University of Basel

UNI NOVA

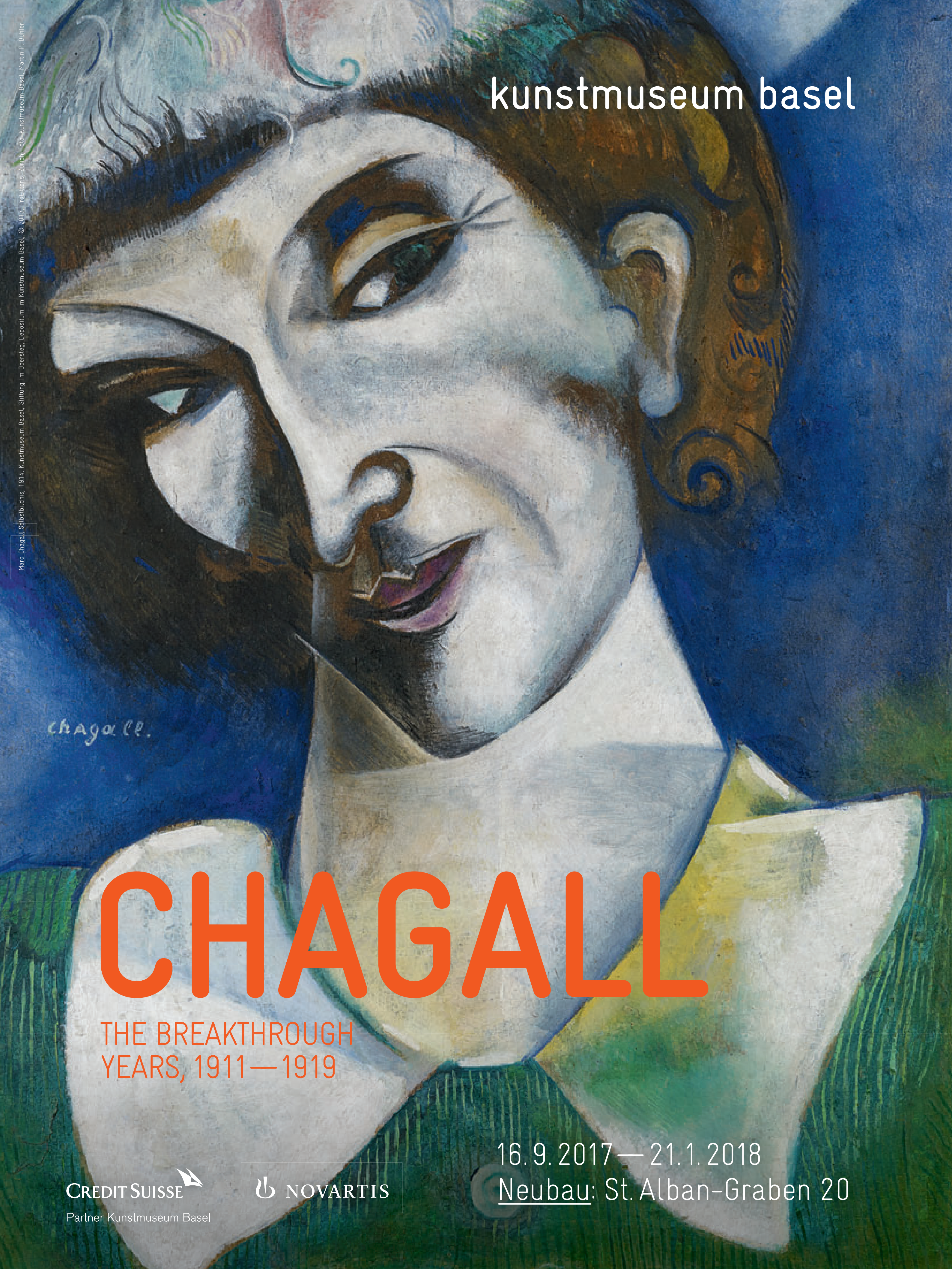
University of Basel Research Magazine — N°130 / November 2017

In conversation
Living in a class society.

Debate
Precision in the arts and sciences.

Album
How an invasive species is taking over.

Essay
Facets of politically correct speech.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Team

Contributors to this issue

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2

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1 Dominik Zumbühl is head of the Department of Physics at the University of Basel. As an experimental physicist, his research fields include quantum transport, quantum coherence, electron and nuclear spin effects in nanostructures. The 43-year-old describes himself as a person fascinated by physics with a drive to discover new laws of nature and to use these to develop useful technologies. Pages 16–17

2 Benedikt Vogel lent substantial support to our editorial team in producing the dossier in this edition. A graduate in both German studies and physics with a doctorate, he later worked for around 20 years as an editor. Today, he is a freelance science journalist in Berlin. Pages 14–33

3 Luca Gaggini is a doctoral student in the conservation biology research group and investigates the effects of invasive plant species on biodiversity and ecosystem functions. The series of photographs in this issue provides an illustration of his research project on the spread of the Himalayan Balsam plant throughout forests in the region. Pages 38–49

A new kind of computing.

While quantum computers still exist only in the lab, they are seen as holding out great promise for the future. The expectation is that they will be able to solve complex problems and compute vast amounts of data in real time. Encryption methods in use today, for instance, would be cracked in no time at all. All over the world, scientists are now engaged in a competition to build the first fully functional quantum computer.

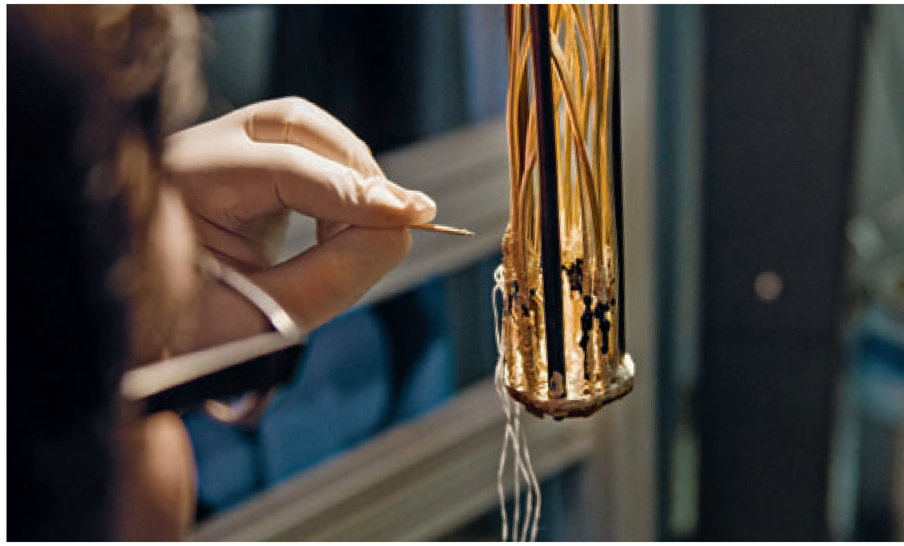
Unlike traditional computers, quantum computers rely on the effects of quantum mechanics. The world of the tiniest particles is governed by laws at odds with our everyday experience: particles can exist in different states at the same time, can be linked to one another in a strange way, and can change the moment we observe them. By making use of these phenomena, quantum computers are able to store a much greater amount of information and to process it far more quickly than will ever be possible using conventional electronics.

While the theoretical concepts are at an advanced stage, creating a functioning quantum computer requires not just computing and storage units that remain stable over a long period and can be connected to one another, but new approaches to error correction, for instance, as well as new kinds of measurement instruments and production technologies. Research into all of this is happening right now in Basel.

In this issue, we introduce some approaches to quantum computing and describe the work that researchers at Basel University are conducting on the future of computing, through a combination of theoretical ideas and ingenious experiments. We hope that you will find it illuminating!

Reto Caluori,
Editorial team, UNI NOVA

Class differences are a reality:
Oliver Nachtwey in conversation, page 8



Quantum research arises from an interplay of theory and experimentation.

Dossier Quantum computers

Machines of the future.

Cover photo
Mario Palma, doctoral student in the research group led by Professor Dominik Zumbühl, places a chip on the tip of a cryostat. This device enables experiments to be conducted at extremely low temperatures.

Genetic analyses help to understand the spread of invasive neophytes, page 38

Imprint

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EDITORS: Reto Caluori, Christoph Dieffenbacher

POSTAL ADDRESS: University of Basel, Communications & Marketing, PO Box, 4001 Basel, Switzerland.

Tel. + 41 61 207 30 17
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Historical press photos

Radical changes in everyday life.

Sarajevo, Istanbul, Belgrade and Ankara underwent a rapid process of modernization following the fall of the Ottoman Empire. This dynamic period wa s captured in the pictures taken by press photographers and published in major Turkish and Yugoslavian newspapers between 1920 and 1940. They bear witness to the cultural, political and urban development.

Together with international partners, a research project at the department for Middle Eastern Studies has made the photos accessible online and designed a traveling exhibition. After its preview in Basel, the exhibition will also travel to Belgrade, Istanbul, Sarajevo, Graz and Cambridge. The photo from 1939 shows a Catholic peasant couple from an area near Sarajevo. Both of them are wearing clothes typical of that region. ■

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Natura Obscura

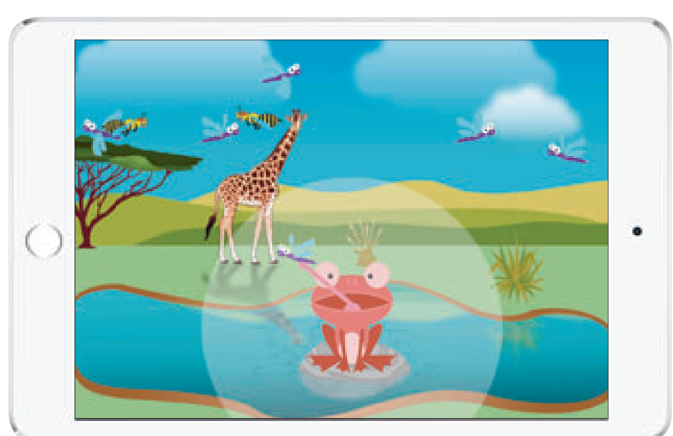
Nature’s magic garden.

For 200 years, the Naturforschende Gesellschaft (Society for Natural Sciences) in Basel has been conducting research in the field of nature and science, thereby contributing – often in close co-operation with the university – to Basel’s development as a centre of knowledge and research. To commemorate its anniversary, the society has published a book entitled *natura obscura,* in which 200 people with an interest in natural sciences have written about something that they find fascinating in nature. It is a volume with magnificent pictures, such as this photo of a *Cuthona coerulea:* a sea slug that has developed clever defense strategies to compensate for not having a protective shell like a sea snail. ■
ngib.ch/jubilaeum

Neurosciences

Playing for science.

Using online games, the Cosmos research project is breaking new ground in psychological research. Four video games are intended to contribute to a better understanding of how the human brain works. The individual games measure different cognitive abilities, such as reaction, short-term or working memory. The fly-eating frog that jumps from one pond to another, for example, is a go/no go test that allows conclusions to be drawn regarding behavior under time pressure. The researchers examine what molecular mechanisms are important for certain cognitive or emotional functions. The online platform serves as a tool to reach out to the large number of participants needed. ■
cosmos.psycho.unibas.ch



“…the economic and cultural resources are unequally distributed and are reproduced unequally.”

Oliver Nachtwey

"We live in a class society."

The sociologist Oliver Nachtwey thinks people should argue openly about their different economic interests and believes that the class society has never ended.

Interview: Urs Hafner Photo: Christian Flierl

Oliver Nachtwey is a new professor of sociology at the University of Basel. At the beginning of August, a few days after he took up his new position, his office on Petersgraben is hard to find as his name is not yet on the door. The room looks like it has been redecorated, the empty bookshelves are awaiting the first books. In the corner, a smart suitcase is ready for Professor Nachtwey's weekend trip to Frankfurt, where he still lives until he moves to Basel with his family in November. Before serving coffee and water, the young sociologist stresses that he will soon be moving to Basel and wants to live and get involved here. He reports that he has just ventured into the Rhine for a swim for the first time on the spur of the moment. With a fashionable haircut and beard, he wears a suit and an elegant German wristwatch.

UNI NOVA: Mr Nachtwey, do you feel like you are living under socialism in Switzerland?

OLIVER NACHTWEY: I imagine socialism to be somewhat different … the quality of life is very good here. I went to Valais on vacation a few times as a child and loved it there each time.

UNI NOVA: I was thinking more of figures rather than feelings: the right-wing liberals claim that we're living in socialism or semi-socialism because the public spending ratio is over 50 percent.

NACHTWEY: (laughs) The public spending ratio, in other words, the proportion of the gross domestic product spent by the state, is an extremely imprecise measure to determine socialist or even just social conditions. In Germany, the public spending ratio barely decreased after the welfare state cuts. A high public spending ratio can mean various things: extensive bureaucracy, high military expenditure, low wages that necessitate state transfer payments. You have to look very closely. The right-wing liberals' question could be countered with another question: is the high public spending ratio also a bad thing when the state is in a position to rescue ailing banks and to safeguard the economy from more serious damage?

UNI NOVA: Let's leave the socialism question unanswered then. In your sensational book about "downward mobility" you describe plausibly how the lower middle classes and lower classes in Europe are becoming poorer while the upper classes are gaining in economic terms. Are we living in a class society again?

NACHTWEY: We've always lived in a class society, so it's not a question of going back – although I don't yet know the conditions in Switzerland well enough to be able to make qualified statements. Western societies, at any rate, continue to be pervaded by structural asymmetries that are characteristic of class societies: the economic and cultural resources are unequally distributed and are reproduced unequally. From the 1950s until into the 1980s, class differences seemed to be losing importance – the sociologist Ulrich Beck spoke of the "elevator society": everyone was doing increasingly well in economic terms. But even then structural disparities still remained.

UNI NOVA: Did the economic miracle muddy the waters of science?

NACHTWEY: For a while, yes. And now the social classes have become more visible again: the richest and most powerful, in other words the top five to ten percent of the population, are blatantly flaunting their wealth. Wealth is seen per se as a sign of achievement; someone who earns a lot is regarded as a key player, no matter how he or she made their money. If a firm's performance declines, the top manager's salary is not reduced. The lower classes, on the other hand, are growing and are virtually losing their connection to society. In Germany, a quarter of all jobs are in the precarious low-wage sector. There is still just one single member of the working class with a seat in Germany's parliament.

UNI NOVA: Anyone who says "class" evokes Marxism, but the theories of class consciousness, of class in itself, of the proletariat and so on – they're mistaken.

NACHTWEY: It's not that simple. Even for

> **“Today, there are too many precarious job situations that no longer provide people with security.”**
>
> **Oliver Nachtwey**

the sociologist Ralf Dahrendorf, who was anything but a Marxist – he was a staunch liberal – capitalist societies were necessarily class societies. As early as the 1990s, he said that the significance of class would increase again. The term “class” means that people have different interests due to the fact that they’re in different economic situations. And this inevitably leads to conflicts: the classes argue and fight one another, but they also have to negotiate and try to find solutions. Ideally, the conflict will result in integration and pacification. Those who deny the existence of the class society declare themselves in favor of an apparent consensus that can end in social anomie.

UNI NOVA: Anomie – so you assume that social norms are eroding, that society is facing disintegration?

NACHTWEY: Not necessarily. But phenomena such as the German right-wing Pegida movement, the conspiracy theories that are circulating among like-minded people on the Internet or also the anonymous hate comments, which, as we all know, are sometimes distributed by well trained technicians, they all indicate that social pathologies are spreading at an alarming rate. Many people bottle up frustration and fears while the pressure to perform on the labor market increases. The number of days of sickness absence in firms is falling, so people are going to work even though they’re not really fit, but at the same time psychosocial disorders are on the rise.

UNI NOVA: Why don’t people defend themselves when they’re under pressure?

NACHTWEY: They do, but in a destructive way. They reappear protesting vociferously in right-wing populism. They see this as a kind of self-defense…

UNI NOVA: … self-defense?

NACHTWEY: Because they feel that no-one is listening to them any longer. The people who belong to the lower classes and to the middle classes that are threatened by social descent have become less important and less visible in public life. They no longer see themselves represented by the established popular parties. The associations are disappearing and the trade unions are weakening. In these organizations of civil society, people used to be able to vent their anger and express their indignation, and they met with a positive response. The trade union offered protection from the unreasonable demands of the market, the regulars at the local pub comforted each other and recommended restraint after the last glass of beer. The erosion of this social environment is leading to anomie.

UNI NOVA: So that means everything used to be better in the days when lively associations and strong trade unions still existed?

NACHTWEY: Today, there are too many precarious job situations that no longer provide people with security, but I don't long for the good old days that never existed in that way. Conditions were also retrogressive, for instance with regard to women's emancipation. That's why it's not possible to simply turn back the clock. The situation is more open today, much more is possible. The problem is not the disappearance of the associations but what is going to take their place, what kinds of communities does it make sense to build? The internet, which speeds up social change, can be a medium of both emancipation and regression. In global terms, I see both authoritarian and democratic tendencies at the moment, the stalling Arab Spring and the Occupy movement, on the one hand, and the new autocrats, on the other hand. I believe Bernie Sanders would have beaten Trump in place of Hillary Clinton. In Germany, there is Pegida, but there is also the "welcome culture" that was supported by some six million people. Germany took in the refugees and the country didn't collapse.

UNI NOVA: German daily newspapers describe you as a left-wing academic. What do you say to that?

NACHTWEY: If it's written in the newspaper, it's probably right, isn't it?

UNI NOVA: What does a left-wing sociologist do?

NACHTWEY: I'm interested in labor, in social justice, the economy and political phenomena. My ideal aim is to obtain scientifically sound results on social injustice and social change. My findings should enable keen citizens to better understand the world and perhaps even to improve it. I'm not going to take charge and tell everyone what to do.

UNI NOVA: Not like Lenin then. And how does a conservative sociologist work?

NACHTWEY: He or she should actually reach similar results to those of a left-wing sociologist, but will interpret them differently. Many conservative sociologists claim that the contrast between right-wing and left-wing no longer exists, or that they are not on the right but work objectively and free from value judgments as the great sociologist Max Weber demanded. Yet people who argue like that are themselves ideological because research is always influenced by personal belief systems. Left-wing sociologists are more likely to analyze the consequences of social change with regard to social justice, conservative sociologists are more likely to examine how social stability can be maintained. Left-wingers criticize the negative effects that the market has on income distribution, conservatives criticize the – also negative – consequences for the traditional family.

UNI NOVA: In Switzerland, empiricist sociology dominates. This deals with evaluating very detailed data, and – unlike you – is scarcely present in public discourse. Will you be entering into a fierce academic debate?

NACHTWEY: I don't like fighting. First of all, I'd like to get to know my colleagues better – I admire their work. However, it would benefit such a diverse science as sociology if more collegial discussions were held in order to better understand social change. But we should argue in society. It may sound paradoxical, but conflicts promote social integration – provided that the fight is not supposed to end in the elimination of the opponent, as the influential state theorist and Nazi sympathizer Carl Schmitt had in mind. Debating results in friction but also compromise and sometimes even a little warmth. ■

Oliver Nachtwey
Born in 1975, Oliver Nachtwey has been a professor of social structure analysis at the University of Basel since 1 August 2017. Prior to that, he was a lecturer and researcher at the Technische Universität Darmstadt and at the Institute for Social Research in Frankfurt am Main. The economic sociologist focuses on labor, inequality, protest and democracy. He writes for daily and weekly newspapers, as well as for online portals. His study "Downward Mobility: Dissent in the Age of Regressive Modernity", which was published by Suhrkamp in 2016, met with a lively response and became a bestseller – a rare distinction for a substantial work of non-fiction.

Prize, presence and political science.

Uni goes to market

Out and about in the Baselbiet.

From Reigoldswil to Birsfelden, Reinach to Gelterkinden: This fall, the university will introduce itself to the people of the Baselbiet at eight different regional markets. University members who come from the area will hold informal chats with visitors to the market. The “Uni am Markt” initiative aims to increase the university’s visibility in the Baselbiet and make contact with people who have no direct link with the university. Over a glass of cider, employees from various subject areas will answer questions about the university and talk to local residents. Next dates: Sissach (November 15) and Muttenz (November 22). ■

Lasker Award

Major honor for Michael Hall.

Professor Michael N. Hall (Biozentrum, University of Basel) has received this year’s Lasker Award for Basic Medical Research – one of the greatest and most prestigious accolades in biomedical research. The 64-year-old biochemist was honored by the New York-based Albert and Mary Lasker Foundation for discovering and researching the protein target of rapamycin, or TOR for short, which controls the growth and size of cells by activating and deactivating various signal pathways. Michael Hall (pictured here with Claire Pomeroy, President of the Lasker Foundation, and Willard J. Overlock, Chair of the Board of Directors) has discovered a key element in controlling cell growth, which is also connected with the development of conditions such as cancer, cardiovascular diseases and diabetes. ■

Michael Hall on the protein that can regulate the growth of cells: **youtu.be/yRsSBSiRQ-o**

New degree subject

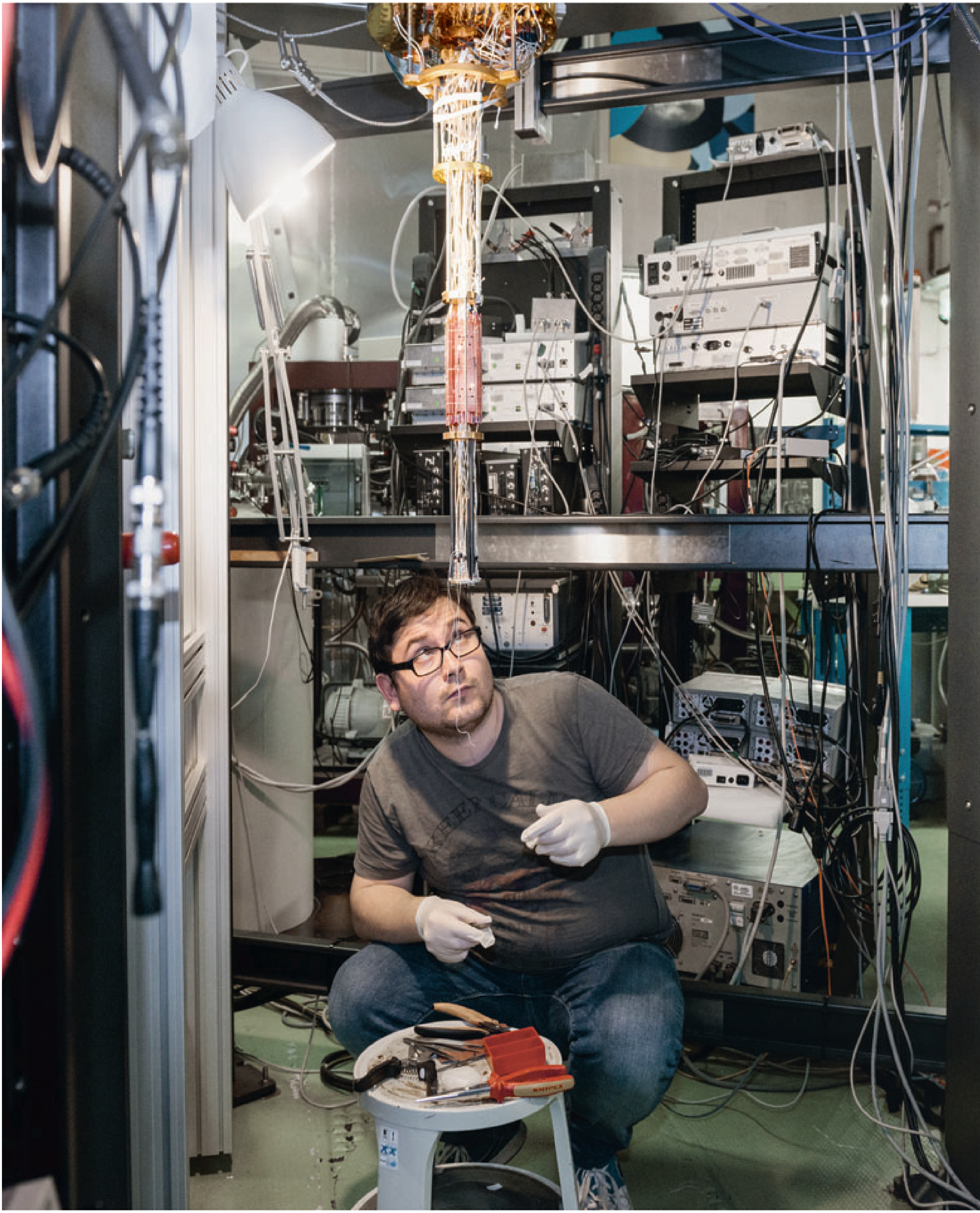
Brilliant start for political science.

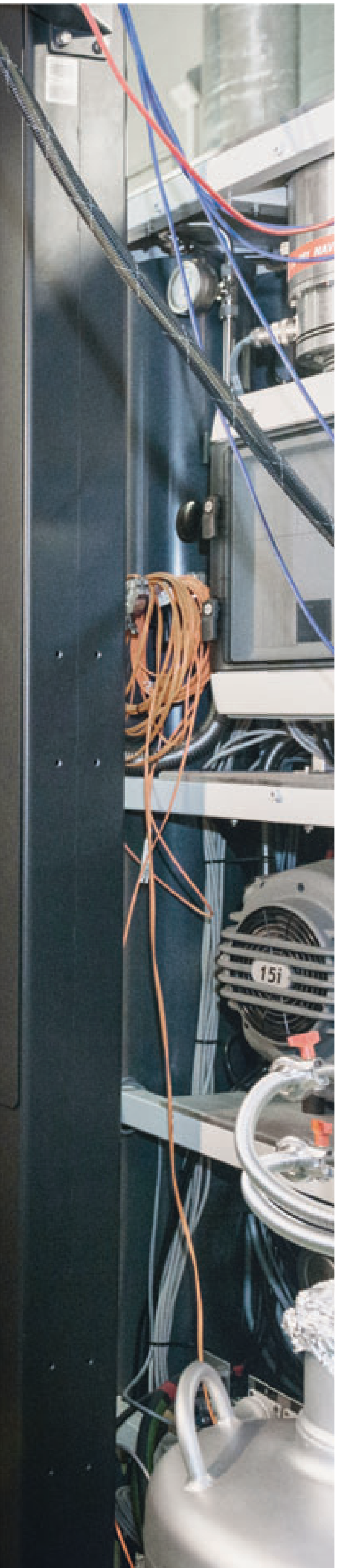
In September, 95 students – around half of them female – began their bachelor's studies in political science, the first time this subject has been offered in Basel. Their studies will begin with the basic principles of comparative politics, international relations, and political theory. Students can choose to focus on a specific region of the world during their bachelor's degree and explore this in more depth on the new master's program. The subject area focuses on peace and conflict studies, democracy, European integration, foreign policy analysis, the European Union and political representation. Over 1,900 new students joined the University of Basel in September, 1,500 of them on bachelor's programs. First-year students began with a Start Smart week, which eases the transition by providing an insight into university life and helping the new students to socialize. ■

Rankings 2017–2018

Basel stays in the top 100.

Once again, the University of Basel has been ranked among the world's 100 best higher education institutions according to the annual "Times Higher Education World University Ranking", moving up three places to number 95. It has also been ranked 95th by the "Academic Ranking of World Universities" (or "Shanghai Ranking") published each year by Shanghai Jiao Tong University, after missing out on the top 100 in 2016. ■





Machines of the future.

Photos: Christian Flierl

Harnessing quantum effects is considered an emerging key technology: once fully functioning, quantum computers will be able to solve problems that cannot be calculated using today’s technologies.

The second revolution in quantum physics.

Quantum physics promises to deliver revolutionary new technologies such as the quantum computer – with far-reaching consequences for the economy and society. For many years, the University of Basel has been playing a pioneering role in quantum research.

Text: Dominik Zumbühl

Dominik Zumbühl is Professor of Experimental Physics and Chair of the Department of Physics at the University of Basel.

In the first third of the 20th century, physicists such as Max Planck, Albert Einstein, Erwin Schrödinger, and Werner Heisenberg fundamentally changed the way we understand nature. With the development of quantum mechanics, a theory was emerging that would challenge human understanding and intuition. Its pioneers were simultaneously astonished and bewildered, and used thought experiments to try to illustrate the paradoxical consequences of the new theory. In the most famous example, Schrödinger describes a cat that, according to the laws of quantum physics, is alive and dead at the same time. However absurd ideas like this may seem, quantum theory is now seen as one of the greatest achievements in science and has revolutionized the way we see the world.

Over the last 20 years or so, quantum physics has given rise to a second revolution. With a steady stream of new experiments, scientists have shown that we can use the crazy world of quantum physics to do useful things that would be impossible in classical physics.

Today, highly sensitive quantum sensors allow us to measure magnetic fields faster and more accurately than ever before. In the near future, quantum physics could pave the way for secure communication channels. In the past, medical diagnostic devices such as magnetic resonance imaging (MRI) scanners have been developed based on the laws of quantum physics.

A computer for completely new problems

Quantum physics offers breathtaking potential for innovation. Against this backdrop, physicists at the University of Basel are pursuing the vision of a computer that takes advantage of the laws of quantum mechanics.

A quantum computer can perform a large number of computing operations in parallel. It is therefore incredibly fast and solves problems in a matter of hours that would take today's supercomputers billions of years. Whereas the latest supercomputers contain a billion transistors, a quantum computer would contain a billion quantum bits (qubits). While classical bits can adopt only states of 0 or 1, qubits allow you to define more than just two states. In the future, their sheer computing power could allow us to answer questions we have not even dared to ask yet. It is conceivable, for example, that we will be able to create molecules and therefore materials with previously unknown properties: new types of pharmaceutical active substances, for example. Or superconductors for transporting electricity without loss at room temperature. Or chlorophyll-like substances that convert sunlight into useful energy. Until now, innovative substances tended to be discovered by chance. However, in the future, quantum computers could allow scientists to design materials with desirable properties in a targeted manner.

The quantum computer is a highly promising innovation. Its realization is now the subject of work by leading researchers from Harvard to Tokyo. One promising implementation is based on an idea, formulated 20 years ago by the physicist Daniel Loss, that the angular momentum (spin) of individual electrons can be used as the smallest information carrier in a quantum computer. In laboratories around the world, qubits of this kind are considered the most promising candidates for building a quantum computer. The idea's originator, Daniel Loss, works in Basel and devotes his time to developing a Basel qubit. Manufactured from a semiconducting material, this qubit is extremely small and fast. As silicon is a thoroughly tried-and-tested material for computer chips, silicon qubits offer key advantages over other qubit concepts. Developing a qubit is the overarching objective of Basel's physics department, where 12 professors are channeling the expertise of their research teams into achieving this common goal.

Basel researchers lead the field

Let me state clearly the magnitude of the challenge: the Department of Physics at the University of Basel is not an industrial laboratory seeking to build a quantum computer in the next few months or years. Rather, we are carrying out research on the foundations of the quantum computer. Research of this kind is very time-consuming but has the potential to bring about genuine innovations. It is worth remembering that, after the transistor was discovered in 1947, it took half a century for personal computers and mobile phones to make their way into our everyday lives and to turn the world of work upside down. With regard to the quantum computer, the marathon has only just begun. Today, companies like Microsoft, Google, and Intel are pinning their hopes on the quantum computer as they realize that the increasing miniaturization of classical CMOS chips is reaching its limits. Basel's ambition is to be among the front-runners.

So far, we've been making great progress. In recent years, Basel's physicists have secured eight of the prestigious grants from the European Research Council (ERC), with the last two going to our professors Jelena Klinovaja and Ilaria Zardo. This success demonstrates the excellence of our research portfolio. Many young researchers are attracted to the brilliance of the quantum research carried out in Basel. Operating since autumn 2016, the PhD school for "Quantum Computing and Quantum Technologies" currently brings together 20 doctoral researchers. In addition, generous support from the Georg H. Endress Foundation will allow us to set up a cross-border postdoc cluster in cooperation with the University of Freiburg from January 2018. As a result, there will be ten additional scientists working in the field of quantum computing. This initiative is modeled on foundations in the US that provide funding for postdocs at top centers of research.

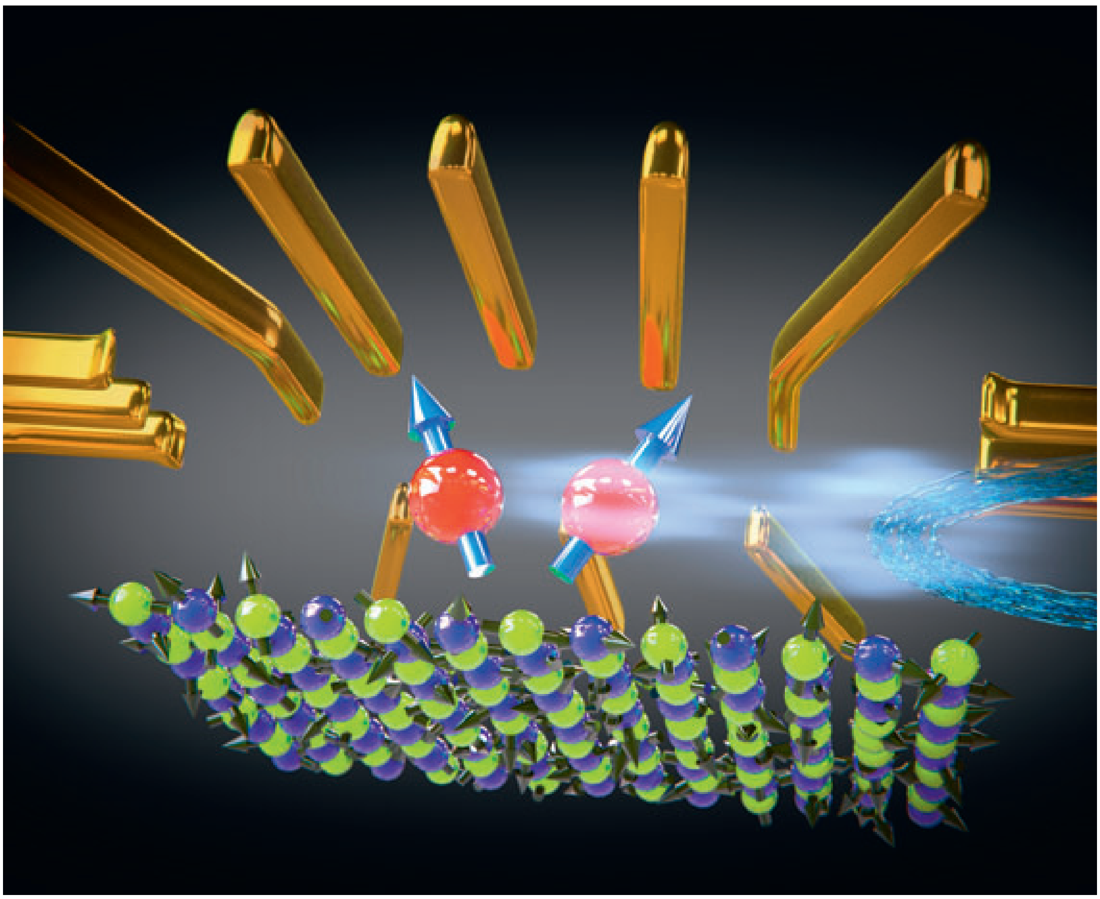
Collaboration with industrial partner IBM

There are some critical decisions that we currently have to make in the field of quantum physics in order to further strengthen this strategic focus at the University of Basel. These include participation in the EU's billion-euro flagship project on quantum technologies, which is planned to begin next year. At present, we are preparing an application for a National Centre of Competence in Research (NCCR) from the Swiss National Science Foundation with Basel as the leading house on the topic of scalable quantum computing. For this NCCR, we have chosen the IBM Zurich Research Laboratory as our main, co-leading partner, together with other universities as partners. Our goal is to build silicon spin qubits. In 12 years, the ambitious target is to have a fully scalable logical qubit consisting of ca. 15 physical qubits. Although this is not yet a complete quantum computer, it does provide a copy-paste blueprint for a quantum chip.

When the first concepts for a quantum computer emerged, they did so in Europe. With this as our starting point, we now have the opportunity to build the foundation of a new Silicon Valley. Research on the quantum computer is an investment in a future technology and therefore in Switzerland's industrial base. Our laboratories are also currently home to a rising generation of experts who can understand, shape and disseminate this emergent technology. Only with their help can we succeed in turning the second revolution of quantum physics to the advantage of society as a whole. ■

"When the first concepts for a quantum computer emerged, they did so in Europe. With this as our starting point, we now have the opportunity to build the foundation of a new Silicon Valley."

Dominik Zumbühl



Model of the Basel qubit: Two individual electrons (red) are captured within a quantum dot. Their spin states (arrows) form the information units (qubits). Gold contacts allow the electrons to be held in stable electrical fields. The structure is approximately half a micrometer in size and is embedded in a semiconducting material – in this case, gallium and arsenic atoms (green/violet). An adjoining sensor is used to measure the spin.

Qubits – the building blocks of the quantum computer.

A qubit can store a single bit – the smallest possible unit of digital information – and is the fundamental building block of a future quantum computer. Qubits made of semiconducting materials, such as those being researched in Basel, are among the most promising candidates.

Text: Benedikt Vogel

Like conventional computers, quantum computers also process and store information digitally: information is encoded using a system made up of only two digits (0 and 1). Each of these digits contains one "bit" of information, which can be stored using any technical system that you can switch on and off. In computers, a bit is stored in a switchable circuit that is either on (ON = 1) or off (OFF = 0). Computers break down complex information such as numbers and text into bits, which are then processed using a multitude of very fast on/off switching processes.

ON and OFF at the same time

A future quantum computer would also break complex information down into bits. However, instead of using switchable circuits, it processes and stores this information using a quantum physical system that can adopt the states ON and OFF. Whereas the switchable circuit is either ON or OFF, in quantum physical systems the states ON and OFF exist *simultaneously* – even if this goes against our everyday experience. A system of this kind, featuring the superposition of two states, has come to be known as a quantum bit (or qubit).

Still, we should not allow ourselves to be dazzled by the trendy name: a qubit *on its own* also contains just one bit of information – exactly as much as a switchable circuit. The special properties resulting from superposition only come into play after a qubit is coupled with other qubits in a specific manner – namely, using a characteristic phenomenon of quantum physics known as entanglement. It is only when multiple qubits are entangled into groups (quantum registers) that they give rise to highly powerful information-processing systems.

100 million in one square centimeter

Quantum bits could conceivably be produced in several very different ways. "In physics, we are aware of many systems with two precisely defined states that are subject to the rules of quantum physics. Over the last 20 years, therefore, countless methods have been proposed for building quantum bits," says Daniel Loss, Professor of Physics at the University of Basel. "However, most of these proposals were later abandoned." This is because physical systems intended to serve as qubits must have a number of special properties in addition to their quantum physical properties: for example, the qubits must be small enough that you can ideally accommodate 100 million of them on a chip with an area of one square centimeter; otherwise, it will not be possible to build a manageable computer. It must also be possible to switch the qubits from ON to OFF and vice versa at high speed – ideally a billion times a second, as is customary with electrical circuits in modern computers.

As these requirements illustrate, designing a functional qubit is a Herculean challenge. Even a quarter of a century after the first experiments, scientists still have a long way to go. Nevertheless, they

Daniel Loss
is Professor of Theoretical Physics at the University of Basel. In 2017, he was awarded the King Faisal International Prize for Science.

have made considerable progress since the 1990s – thanks in part to a plan that Loss published in 1998 together with the American physicist David DiVincenzo. In it, the two scientists outlined a concrete method for creating qubits and using them to build a quantum computer.

Electron spin as a circuit component

Today, the two physicists' publication is the most cited scientific article on quantum computing. It serves as the basis for the study and construction of qubits made of semiconducting materials in the laboratories of top universities and industrial companies around the world. Among the leading research groups are the solid-state specialists led by Loss. Their basic idea is to use an electron spin as a qubit. It is a bold idea – after all, an electron is extremely small, and the magnetic field associated with the spin is extremely weak and thus hard to measure. However, since the spin can only point "up" or "down", it has exactly two states.

Moreover, the electron spin is subject to the laws of quantum physics. This system therefore has the ideal prerequisites to serve as a fundamental building block in a quantum computer.

For an electron spin to be used as a qubit, there must be a reliable way not only to determine but also to switch its direction. The scientists hope to achieve this by using a concept known as the quantum dot. In very simple terms, a quantum dot is a (dedicated) spherical volume, typically with a diameter of one ten-thousandth of a millimeter, and located inside a solid. A free electron (that is, one that is not bound within an atom) is "locked inside" the sphere. The surrounding solid is built up in layers made of two semiconducting materials (such as silicon and germanium) and cooled to a very low temperature – just one tenth of a degree above absolute zero – and the free electron is held in place using electrical fields. In this configuration, the electron spin can be switched "up" and "down" electrically – and can therefore be used to store one of the smallest units of information (0/1).

Phenomenal power

Twenty years ago, creating a qubit in the form of a quantum dot was merely a bold vision. The intervening years have seen it become a reality in a variety of material systems and configurations. Now, it also enjoys the backing of companies such as Intel. To use the electron spin inside a quantum dot for data processing, two conditions must be met: the superposition of the two spin states ("up" and "down") must hold for as long as possible, and it must be possible to change the direction of the spin very quickly.

Researchers have managed to maintain the superposition over the space of one millisecond and, in this short time, to perform a million switching processes using electric fields. "As a result, qubits operate at a clock frequency in the gigahertz range, as we are used to seeing in modern computers," says Loss. "With the quantum dots, we're also able to entangle multiple qubits, which is a prerequisite for combining large numbers of them in the future to create a computer. This computer's phenomenal performance would stem from its ability to perform arithmetic operations *in parallel* as a result of the quantum physical properties of the qubits."

Three further candidates

In addition to quantum dots made of semiconducting materials, scientists are currently discussing and testing three further concepts for the production of qubits: companies such as IBM and Google want to make qubits from superconducting materials – that is, from substances that conduct electricity with zero resistance when cooled to a very low temperature. These qubits allow relatively fast switching but are currently around 1,000 times bigger than quantum dots made of semiconductors.

Several research groups want to produce qubits based on trapped ions (such as calcium ions). Although these qubits have the advantage that they are 100 times smaller even than quantum dots, their switching is sluggish and they cannot be built into compact qubit clusters. The reason for this is that the ions must be positioned far away from one another to prevent them from interfering with each other in an uncontrolled way. A fourth group known as topological qubits represent a combination of the semiconductor and superconductor approaches. Although this concept is still in its infancy, Microsoft is putting a great deal of money into research in this area. ■

"With the quantum dots, we're also able to entangle multiple qubits, which is a prerequisite for combining large numbers of them in the future to create a computer."

Daniel Loss

A new world record of 57 seconds.

Basel-based physicists are working on a quantum computer that will hopefully use the electron spin to carry digital information. For this to work, they will need to keep the spin stable for a sufficient length of time. Only recently, a new world record was set in Basel.

Text: Benedikt Vogel

We find ourselves in the laboratory on Basel's Klingelbergstrasse. Where there was once a particle accelerator, scientists have now set up an experiment that allows them to trap electrons within a tiny space. Alongside two helium tanks and a tower of measuring apparatus, a kind of piston rises up into the air. At the tip, there is a 5 × 5 mm chip made of the semiconductor gallium arsenide. Using this setup, researchers led by Professor of Physics Dominik Zumbühl are investigating how an electron can be manipulated so that it is suitable for building a quantum computer.

The scientists recently announced a new world record: they managed to maintain an electron's spin in one direction, and to prevent it from flipping to the opposite direction, for a period of 57 seconds. By doing so, they broke their own one-second record, dating back to 2008, as well as the 30-second record set by an Australian team in spring 2017 using a silicon chip. "This result is a milestone on the long road towards a quantum computer," says Zumbühl. "If we want to build a high-speed computer of this kind, we'll need to be able to keep the electron spin stable and control it in a well-controlled manner."

Preventing the spin from flipping

To appreciate the significance of the new world record, you have to bear in mind that the Basel physicists are working with an unimaginably small object. Electrons are particles of the minutest dimensions: if a pinhead were the size of the Sun, you could still fit more than 1,000 electrons within the diameter of a human hair. This tiny object carries an electrical charge that produces an extremely weak magnetic field – the spin – as a result of its intrinsic rotation. Since a magnetic field always has a direction, the electron's spin is usually depicted by an arrow. When an external magnetic field is applied, the spin can adopt one of two directions under its influence: "up" or "down". In the natural state, the spin tends to flip from the "up" state to the lower-energy "down" state.

The scientists in Zumbühl's group are attempting to prevent this flipping process – which physicists refer to as relaxation – or to delay it for as long as possible. This is because the electron spin can be used as a reliable information carrier as long as the electron spin can be held in one direction. In one experiment, the researchers have now managed to keep the electron spin pointing "up" for 57 seconds. Creating a stable and effective experimental setup in such a tiny space was quite a challenge. It involves cooling the electron – positioned on the aforementioned chip – to a temperature of 60 millikelvin, or just above absolute zero, using sophisticated techniques. Over the course of the several-day experiment, thousands of relaxations were measured – producing an average value of 57 seconds.

The trick of measuring the tiny spin

The experimental setup included a mechanism for establishing how long the spin points "up" before it flips. Determining the direction of the spin is difficult because the electron's magnetic field is extremely weak and thus hard to measure. However, the physicists had a trick up their sleeve: instead of determining the spin's direction using the magnetic field, they developed a measuring setup that works based on the charge and the higher energy level of the "up" state.

The relaxation time of 57 seconds is a scientific triumph. Still, the prospect of developing a quantum computer in the future will depend not on relaxation, but rather on coherence. This is the time during which the spin can be reliably held in one direction ("up" or "down"). Researching the process of relaxation will help the pioneers of the quantum computer utilize the coherence of the electron spin. ■

Computing with qubits.

Quantum bits, or qubits for short, form the central computing and memory units of a quantum computer. Their quantum mechanical properties pave the way for a new type of computing.

Classical bit.

A classical bit has two states: it can adopt a value of either 0 or 1.

0 1

Qubit.

A qubit has many more possible states, because the world of quantum physics allows superposition of the two states. The qubit can therefore adopt values of 0 and 1 simultaneously, as well as any number of states in-between.

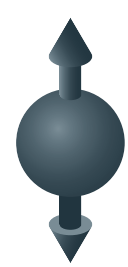
0 and 1

Superposition.

Quantum theory permits the overlapping, or superposition, of states. This means that a qubit can be in the states 0 and 1 at the same time. As a result, a quantum computer can also perform numerous calculations simultaneously.

A qubit can be created using the intrinsic angular momentum (spin) of an electron, for example. This can adopt the states 0 and 1 ("up"/"down") at the same time, as well as all of the other states resulting from the superposition.

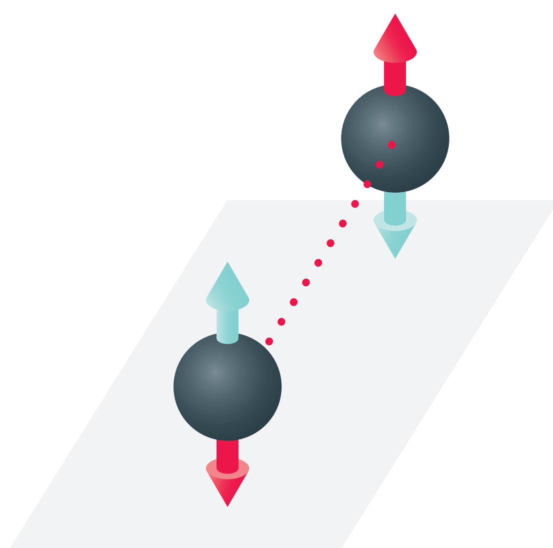
When you determine a qubit's state, the superposition is lost and the measurement yields a classical bit again – a zero or a one. It is only the connection and entanglement of multiple qubits that gives rise to the potential power of a quantum computer.



Entanglement.

Multiple quantum particles can be entangled with one another. They are then connected in such a way that a change in one particle causes a change in the other – even if they are far apart. The action of measuring one particle also determines the result for the other. If two qubits can be entangled successfully, their joint state represents a superposition of all the individual states.

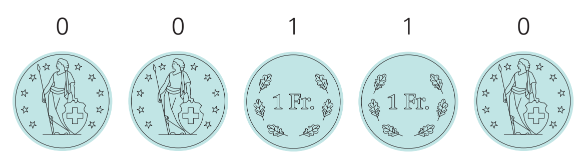
The number of combinations in a quantum register then grows exponentially as the number of qubits rises.



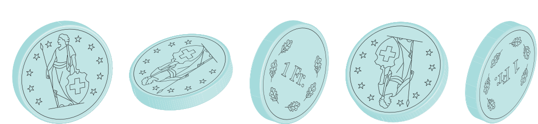
Quantum register.

Qubits can be connected with one another to form registers. As a result of entanglement, it becomes possible to process large volumes of data in parallel. Thanks to superposition and entanglement, a quantum computer can carry out a large number of possible calculation steps at the same time.

This is the origin of its speed. Take chess, for example: instead of calculating one move after the other like a conventional chess computer, a quantum computer would calculate all of the possible moves simultaneously.



With five classical bits, only one out of a total of 32 possible combinations can be represented at the same time, such as in this example: 00110



A quantum register can adopt a superposition of all 2^n states. With five qubits, it is already possible to have 32 states at the same time:
00000 / 00001 / 00010 / 00011 / 00100 / 00101 / 00110 / 00111 / 01000 / 01001 / 01010 / 01011 / 01100 / 01101 / 01110 / 01111 / 10000 / 10001 / 10010 / 10011 / 10100 / 10101 / 10110 / 10111 / 11000 / 11001 / 11010 / 11011 / 11100 / 11101 / 11110 / 11111

The volume of stored information that a quantum computer can process rises accordingly. ■

The miraculous property of the Majorana fermion.

Quantum computers of the future promise to outshine their conventional forebears with their powerful ability to perform arithmetic operations in parallel. The problem is that qubits, the building blocks of quantum mechanical memory, can still only store information for a short space of time.

Text: Tim Schröder

Qubits store information using their "spin", or rather using the alignment of the magnetic field of a fundamental particle such as the electron, for example. This spin can adopt certain states – that is, it can exhibit different spatial orientations. Applied to the computer, different orientations would correspond to the states "on" and "off", or "1" and "0" in binary code.

Today, qubits are still a decidedly unstable form of memory and are sensitive to interference from their surroundings – especially heat or electromagnetic fields, such as those found in electronic systems. The spin can flip over within a few seconds, or even fractions of a second, at which point the information is lost.

Accordingly, quantum computers of the future will, to some extent, need memory modules with greater stability. The development of such modules is the focus of researchers at the University of Basel, including Jelena Klinovaja, Professor of Physics and an expert in the physics of condensed matter. Klinovaja is a specialist dedicated to searching for an extremely unusual fundamental particle. This particle should, in theory, be far less sensitive to interference by electromagnetic fields and would therefore make a promising candidate for a future quantum computer.

Insight from an Italian physicist

The specific fundamental particle concerned is the Majorana fermion, named after the Italian physicist Ettore Majorana who first postulated the idea over 70 years ago based on theoretical calculations. More precisely, as is so often the case in physics, the Majorana fermion actually refers to two counterparts: a fundamental particle and its antiparticle. There are plenty of examples of pairs of this kind, such as the proton and the antiproton or the electron and the positron. A common feature of all such pairs is that the two partners have very similar properties, but also that there is always a key difference. This is not true of the Majorana fermion, however. Based on theoretical considerations, Ettore Majorana concluded that there must be particles of matter that are simultaneously their own antiparticle.

Moreover, these exotic particles have an almost miraculous property: if you exchange the positions of two identical particles of this kind by revolving them around one another, it is possible to use this change as a way of storing quantum information. As this exchange is not dependent on a specific path, qubits of this type are often also described as "topological". In this context, "topological" means that a property remains the same regardless of the type of change – in this case, regardless of the exchange and of the path that it describes.

Evidence of Majorana states

A few years ago, a team of Dutch researchers actually succeeded in using a complex experimental setup to detect the first reliable signs that particles with Majorana properties exist. They attached a nanowire made of semiconducting material to a superconductor, and then altered the magnetic fields and voltages within the system in such a way that signals could be detected at the ends of the nanowire. In theory, these signals corresponded to those of Majorana particles. This principle has been perfected by multiple research groups around the world – including by Jelena Klinovaja and other researchers at the University of Basel.

To even detect these exotic Majorana particles in the first place, it is key above all to synthesize very pure materials for the experiments. "I'm a theorist," says Jelena Klinovaja. "In my research group, we focus on developing material systems that can most likely be used to generate quantum mechanical states corresponding to those of a Majorana fermion or of even more exotic particles – so-called parafermions."

The theoretical ideas are then put into practice by other research groups at the University of Basel, who use them to produce tailor-made semiconducting and superconducting surfaces."That's the really great thing about working here in Basel – theory and experimentation take place next door to one another," says Jelena Klinovaja. "Our theoretical ideas can be put into practice immediately."

Understanding interference better

Jelena Klinovaja's work is a bit like researching an object when all you can see is its shadow: she has not yet been able to grasp the particle, but rather only its electromagnetic shadow – that is, its properties. What makes her work so difficult is the fact that she is essentially looking for a needle in a haystack. Majorana states only occur in extremely small numbers. "It's almost as if we're working with a system the size of Earth but need to find a single person," says the researcher. This is compounded by further challenges: Majorana states are indeed more robust than other fundamental particles, which makes them a promising form of qubit memory for future quantum computers. "However, our theoretical reflections also point to other confounding variables in the environment that can influence the Majorana particles."

Before an application in quantum computers can become tangible, it is essential that we gain a more precise understanding of these confounding variables. Jelena Klinovaja therefore wants to study effects of this kind on Majorana particles, as well as parafermions, in greater depth in the future. It is an almost mystical approach to research: so far, the existence of Majorana states has not been definitively proven, but Klinovaja and her colleagues nevertheless want to research the properties of Majorana fermions. It is almost as if they were trying to use a blurry shadow to ascertain an object's properties and weak points – in other words, it presents an enormous challenge. Klinovaja has just been awarded a prestigious ERC Starting Grant in order to push ahead with this research, underlining the significance of her work in this highly competitive field. ■

Jelena Klinovaja
is Assistant Professor of Physics at the University of Basel. In September, the European Research Council awarded her an ERC Starting Grant, thereby supporting her research with EUR 1.2 million of funding.

"That's the really great thing about working here in Basel – theory and experimentation take place next door to one another."
Jelena Klinovaja

Silicon for the super computer.

Today's modern computers rely on silicon chips. Researchers from Basel are convinced that this material will also prove its worth in the development of powerful quantum computers.

Text: Leonid Leiva

One day, quantum computers will solve mathematical challenges far beyond the capabilities of today's computers, but it remains unclear what such a super computer will look like. For instance, we don't yet know the material of the quantum bits (short: qubits) that carry the information. There are some candidates whose development is quite advanced, such as qubits consisting of superconducting rings, or atoms (ions) that are suspended in laser light. Yet these methods have one fundamental flaw: Any viable computer with millions of bits would end up being far too large. "Limited scalability could become a dead end for these approaches," says physicist Professor Richard Warburton.

Richard Warburton is Professor of Experimental Condensed Matter Physics.

Warburton and colleagues at the University of Basel therefore want to pursue a different path, which has worked well for traditional computers: They believe silicon could be the right material for qubits. They are encouraged by recent scientific breakthroughs as well as an increasing interest on the part of key corporate players, which make the semiconductor seem a realistic option for quantum computers. "The timing is perfect," Warburton says, pointing out that Intel, the global leader in computer chip production, has been working on the development of silicon qubits with Dutch scientists since 2015, investing approximately CHF 50 million.

Production processes for silicon are well established; the computer industry knows this material better than any other. Silicon chips have evolved dramatically over the span of decades – confirming Intel-founder Gordon Moore's prediction that the number of transistors per surface unit on a chip would double every 18 months. To achieve today's information density, individual bits cannot be spaced out more than 10 to 100 nanometers (billionths of a meter), which requires ultra-precise manufacturing methods. Therefore, Warburton and his team want to partner with IBM to build the silicon qubits, harnessing the corporation's vast experience in nanomanufacturing.

Silicon still lags behind

Experiments using silicon as a material for spin-qubits made a relatively late entrance into quantum computer research. The electron spin in a silicon atom crystal is a fragile carrier of information. Imagine the spin, the electron's magnetic moment, as a compass needle carried by the electron. The trouble with silicon is that some atomic nuclei – namely, those of the silicon 29 isotope – have their own spin, which influences the electron's spin. This disruption can be eliminated by removing the silicon 29.

This is why Warburton's qubits will consist of high-purity silicon, using nanometer-scale structures called quantum dots that greatly restrict an electron's mobility. Since space is so tight, the electron in the quantum dot behaves similarly to when it is bound to an atom. Quantum dots are also called "artificial atoms" because the electrons inside them can only assume certain states, rendering the information that is coded into the electrons much more controllable.

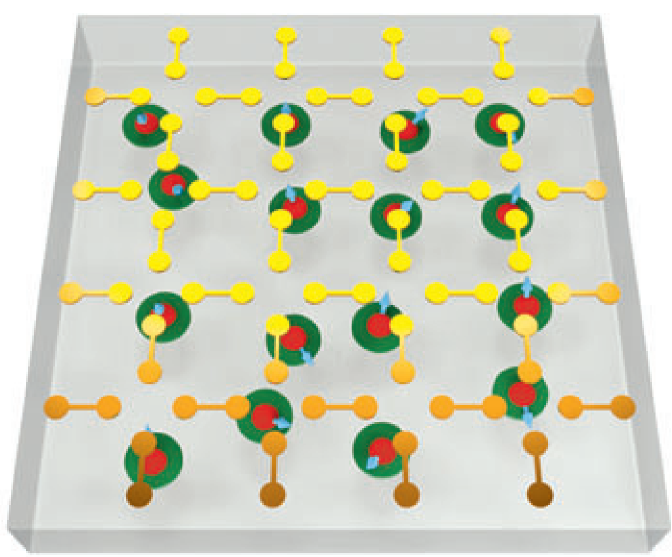
A quantum computer can only work if several qubits are interconnected. Due to this quantum-mechanical phenomenon, any change or measurement of the state of one qubit will immediately impact the qubits that are connected to it. Interconnection therefore means that two or more qubits are so closely coupled to one another that it impossible to disturb one without also impacting its partners. Establishing and maintaining this coupling is a major challenge.

Connected via a "double-bladed paddle"

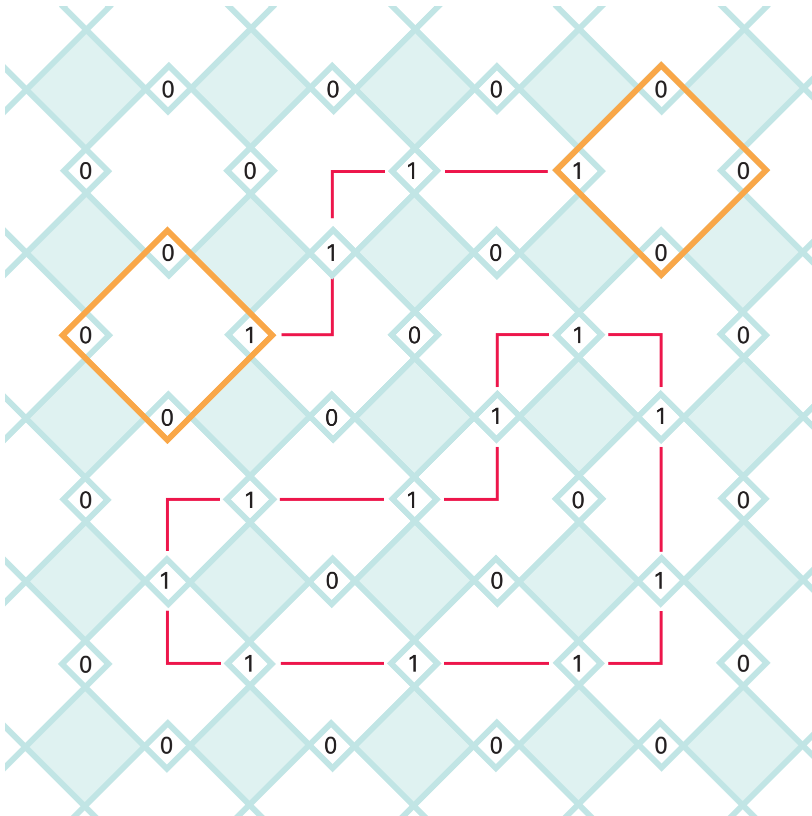
Electron spins can be interconnected directly via their magnetic fields. That only works if they are very close together, for the forces of the electron spins lose most of their power even over very short distances. Also, arranging the qubits close together would create another issue: There would be no more room on the chip for switches and circuits. Spacing the qubits further apart would remedy this problem, but then the direct interaction between electron spins would not be strong enough to couple the qubits. Harnessing electro-static forces could be an alternative way to interconnect the qubits, and that is exactly what Richard Warburton and his team of researchers in Basel are trying to achieve. The idea, proposed by fellow Basel-based physicist Daniel Loss and his team in 2012, involves a specially shaped metal wire called a "floating gate" that looks like a double-bladed paddle. This floating gate is supposed to interconnect the spins of both electrons – and thus make silicon qubits possible.

A step towards miniaturization

Warburton is convinced that electric controls and interconnected qubits will overcome the greatest obstacle in the development of quantum computers – the problem of scalability. We already have functioning quantum computers today, but existing models feature only a dozen interconnected qubits. To make real strides in quantum computer technology, the number of qubits must increase by several orders of magnitude. Floating gates will take us closer to this goal. The goal of Warburton's research project at the University of Basel is to prove, among other things, that this kind of electrostatic coupling of spin-qubits is technically feasible. "If we successfully interconnect two qubits in silicon in a controlled manner, it would be a huge step toward a highly miniaturized, powerful quantum computer with millions of interconnected qubits," Warburton says. ■



Interconnected qubits: A "floating gate" (double-bladed paddle) can interconnect and separate the electron spins underneath (red dots) in a targeted manner.



Example of a surface code: Squares are arranged in a grid structure on an imaginary surface. On the corners of each square are physical qubits – e.g. ions. They are arranged in the states 1 and 0 in such a way that each square has an even number of ones. Deviations from this rule are errors. This pattern allows loops (in red) but no lines consisting of ones. If a line appears, the value of the qubits it is made up of (1 or 0) must be wrong. However, end points for these lines can be found, consisting of squares (orange, top), which each contain one error. By joining these into a loop (example in red, bottom), errors can be removed.

Computing in a chaotic world.

Quantum information is extremely fragile and can be disturbed by even the slightest interference. Error correction in a quantum computer will require highly sophisticated repair mechanisms. A glimpse into the mind of physicist James Wootton reveals what such mechanisms might look like.

Text: Roland Wengenmayr

Quantum information holds the key to algorithms capable of solving complex tasks that are beyond the scope of classical computers. The processing power of a quantum computer derives from an ingenious superposition of the quantum state of qubits. While the computer is performing its quantum logic operations, qubits become temporarily entangled with one another, in a special quantum state that is particularly susceptible to disturbances. The moment this state collapses, the value of the quantum information is lost.

Such a disturbance can be caused even by an attempt to read the quantum information in the course of a measurement. However, it can also be the result of external physical influences on the quantum system – something our world is full of. One example in the microworld is the ever-present effect of thermal energy, which even at low temperatures constantly jostles the physical carriers of quantum information, such as electron spins. Even the Earth's magnetic field can disrupt quantum information – after all, spins are nothing more than tiny magnets, explains James Wootton, a theoretical physicist at the University of Basel. Wootton likens these disturbances to gremlins: little monsters that come out of nowhere to attack the highly sensitive world of quantum information from all sides.

Error correction procedure

James Wootton is researching new methods which allow quantum information to be safely packaged so as to protect it from disturbances. A quantum computer has to be able to detect errors in a kind of ongoing self-diagnosis. Depending on the procedure employed, errors are either repaired immediately, or tracked over the course of the operation and subsequently purged from the result. Diagnosis and correction must be performed with great care, however, as the quantum information itself must never be read while the computer is in action. Reading the information would constitute a measurement, destroying the quantum properties required in order to continue the processing operation.

The procedure can be compared to holding an unopened envelope against the light to find out whether or not it contains a letter, although the correspondence itself may not be read. This ingenious form of error correction goes even further still; the idea is that it will be able to spot individual missing letters and restore them – without actually reading the text itself.

Physical and logical qubits

This approach to error detection and correction is known as surface code. The surface code packages the quantum information so as to be largely protected from disturbances. Furthermore, it offers diagnostic possibilities allowing errors in the qubits to be detected and corrected without touching the quantum information itself. To this end, a distinction is made between two kinds of qubits: The basic building blocks are a large number of *physical qubits*. They

James Wootton is a theoretical physicist and a postdoctoral fellow at the University of Basel.

are referred to as physical because each qubit relies on the quantum properties of an actual particle – e.g. the spin of an electron. These qubits can be thought of as the hardware, and are arranged on a surface – hence the name surface code – in a regular grid pattern, e.g. on the corners of the squares contained in a checkerboard pattern (see graphic). Other patterns are also possible.

Physical qubits can be used to verify the interactions between them without reading the quantum information itself. This information is contained in the *logical qubits,* which can be thought of as encoded software fragments distributed across the grid of physical qubits. By manipulating the physical qubits in a certain way, logical qubits can be moved and made to carry out operations. In correction cycles, they are not directly read by the surface code. Due to the broad distribution of the logical qubits across many different physical qubits, local errors do not have such a disruptive impact – in much the same way that a minor weaving fault is barely noticeable in the pattern of a carpet.

"The procedure can be compared to holding an unopened envelope against the light to find out whether or not it contains a letter, although the correspondence itself may not be read."

James Wootton

Keeping information stable

How can quantum information be packaged as stably as possible in logical qubits? In his theoretical considerations, Wootton sees the surface code as a two-dimensional world which he can populate with exotic particles. His favorites are called anyons. These are not true particles as such, but quasiparticles emerging from the totality of physical qubits. Anyons are also their own antiparticles. Accordingly, on his 2D playing field Wootton can conjure up anyon pairs from nothing and make them disappear again. And that is not all: If he pushes one of a pair of anyons over the edge of the playing field, on to the substitutes' bench, as it were, its partner remaining on the field has no choice but to survive in a stable state, as dictated by the laws of quantum physics. This makes anyons stable transporters for logical qubits.

What is more, anyons can do things in the 2D world that are impossible in three dimensions. When one anyon moves in a loop around another, the anyon inside the loop changes. This enables them to perform quantum logic operations. Quantum physicists call this *braiding.* As the anyons are always carried by multiple physical qubits, the quantum information is much more stably packaged than would be the case in a single physical qubit. Equally, the rules have stabilizing implications for anyons. Quantum logic operations can be compared to different carpet patterns, in which weaving faults can be detected. Depending on the algorithm used, the quantum computer can either correct these faults immediately or record them in a log, without reading the quantum information itself.

Further experiments are needed to find out whether James Wootton's theoretical concepts can be implemented in practice. For now, they remain a vision for the future. At present, the most highly controllable experiments with entangled qubits use ions – electrically charged atoms lined up like beads on an abacus, suspended in special "traps". The next step for quantum computing research is to make the technological leap from one to two dimensions. Only then can surface code error correction be tested in the real world. ■

Quantum sensors revolutionize microscopy.

While quantum computers are still a thing of the future, the application of quantum-based sensors is already a reality. Physicists based in Basel have developed extremely sensitive sensors that are able to provide images at an unprecedented resolution.

Text: Christel Möller

Patrick Maletinsky is Georg H. Endress Professor of Experimental Physics at the University of Basel's Department of Physics.

Martino Poggio is Argovia Professor at the Department of Physics and the Swiss Nanoscience Institute, University of Basel.

For their research, Martino Poggio and his team use the special properties of nanowires to develop innovative sensors capable of measuring electric fields, forces, charges, and spins. Nanowires are extremely thin, elongated crystals with an almost faultless lattice. With a diameter of around 100 nanometers, they are almost a thousand times thinner than a human hair. They come in different shapes and sizes for different applications, have a very low mass, and have a huge surface area in relation to their volume. In addition to nanowires etched or milled from solid blocks of material, Poggio also works with wires that assemble themselves from their molecular building blocks.

Nanowires for diverse applications

These self-assembling nanowires have a special geometry that means they can be used in, for instance, atomic force microscopy to establish both the size and direction of electric fields. Due to their mechanical properties, the nanowires vibrate along two perpendicular axes with roughly the same frequency when the surface is scanned. If an electric field acts on the sensor, it alters the vibration of the two axes. The atomic force microscope developed by Poggio's team can monitor the two perpendicular lines and use the changes in vibration to produce an accurate picture of a sample's force.

With another type of nanowire, the physicists deliberately integrate quantum dots, which are also known as "artificial atoms" because of their resemblance to actual atoms. At between 10 and 100 nanometers in size, quantum dots are much larger than natural atoms and have an adjustable number of electrons that have limited freedom of movement. When excited by a laser, quantum dots emit individual light particles (photons) with similar wavelengths. If heat or an electric field causes the nanowire to vibrate, this creates mechanical tension in the quantum dot and thus changes the wavelength of the light it emits. "By measuring the wavelengths, we can determine the movement and position of the nanowire with an unprecedented sensitivity of just 100 femtometers," explains Poggio. For comparison: 100 femtometers corresponds to 10-15 meters or a quadrillionth of a meter.

> **“We primarily use the sensors to investigate new materials and their magnetic properties.”**
> Patrick Maletinsky

Scientists in the Argovia professor’s lab apply these sensitive sensors to analyze tiny electrical and magnetic fields. It may also be possible to place several quantum dots on one nanowire, to use the motion to link them together and so pass on quantum information.

Imperfect diamonds

Like his colleague, Patrick Maletinsky is also directing his research activities toward a nanostructure – one in which individual electrons are “trapped” and which can be used as a quantum sensor. He uses special diamonds that have natural defects in their crystal lattice. At two neighboring points in the lattice, a carbon atom is replaced by a nitrogen atom, and there is a gap in the direct vicinity. This type of defect – known as a nitrogen-vacancy center – contains single, circling electrons that can be excited and manipulated.

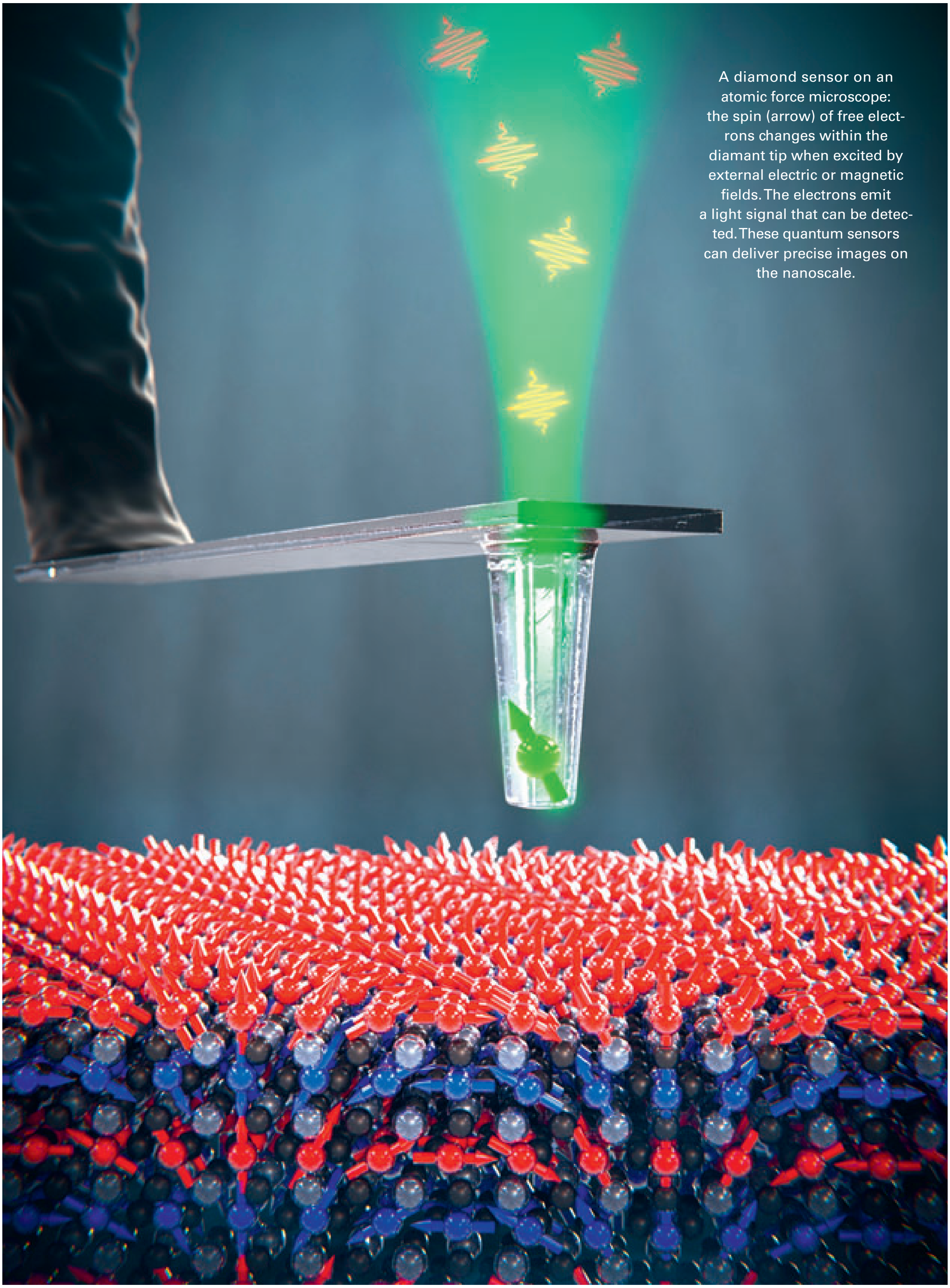
Maletinsky’s team are integrating these NV centers into tiny diamant tips of several 100 nanometers for atomic force microscopes. When excited by external electric or magnetic fields, the electron spin of the free electrons in the nitrogen-vacancy center changes. The scientists use a sophisticated optical measurement method to measure the change in spin, which provides them with a picture of the acting field at a resolution of just a few nanometers.

“We primarily use the sensors to investigate new materials and their magnetic properties,” explains Maletinsky. The quantum method has allowed Maletinsky to raise the sensitivity of the measurements by one or two orders of magnitude over conventional methods. He can now image magnetic fields that were previously invisible. The diamond sensors can be used at room temperature and at temperatures close to absolute zero. This is important when investigating superconductors, for instance, as their particular properties only emerge at around –200°C. The sensors can also be used to analyze biological samples because the diamonds do not interact with biological material and can be used at room temperature.

Bringing quantum sensors to the market

To make the multipurpose diamond sensors available to other research groups and users, Maletinsky and Dr. Mathieu Munsch, a former postdoc at the Department of Physics, founded a startup called Qnami in early 2016. “Qnami produces the highly sensitive sensors, advises customers from research and industry, and responds to individual requests,” says Maletinsky, describing his startup. There are also plans to develop a complete atomic force microscope equipped with diamond sensors. This will significantly increase the number of potential Qnami customers.

The development of sensors based on the laws of quantum mechanics would not have been possible without advances in our understanding of the quantum world. The new sensors will revolutionize microscopy, pave the way for other exciting applications, and help advance the development of the quantum computer. ■



A diamond sensor on an atomic force microscope: the spin (arrow) of free electrons changes within the diamant tip when excited by external electric or magnetic fields. The electrons emit a light signal that can be detected. These quantum sensors can deliver precise images on the nanoscale.

Laboratory for maximum quality standards.

Particularly strict regulations apply to medicines and preparations that are intended for use in humans. The Department of Biomedicine operates a clean room that satisfies the "Good Manufacturing Practice" regulations. Researchers use this clean room for the production of artificial tissue and vaccines for immunotherapy.

Photo:
Basile Bornand

Paul Zajac
Seen here in the middle of the photo, Zajac is a private lecturer of experimental medicine. He conducts research into anti-cancer vaccines at the Department of Biomedicine.

1 The clean room is divided into different hygiene zones. Preparatory work is carried out in a separate area, where there are also incubators and refrigerators. Cleaning or disinfection takes place after each step in the process.
2 Products and materials enter the highly sterile area through an airlock. Those working in this area wear sterile clothing and have to complete special training beforehand.
3 The clean bench is the area with the highest level of cleanliness. It is used for the preparation and bottling of medicinal products – here, for example, immune cells for therapeutic vaccinations.
4 A particle counter measures whether the permissible number of particles in the air is exceeded. Filters and a glass screen at the front provide additional protection against contamination.
5 Further sensors monitor temperature, pressure, and humidity, as well as device functions and air currents.
6 A pressure difference exists between the different hygiene zones, ensuring that air can only move from a clean area to a less clean one. The inlet and exhaust air controller generates a constant excess pressure.
7 If the permissible values are exceeded, a warning system sounds the alarm.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How precise are the sciences?

The humanities and natural sciences differ fundamentally on the issue of how to depict the world accurately. They also deal with the problem of imprecise findings in different ways.

History students learn as early as their first semester that there is no such thing as an objective fact, as our perception of the past is always highly selective. Much of what happened has simply gone unrecorded, and how we interpret sources is always dependent on our personal preferences, which are influenced by all sorts of factors. Some of those factors we are aware of, but not others. Full disclosure of our epistemological interests remains a utopian ideal.

Yet history still insists on being regarded as a science. Students are taught how to write, analyze sources critically, and evaluate secondary literature. The underlying aim of all research is to set out as clearly as possible its line of argument and the empirical basis for that. The scholarly value of a historical study is measured in terms of how well it can be understood and tested by others.
Economic history makes an even stronger claim than general history to be a science, on the grounds that its empirical basis consists not only of qualitative sources, but also of serial data, which are often subjected to statistical analysis. Like economics, quantitative economic history (cliometrics) seeks to identify and assess the impact of particular factors on a clearly defined phenomenon.

How are students to interpret these contradictory signals? Are the humanities and social sciences really scientific in their approach, or are they merely engaged in a doomed attempt to describe particular patterns of human thought and action? From a strictly epistemological point of view, the latter is undoubtedly the case. The notion that people's behavior is governed by universal rules, which it is our job to discover, is implausible. The natural sciences, by contrast, are wholly capable of identifying such laws. Thus, when knowledge is passed on to them, students of history or economics should always be mindful of how imprecise that imparted knowledge is.

Tobias Straumann
is Honorary Professor of Modern History and teaches at the Center for Business and Economics at the University of Basel and at the University of Zurich. His research focuses mainly on the monetary and financial history of Europe and on Swiss economic history and economic policy.

From an ethical point of view, however, the humanities and social sciences fully deserve the label "scientific", as they seek to organize their research as systematically as possible and to make their findings as transparent as possible. Although economists and historians may not be in possession of universal truths after completing their studies, they are capable of distinguishing sound research from charlatanism. In today's world, the significance of this should not be underestimated.

Yet, if students are to develop a strong methodological awareness, this ideal must be adhered to consistently. Unfortunately, that is not always the case. In economics, the approach can be to "interrogate" data until a "confession is made". Sometimes data are fed into a model, even though they are of extremely dubious quality. In history, occasionally authors whose opinions are considered unpalatable on political grounds are just not cited. In my view, therefore, the scholarly value of research in the social sciences and the humanities ultimately comes down to the character of those practicing the disciplines. ■

The natural sciences – sometimes described as the "exact sciences" – are often associated with the uncovering of facts and laws. Even at school, people learn physics, chemistry and biology in the form of clear concepts and established facts. That is what distinguishes the natural sciences from the humanities. However, in modern biology – although not only there – this is becoming less and less true, with statements of fact increasingly being replaced by probabilities.

The sort of statements we are familiar with from the weather forecast – for instance, that there is a 50% chance of rain – also feature in biology and medicine. Vaccines reduce your likelihood of coming down with a particular infection, specific gene variants increase the risk of breast cancer, and there is a certain probability that plant seeds will germinate the following spring. The reasons for this lack of precision are different in each case, and are often impossible to check for. If I have only one seed, I cannot say whether it will germinate. If I have 100 seeds, however, it is possible to state what percentage of them is likely to germinate. Thus, to express findings we need statistics – indications of the frequency with which a statement holds true.

In order to place statements within a meaningful framework, scientists compare probabilities. The effect of one treatment (a drug, a fertilizer, a toxin or radiation) is compared with that of another (no active ingredient or a placebo), for example. If the difference between the objects that have been exposed to different treatments is big, we say that there has been a significant treatment effect. The question of whether the difference is great enough to constitute a significant effect is determined by a convention, which can be explained like this: If you conduct an experiment 20 times using an ineffective treatment, it may produce a significant difference on one occasion by chance. In other words, now and again you find a significant effect that is not really there. The converse is also true: By chance, an effective treatment may fail to produce a significant effect. By increasing the outlay, it is possible to reduce the incidence of such false conclusions, but they can never be wholly eliminated. The gold standard is to repeat an experiment that has demonstrated an effect. If it has revealed a true correlation, it will probably do so again. Unfortunately, experiments are often not repeated when they yield positive results, but rather only when the results are negative. Unfortunately, this even reduces the probability of finding the real correlation.

Dieter Ebert
is Professor of Zoology and Evolutionary Biology at the University of Basel. His research group is looking at the environmental and genetic factors underlying rapid evolutionary processes such as local adaptation, co-evolution of hosts and parasites, and evolution in structured populations.

Such practices, and others, are partly responsible for the so-called replication crisis, which has been rocking the life sciences for some time now. According to various studies, a high proportion of biological and medical findings are not replicable. Can biology still be trusted? I think that it can – that is quite clear from the advances that the field is making overall. However, progress could be faster, as every negative result is a backwards step. As a scientist, I have developed a healthy mistrust when evaluating new findings. For example, I evaluate new scientific findings within the framework of what we think we already know. If something is totally new and cannot be compared with any previous findings, I am automatically more skeptical. Another factor is the quality of the scientific approach employed. Besides inspiration and motivation, good science requires the use of considered and careful strategies, which is unfortunately rare. We need to teach such strategies at universities. Good scientific approaches and an understanding of quantitative and statistical relationships are necessary basic tools of modern science. ■

The weed from the east.

Photos: Christian Flierl
Text: Christoph Dieffenbacher

Like other invasive neophytes, Himalayan Balsam *(Impatiens glandulifera)* drives out native species, changes the surrounding flora and retards the growth of nearby saplings. Originally from the western Himalayas, the plant reached England as early as 1839. From there, it made its way into many European gardens, where it became a popular ornamental plant. For several decades, the species has been spreading explosively along the banks of our streams and rivers and in forests, and impacting on existing floral diversity. The newcomer appears to act via the underground connections between trees and mycorrhizal fungi: its leaves and roots contain a substance that retards the growth of mycorrhizal fungi. In young beech trees that are surrounded by the imported plant, the number of root fungi is 60% lower than in trees with no neophytes nearby.

The Laufen valley in the Canton of Baselland, for example, now has extensive, dense patches of this fast-growing plant. The doctoral student Luca Gaggini (pictured), supported by Dr. Hans-Peter Rusterholz and Professor Bruno Baur of the University of Basel's conservation biology research group, is studying the impact the new arrival is having on the subterranean diversity of fungi and plants in the area.

One suggestion is that the increased prevalence of this invasive neophyte in our forests is the result of forest management practices, which encourage the spread of Himalayan Balsam. Students are kept up to date with current research findings whenever they undertake field trips.

Explosive seed capsules: seeds of the imported, purple-flowering Himalayan Balsam. One plant can produce up to 2,500 seeds per growing season. These are scattered as far as 7 meters away using explosive seed capsules (left).

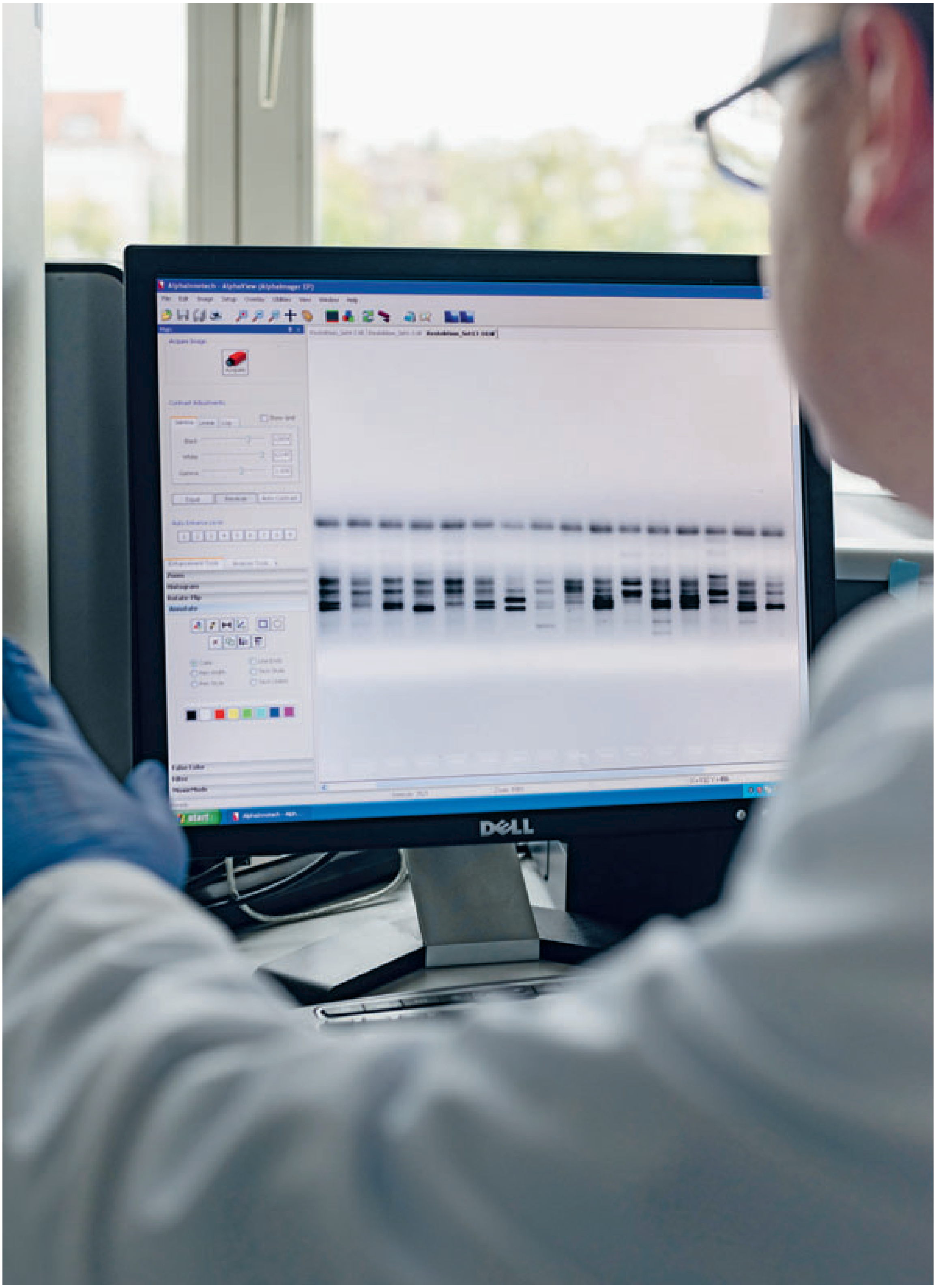
Increasingly rare: the yellow-flowering native variety of the plant, the touch-me-not balsam *(Impatiens noli-tangere),* is steadily being driven out by the invader (right).

Himalayan Balsam is widespread in damp and nutrientrich soils throughout Switzerland. Root samples are collected using a sampling ring and put into bags.

Sieving and washing: In the lab, the roots and rhizomes are extracted by sieving and washing the soil samples. The fragments are then freeze-dried and ground.

Uprooting: experts advise that the neophyte should be removed from forests and gardens; torn-up roots of Himalayan Balsam, which has a relatively small, shallow root system (left).

DNA analyses are used to identify the subterranean diversity of plants. Gel electrophoresis – shown here on the right – provides a control in the analysis of the genetic material.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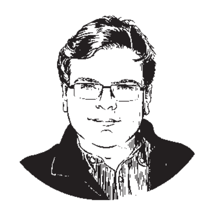
Lab analysis: Genetic analysis of the collected material is carried out in the lab on St.-Johanns-Vorstadt in Basel, with a view to identifying differences between subterranean floral diversity where the neophyte is present and where it is not.



Luca Gaggini is a doctoral researcher in the nature conservation biology research group. He is studying the impact of invasive plant species on native forests, both in Ticino and in the Basel region.

Using stem cells to combat cerebral palsy.

Text: Irène Dietschi

Cerebral palsy is a physical disability caused by brain damage in early infancy. Raphael Guzman explores the potential of using stem cells to treat this paralysis of the brain in his laboratory at the Department of Biomedicine. In the future, the neurosurgeon hopes to be able to help affected children shortly after birth.

For decades, medical doctrine held that the nerve tissue of the central nervous system was not capable of regeneration. Medical students learned that "people are born with a certain number of nerve cells, and, because nerve cells do not divide, no neurogenesis takes place in the adult human brain." Period. In the early 1990s, however, cracks began to appear in this dogma. Namely, studies at the time showed that even the adult brain contains regions where nerve cells regenerate. Accordingly, ideas began to emerge about also applying regenerative stem cell therapy to the brain.

Since completing his studies, Raphael Guzman has been following these developments very closely. Today, the 46-year-old native of Berne is Vice Chairman of the Department of Neurosurgery at University Hospital Basel and a senior physician at the University Children's Hospital Basel (UKBB). He also holds a professorship in pediatric neurosurgery at the University of Basel – currently the only one in this field in Switzerland. However, equally important to his clinical work is his research: at the Department of Biomedicine, Guzman leads a research laboratory working on stem cell therapy for brain ischemia and cerebral palsy.

Therapy shortly after birth

"In Switzerland alone, around 150 children are born with cerebral palsy each year, for example due to a lack of oxygen during birth," explains Guzman. At UKBB, those affected by the disease are treated by an interdisciplinary team of experts, and the clinic also sees young patients from all over Switzerland, Italy and Germany who have been referred for evaluation. Guzman's concept involves treating the children with autologous stem cells, i.e. stem cells from their own body, shortly after birth. His laboratory studies funded by the Swiss National Science Foundation among others, are intended to form the basis for clinical trials.

When neurogenesis – the generation of new nerve cells – in adults first became a serious research topic in the mid 1990s, Guzman was doing his state examination in Berne. "It felt like a new awakening in the neurosciences, and lots of ideas were being discussed in relation to therapeutic approaches," he recalls. At the time, he was working at University Hospital Bern on one of the first cell therapy trials, in which dopamine-producing neuronal cells were transplanted into the brains of patients with Parkinson's disease. After that, Guzman spent 10 years doing research and clinical work at Stanford University in California, where he was involved in projects that led to key advances in scientists' knowledge of neuroregeneration using neuronal stem cells.

Attempting to replace cells

For example, the researchers studied the white brain matter in more detail. "When it comes to the brain, we automatically think of the nerve cells first, but these cells are dependent on a substantial infrastructure of supporting cells," explains Guzman. These include what are known as glial cells, which make up the "substance" of the white matter and are described as the supporting cast of brain cells: running through them are the axons, or the continuations of nerve cells, which transport the impulses from one nerve cell to the next. Surrounding the axons like a protective winter coat is the myelin sheath, which is produced by the oligodendrocytes; these are essential supporting cells. "Axons and nerve cells could not function without the support of the oligodendrocytes," explains Guzman.

Now, if the brain tissue is destroyed as the result of a stroke, for example, the body tries to replace the cells itself through neurogenesis. "New neurons and oligodendrocytes are formed, regardless of whether it's an adult brain or the brain of a newborn," Guzman says, although "it seems these oligodendrocytes are not regenerated in sufficient quantities and/or do not survive adequately".

For this reason, Guzman and other stem cell researchers began by addressing this mechanism within the white matter. They soon achieved success in the laboratory: "It turned out that, if we inject the stem cells into the carotid artery of our laboratory animals, they migrate into the brain tissue. What's more, the transplanted cells stimulate the body's own repair mechanisms. In other words, the damaged brain begins to produce large numbers of new cells itself, especially myelin-forming oligodendrocytes." The animals in which the researchers had previously induced a stroke showed visible improvements in body functions following stem cell therapy.

Stimulating the body's own repair mechanisms

These findings led to a new therapeutic concept: researchers moved away from the idea of "replacing" cells, as in the first Parkinson's studies, for example. Instead, the aim was to use transplanted stem cells to stimulate the body's own repair mechanisms, such as neurogenesis. "From cell replacement to trophic support," was the title of an editorial that Guzman published in a journal in relation to this paradigm shift.

Raphael Guzman is Professor of Neurosurgery and deputy chief of neurosurgery at University Hospital Basel.

As part of his ongoing research activities in Basel, the scientist wants to work with his team to expand these insights into cell biology. "For example, we want to find out which proteins are responsible for the regeneration process," says the neurosurgeon. In order to obtain rapid findings from the practically unlimited possibilities, Guzman is working closely with international and local research groups, for example with the neonatologist Sven Wellmann in Basel.

Therapy as an objective

This prompts the question: is it absolutely necessary to understand the cellular mechanisms down to the last detail in order to test the concept in humans – especially as it appears to work in animal experiments? "That's a difficult question, including from an ethical perspective," says Guzman. In his view, you need to weigh up very carefully whether and when enough knowledge is available for a clinical application. At the same time, he feels that it's a fair point: "Before you spend forever and a day exploring the basic principles in the laboratory, there has to be an intermediate path so that you can reach the patient within a sensible period of time."

With regard to stem cell therapy for cerebral palsy, this "sensible period of time" already appears to be within reach. "A colleague from the University of Texas is currently preparing a multicenter clinical trial whose protocol we could probably adopt in Basel," says Guzman – provided, of course, that the study clears the relevant hurdles at Swissmedic and the ethics committee. He says that treatment could then hopefully begin in two or three years' time.

Of course, as a doctor, he is also interested in pushing ahead with clinical trials. "You know, I see these children in outpatient clinics and I witness firsthand their motor and – in some cases – cognitive developmental deficits. And it's distressing." His research, which primarily takes place in the laboratory, is ultimately a means to an end, says Guzman. "The objective is to develop a therapy – so that children with a poor start in life might have a better chance at normal development." ■

How snowflakes are formed.

Cold temperatures alone are not enough: for snowflakes to form, biological particles are often needed to act as ice nuclei. It is precisely these particles that Basel-based environmental scientists are researching on the Jungfraujoch glacier saddle and in the most northern part of Norway.

Text: Yvonne Vahlensieck

Most travelers taking the train up to the Jungfraujoch saddle in the Bernese Oberland are hoping for blue skies and sunshine when they reach their destination, but environmental scientist Claudia Mignani is not like other visitors. She wants thick clouds, snow, and below-zero temperatures – precisely the weather conditions that the doctoral researcher needs for her research project that asks: How exactly is snow formed?

The simple answer to this question is that pure-water ice crystals can only form below –36° C. Cloud droplets can, however, freeze in warmer temperatures, too, as a result of tiny particles in the air such as dust, soot, fungal spores and bacteria. These particles function as so-called "ice nuclei", whereby water can, for example, condense onto them and then freeze. "These tiny ice crystals then grow as they approach the ground and finally fall to the earth in the form of snowflakes," Mignani explains.

Mignani's goal is to explore the frequency and properties of ice nuclei in greater depth. The high-alpine research station on the Jungfraujoch saddle is a perfect location for the study: "We are right in the middle of the clouds here, and can collect the ice crystals at the very site where they form." There are plenty of opportunities to do this, since the research station is in the clouds around half the time.

Finding tiny particles

In spite of the ideal conditions, it is not easy to find or analyze ice-nucleating particles: They are not only microscopically small; they are also quite rare. "Not every snowflake contains an ice nucleus," explains Emiliano Stopelli, who also completed a doctorate at the University of Basel. Snowflakes can also occur as a result of so-called "ice multiplication". "For example, when two pieces of ice collide, small fragments break off and new ice crystals grow from these," says Stopelli. According to his research data, the concentration of ice nuclei in one cubic meter of air on the Jungfraujoch fluctuates between (less than) one and several hundred ice nuclei, depending on the weather conditions and the time of year.

For this reason, the Basel environmental scientists developed a new method for quickly testing a large number of snow samples for ice nuclei. Mignani collects freshly formed snowflakes in specially designed containers and seals them in plastic bags. After the samples have melted, she slowly re-cools them down to minus temperatures in a water bath and records the temperature at which they freeze. "This is how we can identify which of the samples contain ice nuclei that are active in the temperature ranges that we are analyzing," Mignani explains. Using the results of this analysis and considering various other factors, she is then able to calculate the concentration of ice-nucleating particles in the air.

Bacteria as ice nuclei

The researchers focus on temperatures between 0 and –15 °C in their studies. This is the temperature range in which biological particles like pollen, spores, bacteria and soil particles are active as ice nuclei. "We believe that biological particles are most likely to trigger precipitation in these warmer temperatures. According to our results on the Jungfraujoch saddle, this can happen very frequently along weather fronts," Stopelli commented.

Little is known about which of these biological ice nuclei are the most dominant in the atmosphere. This is the reason Mignani is looking to identify more closely which particles are swirling about in the air. To do this, she sucks air through a particle collector – a bit like a vacuum cleaner – that has a thin silicon pad that the particles attach to. This pad is then slowly cooled under conditions that facilitate the forming of ice: "Small ice crystals form on the pad in the spots where ice nuclei are attached. We magnify these spots to a much bigger size and then examine them using a scanning electron microscope in order to identify the individual ice nuclei."

If the ice nuclei turn out to be living bacteria, it is sometimes possible to propagate these in the laboratory and to identify the exact kind of bacteria using DNA analysis – this is how Stopelli managed to gather cultures from the *Pseudomonas syringae* bacterium from several snow samples. This kind of bacteria is harmful to plants and primarily affects the farming industry, since it attacks agricultural crops such as soya beans, beets, and wheat. Microbiologists speculate that the bacteria cover vast distances through clouds, and then fall to the ground as ice nuclei inside snowflakes, and that this is how it proliferates. Stopelli believes this to be plausible: "It is exciting to see how the bacteria can survive several days or weeks at high altitudes, in cold temperatures, and can withstand powerful UV radiation."

Global connections

As a result of the findings so far, the environmental scientists believe that biological particles play a relatively significant role in the formation of precipitation: "Our fundamental research contributes to a better understanding of how ice is formed in clouds. This is extremely important because ice changes the properties of clouds, and in turn influences the weather and climate," explains Mignani. At present, the distribution and frequency of biological ice nuclei is only taken into account when calculating climate models to a limited degree, since so little is known about the origin of biological ice nuclei. This is why Mignani also travels to the arctic region to undertake further research, taking her equipment for gathering air and snow samples up to the Haldde observatory at the northernmost point of Norway. When she is up there, however, she sometimes hopes for a clear sky – then, with a little luck, she can also observe the Northern Lights. ■

Second-language support for children: the sooner, the better.

The sooner children from immigrant backgrounds can benefit from care outside the family, the more quickly they will learn to speak German, which in turn means they will be less disadvantaged once they enter school. These are the findings of a long-term study conducted by Basel developmental psychologists.

Text: Samuel Schlaefli

Basel-Stadt is a canton with a very strong immigrant presence: More than 100 languages are spoken in the city, and most children living here do not speak German at home. The canton recognized years ago that this was going to have far-reaching implications for playgroups, kindergartens and schools. "Research findings on early intervention were conclusive already at that time," says Alexander Grob, Professor of Developmental and Personality Psychology at the University of Basel: "The sooner children from socially disadvantaged groups receive help with second language acquisition, the easier they will be to teach later on, and the social and economic burden on society will be lightened accordingly."

Trail-blazing local project

Using advice from former head of the ministry of education Christoph Eymann, Professor Grob called into being a project entitled "Mit ausreichenden Deutschkenntnissen in den Kindergarten" (Starting Kindergarten with Adequate German Skills). Parents living in the canton of Basel-Stadt are – based on law – expected to fill out a questionnaire on their children's proficiency of German 18 months before the children enter kindergarten. The questionnaire is now available in the ten languages most widely spoken in Basel. Where necessary, a cross-cultural communicator helps with translating and filling out the form. If the answers given point to a second language deficit, the child's parents are obliged to send their two- to three-year-old to a playgroup or day care center that provides second-language support integrated into daily learning. The minimum attendance is two half days per week for a year.

"What is unique about the Basel project is the early stage at which intervention occurs," says Grob, whose research group accompanied the project with an extensive longitudinal study over eight years. Every year, 18 months before their children start kindergarten, around 1,800 parents receive a letter asking about their children's language skills. Over four years, the team selected subsets of around 120 children each and then monitored their respective progress for four years. A total of 586 children took part in the study.

Over the course of the study, the researchers collected data on the children's learning progress at four different stages: at pre-Kindergarten age (3.3 years on average), at the beginning and end of kindergarten (4.8 and 6.2 years, respectively) and at the end of their first year in elementary school (7.3 years). In addition to the children's German skills, their individual life context was assessed, including the amount of support received from parents, playgroup workers and teachers. For instance, researchers would observe how parents communicated with their children and check how many children's books were available in their homes, and in which languages. They also took an interest in how teachers evaluated the children's German skills and levels of social integration and self-competence.

Decisive role of life context

"What surprised me most was that as many as 75 percent of children for whom German was not a first language were in need of support," Grob recalls. "One in two spoke and understood hardly any German at all." Another finding was less than surprising: The earlier and more frequently a child attended a child care facility, the better their command of German ultimately became. "Up to the age of about six, children are able to learn a language without even making an effort; they simply pick it up," he remarks, before adding, "But this works only if the child is exposed to the right kind of life context." These conditions are the intended aim of Basel-Stadt by making formal child care with second-language support mandatory for some children.

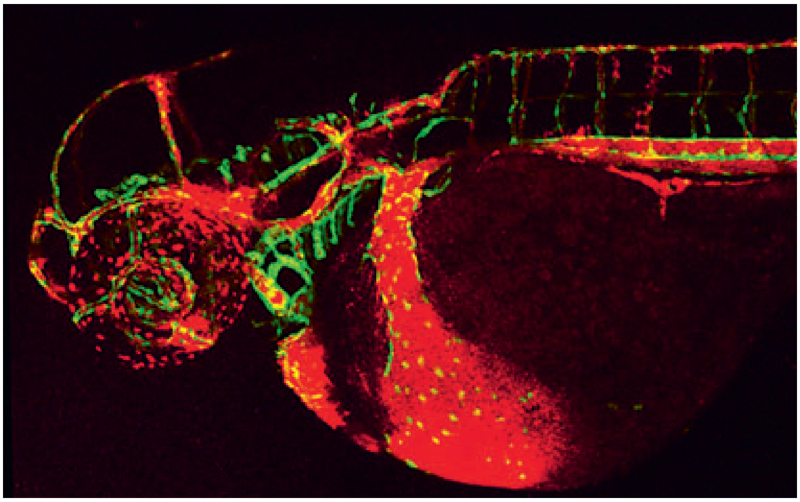
Heike Behrens, Professor of Cognitive Linguistics and Language Acquisition Research at the University of Basel, explains that findings from psycholinguistic research confirm the importance of early intervention: "During the first three years of life, conditions for language acquisition are ideal in that a lot of developmental changes coincide and feed into each other." She adds that there is evidence that a language deficit at this stage is extremely difficult to overcome later on. However, she stresses, age is not the only influential aspect, with language acquisition depending on a number of other positive factors.

Grob's study shows that one of these preconditions is what is known as parental acculturation: The higher the degree to which parents from an immigrant background identify with Switzerland – in other words, the more motivated they are to integrate and the more confident they are of being allowed to stay in the country – the steeper their children's learning curve will be. If acculturation fails to occur, by contrast, then the children's second language acquisition is adversely affected even if the parents speak German at home. It thus seems that the reassurance of having found a permanent new home is of greater importance to a child's second language acquisition than the language spoken in the family.

This has political relevance, especially for the treatment of refugees: "Being prepared to welcome immigrants entails more than just giving them the opportunity to learn German," says Grob. "The host country also needs to reassure them that it will be beneficial in the end." He goes on to say that allocating public funding to German courses for refugees is therefore worthwhile only if the participants can see some chance that they will be allowed to stay in Switzerland in the long run.

Potential value of bilingualism

The Basel model of a "selektives Obligatorium" (selective obligation) represents a requirement for children to attend childcare facilities with second-language support. This model has come to be regarded as an example of best practice, both nationally and internationally. For instance, the canton of Lucerne and the cities of Chur, Zurich and Schaffhausen have all adopted the questionnaire created by Grob. In Basel, the questionnaire is being translated into Tigrinya and Arabic to accommodate shifting geopolitical realities. In addition, Professor Grob and colleagues from other universities are planning a further long-term study on metacognitive competence in bilingual children. The aim is to test his hypothesis that children who grow up bilingual find it easier to see things from the perspective of others. "If this is borne out by our research, then we can't afford not to promote bilingualism," he stresses: "In increasingly polarized societies, building up social and emotional skills is enormously important." ■



Pharmaceutics

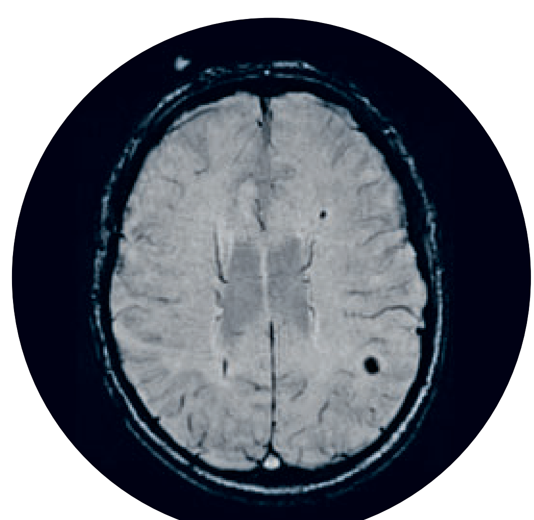
Zebrafish in nanomedicine.

Nanoparticles can deliver drugs specifically to diseased tissue, thus drastically reducing side effects. While some of these transport systems are already approved, for instance in treating tumors, the circulation behavior of novel nanoparticles in a living organism is difficult to predict. Zebrafish could be valuable beyond their use in genetic and developmental biology as a new model organism in nanomedicine development. Mutants, for example fish that express green fluorescent proteins in their vasculature, are of particular interest. Scientists can for instance inject nanoparticles that are labeled in red into a zebrafish and then precisely observe and analyze how these particles distribute through the organism. A team at the Department of Pharmaceutical Sciences at the University of Basel, including Sandro Sieber, Dr. Dominik Witzigmann, and Professor Jörg Huwyler, studied various nanoparticles. They were able to demonstrate that even minute changes in the composition strongly affect how long the nanoparticles will circulate in the zebrafish. The differences they observed correlate with published and experimental findings from experiments in mice and rats. The zebrafish could therefore serve as a model for testing nanoparticles at an early stage of pharmaceutical development. This would enable faster and better identification of potentially effective formulations, which might reduce the number of required experiments on higher vertebrates such as mice and rats. ■

Medicine

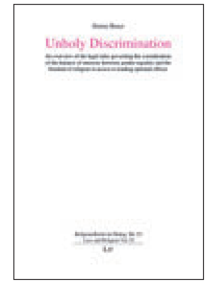
Atrial fibrillation and the risk of dementia.

Patients with atrial fibrillation, the most common type of cardiac arrhythmia, have an increased risk of small, unrecognized circulatory disorders and also small cerebral hemorrhages – which may contribute to gradual cognitive decline in older adults. This is reported by the Basel cardiologists working with Dr. Michael Kühne, Professor Stefan Osswald and Professor David Conen in an individual study conducted as part of the Swiss-AF Study (Swiss Atrial Fibrillation Cohort), which is funded by the Swiss National Science Foundation. For this study, 1,978 patients aged 65 or over and suffering from atrial fibrillation were examined once a year by means of blood tests, imaging and cognitive function tests. Central to the study was a 30-item test to measure different cognitive functions such as short-term memory, attention, language, orientation and the ability to name objects. Overall, 46% of the study participants exhibited pathological values below 26, one in four had values below 23. These patients therefore had considerable cognitive impairment. Compared to patients with normal values, they were older on average, had a greater need for stroke prophylaxis and were more likely to be taking blood thinners to prevent thromboembolism. It is currently assumed that 9% of people over the age of 65 and more than 40% of those aged over 90 are affected by dementia. It is the most common reason that people need nursing care in older age and the third most frequent cause of death in Switzerland after cardiovascular diseases and cancer. ■



Female Leaders

Gender Equality in Religion.



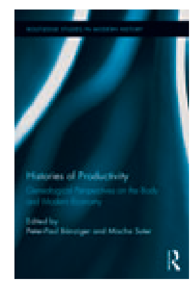
Denise Buser: Unholy Discrimination. An overview of the legal rules governing the consideration of the balance of interests between gender equality and the freedom of religion in access to leading spiritual offices, LIT Verlag, Zürich 2017, 110 pages, CHF 29.90

This book concerns the clash between gender equality and religious freedom, and the lack of female access to leading spiritual offices. All three great monotheistic religions are committed to a tradition of male religious leaders. In the Roman Catholic Church, canon law forbids female priesthood: "Only a baptized man can validly receive sacred ordination" (can. 1024). Islam poses no comparable legal, only social, barriers. In Judaism too there are inequalities between men and women which, to a large extent, block access to a female rabbinate. This contradiction between the right to non-discrimination and the right to religious freedom evoked by religious communities needs to be solved.

Denise Buser, a lecturer and titular professor in the Faculty of Law at the University of Basel, takes a legal approach to the equal treatment of men and women. Her study discusses the question of the aptness of this method to the religion field, and also considers the state's duty to protect the fundamental rights of its citizens. The book also includes interviews with a German Roman-Catholic female priest "contra legem," a Swiss female rabbi, and a female law professor and expert on Islam from Morocco. ■

Modern Economy

Histories of Productivity.



Peter-Paul Bänziger and Mischa Suter (Eds.): Histories of Productivity. Genealogical Perspectives on the Body and Modern Economy, Routledge, New York 2017, 201 pages, GBP 110

Global issues such as climate change and the aftermath of the 2008 financial crisis have spurred interest in thinking about the history of the modern economy that goes beyond disciplinary economic history.

This book contributes to the cultural history of capitalism and its different regimes of productivity by pursuing the perspective of body history and by providing a global scope. Throughout modernity, the body served as a fundamental, albeit essentially changing, linchpin for both the organization of economic practices and for intellectual reflections on the economy.

The book explores this central thesis in a range of case studies, drawing on source material from West Africa, Europe, Mexico, and the US. Framed by a theoretically informed introduction, which also provides a conceptual history of notions of productivity, and by an afterword that brings the approaches explored in this volume into dialogue with scholarship inspired by Marx and Foucault, the individual chapters tackle the concept of productivity from a wide array of angles.

Both editors work at the University of Basel, Peter-Paul Bänziger is currently the recipient of an Ambizione grant from the Swiss National Science Foundation, and Mischa Suter is a lecturer in Modern European History. ■

Short Essays

Rejecting Major Economic Concepts.

Bruno S. Frey and David Iselin (Eds.): Economic Ideas You Should Forget, Springer, Cham 2017, 166 pages, CHF 33.00

A fascinating and thought-provoking collection of short essays written by respected economists and social scientists that shows the weaknesses of various traditional economic concepts. It rejects major economic ideas and provides a broad overview of the economic profession and currently dominant thought.

Reporting on cutting-edge advances in economics, this book presents a selection of commentaries that reveal the weaknesses of several core economics concepts. By discussing problematic theoretical assumptions and drawing on the latest empirical research, the authors question specific hypotheses and reject major economic ideas from the "Coase Theorem" to "Say's Law" and "Bayesianism." Many of these ideas remain prominent among politicians, economists and the general public. Yet, in the light of the financial crisis, they have lost both their relevance and supporting empirical evidence.

Bruno S. Frey, who co-edited this book, is a permanent visiting professor at the University of Basel who seeks to extend economics beyond the standard neo-classics by including insights from other disciplines, including political science, psychology and sociology. ■

Is there such a thing as politically correct language?

Political language criticism teaches us about the effects words actually have – and invites us to open up to other people through language.

Text:
Deborah Mühlebach

Everyone seems to be talking about political correctness or "being PC". On social media in particular, some rail against the regulation of language while others hurl torrents of abuse at a rampant "language police". Newspapers increasingly claim that our freedom of speech is in danger. Often we are confronted by two ways of talking about the same people – the intended way and the politically correct way. In these cases, PC becomes a code for a gag order: you can no longer say what you're thinking.

"Political correctness" means to behave in a way that rejects discriminatory speech acts and the term is mostly used as an insult. However, anyone who speaks out in favor of a political language criticism is not talking about political correctness, but rather of a heightened awareness of the effect that we have with our words. What's the difference? The philosophy of language offers an interesting perspective on what happens when we replace a certain phrase with a so-called politically correct one.

Words and sentences are tools for understanding things in the world. The meaning of words and sentences is defined by how they are used in our language community. If we replace one word with another, it will often take on a new meaning. A simplified model of linguistic meaning is the following: The meaning of a sentence is defined by the sentences from which it can be inferred, and by the other sentences that can be inferred from it.

If I say that "Laura is older than Malek", I must also agree with the statements, "Malek is younger than Laura", and "Laura and Malek are not the same age", if I am not to be accused of conceptual confusion. I have therefore committed to these additional assertions too, even if I am not conscious of this commitment. This is because our language stipulates that "older" and "younger" are used as opposite terms. The definitions that accompany one meaning are also evident in our actions. For example, it makes sense that I would congratulate Laura on her 30th birthday before congratulating Malek on his. The other way around would appear confusing. The conceptual norms that define the way we use words influence other social norms that regulate our actions, and vice-versa. It is therefore not in the power of an individual person to control the linguistic meaning of a word.

When it comes to words for people and social groups, this connection becomes morally and politically more explosive. On the one hand, changing social relations can end up altering the meaning of an expression. A few decades ago, the conclusion to be drawn from "Juan is an unmarried man" seemed to be clearly that "Juan is a bachelor". In the meantime, however, there are numerous different forms of long-term romantic relationships that do not involve marriage and which mean that "unmarried" can no longer be directly equated with being single. On the other hand, words for people or social groups can seem pejorative or exclusionary. This is neither dependent on the perspective of the person speaking nor on the hurt feelings of the conversational partner. The n-word does not lose its highly derogatory effect if the speaker says that she did not mean it to be insulting, nor if the conversational partner is not hurt by it. The degradation associated with this word originates from social relationships in which black people have been and continue to be structurally oppressed by white people.

Our social relations contribute to the linguistic meaning of words. This is why political language criticism implies neither the cruel intentions of a particular person nor the expression of conversational partner's sensitivity in the first place. Nor does it suggest that we should always use the word "humankind" when we really mean "mankind". As the influential US sociologist and civil rights lawyer W. E. B. Du Bois remarked, simply exchanging one word for another does not get us very far: "If a thing is despised [...] you will not alter matters by changing its name. If Men despise Negroes, they will not despise them less if Negroes are called 'colored' or 'Afro-Americans'".

If we introduce a new expression that is intended to replace an existing problematic one, it can only have a different meaning if it prompts different conclusions to be drawn. To exercise political language criticism therefore means to put forward new practices in which unjustified derogatory conclusions are not treated as valid. To participate in this kind of new practice means to let those voices to be heard – loud voices in numerous studies – that illustrate how our sentences lead people to draw varying conclusions depending on which words we use, whether humankind or mankind, regardless of what we intend to say. Gender often makes a difference. This kind of language practice also means making more decisions about when the naming of different genders is relevant and when it is not.

Deborah Mühlebach is a doctoral researcher in philosophy at the University of Basel. She has held guest fellowships at the Massachusetts Institute of Technology (MIT) in Cambridge, USA, and at the University of Sheffield (UK). She previously studied Philosophy, Gender Studies, Sociology and Arabic in Zürich and in Paris. Her doctoral thesis is about the philosophy of language and the critique of verbal derogation.

In the framework of this new language practice, the term "political correctness" is imprecise at best and counterproductive at worst. It has little to do with a gag order or forcing a person to use supposedly correct words. On the one hand, using a new expression without changing language practices is futile. On the other hand, our language community is based on unequal power relations, and certain social identities are often not accepted. This makes it difficult to find terminology for certain people and groups that does not prompt derogatory or exclusionary conclusions to be drawn. It is not in vain that African Americans have been engaged in discussions about an appropriate self-identification for decades. There are however different levels of derogatory language and various strategies for opposing it. If we understand political language criticism as an invitation to open up to other people's perspectives, people who have a different place to us in the fabric of society, then we will all learn more about the effects that our words actually have. If we remain fixated on our own intentions (what we meant to say), however, the meaning behind many of our speech acts remains hidden. ■

"The n-word does not lose its highly derogatory effect if the speaker says that she did not mean it to be insulting."
Deborah Mühlebach

The international law expert and sea piracy.

Text: Christoph Dieffenbacher Photo: Andreas Zimmermann

The office is still only sparsely furnished so soon after the election. Some children's drawings are already hanging on the wall by the door. One of them is by three-year-old Ida and is supposed to be of a ship "although it looks more like a heart", says Anna Petrig. Her daughter likes drawing, whereas Ida's older brother, Till, prefers building things. In her drawing, Ida has portrayed what has been her mother's research field for years now: deep sea shipping and the legal issues associated with it. Nowadays, her expert knowledge is in demand globally.

Shipping at risk

A pirate is generally pictured as a sinister, bearded man with a bandana, an eye patch and a wooden leg. This form of robbery, which was practiced for centuries, was suppressed and for a long time seemed to have been eliminated. However, in times of increasing trade and globalization, crime at sea has become highly topical again. Nine tenths of world trade is transported by sea today.

So how did a young woman from a landlocked country actually come to conduct research on this topic? Chance played a part, she recalls. She had just completed an internship at the ICRC in Geneva in 2008, when the UN Security Council passed a resolution to combat piracy off the coast of Somalia. The country itself was unable to take action against it. "That was the first ever international police mission to tackle crime at sea," she tells us.

Military or police operation?

According to the UN resolution, human rights and international humanitarian law were to be respected in the fight against piracy off the Somali coast. Yet, the reference to the law of armed conflict perplexed the young lawyer: "This wasn't an armed conflict situation, but rather a police operation." Together with a colleague, she examined the legal problems surrounding that mission and published the first monograph on modern piracy in English, which attracted a great deal of attention.

The offense of piracy is defined only vaguely, the lawyer tells us – broadly speaking as an act of violence or deprivation of liberty committed by the crew of one ship against that of another. Somali pirates prefer ships that are easy to seize, such as tankers. Petrig explains that today almost all merchant ships are protected by security firms and are therefore no longer attractive targets. What makes it difficult to eliminate piracy, the professor says, is that pirates are generally the last link in a longer chain, similar to small-time drug dealers.

Under flags of convenience

What makes the law of the sea more complicated is that certain states are not even able to police their coastal waters. In legal terms, the state in which a ship is registered has responsibility on the high sea beyond the twelve-mile territorial waters. A large proportion of merchant ships sail under flags of convenience such as those granted, for example, by Panama or Liberia. Petrig thinks the legislation is actually quite detailed, but "a considerable number of flag states don't enforce the standards, for instance regarding labor law or environmental regulations".

In the meantime, Petrig has extended her field of research to encompass maritime security in general. A key question in this respect is, for example, whether human rights also have to be respected at sea. The lawyer is completely convinced that they should be, but due to the specific operational context there are still dozens of finer points to be clarified. What if a pirate who has been arrested has to be brought directly before a judge while still out at sea? Who is obliged to provide assistance to shipwreck victims if a ship is attacked by unmanned systems or from a long distance?

During our conversation about seafaring, piracy and law in international waters, a torrent of rain lashes against the high office windows. "It's really pouring now," the lawyer says with a laugh, closing the window quickly. The element of water in general seems to characterize our interview. Later, the professor goes on to tell me that as a member of a rowing club she gets out on the water whenever she can make time – in other words when work and family allow her to do so.

Her path to the legal profession was not mapped out in advance: her father, who had moved to Fribourg from Valais, was a teacher for children with special needs; her mother teaches creative drawing. It was Petrig's early interest in politics that led her to study law. While still at school, she had taken part in and helped to organize the Federal Youth Session in Bern: "Then I told myself that you can't go into politics until you understand something about the law."

In her habilitation thesis she is currently addressing the question of how

When it comes to piracy and crime at sea, Anna Petrig, recently appointed Professor of International Law at the University of Basel, is very knowledgeable: the Swiss lawyer is regarded throughout the world as a sought-after expert in this subject. She also spends her free time on the water.

Anna Petrig
was born in 1977, studied law in Fribourg (Switzerland) and Paris, gained an LL.M. from Harvard Law School and a doctorate in Basel in 2013. Prior to that she worked, among other things, as a guest researcher at the Max Planck Institute for Comparative Public Law and International Law in Heidelberg and in Lund (Sweden) and as assistant professor at the University of Zurich. As a member of the Constitutional Council, she was involved in the drafting of the constitution of the Canton of Fribourg.

international law can be incorporated into Swiss national law. Her theory is that the domestic gateway provisions for accommodating international law in the national legal sphere are no longer fitting, as international law has changed so radically.

Student and member of the Constitutional Council

After graduating from high school, she traveled to China on the Trans-Siberian Railway, often staying with host families. Later, she also learned Russian. As a student she was involved in founding the Fribourg Young Socialists and held a seat for them in the Fribourg Constitutional Assembly: “That was an exciting time: I was able to put into practice what I’d heard in the lectures, for example in constitutional law. And I had the chance to deal with fundamental issues surrounding the organization of a community.”

After graduating from university, she decided – unlike some of her colleagues – to move away from politics to begin a career in research and do postgrad studies in the US. “At the time, it wasn’t possible to do both: research demands mobility and flexibility, which also appealed to me more,” she says. She was still politically active in the broader sense, working now and again for NGOs: “In politics you have to commit yourself to one place, you’re tied to interests and are supposed to have an opinion on everything straight away.” Reviewing an issue thoroughly and turning it over in her mind – that suits her better. ■

Alumni Careers: Theo Stich

"My degree was training for life."

Text:
Bettina Huber

Theo Stich, alumnus of the University of Basel, is a freelance writer/producer, and owner of the company Lumenfilm. He takes an individual approach to filmmaking: he looks for new subjects or explores an existing topic from an original perspective.

UNI NOVA: Theo Stich, how did you discover your love of film?
THEO STICH: I originally wanted to become a journalist. At the end of my internship with Swiss television I was given the opportunity to make a documentary film about immigration policy in Basel during the Second World War, which was the topic of my Master's thesis. This film motivated me to move toward becoming a freelance documentary filmmaker after spending a few years as a television reporter. Some of my films are about historical topics; I developed an interest in history during my history degree at the University of Basel.
UNI NOVA: How influential was your time at the University of Basel?
STICH: My degree has been hugely influential. I still draw on the topics and methods that I learned during that time. A key moment in my studies was when I took intermediate Latin. I wasn't too enthusiastic at first and had to pass the exam, but I put myself to task and decided to study with greater conviction and motivation. I gained skills that allowed me to be independent and disciplined, and learned to engage in the things that interest me. All in all, I think of my degree as training for life – it's thanks to these experiences that I'm now doing what I'm doing.
UNI NOVA: Can you describe the journey from an idea to a cinema release?
STICH: For my current film, *Under the Spell of the Föhn Wind,* I first had the idea in 2001 but only began researching the topic ten years later. Once I had secured funding for the film, we shot and edited it in 2015. The film premiered in January 2017 at the Solothurn Film Festival, and the film was officially released in March of that year in Basel. Developing and producing a film usually takes four to five years – and very few writer/producers can make a living from this alone. There have often been phases in my life when I have relied on other sources of income. Nevertheless, my job has a certain appeal: I always meet interesting people, conduct research in different places, and am able to realize my ideas. Of course, life as a creative artist is a balancing act; however, the pleasure of working independently and the positive reactions to my work make it worthwhile. I currently have a number of different concepts in development, but it remains to be seen whether they will come to fruition – there is limited funding available and more and more funding applications are submitted to federal and canton funding competitions. ■

PRO IURE

New program funds visits within Switzerland and abroad.

Text: Roman Baumann Lorant, President of PRO IURE

PRO IURE, the alumni association for Basel law students, has created a program that regularly pays for current students to visit legal institutions in Switzerland and abroad. One such group recently travelled to Great Britain on a visit to Oxford and London.

PRO IURE, the association for graduates from the Faculty of Law at the University of Basel, has developed a new funding instrument to provide students with continuing education relating to their field. The aim of the program is to enable students to visit Swiss and foreign institutions such as courts, parliaments, penal institutions, and international organizations. The association eases the financial burden by covering travel expenses up to a fixed amount. The program's goal fits perfectly with the general purpose of PRO IURE: To establish a link between teaching and practice. The first visit took place in October 2016, when a group of students travelled to the European Court of Human Rights in Strasbourg to gain an insight into its work.

Visiting Oxford and London

In October 2017, the project funded another trip – this time to Oxford and London – to help students link what they have learned with legal practice. Those interested attended a comparative law seminar led by Professor Corinne Widmer Lüchinger at Corpus Christi College in Oxford. Participants had previously written a seminar paper or master's thesis on a comparative law topic, which they then presented in Oxford.

The group then continued to London to visit the UK Supreme Court, where they attended a hearing and were received by judge and legal scholar Baroness Brenda Hale. They also visited the Royal Courts of Justice and the Old Bailey, learning about their workings at first hand. During their time in London, the students gained insights into England's highest courts, watched a court hearing in action, and met with various judges who provided an overview of the English court system.

Links with the faculty

This project is another way for the association to forge relationships between current and former students of the Faculty of Law at the University of Basel. Existing contacts can be maintained and new contacts made – bringing benefits both for the students and for the graduates who stay in touch with their former faculty. ■

pro-iure.ch

AlumniBasel

New website.

The AlumniBasel website has been completely redesigned. It is now optimized for mobile devices and, along with a whole new look, the AlumniPortal and events information have been improved. Additional features such as a gallery and job board are also planned. To keep the AlumniNetwork going, the office asks that all alumni and alumnae update their profiles and add a photo. ■

alumnibasel.ch

Literature and more

Discount at Labyrinth.

Members of AlumniBasel can now enjoy a 10% discount at the Labyrinth bookstore on Nadelberg. The store focuses on the humanities and its prices are often lower than many online retailers. Its website features various book recommendations, news from the bookstore, and information about a range of events. ■

buchhandlung-labyrinth.ch

Book publication

Mama Mafia – an action-packed New York novel.

Swiss writer Daniel Zahno was born in 1963 and lives in Basel and New York. He studied German and English at the University of Basel and wrote his qualifying thesis with Professor Karl Pestalozzi on the symbolism of the butterfly in literature. His affinity with literature has continued; he has written nine books and received numerous awards, including the 1997 Clemens Brentano Young Authors' Prize of the City of Heidelberg for his first work, a collection of stories entitled "Doktor Turban". Zahno was also the 2010 Writer in Residence at the Deutsches Haus at New York University in Manhattan – the setting for his latest book.

Mama Mafia is the story of rock singer and survival artist Harvy, who steals an iPhone from the Apple Store in New York's Grand Central Station – although Zahno himself does not own a cell phone. After this, Harvy's life changes completely and he faces a whole range of challenges: Blackmail, disposing of a corpse, and falling for the lover of New York's top Mafia boss, Tony Tangeroli, who is a fan of Harvy's band and wants to help them make it big. Harvy embarks on a dangerous, wild, and complicated journey into the Mafia world. The novel is entertaining, eloquent, and thrilling, deliberately playing off films like The Godfather and Pulp Fiction. This absurd gangster story is told with unbelievably grotesque humor and a sharp, exhilarating chase through New York's urban canyons with a surprisingly open ending.

Daniel Zahno started his first book at the tender age of 11. *Mama Mafia* may be his ninth book, but Zahno explains that it takes time to write a novel, two to three years in fact. Writing chapter after chapter is a huge battle for him. Nevertheless, Zahno has long been making a living from his passion for writing – with great success. ■

Mama Mafia
Novel by Daniel Zahno
Schöffling & Co., Frankfurt am Main 2017,
248 pages, CHF 28.50

Letter from Seoul

Christian Theology in South Korea.

Meehyun Chung is Professor of Systematic Theology at the Yonsei University in Seoul, South Korea. She completed her doctoral dissertation at the University of Basel in 1993 on the topic of Karl Barth. She taught in Seoul until 2004, and was head of the "Women and Gender" section of Mission 21 in Basel between 2005 and 2013. She was a founding board member of AlumniBasel.

I have such fond memories of Basel University: I lived in student halls of residence in Bernoulli Street, where almost everyone else was Swiss. A few of my fellow students came from Ticino and they would often cook specialties like gnocchi or tiramisù. I learned so much while living there, including the idiosyncrasies of the different Swiss cantons. The doctoral colloquium was held at the home of my supervisor, Professor Jan Milič Lochman, who lived on Heuberg street in the city center. I was impressed to be taking part in theological discussions in such a historical place. As teachers, Lochman and my co-supervisor, Professor Martin Anton Schmidt, were always positive role models for me: Just like the sculpture at the entrance of the old university building, they stood behind their students and supported them.

I have been Professor of Theology at Yonsei University in my home town of Seoul since 2013, which has around 35,000 students and 15,000 academic and non-academic staff members. I research feminist theology, gender perspectives, and the ethical consequences of theology. I am the first woman to hold a professorship since the founding of the University in 1885, which means that my working environment is predominantly male. I consider this a challenge and work to raise awareness of gender issues amongst my colleagues. I am also interested in interdisciplinary collaboration and the intersection between theory and practice. As the university chaplain, I give a sermon once a month in the university church and speak in front of lecturers, students, and other staff members; I also alternate with colleagues in leading the Bible study group.

Even now, I have the opportunity to strengthen my longstanding ties with Basel. My university here in Seoul – including the University Hospital and the Medical Faculty – signed a memorandum of understanding with the University of Basel last year. Collaborations in clinical research and joint degree programs are planned in the field of life sciences. The universities are slowly growing closer, and I am delighted to be in a position to build bridges between the two. ■

A Korean with a Basel connection: Theology Professor Meehyun Chung

Sabine R. Huebner is Associate Professor of Ancient History at the University of Basel. Her main research interests are the social, religious and economic history of the Greco-Roman Mediterranean world, historical demography, epigraphy and papyrology.

Photo: Andreas Zimmermann

Sabine R. Huebner

A Thousand Miles up the Nile: a momentous journey.

"Edwards's travelogue was an immediate bestseller and made her rich almost overnight."

As a single woman in Victorian England, the writer Amelia Edwards decided quite spontaneously to set off on an expedition to Upper Egypt. This riverboat trip, which took her all the way up to the Sudanese border, was to change her life. I am fascinated in equal measure by Edwards's account of her journey up the Nile in 1873/74 and by the author herself, who was exceptional for her time and held fast to her ideals in the face of numerous obstacles. Despite her lack of academic training, after her trip she devoted herself to the preservation and study of Egyptian antiquities, led archaeological digs and became one of the founders of Egyptology. In *A Thousand Miles up the Nile* (1877), Edwards was the first to express misgivings about the sustainability of tourism in Egypt. She had seen for herself that the monuments were at risk and witnessed the carelessness of tourists and the methods excavators were using, which were geared towards profit. However, financial resources were needed to fund the academic study and preservation of Egyptian antiquities. With that in mind, Edwards, an inspirational speaker, undertook a series of lecture tours around England and the USA, where she was able to secure the backing of some wealthy patrons. Soon a fund that she had helped to establish was supporting a number of scientific digs on the ground.

Her efforts did not go unrecognized by the profession: at a time when women were not even admitted to most universities, she held three honorary doctorates. She also left a bequest to set up the first British chair of Egyptology. Incidentally, Edwards's travelogue was an immediate bestseller and made her rich virtually overnight. When a nitpicker complained that the distance from Alexandria to Abusir was only 964½ miles, not 1,000, she retorted that she had been able to see for at least another 145 miles from the endpoint of her journey, as far as the mountains at the third cataract. The horizon represents the limits of the attainable. If, instead of stopping, we press on, those limits can be pushed back indefinitely. ■

unibas.ch/aktuell

A selection of events. November 2017–February 2018

November 28, 4 pm

Play and Coming of age in Ancient Greece

Lecture by Véronique Dasen, assistant professor of Classical Archaeology, Université de Fribourg

Vesalianum, great lecture hall, Vesalgasse 1, Basel

November 29, 6.15 pm

Political and Cultural Movements in Post-Cold War Greece

Lecture by Teresa Pullano, Assistant Professor of European Global Studies, Institute for European Global Studies, Basel

University of Basel, Kollegienhaus, lecture hall 115, Petersplatz 1, Basel

November 29, 5–6 pm

Acute Effects of LSD on Brain Activity and Connectivity

Lecture by Stefan Borgwardt, professor of Neuropsychiatry, University of Basel and Psychiatric University Clinics Basel

Pharmazentrum, lecture hall 1, Klingelbergstrasse 50, Basel

December 5, 7 pm

Politic of the Punch: Muhammad Ali, Mobutu Sese Seko and the Fight of the Century

Lecture by Dominique Malaquais, Senior Researcher at the Institut des Mondes Africains, CNRS, Paris

University of Basel, Kollegienhaus, Regenzzimmer 111, Petersplatz 1, Basel

December 7–8

Helminth Infection – From Transmission to Control

The Swiss TPH Winter Symposium 2017 invites medical parasitologists, infection biologists, epidemiologists, global health specialists and students to review and discuss progress in research, control, elimination and eradication of helminth infections.

Parterre Rialto, Birsigstrasse 45, Basel

December 14, 7 pm

Residual Governance: Mining Afterlives and Molecular Colonialism, Seen From an African Anthropocene

Lecture by Gabrielle Hecht, Frank Stanton Foundation Professor of Nuclear Security at Stanford University

University of Basel, Kollegienhaus, Regenzzimmer 111, Petersplatz 1, Basel

December 15, 5.15 pm

"No roots, no fruits!"

Marcel Tanner, former director of the Swiss Tropical and Public Health Institute (Swiss TPH), is ending his highly successful career as a professor at the faculties of medicine and science at the University of Basel with a farewell lecture.

University of Basel, Kollegienhaus, Aula, Petersplatz 1, Basel

December 20, 4.30 pm

Dynamics, Flexibility, Cooperativity and the Evolution of Enzyme Function

Lecture by Lynn Kamerlin, professor at the Department of Cell and Molecular Biology, Uppsala University

University of Basel, Department of Chemistry, Room 4.04, Klingelbergstrasse 80, Basel

January 11–12

Arbitration and Crime – Dealing with Allegations of Economic Crime in Arbitration

Conference on the objection of corruption, money laundering, fraud or bid rigging in investment and commercial arbitration

University of Basel, Faculty of Law, Peter Merian-Weg 8, Basel

January 14–15

Rethinking Peace – Innovating the Future

The Basel Peace Forum 2018 inspires new and unconventional ideas for peacebuilding. To achieve this, carefully selected leading personalities and decision-makers from business, diplomacy, academia, and civil society are invited.

Museum of Art, St. Alban-Graben 16, Basel (Jan. 14) and Congress Center Basel, Messeplatz 21, Basel (Jan. 15)

February 1, 9 am – 7.15 pm

Farewell Symposium Erich Nigg

The Biozentrum is holding a Farewell Symposium for their director Erich Nigg. The scientific talks will focus on current research and span a wide range of contemporary topics. At the end of the Symposium, Erich Nigg will present his farewell lecture: 40 years of exploration come to an end – time to say «thank you».

University of Basel, Biozentrum, Klingelbergstrasse 50/70, Basel