

Feel-Good City

Green roofs, art,
eco-friendly mobility:
Urban planning can
boost well-being

Sciencefluencers

Networking as a
scientific passion:
Increasing the reach
of your research

Water Scarcity

Misunderstood phenomena:
Why does Groß Glienicker
Lake lose more water than
Sacrower Lake?



We/Four

Technische Universität Berlin in the Berlin University Alliance





X Is for Excellence

Delaram Darivasi, a TU master's student featured on our front page, is enthralled by ice-covered moons such as Enceladus (see photo above). This led her to join the X-Student Research Group "The physics of water-rich asteroids." In this constellation, she worked with fellow students to explore such minor planets through research. The students pictured on the back of the magazine are transforming a water container into a physical reservoir computer. The X-Student Research Groups are open to all students of FU Berlin, HU Berlin, TU Berlin, and Charité – Universitätsmedizin Berlin and thus transcend university boundaries. That is precisely the mission of the four research institutions that have banded together to form the Berlin University Alliance. Our photos on pages 24–28 illustrate the wide spectrum of topics pursued by the X-Student Research Groups. (sn)

MASTHEAD

EDITOR

Technische Universität Berlin
Office of Communication,
Events and Alumni
Straße des 17. Juni 135
10623 Berlin

CONCEPT & COORDINATION

Barbara Halstenberg (ME)
Steffi Terp (EIC)

AUTHORS

Anna Groh
Barbara Halstenberg (hal)
Sybille Nitsche (sn)
Patricia Pätzold
Wolfgang Richter
Julie Spielmann

DESIGN

Jonas Schulte

EDITORIAL

Helen Bauerfeind

PRINTING

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in the Berlin University Alliance



**Berlin
University
Alliance**

We/Four

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The time has come to tackle another significant topic through the collaborative efforts of our four partners: the *Next Grand Challenge* of the Berlin University Alliance. In an exciting and unprecedented process that united minds from science and society, we defined our focus: “Responsible Innovation in Times of Transformation.” In an age marked by overlapping and entangled challenges, our society is undergoing a complex transformation. In addition to driving sustainable innovation, it is essential that we also explore transformation processes.

Over the next two years, we aim to fund between one and three transdisciplinary research projects with a total of 1.4 million euros to advance and develop innovative solutions for social transformation. Applications were accepted until the end of April 2024. We aspire to engage as many different stakeholders in the Berlin ecosystem as possible to ensure we benefit from a broad range of perspectives. It is only through collaborative efforts that we can play an instrumental role in overcoming the most pressing challenges of our time. Science must forge innovative and creative partnerships with society, politics, business, and culture to mold a sustainable future.

Join us on this exciting journey and discover more about our accomplishments within the Berlin University Alliance and where we plan to take our collective expertise in the future.

Professor Dr. Geraldine Rauch
*President of TU Berlin and spokesperson
of the Berlin University Alliance*

“We are creating a framework for working together in a spirit of trust”

Anika Rehder directs the Excellence Strategy Task Force at TU Berlin, the office that coordinates the University's participation in the Excellence competition and the funding obtained through it. In this interview, she speaks on the upcoming evaluation and the current state of the Alliance of Excellence.

INTERVIEW Julie Spielmann

The application phase for the next round of the Excellence Strategy is currently underway. How does this process for the Berlin University Alliance (BUA) work? What are the milestones?

An interim evaluation is required every seven years for the Universities and Alliances of Excellence funding line. To meet this condition, we will submit a report and receive a site visit from reviewers. We are currently in the process of preparing the evaluation report for submission, which includes a review and projections for the next potential funding

phase. For the latter, the Board of Directors and the Executive Board of the BUA have refined the vision, mission, and scope of action to be pursued in the upcoming funding phase. Building on this, specialist working groups were formed to map out the content over the course of 2024, which will be formalized in 2025 so that we are ready to submit the report in August of the same year.

What is important for the application?

The interim evaluation will highlight the positive impact the Alliance of Excellence has for Berlin as a scientific hub and, by extension, for all Alliance partners. We are also required to identify strategic adjustments during the implementation phase.



What tasks are still outstanding?

The Alliance's central task is to further underscore the added value it creates for all institutions and stakeholders. Every now and then, this calls for us to remember why we embarked on this adventure together in the first place: We have cut countless Gordian knots and should be proud of what we have achieved.

PHOTO Christian Kielmann

How is TU Berlin preparing for the upcoming evaluation process?

TU Berlin's task in this evaluation process is to initiate discussions internally: What are our strengths and weaknesses, and what opportunities and risks do we expect to face in the long term? What are the main areas for the Alliance to address collectively in the coming years, and which might be more effectively addressed in other constellations such as the TU9 Alliance? These are the issues currently being deliberated.

The Excellence status depends on the number of funded Clusters of Excellence. TU Berlin is the applicant university for the MATH+, UniSys-Cat, and Science of Intelligence clusters. How is it supporting them with their follow-up applications?

TU Berlin offers the clusters strategic and structural support, for example by providing rooms and equipment. The University also advises on cross-cutting topics, supports researchers in the early stages of their careers, and drives knowledge transfer. What's more, it works to forge closer ties between the clusters and the Alliance.

The BUA strives to take cooperation between the partners and with external institutions to the next level. What are the signs that this is successful?

The Alliance facilitates a type of systematic institutional cooperation that did not exist to this extent beforehand. While there have certainly been political, research-related, and administrative cooperation projects in the past, what is new is the way we are systematically establishing and rolling them out to create added value for all. And I believe we are faring quite well: We are creating a framework for working together in a spirit of trust between the poles of competition and cooperation.

Where are the roadblocks?

As an Alliance of Excellence, we aspire to be innovative and pave the way for innovation. Our efforts are sometimes hampered by lengthy decision-making processes at the universities, some of which are then repeated within the Alliance. I am hopeful that we will be able to learn from our experiences and continuously optimize our processes.

There were quite a few reservations surrounding the Alliance of Excellence at the outset. What are the tangible changes that the BUA has brought about for TU Berlin?

Many positive ones! TU Berlin is a member of Germany's only Alliance of Excellence and is able to participate in all its developments. It reaps the rewards not only in terms of reach and reputation, but also with regard to opportunities for external partnerships, for example with the University of Oxford.

We also have the opportunity to underpin our strengths by taking an active role in topics such as transfer, knowledge exchange, participatory research, and science communication. At the same time, we benefit from the strengths of our network partners, for example

in open science and research quality. The establishment of Berlin Universities Publishing, an open access publisher in Berlin, was the fruit of the collaboration within the Alliance and its funding.

What can researchers at TU Berlin expect from the BUA in concrete terms?

They can expect excellent administrative research conditions within the bounds of what universities have at their disposal. This also includes up-to-date resource management in terms of administration, IT, device usage, and so on.

Our researchers can take an active part in the cultural transformation of third-level education. Not only that, but the networking opportunities in the Alliance extend beyond the walls of the individual universities, offering a valuable means for TU researchers to promote scientific advancement – the BUA develops and maintains a range of formats designed to facilitate such networking.

The subject of the BUA's Next Grand Challenge "Responsible Innovation in Times of Transformation" is quite broad. Do the researchers at TU Berlin, who are quite often involved in basic research, fit into this topic at all?

Absolutely! For decades, TU Berlin has been championing the cause of conducting research for the benefit of society. Our UniSysCat Cluster of Excellence, the greenChem project, and many other projects prove that we can bridge the gap between basic research and application. The topic of the Next Grand Challenge is therefore extremely relevant for TU researchers across disciplines and specializations.

Misunderstood Phenomena



Groß Glienicker Lake and Sacrower Lake are only a couple of hundred meters apart, but fluctuations in their water levels tell a different story. Researchers are working to unravel the mystery.

TEXT Sybille Nitsche PHOTOS Kevin Fuchs

It all started around a decade ago. Since then, the water level of Groß Glienicker Lake has been dropping year after year. The decline now totals one and a half meters since roughly 2013, to the extent that the jetty at the DLRG water-rescue and first-aid station on the south-eastern shore no longer extends out onto the lake. Its supporting posts are landlocked. It appears as though the lake is trying to negate its own existence.

Such high-flown language is alien to Dieter Scherer. As a scientist, he poses questions: What happened ten years ago that led to this development? Why is the water level sinking?

In search of the answers, the professor of climatology is analyzing the climate data of Groß Glienicker Lake collected over the past 40 years: wind, temperatures, rainfall, and actual evapotranspiration. Actual evapotranspiration

is the total amount of water evaporated from water bodies, the soil, and other land surfaces, plus the water released into the air by plants through transpiration. It is a pivotal value for understanding the lake's declining water level: Located on the western outskirts of Berlin, Groß Glienicker Lake does not have an above-ground inflow from a body of water, meaning it is mainly supplied by precipitation and groundwater. However, water evaporates from the lake, especially in the summer months, and some of the lake water becomes groundwater again. In addition to data on the groundwater flows, data on the actual evapotranspiration in the entire area that influences the lake through the recharge of groundwater is also required in order to be able to calculate the change in the lake's water volume.

Measuring station urgently needed

But the theory of the matter is easier said than done, because actual evapotranspiration is extremely difficult to measure. "At the moment, we're using data on actual evapotranspiration from the Lindenberg Meteorological Observatory and the Urban Climate Observatory in Berlin," says Professor Dr. Dieter Scherer, adding: "For our research, we urgently need a measuring station serving Groß Glienicker Lake or neighboring Sacrower Lake." The TU researcher refuses to make calculations that, in the absence of this data, ignore complex relationships and thus lead to the sweeping conclusion that evapotranspiration is increasing because temperatures are rising. He continues: "Even though experts are repeating this ad nauseum, so stated, that conclusion is wrong."

Using a special technology, his academic chair calculated and evaluated the climate data for the last 40 years. The result: "The data shows firstly an irrefutable trend towards rising temperatures; second, fluctuating precipitation, although our findings do not identify a reliable trend; and third, fluctuating water levels, that, owing to the rainfall and actual evapotranspiration, are to be expected," says Scherer. "That said, around ten years ago the water balance of the lake changed. Water levels are still in flux, affected by the prevailing weather conditions as always. In comparison to previous periods,

less groundwater is flowing into the lake and more is escaping it. And we have not been able to explain this shift.”

Not only that, but Groß Glienicker Lake is only two kilometers away from Sacrower Lake, which is “behaving” differently. While the Sacrower water levels are on the decline too, they are far from as drastic as its sister lake. “This means that we are witnessing phenomena in the Groß Glienicker and Sacrower Lakes that cannot be explained by climate change alone. It is simply not conceivable that climate change is having such different impacts on pockets of water just a few hundred meters away from one another. There have to be more factors at play,” says Scherer.

One of the hypotheses the researchers investigated in the project “Case study: Groß Glienicker Lake and Sacrower Lake” is that the groundwater flows in the west part of Groß Glienicker Lake’s catchment areas have changed: The water that used to flow into the lake has now re-routed to head north-west toward Nauen. “There is a very water-deficient area there,” Scherer explains. Another hypothesis links the so far unexplained loss of water from the Groß Glienicker Lake to the regulation of the water level of the Havel River. Another theory is that too much groundwater is being extracted for drinking water and irrigation. Climatologists, hydrologists, and hydrogeologists are working to get to the bottom of these hypotheses.

Willing to chip in

The case study also involves representatives from social and political science, politics, practical settings, as well as citizens’ initiatives. The research on the two lakes is being carried out under the “Climate and Water under Change” project (CliWaC), funded by the Berlin University Alliance (BUA) – the Alliance of Excellence of HU Berlin, FU Berlin, TU Berlin, and Charité – Universitätsmedizin Berlin. In addition to the “Rural case study” being carried out, the “Urban case study” looks at heavy rainfall in Berlin, while the “River case study” investigates the effects of climate change on the River Spree and its water resources in the Berlin-Brandenburg region and to use these



The measuring station at the Moorloch swimming area on the southern shore of Groß Glienicker Lake measures the water level and other values.

findings to make scientifically-sound decisions on measures to mitigate the adverse effects of climate change for both people and nature. “The social scientists involved in the project carried out a survey to gauge the extent to which the population sees the sinking water level as a problem, and if they would be willing to contribute financially to programs to maintain the lake,” explains Scherer. The survey revealed that many people are very fond of the lake and would be willing to chip in. Some, such as the landowners at Groß Glienicker Lake, because they fear their property losing value. Others because they see the preservation of nature as a value in itself.

Shared Microcosm

The newly established Alliance Center Electron Microscopy (ACEM) supports the BUA scientific community with electron microscopy

The meshwork of colored orbs is an image from TU Berlin's scanning electron microscope. And although reminiscent of a tree, the image actually shows yeast in sour dough. The state-of-the-art technology in the Center for Electron Microscopy (ZELMI) at TU Berlin allows us to steal a glimpse into the hidden world of matter and structures. The spectrum of observations ranges from the millimeter scale down to the subatomic scale, smaller than a single atom. In early 2024, the Berlin University Alliance, which had just founded the open access publishing house



Berlin Universities Publishing (BerlinUP) in 2023, established the Alliance Center Electron Microscopy (ACEM).

The virtual and interdisciplinary electron microscopy equipment center supports the electron microscope scientific community in the BUA, strengthens the partners in joint initiatives and appointment negotiations, and aims to make

electron microscopy within the BUA competitive on both a national and international level. A new shared microcosm. (hal)



PHOTO TU Berlin



Excellent Networked

The BUA Postdoc Academy offers targeted support for postdocs of the four institutions in their career development. It provides advising services so that researchers can make informed decisions that are conducive to their chosen career path. The Academy creates an environment where postdocs can recognize their strengths and advance their skills and expertise. Professor Dr. Annette Mayer represents TU Berlin in the Academy Council.

One key aspect of the Academy's services is networking, promoting the exchange of ideas and the interdisciplinary networking of postdocs with other players in the scientific community and beyond. To achieve these goals, the BUA Postdoc Academy has developed a comprehensive program portfolio that consists of nine core elements (see illustration).





1. Postdoc Career Fair

Career opportunities in academia and research as well as in industry and commerce

2. Postdoc School

Workshops and coaching on:

- Research management
- Career advancement
- Scientific communication
- Self-management

3. Information Platform

Integrative online information portal that consolidates career-relevant events and news for postdocs

4. Career and networking events

Events and programs to promote careers and upskill

5. Job shadowing

Discovering new career paths by shadowing leaders in science and science management

6. Postdocs at Risk

Program for postdocs in crisis

7. Online Competence Tool

Quick, self-guided assessment of individual skills

8. Serious Transfer Game

Process-based serious game for research groups (interdisciplinary)

9. Spot On

Podcasts, videos and shorts for postdocs

The Postdoc Academy is an offer of the:

Berlin University Alliance 

Performative Art for the Urban Climate

Today, more than half of the world's population lives in cities. The UN estimates that this figure will rise to more than two thirds by 2050. But how do city dwellers stay healthy, physically and mentally? "Exploring and Designing Urban Density. Neurourbanism as a Novel Approach in Global Health" is one of four projects in the BUA Alliance investigating global health. It explores how major urban centers affect people, and what measures can be taken through urban planning.

TEXT Patricia Pätzold



Paradise: What does it look like? What does it feel like? These two questions have preoccupied humankind for centuries. And the *umschichten* artists' collective, active in Berlin, Hamburg and Stuttgart, also raises them in its works exploring the emotions people feel in cities. This summer, researchers and students will collaborate with the collective to erect artistic installations around the TU campus. They are intended to evoke positivity and offer city dwellers a slice of paradise. The campaign is part of the BUA project, which is researching the possible influence of urban planning on the health of city dwellers.

“Rest, relaxation, well-being, exercise, and stress management are environmental factors that are beneficial to people's psychophysical

Interventions, like the temporary play street in Berlin Mitte pictured here, offer residents respite from the hustle and bustle. On a level grassy hill three meters above the road, a man enjoys his breakfast every morning and receives visitors. Installed in Berlin-Neukölln in 2006, Christian Hasucha's artistic intervention “The Island” has toured several European cities.

health,” says Dr. Felix Bentlin, senior researcher at the Chair of Urban Design and Urban Development in the Institute of Urban and Regional Planning at TU Berlin. Professor Dr.-Ing. Angela Million is leading the project in the novel research field of neurourbanism together with Professor Dr. Klaus Gramann's Chair of Biological Psychology and Neuroergonomics.

“These factors can be influenced by spatial planning on a global scale,” adds Bentlin, who is coordinating the planning and implementation of the installations. “With the installation campaign on the inner-city campus and in the surrounding neighborhoods, we want to find out if and how we can manipulate people's perceptions and thus their emotions in an urban space through planning and design; for example, a sense of comfort through aesthetics or the joy of urban density through shared moments in a community. This makes the installations performative art.” According to Felix Bentlin, this means that the builders engage with the space during construction, tap into the prevailing conditions, and integrate their own desires and feelings into the installation. “The builders are not just anyone, they are mostly students who know and use the space themselves.” They and the collective are supported by external construction specialists.

Social stress from cramped conditions, noise, and sensory overload

People who live in cities are at a higher risk of suffering from poor mental health. In fact, the risk of city dwellers developing schizophrenia, depression, or an anxiety disorder is almost twice as high as for people living in the countryside. This is why the twelve-member project consortium also includes doctors from Charité – Universitätsmedizin Berlin, such as psychiatry professor Mazda Adli. He suspects that what makes people ill is above all social stress. This comes about particularly easily where people live together in very limited space. It is compounded, he says, by sensory overload, noise, and environmental pollution. Not to mention loneliness as a further stressor, fueling what is known as isolation stress. But the Charité professor also points to significant advantages that



make life in the city attractive: better healthcare, access to a wide range of educational and cultural opportunities, and greater prospects for prosperity and personal development.

How can urban planning have a positive impact on the psyche?

However, another important factor can potentially have a negative impact on the mental health of city residents. “In our research association, we are working on the assumption that, in addition to the large number of people in a confined space, the many things that happen, and the dense traffic, structural density can also be at the root of residents' malaise,” explains TU urban planner Angela Million. “In addition to the quantitative experiments conducted by our colleagues in the association, we use qualitative interviews to investigate how people perceive the space they live in. This is because urban density can also convey a sense of community and thus have a positive effect on the psyche. We are interested in learning how we can influence these feelings through urban planning.”

Angela Million highly values the interdisciplinary nature of the project. “I find neurourbanism to be an extraordinary research field,” she says. “This intensive dialog between such different disciplines as architecture, art, medicine, and psychology with their specific approaches is new for us all.”

Ideal urban setting – The lively university in the city center

The first interviews have been carried out in a pilot project to put the questionnaire to the test. Now the planners and spatial researchers are ready to implement the first structural modification of public space – and not just anywhere, but on the main campus of TU Berlin in Charlottenburg.

Felix Bentlin explains what is so promising about the location: “Our campus offers an excellent site in the middle of the city. It's a mere couple hundred meters from the turbulent city life with cafés, offices, hotels, movie theaters, and hotspots like Savignyplatz and Steinplatz. Not to mention the campus of the Berlin University of the Arts, the large public canteen, the

bustling Ernst-Reuter-Platz, and the Zoo train station are also only a stone's throw away.” The researchers want to use these characteristics to understand how people can be motivated by urban interventions. “Regardless of the backgrounds of individual users, such as gender, age, affiliation, and legal status, and regardless of the surrounding residential neighborhoods, these public streets and squares open up a realm of experience for the entire city.”

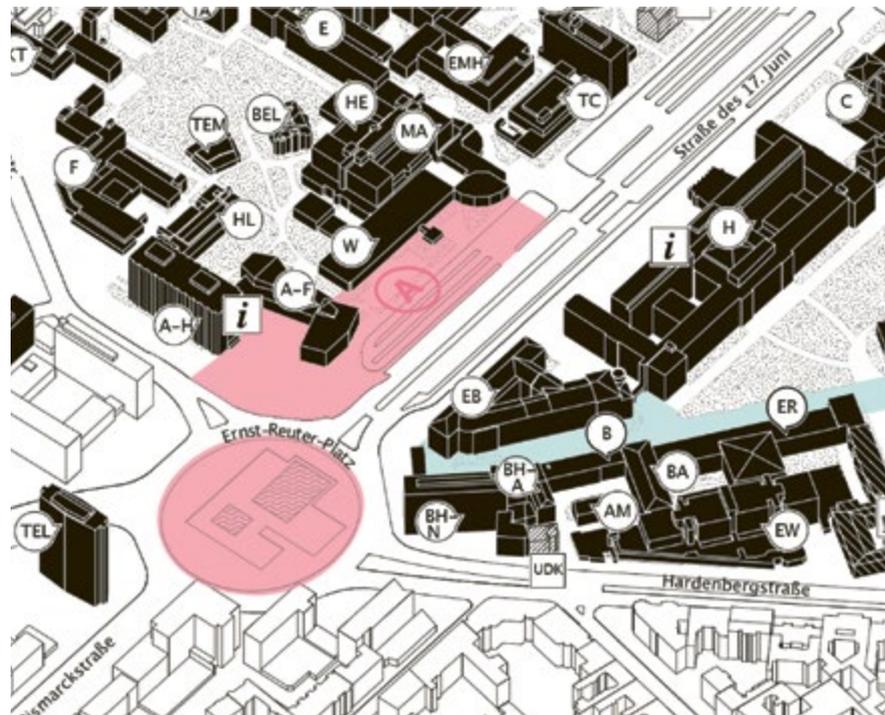
The role that biographical aspects could play in our perception of the world around us must also be given weight: For example, do people in cramped living conditions, who have no private retreats such as their own gardens or living spaces, perceive their surroundings differently from those who do have such spaces? Or do those who have grown up in other cultures, perhaps with a different traffic density, demonstrate greater tolerance? “Someone from Berlin,” Felix Bentlin continues, “could have a similar, but also different perception of density to someone from Austin, Bangkok, Cape Town, or Santiago de Chile. We don't yet know whether this is the case and what factors determine it.” In order to shed more light on these qualitative aspects and to discuss them alongside the quantitative surveys mentioned previously, drawings, pho-



Felix Bentlin conducts research on sustainable urban structures and on healthy and climate-friendly urban redevelopment. He is coordinating the installation campaign on the TU Berlin campus.

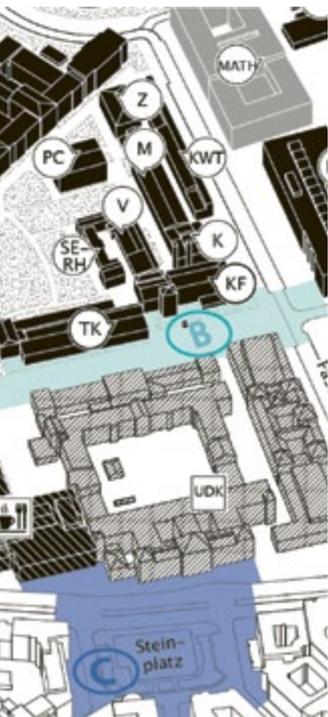


Angela Million is head of the Chair of Urban Design and Urban Development at TU Berlin. She is one of three spokespersons for the Research Platform Neurourbanism (RPN).



The planned sites of the “Symbolic representations” project: This is where the performative installations will be implemented.

- A** Hydraulic engineering hall on Straße des 17. Juni and Ernst-Reuter-Platz
- B** Hertzallee, which cuts through the center of the campus
- C** Steinplatz, which was redesigned in summer 2018 for a variety of urban and cultural uses



tos, videos, and interviews will be used both before and after the structural intervention to record how people behave in these spaces and their feelings and perceptions. The research association intends to use this data to carry out computer-aided follow-up experiments in the Berlin Mobile Brain/Body Imaging Lab (BeMoBIL) in cooperation with Professor Klaus Gramann.

One million euros for climate adaptation strategies on the TU campus

The installations will be temporary and reversible, and are scheduled to be erected in the summer semester of 2024 from a construction kit of sustainable materials. The students will decide on the details – colorful or not, horizontal or vertical, shaded or not – together with scenographer Alper Kazokoglu and architect Lukasz Lendzinski from the *umschichten* collective. The second major partner is the ClimateHOOD_CampusPARK Charlottenburg project, which has been largely spearheaded by Dr. Grit Bürgow and Dr. Anja Steglich from TU Science and Society. In this project, the Stadt-Manufaktur of TU Berlin, the Berlin University of the Arts (UdK), and the Charlottenburg-Wilmersdorf district office are working together to adapt the campus to climate change. The Federal Ministry for the Environment and Nature Conservation earmarked almost one million euros for the project in 2022.

“Our performative installation campaign thus integrates numerous partners and projects, which is common practice in urban planning,” says an enthusiastic Felix Bentlin. “The interventions are meant to set an example right here in an inner-city campus, in a place where the city is already transforming. They serve as a symbolic representation of a technologically driven and urban-natural transformation into a climate-resilient city, standing out in the urban landscape like an exclamation point!”

The first catalog of measures for the blue-green infrastructure with rainwater management and façade and roof greening for Hertzallee and Straße des 17. Juni have been prepared. Steinplatz, which is also to be included, is a classic Berlin neighborhood square that has been extensively modernized in recent years. Water

reservoirs below and above ground, plants and hydroponic features such as marsh roofs, water basins, and water sculptures are designed to keep public spaces and buildings cool while conserving resources, along with reed beds, ponds, and green spaces that are suitable for growing food. The future museum pavilion on the grounds behind the main TU building will also be clad with a green roof. Before the year is out, a climate façade with plants and an irrigation system will be installed on the large hydraulic engineering hall on Straße des 17. Juni. These are precisely the places where the art installations, or “symbolic representations,” will be staged, and where interviews with passersby will be carried out.

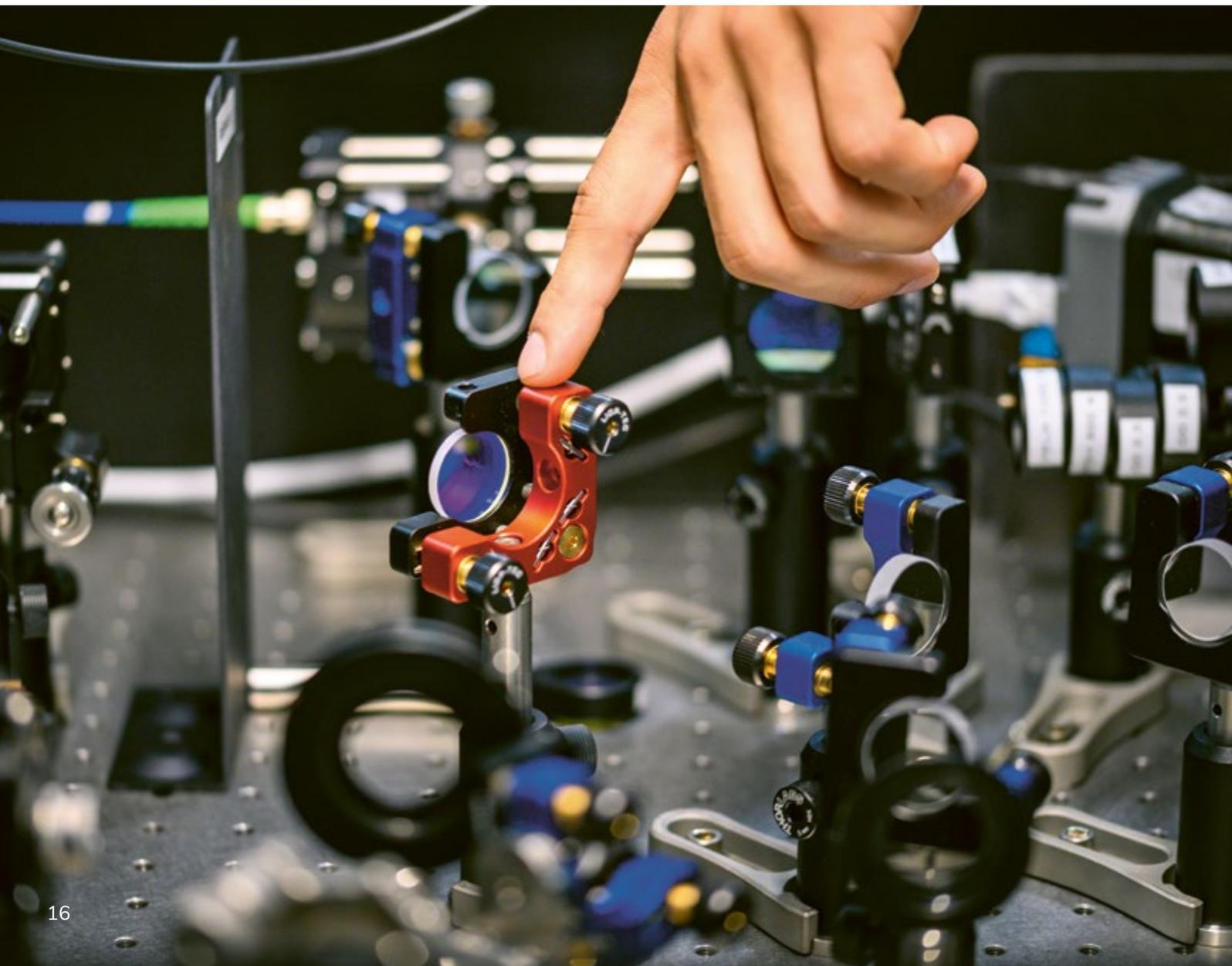
Building a network for tomorrow's healthy city

The team was first made aware that people have very different perceptions by the test interviews that students conducted on Hertzallee as part of a seminar. “The emotional responses were very much dependent on gender, age, and the respective use of the space,” explains Angela Million. “Employees who only walk through find it rather unappealing, while students who spend more time on the benches find it more exciting. Some feel secluded under the foliage of the trees, while others are made uneasy by the surrounding buildings as they feel they are being watched from the windows. Others feel a sense of urban community precisely because of this.”

In the next step, the findings from the interviews before and after the installations will be compared with the results of the sensor-based experiments in virtual spaces from the biopsychology sub-project and the Urban Mind App from a Charité project on the “Emotional City.” In the latter, people were able to record their perceptions of various places in Berlin, which then resulted in an “emotional heat map.” Lastly, the Research Platform Neurourbanism (RPN) will present a holistic assessment. This interdisciplinary network of researchers collects all research results and serves as a data source for global research on the topic in order to initiate further international cooperation.

→ www.neurourbanism.eu

Hand in Hand Through Quantum Land



The Berlin Quantum Alliance, which is receiving funding through the Berlin University Alliance, is creating a network of regional expertise to pave the way towards a world with quantum computers and quantum-mechanically secured communication.

TEXT Wolfgang Richter PHOTOS Cathrin Bach

The advent of the quantum age brings with it a lot of hope, yet at the same time raises a concern. Hope that functional quantum computers will be able to simulate the exact processes in materials, and thus enable the development of new drugs – or even new catalysts to convert the carbon dioxide from our atmosphere into useful chemicals. Hope that secure quantum communication methods will provide us with protection from attacks on our digital infrastructure. And hope that new types of sensors based on quantum effects will open up new possibilities in medicine, environmental research, and industry.

25 million euros for “Berlin Quantum”

At the same time, the quantum computers of the future will be powerful enough to easily crack our current encryption methods used for card payments, on the Internet, and for mobile communications. This makes the need for research into quantum encryption methods and new, classical algorithms able to withstand attacks by quantum computers all the more urgent. It was as a response to all these challenges that the Berlin University Alliance (BUA) began supporting the work of the city’s quantum scientists back in 2022. Following the funding of the Einstein Research Unit “Perspectives of a quantum digital transformation,” which ends in 2024, funding is now being provided for the Berlin Quantum Alliance (or Berlin Quantum for short), established in 2023.

Quantum optics experiment conducted in the lab of TU researcher Dr. Tobias Heindel

A total of 25 million euros is available over a five-year period from the State of Berlin’s innovation promotion fund, which will then be used to acquire further third-party funding. “In Germany, we already have the ‘Munich Quantum Valley’ and the ‘Quantum Valley Lower Saxony’ in Hanover and Braunschweig as successful examples of quantum networks,” says Professor Dr. Jean-Pierre Seifert, head of the Chair of Security in Telecommunications at TU Berlin and the University’s representative on the executive board of Berlin Quantum.

Funding will be divided into two parts: 15 million euros will be used directly for university research, with a further 10 million euros available for application-based collaborative projects, which are also open to researchers. In addition to companies from Berlin’s dynamic start-up scene, the Fraunhofer Institute for Open Communication Systems (FOKUS) and the Fraunhofer Institute for Telecommunications (HHI) will be involved in these collaborative projects.

“The funding for university research is further divided into three lines,” explains Professor Dr. Stephan Reitzenstein, head of the Optoelectronics and Quantum Devices Research Group at TU Berlin and director of the Berlin School of Optical Sciences and Quantum Technologies (BOS.QT), a graduate school which was established in 2019 and whose office is located at TU Berlin. The first funding line will strengthen the work of BOS.QT, primarily through the creation of seven doctoral positions integrated into the school’s network as BOS.QT Fellows.

Professorships for quantum research

“The second funding line is for postdoctoral positions, travel, and equipment,” says Reitzenstein. “The third funding line supports the reassignment of professorships, where new appointments are due, to scientific fields that are specifically relevant to quantum technologies.” This means that no new professorships will be created. Instead, existing professorships will be provided

with better funding for equipment and resources to make them more attractive for top-class quantum researchers when re-advertised.

“A position at HU Berlin as well as a professorship for theoretical computer science at TU Berlin with a focus on quantum computing are already in the pipeline,” adds Jean-Pierre Seifert.

But what is Berlin Quantum’s unique selling point when compared with the quantum networks in Munich and Lower Saxony? “Berlin has always had a very strong research base in the field of optical technologies, which are of immense importance for quantum innovations,” says Reitzenstein. This was demonstrated very clearly in 2021 when the Dutch royal couple attended the ceremony at TU Berlin to mark the official signing of the co-operation between the Dutch and Berlin-Brandenburg competence networks for photonics.

Reitzenstein’s expertise is in quantum dots, which emit individual particles of light, or photons. These can be coded as zeros and ones and thus transmit digital keys in future quantum communication networks. In many cases, they also play a central role in the construction of quantum computers for storing information or manipulating calculations.

TU Berlin contributes expertise in quantum communication to the Berlin Quantum Alliance

“TU Berlin is contributing its application-based research, which has a strong focus on quantum communication, to Berlin Quantum,” says Jean-Pierre Seifert. The tubLAN Q.0 project is planning a mini-network for the secure exchange of quantum keys between different buildings at TU Berlin. In the Q-net-Q project, a quantum-secure, long-distance connection is to be established between Berlin and Frankfurt am Main, funded by the Federal Ministry of Education and Research. Meanwhile, the Quantum Internet Alliance is striving for nothing less than a European quantum Internet; TU Berlin is one of three German universities involved in this project.

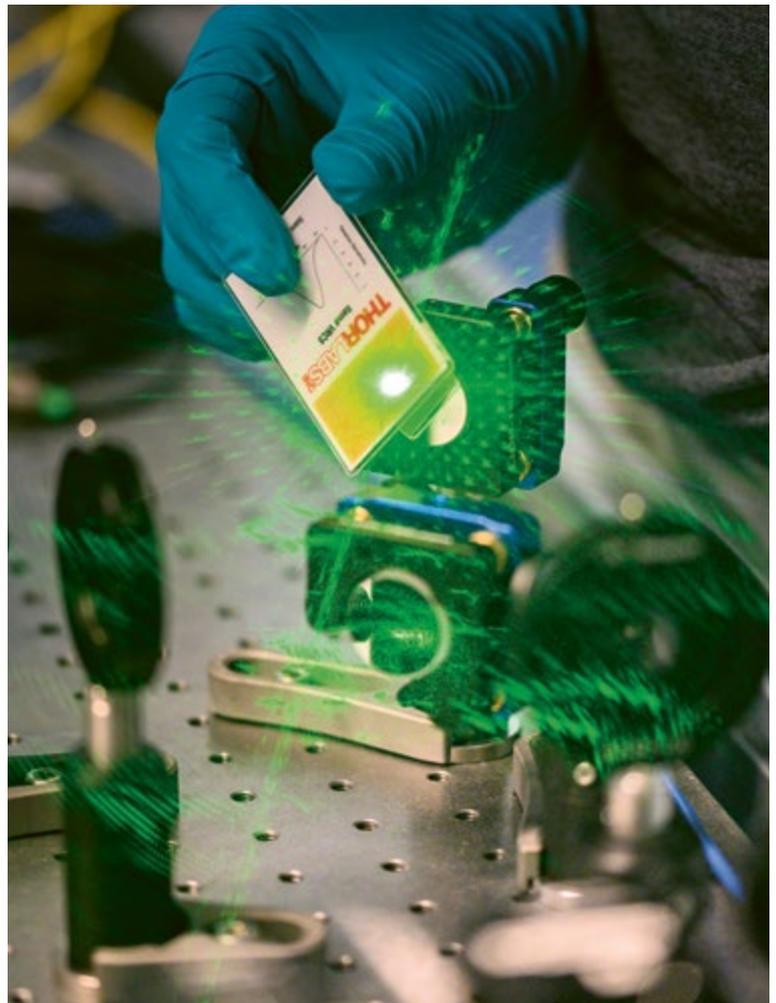
Maria Kalabakov, who is one of two doctoral spokespersons for the BOS.QT graduate school, particularly values the Berlin quantum research community for its culture of discussion and the opportunity to benefit from the courses offered by three outstanding universities.

“The BUA partners offer both lectures and special seminars tailored to our needs,” says Kalab-

akov. Guest speakers from all over Europe are invited to events, such as the annual BOS.QT Retreat and BOS.QT Day. BOS.QT also offers workshops on soft skills such as academic writing and lectures on socio-cultural aspects of science, such as toxic power structures. “The networking that takes place at these events has already resulted in collaboration between working groups from the three BUA universities,” confirms Kalabakov.

“Berlin has always had a very strong research base in the field of optical technologies, which are of immense importance for quantum innovations.”

Stephan Reitzenstein



Reflection of an alignment laser in a quantum optics experiment

Global Engagement

Climate change, pandemics, and migration:

The major challenges of our time know no borders, and as such call for scientific cooperation at the global level. The Berlin Center for Global Engagement (BCGE) is the Berlin University Alliance's platform for research cooperation with the Global South, as well as for academic freedom and science diplomacy. As an alliance committed to its responsibilities, the BUA seeks to contribute to a just, inclusive, and secure international science system. The BCGE's Flexible Travel Funds support the Alliance's projects and research cooperations by financing international stays of up to four weeks. We present a selection here. (hal)

PHOTOS Christian Kielmann, private ILLUSTRATION freepik

MEXICO



"Our visit to Mexico provided the basis for future cooperations in research, teaching, and knowledge transfer between TU Berlin and the Instituto Tecnológico y de Estudios Superiores de Monterrey (ITESM), one of Latin America's leading universities of technology. Our goal for the future is to work together to develop innovative research projects that contribute to regional and global progress in education and technology. At the moment, we are planning online meetings on exciting topics such as serious games and other innovative teaching methods."

Prof. Dr. Søren Salomo, head of the Chair of Technology and Innovation Management at TU Berlin

Dr. Birgit Peña Häufler, Marie Skłodowska-Curie Fellow

KENYA



"In the 'Urban-Rural Assembly' project, we are working to improve sustainability in the heavily urbanized Huangyan-Taizhou region in China. We are pursuing a participative process to develop new visions for the interface between urban and rural areas to make up for the fact that politicians often neglect rural areas in their planning. While conducting a BCGE-funded literature review at the UN Habitat Office in Nairobi, Kenya, I had the chance to learn a lot about projects in African countries focusing on the urban-rural nexus – for example, how cities and rural areas are connected with each other in other regions of the world. As academic projects, our research seeks to pursue a global perspective, even when focusing on local areas."

Dr. Li Fan, research associate at the Institute of Architecture at TU Berlin

UZBEKISTAN



"In Uzbekistan, the sun shines more than 320 days a year, while Germany basks in the glow of its technical expertise and strong infrastructure for green hydrogen and solar technologies. A close scientific partnership between the two countries is accelerating the transition to environmentally friendly and renewable energies. During my visit to Tashkent, I not only gained fascinating insights into the importance of adsorption energy for solar water splitting reactions, but also wonderful impressions of the culture there. Promoting intercultural understanding strengthens our collaboration and paves the way for innovative scientific partnerships. I am really looking forward to the planned international cooperation between TU Berlin and the Uzbekistan-Japan Innovation Center of Youth."

Dr. Mirabbos Khujamberdiev, research associate at the Chair of Inorganic Chemistry / Solid State Chemistry at TU Berlin

Open Science



Berlin Style



PHOTO Philipp Plum / Fraunhofer FOKUS

At the end of 2023, the BUA partners adopted a mission statement for open science. The goal is to conduct research that is transparent, cooperative, and sustainable. What does this mean exactly?

Open science pursues a number of principles and goals that are embodied in these three adjectives. Transparency means making research results and quality assurance methods openly accessible. This is what most researchers understand by openness. We also want to involve non-academic knowledge holders in research in a cooperative and inclusive manner, as is the case in transdisciplinary projects, for example. In addition, research results should be reusable for everyone, so that they can be verified and new knowledge created.

The mission statement serves as a frame of reference for the BUA

The Berlin University Alliance (BUA) adopted its mission statement for open science in November 2023. TU Berlin Professor Dr. Manfred Hauswirth, who is also a member of the BUA steering committee Advancing Research Quality and Value, discusses how the mission statement came about and what makes it special.

INTERVIEW Julie Spielmann

partners to strengthen and promote open science in research. What might this actually look like in practice?

The mission statement not only expresses the principles and values

to which we are committed for open science. It also includes nine goals that give concrete expression to our vision. These nine goals make clear what we want to work on and what we actually can work on as an alliance given our resources. These include, for example, the promotion of a new publication culture as well as the cooperative development of new infrastructures for research data, but also the understanding that we, as science policy actors, are committed to good framework conditions for open, high-quality science. The mission statement thus provides us with a good framework for our research and our efforts to achieve the right conditions for openness in our central institutions and administration.

Within the framework of the mission statement, the BUA partners can set their own priorities and make use of funding opportunities offered by the Berlin University Alliance. What priorities do you see for TU Berlin in terms of open science?

At TU Berlin, we have a number of projects aimed at safeguarding and improving the accessibility of research results beyond what has been achieved to date. The University Library already offers a wide range of services, for example for open access and research data management. Also relevant for researchers at TU Berlin are open software, open hardware, and open research methods, transdisciplinarity, and knowledge transfer. TU Berlin must support and further promote innovative offers and initiatives, both within the Berlin University Alliance and together with national and international partners.

The BUA partners are not the first to formulate guiding principles in the field of open science. What makes this mission statement special?

The mission statement was specifically developed and adopted within, with, and for the university alliance. All four partners are thus committed to the mission statement as well as to contributing their respective expertise and strengths to ensure its sustainable implementation. In the Berlin research community, we thus have excellent conditions for promoting open scientific practice and innovation. At the same time, we can pool our resources to meet the requirements of funding organizations or legislators, for example at the state level.

The mission statement was developed jointly in a participatory process across the Alliance. How

exactly did that work and was it worth the effort involved?

The participation and drafting process lasted two years and was very much worth the effort. Around 100 people from all status groups of the BUA partners were involved in focus groups, a strategy conference, multiple committee meetings, and a representative writing group to create the mission statement we have today.

“In Berlin, we have outstanding conditions for innovation in open science practices.”

The discussion and adoption of the mission statement by the Academic Senates of FU Berlin, HU Berlin, TU Berlin, as well as the Faculty Council of the Charité is also an important step and a sign that the mission statement is very much the product of cooperation between the different institutions.

Did any points of contention arise while developing the mission statement? If so, what were they and how were you able to resolve them?

What we often had to discuss was the level of abstraction, or rather how detailed and scientific we wanted the document to be. It has evolved into a mission statement in the sense of guiding principles or something similar, rather than a policy paper or a fully formulated strategy. This is why some find the mission statement too

vague in its present form. We are taking account of this when developing measures for its implementation. For example, we are currently discussing the mission statement with researchers from a wide range of disciplines to ensure that the specific challenges and priorities of different disciplines in the field of open science are reflected in the implementation and adaptation of the mission statement at a later date.

What content did you, as head of the Open Distributed Systems Group and the Fraunhofer Institute for Open Communication Systems, contribute to the mission statement? Which aspects were particularly important to you?

My research group and Fraunhofer Institute have included the term “open” in their names from the very beginning. For decades, openness has been a necessary prerequisite for successful and comprehensible research in this field of informatics. I sought to incorporate the underlying concepts and tried-and-tested strategies of my field within the mission statement.

The mission statement is a “living document,” what does that mean? What comes next?

We are currently presenting the mission statement to the faculties and departments of the Alliance partners, as well as learning about their experiences, needs, and wishes, which we will then use to work on implementing the mission statement over the next few years. In early 2025, all Alliance partners will be invited to a conference to discuss the first implementation steps and the contents of the mission statement and adapt them if necessary. We want to hold further conferences as a chance to reflect together on a regular basis.

Networking as a Scientific Passion

Introducing the Berlin University Alliance's Sciencefluencers

The Berlin University Alliance has been running the “Berlin is Looking for the Sciencefluencer” training program since November 2023. In the program, 15 researchers are learning how to use their social media profiles to reach as many people as possible and generate interest for their research. After completing a number of workshops, one of the participants will be crowned “Sciencefluencer 2024” by a jury of experts in May of this year. In this section, three researchers at TU Berlin present their work, their motivations, and their passion for science communication.

TEXTS Anna Groh

Stefanie Giljohann



Learning Snacks for Junior Scholars

A single profile with two exciting perspectives: Encouraged by the Sciencefluencer program, Stefanie Giljohann illustrates on LinkedIn how research topics and training programs for junior scholars can be combined. She coordinates the Work and Management Techniques and Science Communication units at the Center for Scientific Continuing Education

and Cooperation (ZEWK), and as a researcher she focuses on criminology and police research. Her social media content incorporates both aspects of her work, offering tips and learning cues for better science communication, while also drawing on her own research to illustrate effective science communication. Her research is interdisciplinary and practice-oriented, making networking on LinkedIn essential, not only with academics, but also with practitioners from the police as well as the legal, social, and medical sectors. The exchange this provides is particularly beneficial for her focus on preventing domestic violence.

+ FOLLOW



“Quick, low-threshold exchange in different areas of specialization – this is something all researchers dream about.”

#KnowledgeForAll

#LearningFromEachOther

#ShapingTheFutureTogether

“LinkedIn gives me the opportunity to share my research findings with people in the field, including businesses. This is a target group that the usual academic channels rarely reach.”

My influencers:

Antje von Dewitz
Strong leadership figure at the sustainable outdoor gear company Vaude

Sebastian Klein
Forward thinker for the common good

Stefanie Giljohann
Sciencefluencer working for greater visibility for violence prevention

My influencers:

People

- ... who share their knowledge or resources without fear of losing anything;
- ... who offer their support and add value to the network without expecting anything in return;
- ... who advocate for our society and take a decisive stand against injustice and grievances;
- ... who always remain respectful and treat others as equals.

Jasmin Wiefek



Working to achieve sustainable business practices

As a transformation scientist, Jasmin Wiefek investigates how companies can operate in a social-ecological and community-oriented way. As a professional network, LinkedIn is particularly

suitable for communicating her research, as it is here that topics relating to corporate sustainability can be put forward. This is also reflected in the response to her posts: The reach of Wiefek's LinkedIn profile has increased many times over in recent months – not least thanks to the exchange and support of the sciencefluencer community. The platform offers her the opportunity to publish articles that are both appealing and scientifically accurate. Wiefek is also a co-founder of the "Club der guten Zukunft," a collective of transformation experts that also maintains its network on LinkedIn. Other topics she is involved in include women's empowerment issues – in particular the sharing of childcare responsibilities within the home and gender-equitable career opportunities.

+ FOLLOW



#Visibility

#Exchange

#BringScienceAndPracticeTogether

#OpenScienceCommunication

#ScienceForAll

#InclusiveScienceCommunication

Narges Poursangari



For more equal opportunities and equal rights in science

Narges Poursangari's interest in combining research and science communication goes beyond the topic of her dissertation, which focuses on mushroom-based composites. She is also one of the hosts of the podcast "Kein Einzelfall," where she intensively explores the topics of equality and anti-discrimination in academia. Poursangari has built up a large following

on Instagram and is now focusing on LinkedIn, with the goal of making her research accessible to a professional audience and expanding her professional network. Sustainability and environmental protection in the context of materials research and technological innovation are particularly close to her heart. What she finds particularly enriching about being a sciencefluencer is the broad spectrum of scientific perspectives she encounters among her fellow sciencefluencers.

+ FOLLOW



My influencers:

Prof. Christina Völlmecke First female professor at TU Berlin's Institute of Mechanics

Dr. Heike Pantelmann Managing director of the Margherita von Brentano Center

Prof. Vera Meyer TU mushroom researcher committed to a circular economy

PHOTOS: Lotte Ostermann, private

THE PATH TO BECOMING A SCIENCEFLUENCER

In a series of eight workshops given by corporate influencer Irène Kilubi, the candidates find out more about strategies for publishing effective content in social media. The focus of the candidates for "Sciencefluencer 2024" is on LinkedIn, as this is the most interesting channel for people pursuing a career in

science. The aim is to communicate research topics in a more approachable manner and to demonstrably raise the profile of their own research. The criteria used to measure this include the reaction to their content, the number of likes received, and the comments posted. With this training program,

the Berlin University Alliance seeks to make academic research in Berlin more accessible and attractive as well as raise the profile of its researchers. You can follow the competition via the BUA's LinkedIn channel, the BUA newsletter, and the BUA website for sciencefluencers.

X Is for Excellence

They are tackling Berlin's housing crisis, researching ice-covered moons, investigating whether mushrooms can replace carbon-intensive foods, and developing an environmentally friendly AI using water. The Berlin University Alliance's X-Student Research Groups offer students the opportunity to participate in current research projects at HU Berlin, FU Berlin, TU Berlin, and Charité – Universitätsmedizin Berlin. In this article, we present four X-Student Research Groups.

PHOTOS Kevin Fuchs



Using all our senses

Pale yellow cap. White lamellae beneath, running along a cylindrical stem. There is a lot to discover about *Pleurotus citrinopileatus*, or the golden oyster mushroom. It smells pleasant too, enveloped in a delicate lemon scent. And it also goes well in salads. The goal of the X-Student Research Group

“Berlin wild foods: Foraging, growing, and cooking mushrooms” is to get people to experience using all their senses. It was this that persuaded agronomics student Leon Wannemacher to join the group. He is delighted that in this seminar, you put in the practical work before moving on to theoretical research, and not the other way round:

First, it's out into the forest, foraging and identifying mushrooms, creating dishes in the TU teaching kitchen, and only then carrying out work on formulae for determining nutritional value and the question of whether mushrooms can replace carbon-intensive foods. For Wannemacher, this is the right way to acquire sound knowledge. (sn)



What we can learn from icy moons

Water, as we all know, is the source of all life on Earth. But what we still don't know is how water came to our planet in the first place.

To answer this question, researchers are quite literally staring into space. One of the moons they are focusing on is Enceladus, an icy satellite of Saturn, presumed to consist mainly

of water ice. Research into such icy moons and the dwarf planet Ceres will be used to draw conclusions about the origin of water on Earth.

As part of the X-Student Research Group "The physics of water-rich asteroids," TU Berlin student Delaram Darivasi is developing numerical tools that calculate the internal struc-

ture and rotational speed of Enceladus. "The wonderful thing about this research group is that project leader Dr. Wladimir Neumann has designed a seminar that provides us students with something like a journey into the world of real research as well as a forum for intellectual exchange," says Delaram Darivasi. (sn)



Artificial intelligence in a bucket of water

A bucket of water that you can transform into a computer may sound unusual, but this is precisely what has been achieved by seven students from different disciplines, who together in the “AI in a bucket of water” X-Student Research Group have developed a physical reservoir computer. Sound waves

of spoken numbers control vertical floats that create waves on the surface of the water. A camera captures these waves, while an algorithm converts them into clear visual patterns and links them to specific numbers. The result? The water is transformed into an intelligent learning system that unites nature and technology. The experiment represents a

real paradigm shift: away from complex and energy-intensive AI systems and towards the use of natural resources for intelligent solutions. The result is an environmentally friendly alternative to traditional deep learning techniques, and one that offers immense potential for environmentally friendly AI. (hal)



Berlin's new living spaces

Finding affordable accommodation in Berlin quickly is well-nigh impossible. Many new arrivals, particularly those on low or unstable incomes, are affected by the situation. The process of looking for a place to live is a lengthy one, and one where personal connections are important. As a result, many

people have to rely on short-term (sub)rentals and/or accept compromises in terms of quality, location, and price. In the X-Student Research Group "Navigating the housing crisis," an interdisciplinary group of students is using the stories of new arrivals in Berlin to research which new housing practices are emerging. The research shows that rooms

are often converted to accommodate more people in apartments, and reveals how those affected try to create a home despite unstable circumstances, as well as the emotional stress tenants experience in precarious housing situations.

(le)

Appeal: Fix the Institution, not the Excluded!

BY Aline Oloff, leader of the BUA junior research group “Fix the Institution, not the Excluded!” at the Center for Interdisciplinary Women’s and Gender Studies at TU Berlin

When it comes to gender equality in higher education, people have been saying “fix the institution” for many decades. The aim is to shift the focus of the debate towards structural barriers and institutional mechanisms of exclusion. Alongside “fix the knowledge” and “fix the numbers,” this is the third key area in achieving gender equality. It’s a considerable and complex task – an integrated approach that simultaneously takes into account the institution, knowledge production, and representation.

In their guiding principles and mission statements, universities have long been committed to achieving equal opportunities and freedom from discrimination. However, they often lack sustainable structures. In order for universities to live these principles in practice, two conditions in particular must be met:

1. Equality, diversity, and anti-discrimination should be recognized and systematically pursued as components and goals of strategic university development.

Instead of short-term one-off projects with unreliable funding sources, we need a long-term and systematic perspective for bringing about sustainable change in all areas of higher education. Only when you have established what you are aiming for (with strategy and objectives!) can you set up projects and evaluate them in a meaningful way.

2. Equality, diversity, and anti-discrimination are tasks that have to be performed continually and on

an ongoing basis (and this takes resources!). You need qualified staff who dedicate 100% of their working time to these ongoing tasks, which can be roughly divided into four areas: organizational development and support for university work teams (consulting), quality assurance and monitoring, communication and training, and advising in cases of discrimination, as well as, where appropriate, complaints procedures. Each of these four areas requires specific competencies and qualifications. Diversity work cannot be done “on the side:” It is an independent field of work that must be appropriately resourced and managed.

A stable diversity architecture like this – with a long-term perspective, clear allocation of responsibilities, and adequate resources – is absolutely essential to the collaborative work of all university members with the aim of creating diversity-oriented, inclusive and equitable institutions, knowledge production, and representation (institution, knowledge, and numbers). The Berlin University

Alliance offers the opportunity to think about the diversity architecture across the different member universities and to agree on a joint approach, for example in terms of monitoring, dissemination of information, training, and advisory services. This is what we are working on in the BUA junior research group “Fix the Institution, not the Excluded! How can diversity policies and anti-discrimination work at universities be designed with a critical, collaborative, and knowledge-based approach?”. Let’s work together!

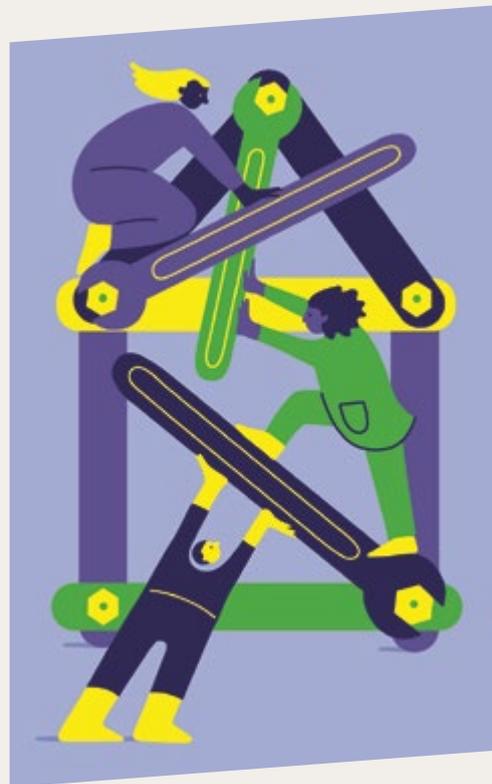


ILLUSTRATION Doro Spiro

Proteins – Tiny Medicine Factories in Our Bodies

We need chemicals for all kinds of things: new medicines, fertilizers, housing construction, infrastructure, cell phones, computers, and everyday items. The aim of the UniSysCat Cluster of Excellence is to transform the chemical industry into a green circular economy. The key technology here is catalysis. TU Berlin bio-analyst Professor Dr. Juri Rappsilber has been a UniSysCat spokesperson since January 2024.

INTERVIEW Patricia Pätzold

Mr. Rappsilber, the aim of UniSysCat – short for “Unifying Systems in Catalysis” – is to drive forward the transition to green chemistry. And it has made significant progress over the past five years. The cluster is now applying for the next round of funding. What is behind its success?

We are very proud of what we have achieved. It is mainly down to really strong collaboration across disciplines. Chemists, biologists, biotechnologists, biochemists, physicists, engineers, and other experts have crossed disciplinary boundaries in pursuit of a common goal: to understand cell processes, develop new catalysts and accelerators for these processes, and make them applicable in everyday contexts. We have also built on many years of interdisciplinary catalysis research in UniSysCat and our predecessor cluster, UniCat.



What are the biggest achievements?

One example is being able to understand and imitate the natural catalytic process of photosynthesis on which all life on earth is based. This is where CO_2 is converted into sugar. We went even further and produced new catalysts that help convert CO_2 into recyclable materials, plastics, and dyes. In the long-

term, they could be used to replace coal, oil and gas. So, we are taking our cue from nature, which efficiently converts billions of tonnes of CO_2 . We are providing the first building blocks for transforming the current fossil-based chemical sector into a CO_2 -based industry that uses the compound to produce building materials, fertilizers, and medicines. After all, CO_2 is an unlimited resource.

If, in the future, the chemical industry uses CO₂-based raw materials, this will also reduce the carbon footprint of the products manufactured...

Exactly! Currently, 98% of the carbon we use to produce paints, bicycle tubes, tires, detergents, and many other everyday items comes from crude oil. So, if we are able to produce this carbon ourselves at scale, in the same way nature does, then we can close this cycle. And that is precisely our goal for the next funding period of the Excellence Strategy: to show the chemical industry the way to a sustainable, green, and financially viable circular economy.

How exactly do you transfer this knowledge to industry?

A really effective example of this is the BasCat – UniCat BASF Joint-Lab, which we launched on the TU Berlin campus in cooperation with BASF, one of the world's largest chemical companies. In the lab, we are jointly developing energy-efficient catalysis technologies, for example for plastic recycling and for using biomass as a raw material.

More than 16 start-ups have already completed their first phase in the INKULAB lab container, which is also based on the campus and is now being expanded into the Chemical Invention Factory, or CIF for short. Along with the greenCHEM initiative, which is receiving ten million euros in funding, the entire capital region is set to become an international hotspot for deep-tech chemical innovations. With its catalysis expertise and international contacts, UniSysCat is already at the center of the network. And we have huge development potential. For instance, we will soon be appointing someone at TU Berlin in the

area of green chemistry. This will be a Joint Berlin Professorship, with the call being made through the BUA. The new appointment will also bring new ideas and networks.

In 2026, building work will begin on the Center for the Transformation of Chemistry (CTC), a major new research center worth billions and located in Delitzsch, Saxony. The center's aim is to help transform the chemical industry into a sustainable circular economy. What does this mean for UniSysCat?

Our proximity to the CTC is incredibly valuable. The center shares our interests in the circular economy, recycling, green chemistry, and transitioning to sustainability and emissions reduction. It was initiated by Professor Peter Seeberger, who is the director of the Max Planck Institute and a UniSysCat member.

“Through photosynthesis, nature converts billions of tonnes of CO₂. We want to emulate that.”

So we are closely connected. The entire region will gain a global appeal thanks to this transdisciplinary approach involving science and research, the private sector and civil society. And we are the experts in catalysis. It is the basis of 95% of all chemical processes, across sectors such as health, energy, and consumer goods. This also makes us very valuable to the CTC, both as a technology partner and for exchanging expertise and creating synergies.

Robotics are being developed at the center for high-throughput screening, along with huge computers that will use AI to process and interpret enormous amounts of data. A cluster of excellence could not afford that. We will also look into making joint appointments in order to strengthen the network.

You and three scientists from Germany and the USA recently received an ERC Synergy Grant for the TransFORM project to the tune of 14 million euros, with TU Berlin receiving 4.7 million. What are you planning to do with this?

In UniSysCat, we are currently working on a new catalytic-based cancer therapy. We add a catalyzer to proteins and antibodies, and this produces a specific therapeutic agent. We send the antibody on its way to the cancerous tumor. Like a shuttle, it transports the catalyst to a specific location in the body. It produces the medication locally within the cell – like a tiny factory. In this way, we can avoid the harmful side effects that come with current immunotherapies. But we need to know exactly how the proteins in the cell communicate with each other. TransFORM allows us to take a deep look inside the cell, for instance, by using a valuable high-tech device, our liquid chromatography mass spectrometer. AI then helps us build atomic models for our structural predictions from the immense amount of measurement data.

What role does UniSysCat play in this?

UniSysCat has laid the foundations for TransFORM. And the project will feed back its findings. These will provide an important building block in the new phase. It's a good return on an investment.



PHOTO Kevin Fuchs

Landscapes of Evolution

As part of an international team, a member and Distinguished Fellow of the MATH+ Cluster of Excellence has developed a method that brings together biology and geometry.

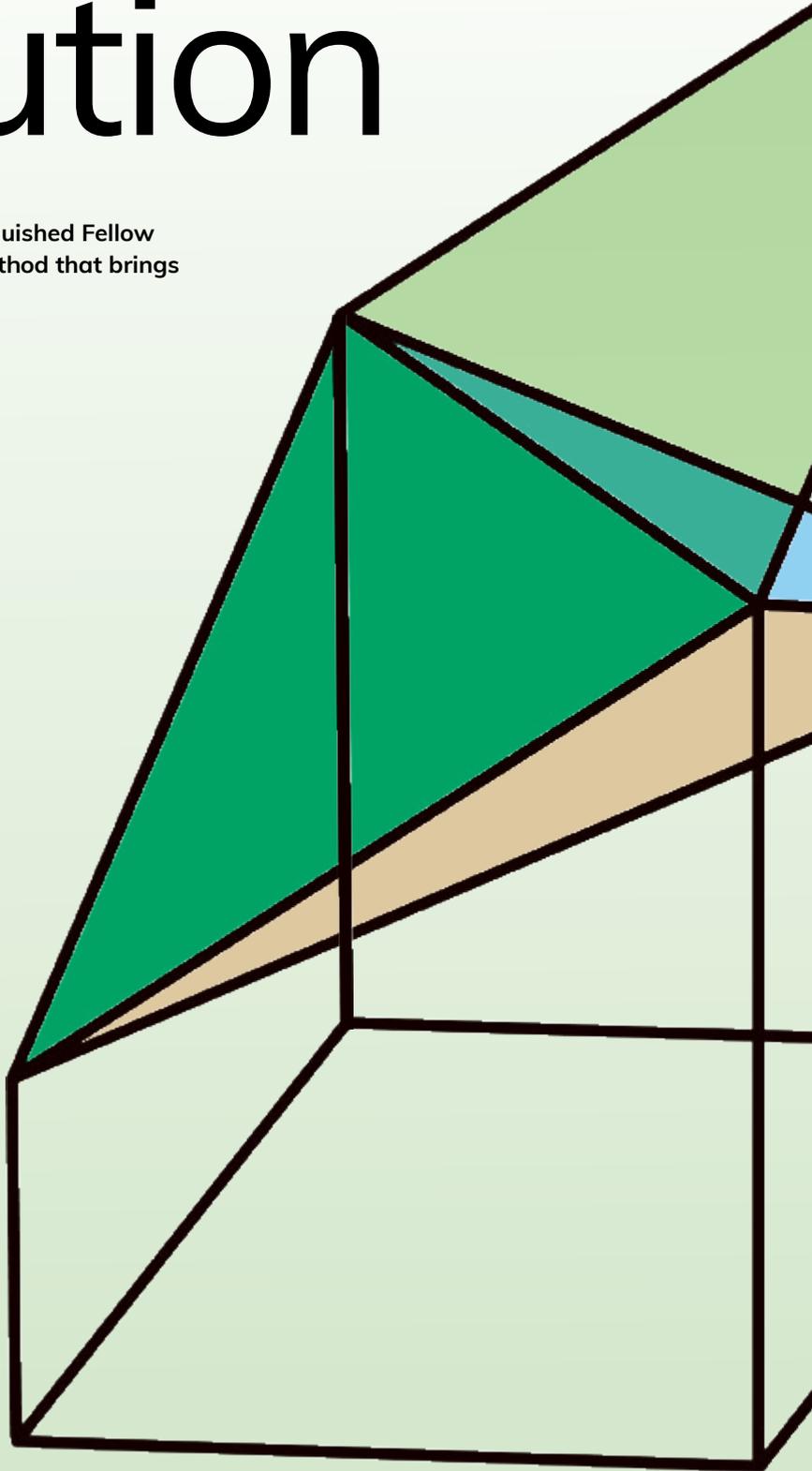
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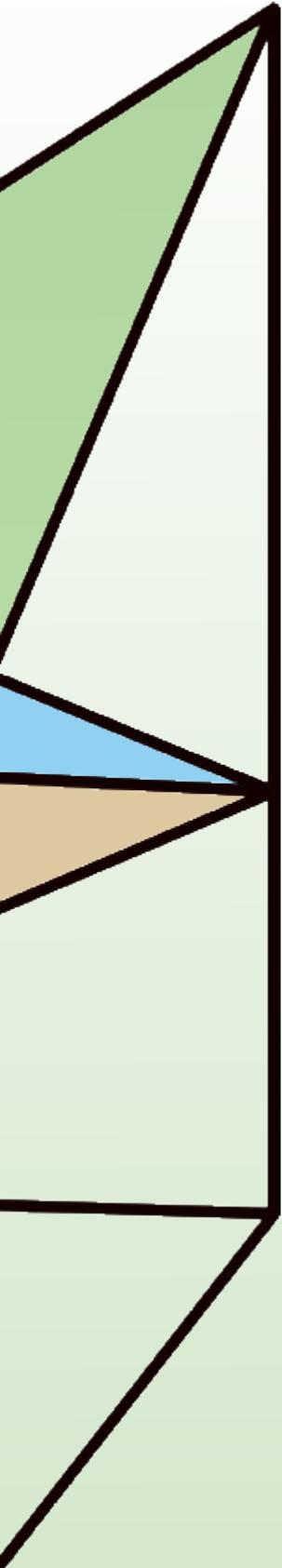


What do starfish, wolves, and the protein mTOR (which controls metabolism in cells) have in common? Many different biological systems on our planet contain keystone species that can give rise to a whole chain of events. In a famous experiment from 1963, American ecologist Robert Paine removed all the starfish from an area of a beach containing rock pools which would remain filled with salt water at low tide. Starfish are predators feeding mainly on mussels. Once they had been removed, the entire ecosystem changed. Wolves, for their part, hunt moose, which nibble on the young shoots of birch trees. The carrion of the moose is, in turn, eaten by eagles, coyotes, and bears. And researchers have now identified over 300 genes that are influenced by the mTOR protein. The cancer drug Rapamycin, which inhibits mTOR, is considered a prime candidate for an anti-aging drug that could prolong our lives.

“Many questions remain unanswered about these keystone species: How did they evolve into their current position? How many other

PHOTO Sarah Elizabeth / Unsplash





species are involved in the various interactions? And how can these master regulators regulate themselves?” says Dr. William Ludington, principal investigator at the Carnegie Institution for Science in Baltimore, USA. Ludington is a molecular biologist and is particularly interested in the microbiome – the ecosystem of bacteria in the intestines of humans and animals. In the gut, there are also certain types of bacteria that act as master regulators. According to Ludington, there has already been a lot of research into pairwise interactions – between one master regulator and another bacterium – for example in the gut of the fruit fly *Drosophila*. “But we know very little about higher-order interactions, i.e. between several bacterial species.” This complex interaction is like an orchestra: “We may know how the conductor directs the oboe, but not whether it drowns out the flute.”

Help from the MATH+ Cluster of Excellence

Ludington had heard that the mathematics of “convex polytopes” – a branch of science that seems far removed from his own – might be able to help him here. Art lovers may know these objects from the work of the painter Albrecht Dürer, who created drawings of octahedrons, dodecahedrons, and icosahedrons at the beginning of the 16th century. If you add the cube and the tetrahedron, you have the five Platonic solids whose symmetry fascinated people in ancient times.

“Of course, there are other interesting polytopes, but even I can’t escape the fascination of these five,” says Professor Dr. Michael Joswig, head of the Chair of Discrete Mathematics/Geometry at TU Berlin and an expert in the use of geometry to solve applied problems. Joswig is one of five Distinguished Fellows at the MATH+ Cluster of Excellence, a joint project of the co-applicant universities TU Berlin, FU Berlin, and HU Berlin. Each fellow receives a grant, which they can use how they wish to develop new ideas and initiate collaborations.

“I met Will Ludington during a research residency at the University of California in Berkeley, and we immediately hit it off,” says Joswig. One reason for this was that Ludington was immediately willing to share not only his research

findings, but also his experimental raw data with Joswig. And that is by no means a given, as Joswig explains.

“I had been planning to collaborate with a researcher at a German university. But this did not end up happening because I was not allowed to see the raw data he had obtained from elaborate biochemical experiments.” The researcher feared that the data would fall into the hands of competing scientists. “Some people guard their data like gold.”

Biology translated into geometry

William Ludington and Michael Joswig set to work and developed a method to investigate the higher-order interactions of the master regulators in biological systems. They published their findings in the journal PNAS at the end of 2023. Building on preliminary work, they introduced a key innovation that enabled them to apply certain mathematical procedures from convex polytopes to biology.

Michael Joswig fetches a blank sheet of paper from the printer in his office at the Charlotenburg campus of TU Berlin. He explains the new method step-by-step, making it easy to follow. And you can see what mathematicians mean when they say that they do research with pencil and paper. Joswig draws a square. It is shown in perspective, lying flat with one corner facing the viewer. The square can be used to explain the principle behind the method, because it applies to the simple case in which a master regulator interacts with only one other actor. Joswig writes numbers on all four corners of the square. “Let’s say there are two types of bacteria. Then we have four possibilities for carrying out experiments on the fruit fly *Drosophila* for example,” he says. Firstly, the case that its intestine does not contain either of the two types of bacteria; Joswig writes “00” on the corner facing us. Then, the case that either one type of bacteria is present or the other.

He puts “01” and “10” on the two corners either side. Finally, he writes “11” on the back corner of the square. This is the interesting case: where both types of bacteria are present and may interact with each other.

“We carried out all four experiments. And we did so many times over, because there

are countless boundary conditions in biological experiments that can never be precisely controlled. Only the statistical mean is really meaningful,” explains Joswig. The researchers measured a basic parameter: the lifespan of the flies. Joswig plots the average lifespan as vertical lines over the four corners of the square. In order to make his point, he assumes the unrealistic case that each type of bacterium greatly prolongs the life of the fly, for example from 50 to 100 or 120 days. The end points of the vertical lines above the corners “00,” “01,” and “10” are at different heights, and together they form a triangle. “What happens if both types of bacteria are present in the gut?” asks Joswig. This is case “11”.

If the bacteria do not interact with each other at all, then the increases in lifespan resulting from the two species simply add up. In this case, the vertical line above “11” would be just 170 days high and its end point would lie in the same plane as the triangle of end points at “00,” “01,” and “10.” However, if the bacterial species influence each other, the lifespan of the flies

will either be higher or lower than 170 days. In this case, the end point of the vertical line above “11” lies above or below the triangle. If you now connect all the points together, you get the three-dimensional body of a polytope. “Its volume tells us about how strong the interaction between the bacteria is, and its shape tells us whether this interaction is positive or negative,” says Michael Joswig.

New principle and universal tool

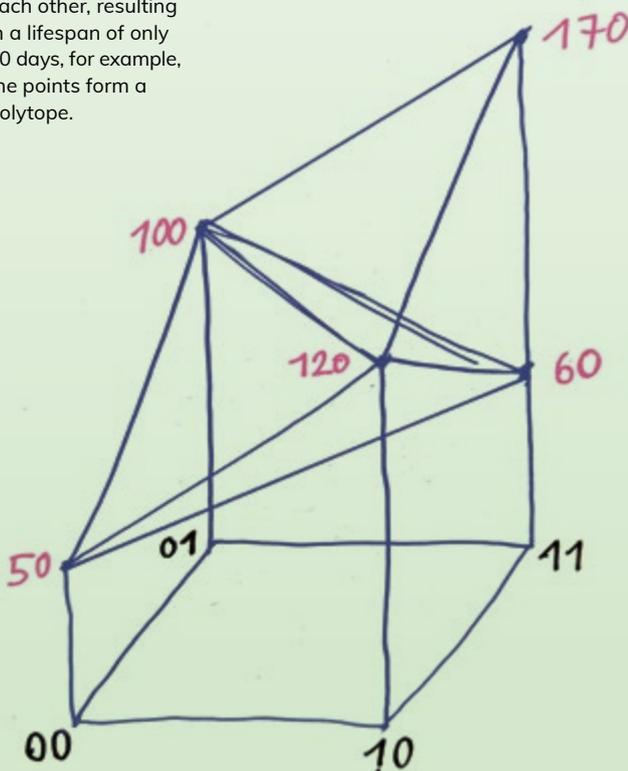
And that’s how the innovation works. Because mathematicians can work with polytopes in any dimension, the method can also be used to analyze interactions between three or more actors.

“For an entire biological system, there is ultimately a geometric landscape made up of mountain ranges, valleys, and ridges. In evolutionary terms, the one at the top is the fittest,” says William Ludington. For him, these fitness landscapes are a new fundamental principle of evolutionary biology.

Michael Joswig is particularly interested in applying established methods in polyhedral geometry, such as linear optimization, to the newly developed field of evolutionary biology. If you project the fitness landscapes onto a plane, i.e. onto one dimension lower, statistical methods can be combined with geometric methods to include the entire distribution of the raw data. “Instead of only using the mean values for calculations, we could check the significance of all experimental data. This filter function would prevent individual data from being thrown out too early in the process and thus enable better model formation,” says Joswig.

In order to disseminate their method, the researchers have set up a website where other scientists can analyze their data using the new method. In addition to genetic research and ecology, brain research could also benefit from this, with studies into important features in neuronal networks. Michael Joswig is delighted with the universal applicability of his method, as the interaction between mathematics and biology is underdeveloped, when compared to physics, for example. “My whole life I’ve been drawn to doing things that other people don’t do.”

Translating biology into geometry: fictitious lifespan of the fruit fly (in days) if either none (00), one (01 or 10) or both (11) of two bacterial species are present in the intestine. If the species do not interact in case (11), the increases in lifespan simply add up to 170 days. All the values are then on one plane. But if the species do interact with each other, resulting in a lifespan of only 60 days, for example, the points form a polytope.



Airbound: Designing Collective Futures

From the molecule to the atmosphere: the air will play a role in determining the outcome of the global climate crisis and the future of society. We are airbound – connected to the air. But what could connect us in the future? In the exhibition “Airbound,” the CollActive Materials experimental laboratory presented climate fictions and speculative everyday scenarios – developed in an open process by people from civil society, science, and design. The inter-

active works in the exhibition highlight some of the issues around the technical promises of climate engineering and human co-existence in the face of ever-increasing emissions. The work “echos von übermorgen” (“echoes of the day after tomorrow”) by Lena Böckmann and Rodolfo Acosta Castro uses technical and speculative means to test how messages from possible futures can be deciphered and sensually experienced. (hal)

COLLECTIVE MATERIALS

Collaborative Science

What materials and objects could we surround ourselves with in the future? Are they more active, more intelligent, more alive? The CollActive Materials experimental laboratory run by the Berlin Clusters of Excellence Science of Intelligence (TU Berlin) and Matters of Activity (HU Berlin) brings together people from science and civil society in speculative workshops.

→ www.collective-materials.de

PHOTO Michelle Mantel





We've got the brains for the future.
For the benefit of society.

