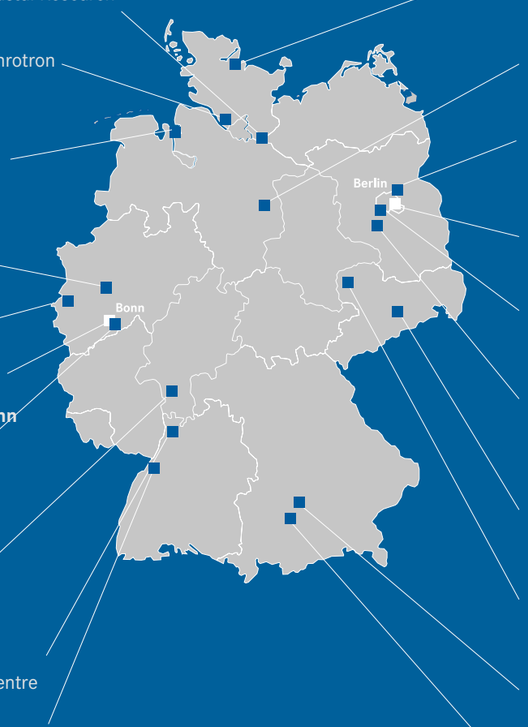

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→ HELMHOLTZ extreme

The lowest-elevation meteorological monitoring station in the world

Every morning, these scientists commute to their monitoring equipment along a shoreline railway that is otherwise used only by tourists in bikinis and swimsuits. In temperatures of up to 40 °C in the shade, they travel with their carrying cases to the shores of the Dead Sea, where they have erected a six-metre tower equipped with their measuring instruments. The station is situated 428 metres below sea level and is thus the lowest-altitude meteorological measuring station in the world.

Evaporation of the Dead Sea is being investigated by scientists from the Karlsruhe Institute of Technology in collaboration with international colleagues within the research network Virtual Helmholtz Institute Dead Sea Research Venue (DESERVE). They have been collecting data from the measuring station since March 2014, but the mast – set up directly on the shoreline – will not stay in that position for long. This is because the Dead Sea's water level has sunk by one metre since the installation and by about 34 metres since the 1970s. Holidaymakers can experience this extreme recession for themselves – the changing rooms used to be on the coastline, but now visitors have to travel an additional 1.5 km to reach the beach on the railway line that is also used daily by the scientists.

There are numerous causes for this extreme recession. The quantity of surface water that flows into the Dead Sea every year is continuously diminishing. Evaporation, too, seems to be responsible for much of the lowering water levels – although precisely to what degree remains a mystery thus far. Researchers have successfully collected information that should help them explain the mystery. Before too long, they hope to be able to make assertions regarding water availability in the region – even if they have to travel even further to get to the beach.

Angela Bittner

You can access all archived editions of HELMHOLTZ extreme here: → www.helmholtz.de/en/extreme

The sea used to be here This tower with its measuring devices is 428 metres below sea level. Measuring-station data can be viewed live at: www.deserve-vi.net/index.php/links. Photo: Ulrich Corsmeier/KIT, IMK-TRO

Dear Readers,

Helmholtz Perspektiven is published by the Helmholtz Association – with 37,000 employees, the largest research organisation in Germany. In this issue we report on the discovery of new active substances that could one day be deployed in the fight against infections caused by multi-resistant bacteria. Each year tens of thousands of people in Germany alone are infected by these germs – colloquially referred to as “hospital germs” or “hospital bugs”. Behind this seemingly innocuous term lurk bacteria that are barely affected by conventional antibiotics. They thrive in hospitals, where they can be life threatening to patients in a weakened condition. Researchers at the Helmholtz Institute in Saarbrücken have recently found two substances that are capable of eradicating these hospital germs; they are produced by other bacteria that use them to kill their rivals in order to gain more nutrition and living space for themselves. In our cover story, we describe the high hopes invested in this discovery (p. 6).

Even today, very few women are successful in their attempts to reach the upper rungs of the career ladder. We met two female scientists – one aged just 32 and the other 83 – and asked them about their professional experiences in the scientific community. There have been many differences but also a few surprising similarities (p. 14).

26 December 2014 marked the tenth anniversary of the devastating 2004 tsunami in the Indian Ocean. On that terrible day, hundreds of thousands of people lost their lives. In the meantime, a state-of-the-art early-warning system has been developed and installed in Indonesia. One geoscientist shows us how reliable the system actually is and talks about exactly what might happen during the next large-scale tsunami (p. 20).

I wish you a pleasant read!

Andreas Fischer
Editor-in-chief

Imprint

Helmholtz Perspektiven
The magazine of the Helmholtz Association
perspektiven@helmholtz.de
www.helmholtz.de/en/perspektiven

Publisher Helmholtz-Gemeinschaft
Deutscher Forschungszentren e.V.
Berlin Office, Communication und Media
Jan-Martin Wiarda (V.i.S.d.P.)
Anna-Louisa-Karsch-Str. 2 · 10178 Berlin
Tel +49 30 206329-57 · Fax +49 30 206329-60

Photo credits Title page: Uwe Bellhäuser; p. 4: Kim Keibel; p. 5: Uwe Bellhäuser, DLR, Gundula Krause, Daniel Friederichs/dpa, Tommounsey/istockphoto; David Ausserhofer; p. 14–15 and 17: Gundula Krause; p. 24–26: Jindrich Novotny; p. 27: pavila/shutterstock; p. 36: David Ausserhofer; p. 38: dkfz.de, HZG, HZI; p. 39: DESY, createvil/shutterstock

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Design concept Kathrin Schüler, Grafikdesign
Print/Distribution mediabogen, Berlin

ISSN 2197-1579
Paper Balance Silk® (produced from 60% recycled fibre and 40% FSC® pulp, FSC® certified, comes with eco label EU-Blume, certified according to ISO 14001 environmental management)

Subscription

The printed version of *Helmholtz Perspektiven* also appears at irregular intervals in English. If you would like a subscription free of charge send an e-mail to: *perspektiven@helmholtz.de*

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Staphylococcus aureus is the most common germ. Photo: Manfred Rohde/HZI

Preparing the counterstrike

They are one of the worst problems facing German hospitals: germs that have become resistant to antibiotics. In their battle against perilous bacteria, scientists are now hoping for positive results from two new substances

What Rolf Müller discovered this year could finally represent the crucial turning point in a ten-year war. It has been a merciless war, with an arms race, nationwide offensives, mass mortalities and sophisticated defence strategies. Germs are running riot in German hospitals, day and night. But we can't recognise these insidious perpetrators with the naked eye as they are just too small. Hands, noses, creases in the skin and the mucous membranes of the patients, visitors, nurses and doctors are the scene of the crime, along with doorknobs and insufficiently-cleaned nightstands – actually, almost everything you find in a hospital.

> In Germany more than 1,500 individuals die every year from infections caused by MRSA

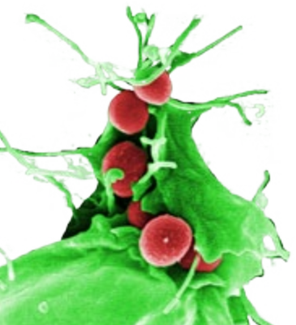
And thus bacteria that don't belong on the surface of human skin – and certainly not in human bodies – attempt to take up residence precisely there. If they do settle there, patients are given antibiotics with the intention of destroying the bacteria. Once the antibiotics have been administered over several days, they usually annihilate almost all of the problem germs – however, "almost all" remains the crux of the issue in hospitals. Those bacterial strains that are able to survive such a massive assault of antibiotics have most likely developed, by means of mutation, better defence mechanisms that render them resilient and dangerous. Antibiotics are powerless against them, and, ironically, even promote the spread of the germs. Once the antibiotics have wiped out all other bacterial strains, the multi-resistant pathogens have even more room to wreak their havoc.

Bacterial colonisation of the skin is seldom a problem, but in people with a weakened immune system, or with injuries or wounds from operations, germs can quickly invade the body, where they can contaminate the blood or cause life-threatening lung infections, for example. In recent years, these multi-resistant germs have made tens of thousands ill and caused the deaths of more than 1,500 patients each year. There is thus an urgent need for improved antibiotics.

Perhaps Rolf Müller's working group can bring this much needed relief. Müller is Managing Director of the Helmholtz Institute for Pharmaceutical Research Saarland, and he and his team have identified two active ingredients that are highly effective against the multi-resistant common germ *Staphylococcus aureus*, also known as MRSA, against which classic antibiotics can achieve little. "These substances are effective against MRSA, but leave human cell cultures unscathed. It looks like we've hit the mark at this point," says Müller.

Disciformycin A and B, as the two newly-discovered substances are called, are natural products: Müller's team did not produce them in the laboratory; rather, they found them with a different bacterial strain, the mycobacterium. Mycobacteria are prevalent where decomposing plant remains are found: in compost heaps, in soil, in gardens and woodland, and in animal faeces. Müller has been tracking this type of bacteria for several years now; whenever he or his employees take excursions with the institute, they always collect soil samples.

Subsequently, the team performed laboratory analyses to find out whether the discovered strains of mycobacteria were producing something that destroys other pathogens such as *Staphylococcus*



Rolf Müller (49) and his team are working on improved antibiotics. Photo: Uwe Bellhäuser

aureus as part of the competition for space and nutrition. "Mycobacteria look quite promising, because they are able to survive in all possible complex environments and, indeed, against other bacterial strains as well," says Müller, who has been engaged in the quest for new substances that function as antibiotics for more than 20 years.

> The discovered substances are able to circumvent the germs' line of defence

One Monday morning a few months ago, one of Müller's staff checked the cell cultures and discovered an "inhibition alarm" in one of the samples. In other words, an extract from the mycobacteria was inhibiting the *Staphylococcus aureus*. The team of biotechnologists and pharmacists got excited, and conducted further tests. Over the course of several years, Müller and his colleagues had assembled a database of all the substances known to them from the mycobacteria. This gave them a technological head start that was the envy of several pharmaceutical companies. The database allowed the substance responsible for the inhibiting effect on the bacteria to be identified faster. When the extract from the new mycobacteria was fed into the database, the group found an entirely new substance, one that appeared to inhibit the growth of the bacteria in a different way to classic antibiotics.

"The fact that a novel therapeutic mechanism has been discovered makes the whole thing quite promising," says Reinier Mutters, a microbiologist and head of the Hospital Hygiene department at Philipps-Universität Marburg. "Many antibiotics

disintegrate the bacteria's cell wall. This is good for treating patients, because human cells don't have a cell wall, which is why antibiotics that affect the cell wall have almost no undesired side effects. However, over time they have been deployed so often that those bacterial strains whose cell walls are vulnerable to antibiotics, slowly die out. Conversely, resistant strains that have developed defence mechanisms are able to propagate. Substances that affect the cell wall are practically powerless against today's multi-resistant germs." Mutters goes on to say that some germs have become resistant particularly quickly because sometimes antibiotics are not being administered consistently or for the full period of time. This is "evolution in the fast lane". Consequently, multi-resistant germs are becoming widespread: about 12 to 25 percent of the *Staphylococcus aureus* strains in Germany have already become multi-resistant, and in other countries such as Poland or the US, where antibiotics are administered more often, the rate is even higher, at more than 50 percent.

As long as infections involving resistant germs continue to be treated improperly, an increasing number of people will be at risk – in hospitals, of all places. "The death rate of patients who have had an operation with no infected wound is almost three percent. Ten percent of those who have had an operation and been infected with the conventional *Staphylococcus aureus* die, while the death rate of operation patients who have been infected with multi-resistant *Staphylococcus aureus* is around 20 percent," says Mutters. Patients in intensive-care and geriatric units are especially susceptible as their immune system is frequently impaired.

There are still a few antibiotics that have some impact on multi-resistant germs. "With vancomycin, for example, you can still get MRSA somewhat under control," says Dirk Schlüter, Director of the Institute for Medical Microbiology and Hospital Hygiene at University Hospital Magdeburg. He adds, however, that this is a so-called "reserve" antibiotic whose application involves a higher rate of risk: the dosage has to be adjusted to the kidney function to achieve an effective level, and also to avoid overdoses with undesired side effects.

Multi-resistant bacteria are particularly problematic for children, too. "For newborns and babies, infections with multi-resistant germs are often a matter of life and death," says Schlüter. This is partly due to the fact that children are not permitted to receive certain antibiotics. The problems are being exacerbated by the spread of multi-resistant germs outside hospitals.

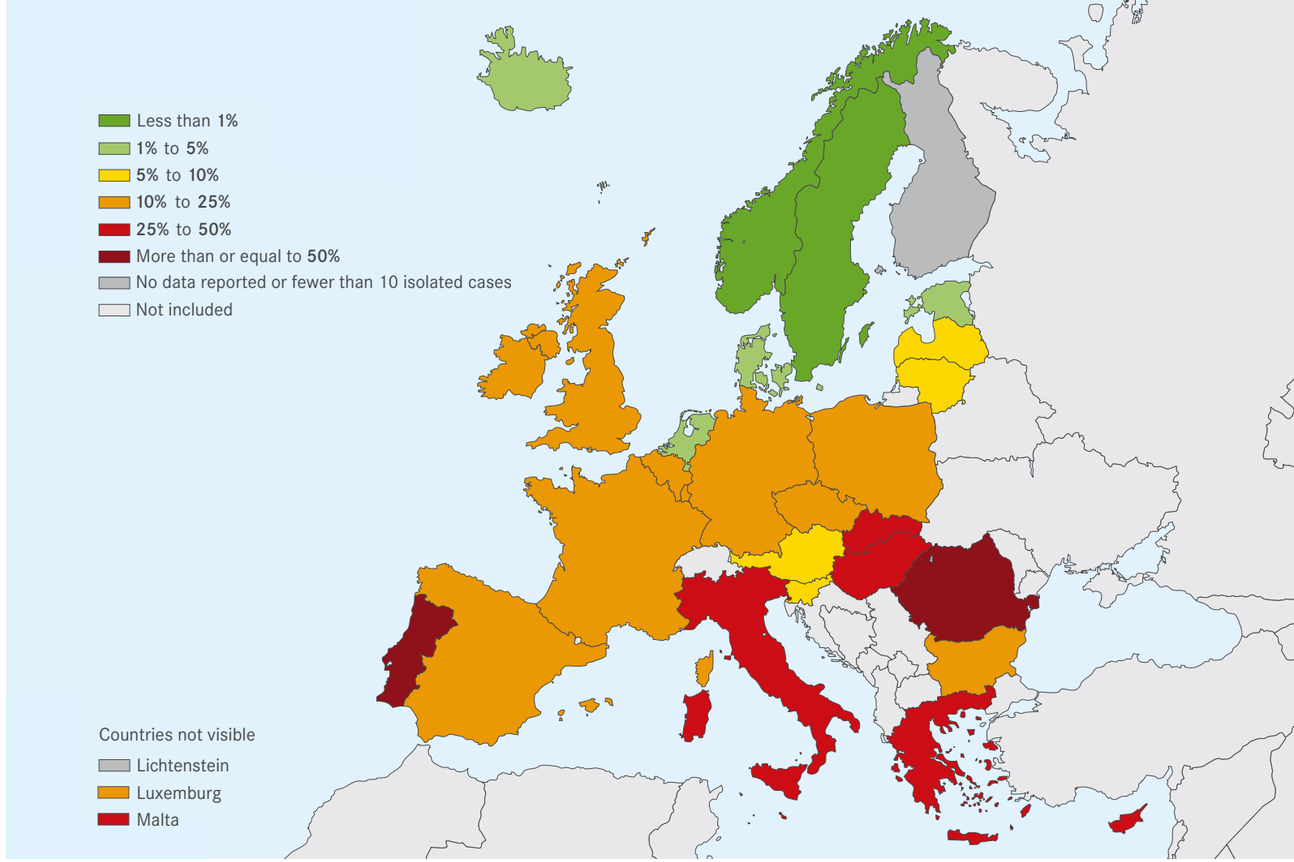
With the aid of the discovered substances and their new therapeutic mechanism, doctors hope to be able to take the germs by surprise in a place where they have not adapted any defence mechanisms and will thus be vulnerable. Schlüter: "Such substances are urgently needed. That's why researchers are hard at work and why discoveries such as this most recent one are of such significance."

If the substances discovered by Rolf Müller prove to actually deliver what the initial tests promise, they could stop the spread of the bacteria and destroy them precisely in those places where they could become so dangerous. There is still a way to go until that will be possible, however. Müller warns that the fact that the substance thus far seems to have no undesirable effects on human cell cultures does not guarantee that it will not ultimately turn out to be unsafe for humans. Apart from that, the substances must also be brought to the intended area, which frequently proves to be a challenge; active ingredients aren't always transported out of the intestinal tract and into the bloodstream, as desired. "And," Müller adds, "we have to somehow get our mycobacterial cultures to produce the substance in large quantities."

These challenges are being tackled in a concerted scientific effort. For example, researchers at the Leibniz Institute for Natural Product Research and Infection Biology (Hans Knöll Institute) in Jena discovered a similar substance around the same time as Müller's team. Only when both groups wanted to register patents did they actually learn of one another's work. Without further ado, they decided to collaborate in the future and applied for a joint patent. The weapons in the war on germs are undergoing an upgrade.

Christian Heinrich

The search for new antibiotics Research is being conducted on mycobacteria at the Helmholtz Centre for Infection Research as well; here Diana Telkemeyer (left) and Birte Trunkwalter study a culture under the microscope. Photo: Uwe Bellhäuser/HZI



Distribution in percentages Antibiotic-resistant strains of the "hospital bug" *Staphylococcus aureus* in Europe in 2011.

View from the HALO cockpit This photo shows the nose boom of the research aircraft HALO in front of a retreating storm. The data collection flights over the Amazon region each took about seven hours. Photo: DLR (CC-BY 3.0)

Telegram

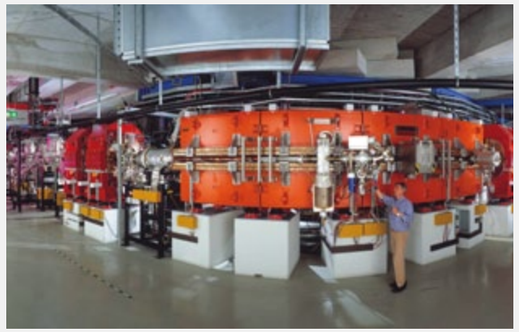
Research +++ Research policies +++ Dates

Tracking down thunderclouds

Scientists involved in the ACRIDICON-CHUVA project have been studying the large thunder clouds that regularly form over the rainforest. From September to October 2014 they carried out data collection flights in Brazil's Amazon region in order to find out how thunderstorms form, what effect they have on the climate system, and what micro-physical processes are taking place inside the clouds. The flights were carried out with the research aircraft HALO, operated by the German Aerospace Center (DLR). Also on board were a team of scientists from Forschungszentrum Jülich who are primarily interested in the interactions between aerosol particles, cloud droplets, ice crystals, wind, and solar radiation in the atmosphere. Many of the aerosol particles in the atmosphere above the Amazon region originate from slash-and-burn clearing operations. Initial analyses of the data show that the aerosol particles evidently exert a huge impact on the formation of clouds. Clouds polluted with aerosol particles have a higher concentration of water droplets than clean clouds, and the water droplets are smaller. They thus allow less sunlight through to the earth's surface than a cloud with larger droplets and have a stronger cooling effect, resulting in quicker formation of rain.

Einstein's theory of relativity stands up to the test

Two fundamental theories of physics were tested under extreme conditions at the experimental storage ring of the GSI Helmholtz Centre for Heavy Ion Research. The two theories in question were Einstein's special theory of relativity and quantum electrodynamics. Scientists from TU Darmstadt and their international colleagues confirmed the predicted concept of time-stretching at high velocities with a degree of precision never before seen. The scientists were also able, for the first time, to give a direct proof of a spectral line with highly charged bismuth ions. Previously, researchers had searched unsuccessfully for almost 14 years for this proof for quantum electrodynamics.



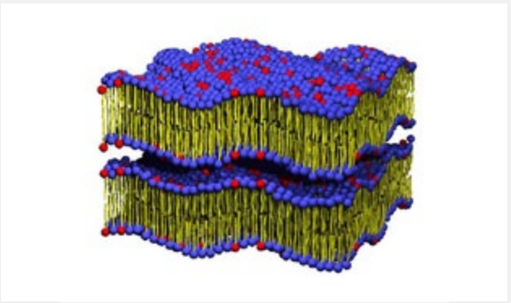
Fundamentals of physics confirmed The experiments took place at the GSI experimental storage ring. Photo: J. Mai/GSI

Skin creams as vaccinations

Scientists at the Helmholtz Centre for Infection Research and the Helmholtz Institute for Pharmaceutical Research Saarland have discovered a new vaccination method that allows active agents to be administered directly through the skin. The researchers packaged the agents in nanoparticles, which settle next to hair follicles and can thus enter the body. In early trials, the vaccine dosage dispensed in this manner did not trigger a sufficient reaction from the immune system, so the researchers developed additional agents. Now, when the creams are applied to the skin, this fortifies the immune response, allowing the body to build up immunisation protection.

Researchers film oscillation of lipid membranes

Scientists at the Universities of Göttingen and Augsburg have recorded the motion of lipid molecules at the Deutsches Elektronen-Synchrotron DESY. Double layers of these molecules form membranes that surround the cells or some cell components. Their properties are of great interest as they control which substances can enter and exit a cell and which materials can be exchanged between different areas of a cell. The researchers set layers of lipid molecules in motion by means of ultrasound and "filmed" them with short X-ray flashes from the light source PETRA III. They were thus able to observe that the layers did not only move up and down, but rather that their inner structure also began to vibrate. Through this involuntary movement, the layers periodically change their thickness and density. These findings have provided completely new perspectives on the dynamic characteristics of such molecules.



Collective vibrations Lipid membranes are stimulated to vibrate using ultrasound. Image: T. Reusch/T. Salditt, University of Göttingen

Cosmic jets reproduced for the first time in the laboratory

Astrophysical jets are among the universe's most spectacular phenomena; they are jets of matter that shoot out of the centre of a black hole or young star – sometimes across light years of space. Researchers at Helmholtz-Zentrum Dresden-Rossendorf have been working with international colleagues to develop a model to show how magnetic fields form these jets. In the future, these findings may help scientists to develop cancer therapy using proton beams.

Gyroscope in outer space Sometimes the jets of matter spurting from a forming star shoot light years across space. Photo: ESO/L. Calada

Methane identified in the Antarctic Ocean

An international research team has discovered more than 130 active methane sources on the seabed off the sub-antarctic island of South Georgia. The team conducted their investigations using an echo-sounding system on an expedition with the research vessel Polarstern, which is operated by the Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research. The scientists were also able to prove that the emergent gas is not escaping into the atmosphere and is thus not compounding the greenhouse effect.

Polarstern in South Georgia The German scientific research vessel Polarstern in Cumberland Bay. Photo: Thomas Ronge, Alfred-Wegener-Institute

Can steel keep its promises?

Scientists have developed a new procedure to examine the material quality of steel. Using neutron tomography, an imaging procedure, researchers at Helmholtz-Zentrum Berlin and the University of Tennessee, Knoxville are able to gain precise insights into the inner life of steel. They are thus now able to identify where precisely the material changes under stress – irregularities that are not visible using conventional techniques. Thanks to the new methods, defects can be detected in good time, improving reliability and safety.

EU Parliament rejects research budget reduction

Helmholtz Office Brussels: The European Parliament Committee on Industry, Research and Energy (ITRE) has vehemently rejected the EU Budget draft for 2015. The EU Council budget proposal includes considerable cuts – particularly in research and innovation. Accordingly, there would be around ten percent less funding available for research than in the committee's original proposal. Agricultural programmes, on the other hand, would only experience a cut of 0.1 percent. As a result, Horizon 2020, the EU's Framework Programme for Research and Technological Development, is set to lose about EUR 200 million for new projects and roughly EUR 1 billion for on-going projects. Now, the Council, Commission and Parliament will have to reach some form of compromise.

Russia's largest solar power plant opens

Helmholtz Office Moscow: Russia's largest solar power plant has been brought on line in the western Siberian republic of Altai. The power station in the district of Kosh-Agach provides an output of five megawatts and supplies the entire region with clean electricity. It is the first of a total of five solar plants planned in the Republic of Altai with an overall capacity of 45 megawatts. All five plants are to be completed by 2019. Investments total approximately five billion roubles (about EUR 105 million). At the plant's inauguration ceremony, Russia's President Vladimir Putin emphasised that the continued development of alternative sources of energy is a crucial goal for Russia.

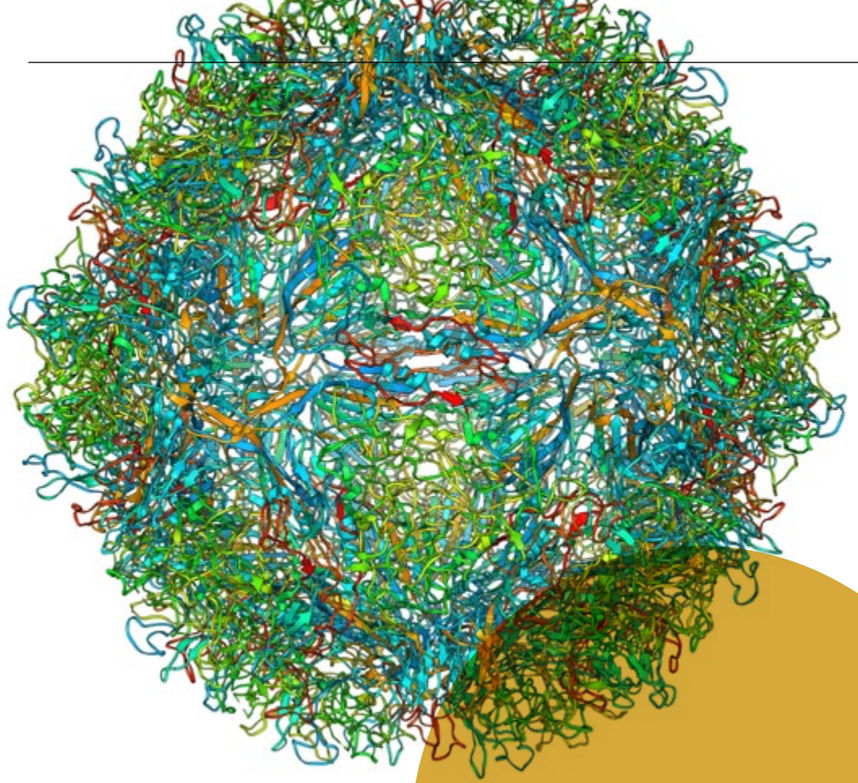
Saskia Blank

Important Dates

14 Feb. 2015
AAAS 2015 Annual Meeting
Press breakfast: "How to become a successful scientist – scientific careers in different times and systems"
Discussion with two experienced and two younger scientists from the United States and Germany about career opportunities
7:45 AM, AAAS 2015 Annual Meeting, San Jose, USA
→ http://meetings.aaas.org

20 Feb. 2015
Destination Europe Conference
Information event for job and funding opportunities in European research, organised by the European Commission
9 AM – 5 PM, Massachusetts Institute of Technology, Boston, USA

21 Feb. 2015
European Career Fair
Event for students at all levels offering the opportunity to connect with European employers,
Helmholtz information desk "Research in Germany"
9 AM – 4 PM, Johnson Athletic Center, Massachusetts Institute of Technology, Boston, USA
→ https://ecf.fairsey.com



Q&A!

Why are certain viruses attracted to cancer cells?

Cancer-eating cluster A three-dimensional model of the external envelope of a parvovirus, which surrounds the genetic material of the virus. Photo: LAGUNA DESIGN/SPL

Parvoviruses are able to attack and kill cancer cells without causing disease in human beings; this important information is being used by scientists at the German Cancer Research Centre (DKFZ) in Heidelberg. Since 1992, they have been developing a virus therapy to fight dangerous and barely treatable brain tumours. In 2013 a clinical study demonstrated for the first time how safe the parvovirus therapy is. Here, DKFZ researcher Jürg Nüesch explains how the viruses take on the cancer cells:

"There are several mechanisms that help cancer cells to multiply quickly – for example, signal chains that counteract programmed cell death, or signals that allow the cell to separate from the original tissue and resettle in a different location. It is these same mechanisms, however, that also help the parvovirus to mature quickly. Once the viruses have sufficiently multiplied, they cause their host cells to burst – thus allowing them to immediately attack new cancer cells. Following the viral attack, the immune system becomes aware of the cancer cells and helps to destroy them. This is particularly useful in the fight against brain tumours, since operations on the brain are difficult.

Parvoviruses originally stem from rats and cannot replicate in human cells that do not divide. But cancer cells divide frequently – and thus the virus inside them matures as well. We are currently working on a study involving 20 patients with a certain kind of brain tumour called glioblastoma. We are steadily increasing the dosage of the viruses. We have already observed that the viruses are able to find the brain tumours even after being injected into a vein in the arm. Thus far we have seen no side effects, even though we have reached the second-highest dosage level. In a larger subsequent study, we would now like to examine whether the viruses also help to prolong patients' survival."

Stefanie Seltmann asked the question

“You don’t want this girl to make fools of you, do you?”

Two female scientists, one at the beginning of her career, the other at the end, met to talk about old prejudices, small victories, and the crucial question: How can I carve my own path? A discussion with Brigitte Wittmann (83) and Eva Rosenbaum (32)

Pinoneers
Anandabai Joshee from India, Kai Okami from Japan, and Tabat M. Islambooly from Syria completed their medical training at the Women's Medical College of Pennsylvania in 1885. Each was the first woman from her respective country to acquire a degree in western medicine.
Photo: http://xdl.drexelmed.edu/item.php?object_id=2373

Ms Wittmann, you were enrolled at the University of Gießen in 1950. Was it difficult, as a woman, to get a place at university?

Wittmann You bet! The soldiers who had fought in the war had returned and they were given first choice. I changed universities three times in order to be finally accepted on the undergraduate and graduate programmes in chemistry. In the meantime I was forced to study biology because women weren't accepted in the laboratory.

Was it actually put to you like that: We don't accept women?

Wittmann Just like that. There were no set rules, but the professors simply didn't want it. For them it was clear that a woman would simply quit after completing her degree. In Tübingen it was particularly difficult, but I still really wanted to go there. There was only one other female student, out of about 60 students. And she did in fact leave after getting her degree. When I announced that I wanted to go on to get my PhD, they claimed that I would never be able to get a job, certainly not in industry – in a library at best.

Rosenbaum There weren't that many women in my first semester either – five or maybe eight out of 120. But I've never heard of a situation like yours, Ms Wittmann. In my day it was more subtle. When I was in a maths class in school, for example, and I was the only one who knew the answer, the teacher once said, "You don't want a girl to make fools of you, do you?" Later on I had an English teacher who was asking the class about what we wanted to study. When a boy said "Physics", he said, "That's a really exciting subject", but when I said "Physics", he asked, "Really? That's very difficult!"

Wittmann But when you started studying, it was different, right?

Rosenbaum When I began studying in Heidelberg in 2000, they were grateful for each individual starting the programme. The workgroup leaders were in competition over who could get the most students to join their laboratories. In this respect, I think that the professors were pleased when a woman showed interest in their subject. But I was never sure if it was just about keeping up with quotas set by politicians to get more women to study natural sciences.

Wittmann For me, the turning point came later on when Adolf Butenandt, who went on to become President of the Max Planck Society, was trying to establish a Max Planck Institute for Biochemistry in Munich. At the time I heard about that, I was working towards my final exams in Tübingen and I instantly knew "This is it!" Butenandt employed female biologists, pharmacists, medical physicians – you didn't really stand out so much as a woman. And he did indeed take me on! The topic that he gave me for my doctoral thesis, though, was not what I had originally wanted. As the daughter of a pharmacist, I wanted to conduct research into plant compounds, but Butenandt said: "We'll begin with the structure of haemoglobin, and you'll be the first to study in that area."

Rosenbaum We were able to choose our topics ourselves. All of the possible topics were listed on the university website, offered by the various laboratories. And of course, there were more topics than students.

So, suddenly, you were there in a Munich laboratory, Ms Wittmann, and you were supposed to conduct research on the structure of adult haemoglobin, a large protein. What was that like?

Wittmann There were no guidelines, no instructions. The only group doing research on this topic was in Prague. They were doing paper chromatography. But you couldn't just go to Prague and interview them. So I showed my supervisor the Prague article and said, "This is how I want to do it." He was against it at first, but I didn't give in. When Mr Butenandt came around, every two or three months, I always had everything prepared. But he just said that it was all very interesting but he couldn't give me any advice because he hadn't worked in that field before. I thought that was really honest of him.

Rosenbaum My boss didn't know much about my topic either, but he knew someone who knew someone that we could ask. And in the age of e-mail, low-cost telephone connections, and regular conferences, it was no problem to get in touch with the people.

How did you go about getting advice from your colleagues in Prague, Ms Wittmann?

Wittmann You couldn't even write a letter. It would have been opened and the scientists there would have got into trouble. Later on, when one of the Prague students travelled to Paris, I was able to meet him. We were finally able to meet!

With the aid of paper chromatography, you were able to separate peptides, that is, fragments of proteins. Does this method still exist?

Wittmann Not at all! From a modern standpoint, that method was totally primitive: using a sewing machine to sew together one or two-dimensional strips of paper with the pre-separated peptides for subsequent separation onto paper. We had a kind of big tank in the chromatography room, which we had to patch it up once a week, because the gasket always slipped. Friday was patch-up day, to make sure we could suspend more chromatograms again the following week.

Rosenbaum In biology I also made all my samples myself, doing the pipetting in particular. Of course, our equipment was not patched up so much, because today there are commercial suppliers for things like that. But I did put things together myself a bit, with lots of tape and screws and stuff. That was actually the most fun part.

Mr Butenandt came around every two or three months to see Ms Wittmann. Ms Rosenbaum, how often did you see your professor?

Rosenbaum He had just been made professor and didn't have very many students to advise at that time. I could just go into his office and ask him anything. But I didn't have very much contact with the director of my institute. She knew my name, but that was about it.

Wittmann Mr Butenandt organised a seminar once a week that we called "kiddies' hour". He specified a certain topic for the week, and we had to prepare for it. Then he would ask, "Honourable colleague, could you please stand up and draw that on the blackboard?" It was a bit like an examination.

From 1967 to 1991 bio-chemist **Brigitte Wittmann (83)** was a group research leader at the Max Planck Institute for Molecular Genetics in Berlin. In 1992 she joined the Max Delbrück Center in Berlin-Buch. She wrote her doctoral thesis on the primary structure of protein components in human haemoglobin in the late 50s under Adolf Butenandt, later President of the Max Planck Society.

Bio-physicist **Eva Rosenbaum (32)** has been a postdoc at the Max Delbrück Center (MDC) since 2011. She is investigating the structures and mechanisms of membrane-deforming proteins. She studied at the University of Heidelberg and then at Grenoble, where she completed her PhD.

Rosenbaum There wasn't anything like that during my PhD in Grenoble. But on the other hand, that's the way it is now at the Max Delbrück Center, where I am now. Once a week someone presents the progress they've made in their studies.

Wittmann But today that's limited to the narrow field of one's own research. Nobody is an all-rounder any more, knowing all about an entire field, be it biology, medicine or chemistry.

Rosenbaum We also try to look beyond the end of our noses. We have another seminar where someone has to introduce a publication that is not directly related to our topic. It's not exactly outside our field, though – it mostly deals with molecular biology, biochemistry or biophysics.

How did you finance your PhD studies, Ms Wittmann?

Wittmann Thankfully, I had a very understanding father. There were no scholarships at that time; I just got 100 deutschmarks per month in the final year of my PhD. The fact that my mother had also studied chemistry and finished her PhD in 1924 certainly helped. I was 29 by the time I completed my PhD. My parents helped me throughout that time, even though there were four of us kids. I was working as well, to make a little extra money.

Rosenbaum At the university?

Wittmann What are you thinking? Women couldn't do that! I worked for TOTO, checking lottery tickets. Row after row, number after number, using a template. In the evening I was ready for the funny farm.

Rosenbaum For me, it was normal that we all had a PhD research position. In France, I had a grant from the Ministry of Research and a small teaching job at the university. It wasn't a lot of money, but since I'd been on a student budget before that, it seemed a lot.

Ms Rosenbaum, you went to France for your Master's Degree. Is international study more important today than it used to be?

Rosenbaum If you want to start a career in science, you have to go abroad early on. I find that dogma a little too extreme, though. Of course it's important that the people change laboratories once in a while, but you could theoretically do that within Germany too. However, the reality is that if you apply somewhere and they see that you haven't spent at least two or three years in a foreign country, you're out of the race.

Ms Wittmann, before you moved to the Max Delbrück Center, you had been at the Max Planck Society for 30 years.

Wittmann Yes, but I was lucky. When I was working as an assistant in Munich while I was doing my PhD, they made it clear to me that, as a woman, I didn't have a chance to stay any longer than two years. Actually, I wanted to go to America, but in the end I got married and went to the institute where my husband was working.

Was it typical at that time to be taken on at an institute where one's husband was working?

Wittmann Of course not. We met because we were working in the same field. My husband had been sent to Munich to learn our methods. I was the one who showed him everything about proteins. And then we just kept on working with one another.

Was there any pressure for you to just stay at home?

Wittmann No. I was even being paid for my work, which was important because I had children and needed my money for childcare. Later, our group leader was appointed to a professorship in Belgium and asked me if I would take on four of his doctoral students. I said, "I've got a small baby at home, how am I supposed to manage that?" In the end I did it anyway, and got the students through. But that was never the intention – I always had just a simple employee position, like a postdoc. Officially I was a group leader, but the salary didn't reflect that.

Rosenbaum A position as group leader is my next goal, too. Nowadays it's not hard to find a postdoc position – there are so many of them. But they are all with limited contracts. And we've all got this contract law for scientists hanging over us that says we can't have an indefinite period of employment for any longer than twelve years. Those individuals who haven't been able to land a permanent position by then are out.

What do you mean when you say "a permanent position"?

Rosenbaum A professorship. There are almost no other permanent positions. According to the statistics, three percent of all PhD graduates get a professorship, and ten percent of postdocs. That means that we postdocs are faced with a 90 percent chance of things not working out.

Wittmann In other countries, scientists are part of the institute or the university, and they have a permanent job there. Also, they are always allowed to change their assignments or move to new projects.

Ms Rosenbaum, would you be satisfied with a group leader position? Or are people obsessed with continually climbing the ladder?

Rosenbaum That's just what I've been asking myself lately. I really like working in the laboratory. My boss, on the other hand, is almost always busy with fundraising and evaluating the publications of other people. I've never seen him actually pick up a pipette.

Many scientists complain about the pressure to publish. Did this problem already exist back in your day, Ms Wittmann?

Wittmann Back then things were just getting going with the English-language journals. But our bosses still wanted to publish in German. They wanted everything to go back to how it was. That was something us young folks found easier. But what we didn't have back then, thank goodness, was this scaling system – the idea that there are so many points for one journal and fewer for another.

Rosenbaum That's just what I find so frustrating – the fact that it doesn't matter how good your research is but rather where it's published. That is then seen as the only measure of quality. And if someone wants to publish something that goes against scientific doctrine, they won't get into the best-regarded journals. The irony is that it's only ten years later that you can tell whether something was revolutionary or not.

Let's talk about the topic of how to combine family and a career. Do you think anything has changed in that regard, Ms Rosenbaum?

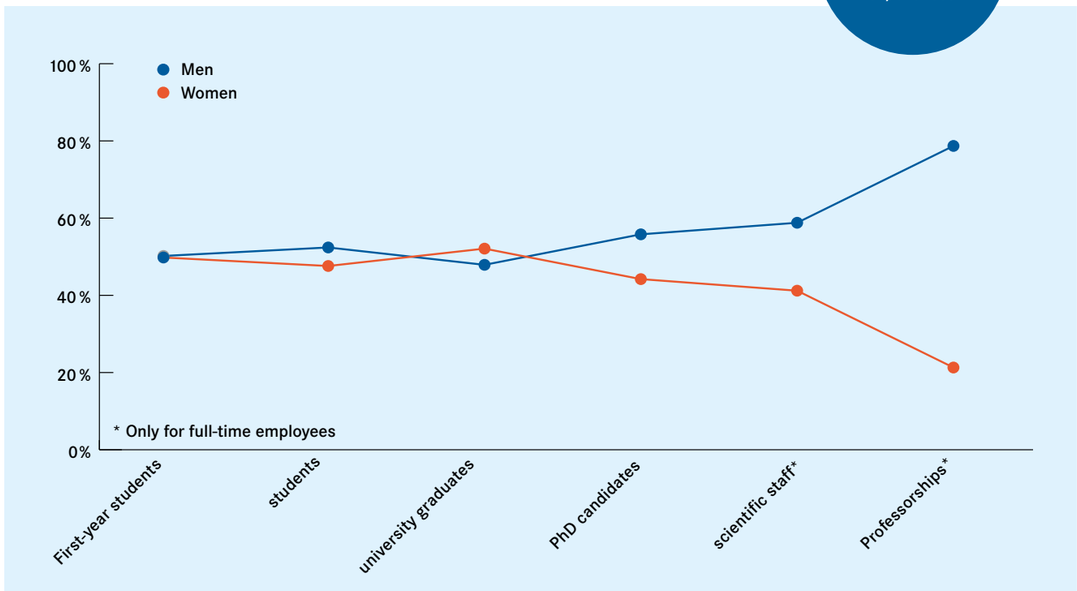
Rosenbaum It's difficult enough for a single person to get to stay in the same city. I know a lot of couples in my circle of friends who have to maintain a long-distance relationship. That brings me back to the fixed-term contract law, which represents a huge obstacle for us women. You can get one extra year per child, but the time most women want to start a family is precisely the period of time when we have to be the most productive if we want to achieve anything within this system.

Wittmann I think the main difference today is that women have really good opportunities – as long as they're willing to defer having kids. You have too many responsibilities, you've got to travel to conventions, work nights in the laboratory – and on Saturdays and Sundays. That's very difficult to manage if you have small children.

Rosenbaum Men manage it. If we were to turn those traditional roles around then just maybe it would work.

Interview: **Jan-Martin Wiarda**

More on this topic at: → www.helmholtz.de/en/chances



The percentage of women in science decreases as we move up the career ladder. Source: Federal Statistical Office

Ao Nang Beach 26 December 2004: The third and largest tidal wave hits the beach. Photo: Jeremy Horner/Corbis

Those crucial five minutes

Ten years ago, a tsunami in the Indian Ocean claimed hundreds of thousands of lives. In the meantime, scientists in Indonesia have constructed one of the most modern tsunami warning systems in the world. It is meant to give inhabitants enough time to reach safety

It is the morning of 11 April 2012, and the sirens in the Indonesian city of Banda Aceh sound their sinister warning – tsunami alarm! Urgent announcements are made over loudspeakers, radio and television channels interrupt their programmes, and mobile phones send alarms via SMS. Inhabitants and tourists quickly leave the beaches, while rescue teams initiate the evacuation procedure. The earthquake that shakes the seabed off the coast of Sumatra on this day is one of the most powerful since the beginning of seismological recording.

The locals sat in fear for three hours on that day in April before the officials announced the all-clear. It was only due to a fortunate geological coincidence that the powerful earthquake did not trigger a tsunami. Yet the area-wide evacuation served as confirmation that the early-warning system works – and that it can save thousands of human lives.

That was the crucial difference to the devastating tsunami of December 2004. When waves of up to 30 metres in height crashed onto the coastline that fateful day, there were no warnings whatsoever. Almost a quarter of a million people lost their lives, and Banda Aceh looked like a wasteland. “It was clear to us that we had to do something,” says Jörn Lauterjung, a geoscientist at the Helmholtz Centre Potsdam, German Research Centre for Geo-Sciences (GFZ). As project leader of a team representing nine German research facilities, he was given the huge task of constructing a tsunami early-warning system in the Indian Ocean. The funding came from the aid fund for the tsunami victims. Lauterjung was confident from the beginning despite all the challenges that lay ahead: “We had the technology that would enable us to help the people on site.” The system that was ultimately developed by the team of geoscientists, oceanographers and IT experts is an ingenious one adapted specifically to the conditions in the Indian Ocean. More than 160 seismometers distributed through Indonesia and an array of GPS satellite sensors provide constant real-time data. There are also tide-gauge stations along the coast and on offshore islands to monitor the sea level. The data

Disaster drill Indonesian schoolchildren learn what to do in the event of a tsunami. Photo: GITEWS

Prepared for the worst Warning system officers receive training. Photo: H. Letz/GFZ

all flows into a specially designed warning system in Indonesia's capital Jakarta, where scientists monitor the Indian Ocean day and night. The high-tech headquarters in the city are the centrepiece of the GITEWS (German-Indonesian Tsunami Early-Warning System).

The technology is precisely configured to detect tsunamis as they occur; they are almost always activated by a strong earthquake on the seabed. Two tectonic plates meet off the Indonesian coast, where the Indo-Australian Plate slowly creeps several centimetres underneath the Eurasian Plate every year, resulting in frequent strong earthquakes. A dense network of earthquake stations thus forms the core of the early-warning system. The seismometers are distributed so that an earthquake can be detected within two minutes by at least three stations. The more precisely the staff at the warning centre can identify the location and strength of the earthquake, the better they can predict when and where a tsunami might hit. But not every strong earthquake generates a tsunami. The data from the seismometers alone cannot determine whether or not a tsunami will occur.

The warning system therefore receives additional information via GPS regarding the direction in which the seabed is shifting. It is only when the seabed actually rises during an earthquake that it displaces the mass of water located immediately overhead. A tsunami subsequently spreads out in a circular pattern on the surface of the ocean. Conversely, if the seabed merely shifts to the side, the wave fails to materialise – which is why the earthquake off the coast of Sumatra in 2012 turned out to be so harmless.

> "Even if an early-warning system is incredibly sophisticated, fatalities can still never be avoided completely"

Every alarm is nerve-racking for the staff at the warning centre, as in the event of an earthquake they only have five minutes to initiate an evacuation. The geology of Indonesia allows very little leeway, because the first tsunami waves can reach the main islands in the country just 20 to 40 minutes after a quake, with the numerous offshore islands getting hit even earlier. That's why Lauterjung and his colleagues made only limited use of the technology employed in other early-warning systems in the Pacific. In Hawaii, for example, it usually takes several hours for a tsunami to reach the beaches following an earthquake. "In Indonesia, on the other hand, officials have to decide very quickly, on the basis of limited data, whether an evacuation should or should not take place," explains Lauterjung. Because the lives of hundreds of thousands of people could depend on such a decision, there is a clear maxim for the employees on site: "For all warnings with uncertain data, the worst-case scenario has to be assumed."

It is impossible for the employees to evaluate all of the data in an emergency, since that would take several days. To enable them to make decisions as precisely as possible, Lauterjung and his team have designed a Decision Support System. The core of the system is comprised of simulations; more than 3,000 model calculations with multiple scenarios are available in the database. A computer compares the current readings with these models and is thus able to ascertain with lightning speed which of the pre-calculated scenarios best corresponds to the reality of the situation. The technicians are then able to use this more precise information to make their decisions. Despite the previous success of GITEWS, Lauterjung is aware of the limitations of the tsunami prognoses: "Even if an early-warning system is incredibly sophisticated, fatalities can still never be avoided completely."

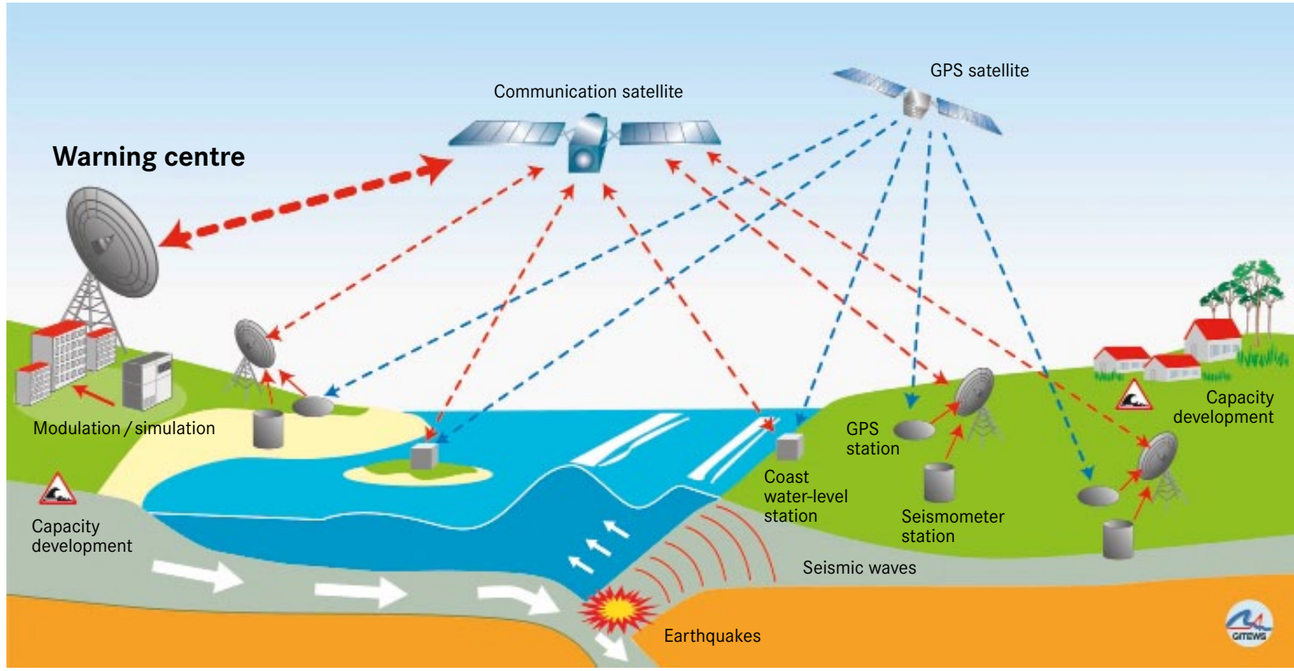
Evacuations in Indonesia are extremely complicated, since the country is made up of more than 17,000 islands and has an extremely long coastline. Also, many of the roads are in poor condition. That's why evacuation exercises take place annually, and people are trained in the right behaviour to adopt in case of a tsunami. Employees of relief agencies make a considerable contribution. The international aid organisation Diakonie Katastrophenhilfe, for example, works with locals in high-risk tsunami regions, equipping them with alarm devices and helping them to take precautionary measures. Flood-risk maps have also proved to be a useful aid. These mark dangerous areas, escape routes and shelters. "We want to make sure the inhabitants can recognise the early signs of a tsunami, such as retreating water, and can pass on warnings to other endangered individuals and help them evacuate," says Caroline Hüglin, who coordinated the Diakonie Katastrophenhilfe project in Sumatra until 2007. Hüglin is convinced that the most effective protective measure is knowledge about how tsunamis work, since there is such a short window of opportunity following the warning signal.

Indonesia has acquired the status of a Regional Tsunami Service Provider that warns other countries in the region when a tsunami is imminent. The Indonesians are thus able to relieve technicians in Japan and the US, who were thus far in charge of tsunami monitoring in the Indian Ocean. In the future, perhaps the five-minute warning period can be reduced. Jörn Lauterjung of the GFZ is optimistic that tsunami early-warning systems can become faster. He says it is conceivable that additional sensors and satellites could be deployed to fortify the detection network. In the end, however, there are physical limitations to what is technically feasible, because earthquakes are not predictable: "Something has to move before we can measure it."

Sebastian Grote

Jörn Lauterjung. Photo: GPM

Early-warning system
The operating principle of the tsunami early-warning system for the Indian Ocean.
Image: GITEWS



Should there be more permanent contracts in research?

The German Education Union GEW has been calling for more long-term jobs in science for many years, and now Federal Minister of Education and Research Johanna Wanka is adding her voice to the demands. Is the need for action really that severe? We present two points of view

"A permanent position for all staff would prevent scientific facilities from reacting quickly to new scientific developments",

says Hans Müller-Steinhagen, Rector of TU Dresden

I should point out right away that I have always been in favour of family-friendly working conditions and personal development. Longer-term employment contracts allow for more comprehensive planning security, particularly in core subjects and at larger research facilities.

Nevertheless, calls for a vast increase in the number of permanent employment agreements are going too far. If we compare Germany to the international scientific landscape, we see that there are no permanent positions according to the German model in many countries. On top of that, there are five factors that I think serve as justification for retaining a substantial proportion of non-permanent employment contracts. These are: staffing structure, our obligation to be fair to all generations, the unpredictability of scientific developments, the availability of positions that can be filled by newly appointed junior professors, and finally, the need to acquire the brightest minds.

At my university there are 4,661 scientific staff members. Fifty-six percent of those positions are financed through projects. These people cannot be taken on permanently precisely because of the limited duration of the projects and the limited financing available for them. Among the remaining 44 percent, there are many so-called "qualification positions". If we were to make all these permanent today, we would not be able to staff the positions with new doctoral candidates for decades to come. This would lead to a lack of new and fresh ideas and would be unfair to subsequent doctoral candidates, who would be short of opportunities.

Scientific personnel are linked to certain topics. A permanent position for all employees would prevent scientific facilities from reacting quickly to new scientific developments. New topics would be recognised, but new personnel could not be appointed. There are no professional negotiations in which the question is not posed of how many positions can be filled by candidates within our own personnel. If the answer is "none", the odds of filling that position are extremely bleak – no matter how good the existing personnel are.

In my opinion, the solution can be found in a measured balance between permanent and temporary posts and in taking a flexible approach to employment contracts in the interests of science.

"It is time for science to start thinking about new forms of staff development",

says Andreas Schlossarek of the working group of the works and staff councils of non-university research institutions (Arbeitsgemeinschaft der Betriebs- und Personalräte der außeruniversitären Forschungseinrichtungen)

It seems that the topic has at least registered with the responsible parties now. There has been a lot of discussion in recent years in universities and research facilities about how non-permanent work contracts have made it difficult, if not impossible, for employees to make longer-term decisions about their lives and family planning. Also, high levels of fluctuation have cost the research sector much valuable know-how. The fact that the debate is becoming heated can be seen, for example, in the recommendations from the council on career advancement in universities, which includes criticism that there are not enough permanent positions for permanent tasks. It has also been observed that the lack of permanent positions generates insecurity and dependency, is not family friendly, and hampers equal opportunities.

I can only agree with Education Minister Johanna Wanka's warnings to the universities that the money made available to the states now that the Federal Government has taken on responsibility for student grants should also be used for permanent positions. But certain areas of the Helmholtz Association also offer short-term contracts, apparently with the goal of ensuring flexibility but this does lead to on-going insecurity for employees. In principle, so long as the human resources department practices forward-looking workload planning, the problems with temporary positions could be avoided. Moreover, a principle of "permanent positions for permanent tasks" should be adopted. The fact that some projects are of limited duration does not have to conflict with this. Of course there have to be postdoc positions, and in certain fields temporary contracts are needed to allow science to remain responsive. But in my experience, many institutions use this argument to shirk their responsibility – they feign a need for flexibility in order to avoid having to offer any permanent contracts at all.

I believe it is time for science to start thinking about new forms of staff development. And researchers on temporary contracts have to be incorporated into these considerations. Their motivation increases if they can see, from an early stage, what perspectives they might have in another position once their temporary contract comes to an end. And research facilities and universities could use these opportunities to improve their reputation as attractive employers.

JUNQ – Unsolved Questions

Which of the two biblical Marys had the correct praying posture?

It doesn't make any difference how you hold your hands when you pray. Does it? Psychologist Wolter Seuntjens reports on an unexpected discovery and an open question. A contribution taken from the *Journal of Unsolved Questions (JUnQ)*

Christians have preferred, ever since approximately 1000 AD, to pray with folded hands. But the hands can be folded in different ways – symmetrically or non-symmetrically, either with the palms touching or with the fingers interlaced. One might assume that artists randomly and arbitrarily represent the folded hands symmetrically or non-symmetrically in their sculptures and paintings. But it turns out that it is not merely a matter of chance in the case of the Virgin Mary and Mary Magdalene.

Without a doubt, the Virgin Mary is the most-reproduced woman in the history of art, while Mary Magdalene takes second place. There is thus plenty of material for an empirical study. Art historians have always studied the iconography of the two sacred figures quite thoroughly, but one peculiarity has always been overlooked – the Virgin Mary prays with a symmetrical hand position in 72.3 percent of the 801 observed images, while Mary Magdalene is portrayed with a non-symmetrical hand position in 70.3 percent of the 290 observed images. With a total of 1,091 objects, this is a statistic that scientists working in other fields could only dream of.

The innumerable portraits of the Virgin Mary and Mary Magdalene can be categorised into various thematic areas, or into one of the three periods "Pre-passion", "Passion" and "Post-passion". When we evaluate the themes and periods individually, the significance of the phenomenon becomes even greater. For example, in portraits focusing on the Assumption, the Virgin Mary is represented without exception with symmetrical hands, while in portraits from the Passion period, Mary Magdalene is represented with non-symmetrical hands in 85.9 percent of cases.

This discovery causes many to ask why the Virgin Mary is usually portrayed with a symmetrical hand position, while Mary Magdalene is shown primarily with non-symmetrically folded hands. A possible explanation is that the Virgin Mary is traditionally the symbol of perfection, while, conversely, Mary Magdalene represents a woman with a past. The symmetrical hand position thus expresses virginal perfection, while the non-symmetrical hand position represents imperfection and emotional turmoil and thus characterises the more earthly Mary Magdalene. As plausible as it sounds, however, this is still only speculation. Other theories are welcome at any time.

More unsolved questions: → www.junq.info

Wolter Seuntjens

Praying in different positions
The Virgin Mary (right) and Mary Magdalena in a ceiling painting (image) in St. Jakob's Church in Hechingen.
Image: Wikimedia Commons

Soon to become a familiar scene? On 22 October 2014 these stilt houses on the beach in the seaside town of St. Peter-Ording were deep in the water. Hurricane Gonzalo brought the season's first storm tide to the North Sea coastline. Photo: Daniel Friederichs/dpa

"We're going to have to raise the dikes by one metre"

Climatologist Peter Lemke talks about mild winters, extreme hailstorms, and new tree species arriving in Europe

Mr Lemke, you use model calculations to predict the climate of the future. How do things look for Germany at the end of this century?
That depends on whether we continue to release as much CO_2 into the atmosphere as we are doing now. If we continue to do this, we'll have to expect sea levels about one metre higher. The temperature will rise by three to four degrees on average. As early as 2040, very hot and dry summers like in 2003 will be the norm. The winters will be milder and bring more rainfall.

What does this mean for individual regions in Germany?
People on the coasts can tolerate a hotter summer, since there is more of a breeze there. On the other hand, in a city such as Stuttgart, situated in a valley, things will get stuffy. The Alpine foothills will experience increased orographic or relief rainfall. And there won't be much left of the Alpine glaciers. In a region such as Brandenburg, which already has hotter summers than other places in Germany, things will become even more extreme.

What effects will rising sea levels and higher temperatures have?
We're going to have to raise the dikes by one metre. This is doable, of course, but it will cost a lot of money. And it will take up more space as well, since a higher dike will need wider foundations. In other regions in the world, for example in a flat and bifurcated river delta, this will not be possible. In those areas, large numbers of people will have to be relocated. But the hot summers will lead to problems here in Germany, too. For one thing, it will be a problem for agriculture, which can't survive without irrigation. But that will presumably be manageable as well, since there will be more precipitation in the winter to replenish the groundwater. On the other hand, it will be a problem for people – in the hot summer of 2003, there were about 20,000 heat-related fatalities, and summers like that will be normal from 2040.

Will we have to cultivate different plants than we do today?
Yes. Forest workers are already asking us what kind of trees they should be planting now, trees that will be harvested 50 years later. For some native trees such as spruce, the dryness will cause problems. Conversely, the Douglas fir, a conifer from North America, could do quite well in a warmer and drier climate. But it is not a native tree and it is not, in that sense, suited to our ecosystem.

Will there be more extreme weather events?
That is still difficult to predict, since extreme weather events occur with relative infrequency, meaning that we have few data from the past that we can use for predictions. It's clear that a warmer world will have greater humidity, which increases the likelihood of precipitation. We have observed that hailstorms increased between 1970 and 2000, particularly in southern Germany.

What is the reason for that?
Hail originates in storm clouds. These are towering vertical clouds formed from water vapour carried by powerful upward air currents. If the cloud is high enough and the updraft strong enough, the water droplets turn to ice. The higher the clouds and the stronger the updraft, the bigger the hailstones become. Once they are large and heavy enough, they fall as hail. The strength of the upward current depends on the heat at ground level – which is getting hotter as a result of global warming.

Imagine we would succeed in reducing our CO_2 emissions. What could we expect then?
If we could actually do that, it would be possible to reduce global warming by two degrees. The basic requirement for this, however, would be that we produce practically no CO_2 after 2070. This two-degree target is on the table in the climate negotiations between heads of state and government. In order to reach this goal, the nations have to agree on legally binding targets for the reduction of CO_2 emissions.

Interview: **Martin Trinkaus**

PETER LEMKE is Professor for Environmental Physics at the University of Bremen. Until his retirement on 30 September 2014, he headed the Climate Sciences division at the Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research. Since 2009, he has been scientific coordinator for the Helmholtz Climate Initiative REKLIM, whose Managing Director is Klaus Grosfeld. Nine research centres from the Helmholtz Association work together within REKLIM to produce increasingly precise regional and global climate models based on readings taken on the ground, in the air and in the ocean, as well as on satellite observations and computer simulations: → www.reklim.de/en
The Helmholtz Association's regional climate offices and the Climate Service Center also help decision-makers to assess the risks and opportunities of climate change and to develop avoidance and adaptation strategies.
Hear more about REKLIM and hail research in two audio files on science podcast Resonator (in German only): → https://resonator-podcast.de/

Late delivery Fisherman Konrad Fischer (left) and crew members Klaus Matthiesen and Thomas Buick hold up a message-in-a-bottle on 5 May 2014 in Kiel. The card inside the bottle is dated 17 May 1913. Photos: Uwe Paesler/dpa

The truth is lying on the bottom of the Baltic

A fisherman finds a 101-year-old message-in-a-bottle and sells it for thousands of euros. But can his story really be true? One reader has his doubts – and contacts the editorial office at Helmholtz Perspektiven. An investigation to uncover the truth

It's one of those stories the media love – a fisherman pulls what appears to be a very old beer bottle out of the Baltic Sea and finds a letter inside. It was written 101 years ago, in Gothic script. In it, a certain Richard Platz requests the finder to kindly send this letter to his Berlin address. Stamps from imperial Germany are included. A genealogist investigates – and actually finds a granddaughter of the letter's author. When the genealogist tells her about his discovery, tears roll down her face. The fisherman, who happens to be named Fischer, gets a place in the Guinness Book of Records, as the world's oldest message-in-a-bottle before that was "only" 100 years old.

This was the story that we read in numerous newspapers and on many websites; we even heard about it on the radio. But is the story actually true?

> "Perhaps the letter was taken out of the water a long time ago"

One person who doubts its authenticity is Werner Paustian, a native of Kiel who was a construction worker for many years. He described his own experiences to the editors of Helmholtz Perspektiven, saying that a bottle swing top, typical in those days, would not be able to survive so many years free of rust. He says, "Over the years I found many beer bottles in attics that had been left by workmen building the houses – the clasps were always very rusty and the rubber seals had perished. I don't see any reason why it would be different under water." Paustian thus believes that an air-tight, water-tight seal would not have been possible. He mentions a local diver who retrieved several hundred historical bottles from the Baltic – on none was the wire clasp intact, only the ceramic stopper had survived. "But that wouldn't make the bottle air-tight all on its own and allow a letter inside the bottle to survive more than 100 years," says Paustian. As a matter of fact, Fischer didn't make any reference to a wire clasp; he only referred to a ceramic stopper, which "disintegrated immediately upon opening".

Can that be? Carsten Blawert is a corrosion expert at Helmholtz-Zentrum Geesthacht. He says that "under certain conditions a bottle can in fact remain air-tight." It would have been possible, for example, that the bottle was lying in mud, without oxygen contact. Thus the swing top could have remained intact for a long time. "Then perhaps the rubber seal became slightly liquefied, allowing it to work like an adhesive." This would mean that even if the clasp did subsequently corrode, the water-tight seal could still have held. This is possible, says Blawert, but it can't be proved. Yet he does find it remarkable that the ceramic stopper is supposed to have disintegrated. "Ceramics stay intact for centuries. That sounds more like a cork covered in barnacles that falls apart when it is pulled out. The fact that he said this happened to a ceramic stopper makes me suspicious."

The experts who studied the letter itself found it to be genuine, and it is now on display in the International Maritime Museum in Hamburg. But Werner Paustian believes that it could have had a different origin: "Perhaps the letter was taken out of the water a long time ago, when the swing top was still intact?" Maybe somebody waited many years, until the discovery could be regarded as a sensational discovery? "In any case, nobody has been able to explain to me how a ceramic stopper could just disintegrate like that!"

Will we ever find out what really happened? In the meantime, Konrad Fischer has received a four-figure sum for the message-in-a-bottle, which has enabled him to repair his boat. In the end, whatever really happened, and when, is something only the fish can ever know for sure.

Marike Frick

Helmholtz Perspektiven No. 01 – 2015

Breaking the law

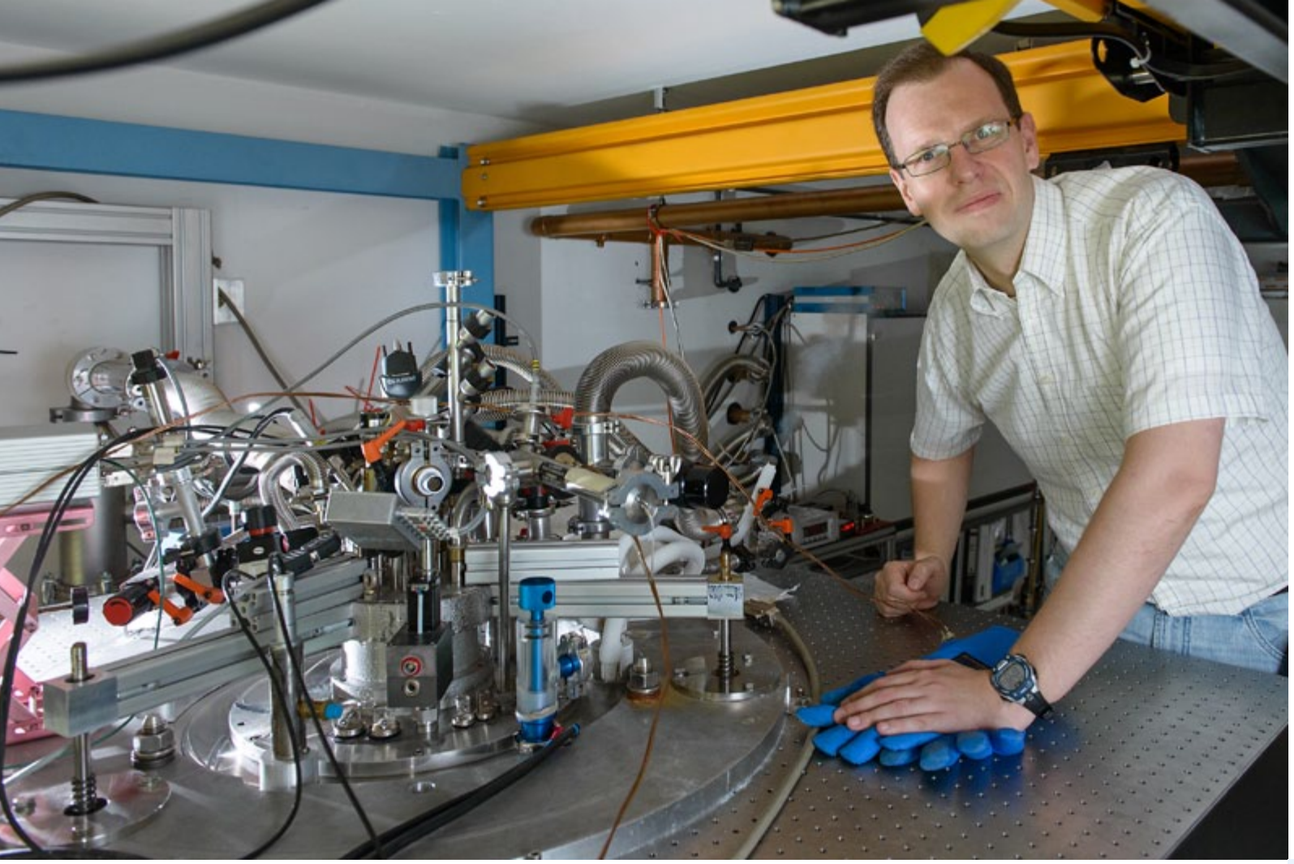
Using neutron beams and extreme temperatures, research scientists are delving deep into the secrets of magnets. Their findings have enabled them to challenge a previously undisputed certainty

Magnets have two poles – that is one of the natural laws that children learn in primary school. But wrongly so, it would seem. As early as 1931, British physicist Paul Dirac predicted that there must be isolated magnets with only one magnetic pole – "magnetic monopoles" – and today, scientists are finally on track to solve the problem. If their findings are substantiated, will the physics text books have to be rewritten?

All previous experiments attempting to confirm Dirac's 83-year-old thesis have failed. Those who attempted, for example, to separate the north and south poles in a bar magnet by simply cutting it across the middle found that each of the two new halves had two poles again. In the end, researchers conjectured that magnetic monopoles only existed in outer space, and they hoped to be able to track them down in particle accelerators. But the experimental evidence to confirm their existence failed to materialise. The first hot lead came in 2009, discovered by researchers at the Helmholtz-Zentrum Berlin für Materialien und Energie (HZB). The researchers found virtually free magnetic monopoles – called "quasiparticles" – in the core of ice-cold crystals. In temperatures around absolute zero, i.e. less than minus 272 °C, they examined the magnetic structures in a crystal with the complicated name dysprosium titanate. Dysprosium is a rare earth element. In connection with titanium and oxygen, it crystallises in a pyrochlore lattice. This lattice is characterised by its special geometry, which resembles that of frozen water as it has many conjoining tetrahedral structures. And in each of the four corners of a tetrahedral, a magnetic moment or "spin" is arrayed.

Spin can be pictured as a kind of mini-barbell. In this case, one end of the barbell represents a magnetic south pole and the other end a

Fascinating visual effects A classic magnet attracts iron filings – the two poles can be clearly identified here.
Bild: Tommounsey/istockphoto



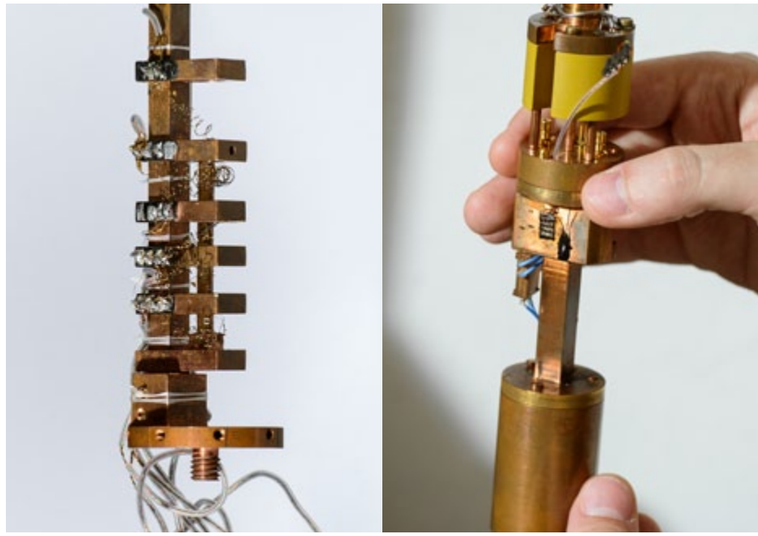
Cooling machine Bastian Klemke shows us the top plate of the cryostat, which is able to generate temperatures of minus 272 °C. Photos: Phil Dera

magnetic north pole – in principle, it is similar to a small bar magnet. “If a magnetic field is applied, the four spins within a tetrahedron arrange themselves in such a way that two barbells align their north pole and the other two their south poles outwards,” explains experimental physicist Bastian Klemke, who was part of the monopole discovery. In this way, one barbell is always partitioned out to two tetrahedrons. “As we reduced the strength of the magnetic field, we could observe how ‘spin spaghetti’ was formed,” says Klemke. “Spin spaghetti” is the name scientists give to the cluster of long, closely-intertwined chains that are formed by the spins. They consist of lined-up spins whose north and south poles are aligned alternately, like a series of small bar magnets. These magnetic structures were then made visible by the HZB researchers using neutron beams. Klemke: “The ends of the spin spaghetti, i.e. a magnetic north pole on one end and a magnetic south pole on the other, were able to migrate within the crystal in any direction. They don’t need any energy for this, they can be regarded as free, and they behaved like magnetic monopoles.”

> These investigations verify 83-year-old calculations on the possible existence of magnetic monopoles

With these investigations, the scientists have revealed essential characteristics of matter that were hitherto unknown. And they have provided experimental evidence for the existence of the magnetic monopoles predicted by Dirac – even if they are only quasiparticles in a solid-state body. The scientists have not yet been able to verify magnetic monopoles at room temperature, but they have not given up hope. They dream of a new generation of magnetic storage media – in computer hard drives, for example. “In addition to dramatically multiplying storage density by as much as ten thousand times, such media could also be operated much more energy efficiently than today’s standard storage on the basis of conventional magnetic materials,” says Klemke. He does point out, however, that the discoveries to date have not yet reached a point where it would be necessary to rewrite the physics text books: “Since the magnetic monopoles that we have found are only quasi-free, our discoveries can only really add an interesting chapter to the textbooks.”

Nicole Silbermann



Crystal and measurement platform The crystal is clamped into the sample holder (left) and attached, hidden in a copper casing (lower right), to the cryostat’s measuring platform (upper right)

Understanding cancer

Berlin-based scientist Ulrike Stein has discovered a gene that is responsible for the growth of tumours. Will this make cancer more predictable in the future?

As I look out of the window on the fourth floor of this building in Berlin's northern district of Buch, my gaze falls on the trees at a slight distance. Once their leaves have fallen in the winter, I'll apparently be able to see Berlin's famous TV tower all the way over in the city centre. But this sweeping view is in stark contrast to the office from which it can be seen. Mounted to the wall above two desks hidden under piles of books and papers are two shelves crammed full with folders. Cancer researcher Ulrike Stein is sitting at one of the desks.

Five years ago, Stein and her colleagues Peter Schlag and Walter Birchmeier made an exciting discovery. They identified a gene in colorectal cancer patients that is responsible for the growth of cancer cells and the formation of metastases. It was soon revealed that MACC1, the identifier for the gene, constituted an additional important piece in the mosaic that is cancer research, and that tremendous therapeutic opportunities could emerge from the discovery.

For Stein, now in her early fifties, this was the realisation of a childhood dream. From earliest childhood, she wanted to be a cancer researcher – indeed, she had even written an essay on the topic in school. There are personal reasons for this, she says, without offering any further details. She would rather talk about her research. Stein began her career in the German Democratic Republic, studying biochemistry in Halle and subsequently completing her PhD at the Central Institute for Cancer Research here in Buch. When Germany was reunified in 1990, Stein was able to travel to the United States, along with her husband and son. She worked at the National Cancer Institute in Frederick, Maryland, a place that clearly inspired her as she still flies back for a few weeks every year to keep in touch with her colleagues and to tackle projects jointly, as she enthusiastically explains.

Her return to Germany in the mid-90s brought Stein back to Berlin-Buch. Here at the Max Delbrück Center (MDC), scientists were already conducting basic research whose findings were being applied to treat or help prevent disease. Stein had always wanted to perform this kind of application-based research, she says, and that was something that she was able to do here: "That's why I came back, even though I had offers in the US." Later she qualified as a professor and was awarded a professorship. And thus she stayed here, and had a daughter here. Today, she and her family still live close to her office.

Stein no longer works in the laboratory. As leader of the Translational Oncology of Solid Tumours research team of the MDC's Experimental and Clinical Research Center and the Charité University Clinic, she has too many other tasks. She promotes networking activities with other working groups, attends conferences, seeks out partners in industry, and monitors global research in her sector. E-mail correspondence is neatly sorted on her desk. She finds what she is looking for quickly and easily. Efficiency is paramount if she is to manage everything she has to do. "Most importantly, I have to make sure our research is going in the right direction," she explains.

She is particularly proud of the achievements of her approximately 30 employees. Everyone has the same common goal: "We want to stop patients dying of cancer," says Stein, succinctly. With the discovery of the MACC1 gene, Stein and her team are in a position to make a significant contribution, since it may put doctors in the position of being able to predict a tumour's propensity to metastasise. After all, this is what makes tumours so dangerous. "We can now develop drugs that work against this metastasis propensity." So far, 30,000 substances have been tested for such an inhibitive effect. In the meantime, the gene has been found to play a significant role in many solid tumours such as in lung cancer, stomach cancer, breast cancer, cancer of the liver, and many more. MACC1 can even be detected in the blood, thus serving as an important biomarker. Claus Scheidereit, coordinator of the Cancer Department at the MDC, is very familiar with Stein's research. "By identifying the responsible gene, Ulrike Stein has shown that basic molecular research is getting very close to practical application."

"In the beginning we experienced a few sleepless nights," says Stein, recalling the days when her research was first getting published. "After all, you never know whether or not other scientists are going to confirm your results." In the meantime, hundreds of follow-up publications by colleagues have supported her findings. Stein collects the most important papers, and they are continuing to fill up folders in her office, offering bright prospects for scientists and patients alike.

Roland Koch

Personalities

Nobel Prize for Stefan Hell

Stefan Hell of Göttingen was awarded the Nobel Prize in Chemistry for the development of super-resolved fluorescence microscopy. Hell is the Director of the Max Planck Institute for Biophysical Chemistry in Göttingen as well as a department head at the German Cancer Research Center (DKFZ), which is part of the Helmholtz Association. Hell is the second scientist from the DKFZ to be honoured with the highest distinction in science after Harald zur Hausen, who received the Nobel Prize in Medicine in 2008.

Leibniz Prize for DESY scientist

DESY researcher Henry Chapman is being honoured with the 2015 Leibniz Prize, worth EUR 2.5 million, for his groundbreaking contributions to the development of serial femtosecond crystallography. With the aid of X-ray lasers, this procedure makes it possible to decipher the structure of complex biomolecules in their natural environment – with atomic-level precision. The new technique will facilitate new research into around 100,000 biomolecules that have not yet been decoded. Chapman joined the Deutsches Elektronen-Synchrotron DESY in 2007 and became the founding director of the Center for Free-Electron Laser Science, a joint facility of the University of Hamburg, the Max Planck Society, and DESY. Chapman will use the prize money to further his research using the electron laser facility XFEL, due to be completed soon.

Johann-Dietrich Wörner appointed General Director of ESA

On 18 December, the Council of the European Space Agency (ESA) selected Johann-Dietrich Wörner as its new General Director. Wörner is currently Chairman of the Executive Board at the German Aerospace Center (DLR), which is part of the Helmholtz Association, and is expected to retain this post until mid-2015. This is the first time in 25 years that a German has been appointed to the top position at ESA.

Young scientist award for pharmacist Maike Windbergs

In recognition of her outstanding scientific accomplishments, pharmacist Maike Windberg of the Helmholtz Institute for Pharmaceutical Research Saarland has been awarded this year's Preis für Nachwuchswissenschaftler by the Horst-Böhme-Stiftung, a foundation of the Deutsche Pharmazeutische Gesellschaft. The prize includes a cash award of EUR 5,000.

Behnken-Berger-Stiftung awards Karl Zeil

Physicist Karl Zeil from the Helmholtz-Zentrum Dresden-Rossendorf was awarded by the Behnken-Berger-Stiftung for his PhD dissertation, in which he dealt with the topic of new accelerator technology for cancer therapy with charged particles. The first junior scientist award endowed with EUR 15,000 was conferred under the auspices of the German-Austrian-Swiss Three-Nations Conference for Medical Physics in September 2014 in Zurich.

Ramona Alborn

The Straw Trick

Here's how it's done:

1.) Stick the straw halfway down into the juice.
2.) Close off the straw at the top end with your finger and pull it up out of the juice. What happens? Why?
3.) Now release your finger from the straw. What happens? Why?

Explanation

Just like you, the air around us has its own weight. It presses down on the earth and on everything that is on the earth. This pressure is called air pressure.
When you pull the straw out of the juice the juice sinks down a bit because it is being pulled down by gravity. In the straw – between the juice and your finger – this creates lower air pressure than there is outside the straw. While the higher pressure of the outer air is pressing the juice into the straw, the lower air pressure in the straw plus gravity are counteracting – working against this. For this reason, the juice stays in the straw. Once you remove your finger, the air pressure equalises and the juice flows out of the straw.

Here's what you need:

- A cup or a glass about half full of juice
- A transparent straw

This experiment was taken from the School Lab "physik.begreifen" held by the Deutsches Elektronen-Synchrotron DESY in Zeuthen. DESY actively promotes public education and scientific excellence in the fields of air pressure, vacuums and measurement of cosmic particles. More than 25,000 young people are already taking advantage of this opportunity to peek into the fascinating world of physics and to get involved in topical science issues.


Horizontale und vertikale Schieber nicht gleichzeitig öffnen