



Welcome to Baden-Württemberg

CONDUCTING RESEARCH IN THE LAND OF THE FUTURE!

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Baden-Württemberg

The German Southwest.





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.

- Research Universities
 - Universities of Applied Sciences
 - Baden-Württemberg Cooperative State University
 - Universities of Education
 - Universities of Arts and Music
 - Max Planck Institutes
 - Helmholtz Research Centres
 - Leibniz Institutes
 - Fraunhofer Institutes
 - Baden-Württemberg Innovation Alliance
 - International Research Institutions
 - Heidelberg Academy of Sciences and Humanities
- The map only shows state universities.



Baden-Württemberg

THE LAND OF IDEAS, RESEARCHERS AND INVENTORS

Baden-Württemberg

A WEALTH OF NATURE, CULTURE AND PLEASURE



FOR BODY, MIND AND SOUL

35

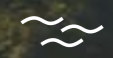
MINERAL BATHS



NATURE AT ITS PUREST

2.4 %

OF ITS SURFACE AREA IS COVERED BY NATURE RESERVES



OUR BIG LAKE

536 km²

SURFACE AREA OF LAKE CONSTANCE



BW IS EASY TO GET AROUND

40,000 km

OF BIKE ROUTES



BEAUTIFUL VIEWS

1,493 m

THE HIGHEST MOUNTAIN – THE FELDBERG



BORDERLESS HIKING

around 50,000 km

OF HIKING PATHS



THE BEST LOCATION

3rd

LARGEST WINE-GROWING AREA IN GERMANY



HISTORY AT YOUR FINGERTIPS

59

STATELY HOMES, CASTLES, MONASTERIES AND GARDENS



FIRST-CLASS ART

more than 1,300

MUSEUMS

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.



Living in Baden-Württemberg

RECREATION, FUN AND RELAXATION

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 "Fischerstechen" 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.

more than 57 million
OVERNIGHT STAYS (2019)

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

Germany's biggest theme park:
EUROPAPARK IN RUST

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.

NATURE AND TRADITION –
the Black Forest



THE PERFECT PLACE TO RELAX –
on the shores of Lake Constance



SPA, BEAUTY, WELLNESS –
where better than in Baden-Baden?

WHERE THE WORLD IS AT HOME –
184 different nationalities



ROMANTIC AND IDYLIC –
the Swabian Alb



Baden-Württemberg

RESEARCH IS OUR ECONOMY'S DRIVING FORCE



ONE OF GERMANY'S TOP BUSINESS REGIONS

€ 524.3 billion
GROSS DOMESTIC PRODUCT (2019)



INVESTMENT IN THE FUTURE

€ 27.9 billion
FOR RESEARCH AND DEVELOPMENT (2017)



FOCUS ON HEALTH

838
MEDICAL TECHNOLOGY COMPANIES



EXCELLENT GLOBAL POSITIONING

over 400
GLOBAL MARKET LEADERS



ENERGY TRANSITION

80 %
OF ENERGY FROM RENEWABLES BY 2050



TRANSPORT PIONEERS

1886
INVENTION OF THE AUTOMOBILE



FIT AND HEALTHY

84 (women) & 80 (men)
LIFE EXPECTANCY



TOP INDUSTRIAL LOCATION

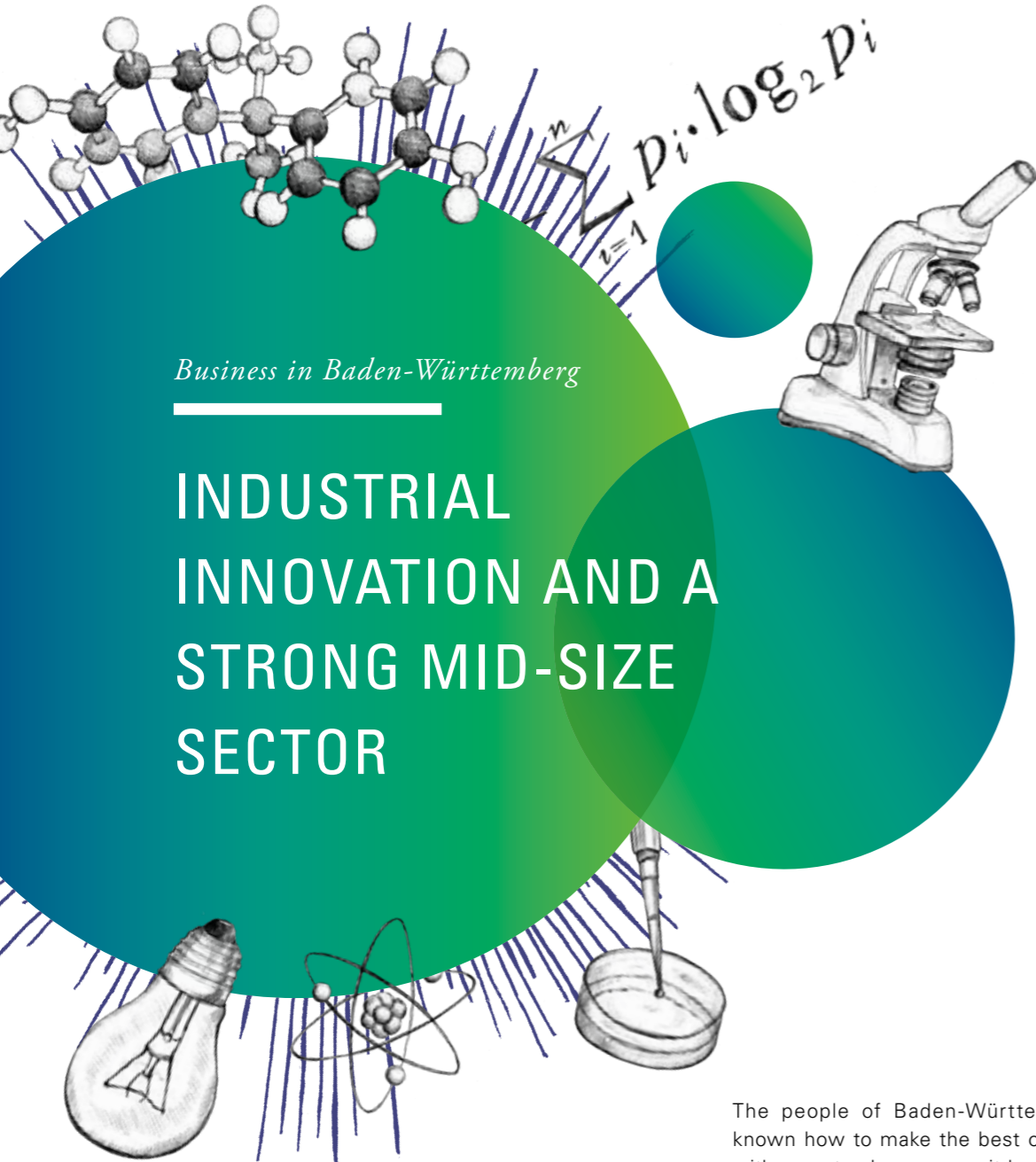
almost 34 %
OF EARNINGS FROM MANUFACTURING (2019)



A HEALTHY ECONOMY

3.2 %
UNEMPLOYMENT RATE (2019)

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!

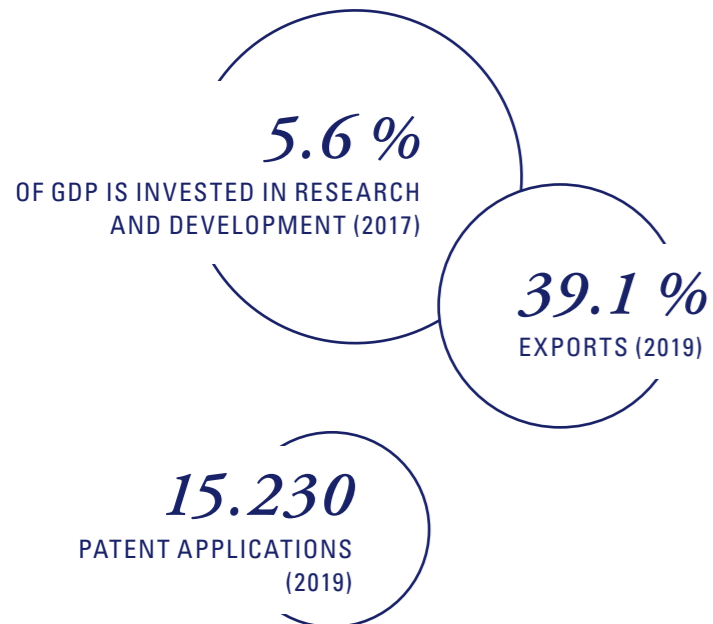


Business in Baden-Württemberg

INDUSTRIAL INNOVATION AND A STRONG MID-SIZE SECTOR

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, rawnl 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.

INVENTORS AND TINKERERS –
Carl Benz, Robert Bosch, Artur Fischer to name but a few



AUTOMOTIVE GIANTS –
Daimler, Porsche & Audi



GLOBAL MARKET LEADERS –
Stihl, Trumpf, Kärcher & Co.



Baden-Württemberg

EXCELLENCE IN RESEARCH



 NETWORKED <hr/> 110 CLUSTER INITIATIVES AND NETWORKS	 DISTINGUISHED NATIONWIDE <hr/> 4 UNIVERSITIES OF EXCELLENCE	 LEADING POSITION <hr/> 38 out of 224 FUNDED GRADUATE SCHOOLS IN BADEN-WÜRTTEMBERG
 DIVERSITY, BREADTH AND DEPTH <hr/> over 100 RESEARCH INSTITUTIONS	 INDEPENDENT <hr/> 117 JUNIOR PROFESSORSHIPS WITH TENURE TRACK (2019)	 THE NUMBER ONE <hr/> 1st place THE EU'S TOP REGION FOR INNOVATION (2018)
 INVESTMENT IN THE FUTURE <hr/> € 5.3 billion ALLOCATED TO SCIENCE, RESEARCH AND THE ARTS IN THE STATE'S 2019 BUDGET	 HIGH ENDOWMENTS <hr/> € 200,000 BI-ANNUAL STATE RESEARCH PRIZE	 GENEROUSLY FUNDED <hr/> up to € 150,000 PER JUNIOR PROFESSORSHIP (COMPETITIVE PROCESS)

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.



Research in Baden-Württemberg

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.

Careers

TO FIND OUT MORE ABOUT CURRENT VACANCIES AND RESEARCH PROJECTS, VISIT: WWW.BW-CAREER.DE/EN



The careers platform for academics and researchers www.bw-career.de/en offers a fast-track to success in Baden-Württemberg – with the latest vacancies at universities, research institutions and other interesting employers for those seeking academic careers.

EXCELLENT PERFORMANCE *University 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.

INTERNATIONAL IMPORTANCE *Non-university research*



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

BUILDING SYNERGIES THROUGH NETWORKS *Research infrastructure*



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

STRATEGIC RESEARCH TOPICS

DFG & BWS

(DEUTSCHE FORSCHUNGSGEMEINSCHAFT AND BADEN-WÜRTTEMBERG STIFTUNG)
WWW.DFG.DE/EN/INDEX.JSP AND
WWW.BWSTIFTUNG.DE/STARTSEITE

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, Medien- und Filmgesellschaft BW and Umwelttechnik BW.

**Baden-Württemberg
 Ministry of Science,
 Research and Arts**

RESEARCH IN THE REGION FOCUSES ON AREAS WITH CONSIDERABLE GROWTH POTENTIAL FOR THE FUTURE. TO THIS END, IT HAS SPECIFIED KEY AREAS OF RESEARCH.
WWW.MWK.BADEN-WUERTEMBERG.DE/DE/STARTSEITE/

Energy

CELEST

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. Its findings will show the way forward for electric cars and power grids.

Industry 4.0

ARENA2036

More than 40 partners from science and business have been 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 since 2013.

Artificial intelligence

CYBER VALLEY

Cyber Valley at the locations in Tübingen and Stuttgart is Europe's largest initiative for artificial intelligence, the key technology of the 21st century. It carries out research into areas such as optimised algorithms, self-driving cars and 'seeing' rescue robots.

Medical technology

M²OLIE

At the "Mannheim Molecular Intervention Environment" research campus, around 100 researchers are working on developing a highly efficient intervention environment that allows for comprehensive treatment of cancer patients with multiple metastases.

Mobility

HIGH PERFORMANCE CENTER FOR MOBILITY RESEARCH IN KARLSRUHE

Seven research institutions have come together to form the "High Performance Center for Mobility Research" in Karlsruhe, where they are developing the mobility concepts of the future, including electric vehicles and driverless cars as well as sustainable fuels.

Physics

STRUCTURES

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 physics to cosmology and neuroscience.

Social sciences

THE POLITICS OF INEQUALITY

From the gap between rich and poor to equal opportunities in education, many of the issues currently being debated relate to inequality. Research into inequality is at the heart of what the Cluster of Excellence "The Politics of Inequality" at the University of Konstanz does.

Environmental technology

SUSTAINABILITY CENTER FREIBURG

Since 2015, scientists at the Sustainability Center Freiburg have been carrying out interdisciplinary research in the fields of sustainable materials, energy systems, resilience engineering and approaches for ecological and societal transformation.





Energy

CELEST



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.

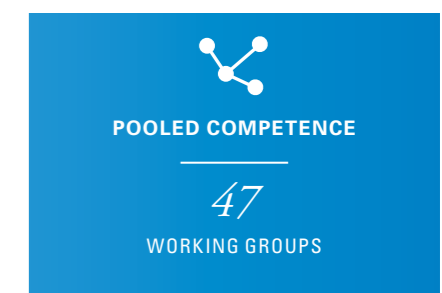
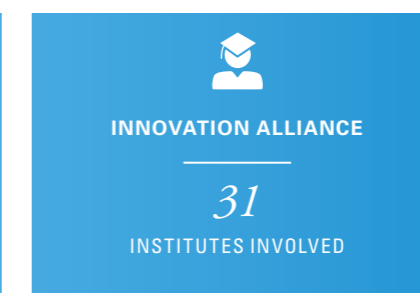
This is also true of the well-known lithium ion technology. Although the capacity and number of charging cycles have now increased to a high level and the costs are reasonable, scientists are puzzled for example by what is referred to as an 'interfacial layer' that develops in the lithium ion battery 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

DATA AND FACTS





Industry 4.0

ARENA2036



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.



The factory hall of Arena2036 functions as an open co-working space.

“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 standstill. 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/

DATA AND FACTS

INNOVATION ALLIANCE

41

PARTNERS FROM SCIENCE AND BUSINESS

FUNDING

up to € 30 m

IN BASIC FUNDING FROM THE BMBF

DIVERSITY

roughly 90

RESEARCH PROJECTS IN THE FIRST FUNDING PHASE (2013 – 2018)



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 scientists are training the robot Apollo.

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

DATA AND FACTS

INNOVATION ALLIANCE
11 PARTNERS FROM SCIENCE AND BUSINESS

FUNDING
roughly € 165 m IN STATE FUNDING

RESEARCH GROUPS
10



Medical technology

M²OLIE



The “Mannheim Molecular Intervention Environment” (M²OLIE) Research Campus is a flagship project in medical technology in the Rhine-Neckar region. Within the framework of a public-private partnership, around 100 researchers are working on developing a highly efficient intervention environment that allows for comprehensive treatment of cancer patients with multiple metastases. The aim is to create the intervention room of the future, where the patient will receive a precise diagnosis and therapy all in one day as part of a one-stop shop solution.

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

technologists, 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.



A medical robot supports the taking of tissue samples.

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/

DATA AND FACTS





Mobility

HIGH PERFORMANCE CENTER FOR MOBILITY RESEARCH IN KARLSRUHE



Seven research institutions have come together to form the “High Performance Center for Mobility Research” in Karlsruhe, where they are developing the mobility concepts of the future. The research involves not only electric vehicles and driverless cars but also sustainable fuels and human-machine interaction. The aim of this innovation platform is to ensure that Baden-Württemberg retains its leading position even as the face of mobility changes.

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.

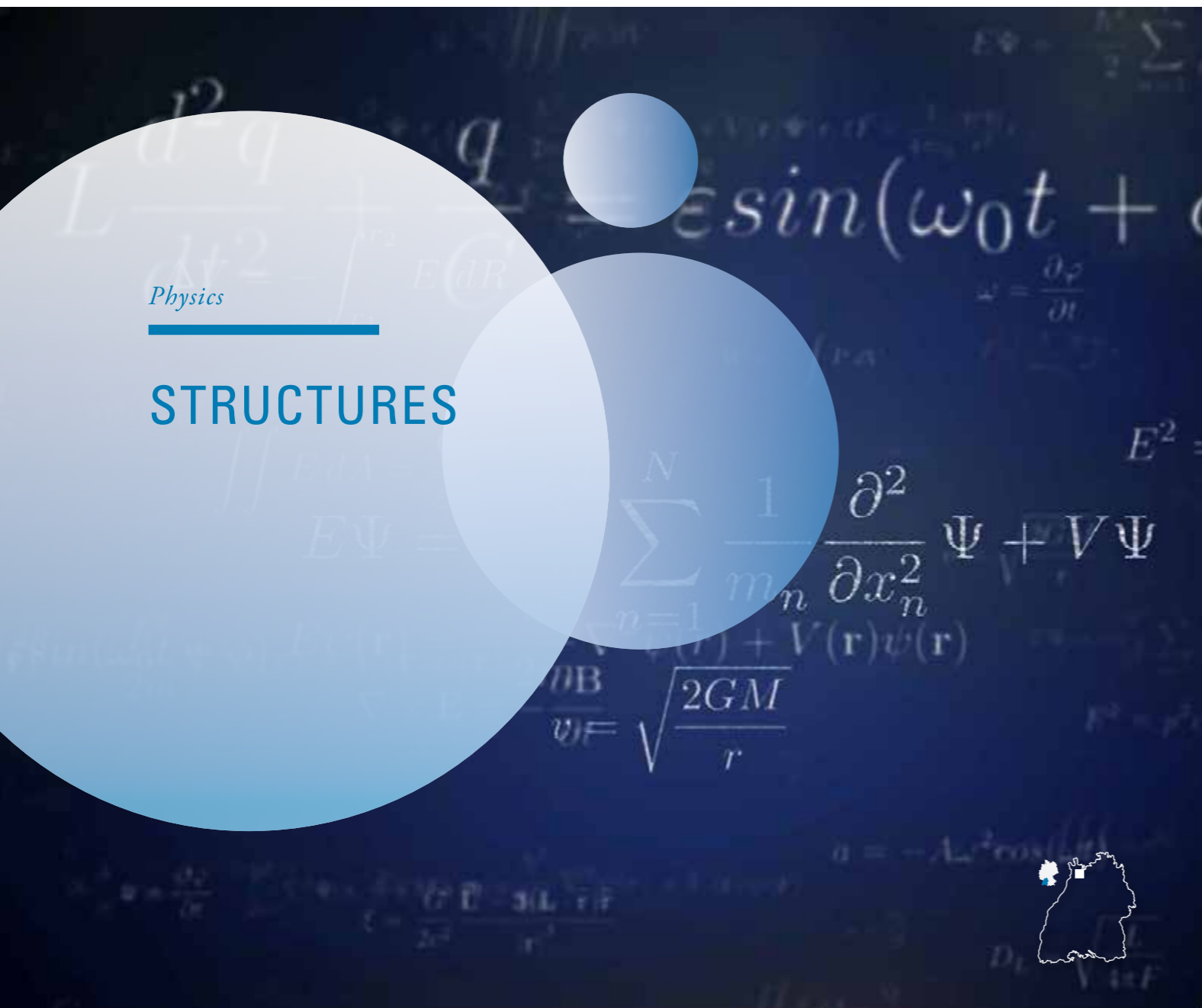
Collaborative research has been under way at the High Performance Center for Mobility Research in Karlsruhe since 2016, and numerous scientific findings have been made in different areas. One of those findings relates to communication between self-driving cars. It involves LED headlights which emit light 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.

INFORMATION AT

www.profilregion-ka.de/index.php/en

DATA AND FACTS





Physics

STRUCTURES



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.

The Philosophenweg path winds up Heiligenberg hill roughly 100 metres above the Neckar river. This famous attraction in the city of academia that is Heidelberg has always been more than just a tourist magnet, acting also as a research location for Heidelberg University. The university's Institute for Theoretical Physics is situated there, and with it – since the summer of 2019 – the Cluster of Excellence STRUCTURES. More than 50 professors and research group leaders are based there. Together with over 80 international young researchers, they take the space and the time to reflect on and research universal structures in a broad range of natural phenomena – funded by federal and state funding as part of Germany's Excellence Strategy.

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",



The StrucStar is the symbol of the Heidelberg Cluster of Excellence.

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



Social sciences

THE POLITICS OF INEQUALITY



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 Busemeyer, 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 Busemeyer. 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



The issue of inequality also resonates with the climate protests.

causes and consequences”, explains Busemeyer. 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 peoples’ 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 Busemeyer, “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

DATA AND FACTS





Environmental technology

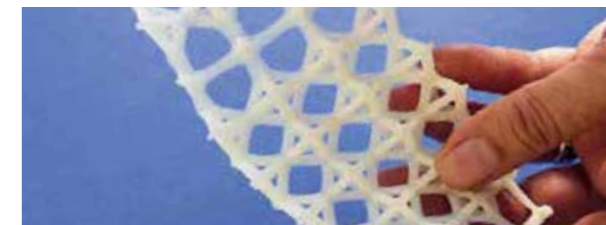
SUSTAINABILITY CENTER FREIBURG



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 (FMF) 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.

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.”



This additive-manufactured plastic is easier to recycle.

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 composites 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 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.

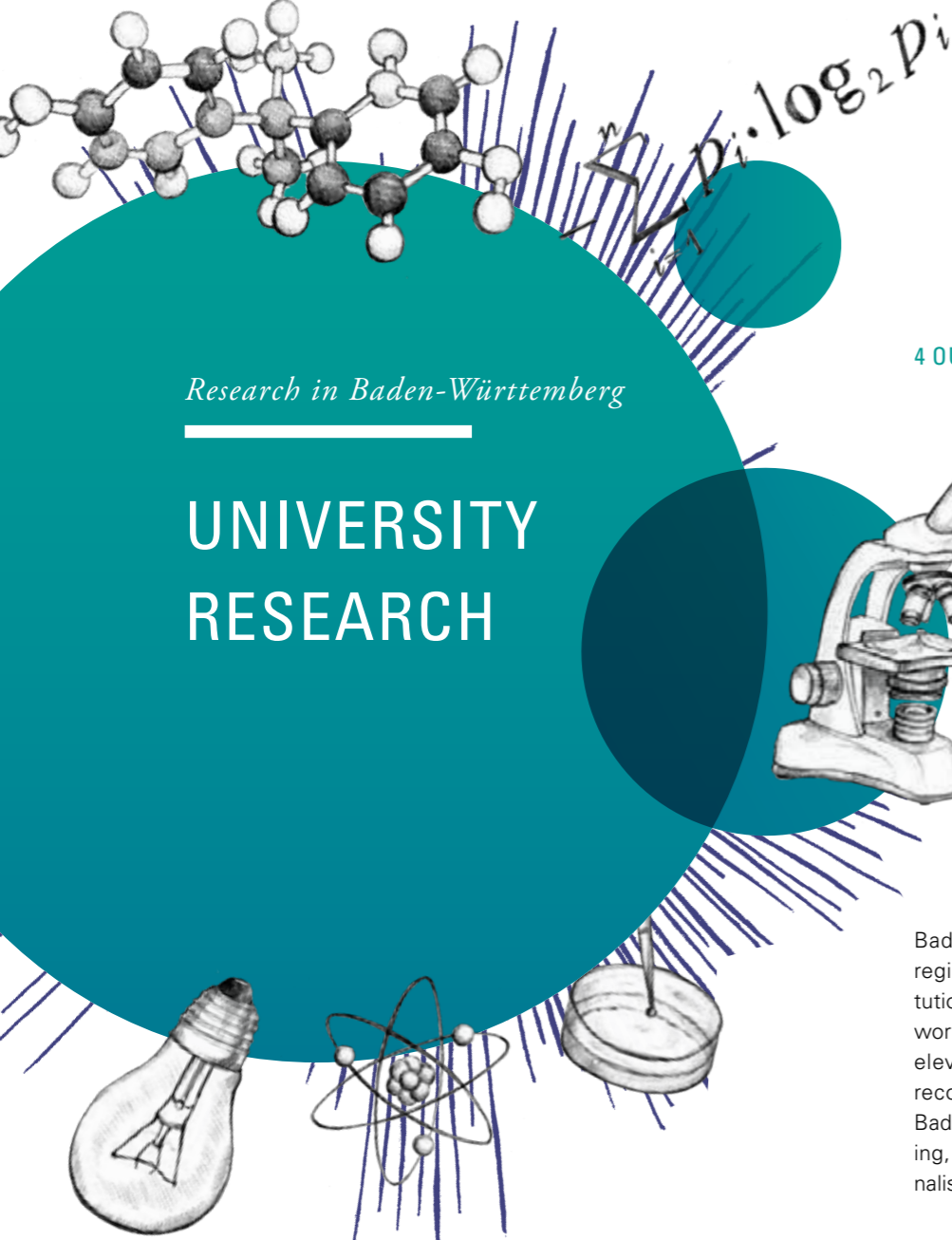
The Center offers workshops, liaises with industry and provides support for start-ups. The research projects relate to the areas of sustainable materials, energy systems, resilience engineering and societal and ecological transformation. Researchers are working on refining LED lighting, using drones 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 LNZ Central Office. “Luckily, in Freiburg we have the scientific and societal skills to help provide solutions.”

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

INFORMATION AT
www.leistungszentrum-nachhaltigkeit.de/en

DATA AND FACTS





*** Excellence Strategy**



4 OUTSTANDING UNIVERSITIES IN BADEN-WÜRTTEMBERG

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.

UNIVERSITY

EXCELLENCE STRATEGY

GRADUATE SCHOOLS | CLUSTERS OF EXCELLENCE | IDEAS FOR THE FUTURE

 <p>UNIVERSITY OF FREIBURG www.uni-freiburg.de/?set_language=en</p>	<p>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.</p>
 <p>UNIVERSITY OF HEIDELBERG www.uni-heidelberg.de</p>	<p>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:</p>

<p>GRADUATE SCHOOL</p> <ul style="list-style-type: none"> • Spemann Graduate School of Biology and Medicine • Graduate School of Robotics
<p>CLUSTERS OF EXCELLENCE</p> <ul style="list-style-type: none"> • BIOSS Centre for Biological Signalling Studies • BrainLinks – BrainTools • Living, Adaptive and Energy-autonomous Materials Systems
<p>GRADUATE SCHOOLS</p> <ul style="list-style-type: none"> • Heidelberg Graduate School for Physics • Heidelberg Graduate School of Surgery • Heidelberg Graduate School of Mathematical and Computational Methods for the Sciences • Heidelberg Biosciences International Graduate School

UNIVERSITY

EXCELLENCE STRATEGY

GRADUATE SCHOOLS | CLUSTERS OF EXCELLENCE | IDEAS FOR THE FUTURE

 <p>UNIVERSITY OF HOHENHEIM www.uni-hohenheim.de/en/english</p>	<p>individuals and organisations". Together they build the core of Heidelberg's research strategy. The university places a priority on advancing excellent individual disciplines, encouraging dialogue across traditional disciplines and providing research results that are useful to society and business.</p> <p>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.</p>	<p>CLUSTERS OF EXCELLENCE</p> <ul style="list-style-type: none"> • STRUCTURES • 3D Matter Made to Order
 <p>KIT Karlsruhe Institute of Technology UNIVERSITY OF TECHNOLOGY www.kit.edu</p>	<p>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.</p>	<p>GRADUATE SCHOOLS</p> <ul style="list-style-type: none"> • Karlsruhe School of Optics & Photonics • Karlsruhe School of Elementary Particle and Astroparticle Physics • BioInterfaces International Graduate School <p>CLUSTER OF EXCELLENCE</p> <ul style="list-style-type: none"> • 3D Matter Made to Order • Energy Storage Beyond Lithium: New Concepts for a Sustainable Future
 <p>UNIVERSITY OF KONSTANZ www.uni-konstanz.de/en/</p>	<p>The University of Konstanz takes an interdisciplinary approach to science. Key areas of research are cultural and decision-making studies, chemical biology and ecology, molecular nanoscience and materials science. This young university actively promotes careers in new areas of science.</p>	<p>GRADUATE SCHOOLS</p> <ul style="list-style-type: none"> • Graduate School of Decision Sciences • Graduate School Chemistry • Graduate School Biological Sciences • Konstanz Research School Chemical Biology <p>CLUSTERS OF EXCELLENCE</p> <ul style="list-style-type: none"> • The Politics of Inequality: Perceptions, Participation and Policies • Centre for the Advanced Study of Collective Behaviour
 <p>UNIVERSITY OF MANNHEIM www.uni-mannheim.de/en/</p>	<p>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.</p>	<p>GRADUATE SCHOOL</p> <ul style="list-style-type: none"> • Graduate School of Economic and Social Sciences
 <p>UNIVERSITY OF STUTTGART www.uni-stuttgart.de/en/</p>	<p>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.</p>	<p>GRADUATE SCHOOLS</p> <ul style="list-style-type: none"> • Graduate School of Excellence Advanced Manufacturing Engineering • Graduate and Research School for Energy Efficiency Stuttgart <p>CLUSTERS OF EXCELLENCE</p> <ul style="list-style-type: none"> • Data-integrated simulation sciences • Intergrative Computational Design and Construction for Architecture
 <p>UNIVERSITY OF TÜBINGEN www.uni-tuebingen.de/en/</p>	<p>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 neurosciences, translational immunology and cancer research, geological and environmental research, astrophysics, particle physics and quantum physics.</p>	<p>GRADUATE SCHOOL</p> <ul style="list-style-type: none"> • Learning, Educational Achievement, and Life Course Development <p>CLUSTERS OF EXCELLENCE</p> <ul style="list-style-type: none"> • Image-Guided and Functionally Instructed Tumor Therapies • Control of Microorganisms to Fight Infection • Machine Learning in Science
 <p>ULM UNIVERSITY www.uni-ulm.de/en/</p>	<p>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.</p>	<p>GRADUATE SCHOOL</p> <ul style="list-style-type: none"> • International Graduate School in Molecular Medicine Ulm

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

topics nationally to create infrastructure synergies for high-level research.

As a strategic joint HAW project, Centres of Applied Research at Universities (ZAFH) have been set up to consolidate research structures in proven areas of competence. Strong research groups have provided the foundation for the establishment of numerous cooperative graduate programmes to encourage young academics in applied research, provide them with close supervision and structured doctoral studies in conjunction with 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.

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.

BADEN-WÜRTTEMBERG COOPERATIVE STATE UNIVERSITY

www.dbbw.de/english/home.html

DHBW HEIDENHEIM
www.heidenheim.dbbw.de/en/home.html

DHBW HEILBRONN
<https://www.heilbronn.dbbw.de/international/junior-program.html>

DHBW KARLSRUHE
www.karlsruhe.dbbw.de/en/general/about-us.html

DHBW LÖRRACH
<https://dbbw-loerrach.de/international-visitors/>

DHBW MANNHEIM
www.dbbw-mannheim.de

DHBW MOSBACH
<https://www.mosbach.dbbw.de/en/international-office/international/about-us/>

DHBW RAVENSBURG
www.ravensburg.dbbw.de

DHBW STUTTGART
<https://www.dbbw-stuttgart.de/zielgruppen/international-visitors/overview/>

DHBW VILLINGEN-SCHWENNINGEN
www.dbbw-vs.de

INVOLVEMENT OF UNIVERSITIES IN BW-CAR RESEARCH TOPICS

	Aalen University of Applied Sciences	Albstadt-Sigmaringen University of Applied Sciences	Biberach University of Applied Sciences	Esslingen University of Applied Sciences	Freiburg Protestant University of Applied Sciences	Catholic University of Applied Sciences Furtwangen	Heilbronn University of Applied Sciences	Karlsruhe University of Applied Sciences	Kehl University of Applied Sciences	Konstanz University of Applied Sciences	University of Applied Sciences Ludwigsburg – Public Management and Finance	Ludwigsburg Protestant University of Applied Sciences – Administration	Mannheim University of Applied Sciences	Nürtingen-Geislingen University of Applied Sciences	Oftenburg University of Applied Sciences	Pforzheim University of Applied Sciences	Ravensburg University of Applied Sciences	Reutlingen University of Applied Sciences	University of Applied Sciences Weingarten	University of Applied Sciences Stuttgart	University of Applied Sciences Design Forest Sciences	Stuttgart Media University	Stuttgart Technical University Applied Sciences	Ulm University of Applied Sciences	
Energy systems and resource efficiency	•	•				•	•	•	•				•	•	•	•	•	•	•	•	•	•	•	•	•
Materials design and manufacturing	•					•	•	•	•				•	•	•	•	•	•	•	•	•	•	•	•	•
Technology for smart systems	•		•			•	•	•	•				•	•	•	•	•	•	•	•	•	•	•	•	•
Information and communication systems	•					•	•	•	•				•	•	•	•	•	•	•	•	•	•	•	•	•
Management, innovation and society	•		•	•	•	•	•	•	•			•	•	•	•	•	•	•	•	•	•	•	•	•	•
Diagnostics and therapy	•	•	•			•						•												•	
Interaction between man and machine	•					•	•	•	•							•							•	•	

UNIVERSITIES OF EDUCATION

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 mandate the right to award doctorates and habilitations 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).

PH FREIBURG
www.pb-freiburg.de

PH HEIDELBERG
www.pb-heidelberg.de/en/home.html

PH KARLSRUHE
www.pb-karlsruhe.de

PH LUDWIGSBURG
<http://www.pb-ludwigsburg.de/I+M537721956c0.html>

PH SCHWÄBISCH GMÜND
www.pb-gmuend.de/en/ph-gmuend

PH WEINGARTEN
www.pb-weingarten.de



Research in Baden-Württemberg

NON-UNIVERSITY RESEARCH

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.

INSTITUTION



MAX-PLANCK-GESELLSCHAFT

MAX PLANCK SOCIETY
www.mpg.de/en

The Max Planck Society for the Advancement of Science e.V. is an independent, non-profit research organisation. Its institutes primarily focus on basic research in selected fields in natural sciences, humanities and social sciences, and their discoveries and findings provide a foundation for innovations that are important for business and society. It has produced more Nobel prize winners than any other research establishment in Germany, including Klaus von Klitzing and Christiane Nüsslein-Volhard. The research topics studied at the Max Planck Institutes complement the work of universities and other research institutions. Baden-Württemberg is home to 13 Max Planck Institutes.

- Max Planck Institute for Astronomy, Heidelberg
www.mpia.de/en
- Max Planck Institute for Comparative Public Law and International Law, Heidelberg
www.mpil.de/en/pub/news.cfm
- Max Planck Institute for Foreign and International Criminal Law, Freiburg
www.mpicc.de
- Max Planck Institute for Biological Cybernetics, Tübingen
www.kyb.mpg.de
- Max Planck Institute for Developmental Biology, Tübingen
www.eb.tuebingen.mpg.de
- Max Planck Institute for Solid State Research, Stuttgart
www.fkf.mpg.de
- Max Planck Institute of Immunobiology and Epigenetics, Freiburg
www.fkf.mpg.de/en
- Max Planck Institute for Intelligent Systems, Stuttgart, Tübingen
www.is.mpg.de
- Max Planck Institute for Nuclear Physics, Heidelberg
www.mpi-hd.mpg.de/mpilen

INSTITUTION

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.

- Max Planck Institute for Medical Research, Heidelberg
www.mpimf-heidelberg.mpg.de
- Max Planck Institute of Animal Behavior,
www.ab.mpg.de
- Friedrich Miescher Laboratory of the Max Planck Society, Tübingen
www.fml.tuebingen.mpg.de



MAX-PLANCK-GESELLSCHAFT

**INTERNATIONAL
MAX PLANCK RESEARCH
SCHOOLS (IMPRS)**

www.mpg.de/en/imprs

Supporting the next generation of academics and scientists plays a key role in the research policies of the Max Planck Society. 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.

- Condensed Matter, Stuttgart
www.imprs-cms.mpg.de
- Intelligent Systems, Stuttgart, Tübingen
<https://imprs.is.mpg.de>
- Astronomy and Cosmic Physics, Heidelberg
www.imprs-hd.mpg.de
- Comparative Criminal Law, Freiburg
www.imprs-cc.de
- From Molecules to Organisms, Tübingen
www.imprs.tuebingen.mpg.de
- Cognitive & Systems Neuroscience, Tübingen
www.neuroschool-tuebingen.de
- Immunobiology, Epigenetics & Metabolism, Freiburg
www.ie-freiburg.mpg.de
- Organismal Biology, Konstanz
www.orn.mpg.de/en
- Precision Tests of Fundamental Symmetries, Heidelberg
www.mpi-hd.mpg.de/imprs-ptfs
- Quantum Dynamics in Physics, Chemistry and Biology, Heidelberg
www.mpi-hd.mpg.de/imprs-qd
- Successful Dispute Resolution in International Law, Heidelberg
www.ipr.uni-heidelberg.de/index_en.html

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, programmed research is focused on six areas: energy, earth and environment, health, matter, key technologies, aerospace and transport. With an annual budget in excess of 4 billion euros the Helmholtz Association is Germany's largest scientific organisation. With the KIT and the DKFZ, the largest biomedical research institute in Germany, two Helmholtz centres are based in Baden-Württemberg. Others have branches in the state: the six German Centres for Health Research with its eleven locations and the DLR with three locations. The DLR carries out comprehensive R&D work in the areas of aerospace, energy, transport and safety. Baden-Württemberg is also home to the National Center for Tumour Diseases (NCT) in Heidelberg and the Helmholtz Institute for Electrochemical Energy Storage in Ulm (HIU).



**HELMHOLTZ
ASSOCIATION**

www.helmholtz.de

- German Cancer Consortium (DKTK), Heidelberg, Tübingen, Freiburg
www.dkfz.de/en/home
- German Cancer Research Center (DKFZ), Heidelberg
www.dkfz.de/en/index.html
- German Center for Diabetes Research (DZD), Tübingen
www.dzd-ev.de/en/index.html
- German Center for Cardiovascular Research (DZHK), Heidelberg, Mannheim
<https://dzhk.de/en>
- German Center for Infection Research (DZIF), Heidelberg, Tübingen
www.dzif.de/en
- German Aerospace Center (DLR), Stuttgart, Lampoldshausen, Ulm
www.dlr.de/EN/Home/home_node.html
- German Center for Lung Research (DZL), Heidelberg
www.dzl.de
- German Center for Neurodegenerative Diseases (DZNE), Tübingen, Ulm
www.dzne.de/en
- Helmholtz Institute for Electrochemical Energy Storage (HIU), Ulm
www.hiu-batteries.de/battery-research-center-in-germany/
- Karlsruhe Institute of Technology (KIT), Karlsruhe
www.kit.edu/english/index.php
- National Center for Tumour Diseases (NCT), Heidelberg
www.nct-heidelberg.de/en.html



LEIBNIZ ASSOCIATION
www.leibniz-gemeinschaft.de/en

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.

- FIZ-Karlsruhe – Leibniz Institute for Information Infrastructure (FIZ), Karlsruhe
www.fiz-karlsruhe.de/en
- GESIS – Leibniz Institute of Social Sciences, Mannheim
www.gesis.org/en/home
- Institute for the German Language (IDS), Mannheim
www.ids-mannheim.de
- Leibniz Institute for Knowledge Acquisition Media (IWM), Tübingen
www.iwm-tuebingen.de/www/en
- Kiepenheuer Institute for Solar Physics (KIS), Freiburg
www.kis.uni-freiburg.de
- Mathematisches Forschungsinstitut (MFO), Oberwolfach
www.mfo.de
- Centre for European Economic Research, Mannheim
www.zew.de/en

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 in order to have an influence on the development of the technology of the future. Research topics include health and the environment, protection and safety, mobility and transport, production and services, communication and knowledge and energy and raw materials. The Fraunhofer Institutes work together in institute associations and joint research projects and also work closely with external partners such as universities and other research institutions. In Baden-Württemberg the Fraunhofer Society is represented by 13 institutions, a field office and three project groups.

 **Fraunhofer**
 FRAUNHOFER SOCIETY
www.fraunhofer.de/en

- Fraunhofer Institute for Applied Solid State Physics IAF, Freiburg
www.iaf.fraunhofer.de/en
- Fraunhofer Institute for Industrial Engineering and Organisation IAO, Application Centre for Solutions for Energy and IT Mobility Interfaces, Stuttgart
www.iao.fraunhofer.de/lang-en
- Fraunhofer Institute for Building Physics IBP, Stuttgart
www.ibp.fraunhofer.de/en
- Fraunhofer Institute for Chemical Technology ICT, Pfaffzettel
www.ict.fraunhofer.de/en
- Fraunhofer Institute for Interfacial Engineering and Biotechnology IGB, Stuttgart
www.igb.fraunhofer.de/en.html
- Fraunhofer Institute for High-Speed Dynamics, Ernst Mach Institute EMI, Freiburg, Kandern branch, Efringen-Kirchen sub-institute
www.emi.fraunhofer.de/en.html
- Fraunhofer Institute of Optronics, System Technologies and Image Exploitation IOSB, Karlsruhe and Ettlingen branches
www.iosb.fraunhofer.de/servlet/is/12481
- Fraunhofer Institute for Physical Measurement Techniques IPM, Freiburg
www.ipm.fraunhofer.de/en
- Fraunhofer Institute for Manufacturing Engineering and Automation IPA, Stuttgart
www.ipa.fraunhofer.de/en.html
- Fraunhofer Institute for Solar Energy Systems ISE, Freiburg
www.ise.fraunhofer.de/en
- Fraunhofer Institute for Systems and Innovation Research ISI, Karlsruhe
www.isi.fraunhofer.de/en.html
- Fraunhofer Institute for Mechanics of Materials IWM, Freiburg branch
www.iwm.fraunhofer.de/en.html
- Fraunhofer Information Centre for Planning and Building IRB, Stuttgart
www.irb.fraunhofer.de
- Fraunhofer Institute for Silicate Research ISC, Würzburg, field office Bronnbach
www.isc.fraunhofer.de/en.html
- Fraunhofer Project Group for Automation in Medicine and Biotechnology PAMB, Mannheim
www.pamb.ipa.fraunhofer.de/en.html
- Fraunhofer New Drive Systems NAS project group, Karlsruhe
www.ict.fraunhofer.de/en/comp/nas.html
- Fraunhofer Lightweight Construction Technologies BTL project group, Stuttgart
www.ipa.fraunhofer.de/en.html



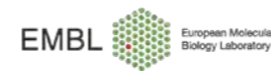
**BADEN-WÜRTTEMBERG
 INNOVATION ALLIANCE**
www.innbw.de

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 institutions 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 4,500 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 transfer. 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, micro-system 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 personnel exchange takes place between the independent research institutes and the universities. Undergraduates and post-graduates 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.



**HEIDELBERG ACADEMY
 OF SCIENCES AND
 HUMANITIES**
www.badw-bw.de

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.



**EUROPEAN MOLECULAR
 BIOLOGY LABORATORY
 (EMBL)**
www.embl.de

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.



**INSTITUTE FOR
 TRANSURANIUM
 ELEMENTS (ITU)**
www.ec.europa.eu/jrc

Founded 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).

- Hohenstein Institute for Textile Innovation (HIT), Bönningheim
www.hohenstein.de
- Research Institute for Precious Metals and Metal Chemistry (fem), Schwäbisch Gmünd
www.fem-online.de/en
- The FZI Research Centre for Information Technology at KIT, Karlsruhe
www.fzi.de/en/home
- Hahn-Schickard, Freiburg, Stuttgart, Villingen-Schwenningen
www.hahn-schickard.de/en
- Institute of Laser Technology in Medicine and Measurement Technology (ILM) at the University of Ulm, Ulm
www.ilm-ulm.de
- Stuttgart Institute of Microelectronics (IMS CHIPS), Stuttgart
www.ims-chips.de
- Institute of Textile Chemistry and Chemical Fibres (ITCF) at the German Institutes of Textile and Fibre Research Denkendorf (DITF), Denkendorf
www.ditf.de/en
- Institute of Textile Technology and Process Engineering (ITV) at the German Institutes of Textile and Fibre Research Denkendorf (DITF), Denkendorf
www.itv-denkendorf.de
- NMI Natural and Medical Sciences Institute, Universities of Tübingen and Reutlingen
www.nmi.de/en
- Centre for Management Research (DITF-MR) at the German Institutes of Textile and Fibre Research (DITF), Denkendorf
www.ditf.de/en
- Centre for Solar Energy and Hydrogen Research Baden-Württemberg (ZSW), Stuttgart, Ulm
www.zsw-bw.de/en

EASY ENTRY TO AN ACADEMIC CAREER

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.

A STRUCTURED APPROACH TO DOCTORAL STUDIES *Doctorates and programmes*



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.

SPECIAL GRANTS *Funding programmes*



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.

JOBS ONLINE *Job seeking*



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
- www.academics.de
- www.research-in-germany.de
- www.gain-network.org/en
- www.duz-wissenschaftskarriere.de
- <https://euraxess.ec.europa.eu>

Doctoral studies

FIND OUT MORE ABOUT DOCTORAL STUDIES IN BADEN-WÜRTTEMBERG AT:
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 and www.bw-career.de/en/home



Editorial information

Published by: Baden-Württemberg International – Agency for International Economic and Scientific Cooperation

Editorial team: Media and Public Relations

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Graphic design: JUNG:Kommunikation GmbH, www.jungkommunikation.de

Photos: S. U3–U4, S. 2–3: Werner Dieterich/Getty Images; S. 4–5: Westend61/Getty Images; S. 7: Tourismus BW, Manuel Schönfeld/Annette Schindler/jarek106/Jürgen Effner/Fotolia; S. 8–9: Voith GmbH; S. 11: HTW Aalen/Reiner Pfisterer, Dr. Ing. h.c. F. Porsche AG, Trumpf GmbH + Co. KG; S. 12–13: HTW Aalen/Reiner Pfisterer; S. 15: Baschi Bender/Universität Freiburg, Voith GmbH; p. 18: Eberhardt/Universität Ulm; p. 20: Zhu Difeng/Adobe Stock; p. 21: Corinna Spitzbarth Fotografie/ARENA2036; p. 22: Santiago Silver/Adobe Stock; p. 23: Cyber Valley; p. 24: DKFZ/Foto: Peggy Rudolph, Medienzentrum, Universitätsklinikum Heidelberg; p. 25: M2OLIE; p. 26: Petair/Fotolia; p. 28: vcalup/Adobe Stock; p. 29: STRUCTURES; p. 30: Jezper/Fotolia; p. 31: DisobeyArt/Adobe Stock; p. 32: Denis Tabler / Shutterstock; p. 33: Leistungszentrum Nachhaltigkeit Freiburg; p. 42: Hochschule Biberach, HBC/Stefan Sättele; KIT Karlsruher Institut für Technologie, SRH Hochschule für Wirtschaft und Medien Calw

Printed by: Übelmesser Druck

Last updated: July 2020

Baden-Württemberg International 

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We're here to help.

Do you have questions about studying or conducting research in Baden-Württemberg? Are you looking for partners for knowledge-sharing or joint research projects, are you thinking about pursuing your academic career in Baden-Württemberg, or would you like to visit us to gain some first-hand impressions? Then Baden-Württemberg International is here to help: wissenschaft@bw-i.de

Baden-Württemberg International (bw-i) is the centre of competence of the German state of Baden-Württemberg for the internationalisation of business and science. We lend support to domestic and foreign companies, clusters and networks, research institutions and universities as well as to regions and municipalities by serving as the central first point-of-contact in all questions relating to internationalisation.

Baden-Württemberg International



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Baden-Württemberg

The German Southwest.