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PRO LOEWE NEWS

The LOEWE Research Initiatives report

MAIN TOPIC

GLOBAL VIRUS OUTBREAKS, CYBER-ATTACKS, NATURAL DISASTERS – HOW CAN WE PROTECT OURSELVES FROM CRISES IN FUTURE?

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Title: The coronavirus (SARS-CoV-2) has become a global challenge and hacker attacks are increasingly becoming a worldwide threat. We have taken this as an opportunity to publish the current ProLOEWE-NEWS with the main heading of: „Global virus outbreaks, cyber-attacks, natural disasters - how can we protect ourselves from crises in future? In this ProLOEWE-NEWS, you will also discover how scientists involved in the LOEWE projects are working very hard to find solutions to the challenges of our day.

DRUID LOEWE CENTRE POOLS RESEARCH ACTIVITIES TO COMBAT CORONAVIRUSES

The HELIATAR joint project, which has emerged from the DRUID LOEWE Centre, will receive almost EUR 1 million from the German Federal Ministry of Education and Research during the next two years

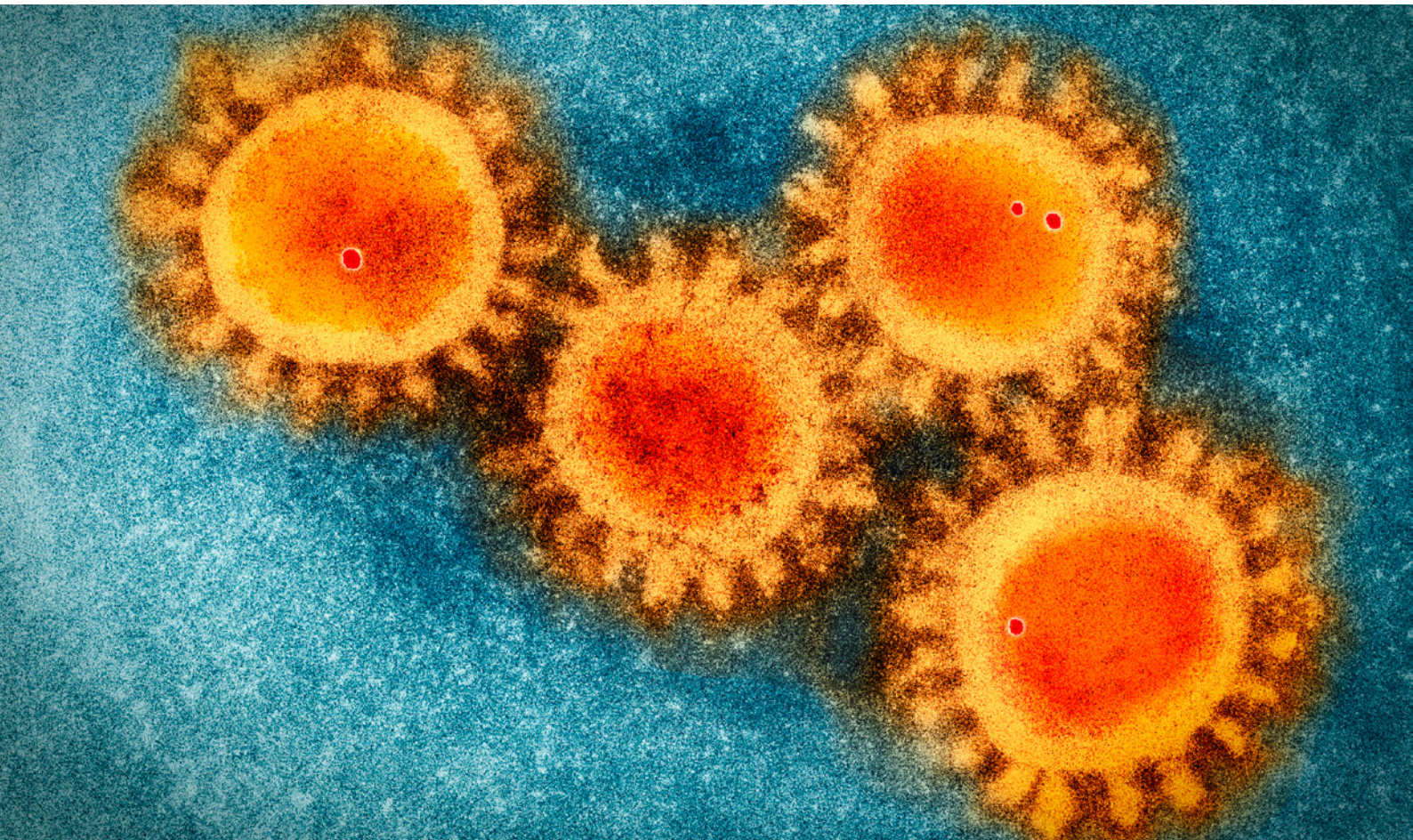
The global corona crisis is showing us all very vividly that there are not yet any vaccinations or effective drugs to combat many serious virus infections. A pandemic, like the one that is currently being caused by the new SARS-CoV-2 coronavirus, creates enormous strain on health care systems worldwide, triggering many avoidable deaths and extreme economic upheavals, and it is impossible to predict the final effects at this time. The appearance of previously unknown, often zoonotic* viruses, such as SARS CoV-2, and the emergence of therapy-resistant variants of viruses that are already known, urgently require a social consensus to develop new drugs that are effective against as large a number of different pathogens as possible and can be used quickly and therefore extremely effectively if an outbreak occurs. These kinds of broad-spectrum antiviral drugs can be directed against the body's own weak points, especially cellular enzymes, which are also necessary for the different viruses to reproduce. Inhibitors of these enzymes have the advantage of being widely effective against numerous viruses and the risk of any viral resistance developing is very low.

In the HELIATAR project, the host enzyme, eIF4A, an RNA helicase, which is necessary to unravel RNA structures in mRNAs, is being assessed as the weak point for broad-spectrum antivirals. Numerous viruses need this enzyme for their own protein synthesis. Several publications have already shown that inhibiting eIF4A in human cells efficiently reduces virus replication and has a low level of toxicity, which is an important prerequisite for any use in human beings.

The team in the HELIATAR joint project, under the leadership of Prof. Dr Arnold Grünweller (Philipps University of Marburg), has set itself the goal of examining in detail eIF4A as an antiviral broad-spectrum target structure and testing and confirming its suitability and effectiveness. For this purpose, experts are examining the global cellular and antiviral effects of curbing eIF4A through well-known inhibitors, such as Silvestrol, (TP Grünweller, Marburg). In other sub-projects, they will analyse the effects of this inhibition on our immune cells (TP Schiffmann, Fraunhofer FfM) and the possible development of resistance (TP Ziebuhr, JLU Giessen), while in a fourth sub-project, new kinds of eIF4A inhibitors are to be developed (TP Heine, Philipps-University Marburg).

*Zoonoses are diseases that can be transferred from vertebrates to humans or from humans to vertebrates. They may be caused by viruses, bacteria, fungi, protozoa or other parasites.

Colour visualisation of an electron microscopic image of the coronavirus (SARS-CoV-2)



PhD candidates at the DRUID LOEWE Centre gained the opportunity to put their theoretical knowledge into practice during the "Marphili simulation" at the Summer School. One of them is Isabell Berneburg.

Information and communications technology is permeating greater areas of our cities, making them more vulnerable to power cuts, natural disasters and cyber-attacks.

INSIGHTS INTO PRACTICAL VIROLOGY
THE 2019 DRUID SUMMER SCHOOL REHEARSES FOR AN EMERGENCY

Virus outbreaks are becoming increasingly important. The most recent example of this is the global outbreak of the new coronavirus (SARS-CoV-2).

Scientists already realised that our society would have to cope with more frequent outbreaks of viruses in future, even before the outbreak of the current coronavirus. That was reason enough for the organisers of the Summer School at the **DRUID LOEWE Centre** (Novel Drug Targets against Poverty-Related and Neglected Tropical Infectious Diseases) in September 2019 to not only give the participating PhD candidates an opportunity to expand their knowledge of methods in the field of drug development against neglected tropical infectious diseases, but also become part of an imaginary team of virologists. Using the "Marphili simulation", a practical course was designed to imitate the outbreak of a new, highly pathogenic virus (the "Marphili" virus) in south-east Asia. The course not only taught laboratory techniques for dealing with infectious patient matter, but also the major organisational and communication challenges involved in working in a field in this kind of outbreak scenario. In other words, this was one more building block in preparing young researchers for the challenges of the future in field trials.

EQUIPPING DIGITAL CITIES BEFORE A CRISIS DEVELOPS
THE LOEWE CENTRE IS WORKING ON NEW CONCEPTS

All of a sudden, nothing worked: standard lamps, televisions, refrigerators, computers and electric cookers all gave up the ghost. Electricity supplies in Ukraine were cut off for several hours in 2015. It was not just a power failure - but was deliberately caused by a hacker attack. We thought that was far away. But a hacker attack struck the University of Giessen in 2019 and a state of emergency continued there for several months. How can we protect our infrastructure from cyber-attacks, natural disasters and human or technical failure? Matthias Hollick, Professor of Computer Science at the Technical University (TU) of Darmstadt and the scientific coordinator at the "emergenCITY" LOEWE Centre, explains why and how we need to equip our cities for crisis situations. Professor Hollick, is our urban infrastructure vulnerable? *Matthias Hollick: Yes, because a prolonged power cut, a natural disaster, a massive cyber-attack or even a terrorist attack with a direct impact on a city are real scenarios. The power outage in the entire north-east of the United States in August 2003 affected about 50 million people. It was triggered by a complex mixture of electrical, operational and specific problems in information and communications technology and this led to effects and failures that only intensified each other. The increasing degree of urbanisation and digitisation is making these kinds of scenarios more likely. We need to be prepared for this.*

What exactly is the challenge that we face? *A crucial factor for cities' adaptability involves making extensive use of information and communications technology (ICT). It is permeating increasingly broad areas of society and we are becoming more and more dependent on technology too. The digitalisation of cities is therefore both a risk factor and an opportunity. We urgently need to understand the vulnerability of digital cities and develop effective measures to increase their resistance – we talk about resilience here – against these modern challenges. It's essential to design*

critical infrastructure such as energy, water, mobility and telecommunications so that they're robust and resilient in order to save lives if a crisis develops.

What exactly does emergenCITY want to achieve within the scope of the LOEWE funding? *The goal of our LOEWE Centre is to strengthen the resistance, adaptability and versatility of our ICT in crises by involving the population. If a crisis hits, emergenCITY helps make available vital services faster to guarantee basic supplies. Cities will then be able to largely launch emergency operations independently so that they can overcome the crisis collectively and then return to normal. emergenCITY is conducting research into the principles, methods and solutions for this.*

Cities are very heterogeneous structures in their makeup. Which disciplines are involved in emergenCITY to develop a comprehensive solution? *emergenCITY is being supported by researchers from computer science, electrical engineering and information technology, engineering, architecture, social sciences, history, economics and law. The German Federal Office of Civil Protection and Disaster Assistance is contributing the practical perspective. It supports the population in organising effective self-help and optimising cooperation with the emergency services. Authorities and emergency services can then register, analyse and manage the situation in the city more effectively.*

Matthias Hollick, Professor of Computer Science at the Technical University of Darmstadt and the scientific coordinator of the emergenCITY LOEWE Centre, explains why and how we need to equip our cities to face crisis situations.

NEW LOEWE PROFESSORSHIP FOCUSES ON KURDS IN GERMANY

A professorship for minority languages in the Middle East has been established as part of the **LOEWE cluster on minority studies (language and identity)**; it will manage a sub-project on Kurds in Germany using the title "Between Self-Identification and Foreign Designation".

The professorship will concentrate on new methodological and conceptual approaches to the development of minority languages by interconnecting the factors of language and religion with historically determined cultural and ethnic backgrounds – and with contemporary social changes. The subject matter of this professorship especially focuses on the fields of oral and textual transmission of minority languages in the Middle East.

Cooperation with the participating research institutions at the Justus-Liebig University in Giessen and the Goethe University in Frankfurt within the LOEWE cluster has created an ideal basis for comparative and interdisciplinary research into the role of language in the formation of identity: one of the main goals of the professorship is to explore the language from an etic and emic perspective and its role in forming identity among the various "Kurdish" groups such as Kurds, Zazas, Yezidis, Alevis, Yarsans etc.

A woman praying at the holy Munzur river in Dersim. Dersim is situated at the heart of what is now the Province of Tunceli (Turkey), the region with the highest proportion of people following the Alevi faith, where the majority of the inhabitants also belong to the Zazas.

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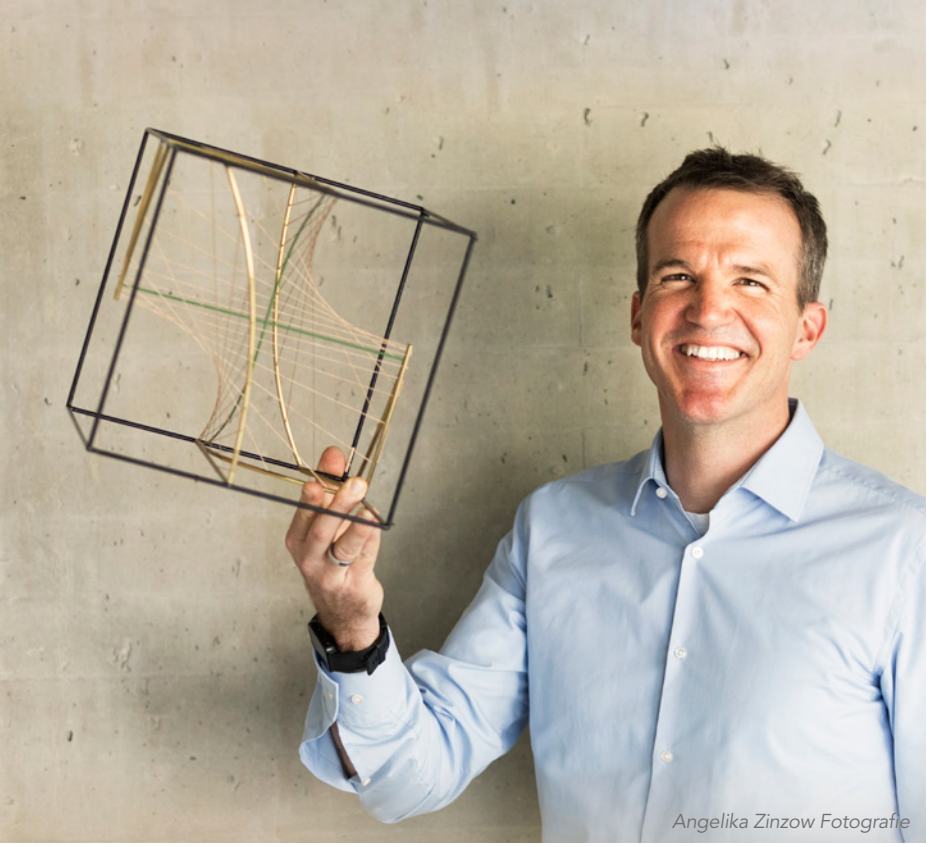
How well are we prepared for an emergency? The young scientists at the DRUID LOEWE Centre were able to test this in their simulated work in BSL-2 conditions (European Mobile Lab Work, EMLab).



The interplay of geometry and number theory is the key element in the USAG LOEWE cluster, which Jan Hendrik Bruinier coordinates.

Professor Dr Jan Hendrik Bruinier
The mathematical genius

Professor Dr Bruinier, "Uniformized Structures in Arithmetic and Geometry (USAG)" is the name of your LOEWE cluster, which has attracted funding since 2018. Can you briefly describe what it is all about and why it is important to conduct research in this field? *The scientific description of the world in which we live is often based on geometric models. For example, in general relativity, space and time are combined in four-dimensional space-time. Gravity is described by means of the curvature of space-time, which leads to complicated geometric spaces.*

The idea behind uniformization involves replacing these complicated spaces by simpler ones without changing the structure in the slightest. It is then possible to describe important properties of the complicated space in terms of symmetries within the simple space. There are several modern generalisations of this basic idea and we're using them in the LOEWE cluster to examine geometrical and arithmetical classification problems. They give rise to important practical applications in areas like encryption methods and digital signatures, which are used for Internet banking, for example.

Can you still remember when and how your passion for mathematics was kindled and what makes it tick? *I was in the seventh or eighth class at grammar school. I'd chosen number theory as my optional course. We worked on prime numbers, for example. I found it fascinating to learn that Euclid was able to prove that there were an infinite number of prime numbers as early as the third century B.C. However, we still don't understand many important questions now.*

Wikipedia has the following entry about you: "In 2011, together with Ken Ono, he (Jan Hendrik Bruinier) developed a finite algebraic formula for the values of the partition function. Both made a major breakthrough." What does this discovery mean for mathematics and for you personally? *A partition of a natural number n involves representing n as the sum of natural numbers. The partition function p(n) counts the number of partitions of n. For example*
$4 = 3 + 1 = 2 + 2 = 2 + 1 + 1 = 1 + 1 + 1 + 1$.
So, the number 4 has exactly 5 partitions and you also denote it as $p(4) = 5$. Partitions play an important role at very different points, for example, whenever symmetries are involved or in combinatorics or in mathematical physics. The partition function has some surprising properties – it grows very quickly, for example. You can easily calculate manually that $p(5) = 7$ and $p(10) = 42$. However, you can already find 190,569,292 partitions for the number 100 and almost 4 trillion for 200. A famous formula from Hardy Rademacher and Ramanujan makes it possible to calculate the partition function by an infinite sum. Ken Ono and I discovered a new formula that represents the partition function as a finite total of algebraic numbers. These algebraic numbers are obtained as special values of a certain module function that is characterised by special symmetries.

The formula for the partition function is a good example of a more general theory that has been developed in recent years. It was a great pleasure for me to play a major role in working on it.

USAG is now in its third year of LOEWE funding. What do you think is special about the research funding programme in the federal state of Hesse? *I find the LOEWE programme very attractive with its open-topic funding that is geared towards scientific excellence. The funding strengthens exciting and promising initiatives, with a view to other joint research programmes too. LOEWE is particularly well suited to our USAG field. We'd already had close cooperation with the working groups in the field of algebra and geometry at the Technical University of Darmstadt and the Goethe University in Frankfurt for several years, for example, as part of a joint research seminar and doctorates that have been jointly supervised. LOEWE funding will enable us to continue strengthening and deepening this cooperation.*

Read the whole interview at proloewe.de