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If you have questions about studying or conducting research in Baden-Württemberg, or you want to find out more about knowledge transfer and joint research projects, we’re here to help. Whether you’re a student, university, or non-university research institution, we can support you in finding your way around and connecting with research partners. Contact us at wissenschaft@bw-i.de.

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Welcome to Baden-Württemberg
CONDUCTING RESEARCH IN THE LAND OF THE FUTURE!

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In Baden-Württemberg, nothing is done by halves. The prosperity, quality of life and readiness for the future that characterises Germany’s southwest are all based on its global reputation for outstanding research. The state’s universities and many research establishments guarantee the production of top-quality basic and applied research. The close ties between science and business have made Germany’s southwest one of the world’s most successful regions.
THE LAND OF IDEAS, RESEARCHERS AND INVENTORS
Baden-Württemberg quite simply has everything: a wealth of cultural and leisure opportunities, wonderful nature, diverse landscapes and the idyllic Lake Constance, bordered by three different countries. Baden-Württemberg is a great place to live, with a high standard of living and friendly people who love to share the good life with others.
Baden-Württemberg has something for everyone, whether you are the sporty type, a culture vulture or a lover of nature. Whether you like mountain biking in the Black Forest, sailing on Lake Constance, relaxing in the thermal baths, attending high quality concerts and exhibitions, savouring vegan fast food or Michelin-starred cuisine – Baden-Württemberg has what you are looking for, and much more. In terms of surface area and population, it is Germany’s third largest state.

But more traditional customs and festivals are also well-established, such as the annual “Heimattage” festival, the “Fischertacht” fishermen’s jousting tournament in Ulm, and the carnival parades. Or simply relax and enjoy one of the region’s many spa and wellness facilities, such as in the beautiful town of Baden-Baden.

Baden-Württemberg is home to a vast range of different landscapes. In the west are the Black Forest and Rhine Valley and in the south are Lake Constance and the foothills of the Alps. Heading east is the Swabian Alb and in the north are the Hohenloher Plateau and Kraichgau.

Germany’s biggest theme park: EUROPAPARK IN RUST

more than 57 million OVERNIGHT STAYS (2019)

The largest beer festival and funfair in Baden-Württemberg: "VOLKSFEST" AT THE CANNSTATT WASEN
Baden-Württemberg

RESEARCH IS OUR ECONOMY’S DRIVING FORCE

This is where ideas are forged – and where the work is done to turn them into reality. Baden-Württemberg is one of the leading economic regions in Germany and Europe. It is home to major corporate groups such as Daimler, Porsche, Bosch, Festo and SAP, along with thousands of successful small and medium-sized enterprises (SMEs). It is a region of innovation, inventiveness, high productivity and low unemployment. The perfect place to start your career!
The people of Baden-Württemberg have always known how to make the best of things. As a region with no natural resources, it has always needed people with bright ideas. That is why innovation has become a tradition in Baden-Württemberg and how it has turned into Germany’s largest exporter. Germany’s southwest is Europe’s most innovative region. No other region in the EU is comparable in terms of developing new products and processes. 5.6% of its GDP is invested in research and development (2017), making Baden-Württemberg the clear leader among all 78 regions in the EU. Nowhere else in Germany, the number of per capita patent applications is so high (138 patent submissions a year for a population of 100,000). Inventions from Baden-Württemberg have changed the world: the automobile – invented in 1886 – but also many everyday items such as lever-arch files, matches, photocopiers, rawl plugs, electric drills and even ski lifts.

Businesses in Baden-Württemberg provide funding for more than 100 endowed professorships at the state’s universities. Many companies carry out their own first-rate research.

Until today, the birthplace of the automobile is dominated by the automotive industry. Vehicle manufacturers and their suppliers account for 30% of industrial turnover, same as engineering firms (30%), as well as the chemical, pharmaceutical and optical industries and the metals and electrical sectors, which all play an important part in Baden-Württemberg’s economy.
Success does not come by chance: No other region in Germany offers such a wide range of educational establishments, non-university research institutions, universities and transfer centres, many of which are world leaders. In this way, Baden-Württemberg is one of Germany’s top research locations and has a clear advantage over its global competitors.
EXCELLENT PROSPECTS FOR RESEARCH

With its many excellent research institutions, Baden-Württemberg stands out from its global competitors. The state’s research universities, universities of applied sciences and institutes belonging to the Helmholtz Association, the Fraunhofer Society, the Baden-Württemberg Innovation Alliance and the Max Planck Society all make major contributions to basic and applied research. The state supports these establishments and institutions of higher education and contributes to their growth through investing in buildings and equipment. The Helmholtz Association, Fraunhofer Society and DLR also receive funding from the federal government. The institutes that carry out research closely linked to business needs contribute in particular to the development of new technologies and technology transfer. They build bridges between basic research and technical advances in companies, open up new areas of technology for business and help firms to bring products and processes to market. Along with the transfer centres run by the Steinbeis Foundation for Economic Development and the Chamber of Commerce innovation consultants, they lie at the heart of technology transfer in Baden-Württemberg.

The state helps brilliant minds to pursue new ideas in order to ensure the region continues to innovate and grow. Outstanding academic work across all disciplines is recognised by the research prize awarded by the Ministry of Science, Research and Arts. The prize money is the highest offered by any state in Germany. A total of 100,000 euros is awarded to one researcher in the area of basic research and one researcher in applied research.

The nine traditional research universities out of the 70 institutions of higher education in Baden-Württemberg provide the cornerstone of university research. Here, research is carried out in almost every field:

- Engineering
- Humanities, social sciences
- Life sciences, natural sciences

The state’s research universities regularly come out on top of rankings of research establishments. Within the framework of the federal and state governments’ Excellence Strategy, 4 of Germany’s 11 top research universities are based in Baden-Württemberg.

Few other regions in Europe are home to as many research institutions as Baden-Württemberg. They include:

- 3 centres belonging to the Helmholtz Association of German Research Centres (KIT, DKFZ, DLR with 3 locations and 6 institutes)
- 17 institutes and subinstitutes of the Fraunhofer Society
- 13 institutes of the Baden-Württemberg Innovation Alliance
- 13 institutes of the Max Planck Society
- 7 institutes of the Leibniz Association
- 9 German Health Research Centres
- European Molecular Biology Laboratory
- Heidelberg Academy of Sciences and Humanities

Baden-Württemberg stands out for its diverse range of partnerships among research universities, research institutions and companies.

- The state encourages work on important topics for the future, new technologies and clusters.
- Networks, research associations and clusters go far beyond the value chain. Each partnership of research stimulates interdisciplinary knowledge transfers.
- Exciting new research and development results are brought to market thanks to a large network for technology transfer and patent exploitation.
Research in Baden-Württemberg as a location for science and business is focused on innovative areas that have major growth potential in the region. In particular, these include digitalisation, artificial intelligence and Industry 4.0, sustainable mobility, the health economy, resource efficiency and the turnaround in energy policy as well as sustainable bioeconomics.

Innovative core topics such as aerospace, the creative and logistics sectors as well as battery, hydrogen and fuel cell technology are also addressed. In addition to the industry-focused growth areas, key technologies relevant for all sectors of the economy (e.g. microsystems technology, microelectronics, nanotechnology, quantum technology, lightweight construction, biotechnology and bionics as well as photonics) are an integral part of Baden-Württemberg’s innovation and research policy.

Baden-Württemberg has created state agencies for some areas that support the transfer of knowledge and technology between business and academia. These include BIOPRO BW, e-mobil BW, Leichtbau BW, Medi en- und Filmgesellschaft BW and Umwelttechnik BW.
The Center for Electrochemical Energy Storage Ulm & Karlsruhe, or ‘CELEST’ for short, carries out research in Baden-Württemberg on powerful and environmentally friendly energy storage systems for the future. One of the things the scientists from Europe’s largest research platform for electrochemical energy storage want to achieve is to lay the foundations for a battery technology that doesn’t need lithium. Their findings will show the way forward for electric cars and power grids.

The airtight containers contain colourful punching plates. They are made from magnesium, calcium or sodium elements that could play an important role in the batteries of the future. Here in the lab, they are tested for suitability. “It is one of many areas we work in”, says Ulm-based Professor Dr. Maximilian Fichtner, Scientific Spokesperson for CELEST, Europe’s largest research platform for electrochemical energy storage.

Since 2018, CELEST has pooled the expertise of three major research institutions in Baden-Württemberg. They are Karlsruhe Institute of Technology (KIT), Ulm University and the Center for Solar Energy and Hydrogen Research (ZSW) in Ulm, which also operates Europe’s largest pilot plant for battery cell manufacture. These partners also work together in the Post Lithium Storage (POLiS) Cluster of Excellence, which has a significant influence on the content of the CELEST research area for post-lithium batteries. POLiS is receiving federal and state funding of roughly EUR 50 million for an initial period of seven years within the framework of Germany’s Excellence Strategy. Furthermore, the three institutions are involved in using a new key technology to set up a European Materials Acceleration Platform, called ‘MAP’ for short. The collaboration involves developing and operating autonomous AI-based robotics that will considerably speed up the search for new functional materials. This will make CELEST a hub for European battery activities.

Electrochemical storage is seen as a key technology. The fight against climate change and scarce resources is driving the transformation of the energy system. “That’s why we urgently need technologies that can be used to store electrical energy from renewable sources in a particularly efficient way”, says Professor Dr. Helmut Ehrenberg from KIT, Deputy Scientific Spokesperson for CELEST. This applies to batteries for electric cars as well as for stationary grid storage for storing solar and wind energy.

At first glance, the structure of batteries looks simple. They comprise a positive terminal, a negative terminal, a separator that separates both sides electronically, and an electrolyte, through which ions (instead of electrons) move as charged particles. However, the internal processes are complex. “Even experts like us have not yet fully figured out what exactly is happening inside”, says Ehrenberg.

This is also true of the well-known lithium ion technology. Although the capacity and number of charging cycles have now increased to a high level and the costs are reasonable, scientists are puzzled for example by what is referred to as an ‘interfacial layer’ that develops in the lithium ion battery when a small quantity of the electrolyte corrodes on an electrode. Researchers from CELEST are working to understand this phenomenon, which determines battery quality and is also important for service life.

Even though lithium ion technology is in use around the globe, it does have disadvantages, as one of its main components is still cobalt. In the form of lithium cobalt oxide, it increases the battery’s storage density and improves fast-charging properties. In terms of serving a mass market, however, there is limited availability of cobalt, making it scarce and thus expensive. This is why several of CELEST’s projects are geared to alternative technologies. Batteries that use sodium ions instead of lithium ions are hotly tipped as one such alternative. Sodium is present in large quantities in nature, for example in salt domes and in the ocean. But sodium ions are larger and heavier than lithium ions, which has a knock-on effect on energy density and weight. “This means that sodium batteries wouldn’t be very suitable for electric cars”, explains Fichtner, “but they would be suited to stationary stores.”

For other uses, magnesium batteries could work. Several institutes in Ulm and Karlsruhe are currently collaborating on research into magnesium batteries. “Scientists recently succeeded in using an organic polymer to create a positive terminal”, says Fichtner. The plan is to now create cells, and then an entire battery. Computer simulations and digital twins of the systems help to understand the different techniques. In addition, technology impact assessment experts are scrutinising the entire life cycle – from the raw material to factory production and recycling of the components.

INFORMATION AT www.celest.de
More than 40 partners from science and business are working on the mobility and production of the future at the research campus ARENA2036 – “Active Research Environment for the Next Generation of Automobiles” – in Stuttgart-Vaihingen. Founded in 2013, the innovation platform is characterised by its interdisciplinary approach across industries and technologies and aims to help strengthen Baden-Württemberg’s leading position in the automotive industry.

Inside the 130 metre long, 46 metre wide and 16 metre high research factory on the university campus in Stuttgart-Vaihingen, work on the production world of the future is diligently under way. Small self-driving vehicles roll boxes of materials to individual stations in the hall, robots and humans work hand in hand to assemble components, machines are powered by induction on an intelligent floor, and LED luminous strips in the floor assist the workers in their tasks.

Welcome to ARENA2036! The highly flexible research platform for the mobility and production of the future is one research campus of nine supported by the funding initiative “Research Campus – Public-Private Partnership for Innovations” by the Federal Ministry of Education and Research (BMBF). Since 2013, scientists from the University of Stuttgart, Fraunhofer, the German Institute of Textile and Fiber Research Denkendorf and the German Aerospace Center have been working together with developers and engineers from companies like Daimler, Bosch and Trumpf as well as start-ups on adaptive automobile production for the future. The research work is focused on the automobile, which will celebrate its 150th anniversary in 2036.

“The collaboration across industries and technologies creates a unique atmosphere that helps make projects successful in the long term and forges connections”. That’s how Peter Froeschle, CEO of ARENA2036, describes the special nature of the innovation platform, which is receiving funding from the BMBF of up to EUR 2 million per year – for a period of up to 15 years. ARENA2036 with its mix of basic and applied research and the open exchange of ideas across institutes and companies aims above all else to result in disruptive and leap innovations. In this way, it wants to contribute to enhancing Baden-Württemberg’s leading position in the automotive industry.

The current funding phase (2018 – 2023) is focused on four joint projects: “FlexCAR” involves the development of an open vehicle platform for the mobility of the future. “Digital Fingerprint” is looking at intelligent components for tomorrow’s world, which collect, process and transfer data along the entire value chain. “Fluid Production” encompasses work on an anthropocentric, cyberphysical production concept, while “Agile InnovationHub” is investigating new cooperation and innovation processes in a research platform negotiating the space of pre-competitive product and production development.

“Our goal on the path to adaptive production is to reduce the time it takes to reconfigure production to two days”, says Manuel Fechter, “Fluid Production” Project Manager responsible for Automotive at the Fraunhofer Institute for Production Technology and Automation (IPA). At present these reconfiguration times can take as long as several weeks in traditional car factories, often resulting in production standstills. To achieve this objective, all production facilities are broken down into location-flexible modules in order to form new systems or machines dynamically. The advantage is that this production system can respond quickly to changes and adapt seamlessly to current production needs.

“One important aspect is the integration of humans as the active designers of their production environment”, says Fechter. Employees work more autonomously in this model and may need to adapt to a changed working environment every day. Experts are working closely in this field with vocational educators and ergonomists at the University of Stuttgart to determine what skills will be necessary in the future, for example.

INFORMATION AT www.arena2036.de/en/
Whether in the form of optimised algorithms, self-driving cars or ‘seeing’ rescue robots, artificial intelligence will soon not only make our everyday lives easier but also strengthen entire industry sectors, safeguarding health and ensuring more safety. This is the kind of research under way in Baden-Württemberg’s Cyber Valley, Europe’s largest initiative for artificial intelligence. The German Southwest wants to use this niche to make sure that it is among the frontrunners for the key technology of the 21st century.

A small silicon strip, just four millimetres wide and scarcely visible to the naked eye, that moves like a fish through liquid, can transport small loads, bend and roll up into a ball. A robot that has just acquired a ‘feel’ for spaces deftly avoids obstacles, while another recognises faces and probes the shapes of different objects. These are the kinds of solutions found in Cyber Valley – in the research groups “Locomotion in Biorobotic and Somatic Systems”, “Autonomous Learning” or “Embodied Vision”.

In December 2016, a meeting in Stuttgart’s Neues Schloss between representatives of the state government, the Max Planck Institute for Intelligent Systems (MPI-IS), the Universities of Stuttgart and Tübingen as well as partners from industry like Daimler and Bosch was held to found Cyber Valley and pave the way for this development. Their goal was that Europe’s largest initiative for artificial intelligence (AI) would combine the research activities of international stakeholders from science and industry and create a thriving cluster for technology transfer. The State of Baden-Württemberg is providing funding of roughly EUR 165 million to establish and expand Cyber Valley at the locations in Stuttgart and Tübingen in a bid to secure Baden-Württemberg a leading position with the key technology of the 21st century.

In this way, it should be possible in future put ground-breaking research findings from the field of AI into practice more quickly and more effectively. In future it could be possible, then, for the milli-silicone fish to perform medical tasks in the human body and for the learning humanoid robots to carry out complex motion sequences, rescue people in impassable terrain or help to solve crimes.

In order to build on such successes in the long term, the research consortium also has an increased focus on training young scientists. Since the autumn of 2017, doctoral students at MPI-IS have been reaching new milestones in artificial intelligence. “Young researchers shouldn’t need to go to the US to work at the highest level”, says Cyber Valley co-founder and Director of MPI-IS Professor Dr. Bernhard Schölkopf. The computer scientist is seen as one of the pioneers of AI, and won Germany’s most prestigious research award, the German Research Foundation’s Gottfried Wilhelm Leibniz Prize, in 2018. “Our research excellence is the main reason why Cyber Valley has grown so much and so successfully since its founding. An AI eco-system that is one of a kind in Europe has emerged in Baden-Württemberg’s heartland.”

Cyber Valley is indeed experiencing steady growth. Further partners such as Fraunhofer and US firm Amazon have joined the venture, the Cyber Valley Start-up Network has been set up, and an expert Public Advisory Board has been formed to help develop an ethical and social model for research into AI. In addition, numerous publications from Stuttgart and Tübingen have garnered attention around the globe. The scientists are carrying out research into new and optimised technologies in the fields of machine learning, robotics and computer vision. Their successes have already translated into figures: in terms of its presence at important conferences, the Swabian Cyber Valley ranks 8th in a global comparison and 1st in Europe and Germany.

INFORMATION AT www.cyber-valley.de/en
Let’s look at a scenario that will soon be a reality at University Medical Centre Mannheim: A patient with cancer and a tumour that has metastasised in the liver despite receiving treatment enters the rooms of the “Mannheim Molecular Intervention Environment” (M²OLIE). The patient enters his data using a tablet, and the data immediately becomes part of his electronic patient file.

From that moment, the further treatment in the intervention room is planned automatically: The patient’s body is scanned using different imaging systems. The data is collated, allowing the precise location of the metastases to be determined. The patient can have tissue samples taken in the adjacent room without having to leave the treatment table. The treating physician is assisted by a robot, meaning that each biopsy is performed in just a few minutes. Without this technical assistance, the doctor would need much longer. The tissue samples are examined for molecules that clearly indicate cancer – a particularly fast method that is only used in Mannheim. On this basis, doctors decide on the best course of treatment for the patient. The group of treating physicians meet virtually – which likewise saves time.

Therapy can then commence, for example in the form of radiation or an injection of particles that destroy cancer cells. The patient can leave the hospital on the same day, either having completed his therapy or with a recommendation to battle the tumour using drugs.

Roughly 100 scientists have been working together on the M²OLIE Research Campus since 2013 to make this vision of a one-day one-stop shop for cancer patients a reality. The project is the only one of its kind in the world. Although research into innovative tumour therapies is also being carried out elsewhere, in particular the process of diagnosing the patient still takes too long for treatment to be completed within a day.

It’s no coincidence that this flagship project in medical technology has been developed in Mannheim, says Prof. Dr. Patrick Maier, Academic Head of M²OLIE Cluster Management. The Rhine-Neckar region is home to medical technologies, doctors and scientists at the universities and third-level institutions in Mannheim and Heidelberg, the Fraunhofer Project Group for Automation in Medicine and Biotechnology and the German Cancer Research Center. “Thanks to a contractually agreed collaborative relationship, the companies can also work closely together in this field. The project would not be possible without this form of partnership”, explains Maier. All of the total of 21 partners from industry contribute devices or staff to the research project.

The Federal Ministry of Education and Research (BMBF) is providing funding for M²OLIE for a period of up to 15 years. The initial focus was on diagnostic and therapeutic methods, but in the second funding phase (2019–2024) the emphasis of the work has shifted to processes and data flows. This is now the major challenge: to ensure a frictionless use of devices and personnel without any avoidable waiting times – and in doing so to work more precisely and more efficiently than was possible in the past. “Clinical trials with the first group of patients are planned from 2023”, according to Maier. If the trials are positive, intervention rooms like M²OLIE could become part of everyday hospital life from 2030.

INFORMATION AT
www.m2olie.de/en/
The future of mobility will be more and more automated and connected. For example, connected self-driving cars offer major potential. However, it won’t be possible to replace the entire fleet of vehicles on the roads overnight. This is why scientists are carrying out research into moves that can be taken in the transition phase – where old and new cars will be sharing the roads – and what benefits these can bring (for example cooperative merging on an expressway).

This study is just one of many projects being undertaken by the High Performance Center for Mobility Research in Karlsruhe. Alongside Karlsruhe Institute of Technology (KIT), four Fraunhofer institutes, Karlsruhe University of Applied Sciences and FZI Research Center for Information Technology are involved in the High Performance Center. The Center was created in 2016 to combine competencies for mobility solutions at the Karlsruhe location. It entered the next funding phase in the spring of 2019, with funding of roughly EUR 9 million provided by the State of Baden-Württemberg and the institutes. The aim of this innovation platform is to ensure that the German Southwest retains its leading position even as the face of mobility changes.

“Around 90 researchers are currently actively involved in our six projects,” says Dr.-Ing. Matthias Pfriem, Cluster Manager for the High Performance Center. They can access a network comprising thousands of researchers and developers as needed. Their scientific work ranges from social issues such as human-machine interaction to the major mobility questions of our time: digitalisation and environmentally friendly transport.

One of the research projects is dedicated to the large weight of drive batteries in electric cars. In passenger cars, the batteries can weigh between 500 and 700 kilograms on account of the heavy battery cells. This cannot be changed unless the cell chemistry is altered. By contrast, the weight of the casing can be reduced, for example by using suitable composites to produce it. Another method for avoiding excess weight is to integrate individual components. “It would be feasible to integrate the battery’s cooling system in its casing”, says Pfriem.

Another project is looking at whether electric engines are always the best solution. It is true that electrically powered drives work very efficiently and convert just 10 percent of the energy used into heat. This figure is 70% for combustion engines, and that’s a disadvantage unless the heat lost is used for the heating system. This could be possible for a city bus, which opens and closes its doors once per minute and therefore constantly has to heat up a comparatively large volume of air. “The combination of an electric engine and a combustion engine in a hybrid drive could be ideal for cases like this”, explains Dr.-Ing. Lars Fredrik Berg, who is also a Cluster Manager for the High Performance Center. The scientists want to find out how temperature regulation of hybrid drives would ideally work in different applications.

There is also a team investigating synthetic fuels, an area where there is still considerable room for development. Although the fuels come from renewable sources, undesired emissions can result when the fuels are combusted. One source of these emissions are aromatic compounds used to increase knock resistance, and there are plans to stop using these compounds. Thorough testing of possible alternatives is needed. Five institutes in the High Performance Center are engaged in such testing, investigating the consequences for the ignition process, efficiency and combustion residues. They are also examining how to align a car’s operating strategy with its fuel type in order to reduce consumption even further.

Collaborative research has been under way at the High Performance Center for Mobility Research in Karlsruhe since 2016, and numerous scientific findings have been made in different areas. One of those findings relates to communication between self-driving cars. It involves LED headlights which emit light signals that are detected and evaluated by sensors on the vehicles approaching from the opposite direction. In this way, information already transmitted wirelessly can be checked again using a different transmission method – for example before a dangerous overtaking manoeuvre.

**DATA AND FACTS**

**FUNDING**

Around €9 million (2019–2020)

**INNOVATION ALLIANCE**

29 participating institutes

**COMBINED COMPETENCY**

Roughly 90 researchers
The Cluster of Excellence STRUCTURES at Heidelberg University addresses questions about the formation, role and detection of structure in a broad range of natural phenomena, from subatomic particles to cosmology and from fundamental quantum physics to neuroscience. The interdisciplinary research initiative attracts renowned scientists from all over the globe and ties young researchers to Baden-Württemberg as a research location.

In seven comprehensive projects, they are working on four central scientific topics: How do structures result from prescribed laws? How can we recognise these structures, particularly in large quantities of data? What can we use these structures for? And what unifies all of the structures? The projects from the fields of physics, astronomy and mathematics range from the reionisation of the universe after the big bang to neural activity patterns in the brain as well as networks, machine learning, quantum geometry and topological methods in physics. What all of the phenomena studied have in common is that they are all based on physical processes.

Over a period of seven years, EUR 32.6 million will be made available for these projects in research funding that can be used flexibly. “This is what makes the Cluster of Excellence so unique for us: We are not bound by specifications for all of the funding and projects. We can restructure as needed if new research approaches emerge, thus progressing the Cluster dynamically”, explains Dr. May-Britt Becker, Managing Director for the Cluster. These innovative projects also include the exploratory projects. “These are high-risk projects that potentially would never get a chance in normal funding procedures. We specifically choose these in the Cluster in order to contribute whole new approaches that could lead to major progress”, says Professor Dr. Manfred Salmhofer from the Institute for Theoretical Physics, highlighting a special aspect of STRUCTURES. He is one of the spokespersons for the Cluster of Excellence, along with Prof. Dr. Anna Wienhard (Mathematics Institute) and Prof. Dr. Ralf S. Klessen (Institute of Theoretical Astrophysics).

Long-term funding such as that provided by the Excellence Strategy provides scope for large projects, but also for an idea that – characteristically for Heidelberg – could turn science on its head: STRUCTURES College. The College gives the researchers space and dedicated time to develop and reflect on their ideas separately from their other commitments. A little like the philosophers of yore, who wandered the Philosophenweg path in deep thought, they meet here for a regular weekly meeting at an interdisciplinary level that transcends career stages. They can take time out to use their most powerful and promising scientific tool, namely their brain. “The main thing that researchers need in order to come up with new ideas is the possibility to reflect on things in peace. The College provides an institutional framework for this by creating a space where researchers can leave their everyday lives behind and focus on their research for a while”, explains Professor Dr. Klessen. This approach also appeals to many highly respected scientists and young researchers from abroad.

INFORMATION AT www.structures.uni-heidelberg.de

DATA AND FACTS

COMBINED COMPETENCY 
over 130 
RESEARCHERS

FUNDING 
€ 32.6 m 
(2019–2025)

YEAR OF FOUNDING 
2019
Around the globe, populist movements are gaining in strength and creating societal division. From the widening gap between rich and poor to equal opportunities in education or discussions around gender, many of the issues currently being debated relate to inequality. Even in the fight against climate change, the debate around burden sharing is central. This political dimension to inequality is the subject of interdisciplinary research being undertaken by around 60 researchers from the Cluster of Excellence “The Politics of Inequality” at the University of Konstanz.

Whether Brexit proponents in the UK or ‘yellow vest’ activists in France, movements protesting against inequality are emerging in a myriad of guises. Inequality is also at the core of the Fridays for Future protests, which call for the burden to be distributed fairly among the generations and between the globalised countries of the North and the countries of the South. The Cluster of Excellence named “The Politics of Inequality” at the University of Konstanz was established in 2019. The researchers there are taking a closer look at the political dimension to inequality. “We want to know to what extent political processes compound or reduce inequality”, says Prof. Dr. Marius Bussemeyer, Professor of Political Science and Spokesperson for the Cluster of Excellence. The first question the Cluster asks is how inequality is perceived subjectively and whether this subjective perception differs from the objective reality. Secondly, the researchers want to find out the extent to which perceptions lead to political mobilisation, such as protests or changes in voting patterns. The third area of research is to determine to what extent this triggers political reform processes that have an effect on inequality.

This bundled expertise reflects the societal relevance of the topic. After just one year, the Cluster comprises 35 professors, referred to as ‘Principal Investigators (PIs)’, and roughly 25 research associates. The research alliance is receiving EUR 30 million in funding (for an initial seven-year period), in part due to its special organisational structure. “We have created a structure for ourselves that forces us to work as an interdisciplinary team”, says Bussemeyer. The core of the Cluster’s work is currently centred around 13 individual projects from PIs in different disciplines. Researchers from the political sciences, economics, sociology, linguistics, psychology, the legal sciences and education research have formed an alliance, with the primary focus on the empirical social sciences. The Cluster’s work builds on the interdisciplinary tradition fostered by the University of Konstanz as well as on existing research into inequality by other institutions. “However, our new question is concentrated heavily on the political causes and consequences”, explains Bussemeyer. This aspect has not been sufficiently researched in the past.

The projects involve collecting survey data, carrying out interviews with experts and analysing political discourse using computer linguistics methods. In terms of content, the projects focus on matters like the labour market, education and political participation in addition to the extensively researched areas of income and wealth inequality. For example, one of the Cluster’s projects investigates how digitalisation and automation impact on different areas of politics, while another examines the perception of gender and seniority wage inequality. Other projects are looking at topics such as how young people’s perception of inequality develops over time or what rights ethnic minorities have and at what point their protests against discrimination turn violent.

The broad gearing of the Cluster’s research programme is breaking new ground, thanks in part to its inclusion of linguistics. According to Bussemeyer, “Measuring linguistic skills should tell us how communication affects the perception of inequality”. A further important component of the Cluster’s work is to transfer knowledge to the general public, aided by measures such as the “Journalist-in-Residence” programme offered by the Cluster. “Numerous individual projects are still in development. We want to grow further”, says the Cluster’s Spokesperson.

INFORMATION AT www.exc.uni-konstanz.de/en/inequality
As a location for science and academia, Freiburg has become an important engine for developing technologies related to sustainability – thanks in no small part to the Sustainability Center Freiburg. Since 2015, scientists at the University of Freiburg and the city’s five Fraunhofer Institutes have been carrying out interdisciplinary research in the fields of sustainable materials, energy systems, resilience engineering and approaches for ecological and societal transformation.

"Imagine a pure-grade composite made from plastic that is self-reinforcing, can be made from carbon dioxide, biomass or waste and that can be virtually entirely recycled," says Professor Dr. Rolf Mülhaupt, "then you know what we are planning." The Professor of Chemistry is Director of the Freiburg Materials Research Center (IFM) at the University of Freiburg. His research project is funded by the Sustainability Center Freiburg (LZN). All of the Center’s projects marry basic research with the development of prototypes that are essentially marketable. Teams comprising scientists from the University of Freiburg and at least one of Fraunhofer’s five institutes for Applied Research work together on all of the projects.

Together with colleagues from the Fraunhofer Institute for Mechanics of Materials and the company Lyondell-Basell, Mülhaupt undertakes research into mixes of low, medium and ultra-high molecular weight polyethylenes. The trick is that the material itself creates reinforcing fibre structures when it is worked, making it much more robust than traditional polyethylene. What’s even better is that if the plastic is used for 3D printing, the orientation of those structures can be controlled by moving the printer head. This means that more complex compositions can be manufactured to a pure grade and reinforced as needed – for example gearwheels, absorbers and plug connectors. According to Mülhaupt, there are many feasible uses for the recyclable material. He now wants to team up with his colleagues at Fraunhofer to test long-term properties under stress. He has been working successfully with Fraunhofer as a partner from industry for decades: “What we are doing is not wishful thinking; it’s already a reality in a pilot system. And it’s something that not everyone can do.”

The objective of the Sustainability Center is to provide technical and scientific answers to questions relating to sustainability. When Fraunhofer was looking for a suitable location back in 2015, Freiburg was the obvious choice, says Dr. Karin Benz from the Central Office: “With five Fraunhofer Institutes, Freiburg has the highest density for Fraunhofer in Germany, along with a fully accredited university with a focus on the environmental and engineering sciences and strong social sciences. Connectivity with regional tech firms is strong, and the city is very open to topics around sustainability.”

Funding

| FUNDING  | € 13.2 m  |
| YEAR OF FUNDING | 2015 |
| DIVERSITY | 20 |

The Center’s engineering core comprises the Department of Sustainable Systems Engineering (INATECH) at the University of Freiburg, which was founded in 2015 and will ultimately number 14 Chairs. Half will be funded by the University and half by Fraunhofer. Baden-Württemberg’s Ministries of Economics and Science as well as Fraunhofer provided funding of EUR 7.2 million for the Center in the pilot phase up until 2018. A further EUR 6 million will be provided up until 2020. “In addition, we acquired almost EUR 14 million in the first three years from orders from industry”, says Benz.

The Center offers workshops, liaises with industry and provides support for start-ups. The research projects relate to the areas of sustainable materials, energy systems, resilience engineering and societal and ecological transformation. Researchers are working on refining LED lighting, using drones to scan natural surfaces, or on new testing methods for power electronic components that can lengthen the service life of inverters in solar units or fast-charging stations for electric vehicles. “There is a global sustainability problem”, says Dr. Juri Lienert from the LZN Central Office. “Luckily, in Freiburg we have the scientific and societal skills to help provide solutions.”

INFORMATION AT

www.leistungszentrum-nachhaltigkeit.de/en
Baden-Württemberg is one of Europe’s leading regions for research, with a wide range of institutions and excellent prospects. Within the framework of the Excellence Strategy, four of Germany’s eleven top research universities that have been recognised for their cutting-edge research are in Baden-Württemberg. They offer top-quality teaching, excellent facilities and a wide range of personalised services.

The University of Freiburg is one of Germany’s oldest and most famous universities. The university’s many research centres have an important role to play. They include centres for neuroscience, material science, medicine and law.

The University of Heidelberg is Germany’s oldest university and one of Europe’s leading centres for research. Based on its broad spectrum of research, its four interdisciplinary areas of research are: the molecular and cellular biology foundations of life, creating structures and models in the material world, cultural dynamics in globalised worlds, and self-regulation and regulation.

The University of Konstanz takes an interdisciplinary approach to science. Key areas of research are cultural decision-making studies, chemical biology and ecology, molecular nanoscience and materials science. This young university actively promotes careers in new areas of science.

The University of Tübingen stands for a 500-year tradition of research in humanities and social, natural and life sciences. Its main areas of research include integrative and analytical research, elementary particle and astroparticle physics, climate and environment, man and technology, materials, structures and functions.

As a research institution, it draws its strength from its close interdisciplinary collaboration. It specialises in research into trauma, ageing, quantum physics, energy storage, and the interaction between man and machine.

The University of Mannheim is one of Germany’s top research centres. Its courses have been ranked very highly for many years.

With its focus on business studies, economics and social sciences, the University of Mannheim is one of Germany’s top research centres. Its courses have been ranked very highly for many years.

The University of Stuttgart enjoys an outstanding position as an internationally renowned research institute with an interdisciplinary approach focusing on natural sciences and engineering. Its research areas include modelling and simulation technology, new materials, complex systems and communication, and technology concepts.

KIT is Germany’s oldest technical university and the research University of the Helmholtz Association. Its specialist areas of research include energy, mobility, information, elementary particle and astroparticle physics, climate and environment, man and technology, materials, structures and functions.

The University of Hohenheim is working on interdisciplinary research in the areas of bioeconomics, global food security and ecosystems and the health sciences. Central academic services, state institutes and laboratories allow interdisciplinary, joint research projects to be carried out in a hands-on way.

ULM UNIVERSITY

As a research institution, it draws its strength from its close interdisciplinary collaboration. It specialises in research into trauma, ageing, quantum physics, energy storage, and the interaction between man and machine.
UNIVERSITIES OF APPLIED SCIENCES

The universities of applied sciences (HAW) in Baden-Württemberg successfully take part in competitive programmes to gain research funding. They apply as individual universities or cooperate with partners from research and industry. In many research projects, the HAW work with companies in the region, particularly SMEs. Their research activities are practical and application-oriented, anchored in the region but part of global networks, and in line with international research and innovation strategies. On this basis they make a major contribution to the transfer of knowledge and technology in the knowledge and business hub of Baden-Württemberg.

The universities’ research is supported by the Institutes for Applied Research, while the Baden-Württemberg Centre of Applied Research (BW-CAR) networks the research expertise in quality-assured research programmes to encourage young academics in the state’s universities.

Subjects range from engineering, economics and the social sciences to the life sciences and integrate interdisciplinary topics such as mobility research, energy and environmental research and the interaction between man and machine.

INVOLVEMENT OF UNIVERSITIES IN BW-CAR RESEARCH TOPICS

<table>
<thead>
<tr>
<th>Energy systems and resource efficiency</th>
<th>Materials design and manufacturing</th>
<th>Technology for smart systems</th>
<th>Information and communication systems</th>
<th>Management, innovation and society</th>
<th>Diagnostics and therapy</th>
<th>Interaction between man and machine</th>
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BADEN-WÜRTTEMBERG COOPERATIVE STATE UNIVERSITY

The Baden-Württemberg Cooperative State University (DHBW) is unique in the way it combines theory and practice. With its accreditation as a university, the DHBW was awarded a joint research project. Research is oriented towards application and transfer, particularly in collaboration with partners in industry. They work together to develop innovative concepts, strategies and technologies and reflect professional and specialist conditions in business, technology and social studies. Joint research offers partners a clear added value and improves the quality of teaching. In return, the DHBW is integrated into specialist networks. The DHBW’s Research Support Centre also offers a comprehensive research service, from developing ideas and drawing up contracts right up to transfer and marketing.

With its six universities of education, Baden-Württemberg is the only state in Germany to offer this kind of specialist university for studying educational science. The universities of education also place a high priority on research. Research topics range from basic research into educational theory to application-oriented educational research across a broad range of disciplines, such as empirical teaching-learning research, studies of education at particular institutions, teaching methods and professionalisation. The universities of education are strong centres for educational research. The universities of education have as part of their remit to advance new generations of academics and therefore shoulder a large degree of responsibility for advancing new generations of academics in educational and methodological disciplines. An outstanding environment is offered by the unique disciplinary and interdisciplinary research programmes and the Graph joint graduate school.

The universities of education carry out research at national and international level and in conjunction with other universities and research institutions. Every year they receive millions of euros in external funding. Funding is provided by institutions such as the German Research Fellowship (DFG), the EU and the Federal Ministry of Education and Research (BMBF).

UNIVERSITIES OF EDUCATION

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<th>Baden-Württemberg Cooperative State University</th>
<th>DHBW Heidenheim</th>
<th>DHBW Heilbronn</th>
<th>DHBW Mannheim</th>
<th>DHBW Karlsruhe</th>
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Few regions in Europe are home to as many research institutions as Baden-Württemberg. Major international and national research centres such as the European Molecular Biology Laboratory in Heidelberg and the German Cancer Research Center in Heidelberg exist alongside the Centre for Art and Media in Karlsruhe and numerous institutions belonging to famous research associations. These include 13 institutes of the Max Planck Society, 3 Helmholtz Association research centres and 17 Fraunhofer Institutes.

The Helmholtz Association employs more than 40,000 staff in 18 research centres with a focus on natural sciences, technology, medicine and biology. The researchers work on solutions to the main, most pressing problems of society, science and business. Their strategic programmes of research are focused on six areas: energy, earth and environment, health, matter, key technologies, aerospace and transport. With an annual budget of excess of 4 billion euros the Helmholtz Association is Germany’s largest scientific organisation. The researchers work on solutions to the main, most pressing problems of society, science and business. Their strategic programmes of research are focused on six areas: energy, earth and environment, health, matter, key technologies, aerospace and transport. With an annual budget of excess of 4 billion euros the Helmholtz Association is Germany’s largest scientific organisation.

Supporting the next generation of academics and scientists plays a key role in the research policies of the Helmholtz Association. The International Max Planck Research Schools (IMPRS) are an important element in this. They offer structured doctoral programmes in innovative and interdisciplinary areas such as molecular biology, neuroscience, demographics, plasma physics, polymer research and IT. There are eleven of these Research Schools in Baden-Württemberg. They provide excellent conditions for gifted students from Germany and abroad to carry out their doctoral studies. Around half of the students are from abroad, and they can choose to complete their doctorates at universities in Germany or in their home country.

The Max Planck Society employs around 3,560 people in the state, including numerous researchers from all over the world. The Max Planck Institutes have a strong international network thanks to its many joint research projects with foreign partners.

A broad spectrum of research is focused on six areas: energy, earth and environment, health, matter, key technologies, aerospace and transport. With an annual budget of excess of 4 billion euros the Helmholtz Association is Germany’s largest scientific organisation. The researchers work on solutions to the main, most pressing problems of society, science and business. Their strategic programmes of research are focused on six areas: energy, earth and environment, health, matter, key technologies, aerospace and transport. With an annual budget of excess of 4 billion euros the Helmholtz Association is Germany’s largest scientific organisation.
The Leibniz Association brings together 95 independent research establishments. Its research includes natural sciences, engineering, environmental science, economics, spatial planning, social sciences and humanities. The Leibniz Institutes focus on issues that are relevant to society, the economy and the environment. They carry out empirical and applied research, including in the umbrella Leibniz research associations, and are or support scientific infrastructures and offer research-based services. Seven Leibniz Association institutes are based in Baden-Württemberg.

Founded in 1949, the Fraunhofer Society works with international partners to advance applied research for the benefit of business and society. It receives research contracts from industry, service companies and public bodies. The aim of its research activities is to transfer its findings into innovative products and services. The Fraunhofer Institutes also carry out their own initial research and innovative products and services. The Fraunhofer Institutes also carry out their own initial research and innovative products and services. The Fraunhofer Institutes also carry out their own initial research and innovative products and services.

In a region that is home to many mid-tier businesses, the Baden-Württemberg Innovation Alliance (innBW) plays an important role thanks to its targeted, applied research activities. innBW is an alliance of 13 independent applied research institutes with a total of 1,150 employees. The institutes target their research to meet the needs of business and the economy and focus on areas of technology that are important for them. With some 4,600 industry-related projects in key areas for the future, such as health and elderly care, sustainable mobility, energy and environmental technology, information and communication, innBW plays an important role in the state’s technology strategy. The majority of its research is commissioned by small and mid-tier companies. For the development of new, innovative products, the focus is on materials and surfaces that are suitable for a range of technologies, microsystem technology/electronics, digitalisation, nanotechnology, biotechnology, photonics, production engineering and management systems. The Innovation Alliance has the key function of building bridges between basic research at universities and the technical advances taking place in industry. The directors of most of these institutes are also professors at universities or heads of university departments. This guarantees that a lot of knowledge and personal exchange takes place between the independent research institutes and the universities. Undergraduates and postgraduates can also gain further qualifications for future work in industry by writing dissertations and doctoral theses that are relevant to current practical issues in industry.

The Baden-Württemberg Academy of Sciences is one of eight German Academies of Sciences. It is a learned society of eminent scientists and a modern non-university research institute that is currently involved in 20 projects. The Academy organises academic conferences and public lecture series and supports new generations of scholars.

The EMBL, based in Heidelberg, was established in 1974 and is supported by more than twenty member states. Its core activities are basic research in molecular biology, education, academic services, developing new research tools and methods, technology transfer and building life sciences networks throughout Europe.

The ITU, based in Karlsruhe in 1963, the ITU aims to provide a scientific basis for protecting against the dangers of highly radioactive materials. The Institute is part of the European Commission’s Joint Research Centre (JRC).
In Baden-Württemberg there is a wide range of structured doctorate programmes, which generally make it possible to gain your doctorate in just three years. They involve a structured supervision and qualification concept and encourage doctoral students to get involved with the scientific community at an early stage. Most of them also offer opportunities for scholarships and employment at universities and research institutes. But it is also possible to study for traditional individual doctorates.

Major companies and research institutions have their own careers pages where they publish job vacancies. The following links may also be helpful:

- [www.bw-career.de/en/home](http://www.bw-career.de/en/home)
- [www.academics.de](http://www.academics.de)
- [www.research-in-germany.de](http://www.research-in-germany.de)
- [www.gain-network.org/en](http://www.gain-network.org/en)
- [www.dzu-wissenschaftskarriere.de](http://www.dzu-wissenschaftskarriere.de)
- [https://euraxess.ec.europa.eu](https://euraxess.ec.europa.eu)

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Baden-Württemberg offers a number of funding programmes, including the Junior Professor programme for young academics, a returning academics programme to support universities in Baden-Württemberg and a female professors programme for appointments of female academics.

Baden-Württemberg offers ambitious graduates, specialists and executives from around the world a wide range of exciting career opportunities. Alongside its many universities and research establishments, the region is also home to a great many companies that also conduct their own research. We have plenty of interesting jobs. These are ideal conditions for starting an academic career.

### DOCTORAL STUDIES IN BADEN-WÜRTTEMBERG

#### Easy Entry to an Academic Career

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**A Structured Approach to Doctoral Studies**

**Doctorates and Programmes**

### Jobs Online

**Job Seeking**

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**A Structured Approach to Doctoral Studies**

**Doctorates and Programmes**

### Special Grants

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**Special Grants**

**Funding Programmes**

### Doctoral Studies

**FIND OUT MORE ABOUT DOCTORAL STUDIES IN BADEN-WÜRTTEMBERG AT:**

[www.bw-career.de/en](http://www.bw-career.de/en)

**FIND OUT MORE!**

For more information on studying, conducting research, living and working in Baden-Württemberg, visit [www.bw-studyguide.de](http://www.bw-studyguide.de) and [www.bw-career.de/en/home](http://www.bw-career.de/en/home)

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*We're here to help.*

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**Baden-Württemberg International**

*Find out more!*

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