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Narratives about Europe

Brexit, the refugee issue, conflicts with Poland and Hungary: the EU is never out of the headlines. But how do people in Europe talk about Europe? An international team at TU Darmstadt is exploring this now.

Terminology

Cohesion: Within European policy this term refers to the aim of strengthening the economic and social cohesiveness between member states. One instrument for this, among others, is the Cohesion Fund set up in 1993 to support infrastructure measures for environmental and transport projects.

Reciprocity: This term describes the principle of reciprocal treatment. In interactions between people the objective is to maintain balance between "give and take". With a view to the European Union, it is up for debate whether benefits for certain member states are in line with what they provide in return, particularly in times of crisis.

By Jutta Witte

They convened in Darmstadt for six months to lay the foundations for a special international project. Researchers from nine member states of the European Union want to know: How do the citizens in their home countries talk about solidarity, fairness, cohesion and reciprocity in the EU? What do people associate with these terms which occur only rarely in everyday language? And what conclusions can be drawn from what they say with a view to the future shape of a Europe that many wish would not just assert itself as a strong economic community but also move towards an "ever closer union" by becoming more politically integrated?

"We want to reconstruct, what stories people tell about Europe, what images and everyday experiences they have in mind as they do so and what they expect from the EU and the agents involved there," explains Professor Hubert Heinelt who is leading the "HEUREC – How Europeans understand fairness, reciprocity and cohesion" project at TU Darmstadt in conjunction with the political scientists Professor Jens Steffek and Professor Björn Egner. Researching narratives is one of the key instruments in political science. On the one hand, meaningful narratives such as Willi Brandt's "Dare more democracy" or Donald Trump's "Make America great again" define the framework for the policies of a party or government. On the other hand, citizens also create their own narratives and give them their own dynamic. "Greece is to blame for the euro crisis because it always lives beyond its means" is an example of one such narrative. Recognising them is not just exciting for scholarship in this area, but also of strategic importance for political decision-makers.

"How integration within the EU progresses will depend very much on whether one manages to address these narratives," believes Egner. In order to unravel these stories, researchers to date have for the most part been examining secondary texts authored by professionals in politics or the media or they conduct interviews with predefined questions. The HEUREC team is adopting a more direct approach in order to document and analyse the public discourse. "We are letting citizens talk to each other rather than about each other," explains Jens Steffek. The plan is to hold moderated discussions in each of the participating countries in three focus groups representing

Professor Jens Steffek

different socio-economic milieus. The groups talking about cohesion in Europe and issues of solidarity will be i) low-skilled workers and the unemployed, ii) highly qualified workers and business executives and iii) young people about to leave grammar school or who have recently started studying at university or college. "We expect each group to have different views on the topic and to share different "stories" accordingly," says the expert in transnational governance.

Designing and monitoring these group discussions is a complex task. The participants do not know each other beforehand. The moderator needs explain the procedure to everyone clearly and help ensure a relaxed environment for the participants, some of whom may be anxious in this academic "laboratory setting" relieved. Researchers should ideally only initiate the debate and potentially correct its course but "without cutting short the thread of the conver-

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Institute of Political Science
Professors Jens Steffek, Björn Egner, Hubert Heinelt
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sation," as Egner puts it. The financial and economic crisis could be one possible discussion starter, with the idea of a European unemployment insurance scheme being the topic that builds on that during the exchange. Politically that is a tricky subject because on the one hand EU members insist on their sovereignty with regard to social policy and on the other hand the issue provokes emotional debates about redistribution. It is all the more exciting to find out "what Europeans personally think about that", continues the political scientist. "Ultimately it is not just about needing solidarity between states but also between individuals."

One of the biggest challenges however is finding a common standard for the discussions conducted in nine EU countries and making the results comparable for subsequent analysis. In conversation with

Professor Björn Egner

Professor Hubert Heinelt

All Images: Katrin Binner

the sociologist Inga Gaižauskaite and her two project colleagues, the political scientists Petros Karpathiou and João Moniz, one gets a sense of how different the view of Europe can be. Their home countries – Lithuania, Greece and Portugal – are among the group of net recipients, i.e. states which receive more money from the EU budget than they contribute and who see themselves as a small cog rather than a big driver of European policy-making. Nevertheless, the three researchers observed highly individual attitudes to and expectations of the European Union.

„We are letting citizens talk to each other rather than about each other."

For example, Moniz perceives that his Portuguese compatriots generally have a high opinion of the EU institutions but at the same time a pragmatic attitude with little enthusiasm towards a community of states, which is felt to be predominantly economic. In Greece, which like Portugal has been an EU member since the 1980s, disappointed expectations with regard to EU solidarity were presently dominating public opinion including among people who are politically active, observes Karpathiou. For Lithuania, which joined in 2004 as part of the first eastern enlargement, the European Union is perceived as distant or out-of-reach for citizens, although trust in Europe and its democratic values is high, says Gaižauskaite.

To get to know each other and the situation in their countries better as well as find a common language for their research, the academics have spent a lot of time together in Darmstadt. With clear guidelines in the bag, they are now starting to work with focus groups in their home countries. In spring 2022 they are planning to return to TU Darmstadt for the comparative analysis of the data. According to Heinelt, the aim is to identify "what resonates with people in the political debate on cohesion in Europe because it is already part of their everyday conversations."

The author is a science writer and holds a doctorate in History.

The project

The international research project entitled "HEUREC – How Europeans understand fairness, reciprocity and cohesion" is supported by the German Federal Ministry of Education and Research (BMBF) and runs until spring 2024. As well as researchers from the Institute of Political Science at TU Darmstadt, the project involves academics from Finland, Greece, Latvia, Lithuania, the Netherlands, Portugal, Slovakia and Spain. In order to put the project findings into practice, three transnational focus groups are planned in cooperation with the Committee of the Regions and the European Parliamentary Research Service in Brussels along with reflection on the research findings with political decision-makers.

Further information:
bit.ly/3oFkdg1

Quantum chemistry for the energy transition

TU Chemistry Professor Vera Krewald doesn't need a laboratory but rather powerful computers. She uses the tools of quantum chemistry to describe chemical reactions – namely those that will play a key role in the transition to a sustainable economy.

By Uta Neubauer

You have to walk past a number of laboratories to reach Vera Krewald's office. As is the case in all chemical research institutes, you are greeted by a subtle smell – a mix of solvents and other chemicals. "I can offer you the aroma of chemicals", says Krewald with a laugh. However, she doesn't contribute to the aroma herself any more as she packed away her lab coat over ten years ago. She moved to TU Darmstadt as an assistant professor for theoretical chemistry at the end of 2018 and has since established her own research group here. Instead of carrying out research using chemicals, flasks and pipettes, Krewald and her team work with the tools of quantum chemistry to decode chemical reaction mechanisms on a computer. "In a sense, our calculations enable us to look inside molecules and into their electronic structures", explains Krewald. "We can switch certain effects on and off and then see the impact this has on the electronic structure and thus on chemical reactions."

„To develop a sustainable process suitable for industrial application, we need to transfer the principle to other compounds that don't contain any expensive metals."

Krewald carries out basic research but her findings are certainly relevant for the chemical industry. "I am particularly interested in processes related to the energy and raw materials transition", emphasises Krewald. Her working group carries out research, for example, on the splitting of dinitrogen – chemical formula N_2 – to make this element available for the production of fertilisers or basic chemicals. This reaction is currently carried out using the Haber-Bosch process, which was developed more than 100 years ago and requires temperatures of several hundred degrees Celsius, high pressure and a catalyst. The process is far from sustainable and in fact counts as one of the largest industrial consumers of energy. This is why Krewald is looking for an alternative solution. Recent research results show that the extremely stable nitrogen-nitrogen bond can also be split with light – in principle even with sunlight – if the dinitrogen is bound with certain chemical compounds. In simple terms, the two nitrogen atoms are given attachments that pull at the bond and weaken their cohesion.

"We are currently aware of about ten compounds that facilitate the photolytic splitting of nitrogen", explains Krewald but then also highlights a problem: all ten molecules contain relatively expensive metals such as rhenium, tungsten or osmium. "To develop a sustainable process suitable for industrial application, we need to transfer this principle to other compounds that contain, for example, iron instead of these expensive metals", says Krewald. Before it is possible to design these types of substances, a more detailed understanding of nitrogen splitting needs to be developed first. This is where the quantum chemical calculations come into play because, as with many chemical reactions, the light-induced processes happen so fast that it is not possible to observe the mechanism using experiments. However, quantum chemical methods can be used to calculate the molecules and intermediate stages that only exist for a very short period of time. In addition, the molecules can be changed virtually to observe the effects on the electronic structure. As Krewald explains: "This enables us to understand how bonds are formed or split."

Quantum chemistry calculations are complex and require a lot of memory. Krewald's team uses both the Lichtenberg high-performance computer at TU Darmstadt and also the group's own computer cluster for the calculations. "In principle, we make use of the same quantum mechanical methods found in physics but adapt the approaches for our purposes", emphasises Krewald. This is because things start to get complicated in quantum mechanics as soon as you want to include three or more particles in the calculations. As a quantum chemist, she investigates *N* particles, where *N* stands for the number of electrons in the molecules – and this number can be in

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Current publication:
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Image: Katrin Binner

Professor Vera Krewald

the hundreds: "It is thus necessary for us to use a few approximations but they do work quite well." She knows this because she has compared her calculations to results found in the laboratory. Krewald's group works closely together with other experimental chemists in their research into the splitting of nitrogen and also in other projects: "As a theoretical chemist, I need to work together with people who can try out our suggestions in the laboratory and check our interpretations." The process is usually based on the interplay of computer calculations and laboratory experiments until they identify the ideal molecule for a particular chemical process or the explanation for a reaction mechanism.

The splitting of nitrogen became her main field of research five years ago as Krewald was a postdoc at the University of Vienna. Her group also carries out research into the bonding and splitting reactions of other small, extremely stable molecules that will play a key role in the energy transition: hydrogen (H_2), oxygen (O_2) and water (H_2O). For example, splitting water with the sun's energy produces the regenerative energy source hydrogen, while the splitting of oxygen is a key reaction in fuel cells. Krewald decodes their catalytic processes together with her colleague Ulrike Kramm, who is also a professor in the Department of Chemistry.

Krewald's research is a good example for the social relevance of quantum chemistry. She received the Young Scientist Award from the Working Group of German University Professors for Chemistry (ADUC) at the beginning of the year for the establishment of her specialist field. In November, she was also awarded the Dr. Hans Messer Foundation Prize, which she shares with Meike Saul from the Department of Biology at TU Darmstadt. Krewald will invest her prize money of 25,000 euros in hardware to provide additional computing power and in organising an international meeting on the photolytic splitting of nitrogen. She knows that it will not only require experimental and theoretical chemists but also other researchers across the world to work hand in hand to achieve the energy transition and overcome other challenges of our time.

The author is a scientific journalist and holds a doctorate in chemistry.

An expert in cellular communication

Meike Saul, head of a research group in the Department of Biology at TU Darmstadt, has decoded the function of a short strand of RNA linked with lung cancer and arthritis. She is now using her findings to develop new diagnostic methods and therapies.

By Uta Neubauer

“I love sEV” is written on the coffee cup used by Meike Saul, head of a research group in the Department of Biology at TU Darmstadt. “It was a gift from my doctoral students”, she says and explains that the abbreviation sEV stands for “small extracellular vesicles”: “They are small bubbles discharged from cells.” It used to be thought that these vesicles acted as mini garbage trucks for unwanted substances but we now know that they also play a key role in intercellular communication. “Our cells have to coordinate their actions with one another, not only in healthy tissue but also in tumours”, says Saul. For this purpose, they fill these small vesicles – also known in technical jargon as exosomes – with messenger substances, which notably include lots of small RNA molecules.

“I love miR-574-5p” would also be a good slogan for Saul’s coffee cup. This abbreviation describes a short strand of RNA – a so-called microRNA (miRNA). Saul recognised how important this particular microRNA was almost ten years ago and it has been the main focus of all of her subsequent projects to this day.

„My projects all sound very different from one another but actually they always have exosomes and microRNAs in common.“

MicroRNAs help to determine which proteins a cell produces and which it does not. Although they do not contain any construction plans for these proteins, they can bond with standard RNAs and influence the protein synthesis in our cells in that way. Several thousand miRNAs have now been identified in humans alone. Since they were first discovered in 1993, these short strands have been numbered consecutively. Saul came across miRNA number 574 as a postdoc at the renowned Karolinska Institute in Stockholm. She can still recall the moment she noticed the sequence as she was sat at her desk: “It was purely an accident and at the same time extremely lucky to find this microRNA because it regulates a really essential process that plays an important role in many illnesses.” The microRNA with the number 574 influences the synthesis of prostaglandin E2, a tissue hormone that helps to control illnesses such as cancer and arthritis and also our pain perception, no matter whether it is rheumatism, a headache or a cut.

Saul’s group recently discovered how miR-574-5p interacts with prostaglandin E2 in the most common form of lung cancer – non-small cell lung cancer. Her team is currently developing a diagnostic method to improve the treatment of this type of cancer in cooperation with the testing laboratory Prolytic in Frankfurt, which is part of the Kymos Group. Prostaglandin E2 drives the growth of the tumour in most people suffering with this cancer. Medicines such as aspirin that have a counteractive effect on prostaglandin E2 could thus be used to support standard cancer therapies. “Unfortunately, the tumour-inhibiting effect of prostaglandin inhibitors does not occur in all patients”, says Saul. To ensure that cancer patients are not unnecessarily burdened by an additional medicine, it is important to ask the following question: Which patients will be helped by administering prostaglandin inhibitors? Saul believes that the answer can be found by measuring the presence of miR-574-5p in the blood. Her most recent study shows that the amount of this miRNA is related to the prostaglandin values in the tumour. To validate the blood tests, Saul’s group is now working together with Prolytic and the University Hospital in Gießen on a clinical study with 150 lung cancer patients. If everything runs according to plan, a test for personalised cancer medicine will be ready to launch on the market in around two years. The idea is for Prolytic to test the samples as a diagnostic service.

Saul is already thinking one step further. She wants to combine measurements of miRNA and exosomes

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Image: Katrin Binner

Dr. Meike Saul

so that it will be possible to detect the cancer in the blood at an early stage – possibly even in other body fluids. This is known as a liquid biopsy. If a patient has a suspected tumour, a special needle has so far always been used to collect a tissue sample. This traditional biopsy, which many people find uncomfortable, could be replaced by the blood test. In order to achieve this aim, Saul's group is now analysing exosomes in more detail. "Based on the surface proteins found in these small vesicles, we can find out from which bodily tissues the exosomes originate and whether they were released by healthy or diseased cells", explains Saul. Her group uses a piece of equipment called Exoview and specially prepared antibody chips to examine the exosomes. A little of the blood or another liquid sample is dripped onto the chips and the exosomes bind to the antibodies fixed on the chip based on the lock and key principle. The bonds that are formed appear as different coloured fluorescent dots when examined in Exoview and these patterns of light could be used to detect cancer.

Saul is not only carrying out research into new diagnostic methods but also innovative therapies. She already has many ideas for new medicines to combat lung cancer and is already carrying out tests on animals for an RNA drug to combat arthritic pain in cooperation with the Karolinska Institute in Stockholm. Saul is also thinking about how to use exosomes as a transporter for pharmaceutical substances. "My projects all sound very different from one another but actually they always have exosomes and miRNAs in common", she admits.

The coronavirus pandemic has delayed some of Saul's projects but at the same time increased the general understanding of her research because terms such as RNA, surface proteins and PCR technology, which is also used to identify microRNAs, are things everybody is talking about: "My ideas for new therapies and diagnostic tests based on miRNAs were not always taken seriously a few years ago", she says. "However, pharmaceutical companies are now extremely interested in them."

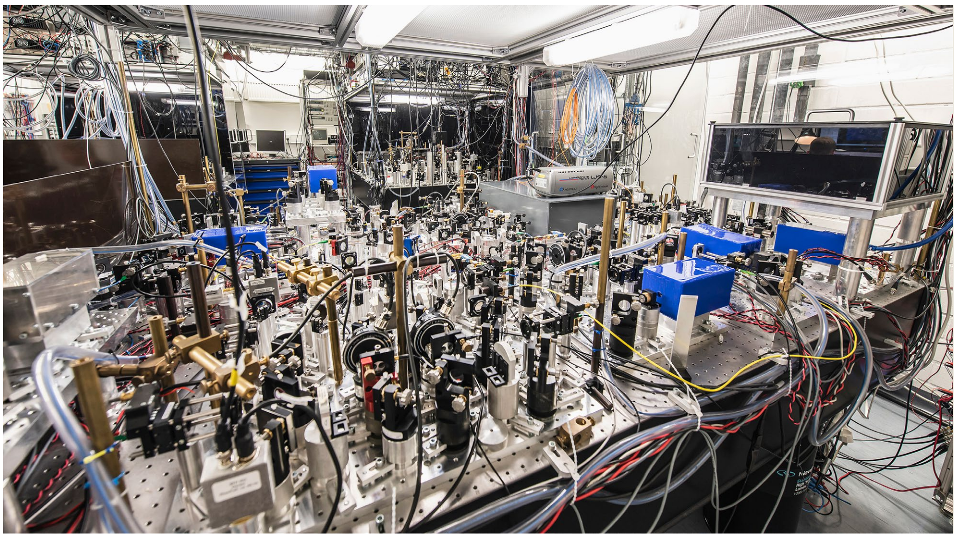
This growing interest is also having a positive impact on Saul's research budget, which was already impressive. Her group has attracted around 1.2 million euros in third party funding over the last five years. For example, Saul financed the purchase of the Exoview equipment with the support of the Wilhelm Sander Foundation, which funds innovative research into cancer. In November, she was awarded the Dr. Hans Messer Foundation Prize for her scientific achievements together with Vera Krewald, a Theoretical Chemistry Professor at TU Darmstadt. Saul intends to use the prize money of 25,000 euros primarily to continue her analysis of exosomes and thus come a step closer to achieving her aim of being able to detect cancer using liquid biopsies.

The author is a scientific journalist and holds a doctorate in chemistry.

Latest publication:
Julia Donzelli, Eva Proestler et al.: Small extracellular vesicle-derived miR-574-5p regulates PGE2-biosynthesis via TLR7/8 in lung cancer, *Journal of extracellular vesicels,* October 2021, **https://doi.org/10.1002/jev2.12143**

Scalable quantum processors in sight

Image: Klaus Mai



Evolved optical setups and the most advanced methods in quantum physics form the basis of the integrated neutral atom quantum technology platform DaNaQTP at the Institute of Applied Physics at TU Darmstadt.

A physics research group at TU Darmstadt, which has received funding of 3.3 million euros as part of the „Quantum Technologies“ program of the German federal government, is pursuing ambitious goals.

“Larger memory units and more processing cores result in increased computing power.” We are all familiar with this classification from the technical specifications of classical computers. This applies even more to quantum computers and quantum simulators. A sufficiently large number of memory cells for storing quantum information – we speak of quantum bits or qubits in reference to bits as the classical information units – is required in order for these novel computing systems to exploit their full potential.

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Accordingly, intensive research is being carried out worldwide to develop novel technological platforms for quantum computers and quantum simulators that make it possible to increase the number of qubits with a reduced use of the additional resources required for this. So what is required is the most efficient scalability of the underlying quantum processors.

In this worldwide competition, the Institute of Applied Physics at the Technical University of Darmstadt can now provide new impulses. With the “Darmstadt Neutral Atom Quantum Technology Platform (DaNaQTP)” project, which is funded by the Federal Ministry of Education and Research (BMBF) by a total of 3.3 million euros as part of the “Quantum Technologies” funding program, Professor Gerhard Birkl’s team can significantly develop its architecture for quantum processors, which is particularly ambitious in international comparison, and fully exploit the potential for scalability. The approach is based on a combination of state-of-the-art optical technology with the most advanced methods of quantum optics, which facilitate scalable manipulation of quantum states.

Based on lithographically manufactured microlens arrays, two-dimensional trapping architectures for individual neutral atoms are generated with laser light. Every single atom stores a qubit, which presents the lowest physically achievable limit of material allocation for a qubit. In DaNaQTP, each atom can be individually inscribed with quantum information – and this can be read out again in a fully controlled manner.

The necessary control of one qubit by another qubit – required for processing information in the quantum processor – is achieved by the interaction between the atoms in high-lying states, known as Rydberg states.

The central goals of the project are, on the one hand, to develop the quantum memory already demonstrated in Darmstadt into a functional quantum processor with 100 interacting qubits, and on the other to significantly increase the number of memory cells for qubits. Here, the tremendous innovation potential of the DaNaQTP platform comes into its own. The next step with scaling to 1000 qubits is to be achieved during the course of the project. But beyond that, the technological basis used already points the way to quantum processors with 100,000 fully controllable qubits. Currently, only few other platform can predict scalability such explicitly.