

## First image of the black hole at the centre of the Milky Way

Theoretical physicists at Goethe University Frankfurt have been instrumental in interpreting the data gathered by a worldwide network of radio telescopes. These data have enabled scientists to publish the first image of the black hole at the centre of our own galaxy, the Milky Way. It was captured by the international research team called the Event Horizon Telescope (EHT) Collaboration and reveals that the object is indeed a black hole. At the same time, the research results yield clues about the workings of such supermassive black holes, which are thought to reside at the centre of most galaxies.

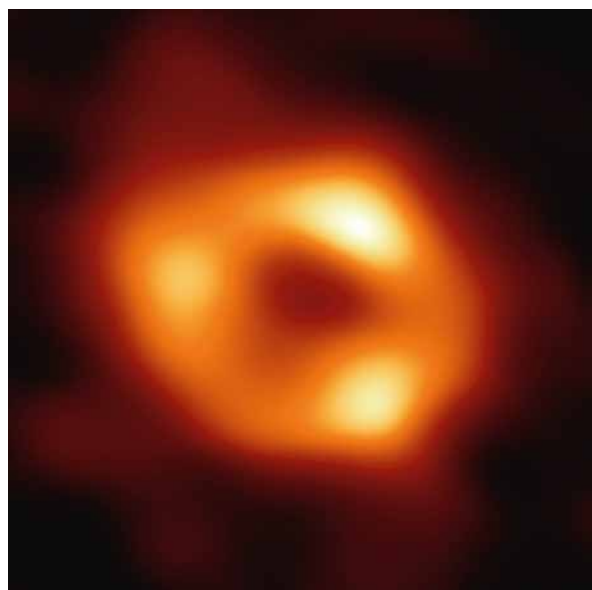
Although we cannot see the black hole itself, the glowing gas around it reveals a tell-tale signature: the image of Sgr A\* shows a dark central region (a “shadow”), surrounded by a bright ring-like structure. This is the light bent by the incredibly powerful gravity of the black hole – whose

mass is four million times that of our Sun.

The enormous quantity of observational data had to be interpreted theoretically – a task assumed by a research team led by theoretical astrophysicist Luciano Rezzolla from Goethe University Frankfurt. The researchers used supercomputers to simulate what a black hole might look like when observed by the EHT – based on what was already known about Sgr A\*. In this way, the scientists created a library with millions of different images. They compared this library with the thousands of other images generated by the EHT observations in order to deduce the properties of Sgr A\*.

The image of Sgr A\* is the second one of a black hole to be produced by the EHT Collaboration, following the first image of another black hole, M87\*, at the centre of the Messier 87 galaxy.

<https://tinygu.de/BlackHoleMilkyWay>



The Sgr A\* black hole at the centre of our Milky Way. Image: EHT Collaboration

## Pandemic: more zombie firms

The COVID-19 pandemic triggered a short but severe recession. Countries around the world tried to mitigate its consequences through state aid programmes, in particular for small companies. When governments made aid payments without a needs assessment, some firms survived in the market although their bankruptcy would have been the better alternative. This is the conclusion of a working paper by the Leibniz Institute for Financial Research SAFE, based on an analysis of the US-American COVID-19 “Paycheck Protection Program” (PPP).

The SAFE analysis compares the PPP, which distributed federal aid in a scattergun approach, with a hypothetical scenario where governments paid funds to targeted companies. “Both scenarios would have a similar percentage of saved companies. However, in the case of targeted payments, the share of zombie firms artificially kept in the market is only 1.3 percent, compared to 16.6 percent due to the PPP,” says Leo Kaas, SAFE fellow, Professor of Macroeconomics and Labour Markets at Goethe University Frankfurt and one of the authors of the working paper.

Accordingly, the PPP prevented 35 percent of all small US business liquidations at the beginning of the COVID-19 pandemic. However, it did not increase either overall economic production or employment, says Kaas. The reasons for this are twofold: the state aid predominantly rescued small, unproductive companies and the PPP often resulted in workers remaining at these firms instead of switching to more productive companies.

<https://tinygu.de/ZombieFirms>

## Asian monsoon causes ice clouds

The Asian monsoon transports enormous quantities of air from atmospheric layers close to Earth's surface to a height of around 15 kilometres. The effect is like a gigantic elevator taking anthropogenic air pollutants to the upper troposphere. A research team from the CLOUD consortium (Cosmics Leaving OUTdoor Droplets), including atmospheric researchers from Goethe University Frankfurt, has reproduced the conditions prevailing there, among them cosmic radiation, in their experimental chamber at the CERN particle accelerator centre in Geneva.

They discovered that up to 100 times more aerosol particles form from ammonia, nitric acid and sulphuric acid than when only two of these substances are present. These particles are then available on the one hand as condensation nuclei for liquid water droplets in clouds, and on the other as solid seeds for pure ice clouds known as cirrus clouds. The research team also observed that ice clouds with the three-component particles already form at lower water vapour supersaturation than anticipated. This means that the ice clouds develop under conditions that atmospheric researchers worldwide had



Air pollutants form the condensation nuclei for icy cirrus clouds (here: *Cirrus spissatus*). Photo: Joachim Curtius

until now assumed did not lead to the formation of cirrus clouds. With model global calculations, the CLOUD research team was also able to show that the cloud nuclei can spread across large parts of the Northern Hemisphere within just a few days.

"The experiment in the cloud chamber was a response to the results of field measurements over Asia. These measurements showed that ammonia is present there in the upper troposphere during the monsoon," explains CLOUD member Joachim Curtius, a professor at Goethe University Frankfurt. "Previously, we had always assumed that ammonia, being water soluble, was washed out of the rising air masses before it reached the upper troposphere." As the CLOUD researchers' experiment now corroborates, ammonia is an essential ingredient for more cloud formation. Ammonia emissions in Asia come predominantly from agriculture. Researchers worldwide are investigating processes associated with clouds as a climate factor in order to improve climate models.

<https://tinygu.de/IceClouds>

## Resistance in cancer treatment

At the Frankfurt Cancer Institute (FCI), a LOEWE research centre, a group of researchers led by Professor Florian Greten from Georg-Speyer-Haus, in cooperation with Professor Claus Rödel and Professor Emmanouil Fokas from the Department of Radiotherapy and Oncology, has identified a new resistance mechanism in the treatment of rectal carcinoma. By examining patient samples from University Hospital Frankfurt, the scientists showed both in the laboratory and in preclinical models that it is not primarily the tumour cells themselves but the surrounding inflammatory connective tissue cells that significantly modulate the response to radiotherapy. If the inflammatory messenger known as IL-1a was inhibited, cellular changes could be halted and the cancer again became vulnerable to radiotherapy. A receptor in the blood serum was identified as a good prognostic marker for the response to treatment.

<https://tinygu.de/Enddarmkrebs>

## Trust in the police

A study by Christian Czymara of Goethe University Frankfurt and Jeffrey Mitchell of Umeå University (Sweden) focuses on the trust placed in the police by immigrants in Europe. The two social scientists have analysed data of almost 20,000 immigrants from 22 European countries between 2006 and 2019. These data, which originate from the European Social Survey, show that trust in the police is in fact on average higher among immigrants than among the native population. However, the longer people live in the destination country, the more their trust tends to decline.

The authors have two explanations for this: first, the memory of the country of origin, and of the situation there, fades with time. The contrast between the country of origin and the country of destination is particularly significant for people who have immigrated from countries where the rule of law is not so well established to a country that is very advanced in this respect. Secondly, immigrants in new surroundings often experience discrimination, especially those



Migrants' trust in the police often diminishes, the longer they stay in the host country. Photo: Pradeep Thomas Thundiyil/Shutterstock

belonging to an ethnic minority there. Moreover, comparisons between European countries clearly demonstrate that trust is on average lower where there are more police officers – for example in Cyprus, Croatia and Greece. The authors conclude that the size of a police force alone is insufficient to boost trust in the police, and instead experiences of discrimination must be reduced.

<https://tinygu.de/police>

# Study finds that women are underrepresented in economics worldwide

**W**omen are still underrepresented in many academic professions. This is particularly the case in economics, as shown in a study by economist Professor Guido Friebel from Goethe University Frankfurt and his team in cooperation with the Toulouse School of Economics. The situation for women is especially difficult in senior positions and at universities that are particularly strong in research.

In total, the study collected data from 238 universities and business schools worldwide, involving over 34,000 individuals. Subsequent analysis revealed that in the US women hold only 20 percent of senior-level positions, that is, professorships, whereas the figure in Europe is 27 percent. The global average is 25 percent. At entry level, 32 percent of positions in US institutions are held by women, in Europe 38 percent. Worldwide, the figure is 37 percent. But there is no reason for European countries as a whole to rest on their laurels as far as support for women is concerned, let alone give themselves a pat on the back: "Once again,

we have the Scandinavian countries to thank for the positive numbers, but also Spain, France and Italy," explains Friebel, who was surprised by the poor US result. He also found it surprising that few women work at institutions with a particularly high research output. Here, too, women are at a greater disadvantage in the US than in Europe.

This disparity can have different origins, as the study shows. Correlating the figures with existing statistics revealed a close connection with the general attitudes prevalent in the respective society. The organisational culture of the particular university, institutional rules, but also the behaviour of women and men in economics are additional factors.

As far as Germany is concerned, Friebel sees one reason for the underrepresentation of women in the fact that when a professorship becomes vacant and is re-advertised, it is often dedicated to the same topic – and thus to the research preferences of men. Women are less often involved in macroeconomics or economic theory than



Since 1969, the Nobel Prize for Economics has been awarded to two women – Elinor Ostrom (2009, photo) and Esther Duflo (2019) – and to 89 men. Photo: Holger Motzkau, Wikipedia/Wikimedia Commons

men and more often work in development economics, health, labour and organisations – areas that should be strengthened anyway.

<https://tinygu.de/FemaleEconomists>

## Developing bio-based products

Early assessment during the development of new bio-based products makes it possible to gauge the potential risks arising from subsequent release of toxic substances. This is shown by a proof-of-concept study headed jointly by Goethe University Frankfurt and RWTH Aachen University. In the course of the study, the toxicities of sustainable biosurfactants, e.g. for use in bio-shampoos, and of a new technology for the economical deployment of plant protection agents were analysed using a combination of computer modelling and laboratory experiments. The study represents the first step towards a bioeconomy that is safe in eco-toxicological terms and which uses sustainable resources and processes to greatly reduce environmental burdens. Two scientists from Goethe University Frankfurt supported the study within the interdisciplinary project "GreenToxiConomy": Professor Henner Hollert and Dr Sarah Johann from the Department of Evolutionary Ecology and Environmental Toxicology.

<https://tinygu.de/bioproducts>

## Reading centre in the brain creates word filters

Recognising words is the basis for understanding the meaning of a text. When we read, we move our eyes very efficiently and swiftly from one word to the next. As a rule, this flow is only interrupted when we encounter an unfamiliar word. In experiments using functional magnetic resonance imaging (fMRI), an international team of scientists from Goethe University Frankfurt and the University of Vienna has now discovered that the distinction between familiar words and unfamiliar strings of characters, in the sense of a filtering process, also serves well as a model for the patterns of brain activity observed during reading. This filter is located in the lower left temporal lobe, a brain area which is important for visual word recognition. The study was headed by Professor Christian Fiebach from the Institute of Psychology at Goethe University Frankfurt.

## Investigating political violence

What effects do global developments such as technologisation and climate change have on political violence? How can political violence be limited – or legitimised – by international institutions? How is it interpreted and justified? These are the questions addressed by the new joint interdisciplinary project "Regional Research Centre – Transformations of Political Violence (TraCe)", in which five Hessian research institutes are cooperating: the Peace Research Institute Frankfurt (PRIF), part of the Leibniz Association, Goethe University Frankfurt, Justus Liebig University Giessen, the University of Marburg and the Technical University of Darmstadt. Germany's Federal Ministry of Education and Research is providing funding of €5.2 million for the collaborative project. The project team includes Professor Astrid Erll, Professor Hanna Pfeifer, Professor Constantin Ruhe and Professor Lisbeth Zimmermann from Goethe University Frankfurt.

# The roots of #BlackLivesMatter

Not just since the death of George Floyd has there been massive public resistance to police violence directed against African Americans. The #BlackLives-Matter movement, founded in 2013, is experiencing broad support worldwide. A new research group led by Professor Simon Wendt, American Studies scholar, is now exploring the forerunners of this movement in the 20th century and analysing the successes and impacts of Black Power.

Over the past 20 years, historians' interest in Black Power has grown, yet many historiographical gaps remain. The new research group aims to bridge some of them. The researchers want to take a fresh look at the Black Power movement in order to better understand its influence on America's democracy and the associated values.

"The Sixties and Seventies had a profound impact on debates about racism and democracy – and continue to do so today. In this context, we want to examine the lesser known Black Power groups as well as neglected topics and, by doing so, shed light on the struggle between competing ideals of US democracy and their long-term effects," Wendt explains. The prime intention

A research group at Goethe University Frankfurt is turning its attention to the historical forerunners of the #BlackLivesMatter movement. Photo: ryanbphoto-graphy/Shutterstock

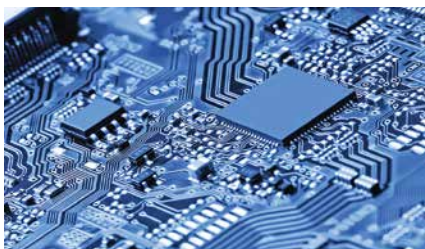


is to combine gender, social, intellectual and political history. What effect did the Black Power movement's anti-racist struggle have on ideas about a just and democratic society?

One of the research group's projects focuses on the tensions between the Black Power and Gay Liberation movements and how they collaborated. To what extent did different perceptions of what constitutes a just and democratic nation help or hinder the

two movements' quest for full equality? Another project analyses the arguments used by contemporary critics of the Black Power movement in order to find out how debates about racism left their imprint on various social groups' understanding of democracy. The third project traces the history of the National Black United Front (NBUF), an African American organisation founded in 1980 in New York by former Black Power activists.

## Novel crystals for future computer electronics



Innovative materials are expected to minimise the electricity consumption of electronic components. Photo: raigvi/Shutterstock

While modern computers are already very fast, they also consume vast amounts of electricity. For some years now, a new technology has been much talked about, which although still in its infancy could one day revolutionise computer technology – spintronics. The name is a portmanteau word created by combining "spin" and "electronics", as with these components electrons no longer flow through computer chips and only the spin of the electrons serves as the data carrier. A team of researchers including scientists from Goethe University Frankfurt has now identified materials that have

surprising properties for spintronics as far as speed is concerned.

Above all crystals with atoms from the group of rare earths are regarded as interesting candidates for spintronics because these comparatively heavy atoms have strong magnetic moments. The rare earth metals include elements such as praseodymium and neodymium, which are also used in magnet technology. The research team has now studied a total of seven materials containing different rare earth atoms, from praseodymium to holmium.

"The most important finding is that in the crystals we have grown, the rare earth atoms react magnetically with one another very quickly and that the strength of these reactions can be specifically adjusted through the choice of atoms," says Cornelius Krellner, Professor of Experimental Physics at Goethe University Frankfurt. This paves the way for further optimisation – as at present spintronics is purely fundamental research.

<https://tinygu.de/spintronics>

## Bacterial biobattery

A team of microbiologists from Goethe University Frankfurt, headed by Professor Volker Müller, has found an enzyme in anaerobic bacteria which binds hydrogen directly to CO<sub>2</sub> to produce formic acid. The process is completely reversible – a basic requirement for hydrogen storage. Fabian Schwarz, who wrote his doctoral thesis on this topic at Professor Müller's laboratory, has succeeded in developing a bioreactor that can store hydrogen for several weeks and then release it again. Schwarz fed the bacteria hydrogen for eight hours and then put them on a hydrogen diet during a 16-hour phase overnight. The bacteria released all the hydrogen. The bioreactor serves as a model for a possible bacterial hydrogen storage device for municipal or domestic biobatteries of the future

<https://tinygu.de/biobattery>

# Theory debunked: no evidence that lipid messengers are involved in resolving inflammation

Inflammation is the result of an active defence reaction by our immune system. It was once assumed that resolution of inflammation was a passive process because the immune cells involved, having done their work, gradually die off or migrate elsewhere. Today, we know that our bodies also actively control the resolution of inflammation. Yet, contrary to a concept propagated for almost 30 years, specialised pro-resolving lipid mediators (SPMs), which our bodies produce from polyunsaturated omega-3 fatty acids, apparently do not actively stop inflammation. Since their discovery in 1984, SPMs have given an ever-growing group of “resolutionists” reason to hope that it would one day be possible to intervene therapeutically in inflammatory processes using synthetic “inflammation resolvers” (resolvins).

Indeed, a doctoral thesis in the Research Training Group “Resolution of inflammation – Mediators, signalling and therapeutic options” established at Goethe University Frankfurt in 2017 showed that anti-inflammatory macrophages form the two enzymes



The resolution of inflammation seems to function in a different way than had long been supposed. Photo: staras/Shutterstock

needed to produce SPMs. However, it was possible to detect tiny amounts of SPMs only under non-physiological conditions. Further suspicion was triggered by earlier work on SPM receptors by Professor Stefan Offermanns, who is a project leader in the Collab-

orative Research Centre “Signalling by fatty acid derivatives and sphingolipids in health and disease” hosted by Goethe University Frankfurt.

On the basis of these findings, a research team headed by Professor Dieter Steinhilber from the Institute of Pharmaceutical Chemistry at Goethe University Frankfurt combed through all the papers on SPMs published so far. This review endorsed their dismantling of the SPM concept: human leukocytes, which include macrophages, can at best synthesise small quantities of SPMs. These amounts are so tiny that they cannot be reliably quantified even with state-of-the-art analytics. There is no correlation between SPM synthesis and the resolution of an inflammatory reaction nor with a targeted intake of polyunsaturated omega-3 fatty acids. To date, there is no valid evidence for SPM receptors. There has to be another mechanism of active inflammation resolution, Steinhilber says.

<https://tinygu.de/inflammation>

## Basis for developing a new class of antibiotics

In collaboration with researchers led by Professor Volkhard Kempf and using the human-pathogenic bacterium *Bartonella henselae*, scientists from University Hospital Frankfurt and Goethe University Frankfurt have unravelled how bacteria adhere to host cells. Bacterial adhesion to the host cells can be traced back to the interaction of a certain class of adhesins – called “trimeric autotransporter adhesins” – with fibronectin, a protein common in human tissue. Adhesins are components on the surface of bacteria which enable the pathogen to adhere to the host’s biological structures. Homologues of the adhesin identified here as critical are also present in many other human-pathogenic bacteria, such as the multi-resistant *Acinetobacter baumannii*.

<https://tinygu.de/bacterialAdhesion>

## How the brain filters sounds

Bats are renowned for their echolocation skills. They navigate by means of their extremely sensitive hearing, by emitting ultrasonic calls and forming a picture of their immediate environment on the basis of the reflected sound. Bats live in an auditory world. A group of researchers led by Professor Manfred Kössl from the Institute of Cell Biology and Neuroscience at Goethe University Frankfurt has looked at how Seba’s short-tailed bat identifies particularly important signals – for instance warning cries from other bats, the isolation calls of infant bats or reflections from fruit in the labyrinth of leaves and branches – from among the wide variety of different sounds. Recordings of the bats’ brainwaves showed that a rare and thus unexpected sound triggers a stronger neuronal response than a frequent sound. This means that the bat’s brain regulates the strength of the neuronal response to frequent echolocation calls by suppressing these and amplifies the response to infrequent communication calls. The signals are apparently already processed in the brain stem.



Seba’s short-tailed bat (*Carollia perspicillata*) on the wing at night in search of food. Photo: Julio Hechavarria

Similar mechanisms are at work in human beings (known as the cocktail party effect). We filter out the conversations of people in our immediate environment in order to concentrate fully on our interlocutor. Bats and humans have similar hearing processes, meaning that a better understanding of how bats hear sound could help us to understand what occurs in disorders such as ADHD (attention deficit hyperactivity disorder), which disrupts adequate processing of extraneous stimuli.

<https://tinygu.de/soundfilter>