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Research Report – *Faculties*

2020

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Offen im Denken

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Inhalt

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Dear readers,

The coronavirus pandemic has been upending all aspects of our lives for more than a year now, and it has posed unprecedented challenges to research and teaching at our university.
But thanks to the enormous personal efforts of all UDE members, thanks to their readiness to adapt to the new circumstances and resulting political conditions and find solid, workable solutions at a moment's notice again and again, 2020 has been the most successful research year the University of Duisburg-Essen has ever seen.

Our researchers have secured three new collaborative research centres and extended two existing ones. They have acquired two research training groups, established one research unit headed by UDE and obtained funding from the German Research Foundation's Heisenberg Programme for six researchers. Our cancer research centre has been selected as a site of the National Center for Tumor Diseases (NCT). Now in its 18th year, the University of Duisburg-Essen is consistently achieving outstanding success at the national and international level.

Having expanded the University's central tenure track programme and appointed 23 new WISNA professors, we are delighted about every new colleague who has embarked on the programme in 2020, every new scholarship holder in the NRW academic returnee programme who has decided to return from abroad to join us, and every prestigious prize awarded to the young leaders of research groups at our university.

The newly established Centre for Start-Ups and Innopreneurship, GUIDE, has injected a large dose of dynamism into research transfer across our university. With funding from the EXIST programme of the Federal Ministry of Education and Research (GUIDE regio), additional funding from the state government (GUIDE plus), an interdisciplinary board and fantastic projects from many university members who are enthusiastic about research transfer, GUIDE has achieved visibility within our region and beyond.

These and the many other impressive developments in our research are reflected in the placement of the University of Duisburg-Essen in the Times Higher Education Young University Ranking 2020. We came sixteenth out of all universities in the world that are younger than 50 years, and we are 'the young top university' in Germany .

I would like to thank every single person who has contributed to the successes and developments of 2020, the year of the pandemic. In particular, I am grateful to all our academics who are working on exciting new research projects about COVID-19 at UDE.

Beyond the many initiatives that happened this year, we have also laid the groundwork for

Professor Dr Dr Dagmar Führer-Sakel

success in future endeavours, such as the 2026 Excellence Strategy.

This research report presents the fascinating research taking place at the eleven faculties of the University of Duisburg-Essen.

We hope you enjoy it.
Yours,

Prof. Dr. Dr. med. Dagmar Führer-Sakel
Vice-Rector for Research,
Career Development & Science Transfer

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Illumination

Faculty of Humanities

Every year, the Faculty of Humanities selects one of its many research topics to present in the UDE Research Report. It started this practice in 2014 in order to reflect the full spectrum of its research over time. The present report focuses on projects which approach their subjects from a cultural-studies perspective. While the Faculty maintains a selection of key topics, its scholarly activities also reflect the sheer variety of research interests and approaches with which the humanities seek to understand culture(s). Research in the humanities covers the entire bandwidth of cultural practices, phenomena and artifacts that teach us about history, define the present and shape the future. It ranges from the establishment of broad theoretical foundations to the focused study of highly specialised topics.

Professor Rolf Parr (German Studies/Literary Studies), Professor Peer Trilcke (University of Potsdam), Dr Gabriele Radecke (Literature Archives, Akademie der Künste, Berlin) and PD Dr Julia Bertschik (FU Berlin) are working together to fill a gap in scholarship on Theodor Fontane. There is currently no comprehensive publication dedicated to the full breadth of research into Fontane's multifaceted oeuvre, including texts from his literary estate. The planned compendium will incorporate all of his literary works and texts and the most important pieces of correspondence, discussed in dedicated groups of articles which take into account and depict the cultural contexts, environments and social relations that shaped Fontane's life and work. His artistic output and endeavours will be examined from the perspective of the culture, mentality, collective imagination and intellectual history of the nineteenth century and placed in the context of its cultural traditions. By applying concepts from cultural studies, the publication project 'Theodor Fontane. Ein Handbuch' effectively overcomes the usual problems inherent to compendiums on individual authors. (Funding: Fritz Thyssen Foundation, 2018–2022)

Professor Dietmar Osthus's (Romance Philology/Linguistics) project on Gilles Ménage, the first major French etymologist in the budding Age of Rationalism, is also funded by the Fritz Thyssen Foundation. It is a comprehensive study into the metalinguistic concepts, methods and research interests of this pioneer of French etymology. For a long time, Romance philologists rejected all approaches that predate the comparative method in historical linguistics as academically immature. That view, however, distorts our understanding of historical linguistic scholarship. The project addresses a key issue in the history of etymological research in the francophone world and beyond.

Motif studies

When Foucault points out that to recognize things is to unveil a system of similarities which binds them to each other, he refers to a deeply human activity that also informs literature and literary scholarship. In concrete terms, this is reflected in the recurring theme (in the sense of Christine Lubkoll's 'inhaltliches Muster') of separation from one's parents, a frequent topic in children's and young-adult media that connects Oliver Twist, Harry Potter and countless other characters across genres, styles and types of media. Foucault calls these relationships "knots in a net". The knots correspond to the literary motif, which constitutes a net of narrative media while simultaneously being constituted by them. Professor Tobias Kurwinkel's (German Studies/Literary Studies) project 'Transmediale Motivik' set out to establish a highly selective, operationalisable definition of the concept of 'motif' alongside a model for analysing and typologising motifs in children's and young-adult media. That model, a crucial foundation for all further research in the project, was first presented in a 2019 publication. It also gave rise to a symposium at the University of Duisburg-Essen. The project results are currently being prepared for publication (with funding from the University of Bremen as a focus project).

Cultural heritage

Dr Liane Schüller's (German Studies/Literary Studies) and PD Dr Simone Loleit's (German Studies/Mediaeval Studies) project 'Grimmwelten' examines the Brothers Grimms' 'Children's and Household Tales' from a range of perspectives. Based on an analysis of sources from the Middle Ages and the early modern period which the Brothers Grimm consulted and evaluated while working on their 'Children's and Household Tales', the project involves a series of events during which students engage with medial adaptations of the fairy tales. They study medial transformations of literary texts to understand the difference between written and visual narratives and the significance of various medial codes. There will be a student conference on the 'Grimmwelten' project, and a dedicated Moodle course room will be made available permanently to all students of German Studies.

At the Department of German as Second and/or Foreign Language, Dr Anastasia Moraitis examines the concept of cultural heritage, whose study is an integral part of all research into the past. It is imperative to instil children with an awareness of material and immaterial heritage

and their inevitable relevance to social policy. Within the scope of the occupational internship for teachers in training, her project has primary school pupils stage theatre plays about eras, events and historical figures (e.g., the Germanic peoples in Xanten, Christopher Columbus). The students and pupils work together on the play and its production. (A publication is in preparation.)

Local and regional research

In 2018, the University of Duisburg-Essen (Professor Ralf-Peter Fuchs, Department of History/InKuR Institut für niederrheinische Kultur und Regionalgeschichte) and Horst Palace in Gelsenkirchen entered into a collaborative partnership involving a range of projects, such as joint lectures and a course at the professorship of local history. The latter examined the history of Haus Horst during the early modern period; at the end of the course, the students got to evaluate the results together with the experts on site. In 2021, the lectures and additional texts will be published in a series on the history and art history of Horst ('Horster Beiträge zur Geschichte und Kunstgeschichte', in print). The InKuR also maintains ongoing partnerships with the towns of Xanten, Emmerich, Wesel, Neukirchen-Vluyn and Geldern.

It has a one-year partnership with the Grafschafter Museum at Moers Castle in Moers (2019–2020*21), which is a continuation of an existing collaboration between the Department of German Studies (Professor Gaby Herchert, Mediaeval Studies; InKuR) and the museum. The lecture 'Die Spanier in Moers (1586–1597)' ('the Spanish in Moers'), which marked the signing of the collaboration agreement, will be published soon.

The RING project, a collaboration between Professor Herchert, the Schlosstheater Moers, the Grafschafter Museum and the Nibelungenmuseum Xanten, concluded in 2019. It involved a RING lecture, public readings of the Nibelungenlied in Moers and Xanten, and school projects on the Nibelungenlied and the era in which it is set (publication in print). Following a series of projects on the Black Death in the Middle Ages, a further literary project is planned for 2021. Titled 'Eine Stadt erinnert sich' ('a city remembers'), it explores the topic of migration in collaboration with the author Feridun Zaimoğlu.

In June 2019, nine historians organised a conference on the Allied occupation of the Rhineland after the First World War ('Besatzungsherrschaft und Alltag im Rheinland. Die belgische, britische und amerikanische Besatzung nach dem Ersten Weltkrieg'; Professor Fuchs/Benedikt Neuwöhner; a partnership between the UDE's Professorship of the Local History of the Rhein-Maas Region, InKuR, Niederrhein-Akademie NAAN e.V. and the LVR-Institut für Landeskunde und Regionalgeschichte). The event, hosted in Cologne, focused on the British, Belgian and American occupation, which has received considerably less scholarly attention than the much more widely studied French zone. The attendants discussed the latest insights into the occupiers' ruling strategies, the complex relationships between the occupiers and the occupied, and the everyday realities of the occupation. They also scrutinised the narrative of the occupation as an extension of the war. By working through previously untouched archive materials, the conference revitalised this field of research, establishing a large body of new questions relating to the lived experience of the occupation and the cultural, political, diplomatic and regional history involved. (The conference transcript has been published in the NAAN series of publications).

The year 2018 saw the 200th anniversary of the dissolution of the old University of Duisburg. To mark the occasion, Dr Hendrick Friggemann (University Archives) and Professor Fuchs organised a conference followed by a series of lectures on the history of higher education in Duisburg and Essen in the 2018/19 winter semester. Hosted by the Kultur- und Stadthistorisches Museum Duisburg, it focused on institutional tipping points in the nineteenth and twentieth century and their impact. How did the structures and tasks of regional (higher-)education institutions change? What was the significance of those changes? An anthology will be published in 2021.

Across the border

Many projects at the Professorship of the Local History of the Rhein-Maas Region, The InKuR, and the Institute of Netherlandic Studies reflect the location of Duisburg and Essen in a region that transcends the historical and cultural boundary between Germany and the Netherlands. In partnership with Radboud University Nijmegen (Professor Wim van Moers), the Rhine-Waal University of Applied Sciences (Professor Alexander Brand) and the HAN University of Applied Sciences in Arnhem, the UDE's Junior Professor Ute K. Boonen (Netherlandic Studies) and Professor Fuchs organised the summer school 'Werkstatt an der Grenze' ('a workshop on the border'; 2018–2021; funded by the Dutch Language Union, the Province of Gelderland and others). It is designed as an annual week of projects involving lectures, exercises, excursions and guided tours of the host city, which changes every year (2018: Kleve, 2019: Nijmegen.) The 2020 instalment of the event was going take place in Essen but had to be postponed due to the coronavirus pandemic. Every year, small groups of researchers develop new insights into a range of regionally relevant topics (e.g., cross-border emergency services, Euregio, European energy policy) and presented them to a broad audience. The results are then published in a concluding report (werkstattandergrenze.ruhosting.nl).

Despite the close geographical proximity between Germany and the Netherlands, both sides still subscribe to stereotypes about themselves and the other. Germans are precise and punctual; the Dutch are relaxed and pragmatic. Such clichés can have cognitive advantages, but they also cause communication problems and misunderstandings. Professor Boonen's project 'Unser Bild vom Nachbarn' ('our image of the neighbour') seeks to answer several questions: which stereotypes shape the view of 'the Germans' in the Netherlands and of 'the Dutch' in Germany? How did each image emerge, and how do literature, language classes and other factors shape it? What experiences do pupils and students make in real-life encounters that confront them with (positive and negative) prejudice? To what extent can intercultural communication and intercultural learning help them identify differences without judgement, teach them to appreciate those differences, and qualify stereotypes?

Our Faculty also studies the border itself – as a complex subject area and a spatial, political, geographical, social and cultural boundary. Border research is a dynamic field informed by several disciplines. Albeit occasionally interdisciplinary in nature, the individual studies it produces tend to be received primarily within the individual disciplines that constitute each author's own academic background. Professor Hannes Krämer's and Dominik Gerst's M.A. (Department of Communication Studies) project 'Konturen kulturwissenschaftlicher Grenzforschung' ('outlines of border research in cultural studies') addresses this intriguing relationship and investigates ways of describing borders beyond the boundaries of specific disciplines. It is based at the Viadrina Center B/ORDERS IN MOTION (Frankfurt/Oder), where Professor Krämer is an external associate.

To study borders, scholars need a concept of 'borders' that is rooted in cultural studies and

Dean: Professor Dr Dirk Hartmann

Professors

Anglophone Studies
Professor Dr Vanessa Agnew
Professor Dr Birte Bös
Professor Dr Barbara Buchenau
Professor Dr Isabelle Buchstaller
Professor Dr Florian Freitag
Professor Dr Jens Martin Gurr
Professor Dr Christoph Heyl
Professor Dr Raymond Hickey
Professor Dr Patricia Plummer
Professor Dr Frank Erik Pointner
Professor Dr Josef Raab †
Professor Dr Bernd Rüschoff
Professor Dr Eva Wilden

German as Second and/or Foreign Language
Professor Dr Katja Francesca Cantone-Altıntaş
Professor Dr Heike Roll
Professor Dr Tobias Schroedler

Geography
Professor Dr Inga Gryl
Professor Dr Rudolf Juchelka

German and Netherlandic Studies
Professor Dr Michael Beißwenger
Professor Dr Ute K. Boonen
Professor Dr Heinz Eickmans
Professor Dr Ulrike Haß
Professor Dr Gaby Herchert
Professor Dr Werner Jung
Professor Dr Tobias Kurwinkel
Professor Dr Miriam Morek
Professor Dr Rolf Parr
Professor Dr Alexandra Pontzen
Professor Dr Judith Purkarthofer
Professor Dr Bernhard Schröder
Professor Dr Martin Schubert
Professor Dr Jörg Wesche
Professor Dr Evelyn Ziegler

History
Professor Dr Frank Becker
Professor Dr Markus Bernhardt
Professor Dr Wolfgang Blösel
Professor Dr Stefan Brakensiek
Professor Dr Amalie Fößel
Professor Dr Ralf-Peter Fuchs
Professor Dr Jan C. Jansen
Professor Dr Christoph Marx
Professor Dr Berna Pekesen*
Professor Dr Benjamin Scheller
Professor Dr Ute Schneider

Communication Studies
Professor Dr Hannes Krämer
Professor Dr Jens Loenhoff
Professor Dr Karola Pitsch

Art and Art History
Professor Jörg Eberhard
Professor Dr Gabriele Genge
Professor Dr Birgit Mersmann
Professor Susanne Weirich

Philosophy
Professor Dr Bernd Gräfrath
Professor Dr Oliver Hallich
Professor Dr Dirk Hartmann
Professor Dr Achim Lohmar
Professor Dr Andreas Niederberger
Professor Dr Neil Roughley
Professor Dr Thomas Spitzley

Romance Languages
Professor Dr Stephanie Bung
Professor Dr Helmut C. Jacobs
Professor Dr Alf Monjour
Professor Dr Dietmar Osthus
Professor Dr Daniel Reimann
Professor Dr Volker Steinkamp

Protestant Theology
Professor Dr Thorsten Knauth
Professor Dr Marcel Nieden
Professor Dr Aaron Schart
Professor Dr Folkart Wittekind

Catholic Theology
Professor Dr Dr Hubertus Lutterbach
Professor Dr Ralf Miggelbrink

Turkish Studies
Professor Dr Sevgi Çıkrıkçı
Professor Dr Işıl Uluçam-Wegmann
Professor Dr Kader Konuk
Professor Dr Berna Pekesen*
Professor Dr Hacı-Halil Usluçan

** interdisciplinary professorship*

incorporates a variety of perspectives into its analyses. The field of cultural studies, which unites approaches from the social sciences and humanities with a foundation of cultural theory, provides the vocabulary for that concept. Borders are to be understood as a specific and arbitrary setting of differences. They must be studied as complex relationships with an empirical and theoretical focus on their symbolism, cultural codes, constitutive practices, material presences and technological infrastructures. The project seeks to determine how to plan and execute such a research endeavour.

In this context, Dominik Gerst has dedicated his dissertation project to the understanding of borders in the field of German-Polish security ('Grenzwissen im deutsch-polnischen Sicherheitsfeld', supervisor: Professor Krämer). What linguistic methods are used to discuss the security field of 'the' border? At the centre of this question lies the categorial order of the border, which indicates a historically grown, locally differentiated understanding of borders. Unlike scholars engaging in interdisciplinary border research and border sociology, those with a background in ethnomethodology do not focus on the effects and impact of borders but on the border itself and its various interpretations.

The appeal of the faraway

In 1582, Adam von Schlieben, Counsellor at the Brandenburg Court of Justice, presented a 'letter of recommendation' from the Moroccan Sultan Ahmed Al-Mansur to his employer, the Elector Johann Georg von Brandenburg. The letter was written in artful calligraphy and sprinkled with gold dust. Schlieben had brought it back to Germany from his travels through Europe, the Ottoman Empire and Morocco. But the Arabic text tells us that the letter was not, in fact, intended for Johann Georg. It was addressed to Philip II of Spain. Nobody could read the original text, so Schlieben was able to reinterpret it to his own benefit. Over the course of the following 15 years, his travel experiences earned him multiple missions to the Margraviate of Brandenburg as well as an appointment to the electoral council and, later, the privy council. Ato Quirin Schweizer's (Department of History/Early Modern History) dissertation project examines how Schlieben and other well-travelled contemporaries obtained high ranks and honours by presenting their travel experiences through the prism of material items from faraway lands, effectively using them as cultural capital to fuel their social ascent. (Dissertation title: 'Der Reiz der Ferne. Die Funktionalisierung und Vermittlung von Reiseerfahrung im Fürstendienst in der Frühen Neuzeit'; supervisor: Professor Stefan Brakensiek)

Afrikaans

Within the scope of the global partnership of institutes of German studies (GIP) between the UDE's Department of German Studies and the University of Namibia in Windhoek, Professor Boonen, Dr Bernhard Fisseni (Leibniz Institute for the German Language) and Professor Herman Beyer (UNAM) collaborated on a variety of projects related to the Afrikaans language. Their work produced multiple joint lectures presented at the GIP conference in July 2019 and a variety of publications. All results will be presented successively at www.uni-due.de/germanistik/afrikaans/start. The research partnership will continue beyond the end of the GIP in 2019.

Like composition and derivation, conversion is considered a productive word formation process. It occurs in German, Dutch and Afrikaans. But there are striking differences between the three West Germanic languages: Dutch employs forms such as zij pint, ik hockey or jij volleybalt, which must be expressed through paraphrasis in German and Afrikaans : sie zahlt mit Karte, ich spiele Hockey, du spielst Volleyball and hy betaal met 'n bankkaart, ek speel hokkie, jy speel vlugbal. The loss of inflections in Dutch may play a role in the productivity of the process, but it fails to explain why Afrikaans, another language with little inflection, does not use conversion. Another set of conversion-like expressions, such as the Dt. klappertanden, Afr. klappertand; Dt. knipogen, Afr. knipoog (literally: to chatter-tooth, i.e., 'have chattering teeth' and to wink-eye, i.e., 'wink at'), occurs in Dutch and Afrikaans but not German. These expressions are left-hand headed and, as such, violate the generally accepted right-hand head rule, by which the right-hand word constitutes the head of a compound. Professor Boonen's project 'Konversion kontrastiv' is a detailed comparative study of the status of this word formation process in the Germanic languages.

Urban research

A large body of texts shaped the townscapes of the Holy Roman Empire and other European regions. Besides impermanent writings, it also included engravings on various solid materials, which inscribed condensed knowledge directly into the urban space. The project 'The Written Town. The Knowledge of Urban Inscriptions in Early Modern Times' focuses on the function of such engravings as well as the historicity of their content. How does the store of knowledge that is bound to objects constitute truth; how does it generate meaning? The background of

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Reflection

the projects is the idea of towns and cities as text and of urban inscriptions as a form of cultural meaningfulness. Dr Teresa Schröder-Stapper's (Department of History) project, which is funded by the German Research Foundation (DFG), focuses on the regulatory function of inscriptions located in time and space in a seemingly confusing town. It seeks to decipher the internal and external reference system of urban inscriptions – their time-bound, urban code. To do so, the project combines multiple approaches from the field of cultural studies. In applying ideas of urban semiotics to a historical research object and combining it with practice theory, the project enters uncharted waters.

Nina Szidat's (Department of History/Social and Economic History) dissertation project, 'An „active promotion of the European ideal"? References to Europe in British-German town twinning' (supervised by Professor Ute Schneider) examines the significance of such relationships in the dynamic space where political, economical and diplomatic interests overlap, using selected partnerships between West German and British towns as case studies. Most scholarship in contemporary history focuses on Europe as a network of institutions. Nina Szidat's project departs from that narrative to study Europe as it is experienced by those who live in it. Since 1955, the Council of Europe has awarded the Europe Prize to towns and cities that have demonstrated exceptional commitment to the European ideal. The establishment and maintenance of town partnerships has always been an important aspect of that ideal. Town partnerships shine a light on the interrelations between European institutions and municipal interests. To incorporate the potential foreign-policy dimension of town partnerships into the project, Szidat also provides a comparative study of cases in which East German towns are twinned with British ones. Based on the observation that the selection of twin towns and the format of the resulting partnerships tends to unveil a certain inherent logic of the places involved, the project explores the negotiation processes taking place between the local, regional, national and international level.

Theological research

Professor Hubertus Lutterbach's (Department of Catholic Theology/Historical Theology) project 'Archaische Religiosität in der Gegenwart' ('archaic religiosity in the contemporary world') applies the theory of the axial age to a selection of primitive religious phenomena that are currently being covered in the German-language and global media. The author first compares them to parallel phenomena which occurred in our cultural sphere during the Early Middle Ages. Second, he explores the equivalence of related phenomena in high forms of religion, such as material offerings vs. offerings to the Immaculate Heart; dynastic sanctity and sanctity of kinship vs the unity of the universal human family etc.) His comparisons show that phenomena of primitive and higher religiousness still coexist in our own modern culture. This surprising expansion of our perspective, which is highly relevant from the perspective of religious history, makes a crucial contribution to our mutual understanding in a world that is shaped by religions and religious conflicts in many ways. It is indispensable for human-rights activists, people working in interfaith contexts, peace activists and those with an interest in ecumenism. The planned publication aims to contribute to interfaith and intercultural dialogue from the perspective of cultural studies.

To what extent do schools in socially precarious environments recognise the connection between religion, poverty/social deprivation and religious and cultural diversity brought about by migration? How do they react to it? Professor Thorsten Knauth's and Silke Reindl's (Protestant Theology/Religious Pedagogy) project 'Religion, Armut und Migration in Schulen. Grundlagen einer armutssensiblen Religionspädagogik der Vielfalt' seeks to answer this question. It is based at the research training group 'Querschnittliche Fragen der Lehrerbildung sowie Schul- und Unterrichtsentwicklung' ('a cross-section of issues in teacher training, school development and lesson planning'). Using qualitative and empirical studies, the researchers reconstruct possibilities and limits inherent to ways in which (religious) pedagogy can overcome 'difficult diversity'. The project also aims to develop a model of diversity-focused religious pedagogy that takes the realities of schools and poverty into account.

Museum-based learning

Cultural and aesthetic education in teaching and learning contexts is an important research cluster at the Department of German as Second and/or Foreign Language. Faculty member

Selected Publications

Borghardt, D., S. Maaß, A. Pontzen (ed.) (2020): *Literaturpreise. Geschichte, Theorie und Praxis. Würzburg: Königshausen & Neumann.*

De Boer, J.-H. (ed.) (2019): *Praxisformen. Zur kulturellen Logik von Zukunftshandeln" (Kontingenzgeschichten 6), Frankfurt a.M.: Campus.*

Gerst, D., H. Krämer, R. Salomon (2019): *Harold Garfinkel's „Studies in Ethnomethodology". An Interview Issue. In: Forum Qualitative Sozialforschung / Forum: Qualitative Social Research 20 (2), www.qualitative-research.net/index.php/fqs/issue/view/64*

Gerst, D., M. Klessmann, H. Krämer (2020): *Grenzforschung: Handbuch für Wissenschaft und Studium. (Baden-Baden: Nomos. Border Studies. Culture, Spaces, Orders. 3.).*

Graf, D., Y. Fadeeva, K. Falkenstein-Feldhoff (ed.) (2020): *Bücher im Open Access. Ein Zukunftsmodell für die Geistes- und Sozialwissenschaften? Opladen: Barbara Budrich. OA-Ausgabe unter https://duepublico2.uni-due.de/receive/duepublico_mods_00071113.*

Gryl, I., C. Scharf (2019): *Fostering Valuable Participation in Shaping Spaces and Societies: Towards Creating an Ethical Meta Level in the Model Design for Innovativeness. In: GI_Forum 2, 180–193.*

Gryl, I., M. Lehner (2019): *„Neoliberalismus". Diskussion eines Grundbegriffs zur Analyse sozioökonomischer Gegenwart und zur Reflexion von Bildungsinhalten. In: GW-Unterricht 155 (3), 5–16.*

Gür-Şeker, D. (Hg.) (2020): *Wörter, Wörterbücher, Wortschätze. (Korpus-) Linguistische Perspektiven. Duisburg: Universitätsverlag Rhein-Ruhr.*

Knauth, Th., W. Weiße (ed.) (2020): *Ansätze, Kontexte und Impulse zu dialogischem Religionsunterricht. Münster/New York: Waxmann.*

Kurilla, R. (2020): *Everyday Life Theories of Emotions in Conflicts from Bali, the Spanish Basque Country, and the German Ruhr Area. In: Frontiers in Psychology, www.frontiersin.org/articles/10.3389/fpsyg.2020.01339/full*

Kurwinkel, T., P. Schmerheim (ed.) (2020): *Handbuch der Kinder- und Jugendliteratur. Unter Mitarbeit von S. Jakobi. Stuttgart: Metzler.*

Marx, C. (2020): *Trennung und Angst. Hendrik Verwoerd und die Gedankenwelt der Apartheid, Berlin: De Gruyter.*

Michaelis, A. (2019)*: Die Zukunft der Juden. Strategien zur Absicherung jüdischer Existenz in Deutschland (1890–1917). (Kontingenzgeschichten 7), Frankfurt a.M.: Campus.*

Pitsch, K., P. Bachmann, M. Dudda (2020): *‚Triage' in Mass Casualty as Situated Interaction. Algorithm and Participation. ECSCW, Siegen, 10.18420/ecscw2020_p05.*

FOR 2600 UND AMBIGUITÄT UNTERSCHEIDUNG

DFG research unit 2600, 'Ambiguity and Distinction. Historical and Cultural Dynamics'

What happens when phenomena are ambiguous? How do individuals, groups and societies handle situations in which the distinctions with which they normally navigate life meet ambiguous phenomena? Why do attempts to establish order with seemingly clear distinctions frequently produce the very ambiguities they were meant to overcome? Established in early 2019, the DFG-funded research unit 2600, 'Ambiguität und Unterscheidung. Historisch-kulturelle Dynamiken' (spokesperson: Professor Benjamin Scheller), explores those and related questions.

Sub-projects:

1: Gender Ambiguity in Media Coverage in the Federal Republic of Germany from the 1970s to the Turn of the Millennium
Professor Frank Becker (project leader)/Max Keilhau/Torben Trellkamp

2: 'Neophytes', 'Renegados', 'Creoles': Dynamics of (Dis)ambiguation in Early American Discussions of the Transition from Colonialism to Nationhood
Professor Barbara Buchenau (project leader)/Dr Elena Furlanetto/Phillip Grider

3: Contemporary Art in Istanbul: Ambiguity in Spatial and Pictorial Politics Between Religion and the State
Professor Gabriele Genge (project leader)/Eva Liedtjens

4: Religious Ambiguity in Turkey's Literatures from 1923 to the Present: A Yardstick f or an Open Society?
Professor Kader Konuk (project leader)/Dr Gulbin Ergunes/Dr Zeynep Tüfekçioğlu/Davut Yeşilmen

5: Between Black and White: South Africa's Coloureds and Apartheid
Professor Christoph Marx (project leader)/Amad Hamid

6: Unveiling Orientalism: Ambiguity in British Travel Discourse of the Long Eighteenth Century
Professor Patricia Plummer (project leader)/Cinja Bösel/Syed Kazim Ali Kazmi

7: The Sea of the New Christians: Mobility and Ambiguity of Converted Jews and their Descendants in the Late Medieval and Early Modern Adriatic
Professor Benjamin Scheller (project leader)/Marcel Müllerburg/Dr Nicolò Villanti

8: Undetermined Baroque Poetry. Poetic and Confessional Ambiguity in Silesia as Cultural Dynamic Factors of a New German Poetry (1620–1742)
Professor Jörg Wesche (project leader)/Julius Thelen

Dorota Okonska is working on a dissertation on art as a source of inspiration in learning German as a second language ('Kreative Impulse zum Lernen des Deutschen als Zweitsprache. Eine empirische Untersuchung zu sprachfördernden Ansätze des Projekts Sprache durch Kunst', supervised by Professor Rupprecht S. Baur). Encounters with art, the project assumes, enable pupils to express themselves as individuals: they find their way to language and back from language to art. The dissertation examines the interrelation between the museum as a place of learning outside of school and language pedagogy as it is applied in school contexts. Based on linguistic data, the researcher analyses under which conditions migrant children can be motivated to learn and make progress at school through new methodological approaches.

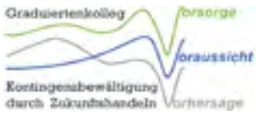
Dr Andrea Schäfer-Jung has also dedicated her research to museums as a site of learning outside of (pre-)school, focusing on aesthetic sources of learning. Her target group are pre-school children in nursery settings who are being prepared for entering primary school. Through encounters with works of art in and around the museum, the children foster their sense of aesthetics and are encouraged to engage with different materials and creative forms of expression. Targeted artistic practice linked closely to the integrated development of children's lexicon and grammar holistically promotes the acquisition of spoken language.

Kitsch

When art and so-called emotional kitsch are contraposed, reflexivity is usually attributed to just one side: art. The contrast is seemingly clear. But this alleged clarity neglects the multitude of intermediate stages of reflexivity. If we focus on those subtle differences instead, we can see how kitsch employs various forms of reflexivity to evoke emotional experiences in a large audience. Dr Thomas Küpper's (German Studies/Literature and Media Practice) post-doctoral Habilitation thesis 'Bewusst im Paradies. Zur Reflexivität von Kitsch' ('awareness of Paradise. On the reflexivity of kitsch') uses examples from literature, visual art, film, television, music and tourism to examine this reflexivity. His objective is not to revaluate kitsch by ascribing to it a form of reflexivity that meets the criteria of high culture. Rather, he explores the programmatic standards that kitsch sets for itself. It is those very standards that are visible in its reflexivity, its self-description (2017–2020).

Culture of work

The changing world of work has plunged the traditional definition of the concept of work into crisis. We can observe the corresponding transformation processes particularly well in the cultural and creative industries, which tend to undergo developments in the labour market before all other sectors, making them early indicators of work-related trends. While this significance of the cultural and creative industries has been observed on various occasions, there are no well-developed, systematic analyses of this field of work to date. Professor Hannes Krämer is the



DFG research training group 1919: 'Precaution, Prevision, Prediction: Managing Contingency'

How can actions overcome contingency, and how do humans perceive the relationship between their present thinking and acting and their uncertain (or perceived-as-certain) future? Since 2013, these highly topical questions have been the research domain of the historians in the DFG research training group 'Precaution, Prevision, Prediction: Managing Contingency' (spokesperson: Professor Stefan Brakensiek/ Professor Benjamin Scheller). The third cohort began their work on 1 November 2019.

More information: www.uni-due.de/graduiertenkolleg_1919/grako1919-start.php

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Advance

project manager of the DFG network 'Artistic and Creative Labour. Network for the Study of Practices of Work and Organisation within the Cultural and Creative Industries'. It is an association of academics researching the relationship between culture and work in contemporary capitalism. Taking a comparative approach, the project systematically puts its members' empirical studies into context in order to categorise specifics of the practice and structure of cultural creative work, thereby advancing the concept of 'work'. The project also includes activities aimed at defining the international position of specifically German discourses and, subsequently, the incorporation of that position into the international discussion about cultural and creative work (2017–2021, publication in preparation).

Reason and law

In his dissertation project on the intellectual history of contractualism ('Der Vernunftbegriff des Rechts. Die systematische Problemgeschichte des Kontraktualismus', supervisor: Professor Dirk Hartmann), Sven Ender M.A. (Department of Philosophy) provides proof that the reciprocity of the legal relation cannot arise from contractualism. Instead, it is a prerequisite for the contractual basis of the law. Fichte justifies the condition of reciprocity independently of the conclusion of any contract. He subsequently demonstrates, using a fictional contract as an example, what legal obligations are meaningful in realising the condition of reciprocity. The best contractualist, then, is simultaneously the best critic of contractualism. The work addresses objections to modern contractualism by highlighting that a universalist, normative philosophy of law is feasible and can help us avoid cultural relativism.

Conspiracy – surveillance

Professor Boonen, Dr Derya Gür-Şeker (Department of German Studies/Linguistics) and Michael Wentker M.A. (Department of Anglophone Studies/Linguistics) are jointly working on an article about memes and their form and function in the discourse of conspiracy theories. It will be published in the compendium 'Conspiracy Discourse' (ed.: Ruth Breeze, Massimiliano Demata et al.). A funding application for further research into conspiracy discourse has been submitted.

How has the media shift over the past decades transformed surveillance? How has it been internalised in terms of self-surveillance, self-control and self-optimisation? These are the questions addressed by the project 'Literatur und Überwachung' (Dr Liane Schüller/Professor Werner Jung), which incorporates approaches from literary studies, cultural studies and media studies. It explores whether and how we can trace a shift in the media of surveillance. Of course, the media that are used to exert control provoke different narratives and depictions at different points of history. The researchers set out to investigate whether the media shift in the surveillance technologies, then, gives rise to a media shift or a shift in the utilisation of media in the arts.

Artificial intelligence

The social consequences of artificial intelligence (AI) is widely discussed not just in the spheres of science and business but also in the media. Dr Gür-Şeker's project 'Künstliche Intelligenz und die Zukunft der Arbeit. Wie KI in den Online-Medien und Social Media dargestellt und wahrgenommen wird' focuses on the way in which AI and the future of work are covered in German online media, online newspapers and social media. The study also analyses the issue from the perspective of media users, including current and future employees who discuss AI online. Dr Gür-Şeker aims to analyse linguistic factors, sentiment and attitudes across the relevant media by examining the used words and contexts (e.g., negative or positive language), thought patterns (e.g., arguments employed) and images (e.g., visualisation of robots etc) systematically (funding: Otto Brenner Stiftung, 2020–2021).

What is hidden behind the term 'artificial intelligence'? How does our own university conduct its research into AI? An interfaculty lecture series on artificial intelligence ('Künstliche Intelligenz zwischen Algorithmen und sozialen Praktiken. Interdisziplinäre Perspektiven') organised by Dr. Gür-Şeker in the summer of 2020 provided an overview of the perspectives, methods and approaches to KI that are being researched, developed and/or applied at UDE. In 13 online lectures, listeners gained insight into current projects from eight faculties and got to know the interdisciplinary research area of AI.

Innovativeness

Professor Inga Gryl's (Institute of Geography/Institute of General Studies) research group focuses on the study of innovativeness. In societies that are constantly changing at an ever-accelerating pace, the popular term of 'innovation' simultaneously describes present conditions and future goals. Not only is it extremely multi-layered and complex, it is also highly charged from a cultural and normative point of view. The ongoing project on the social implications of innovativeness ('Innovativität vor dem Hintergrund der gesellschaftlichen Implikationen von Innovation') aims to shine a light on the term (with reference to concepts such as network theory, action theory and the ethics of responsibility), evaluate it in light of current issues (e.g., sustainability) and, by doing so, make innovativeness – the ability to make qualified contributions to social innovation processes – available to educational processes in consideration of the social conditionality of education.

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Faculty of Social Sciences

The Faculty of Social Sciences employs around 240 academics: 35 professors and 205 research associates. It also has more than 3,000 students, making it one of the largest social-sciences faculties in Germany.
Five institutes make up our faculty: the Institute of Political Science (IfP), the Institute of Sociology (IfS), the Institute of Socio-Economics (IfSO), the Institute of Work, Skills and Training (IAQ), and the Institute of Development and Peace (INEF). The latter two are pure research institutes. With this structure, we cover the full range of the modern social sciences—political science, sociology and socio-economics—and their methodologies.
Our main function is to conduct empirical research underpinned by a solid theoretical framework. Normative research methods ensure the relevance of our academic work and allow our scholars to reflect on their empirical results. With our fundamental research, we make a visible contribution to national and international academic discourse and commit ourselves to high-quality scholarship that tackles current issues in the social sciences. Finally, our applied research efforts allow us to take social responsibility by improving social, political and economic structures and processes in collaboration with our partners outside of academia.

Key research areas and partnerships

The disciplines of our faculty reflect the complexity of the social structures it studies. We have clear specialisms both within the institutes and across the faculty.

The Institute of Political Science conducts research in global governance and area studies, comparative political attitude and behavioural research, governance in Germany, the EU, East Asia and Africa, comparative democracy and democratisation studies, elections, political parties, media and parliaments in Germany, peace and conflict studies, political education and transfer.

The Institute of Sociology focuses on comparative society studies and transnationalisation, migration and participation, family and ways of life, social inequality and gender, labour markets, social mobility and social security, work, organisation, technology, advanced methods of empirical social research, societal and social theory.

The Institute of Socio-Economics specialises in measuring inequality, work, social policy and ecology, growth models, digital and technological transformation, political and social consequences of socio-economical problems, public finance and economic policy, socio-economics and socio-economic education.

The Institute of Work, Skills and Training is organised into the following research departments: Employment, Inclusion, Mobility (AIM), Working Time and Work Organisation (AZAO), Education, Development, Social Participation (BEST), Flexibility and Security (FLEX).

The Institute of Development and Peace (INEF) works on the following three research fields within the scope of its current programme, 'Ordering and Responsibility in the Shadow of Hierarchies': transnational governance and individual responsibility, developmental partnerships in the era of the Sustainable Development Goals (SDGs), resistance and political ordering.

Many cross-institute collaborative research projects are conducted in these fields, some of which involve other central research institutions of the University, such as the Institute of East Asian Studies (IN-EAST), the Interdisciplinary Centre for Integration and Migration Research (InZentIM), the Käte Hamburger Kolleg/ Centre for Global Cooperation Research (KHK/ GCR21), the Rhein-Ruhr-Institut für Sozialforschung und Politikberatung e.V. (RISP) and the research profile 'Transformation of Contemporary Societies'.

Research highlights in 2019/2020

The following research highlights from the past two years give insight into our faculty's diverse projects and funding sources:

ERC Consolidator Grant 'The Ties that Bind: Experimental Analyses of Political Solidarities in Modern European Democracies' (POLITSOLID)

Professor Achim Goerres's (IfP) project POLITSOLID examines why some citizens of European nations are more inclined than others to bear the cost of state redistribution schemes. Using experimental methods, his study aims to model various political solidarities at the individual and macro level in order to improve behavioural predictions. The project is funded by the European Research Council with 2 million euros between 2020 and 2025. It was the first political-science project in Germany to be awarded a Consolidator Grant.

DFG project 'Role Change and Role Contestation in the People's Republic of China: Globalization of "Chinese" Concepts of Order?'

Professor Nele Noesselt's (IfP) research project highlights the global implications of the institutional reforms and the restructuring of the Chinese developmental trajectory which have taken place since 2013. The Deutsche Forschungsgemeinschaft (German Research Foundation, DFG) has allocated 585,000 euros in funding to the project for 2014–2024.

BMBF collaborative project 'Radical Islam versus Radical Anti-Islam (RIRA). Social Polarisation and Perceived Threats as Drivers of Radicalisation and Co-Radicalisation among Young People and Post-Adolescents'

German society has become increasingly polarised over the past years as various social groups continue to undergo processes of mutual alienation and rejection. Prejudices against social groups correlate with the perception of the 'other'

Professors

Professor Dr Gerhard Bäcker
Professor Dr Helen Baykara-Krumme
Professor Dr Ulrike Behrendt
Professor Dr Christoph Bieber
Professor Dr Andreas Blätte
Professor Dr Gregor Bongaerts
Professor Dr Gerhard Bosch
Professor Dr Martin Brussig
Professor Dr Florian Coulmas
Professor Dr Tobias Debiel
Professor Dr Nicolai Dose
Professor Dr Marcel Erlinghagen
Professor Dr Jörg Faust
Professor Dr Achim Goerres
Professor Dr Thomas Haipeter
Professor Dr Christof Hartmann
Professor Dr Thomas Heberer
Professor Dr Gustav Horn
Professor Dr Michael Kaeding
Professor Dr Jakob Kapeller
Professor Dr Ute Klammer
Professor Dr Frank Kleemann
Professor Dr Axel Klein
Professor Dr Dr Karl-Rudolf Korte
Professor Dr Sabine Manzel
Professor Dr Paul Marx
Professor Dr Manfred Mai
Professor Dr Dirk Messner
Professor Dr Hannes Mosler
Professor Dr Nele Noesselt
Professor Dr Susanne Pickel
Professor Dr Sigrid Quack
Professor Dr Miriam Rehm
Professor Dr Theresa Reinold
Professor Dr Rainer Schnell
Professor Dr Karen Shire
Professor Dr Petra Stein
Professor Dr Anja Steinbach
Professor Dr Sybille Stöbe-Blossey
Professor Dr Till van Treeck
Professor Dr Achim Truger
Professor Dr Anja Weiß

as a threat. The (perceived) threat of radical Islam plays an important role in these processes. It has paved the way for a reciprocal spiral of potential radicalisation in German society, and youths and young adults are at particular risk. The proposed project takes an interdisciplinary, transdisciplinary, interreligious, multimethodological and empirical approach to previously unexamined interrelations of social aspects inherent to such a spiral of radicalisation. The results will inform preventive measures for the educational sector. Headed by Professor Susanne Pickel of the Institute of Political Science, the collaborative project is funded by the Federal Ministry of Education and Research with 2,470,000 euros between 2020 and 2024.

EU collaborative project 'sEnECA – Strengthening and Energizing EU-Central Asia Relations' in the EU Horizon 2020 programme

Headed by Professor Michael Kaeding (IfP) and Dr Karin Böttger (Director of the Institute for European Politics, Berlin), the international consortium was made up of twelve organisations from the EU and Central Asia. It realised three concrete objectives over the project duration. Firstly, it has established a transdisciplinary network of academics working on European integration in Central Asia and on Central Asian topics in Europe. Secondly, the participating researchers advised and informed the revision of the EU Central Asia Strategy. Thirdly, the project partners contributed to the expansion of existing relations. The SEnECA project received 1.5 million euros of funding from the EU's Horizon 2020 programme from the beginning of 2018 to the end of 2019.

DFG project 'German Emigration and Remigration Panel Study (GERPS)' in partnership with the Federal Institute for Population Research

In collaboration with the Federal Institute for Population Research, Professor Marcel Erlinghagen (IfS) is conducting a large-scale empirical study into the impact of international migration on the further course of migrants' lives. His case studies involve people who have emigrated from Germany and returned. The project examines the consequences of international migration on the basis of traditional distinctions used in social structure analysis and inequality studies. It is funded by the Deutsche Forschungsgemeinschaft (German Research Foundation) with 2 million euros from 2018 till 2021.

DFG project 'Organizing Creativity under Regulatory Uncertainty: Alternative Approaches to Intellectual Property'

Regulatory uncertainty about intellectual property rights is ubiquitous in creative and innovative processes. Originally implemented to foster creativity by granting copyrights and patents to creatives and allowing them to make reliable estimates about future proceeds, IP rights have gradually become a source of uncertainty. This project examines practical strategies for overcoming IP-related doubts during creative processes. It aims to develop an empirical and conceptual microfoundation of these opposing forces. Professor Sigrid Quack's (IfS) study is part of the DFG research unit 'Organized Creativity', coordinated by Professor Jörg Sydow (Freie Universität Berlin) and funded with 218,342 euros between 2016 and 2020.

DFG project: 'Family Models in Germany (FAMOD)'

Professor Anja Steinbach's (IfS) project examines the situations of mothers, fathers and children in various family models, focusing on the well-being of the individual family members. Her standardised, large-scale study surveys members of 1,500 families living in a variety of family structures. In collaboration with Professor Tobias Helms (University of Marburg), she focuses on issues of family sociology as well as legal questions. The DFG provided 960,000 euros in funding to the project between 2018 and 2021; an application for renewal has just been approved.

DFG Research Unit: Multi-Sectoral Regional Microsimulation Model

The multi-sectoral regional microsimulation model (MikroSim) seeks to answer questions such as: which regions are currently experiencing a shortage of care staff or are at risk of such a shortage? Does urbanisation impoverish rural areas? To what extent can the expansion of digital infrastructure counteract that development? Besides labour requirements in the care sector and the integration of migrants into the labour market, MikroSim can analyse issues such as the acute shortage of doctors or income growth in Germany. The Research Unit is represented by its spokesman, Professor Johannes Kopp (Trier). Professor Reiner Schnell (vice-spokesman) and Professor Petra Stein (both of the IfS) are members. The DFG has allocated two million euros in funding to the project for 2018–2021.

NRW-Rückkehrprogramm for postdoctoral researchers returning to North Rhine-Westphalia: 'Der Einfluss sozialer Probleme auf politische Integration in Deutschland und in vergleichender Perspektive' (The impact of social problems on political integration from a domestic and comparative perspective)

Professor Paul Marx (IfSO) is the first social scientist to join the University of Duisburg-Essen within the scope of the NRW-Rückkehrprogramm, an initiative encouraging postdoctoral researchers to return to North Rhine-Westphalia from abroad for their further research. He previously worked at the University of Southern Denmark in Odense, where he studied the political causes and consequences of changes in the labour market. His research project focuses on the political integration of people with socio-economic problems and the effect of poverty, unemployment and a precarious livelihood on

Dean: Professor Dr Petra Stein

Selected Publications

Bosch, G., F. Hüttenhoff, C. Weinkopf (2019): *Kontrolle von Mindestlöhnen. Wiesbaden: VS Verlag für Sozialwissenschaften.*

Stöbe-Blossey, S., K. Köhling, P. Hackstein, M. Ruth (2019): *Integration durch Bildung als Kooperationsaufgabe. Potenziale vorbeugender Sozialpolitik. Wiesbaden: VS Verlag für Sozialwissenschaften.*

Erlinghagen, M. (2019): *Employment and its Institutional Contexts. Kölner Zeitschrift für Soziologie und Sozialpsychologie: KZfSS, 71 (1), 221–246.*

Mayer, S. (2019): *Ideological congruency, social group linkage or the best-evaluated party of all? Why partisans identify with a political party. Quality and Quantity 53 (1), 297–313.*

Noesselt, N. (2020): *A presidential signature initiative: Xiong'an and governance modernization under Xi Jinping. Journal of Contemporary China, doi: 10.1080/10670564.2020.1744378*

Quack, S. (2019): *From the Hope of Transcendence to Dreams of Domestication? Review Symposium On Tim Bartley's 'Rules without Rights: Land, Labor and Private Authority in the Global Economy'. Socio-Economic Review 18 (1), 295–308.*

Steinbach, A., M. Silverstein (2019): *The Relationship Between Religion and Intergenerational Solidarity in Eastern and Western Germany. Journal of Family Issues 41 (1), 109–130.*

Vüllers, J., R. Krtsch (2020): *Raise your voices! Civilian protest in civil wars, Political Geography, 80 (June) (online first). https://doi.org/10.1016/j.polgeo.2020.102183*

Witting, A., F. Brandenstein, K. Satoh (2020): *Introducing an egocentric method to explore information flow in a postflood governance network. Environmental Policy and Governance: 1–13, doi: https://doi.org/10.1002/eet.1885*

Zuazu, I. (2019): *The growth effect of democracy and technology: An industry disaggregated approach. European Journal of Political Economy 56, 115–131.*

political apathy and radicalisation. The Ministry of Innovation, Science and Research of North Rhine-Westphalia is funding the project with 1.2 million euros for a five-year period.

Research group: 'Migration und Sozialpolitik' (migration and social policy, MigSoz)

Overseen by Professor Ute Klammer and coordinated by Dr Thorsten Schlee (both of the IAQ), this early-career research group examines how municipalities and local authorities react to an influx of refugees and how refugees utilise (or fail to utilise) the structures available to them. The group comprises two post-doctoral Habilitation thesis projects and two doctoral dissertations each at the IfP and the IfS. They focus on a variety of sociopolitical topics (labour, education and healthcare) and examine specific population groups (displaced women, people from sub-Saharan Africa, refugees with a history of substance abuse). The funding network for interdisciplinary social-policy research of the Federal Ministry of Labour and Social Affairs has allocated 1,125,000 euros in funding to the project from 2017 to 2022.

DSF project: 'Parteienwettbewerb und kollektive dschihadistische Radikalisierung in Subsahara-Afrika' (party competition and collective jihadist radicalisation in sub-Saharan Africa)

The region-specific conditions that enable collective radicalisation and the resulting development of jihadist milieus have been studied to a great extent. They include the post-colonial emergence of a puritan reform Islam grounded in Salafism, the socio-economic and political marginalisation of Muslim populations, and pre-existing dynamics of secular polarisation. Meanwhile, researchers have paid considerably less attention to conditions that foster 'non-radicalisation'. Professor Christof Hartmann's (INEF) project approaches this research gap by examining the preventive potential of party competition in a selection of sub-Saharan countries. It is funded by the Deutsche Stiftung Friedensforschung (German Foundation for Peace Research) with 108,000 euros between 2020 and 2022.

Selected prizes and awards won by the Faculty:

- Prof. Christoph Bieber: Thomas Mann Fellowship
- Dr Lea Elsässer: Wilhelm Liebknecht Prize 2019 of the City of Giessen
- Prof. Michael Kaeding: Carl Schurz Professorship 2019/2020 at the University of Wisconsin-Madison, USA
- Prof. Jakob Kapeller and Claudius Gräbner: Kapp Prize 2020 for their article 'structural Change in Times of Increasing Openness: Assessing Path Dependency in European Economic Integration'
- Prof. Ute Klammer: First-Class Order of Merit of the Federal Republic of Germany for achievements in academic policy consultation
- Dr Jonas Klingwort: Gerhard Fürst Prize of the Federal Statistical Office of Germany for the best doctoral dissertation in official statistics
- Dr Jutta Schmitz-Kießler: Research Prize of Forschungsnetzwerk Alterssicherung (FNA)
- Dr Daniela Strüngmann: UDE Dissertation Prize 2020
- Prof. Achim Truger: Kurt Rothschild Prize 2020 of the Austrian Renner Institute

Transfer and sustainability

All five institutes of our Faculty recognise their social responsibility. Knowledge transfer and intensive exchange with social, political and industry stakeholders are a key element of their research. Our transfer work focuses on science and research communication with the interested (professional) public both on a dialogue basis and through educational and participatory formats. Knowledge transfer will continue to be a priority to our Faculty as we strive to make our research results available to the public and decision-makers and shape public discourse.

Our transfer activities comprise a wide range of science communication instruments, including political consulting in the strict sense, provision of expert opinions, information transfer and classification of developments in the (social) media and through other formats aimed at the general public, scientific supervision of policy consulting, networking and engaging with various stakeholders, application-oriented research projects with transfer components, field research and teaching projects involving local players, many training and professional-development programmes (including digital formats) and a large variety of publications aimed at the general (professional) public.

The IAQ, for instance, publishes three online publication series: its regular IAQ Report, which briefly and comprehensibly discusses the Institute's research results, IAQ Research containing longer research reports, and IAQ Standpunkt, a series in which employees of the Institute discuss current issues. This is in addition to its specific publications, such as the age transition report issued as part of the Age Transition Monitor system, some of which are published over the course of several years.

In recent years, the NRW School of Governance and the CIVES! School of Civic Education have bundled some of their research topics into broad categories to give specific external target groups greater insight into their relevant competences. The NRW School of Governance, for instance, offers the Master of Public Policy, a part-time career development course aimed at decision-makers and young professionals working in administrative bodies, political parties, associations, companies and the media. With its CIVES! School of Civic Education, the Faculty makes a significant contribution to boosting the visibility and profile of teacher education at UDE.

Transfer through policy consulting: German Council of Economic Experts

Professor Achim Truger of the Institute of Socio-Economics is a member of the German Council of Economic Experts. He provides knowledge transfer services in the form of high-ranking policy consultations to the Federal Government. As one of the five members of the advisory council for economic policy, he has recently been a key contributor to the 2020/2021 annual expert report, presented to the Chancellor in November 2020, a special report on carbon pricing in July 2019, and a special report on the coronavirus pandemic in March 2020.

Applied-research projects constitute another key component of the Faculty's academic transfer activities. The INEF has achieved great success in acquiring high-ranking research and consultancy projects in the past years, including a flagship project on human rights, corporate responsibility and sustainable development and a project on escaping poverty, vulnerability and food insecurity. Both are funded by the Federal Ministry of Economic Cooperation and Development. In its evaluation on the research discipline of peace and conflict studies, the German Council of Science and Humanities has lauded the INEF not only for its success in securing external funding but as a positive example in the field of transferring practically relevant knowledge.

Transfer through applied research 'ONEWORLD No Hunger'

Since October 2015, the Federal Ministry of Economic Cooperation and Development has been funding a study into ways of helping the world's poorest to escape extreme poverty, vulnerability and food insecurity through developmental aid from the Federal Government. It is part of the initiative 'ONEWORLD No Hunger'. During the first round of funding between 2015 and 2020, the INEF-based project received 1.15 million euros from the Ministry. The second round of funding began in 2020 with a contribution of 600,000 euros.

The research results inform further projects at the INEF, the 'AVE Studies' series, and the compact 'AVE Good Practice Series' for governmental and non-governmental aid organisations. They are continually discussed and scrutinised in workshops and small-scale expert discussions.

More information: https://www.uni-due.de/inef/projekt_ave.php

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Students at the Faculty of Educational Sciences

Faculty of Educational Sciences

The Faculty of Educational Sciences consists of five institutes. It employs around 50 professors, nearly 170 research associates and lecturers, and around 30 technical and administrative staff. Its members conduct a wide range of nationally and internationally visible research in the educational sciences, and some also hold leading positions at the Interdisciplinary Centre for Educational Research (IZfB) and the Interdisciplinary Centre for Integration and Migration Research (InZentIM). Their work makes valuable contributions to our region and tackles socially relevant issues.

Institute of Vocational and Further Education (IBW)

Over the course of the reporting period, the Institute of Vocational and Further Education (IBW) developed a broad spectrum of research disciplines and acquired significant sums of external funding. Its research focus is on adult education and professional development. The IBW's unique research profile comprises several specialisms in the fields of political further education, digital education, vocational and in-house training and professional development, continuing academic education, and knowledge and transfer management.

A variety of interesting, externally funded research activities and projects were realised during the reporting period, such as the following:

- Skills Development in Occupational Enculturation Processes (INTERCONNECT), a project under Professor Ester Winther, funded by the German Research Foundation (DFG)
- Academic Dropout, Habitus and Image in Society (STHAGE), a BMBF-funded collaborative project under Professor Helmut Bremer
- Learning to Use a Digital Workbench to Develop Competence-based Professional Exams in Vocational Education and Training (ASPE), a BMBF-funded collaborative project under Professor Winther and Professor Michael Kerres

The IBW maintains a wide range of partnerships with academic, public and governmental institutions of adult education, vocational training and professional development in Germany, Europe and beyond. During the reporting period, the IBW considerably intensified its long-standing collaboration with the German Institute for Adult Education, Leibniz Centre for Lifelong Learning (DIE). The strengthened partnership manifests itself in a variety of joint projects, such as a research network on literacy and basic education ('Alphabetisierung und Grundbildung'), a meta project on digital transformation in the education sector ('Digitalisierung im Bildungsbereich'), and the EU project 'Promoting Creativity and Innovation Management in an Innovative Blended Learning and Validation Programme at the Interface between Higher Education and Business'. The partnership has been enshrined in a new collaboration agreement between the DIE and UDE.

EU-funded research, in particular, is a stabilising factor for the IBW's international network. The University of Palermo, University of East Sarajevo, Hebrew University of Jerusalem, European University of Tirana and Universum College Prishtinë are permanent members of the Institute's research community by binding mandate. The IBW also maintains collaborative relationships with the Swiss Federal Institute for Vocational Education and Training (EHB) and the European Centre for the Development of Vocational Training (CEDEFOP).

All divisions of the IBW conduct knowledge transfer at a large scale. Within the context of the coronavirus pandemic, our members' expertise in digital education, knowledge management and course planning has been in particularly high demand. The learning lab's OpenLecture services (under Professor Kerres) and the Institute's participation in the series 'Wissenschaft trifft...' of the Initiative Wissenschaftsstadt Essen (under Professor Winther) are just two examples of our transfer activities.

In its key research areas, the IBW focuses on topics that have already gained momentum and significance at the national and international level. Not only do they further the possibility of greater external funding, they may also inform the agenda-setting process in (further-) education research. The AlphaDekade project of the Federal Ministry of Education and Research allocates increasing volumes of funding to research activities in the field of literacy and basic education. It focuses on projects targeting continuous technical and structural improvements in business and society that are aimed at citizens with low literacy.

Institute of Educational Sciences (IfE)

The Institute of Educational Sciences (IfE) engages in a wide variety of research activities. More than any other institute, it carries out quantitative as well as qualitative studies. Based on sound methodology, it advances established methods and makes them applicable to

research-based formats in the field of teacher training (Professor Anja Tervooren, Professor Nicolle Pfaff: 'MethodenLab'; Professor Marten Clausen: 'Portal zum fallbasierten Lehren und Lernen', a portal for case-based approaches to teaching and learning). The Institute's projects are aimed at discipline-specific, theoretical education and the development of educational practice. Its ongoing research can be categorised as follows:

In the cluster of basic research in the educational sciences, the Department for International Herbartianism Research (Professor Rotraut Coriand) and the Hans-Jochen Gamm Archive (Professor Armin Bernhard), which works on advancing the field of critical pedagogy, particularly stand out. Professor Nicolle Pfaff's research into youth, anti-Muslim racism and antisemitism (2017–2024) is a representative example of the second cluster, which tackles the challenges of heterogeneity and diversity in pedagogy. Studies of the digital transformation of the education system tackle questions of school and class development, which make up the third cluster. They include three BMBF-funded projects between 2019 and 2023: 'Metavorhaben Digi-EBF', 'ForUSE-digi', and 'DigiSchulNet', all under Professor Isabell van Ackeren. A ProViel study on children and inclusion, 'Kinder als Akteur*innen der Inklusion' (under Professor Martina Richter since 2019), and an upcoming project on transnational childhoods under Professor Alexandra König, make up the cluster of childhood, youth and family in transition. With these specialisms, the IfE participates in discourses of the Interdisciplinary Centre for Educational Research (IZfB) and the Interdisciplinary Centre for Integration and Migration Research (InZentIM).

The IfE will continue to carry out systematic basic research in the educational sciences and further externally funded projects on the topics listed above in future. They include the DFG-funded project on 'subject discipline specific forms of dealing with key vocational requirements in the teaching profession' (2021–2024, Professor Carolin Rotter) and the project 'International Civic and Citizenship Education Study 2022' with funding from the EU and the BMBF (2020–2024, Professor Hermann Josef Abs).

Institute of Psychology (IfP)

Recent highlights at the Institute of Psychology (IfP) include the successful launch of the Master of Science in Psychology and the appointment of Professor Florian Schmitz to the Professorship of Psychological Diagnostics and Methodology. The entire psychological curriculum is now represented at the IfP, and its research projects cover a large bandwidth of topics.

Professor Silja Bellingrath's research group, for instance, studied the relationship between self-regulation skills and counterproductive academic behaviours, such as procrastination and exam anxiety. Another research project investigated the impact of the Covid-19 pandemic on individuals' experience of stress and well-being.

Professor Annette Boeger's research group has implemented and evaluated the 'Förderuniversum' programme in a collaborative project with the City of Hamm. Furthermore, an interview study on difficult situations in authentic mediation contexts was launched.

Professor Thomas Forkmann's research group examined predictive factors of suicidal ideation and behaviour as part of a prospective, DFG-funded multi-centre study, focusing also on the progression of psychopathological variables in everyday life.

Professor Angela Heine's research group used eye tracking to study atypical cognitive processing chains. It also focuses on the development of user interfaces based on eye-tracking technology.

Professor Philipp Jugert's research group examined processes of social integration and participation of children and adolescents in the context of cultural diversity. Another project, funded by MERCUR (Stiftung Mercator) looked at the integration of displaced and newly immigrated children into schools.

The work of Professor Detlev Leutner's research group focused on academic success and academic dropout (funded by the DFG and BMBF), expertise in the educational sciences and classroom management skills (funded by the BMBF), study strategies and self-regulated learning (funded by Stiftung Mercator and the RAG-Stiftung), and multimedial learning methods.

Professor Andreas Müller's research group examined the efficacy of interventions in improving the mental health of hospital staff (collaborative project 'sEEGEN', funded by the BMBF) and initiated a survey on the impact of the coronavirus pandemic on their working conditions.

Professor Marcus Roth's research group has completed its interdisciplinary collaborative project 'empCARE' on developing and integrating an empathy-based approach to easing the workload of care staff. It is currently looking into ways of measuring empathy based on objective markers and the relationship between autobiographical memory and empathy.

Professor Schmitz's research group focuses on measuring cognitive ability and personality. At the end of 2019, the project 'Disentangling Mental Speed, Working Memory Capacity, and Fluid Intelligence', a DFG-funded study into measuring ability, was finished.

A recent highlight of Professor Gisela Stein's research group was the launch of an international research project in collaboration with Professor Angelo Brandelli of the Pontifícia Universidade Católica do Rio Grande do Sul in Brazil, focusing on perceptions of people with HIV.

Professor Lisa von Stockhausen's research group examines to what extent basic processes of concentration and higher cognitive processes (i.e., executive functions) can be improved through practice. In associated studies, the group focuses on the cognitive mechanisms involved in mindfulness training.

The IfP maintains international partnerships with a large number of institutions, such as the University of Amsterdam, Utrecht University and the Trimbos Instituut (NL), Jagiellonian University in Krakow (PL), Masaryk University in Brno (CZE), the University of Trento (ITA), the Universidad Rey Juan Carlos Madrid (ESP), the Université du Luxembourg (LUX), the University of Glasgow (GBR), the University of Southern Denmark (DNK), the University of California at Santa Barbara (USA) and the Indian Institute of Technology Madras (IND).

Institute of Social Work and Social Policy (ISP)

The Institute of Social Work and Social Policy (ISP) conducts a broad spectrum of research. Basic research in the field of social work and social policy is one of its specialisms. The replication study 'Gentle Inspectors' (2016–2020, Professor Jan Wehrheim), funded by the DFG, examines contact between professionals and their target groups in selected fields of social work. Another DFG-funded research project, 'Collective Representations of Unemployment' (2019–2021, Professor Carsten Ullrich) focuses on the perception of unemployment and the unemployed in Germany.

Professor Dirk Hofäcker's group carries out studies into issues relating to labour market and retirement policy. Two projects funded by the pension research network (Forschungsnetzwerk Alterssicherung) of the German pension

Dean: Professor Dr Steins

Professors

Institute of Vocational and Further Education
Dr Sönke Ahrens (Vertretungsprofessur)
Professor Dr Helmut Bremer
Professor Dr Karl Düsseldorff
Professor Dr Michael Kerres
Prof. em. Dr Gerd Mietzel
Professor Dr Dieter Münk
Dr Daniela Rothe (Vertretungsprofessur)
Professor Dr Esther Winther

Institute of Educational Sciences
Professor Dr Hermann Josef Abs
Professor Dr Isabell van Ackeren
Professor Dr Armin Bernhard
Professor Dr Jeanette Böhme
Professor Dr Marten Clausen
Professor Dr Rotraud Coriand
Professor Dr Kerstin Göbel
Professor Dr Alexandra König
Professor Dr Ingelore Mammes
Professor Dr Nicolle Pfaff
Jun.-Professor Dr Martina Richter
Professor Dr Carolin Rotter
Professor Dr Anja Tervooren

Institute of Psychology
Professor Dr Silja Bellingrath
Professor Dr Annette Boeger
Professor Dr Thomas Forkmann
Professor Dr Annemarie Fritz-Stratmann
Professor Dr Angela Heine
Professor Dr Philipp Jugert
Professor Dr Dr h.c. Detlev Leutner
Professor Dr Andreas Müller
Professor Dr Marcus Roth
Professor Dr Florian Schmitz
Professor Dr Gisela Steins
Professor Dr Lisa von Stockhausen

Institute of Social Work and Social Policy
Professor Dr Klaus Birkelbach
Professor Dr Horst Bossong † (bis 03/2020)
Professor Dr Dirk Hofäcker
Professor Dr Simone Leiber
Professor Dr Ulrike Schwedhelm (bis 09/2019)
Professor Dr Carsten Ullrich
Professor Dr Jan Wehrheim

Institute of Sport and Movement Sciences
Professor Dr Ulf Gebken
Professor Dr Thomas Mühlbauer
Professor Dr Michael Pfitzner

insurance union (Deutscher Rentenversicherung Bund) investigate the employment trajectories of older unemployed people in Germany (2019–2020) and periods of reduced income during the transition to old-age retirement (2020–2021), respectively.

The ISP is also involved in various high-ranking, international collaborative projects. One is the EU's 'Transdisciplinary Solutions to Cross-sectoral Disadvantage in Youth/YOUNG-IN' (2018–2022, Professor Hofäcker). Another is the 'EuroAgencyCare' project, funded by the German-Polish research foundation (Deutsch-Polnische Wissenschaftsstiftung, DPWS), which focused on the role of employment and recruitment agencies for migrant labourers in Germany and Poland (Professor Simone Leiber).

Further projects examine the potential settings and target groups of interventions in social work.

- Professor Leiber's research group is working on a range of projects which investigate political control of nursing care, including a study into family caregivers as a target group of preventive social policy. The same group has carried out an international comparative study into social work as a political player in the welfare state.
- Professor Klaus Birkelbach and the University of Cologne are planning to initiate the fourth wave of the Cologne High School Panel, which was funded by the DFG between 2019 and 2021. It examines the professional and private lives of a group of former high-school students as they reach middle age or transition from their careers to retirement. A proposal for renewal has been submitted.
- Another DFG-funded project (2018–2021, Professor Wehrheim) studies conflicts over the appropriation of urban resources in processes of upgrading and social mixing in inner-city residential areas.
- These approaches from a social-studies perspective are complemented by legal assessments of current developments in the field of labour and social law carried out by the ISP's professors of law (Professor Ulrike Schwedhelm).
- Professor Ullrich's research groups on qualitative methods continues to engage in methodology research. Two DFG-funded projects (2019–2021) tackle issues of interview methodology. The first team focuses on the impact of questions in interviews, while the second (a collaboration with Universität Hamburg) examines the possibilities of online interviews.

In addition to the Institute's high profile in German-speaking academia, its researchers have been attending international conferences on a regular basis, including the annual conference of European Social Policy Network (ESPAnet) and the IMISCOE (International Migration, Integration and Social Cohesion in Europe) Spring Conference 2019.

Institute of Sport and Movement Sciences (ISBW)

The Institute of Sports and Movement Sciences (ISBW) focuses on promoting childhood and adolescent development in and through exercise, play and sports in various settings.

Its research cluster on social science in sports (Professor Ulf Gebken) works on externally funded projects such as the following: 'Kicking Girls', a study into social integration of girls through football (2009–2020, funded by the Laureus Foundation); a project on linguistic awareness in school sports with refugee children (2016–2020); a project on preventing violence in men's football (2018–2020, funded by the City of Essen); 'Open Sunday and Open Area', a project on freely accessible weekend exercise and sports offers for children and adolescents (2015–2019, funded by the RAG Foundation, Anneliese Brost Foundation et al.). The cluster also participates in the ProViel project 'Diversity and Inclusion' (2016–2019, funded by the Federal Ministry of Education and Research). Further, the 'KommSport' project (2014–2019, funded by the Ministry of Children, Family Affairs, Refugees and Integration of North Rhine-Westphalia) seeks to offer children and adolescents community sports programmes tailored to their particular needs, ideally in a club context.

The division of movement and training sciences/biomechanics of sports under Professor Mühlbauer has launched two projects. Firstly, it has acquired a fellowship for digital teaching innovation in higher education (2020–2021, jointly funded by the Ministry of Culture and Science of North Rhine-Westphalia and the Stifterverband für die Deutsche Wissenschaft), which has allowed it to incorporate collaborative and interactive digital technologies into sports classes

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Assessment of neuromuscular parameters

Selected Publications

Böhme, J., T. Böder (2020): *Bildanalyse. Einführung in die bildrekonstruktive Forschungspraxis der Morphologischen Hermeneutik. Wiesbaden: Springer Verlag.*

Deutscher, V., E. Winther (2019): *A conceptual framework for authentic competence assessment in VET: A logic design model. In: S. McGrath, M. Muder, J. Papier, R. Suart (eds): Handbook of vocational education and training. Developments in the changing world of work. New York: Springer, 1299–1312.*

Hofäcker, D., M. Hess, S. König, (2019): *Wandel von Ruhestandsübergängen im politischen Paradigmenwechsel Europas. In: Zeitschrift für Gerontologie und Geriatrie, 52, Supplement 1, 40–51.*

Forkmann, T., H. Glaesmer, L. Paashaus, D. Rath, A. Schönfelder, K. Stengler, G. Juckel, H.-J. Assion, T. Teismann (2020): *Interpersonal theory of suicide: prospective examination. British Journal of Psychiatry Open, 6, e113 1–7.*

Jugert, P., L. Leszczensky, S. Pink (2020): *Differential influence of same- and cross-ethnic friends on ethnic-racial identity development in early adolescence. Child Development, 91, 949-963.*

Kerres, M. (2020):*Against all odds: Education in Germany coping with Covid-19. Postdigital Science and Education, 2, 690–694.*

Klammer, U., S. Leiber, S. Leitner (2019): *Social Work and the Making of Social Policy, Bristol: Policy Press.*

König, A. (2019): *Spielfelder des Selbst. Eine Längsschnittstudie zu jungen Erwachsenen in Handwerksbetrieben, Hochschulen und Kunstakademien. Weinheim: Juventa Verlag.*

Malin, J., C. Brown, G. Ion, I. van Ackeren, N. Bremm, R. Luzmore, J. Flood, G.M. Rind (2020): *World-wide barriers and enablers to achieving evidence-informed practice in education: what can be learnt from Spain, England, the United States, and Germany? Humanities and Social Sciences Communications, 7:99.*

Pfitzner, M., T. Mühlbauer, U. Gebken (2020): *Schulsport 2030 – Anforderungen an einen modernen Sportunterricht und an Sportlehrkräfte im Essen-Duisburger Modell der Sportlehrer_innenbildung. Leipziger Sportwissenschaftliche Beiträge, 61(1), 86–103.*

Veber, M., R. Benölken, M. Pfitzner (2019): *Potenzialorientierte Förderung in den Fachdidaktiken (Begabungsförderung: Individuelle Förderung und Inklusive Bildung). Münster: Waxmann.*

taught as part of the relevant bachelor's teacher training programmes. Secondly, it has collaborated with TU Berlin and Heidelberg University in developing, implementing and testing preventive exercise programmes (PROfit) for residents of stationary care facilities (2019–2022, funded by Techniker Krankenkasse Hamburg).

The cluster on sports pedagogy and didactics under Professor Michael Pfitzner has been conducting a joint project with Professor Petra Scherer (didactics of mathematics) within the scope of the research training group 'Querschnittliche Fragen der Lehrer*innenbildung zur Bewegungsbasierten Lernförderung im Mathematikunterricht' ('a cross-section of issues in teacher training on movement-based ways of promoting learning in mathematics classes'). The project focuses on stimulating executive function. Further, the phase II of the BMBF-funded 'ProViel' project, which focuses on teacher training in the context of diversity, began in July 2019. The current phase will be centred around a sub-project on inclusion in sports. The project 'Im Team Studieren' ('studying as a team'), which sought to develop ways of implementing and evaluating a system for using (online) tools in collaborative student work, has finished. It was a part of the UDE funding line 'Lehr-Lern-Innovationen'. The results of the 'saViS' project, a study into the suitability of students as supply teachers in physical education conducted in partnership with the association of sports science faculties (Fakultätentag Sportwissenschaft) and other disciplines of UDE, are currently being evaluated.

Transfer and sustainability

The Faculty of Educational Sciences is committed to facilitating knowledge transfer and preserving scientific results at various levels. Members of its various institutes have been contributing to the 'Initiative Universitätsschule' since 2018, for example. They work on plans to establish an inclusive primary school. In partnership with the City of Essen, the initiative is developing a concept for an innovative and inclusive district primary school that will inform further plans for a teaching facility that is based on future requirements.

Prizes and awards

Dr Cornelia Arend-Steinebach received the UDE's Diversity Prize in the 'Teaching' category for her use of service learning.

Professor Gebken's project 'Open Sunday' received an award for outstanding preventive projects from Stiftung Gesundheitsservice, a foundation of the company health insurance funds.

Professor Kerres's BMBF-funded project 'HandLeVR: Action-Oriented Learning in a VR Painting Simulator' won the DIVR Science Award of the Institut für Virtuelle Realitäten in the 'Best Tech' category in 2020.

Professor Leiber's study into family caregivers as a target group of preventive social policy was chosen as the 'Best Practice Project' of 2019 by FGW NRW due to the strong media response it attracted.

Professor Leutner, Professor Elke Sumfleth and Professor Hans E. Fischer jointly received the Society of Empirical Educational Research (GEBF) Prize for promoting interdisciplinarity in education research in 2019.

PD Dr Anna Rosendahl received the science prize of the Sparkasse Essen for outstanding academic achievements in her post-doctoral Habilitation thesis in 2019.

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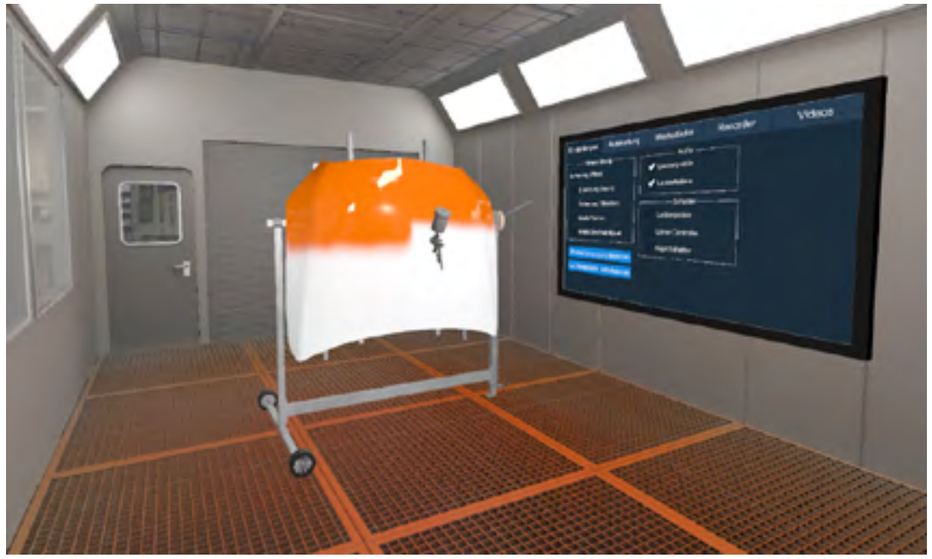
Exercise programmes for students of physical education



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VR painting simulator

The Gymnasium Essen Nord-Ost high school was awarded the German School Award (second place) in 2020. This was partly due to the establishment of mindfulness training as a subject for year five. The project is based on Professor Stockhausen's and Professor Bellingrath's study 'Achtsame Schule' ('mindful school'), which was funded by MERCUR (Mercator Foundation) and advised and supervised by the research groups.

Tim Zosel received the 2020 UDE Teaching Prize upon nomination by the departmental student committee for the educational sciences and psychology.

Outlook

The individual and collaborative research projects carried out at the national and international level during the reporting period highlight the strong research profile of the Faculty of Educational Sciences. Strengthening this profile, expanding its various segments and raising its visibility will be high priorities over the next years. To achieve these goals, the Faculty plans to organise a Research Day involving joint and individual offers for established and early-career academics.

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Faculty of Economics and Business Administration

The Faculty of Economics and Business Administration at the University of Duisburg-Essen analyses the topics of its disciplines from an economic and information technology perspective. It focuses on business structures and processes, the information and communication systems of companies, and the products they manufacture.

The structure of the Faculty of Economics and Business Administration is designed to meet the interdisciplinary requirements of current research issues. It comprises four disciplines: business administration, computer science, economics and business information systems. This network of disciplines allows the Faculty's researchers systematically to process information that are necessary to plan business structures and processes efficiently. Information and communication technology increasingly facilitate innovative business models and company structures. The Faculty analyses and plans these from a variety of perspectives

Key research areas

Health economics and medical management

This research area focuses on health as human capital and the healthcare sector as a system. The National Research Center for Health Economics, CINCH (Competence in Competition and Health) is its linchpin. Within the scope of their collaboration with the RWI Leibniz Institute for Economic Research, the researchers of this group have established the Leibniz Science Campus Ruhr at the Faculty. It focuses on healthcare challenges in regions with declining and ageing populations, and its funding has recently been extended until 2024. The research in health economics and medical management is characterised by a particularly broad methodological approach. The team of the Essen Laboratory for Experimental Economics (elfe), which participates in this research area, is an international pioneer in establishing experimental methods in health economics.

Energy markets and finance

In recent years, climate and energy goals established at the international, European and national level have rapidly and profoundly transformed economies and societies around the world. Energy suppliers, financial institutions, regulators and, as of late, even central banks have been facing unprecedented challenges related to energy markets and finance. This research area tackles the complex issues resulting from these environments. Besides specialist expertise, they particularly require interdisciplinary groups of researchers. The foundation of the House of Energy Markets and Finance (HEMF) in 2015 institutionalised this research area. In addition to its scientific prestige, it has gained a remarkable international reputation by organising high-profile conferences and seminars on a regular basis. The research area excellently represents the Faculty's strategic efforts to establish a local, regional and international academic network that promotes interdisciplinarity in research and teaching.

Software engineering

Software systems have become omnipresent: they permeate nearly all aspects of our lives. Developments in information technology, such as the Internet of Things (IoT) and cloud computing, produce innovative, software-based systems that rapidly achieve mass adoption and significantly influence our daily routines. Engineering such new systems (i.e., their scoping, development and operation) continuously poses new challenges for computer science, in general, and software engineering, in particular. These systems offer immense potential for disruptive automation, new business models and software-based services. They are the driving force behind the digital transformation. That is why research in software engineering focuses on the very challenges raised by the digital transformation itself, including its role in restructuring industries that have already digitised most of their operations and those that are still in the process of doing so. Particular difficulties emerge at the interface of complexity, security and user-friendliness. In order to pool and institutionalise its research in software engineering, the Faculty founded paluno – The Ruhr Institute for Software Technology in 2010.

New key research area: digital transformation

The new key research area of digital transformation will comprise the Faculty's research into modern and 'disruptive' information and communication technologies and their economic impact. This includes edge computing, big data analytics, blockchain and artificial intelligence. Taking the intended economic effects of these technologies as a point of departure, this research group seeks to determine which technical artefacts are suitable for achieving them. It also examines existing artefacts in terms of their economic consequences. Its research focus makes the new key area of digital transformation inherently transdisciplinary, as it utilises methods and theories from informatics, business information systems, business administration and economics. The business information systems research group has taken on a leading role and actively advances the development of this key research area together with its adjacent disciplines.

Business administration (IBES)

Methodological and theoretical pluralism is an important characteristic of the research and teaching conducted in the field of business

administration at the Faculty. The empirical ('positive') and design-based ('constructive') analyses of microeconomic processes and structures utilise a variety of market and company theories. For the sake of epistemological pluralism, the researchers avoid limiting themselves to individual, dominant methods and theories preferred in mainstream research. Instead, they deliberately cultivate the academically charged relationship between different methodological and theoretical approaches. Research in business administration at the Essen campus does not focus solely on its inherent object of inquiry. It answers current research issues from a range of perspectives and, in doing so, establishes connections with many disciplines, such as sociology, psychology, philosophy, mathematics, computer science, the engineering sciences, medicine, law and economics. Due to these close links with other fields, research results are featured in renowned publications in all those disciplines. The business administration arm of the IBES has secured a large volume of external funding for its research (e.g., from the Federal Ministry of Education and Research, Federal Ministry for Economic Affairs and Energy, German Research Foundation, EU, Fritz Thyssen Foundation, Hans Böckler Foundation etc.). It is one of the most successful of its kind in Germany.

Economics (IBES)

The economics part of the IBES focuses on empirical economics research. Its activities and studies cover a wide spectrum of topics, including labour market economics, educational economics, monetary and currency policy, health economics, macroeconomics, econometrics of international trade and experimental economics research. There is enormous potential in its collaboration with the RWI Leibniz Institute for Economic Research, especially in the key research areas of the Ruhr Graduate School in Economics (RGS ECon) and in the healthcare sector. The members of the economics research group regularly publish articles in specialist journals, such as Demography, Econometrics Reviews, Econometric Theory, Economica, European Economic Review, Health Economics, International Economic Review, Journal of Banking and Finance, Journal of Business & Economic Statistics, Journal of Common Market Studies, Journal of Economic Behavior & Organization, Journal of Environmental Economics and Management, Journal of Financial Econometrics, Journal of Health Economics, Journal of International Money and Finance, Journal of the European Economic Association, Labour Economics, Oxford Bulletin of Economics and Statistics and PLOS ONE. Their output consistently earns the Faculty excellent positions in scientific rankings. According to the latest Handelsblatt Ranking of 2019, the University of Duisburg-Essen is one of the top 25 universities in Germany and the German-speaking region in the field of economics. This corresponds to rank 12 in Germany. Its economics researchers are highly successful in acquiring competitive external funding for its projects on a regular basis. While the Federal Ministry of Education and Research is the most frequent sponsor, the German Research Foundation (DFG) and the European Commission are also important contributors.

Computer science (ICB)

The Faculty has expanded its sphere of academic competence in computer science. Its software engineering group continues to be an important player in international top-level research, focusing on the main fields that attract public funding. The research expertise in this field is pooled in paluno – The Ruhr Institute for Software Technology. The Faculty's various departments carry out outstanding research in important sub-disciplines of network engineering, such as communication networks, modelling, network security and application security. They were also able to expand their empirical research activities in computer science education. In the field of software engineering, the departments of the ICB have developed a range of construction and analysis processes that allow engineers to develop complex software for sophisticated applications, manage its deployment and achieve the quality required. The international renown of the software-based work is reflected in the large number of international and national conferences organised by professors of the ICB. Large volumes of competitive external funding have been awarded to the software engineering research, in particular. Members of the ICB have also won several best-paper awards.

Business information systems (ICB)

The study of business information systems is a particularly interdisciplinary field. It combines the application-oriented approach of computer science with the development of applications systems while exploring the utilisation of IT systems in organisations from the perspective of business administration, even incorporating sociological aspects into its work. At its core, it studies phenomena of the digital transformation in a business context. The business information systems research group at the Essen campus particularly focuses on the issues inherent to transforming institutions, which only become clear through an integrative understanding of the technical artefact (from the creators' and users' perspective) and the related economic, social and individual (and, as such, sociological) implications. The digital-transformation process is more than the mere utilisation of information technology to increase the efficiency of existing processes. Rather, it requires a comprehensive transformation entailing not just the reorganisation of business processes but the development of whole new digital products, services and business models. Market-oriented digital innovations, supporting innovation systems, IT infrastructures and organisational handling systems must be designed in a closely interlinked structure, and corresponding management concepts must be developed in parallel. Although the dominance of design-based study of business information systems (design science) is considered one of the strengths of German business informatics, the research conducted at the Essen campus promotes methodological pluralism by incorporating empirical (behavioural science) and construction-oriented approaches.

Junior Professorship of Environmental Economics (with a focus on the economy of renewable energies)

Junior Professor Florian Ziel has led the research group of environmental economics (with a focus on the economy of renewable energies) since 2017. Research in his group is centred on modelling and forecasting energy markets. Thanks to his excellent background as a mathematician and statistician, he primarily uses modern data processing methods of high-dimensional statistics and machine learning. Florian Ziel's specialist expertise has earned him a variety of sought-after awards, such as the 2016 GEE Prize of the Gesellschaft für Energiewissenschaft for the best dissertation in its field and the Award of Excellence in the Global Energy Forecasting Competition 2017. Over the course of his remarkably international career to date, he has researched at the Oxford Centre for Industrial and Applied Mathematics (OCIAM) of the University of Oxford and the European Center for Advanced Research in Economics and Statistics (ECARES) of the Université Libre de Bruxelles in Belgium. Between January and April 2019, he participated in the research programme 'Mathematics for Energy Systems' of the Isaac Newton Institute in Cambridge, UK, as a visiting

Prodean: Professor Dr Tobias Kollmann

Professor Dr -Ing. Lucas Vincenzo Davi

scholar. He has held the position of associate editor of 'Digital Finance' and a seat on the editorial board of 'Forecasting' since 2019. Together with Rüdiger Kiesel, he participates in the jointly acquired, German-Polish research collaboration 'IMMORTAL', a study of intraday electricity markets by the DFG and the Narodowe Centrum Nauki (NCN). He has also been awarded a range of industry projects and the 2020 Maria Weber Grant. Since the summer of 2020, he has been an appointed member of the Berlin-Brandenburg Academy of Sciences and Humanities (BBAW) and the German National Academy of Sciences Leopoldina, where he contributes to the research groups on sustainability and artificial intelligence, in particular.

Junior Professorship of Computer Science (secure software systems)

Headed by Professor Lucas Davi, the research group of Computer Science (secure software systems) researches practical issues in systems and software security. The development of innovative security technologies to prevent software attacks is a high priority. Such attacks exploit security gaps in software in order to manipulate the regular program flow and execute malware. The research groups studies a variety of computer architectures and application domains. It develops innovative update mechanisms for microcomputers used in embedded systems that can fix security gaps during the system runtime. In particular, this allows medical devices to be updated without a restart. In the field of PC software, the researchers carry out automated security analyses for trusted execution environments, such as Intel SGX and ARM TrustZone. Their analyses of software used for fingerprint sensors in Dell, HP and Lenovo laptops have detected severe security issues and helped the manufacturers safeguard their systems. In the field of blockchain technologies, the group has worked on the development of analytics systems and update mechanisms for smart contracts in partnership with NEC Laboratories Europe. Their project has shown that attacks on smart contracts (in particular, re-entrancy attacks), which have facilitated the theft of more than 50 million US dollars' worth of cryptocurrency in the past, can be prevented. Based on the analytics technology produced for this purpose, the researchers developed the first automated update mechanisms for smart-contract software, allowing blockchain developers to protect the vulnerable smart-contract code quickly and effectively. The research group is currently funded within the scope of major DFG projects. In the Collaborative Research Centre CROSSING, they develop attestation protocols that enable the use of verification mechanisms for embedded platforms. In the DFG Excellence Cluster CASA, the group studies analytics tools for secure computing environments and mechanisms to ward off software attacks on PC software, such as web browsers. A further DFG-funded project in the Nano-Security Priority Programme focuses on developing security solutions for future embedded platforms. Professor Davi has been a member of the editorial boards of ACM Transactions on Privacy and Security (TOPS) and a programme committee member of the most renowned IT security conferences: ACM CCS, USENIX Security, PETS and ISOC NDSS.

Research collaborations and transfer

The annual Essen Health Conference provides established researchers and early-career academics a platform for exchanging knowledge and presenting their research results. It is an international event that attracts participants from all over Europe and North America. Besides health economics, it covers adjacent disciplines such as education economics and labour economics.

Every September, the HEMF organises the International Ruhr Energy Conference, which features many high-profile lectures from renowned German and international researchers. Other significant (international) conferences are organised by the HEMF members at the Essen campus on a regular basis. Recently, they have included the annual conference of the German Finance Association in 2019 and the Energy Finance Christmas Workshop in 2016.

The paluno has a strong national and international research network with many high-profile companies and research institutions. It is also active in other national and international research networks. Professor Gruhn coordinated the software research group in the CPS.Hub NRW, for example. Professor Pohl's research group studies dynamically aggregated CPS in the CrESt project, funded by the Federal Ministry of Education and Research. The European technology platform NESSI (The Networked European Software and Services Initiative) aims to establish a coordinated European strategy for information and communication technologies with a focus on software, services and data to facilitate the digital transformation. Professor Pohl's department is a member of the steering committee and executive board of NESSI. The European BDVA (Big Data Value Association) is the European Commission's industrial partner in implementing the public-private partnership (PPP) on big data. Professor Pohl's research group is one of its founding members.

Selected Publications

Ahlemann, F., C. Legner, J. Lux (2020): *A resource-based perspective of value generation through enterprise architecture management. Information & Management.*

Atal, J.P., H. Fang, M. Karlsson, N. Ziebarth (2019): *Exit, Voice or Loyalty? An Investigation into Mandated Portability of Front-Loaded Private Health Plans. Journal of Risk and Insurance 86 (3).*

Dietrich, A., C. Weber (2018): *What drives profitability of grid-connected residential PV storage systems? A closer look with focus on Germany. Energy Economics 74, 399–416.*

Jacobs, H., S. Müller (2020): *Anomalies Across the Globe: Once Public, No Longer Existent?, Journal of Financial Economics, 135, 213–230.*

Massing, T., N. Schwinning, M. Striewe, C. Hanck, M Goedicke (2018): *E-Assessment Using Variable-Content Exercises in Mathematical Statistics. Journal of Statistics Education, 26 (3), 174–189.*

Metzger, A., A. Neubauer, P. Bohn, K. Pohl (2019): *Proactive process adaptation using deep learning ensembles. 31st Int'l Conference on Advanced Information Systems Engineering (CAiSE 2019), Rome, Italy, June 3–7, 2019, ser. Lecture Notes in Computer Science, P. Giorgini, and B. Weber, Springer.*

Nissen, A., C, Krampe, P. Kenning, R. Schütte (2019): *Utilizing Mobile fNIRS to Investigate Neural Correlates of the TAM in eCommerce. International Conference for Information Systems (ICIS)*

Sandoval A., P. Juan, F. Beck, A. Bergel (2019): *Performance Evolution Matrix: Visualizing Performance Variations along Software Versions. Proceedings of the 2019 Working Conference on Software Visualization. IEEE 2019. doi:10.1109/VISSOFT.2019.00009 (VISSOFT 2019 Best Paper)*

Wagner S., N. Fet, M. Handte, P. Marron (2017): *An Approach for Hybrid Indoor/Outdoor Navigation. 13th International Conference on Intelligent Environments (IE'17), Seoul, Korea, 2017. Best Paper Award.*

Ziel, F. (2019): *Quantile regression for the qualifying match of GEFCom2017 probabilistic load forecasting. International Journal of Forecasting, 35(4), 1400–1408.*

Professors

Professor Dr Frederik Ahlemann
Professor Dr Erwin Amann
Professor Dr Fabian Beck
Professor Dr Andreas Behr
Professor Dr Katharina Blankart
Professor Dr Torsten Brinda
Professor Dr Jeannette Brosig-Koch
Professor Dr Volker Clausen
Professor Dr Lucas Vincenzo Davi
Professor Dr Stefan Eicker
Professor Dr Stefan Felder
Professor Dr Ulrich Frank
Professor Dr Michael Goedicke
Professor Dr Volker Gruhn
Professor Dr Christoph Hanck
Professor Dr Wolfgang Hamann
Professor Dr Thomas Herrmann
Professor Dr Heiko Jacobs
Professor Dr Nadja Kairies-Schwarz
Professor Dr Rainer Kasperzak
Professor Dr Martin Karlsson, Ph.D.
Professor Dr Rüdiger Kiesel
Professor Dr Tobias Kollmann
Professor Dr Daniel Kühnle
Professor Dr Pedro José Marrón
Professor Dr Ludwig Mochty
Professor Dr Werner Nienhüser
Professor Dr Sebastian Otten
Professor Dr Klaus Pohl
Professor Dr Erwin Rathgeb
Professor Dr Thomas Retzmann
Professor Dr Ute Schmiel
Professor Dr Reinhold Schnabel
Professor Dr Stefan Schneegaß
Professor Dr Hendrik Schröder
Professor Dr Reinhard Schütte
Professor Dr Jürgen Wasem
Professor Dr Christoph Weber
Professor Dr Stephan Zelewski
Professor Dr Florian Ziel

The department of business information systems maintains a lively exchange with its international colleagues. Besides joint research projects, such as the collaboration 'Language Engineering for Multi-Level Modelling', the Visiting Scholar Academy particularly contributes to this exchange. Every year, one renowned researcher from another country collaborates with the department within the scope of an intensive specialist exchange and a block of classes taught for students of business information systems.

Awards

- Professor Florian Ziel: Maria Weber Grant of the Hans Böckler Foundation, membership of the young academy
- Professor Martin Karlsson: 2021 Research Prize of the Riksbankens Jubileumsfond
- Professor Klaus Pohl: IEEE RE Lifetime Service Award 2020
- Professor Fabian Beck and Shivam Agarwal: Best Paper Award 2020 – Vision, Modeling, and Visualization
- Professor Michael Goedicke: Best Paper Award – ELFI 2019 – 17. Fachtagung Bildungstechnologie, German Informatics Society, Berlin
- Professor Kollmann: EURAM SIMA in Dublin 2020

Outlook

The research of the Faculty of Economics and Business Administration is characterised by international collaboration. Its collaborative projects focus on questions from a range of fields: energy economics, health, trade and services, automotive industry, IT businesses, accountancy, fiscal consultancy and business consultancy. All research groups at the Faculty are concerned with the impact of the digital transformation on forms of work and ways of like, topics which are studied from a variety of mutually complementary perspectives. The research of the Faculty aims to develop theories and methods that can help shape the transition to a more attractive, more humane society.

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Mercator School of Management

With 26 professors and almost 100 research associates, the Mercator School of Management (MSM) is a medium-sized faculty that specialises in business administration.

The School takes its regional and social responsibility seriously. Through its comprehensive, targeted educational programmes and engagement with academic and social issues, it supports economic growth in its region. Its academic profile comprises three specialist disciplines with a focus on research as well as industry applicability: Accounting and Finance, Technology and Operations Management and Management and Marketing. It further incorporates competences in economics and regional studies. The MSM has established an advisory council staffed with high-ranking representatives of the regional and interregional industry, which supports its teaching, research and self-government.

While the School is committed to striking a careful balance between application-oriented and fundamental research, its departments focus on a variety of specialisms. Over the past years, the MSM has made considerable progress in its fundamental research activities. This is reflected by the large number of contributions it has made to international A+/A journals, its increased participation in renowned international conferences, the expansion of its international and institutional research network, and the acquisition of funding from the German Research Foundation (Deutsche Forschungsgemeinschaft, DFG).

The continued practical orientation of the School's research projects is visible in its many long-term partnerships with industry and politics. A large number of projects funded by the European Union and the Federal Ministry of Education and Research (Bundesminsterium für Bildung und Forschung, BMBF), research contracts for the private sector, and regular conferences and workshops underscore its high profile and success in this field.

Alongside the transfer of application-oriented research results to industry practice, the transfer of academic insights to teaching practice plays a central role in the School's activities. This applies equally to all disciplines. The MSM continues to uphold its commitment to the unity of research and teaching. Through its interdisciplinary collaboration with the other faculties of our university, it has developed close working relationships with Informatics, Mathematics, Social Sciences, Humanities, and Engineering.

Research

In 2019 and 2020, the School further increased its publication rate in international A+/A journals. This development underscores its successful internationalisation and increased research performance, as do the additional DFG funding it has secured for its own projects and its increased involvement in DFG-funded collaborative projects. The German Research Foundation currently funds Professor Alf Kimms's project on logistic planning issues in disaster relief, Professor Martin Hibbeln's project on agency problems in loan securitisation, Professor Eugen Kovac's project on the theory and practice of timing games, and Professor Tobias Seidel's project on innovation, technology diffusion and income inequality in interdependent market launches. Professor Marie Paul participates in the DFG priority programme no. 1764, 'The German Labor Market in a Globalized World'. Her subproject is titled 'Female Employment Patterns, Fertility, Labor Market Reforms and Firms: A Dynamic Treatment Approach'.

The DFG research training group no. 2428, which focuses on regional inequality and economic policy, is a joint endeavour by the Ruhr University Bochum, TU Dortmund and the University of Duisburg-Essen. Professor Tobias Seidel from the MSM is its spokesperson alongside Professor Marie Paul and Professor Jens Wrona, who also represent the School in this particularly significant project.

Nearly 20 other externally funded projects contribute to the research output of the MSM during the relevant period. They include various BMBF-funded projects, such as Professor Margret Borchert's study 'AKTIV-kommunal', which examines ways of structuring work for communal companies in digital innovation and change processes, and Professur Gertrud Schmitz's study 'smart Market²' on interactive shopping experiences in inner cities. The IN-EAST School of Advanced Studies, managed by Professor Markus Taube, and Professor Thomas Bienengräber's project BEaGLE, which

Selected Publications

Balafoutas, L., S. Czermak, M. Eulerich, H. Fornwagner (2020): *Incentives for dishonesty: An experimental study with internal auditors. Economic Inquiry, Jg. 58, Nr. 2, 764–779.*

Briskorn, D., A. Kimms, D. Olschok (2020): *Simultaneous Planning for Disaster Road Clearance and Distribution of Relief Goods – A Basic Model and an Exact Solution Method. OR Spectrum 42, 591–619.*

Dizdar, D., E. Kovac (2020): *A simple proof of strong duality in the linear persuasion problem. Games and Economic Behavior, 122, 407–412.*

Fiocco, R., D. Guo (2020): *Regulatory risk, vertical integration, and upstream investment. European Economic Review, 128.*

Gönsch, J. (2020): *How much to tell your customer? – A survey of three perspectives on selling strategies with incompletely specified products. European Journal of Operational Research 280 (3), 793-817.*

Heinberg, M., C.S. Katsikeas, H.E. Ozkaya, M. Taube (2020): *How nostalgic brand positioning shapes brand equity: differences between emerging and developed markets. Journal of the Academy of Marketing Science 48, 869–890*

Hibbeln, M., L. Norden, P. Usselmann, M. Gürtler (2020): *Informational Synergies in Consumer Credit. Journal of Financial Intermediation 44.*

Schur, R., J. Gönsch, M. Hassler (2019): *Time-Consistent Risk-Averse Dynamic Pricing. European Journal of Operational Research 277 (2), 587–603.*

Seidel T., M. v. Ehrlich (2019): *Financial development and inequality in the global economy. Scandinavian Journal of Economics 121, 1533–1560.*

Seidel T., M. Henkel (2019): *A spatial perspective on European Integration: Heterogeneous welfare and migration effects from the Single Market and the Brexit. Economic Inquiry 57, 333–352.*

Seidel, T., J. Wickerath (2020): *Rush hours and urbanization. Regional Science and Urban Economics 85, issue C.*

focuses on qualifying teachers for inclusive education, also receive funding from the Federal Ministry of Education and Research (BMBF).

In 2019 and 2020, like in the previous years, the MSM (co-)hosted many academic meetings, conferences and workshops in Duisburg, three of which will be outlined here as examples. On 19 November, Professor Werner Pascha and Professor Markus Taube contributed to the organization of the symposium 'The EU-Japan EPA in Action: First Experiences and Further Steps'. Both are members of the Institute of East Asian Studies, which celebrated its 25th anniversary at the 23rd East Asia Day held on 14 June 2019. The focus of the event was the future of industrial policy in Japan, China and Germany. On 20 March 2019, the Department of Banking and Finance (chaired by Professor Bernd Rolfes) organised the 23rd banking symposium, an event with a long tradition at the University of Duisburg-Essen. Its topics included sustainable and climate finance and cultural change resulting from the digital transformation.

Transfer and sustainability

The University's start-up and technology transfer activities have been based at the MSM since 2015. They are coordinated by the Competence Centre for Innovation and Entrepreneurship (IDE) under Professor Volker Breithecker and Professor Esther Winther (of the Faculty of Educational Sciences). The University is currently working on expanding its start-up potential beyond research groups by offering screenings and consultations within the scope of the GUIDE project, based at the Science Support Centre. In 2018, the organisation Stifterverband für die Deutsche Wissenschaft lauded the IDE's start-up support programme and the modern methods and formats it employs to promote innovation beyond the narrow framework of traditional transfer. The centre has further launched the EXIST scholarship advice service, design-based innovation workshops, and various EU projects that are co-financed with donated funds from the MSM, such as the InnovationHUB Duisburg-Essen (EFRE InnovationHUB), the Innovations- und Gründungsoffensive Niederrhein (EFRE IGNI) and the Future Champions Accelerator Rhein-Ruhr. Professor Volker Breithecker's project 'small business management' (sbm) offers a variety of extensive courses on entrepreneurship and business succession. It is currently in its 22nd year. The sbm project gave rise to the Master of Arts in Innopreneurship, an interdisciplinary and highly successful programme that is unique in Germany. Launched in the 2017/18 winter semester, it incorporates design-based intellectual frameworks and scientific methods for generating start-up concepts. What began as an interdisciplinary degree programme with only 23 students just three years ago attracted more than 100 applications for the current 2020/21 academic year. In the winter semester, 21 eligible, new innopreneurs began their studies.

In the field of sustainability research, a range of projects was launched to study the resource-efficient use of ecologically relevant developments. They include the EU/EFRE project 'Competence Net Urban Industrial Supply (CONUS)' with its sub-project on smart logistic grids for the bioeconomy and a project on developing revenue management instruments in car-sharing contexts. Both are overseen by Professor Jochen Gönsch.

Prodean Professor Dr Alf Kimms

Collaborations and international affairs

The Mercator School of Management belongs to a global network of around 50 partner universities with which it maintains formal collaboration agreements. Most of these universities are based in Europe (28 out of 50) and are also partnered with the MSM in the ERASMUS programme. Eight partner universities are in Asia; twelve are in the United States. The MSM also has one partner university in South America and one in Australia. Its European collaborators include the SGH Warsaw School of Economics, the Université Paris-Sorbonne, Paris IV and Sabancı University in Istanbul. In the United States, the MSM works with the University of Illinois, Urbana-Champaign, and the University of California, Riverside, among others. Its East Asian partners include Sophia University in Tokyo and the Hong Kong Baptist University (HKBU), with which the School has collaborated for more than a decade, alongside more recent agreements, such as with Chung-Ang University in Seoul. For more than five years, the MSM has jointly organised a very successful, international seminar for doctoral researchers (IDOC) with the University of North Carolina, Charlotte (UNCC).

Professor*innen

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Professor Dr Thomas Bienengräber
Professor Dr Margret Borchert
Professor Dr Volker Breithecker
Professor Dr Peter Chamoni
Jun.-Professor Dr Shuanping Dai
Professor Dr Marc Eulerich
Professor Dr Torsten J. Gerpott
Professor Dr Jochen Gönsch
Dr Dongyu Guo
Dr Marcel Henkel
Jun.-Professor Dr Martin Hibbeln
Professor Dr Alf Kimms
Professor Dr Annette G. Köhler
Professor Dr Eugen Kovac
Professor Dr Yuan Li
Professor Dr Antje Mahayni
Professor Dr Michael Manitz
Dr Marc Nückles
Professor Dr Werner Pascha
Professor Dr Marie Paul
Professor Dr Joachim Prinz
Professor Dr Bernd Rolfes
Professor Dr Gertrud Schmitz
Professor Dr Tobias Seidel
Professor Dr Markus Taube
PD Dr Jochen Theis
Dr Daniel Weimar
Jun.-Professor Dr Jens Wrona
Jun.-Professor Dr Lilia Zhurakhovska

junior professorship of Professor Rouven Schur and, further afield, the chair of Professor Torsten J. Gerpott are the main points of contact in this new research area. Operations Research/Logistics is also a part of the 'Urban Systems' research profile at UDE. The MSM seeks to expand the new key research area further and establish another in the near future.

Outlook

When it was founded, the Faculty was primarily practice-oriented. Over the past four decades, however, it has gradually established and developed its research profile. Besides the industry collaborations and projects that go hand in hand with all applied science, the MSM currently targets outstanding publications and highly competitive third-party funding for its research. During the past few years, it has achieved promising results in research rankings, and it will focus on stabilising that development in future.

Operations Research/Logistics has recently developed into a new key research area at MSM, adding to the existing specialisms of Accounting/Finance, Economics and East Asian Economics. The professorial chairs of Professor Alf Kimms, Professor Jochen Gönsch, Professor Michael Manitz, the recently appointed

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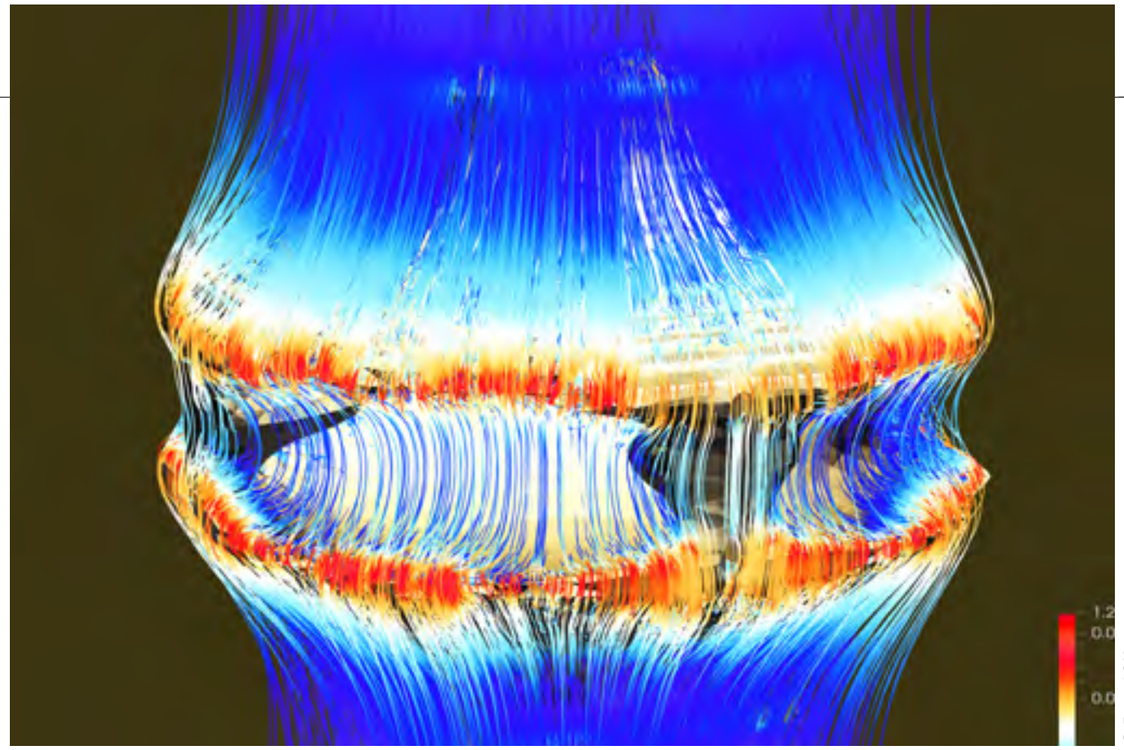

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Shape optimisation of type-II superconductors

Faculty of Mathematics

The Faculty of Mathematics consists of 29 research groups, making it one of Germany's largest mathematics faculties. Its research represents a broad cross-section of the many developments taking place in the discipline. They range from application-motivated questions to curiosity-driven basic research, all closely connected by the universal nature of mathematical concepts. With a wide range of externally funded research projects across the full spectrum of specialisms, the Faculty offers an attractive and international environment for early-career academics to contribute to the latest advances in mathematics. The ongoing pandemic also highlights our work in the field of mathematics education, which explores the opportunities inherent to digital tools.

All our research groups belong to one of the following key areas:

- Algebraic geometry and arithmetic
- Analysis, numerical analysis and optimisation
- Stochastics
- Mathematics education

They are closely interconnected. Our research groups have been able to secure external funding for their projects across the board, which confirms the success of our strategic orientation. During the reporting period, our faculty members were funded within the scope of five Priority Programmes of the German Research Foundation (DFG), three research training groups, two Collaborative Research Centres (SFB) and one European Research Council (ERC) Advanced Grant, in which they were involved either as leaders or scientific contributors. Further funding sources include other DFG projects, the Humboldt Foundation, various programmes of the Federal Ministry of Education and Research and other research institutions. The past two years saw several highlights, including Professor Marc Levine's acquisition of the ERC Advanced Grant 'QUADAG – Quadratic refinements in algebraic geometry' and the establishment of the new research training group 'symmetries and Classifying Spaces: Analytic, Arithmetic and Derived' at the Essen Seminar for Algebraic Geometry and Arithmetic.

Funded by a multitude of external sources, our research projects allow us to integrate our research groups into national and international networks and organise international conferences, workshops and summer schools in Essen. They also attract many academics from Germany and abroad, who bring their own projects with them. Two Heisenberg fellows, Andreas Nickel and André Chatzistamatiou, have chosen our Faculty as the basis for their research. The international researchers Professor Paul Arne Østvær, Professor Kazim Büyükboduk, Dr Daniel Kohen and Dr Mingshuo Zhou came to our faculty as visiting scholars with funds from the Humboldt Foundation, other exchange programmes and their own contributions. A very high percentage of researchers working on the projects of our research groups have an international background. Two Mercator fellows at the newly established research training group further strengthen this international exchange. The international master's degree programme of the ALGANT Network attracts outstanding, advanced students from all over the world to Essen. They join us at an early stage of their university education and often go on to have a successful academic career after graduating.

In the following section, we take our readers on a tour of our key research areas by presenting a select few projects. A full overview would exceed the scope of this report. The universal nature of mathematical structures is a recurring topic at our faculty. Although it is often applied to specific issues in a narrow field, it can express and explain a wide variety of phenomena across disciplines. Our tour takes us from basic research in the field of number theory to partial differential equations and our application-motivated projects. On the way, we will pass financial mathematics, superconductivity and projects focusing on digital transformation and inclusion in mathematical education.

The ERC project QUADAG

Professor Marc Levine has been awarded the ERC Advanced Grant on quadratic refinements in algebraic geometry for a five-year research project in the field of motivic homotopy theory. Levine has been an influential contributor to this field for many years. His project is based on the combination of methods in algebraic geometry with those of homotopy theory. The algebraic foundation of the former ensures that a good local understanding of objects always facilitates global conclusions through long-distance effects. In the latter, geometry facilitates highly flexible deformations at the local level without global effects. A combination of these opposed approaches, which were originally developed to solve issues in number theory, has been applied to many fields of mathematics, including mathematical physics.

For his ERC project, Professor Levine has developed new methods that open up additional fields of application. His goal is to use quadratic refinements to establish new connections between real algebraic geometry, tropical geometry, singularities and objects in number theory.

The project has already attracted four new international members – two post-doctoral researchers and two doctoral candidates – to the Essen-based research group. It originated from the DFG Priority programme 1786, 'Homotopy Theory and Algebraic Geometry', whose researchers from the eponymous areas have been working to find new connections such as those studied in the new ERC project since 2015. Multiple research groups at our faculty are involved in this programme. Over the reporting period, we were able to organise two international conferences and one international doctoral research school on the topic of motives and stacks in Essen.

Algebraic Geometry and Arithmetic: the research training group 'symmetries and Classifying Spaces'

This year, the research training group 'symmetries and Classifying Spaces: Analytic, Arithmetic and Derived' was established at our faculty. Its research groups from the Essen Seminar for Algebraic Geometry and Arithmetic aim to capitalise on the numerous interfaces of their research projects for doctoral training in an extraordinarily dynamic field. The group leaders are Massimo Bertolini, Ulrich Görtz, Daniel Greb, Georg Hein, Jochen Heinloth, Jan Kohlhaase, Marc Levine, Ursula Ludwig, Andreas Nickel and Vytautas Paskunas.

Symmetries and the classification of geometric objects are key issues in mathematics and, in particular, the various approaches to algebraic geometry: classical algebraic geometry, complex geometry, arithmetic geometry, derived algebraic geometry and other fields at the intersection of algebraic geometry, analysis and topology. Our research focuses on groups that describe symmetries of geometric, analytic and number-theoretic objects and classifying spaces, i.e., spaces that parametrise all objects of a given type, to varying degrees. The two topics are often closely connected.

Enormous progress has been made over the past years: the theory of perfectoid spaces, the Langlands programme, progress on the Birch and Swinnerton-Dyer conjecture and the minimal-model programme are famous examples. The development of new methods allows the field to advance rapidly, and new breakthroughs are on the horizon. This makes it a promising field of research for young mathematicians looking to start their careers. With a multitude of methods in use, doctoral candidates benefit from working in an environment where they have access to expertise in many of the numerous approaches. The Faculty of Mathematics offers such a stimulating environment to its early-career researchers in Essen. Our doctoral candidates are supported in their transitions from students to researchers and get to establish themselves in a fascinating mathematical field.

We will outline some of the results produced by the research groups who have contributed to this project and emphasise the interfaces between them. The construction of integer or rational solutions to equations is a fundamental problem of number theory. The Birch and Swinnerton-Dyer conjecture describes a relationship between the structure of rational solutions and the analytically defined invariants of the underlying properties. In order to understand that mysterious relationship, it seems inevitable that we must develop methods for constructing arithmetic solutions using analytical objects. Professor Bertolini's research group has proven new results of this type for p-adic L-functions.

Professor Paskunas's group was also able to use p-adic methods to produce new global, arithmetic results, also taking advantage of the local geometry of classifying spaces. These classifying spaces formally resemble the spaces of spaces of representations of groups arising in geometry, which the research groups of Professors Greb, Hein and Heinloth study. In both situations, the same issue occurs: the global geometry of the problems frequently exhibits pathologies which lead to stability conditions for the objects parametrized by these spaces. Surprisingly, analytic descriptions, which may often be formulated in terms of stability results for solutions of certain differential equations, also yield conditions that can be understood in purely algebraic terms. To understand the relationship between these stability conditions and the geometry of the parameter spaces, the researchers were able to prove results that allow them to reduce the study of stability properties to a few key conditions. Because the spaces thus obtained often exhibit singularities, it is difficult to approach them with analytic methods. Dr Ursula Ludwig's work focuses on this obstacle and expands it to include fundamental analytical methods for interesting classes of singularities.

Analysis – nonlinearity, memory effects and randomness

In the field of analysis, we introduce Professor Petra Wittbold's and PD Dr Aleksandra Zimmerman's work on nonlinear evolution equations. Evolution equations are used to describe the temporal development of systems. Complex issues in biology, medicine, physics, engineering, economics and the social sciences require nonlinear models for adequate description.

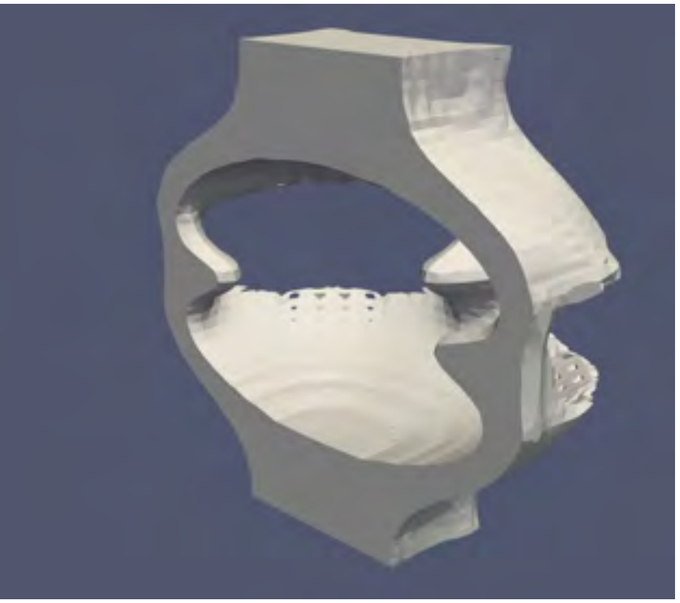
Memory effects and random effects are an important factor in describing the development of such processes, as they influence the present and the future of humans and materials alike. Take filtration processes as an example: if a liquid flowing through a porous medium contains particles that interact with that medium (e.g., by settling in its pores), its flow behaviour will change with time. This is a typical memory effect. Random parameters are introduced into the models in order to account for the heterogeneity of the medium, interactions on various scales and the inaccuracy of measured data. Over the past two years, there has been a lot of research into whether nonlinear evolution equations with memory and random effects are well posed. Many projects were carried out in collaboration with mathematical institutes in Brazil and France. Within the scope of her own externally funded project, Dr Aleksandra Zimmerman has worked with an interdisciplinary research group from the Laboratoire de Mécanique et d'Acoustique (LMA) of Aix-Marseille University on modelling the interfaces of composite materials in consideration of stochastic effects.

Professor Paola Pozzi's research group focuses on geometric aspects of evolutionary processes. In particular, its members were able to produce new results in the field of curvature flows. These flows describe changes in surfaces occurring due to physical processes, which are often described in terms of the minimisation of surface tensions. They can also be used to obtain classification results on the shape of geometrical structures in cases where it can be proven that the limits of the flows have special geometrical properties. A collaborative project between mathematicians from Australia and Japan was able to obtain new existence results for such flows. In the years ahead, the researchers will work on questions on the long-term evolution of networks under various flows, working with research groups in Ulm and Taiwan within the scope of the DFG project on the flow of elastic networks.

Dean: Professor Dr Georg Weiss

Stochastics: evolving networks and nonlinear dynamic processes

The research group on probability theory focuses on networks for modelling complex systems with many interdependencies. Interactions in complex systems are often represented by networks. One problem inherent to this approach is that in real-world problems, the structure of



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Shape optimisation of type-II superconductors

those networks changes with time due to interdependencies. The processes themselves influence the topology of the network, as connections disappear and new ones appear. At the same time, the structure of the network also has a considerable impact on the processes. Within the scope of multiple DFG-funded projects, Professor Anita Winter's research group has developed analytical and probability theory methods that facilitate the mathematically rigorous description of both effects. In the project 'Evolving Pathogen Phylogenies: a Two-Level Branching Approach', funded under the DFG Priority Programme 'Probabilistic Structures in Evolution', the researchers developed a model for describing virus populations influenced by cell division processes, in particular, their long-term behaviour.

Additional projects have been launched in the same field. They are taking place within the scope of the DFG Priority Programme 'Random Geometric Systems'. One of its members, Dr Anton Klimovsky, is an early-career researcher from our faculty. He is contributing an independent project to the programme.

The research group on applied stochastics has secured funding for various projects within the scope of their membership of the CRC 'statistical Modelling of Nonlinear Dynamic Processes'. Their work also focuses on similar mathematical structures that may be applied to problems in financial mathematics as well as hearing acoustics. One of the group's recent projects has produced new results on variance reduction in Markov chains. Variance reduction methods are important tools for reducing complexity in simulation-based, numerical algorithms, such as various Monte Carlo methods. They are also widely used in Bayesian statistics and machine learning.

Issues in machine learning are also a key topic of other research groups that focus on numerical methods, such as Professor Martin Hutzenthaler's group (stochastics) and Professor Johannes Kraus's group (numerics).

Numerics and optimisation: non-smooth variational problems for modelling superconductivity and friction

Below a critical temperature, electrical resistance vanishes in superconducting materials. Electricity is transported virtually without losses.

Disc brakes, such as those used in bicycles, generate the braking action through friction between the brake pads and the brake disc. This friction depends on the surface structure of the brake pads.

With the exception of the present report, these two topics are unlikely to be discussed in the same context.

But mathematical modelling of the physical processes of superconductivity and frictional contact leads to similar mathematical problems. Both are the focus of the DFG Priority Programme 'Non-Smooth and Complementarity-Based Distributed Parameter Systems: Simulation and Hierarchical Optimization'. Professor Irwin Yousept's and Professor Gerhard Starke's research groups are participating in the priority programme throughout its entire period from October 2016 until October 2022. The mathematical similarity between the questions lies in the term 'non-smooth'.

The relevant process variables – current density in the case of superconductivity, tension in the brake pad in the case of friction – are not clearly influenced by the created fields in all parameter areas. Instead, they have a 'kink' in the most interesting area: when reaching the critical current density and during the transition from adhesion to sliding, respectively.

In the mathematical description of the processes, these 'kinks' are variational inequalities. In the past decades, a comprehensive solution theory and numerical methods have been developed to construct approximations of such variational inequalities efficiently. Adaptive mesh refinements based on error estimators are an important component of the solution strategy, as they ensure that the dimension of discretised problems does not become excessive. The strategy further involves suitable iterative processes for approximating a solution to the discretised problems, which are still highly non-linear and non-smooth. Complementarity conditions incorporating Lagrange multipliers play a role in both sub-aspects.

The established methods for variational inequalities are not directly applicable to the problems our sub-projects seek to solve, however. We are working with hyperbolic evolution variational inequalities (in the superconductivity problem) and quasi-variational inequalities (in the friction problem). In the first case, time-dependent irregularities in current densities and singularities in the electromagnetic fields may occur; in the second case, the variation formulation itself depends on the solution. Both projects yielded enough research topics for one doctoral dissertation each, followed by plenty of post-doctoral research.

Mathematics education: new students, digital media and inclusion

The four research groups in the field of mathematics education are closely interlinked with each other within the University of Duisburg-Essen and at the national and international level. They participate in the several joint projects, such as the programs 'Bildungsgerechtigkeit im Fokus' and 'ProViel' funded by the Federal Ministry of Education and Research and the German Centre

Selected Publications

Bögelein, V., F. Duzaar, C. Scheven (2020): *Higher integrability for the singular porous medium system. J. Reine Angew. Math. 767, 203–230.*

Burtscheidt, J., M. Claus, S. Dempe (2020): *Risk-Averse Models in Bilevel Stochastic Linear Programming SIAM Journal on Optimization, 30(1), 377–406.*

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Emerton, M., V. Paškūnas (2020): *On the density of supercuspidal points of fixed regular weight in local deformation rings and global Hecke algebras. J. Éc. polytech. Math., 337–371.*

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Professors

Professor Dr Bärbel Barzel
Professor Dr Denis Belomestny
Professor Dr Massimo Bertolini
Professor Dr Mircea Birsan
Professor Dr Andreas Büchter
Professor Dr Christian Clason
Professor Dr Ulrich Dierkes
Professor Dr Andreas Gastel
Professor Dr Heiner Gonska
Professor Dr Ulrich Görtz
Professor Dr Daniel Greb
Professor Dr Lisa Hefendehl-Hebeker
Professor Dr Georg Hein
Professor Dr Jochen Heinloth
Professor Dr Martin Hutzenthaler
Professor Dr Volker Krätschmer
Professor Dr Johannes Kraus
Professor Dr Jan Kohlhaase
Professor Dr Marc Levine
Professor Dr Frank Müller
Professor Dr Patrizio Neff
Professor Dr Vytautas Paskunas
Professor Dr Paola Pozzi
Professor Dr Arnd Rösch
Professor Dr Florian Schacht
Professor Dr Petra Scherer
Professor Dr Christoph Scheven
Professor Dr Rüdiger Schultz
Professor Dr Gerhard Starke
Professor Dr Heinz Steinbring
Professor Dr Mikhail Urusov
Professor Dr Georg Weiss
Professor Dr Anita Winter
Professor Dr Petra Wittbold
Professor Dr Irwin Yousept

for Mathematics Teacher Education (DZLM), initiated by the Deutsche Telekom Stiftung.

Digital media are an important aspect that connects the activities of all research groups. Various research and development projects are dedicated to the role and utilisation of digital media in mathematics lessons at primary and secondary level, in higher education and in teacher education. Their topics include potentials for the (summative and formative) diagnosis of learning progress and processes, the use of digital media in teacher education, and the role of digital textbooks in mathematics teaching. Due to the coronavirus pandemic, these issues are more relevant today than they have ever been. This is reflected in various activities of the research groups: they rapidly provided new supporting materials for mathematics teachers and analysed the currently used technologies in the international study 'Math@Distance', a joint endeavour with colleagues from Belgium and the Netherlands. The project highlighted stark differences in the way the countries approach remote teaching.

The new project 'Digimal.nrw', which focuses on digital mathematics teacher education in North Rhine-Westphalia, was awarded to the Faculty as early as May. Professor Petra Scherer and Professor Florian Schacht's research groups will be leading the research consortium. The project seeks to achieve targeted improvements to mathematics teacher education at the primary level.

Other projects of our research groups focus on the growing importance of professionalism in teaching in order to prepare budding teachers for the challenges they will face in their work (e.g., digital transformation and inclusion). In collaboration with the German Centre for Mathematics Teacher Education (DZLM), our groups are organising professional development opportunities for multipliers and a nationwide programme to furnish them with basic qualifications. The Centre's developmental department is co-managed by our Faculty's Professor Bärbel Barzel. Various doctoral and post-doctoral projects explore issues of professionalism in mathematics education.

Others address the topic of inclusion and inclusive mathematics teaching. Apart from the development of class-based learning environments, our research covers the design and evaluation of courses, competence development in students, and studies into professional education for teachers.

It takes place in the form of multiple projects, including doctoral dissertation projects, which are closely interlinked. Besides seeking to find ways to gauge the learning capabilities of new students, our scholars focus on research-based methods for advance teaching practices. They include the systematic development of exercises in consideration of learning and problem-solving strategies and the use of supplementary e-assessment tasks or interactive, dynamic visualisations. The Faculty was able to establish a structured range of digital services, which are now used in a wide range of courses for new students. Acceptance of the new services is high. During their development, the researchers behind the project analysed many traditional exercise formats in terms of their digitisation potential and implemented them accordingly.

Conferences, workshops, summer schools

- 'Motivic Homotopy Theory and Refined Enumerative Geometry'
- 14. Doctoral candidates' meeting: stochastics
- Autumn meeting of the group 'Lehr-Lern-Labore'
- Autumn meeting of the group 'Mathematikunterricht digitale Werkzeuge'
- Workshop on prismatic cohomology
- Hausdorff Trimester Programme 'Evolution of Interfaces'
- Workshop 'stochastic Optimization and Related Topics'
- 14th International Conference on Technology in Mathematics Teaching (ICTMT 14)
- Summer School 'Motives and Stacks'
- PP 1786 annual conference
- PP 1590 workshop 'Evolutionary Forces and Genealogical Trees'
- Workshop 'Fundamentals of Complex Networks: From Static Towards Evolving'

Awards and honours

In 2019, Professor Rüdiger Schultz was awarded the research prize of the Gesellschaft für Operations Research.

Outlook

The projects described above lay the groundwork for further research in the years ahead. The Essen Seminar for Algebraic Geometry and Arithmetic (ESAGA) will be focusing on the establishment of a research training group and the associated research programme. We have received an extraordinarily high number of outstanding applications for our new doctoral studentships and are optimistic that the young academics will make interesting contributions to our faculty. Within the scope of the ERC project, Marc Levine has put together an active, international group of early-career researchers who will be shaping this active field in future. The DigiMal.nrw project is a new collaboration; its first members have been confirmed recently.

At the Faculty itself, two appointment processes are nearing completion: that for the tenure track junior professorship of algebra and number theory and that for Marc Levine's successor. Both will influence the character of our faculty.

© Foto: Bettina Engel-Albustin

At a mathematics seminar

Our researchers in the fields of analysis and numerical analysis are working on further collaborative projects, and a new call for papers will be issued in analysis. The coming years will offer many new catalysts for exciting developments.

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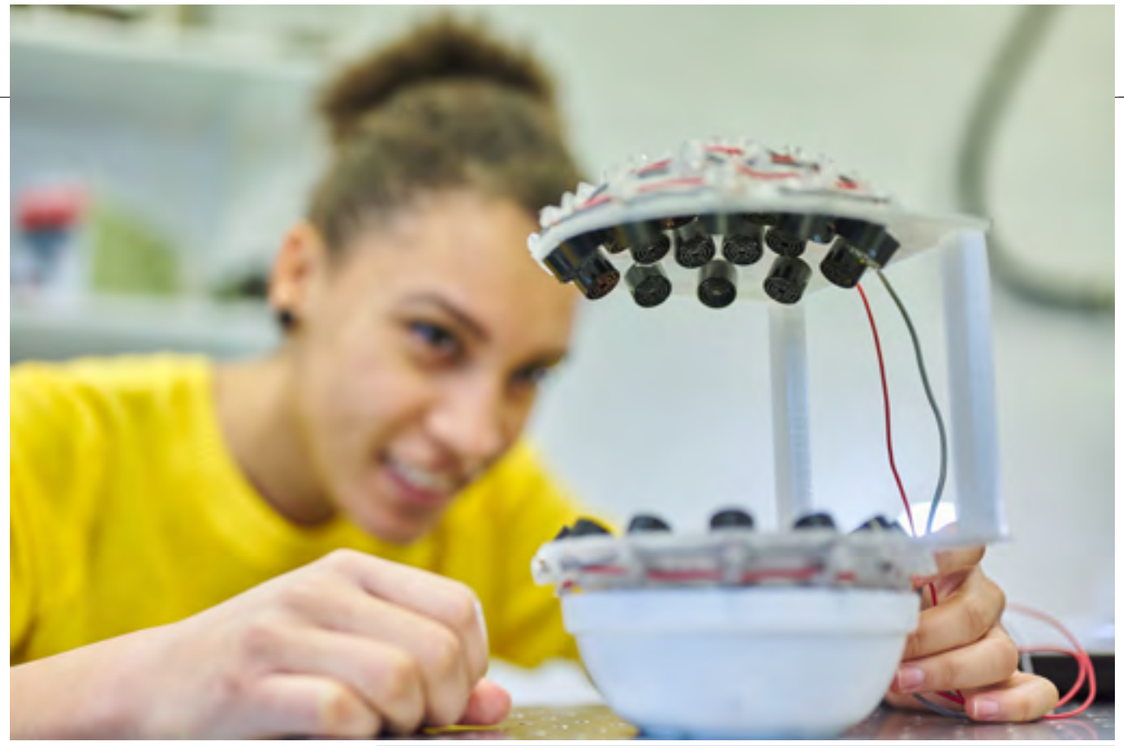

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Contactless examination of suspended particles in an acoustic trap

Faculty of Physics

While 2019 was largely unaffected by the coronavirus, the pandemic soon became the defining aspect of 2020. The research that has been conducted under pandemic conditions is vastly different from that carried out in the past.
Nonetheless, this research report clearly demonstrates that the scientists of the Faculty of Physics were able to work on a wide range of very interesting topics in the past year. Professor Heiko Wende and his team are exploring ways of solving the problem of heat generation in microelectronics, for instance. Professor Axel Lorke's research group seeks to trace the movement of a single electron within an electronic component. Professor Marika Schleberger's group grapples with the question of whether it is feasible to develop a graphene-based pressure sensor that can detect gases with the highest possible precision. The team around Professor Michael Schreckenberg studies communication between automated and non-automated road users and the question of whether it can improve the efficiency and safety of road traffic.
Major milestones of the past two years included the Faculty's participation in the newly established DFG Collaborative Research Centre/Transregio CRC/TRR 270 'Hysteresis Design of Magnetic Materials for Efficient Energy Conversion' in 2019 and the extension of CRC 1242 'Non-Equilibrium Dynamics of Condensed Matter in the Time Domain'.

Pretty tiny – from individual electrons to nanoparticles

From individual electrons to new electrochemical applications

Professor Axel Lorke and Dr Paul Geller were able to trace the movement of individual electrons through an electronic component within the scope of several DFG-funded projects. Minuscule semiconductor nanoparticles called 'quantum dots' display characteristic optical properties depending on their charge state. A single electron determines whether a quantum dot emits light when exposed to laser irradiation. If its charge state changes, the dot produces a characteristic flashing pattern, which shows whether it has just captured or emitted an electron. Professor Jürgen König's research group has evaluated these 'optical telegraph signals' together with the CRC 1242 team.

Metal nanoparticles made from platinum are used to convert chemical into electrical energy, for example, in fuel cells or when generating hydrogen as a power source. For the EU-funded project 'MoreInnoMat', Dr Nicolas Wöhrl of Professor Axel Lorke's research group successfully worked with Professor Stephan Schulz's (Chemistry) group on developing a process for synthesising carbon nanowalls with embedded platinum nanoparticles. In the process, for which a patent application has been filed, two-dimensional carbon atom layers (graphene) are closely connected to platinum nanoparticles, which makes the structure particularly sturdy for practical application.

Nanoscale magnetic systems

Professor Michael Farle's research group studies the properties of nanoscale magnetic systems. Synthesis of new materials has enabled a variety of new applications, such as the use of efficient permanent magnets in electric motors and magnetocaloric materials in innovative cooling technologies. The researchers are studying these and other applications intensively within the scope of the new DFG Transregio CRC/TRR 270, working together with colleagues from TU Darmstadt. Besides nanoparticles for additive manufacturing (3D printing), they are producing special magnetic Heusler compounds, in which small ferromagnetic particles (< 2 nm) in an antiferromagnetic matrix exhibit very high coercivity at room temperature.

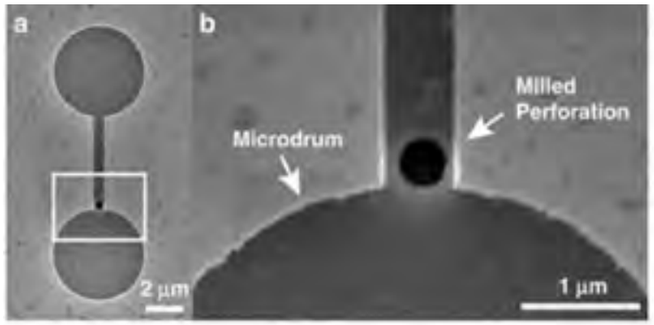
Researchers in the DFG project 'Magnetic Landscapes' use laterally periodically modulated magnetisation to examine ultra-thin layers and control spin wave phenomena in the sub-terahertz range. Another key research area is the development of hybrid nanoparticles for medical theranostics. This is the focus of the EU-funded 'MaNaCa' project, a collaborative endeavour involving colleagues from Greece and Armenia. Its combination of therapy and diagnostics in magnetic nanoparticles paves the way for new approaches to treating cancer.

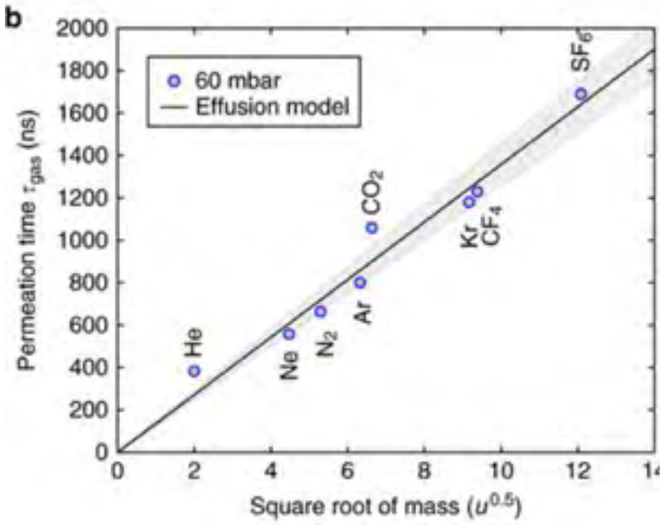
The effect of the hot electron

You may not really see them, but you can still trace the energy flow with your naked eye. It's a bit like thumbing through a flip book: a team of scientists from the groups of Professor Uwe Bovensiepen, Professor Rossitza Pentcheva and Professor Heiko Wende has investigated energy transfer in a metal insulator material. In the long term, their findings may contribute to a solution for the problem of heat generation in microelectronics through precise material design. Any attempt to get to the bottom of this phenomenon will inevitably lead to the atomic level and, as such, to electrons making their way through various materials. But how exactly do they do this?

That is what UDE physicists are studying in CRC 1242 'Non-Equilibrium Dynamics of Condensed Matter in the Time Domain'. They have analysed the layer structures of the metal insulator material using a pump-probe process. A laser pulse feeds energy into the system. This energy stimulates the electrons and 'heats them up', so to speak. Soon after, an X-ray determines from a snapshot how the 'hot' electrons spread through the material.

The result: the hot electrons stimulate the metal lattice within less than a picosecond. Almost simultaneously, the interface between the materials begins to oscillate. Surprisingly, the insulator reacts just a picosecond later. Theoretical simulations have confirmed the significance of interface oscillations.





Electron microscope image of a graphene pressure sensor. The permeation time through the membrane shows a linear increase with the square root of the particle mass.

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Nanoparticles in the quantum regime

Quantum physics describes the microcosm perfectly. If we apply it to large objects rather than to atoms or photons, however, it tend to produce predictions that turn our traditional views of the world upside down. According to these predictions, a single object should be able to exist simultaneously in multiple places and even change its behaviour depending on whether or not it is observed. Professor Klaus Hornberger's research group studies systems that straddle the boundary between this quantum regime and traditional physics.

One of its research highlights in the past two years was the quantum-mechanical description of nanoparticles that are suspended by laser light and, as such, largely uninfluenced by environmental factors. The researchers have recently developed a feasible method of putting such a nanoparticle into the quantum-mechanical basic state of its centre-of-mass motion and rotational motion, i.e., cooling it to absolute zero. This method may be a point of departure for future fundamental experiments and technological applications on which the research group is working.

Electron tunnelling in quantum dots

The flow of electrical currents through conventional circuits involves a vast number of electrons. When circuits are realised in nanostructures, i.e., made very small, however, the current can be transported by much fewer electrons. During the transport of current through a quantum dot, individual electrons exhibit the tunnel effect: they successively jump back and forth between the electricity supply and the quantum dot. Such quantum jumps constitute the smallest possible unit of current transport. Their measurement provides the greatest possible amount of information that can be extracted from the system.

Professor Jürgen König's group develops theoretical tools that makes it possible to analyse electron tunnelling in quantum dots statistically in order to obtain important information about the underlying system. A highlight of this project has been the application of their theory to experiments carried out in Professor Axel Lorke's research group, in which electron tunnelling in quantum dots was measured with high precision using time-resolved methods. This allowed the researchers to determine the spin-relaxation time of an electron in a quantum dot among other insights.

Pretty flat – from thin layers to 2D materials

Two-dimensional magnetic semiconductors

Within the scope of its ongoing theoretical research into novel two-dimensional materials, Professor Peter Kratzer's research group has recently begun to examine materials with magnetic properties. Chromium(III) iodide CrI3 is a well-known member of this class of materials. A stack of atomically thin single layers that are magnetised in the same or different directions could function as an extremely compact, magnetic store of information in future. Due to variable electrical resistance, a current flowing perpendicular to the layers can be used to read stored information. Using a special calculation process, members of Professor Peter Kratzer's research group have successfully modelled the magnetic interaction between the layers and the ratio of resistance with identical and divergent magnetisation of the atomic layers in line with the experimental data. Their results may provide a basis for identifying alternative candidates for envisioned applications, i.e., materials with an altered chemical composition and, as such, enhanced magnetic functionality.

Nanoscale materials for energy conversion

Professor Rossitza Pentcheva's research group uses high-performance computing systems for nonparametric quantum-mechanic modelling of novel materials used in electronic components and energy conversion.

Within the scope of CRC/TRR 80, researchers are studying the occurrence of new electronic phases at transition metal oxide interfaces. This includes topologically non-trivial states in oxide superlattices with honeycomb patterns and ultra-thin films whose properties change drastically under extreme tension, e.g., from a ferromagnetic metal to an antiferromagnetic insulator. Further research focuses on improving thermoelectrical properties by taking advantage of reduced dimension, e.g., in oxide heterostructures. This has led to a European patent. In CRC/TRR 247, researchers optimise anode materials for water splitting by precisely modifying their structural motifs, chemical composition and defects. CRC 1242 focuses on modelling the propagation of laser pulses through metal-insulator interfaces on an ultra-short time scale and the accurate description of spectroscopic properties through many-body theory. Last but not least, the newly established CRC/TRR 270 investigates how a combination of magnetism and lattices can increase the efficiency of magnetocaloric materials.

Dean: Professor Dr Michael Schreckenberg

Thin materials: graphene

Ultra-thin materials are en vogue. Right after their discovery, these materials with a thickness of only few atomic layers mostly attracted the attention of basic research. Recently, however, application-oriented research has become increasingly interested in them, too. The European Union recognised this potential at an early stage and established the Graphene Flagship in 2013. Within the flagship, a team of researchers from the Delft University of Technology (Professor Peter Steeneken's research group), the Université Basse Normandie and the University of Duisburg-Essen (Professor Marika

Professors

Professor Dr Uwe Bovensiepen
Professor Dr Richard Kramer Campen
Professor Dr Michael Farle
Professor Dr Thomas Guhr
Professor Dr Manuel Gruber
Professor Dr Hendrik Härtig
Professor Dr Klaus Hornberger
Professor Dr Michael Horn-von Hoegen
Professor Dr Boris Kerner
Professor Dr Jürgen König
Professor Dr Peter Kratzer
Professor Dr Axel Lorke
Professor Dr Samir Lounis
Professor Dr Frank Meyer zu Heringdorf
Professor Dr Martin Mittendorff
Professor Dr Rolf Möller
Professor Dr Hermann Nienhaus
Professor Dr Rossitza Pentcheva
Professor Dr Marika Schleberger
Professor Dr Martina Schmid
Professor Dr Claus M. Schneider
Professor Dr Michael Schreckenberg
Professor Dr Klaus Sokolowski-Tinten
Professor Dr Björn Sothmann
Professor Dr Heike Theyßen
Professor Dr Heiko Wende
Professor Dr Dietrich Wolf
Professor Dr Andreas Wucher
Professor Dr Gerhard Wurm

Schleberger's research group) has successfully built a graphene-based pressure sensor that can detect gases with extremely high precision. In this process, a small gas reservoir is sealed with a graphene layer that is less than a nanometre thick and perforated with defined pores. What is special about this sensor is that it does not rely on chemical reactions. Instead, detection is based on the permeation time of gases through the porous graphene membrane, which simultaneously functions as a gas pump and a pressure sensor. The idea behind it is simple: light gases are faster, so they escape the reservoir sealed by the membrane more quickly than heavy gases do. This system has a range of advantages over conventional sensors: the sensor is extremely small, fast and energy-efficient yet highly sensitive.

Next-generation solar cells

Material efficiency and more effective light conversion are key topics in photovoltaics. Professor Martina Schmid's research group develops next-generation thin-film solar cells. They are ultra-small or ultra-thin but still harvest sunlight efficiently when combined with optical concepts. In particular, the researchers have made important progress in their work on ultra-thin solar cells with an absorber made of Cu(In,Ga)Se2 applied to a transparent substrate. They have achieved an efficiency of nearly 13% for an absorber layer thickness of less than 500 nm, which trumps results achieved by other groups in the past. Additional improvements are expected as a result of combining the existing system with nano- and micro-optical concepts for targeted light harvesting. Ultra-thin solar cells with transparent back contacts can be used for a wide range of purposes in high-efficiency concepts and in the aesthetic aspect of building integration.

The world's thinnest films

Besides ultra-fast structural dynamics at solid-state surfaces, Professor Michael Horn-von Hoegen's research group studies the growth of the world's thinnest films. The researchers produce 2D materials, layers that are a single atom thick and exhibit completely novel properties compared to volume. They were able to decipher a new growth mode for monolayer boron or 'borophene', which is just as relevant to other materials: boron atoms are dissolved in a metallic substrate at a high temperature following the decomposition of a boronic precursor. They segregate to the surface while cooling and form a perfect monolayer of borone. The boron functions as a surfactant ('surface active agent') and smoothes the metallic substrate to grow as a perfect layer.

Pretty mobile

Physics of Transport and Traffic

Professor Michael Schreckenberg's research group 'Physics of Transport and Traffic' studies a wide range of topics related to mobility.

Within the scope of CRC 876 'Providing Information by Resource-Constrained Data Analysis', it collaborates with electrical engineers and computer scientists to analyse inner-city traffic. Its goal is to reduce traffic jams and travel times without expanding road capacity. The researchers examine various route selection optimisation methods and dynamic methods. They aim to expand the simulation model to account for the behaviour of (communicating) self-driving vehicles in order to simulate, analyse and optimise hybrid traffic.

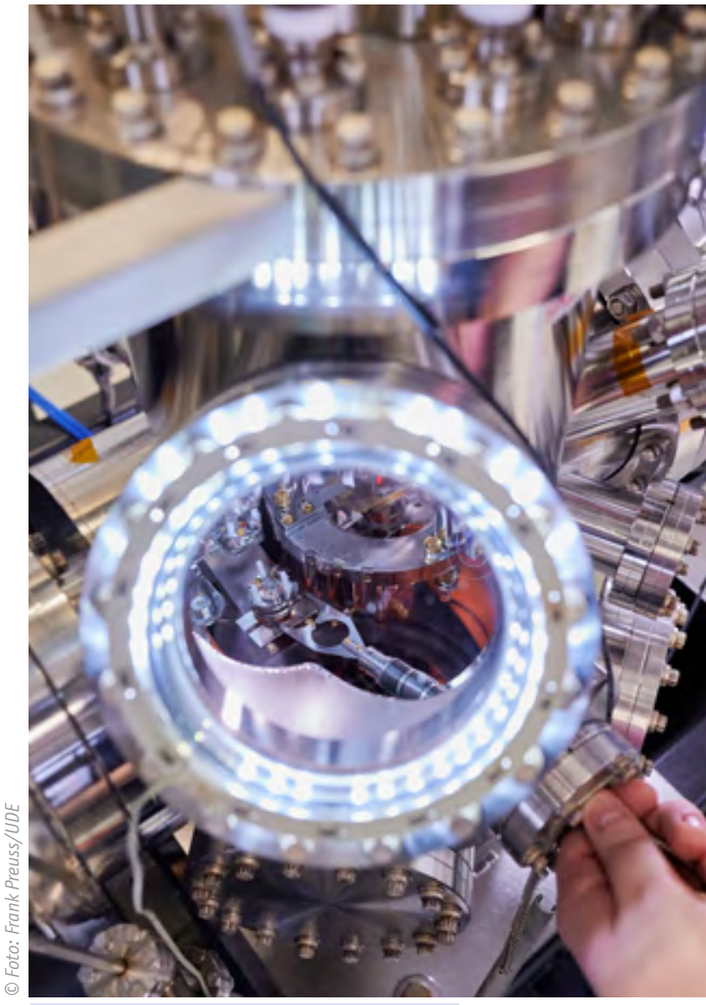
The LUKAS project, funded by the Federal Ministry of Economics and Technology, works on developing a local environmental model for cooperative automated driving. This collaborative research project aims to boost traffic efficiency and safety in the mixed traffic of urban spaces. Reliable cooperation through a fast, safe communication channel connecting automated and non-automated road users plays an important part in this endeavour.

Pretty big

Planet formation

Professor Gerhard Wurm's group focuses on planets and their formation. In a collaborative project, Professor Wurm's and Professor Dietrich Wolf's research groups at the UDE's Faculty of Physics and Professor Troy Shinbrot of Rutgers University were able to close a gap in our understanding of the formation of planetesimals. Their work has shown that particles in protoplanetary disks become electrically charged through impacts. As a result, millimetre-sized particles eventually become more stable, decimetre-sized aggregates. The process also connects various growth phases. Students of the Faculty entered and won an international competition with an idea based on these insights: they successfully investigated the discharge of particles through cosmic radiation on a high-altitude balloon.

The stability of planetesimals was also the focus of several parabolic flight campaigns. Using a low-pressure wind tunnel, researchers were able to quantify erosion boundaries at extremely low environmental pressure levels (few Pa) similar to those present in protoplanetary disks. The planet Mars was one of the group's research subjects, too. In the lab, they evaluated various known and novel processes that could potentially explain how ground particles can reach the thin atmosphere of Mars, which can be engulfed in a global cloud of dust over periods of months.



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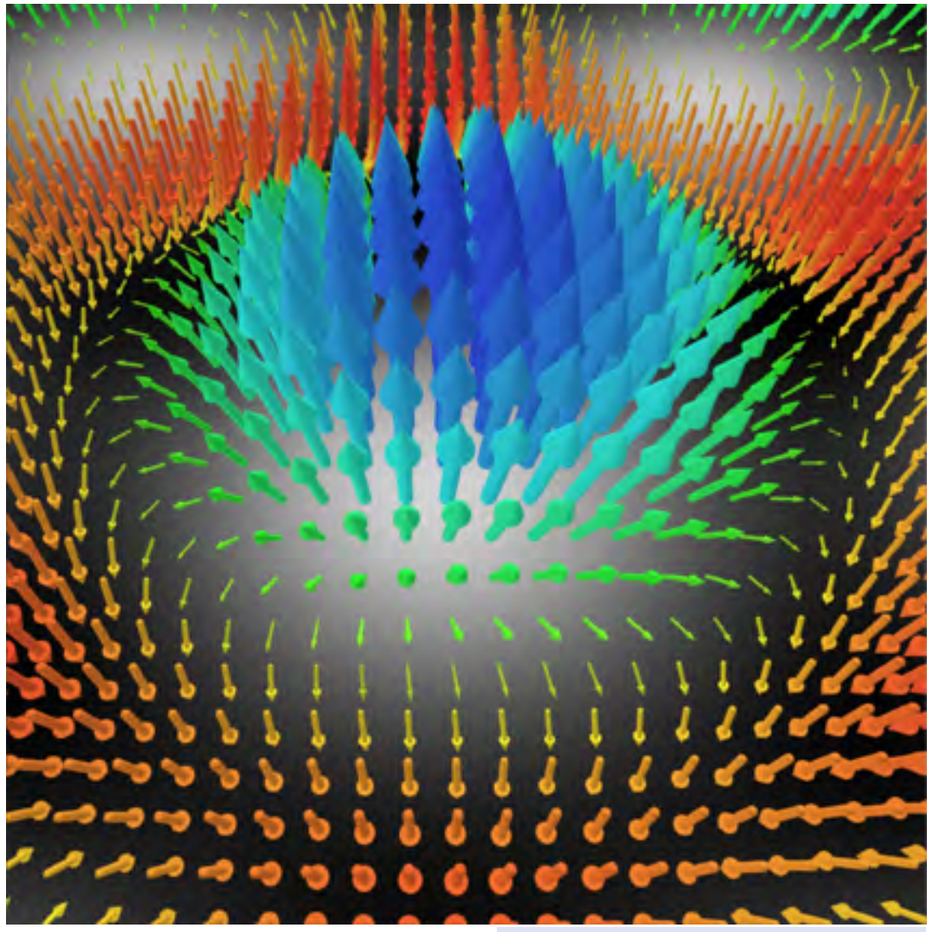
View into the vacuum chamber of an atomic force microscope during a sample change

Now I've got it – physics education

The research groups in the field of physics education conduct basic and developmental



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Reconstruction of the vector field of a plasmonic skyrmion created from experimental data

research into the acquisition of physics proficiency. Professor Heike Theyßen's and Professor Hendrik Härtig's research groups both conduct research in the field of experimental competencies, which involves projects on the individual advancement of experimental skills in general studies and ability-oriented experimental opportunities for pupils at lower secondary level.

The researchers in Professor Härtig's group further study the influence of language on learning physics. In this area, they plan and evaluate concrete learning opportunities and examine text comprehension difficulties in physics. Professor Heike Theyßen's group focuses on the development of diagnostic skills in teacher training students.

Pretty quick

Professor Frank Meyer zu Heringdorf's group researches the emission of electrons from electron density waves, so-called surface plasmon polaritons within the DFG Collaborative Research Centre CRC 1242. By advancing the photoemission microscopy method, the researchers succeeded in reconstructing the electric fields of such plasmon waves with a nanometre resolution and a time resolution of one millionth of a billionth of a second in three dimensions. The researchers used a first (pump) laser pulse to generated a plasmon wave on a nanostructured gold surface, which then moved across the surface at nearly the speed of light. A second (probe) laser pulse was used to image the plasmon wave in the microscope by means of nonlinear photoemission.

Ultra-fast phenomena in solid-state bodies and at surfaces

Professor Uwe Bovensiepen's and Professor Klaus Sokolowski-Tinten's research group focuses on the microscopic interaction mechanisms in play between electronic, magnetic and structural degrees of freedom in condensed matter. The group aims to gain an understanding of the energy exchange taking place between the individual sub-systems and the energy transport in nanoscale materials. Its members use measurement techniques with a high temporal and spatial resolution and a specific sensitivity for the individual degrees of freedom. The group's research spans a wide range of questions: electron dynamics at icy surfaces, spin transport in thin magnetic layers, the non-equilibrium dynamics of photonic stimulation in heterostructures, and rapid changes of the lattice structure of phase-change materials, which constitute the basis of modern electronic storage systems.

CRC 1242: 'Non-Equilibrium Dynamics of Condensed Matter in the Time Domain'

Researchers in the Collaborative Research Centre 1242 'Non-Equilibrium Dynamics of Condensed Matter in the Time Domain' seek to gain a microscopic understanding of dynamic processes in condensed matter.

Selected Publications

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Neumann, K., H. Schecker, H. Theyßen (2019): *Assessing Complex Patterns of Student Resources and Behavior in the Large Scale. The Annals of the American Academy of Political and Social Science 683 (1), 233–249.*

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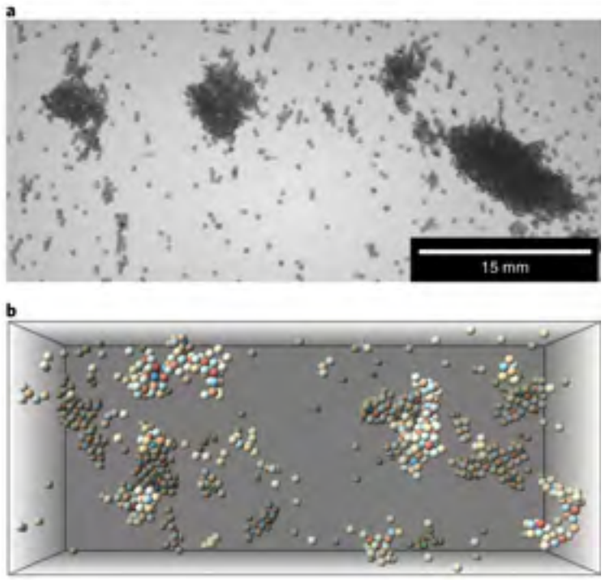

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An experiment simulating the emergence of larger, electrically charged clusters as they develop from dust particles into planets

Their studies focus on dynamics far beyond the thermodynamic equilibrium created by very brief, external stimuli. Carried out exclusively in the temporal domain, their work closely combines experimental and theoretical methods.

During the first funding period (2016–2020), the researchers developed suitable research methods and analysed and described the dynamics within individual degrees of freedom, such as oscillation of the atomic core and electrical charge.

The ongoing second funding period (2020–2024) builds on the results achieved in the years before. It focuses on manipulating the dynamics processes in non-equilibrium. This approach serves two purposes: to expand current understanding of the phenomena involved and to trial adjustments of the time periods available for potential ultra-fast applications.

CRC/TRR 270: Hysteresis Design of Magnetic Materials for Efficient Energy Conversion

New magnets for future energy technologies

From strong, permanent magnets for wind turbines to electrical engines and materials for magnetic cooling: new functional materials are an indispensable component of a successful energy transition and a low-emission future. On 1 January 2020, TU Darmstadt and the University of Duisburg-Essen jointly launched the new Collaborative Research Centre CRC 270 'HoMMage'. It will be funded by the German Research Foundation (DFG) with around 12 million euros for an initial period of four years.

Awards

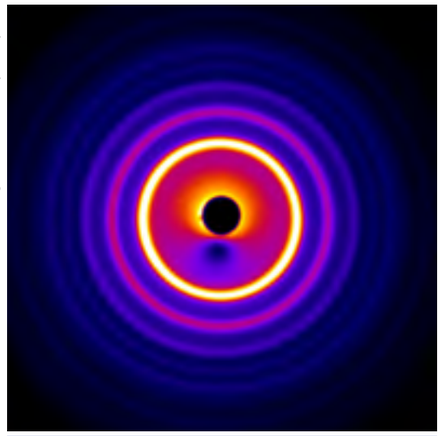
During the reporting period, several members of the Faculty of Physics won awards.

Dr Christian Schneider received a prize of 2,000 euros for his outstanding dissertation. Markus Heckschen received a prize of 1,000 euros for excellent academic performance. The CEO of Sparkasse Duisburg, Dr Joachim Bonn, and the Vice Chancellor of the University of Duisburg-Essen, presented both prizes to their recipients during a small ceremony.

Dr Nora Dörmann won the University of Duisburg-Essen's 2019 Diversity Prize in the managerial category. She is the Managing Coordinator of CRC 1242. The prize honours her commitment to supporting the group's researchers.

Dr Anna Grünebohm has secured one of the sought-after early-career research groups in the Emmy Noether Programme for her research into harmless and easily available materials for generating electricity from temperature differences or mechanical energy. The groups are endowed with 1.3 million euros in funding for a period of six years.

Professor Michael Farle has received a 'Mega Grant' (2019–2021) from the Ministry of Science and Higher Education of the Russian Federation. He researches magnetic MAX phases with Russian colleagues at the L.V. Kirensky Institute of Physics in Krasnoyarsk.



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Electron refraction pattern of an Fe/MgO heterostructure, false-colour image

Dr Mehmet Acet received the Turkic Council's renowned science award for academic and technological research in 2018 (in the 2019 ceremony) for his groundbreaking work on the inverse magnetocaloric effect.

Dr Ulf Wiedwald was honoured by the German Federal Foreign Office and the Ministry of Foreign Affairs of the Russian Federation in 2020 for his outstanding contributions to the two countries' collaboration in science and education.

Outlook

With the appointment of four new professors, the Faculty's team has become younger. The extension of CRC 1242, the establishment of the new CRC/TRR 270 and many successful individual funding applications have given the Faculty access to significant third-party resources in addition to the funding provided by the University. These granted funds verify the excellent scientific output of the Faculty and provide highly favourable conditions for resuming regular scientific work after the lockdowns – for discussing, calculating, measuring, discarding, discussing again, writing and publishing together with several hundred highly motivated students.

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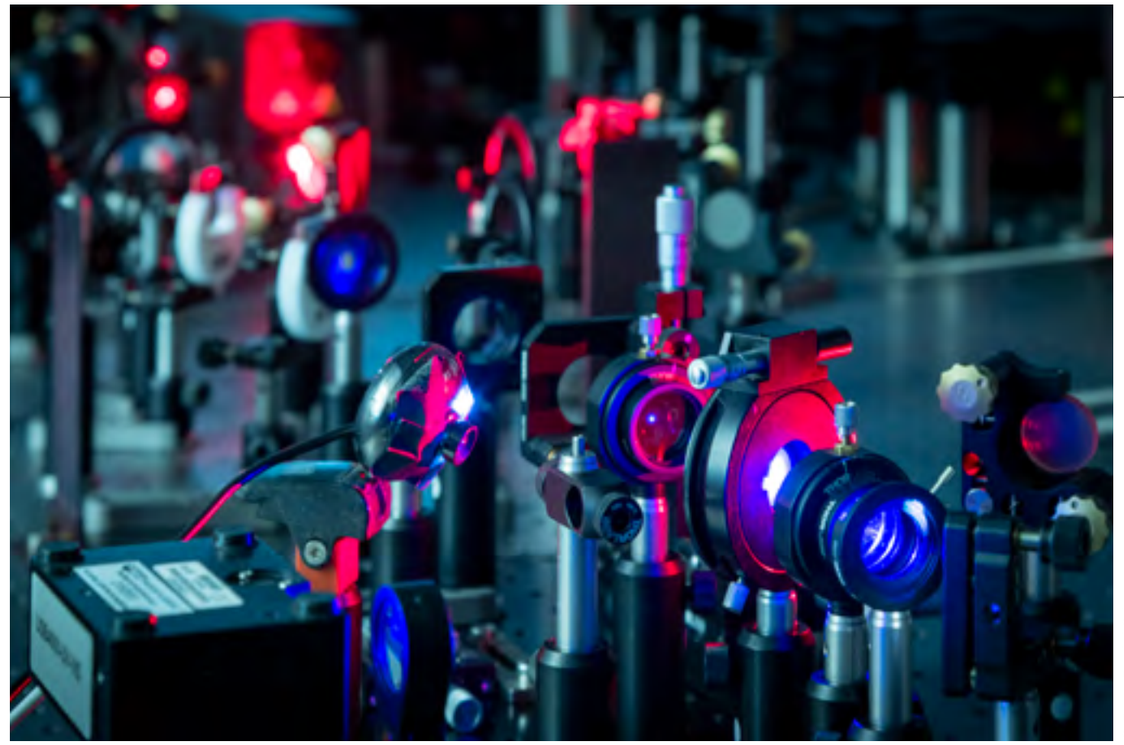


© Foto: Daniel Schumann

An optical structure for observing the four-wave mixing signal generated by three ultrashort laser pulses in a beta barium borate crystal.

Faculty of Chemistry

With around 1700 students distributed more or less evenly across its three degree programmes of chemistry, water science and teacher training in chemistry, the UDE's Faculty of Chemistry is one of the largest of its kind in Germany. Twenty-two professors and three independent junior research groups conduct research in eight fields: inorganic chemistry, organic chemistry, physical chemistry, technical chemistry, analytical chemistry, environmental microbiology and biotechnology, chemistry education, and theoretical chemistry. Between 50 and 60 young scientists complete their doctorates with us every year. Due to the interdisciplinary nature of research at our faculty, their backgrounds range from chemistry to physics, biology and the engineering sciences.

Our research covers the entire range of chemistry, from pure basic research to application-oriented topics. Many projects are externally funded. According to the latest figures, the Faculty secures more than 9 million euros in third-party funding every year, which nearly doubles its regular budget. The Faculty of Chemistry is a member of many coordinated, national research alliances, including five DFG Collaborative Research Centres (CRC), three DFG Priority Programmes (PP) and one NRW Forschungskolleg. Four of these alliances are managed and coordinated by our Faculty. We also coordinate several EU projects fully or partially, one of them being an ERC Advanced Grant in the field of environmental microbiology and biotechnology. This is in addition to many other projects funded by the German Research Foundation (DFG), the Federal Ministry of Education and Research (BMBF), the German Federation of Industrial Research Associations (AiF), the Volkswagen foundation and various industry players.

Our research is concentrated in four key areas: supramolecular chemistry with a focus on issues in biology and materials science, nanosciences with a focus on heterogeneous catalysis and energy research, water research, empirical educational research. With its expertise in these areas, our faculty is an important contributor to three of the five main research areas of the University of Duisburg-Essen. Several central academic institutes of the University are managed by members of our faculty: the Centre for Water and Environmental Research (ZWU), the Centre for Teacher Education (ZLB) and the Interdisciplinary Centre for Educational Research (IZfB). Two external institutes are associated with the Faculty: the Deutsche Textilforschungszentrum Nordwest (DTNW) in Krefeld and the Rheinisch-Westfälisches Institut für Wasserforschung (IWW) in Mülheim. Both specialise in practical, application-oriented research. Members of our faculty hold positions as academic directors at the DTNW (Professor Jochen S. Gutmann) and the IWW (Professor Rainer U. Meckenstock and Professor Torsten C. Schmidt).

Research

The two Collaborative Research Centres based at the Faculty of Chemistry, SFB/TRR 247 Heterogeneous Oxidation Catalysis in the Liquid Phase and SFB 1093 Supramolecular Chemistry on Proteins, are in their first and second funding period, respectively. Both teams are making excellent progress. Audits for a second and third funding phase, will take place over the course of the next two years. The NRW Forschungskolleg Future Water and the DFG Priority Programme 2122 Materials for Additive Manufacturing are also based at the Faculty of Chemistry; their work has been similarly successful. We presented these ongoing collaborative projects at length in the last research report. Three CRCs and CRC/TRRs were established and extended, in 2019 and 2020, respectively. The Faculty of Chemistry was a major contributor to this development. The CRC/TRR 270 Hysteresis Design of Magnetic Materials for Efficient Energy Conversion, based at TU Darmstadt, works on developing and characterising new magnetic materials as a core element of efficient energy technologies. In particular, it focuses on two major categories of magnetic materials: strong, permanent magnets based on rare-earth metals with maximised hysteresis and soft magnets with minimised hysteresis. CRC 1439, Multilevel Response to Stressor Increase and Release in Stream Ecosystems, is based at the Faculty of Biology. The project studies the impact of three selected stressors – temperature, salinisation and hydromorphological degradation – on the components of the stream food web and on ecosystem functions. CRC 1242 Non-equilibrium Dynamics of Condensed Matter in the Time Domain, based at the Faculty of Physics, has been extended. In its first funding phase, the researchers deepened their understanding of these dynamics. Now, the project focuses on manipulating non-equilibrium dynamics through ultrashort, pulsed external stimuli, such as light, pressure and tension. Professor Eckart Hasselbrink's and Professor Sebastian Schlücker's research groups, both from the field of physical chemistry, represent the Faculty of Chemistry in the project. They apply methods of ultrashort

laser spectroscopy (IR/Raman) to observe the behaviour of molecules on surfaces.

Scientists of the Faculty of Chemistry have been working on two projects on the origin of life for several years. The collaborative project of Professor Christian Mayer, Professor Oliver J. Schmitz and Professor Ulrich Schreiber involves deep drilling in the Eifel in order to corroborate the theory of the emergence of the first protocells in the depth of Earth's crust. The core samples, collected from a depth of about one kilometre, are analysed at the Applied Analytical Chemistry group to determine whether they contain any possible precursors of biomolecules that were created in the geological environment. All results are compared with analyses of Australian quartz crystals that are more than three billion years old. Notably, there are long-chain hydrocarbons which were oxidised and spontaneously formed membranes due to their amphiphilic properties. The analysis also found amino acids and precursors of nucleotides. Our physical chemistry team now manages a research group of the German Astrobiological Society (DAbG) focusing on prebiotic chemistry. The team's work on peptide evolution in deep-reaching tectonic faults has continued.

In the second origin-of-life project, which has been funded by the Volkswagen Foundation since 2019, Professor Bettina Siebers, Dr Christopher Bräsen and Dr Sven Meckelmann work with colleagues from the Faculty of Biology and the Wageningen University & Research to solve an issue in evolutionary biology that continues to puzzle researchers: how were eukaryotes able to develop from the archaea domain? The project 'Lipid Divide' seeks to understand the timing and causes of a fundamental change that occurred in the composition of the membrane lipids during the evolutionary process of eukaryotes.

In the field of chemistry education, several research projects took place during the introductory study phase. Professor Maik Walpuski's BMBF-funded CASSIS project ('Chemie, Sozialwissenschaften und Ingenieurwissenschaften: Studienerfolg und Studienabbruch'), which examined institutional and individual variables influencing academic drop-out, concluded successfully. Three members of the chemistry education group – Professor Stefan Rumann, Professor Elke Sumfleth and Professor Maik Walpuski – are participating in the DFG-ALSTER projects, which explore the perception of models in chemistry courses and the influence of digital feedback on exercises.

The outstanding success of our Faculty's young researchers in competitive programmes has been a particular highlight of the past years. Professor Jochen Niemeyer, Professor Michael Giese and PD Dr Bilal Gökce were accepted into the DFG Heisenberg Programme; Professor Corina Andronescu secured a BMBF NanoMatFutur early-career research group; Dr Kai Exner was accepted into the academic returnee programme of the state of North Rhine-Westphalia. Having outlined our Faculty's ongoing research alliances, we dedicate the remainder of this year's report to the work of our young members.

Professor Corina Andronescu's project 'MatGasDif', which is funded within the scope of the BMBF's NanoMatFutur research competition for early-career scientists, seeks to optimise electrocatalytic CO_2 reduction in terms of catalyst selectivity and electrode stability. Her team works on developing catalyst materials that selectively catalyse the electrochemical reduction of carbon dioxide to basic chemicals such as ethanol or ethylene while suppressing parasitic hydrogen evolution as much as possible. The project aims to go further than merely designing catalysts. Its objective is to develop an optimised, porous composite electrode architecture. Ideally, the active catalyst will be embedded stably into this architecture, facilitating the selective conversion of CO_2 at industrially relevant current densities. In particular, MatGasDif seeks to establish strategies for immobilising several different catalyst materials within a carbon matrix. This causes complex secondary reactions to occur in a specific order as a cascade reaction, which increases the selectivity of the reaction.

Interlocked molecular architectures have been known since the last century, but their application is still in its infancy. They consist of several components that are topologically connected, much like the links of a chain or a ring on a bilaterally closed axis. In 2016, the Nobel Prize in Chemistry was awarded to a team of researchers who mastered the highly complex production of interlocked molecular architectures. At the University of Duisburg-Essen, Professor Jochen Niemeyer and his research group use interlocked molecular architectures in processes of cooperative catalysis, where two active units work in concert to control a reaction. They focus particularly on stereoselective catalysis to create chiral products. The German Research Foundation (DFG) accepted Professor Niemeyer's project 'Cooperative Systems Based on Chiral Organophosphoric Acids' to its Heisenberg Programme in 2019. Since November 2020, he has been continuing his work at the Faculty of Chemistry in the capacity of Heisenberg Professor of Organic and Supramolecular Chemistry.

Professor Michael Giese holds a junior endowment professorship funded by the Professor Werdelmann Foundation. Since Professor Carsten Schmuck's tragic passing in 2019, however, he has been representing his late colleague at the Chair of Organic Chemistry. Professor Giese has also received funding under the DFG Heisenberg Programme for his project on supramolecular liquid crystals ('Supramolekulare Flüssigkristalle – Ein modulares Konzept für „smartere" Materialien') in 2020. He and his team are working on a modular kit whose components can be combined to form substances with specific properties. The project focuses on liquid crystals. With the modular kit, the researchers can create liquid crystals with structural colouration, for example. The liquid crystalline materials are also adaptive, meaning that they react to environmental changes. During changes of temperature or in the presence of certain chemicals, the liquid crystals can adapt by changing their properties. This may alter their colour, for instance, which is useful in constructing sensors. Professor Giese intends to continue his work at the Faculty of Chemistry in the capacity of Heisenberg Professor of Supramolecular Chemistry. The appointment procedure is currently in progress.

Dean: Professor Dr Torsten C. Schmidt

In addition to their own research, Michael Giese and Jochen Niemeyer (along with Junior Professor Jens Voskuhl and Dr Christoph Hirschhäuser) help to supervise the research group of the late Professor Carsten Schmuck, since 2019. The first doctoral candidates in the group have already completed their doctorates, and many excellent academic works were completed and published in 2020. In honour of Professor Schmuck's scientific achievements and his role as a researcher, colleague and mentor, his young colleagues have collaboratively produced a review of his life's academic work. Their article 'Guanidiniocarbonyl-Pyrroles (GCP) – 20 Years of the Schmuck Binding Motif', published in ChemPlusChem, provides

Professors

Analytical Chemistry
Professor Dr Torsten C. Schmidt
Professor Dr Oliver J. Schmitz

Anorganic Chemistry
Professor Dr Malte Behrens
(now CAU Kiel)
Professor Dr Matthias Epple
Professor Dr Stephan Schulz

Chemistry Education
Professor Dr Mathias Ropohl
Professor Dr Stefan Rumann
Professor Dr Elke Sumfleth
Professor Dr Maik Walpuski

Organic Chemistry
Professor Dr Gebhard Haberhauer
Professor Dr Jochen Niemeyer
Professor Dr Thomas Schrader

Physical Chemistry
Professor Dr André Gröschel
(now WWU Münster)
Professor Dr Jochen S. Gutmann
Professor Dr Eckart Hasselbrink
Professor Dr Christian Mayer
Professor Dr Sebastian Schlücker

Technical Chemistry
Professor Dr Corina Andronescu
Professor Dr Stephan Barcikowski
Professor Dr Mathias Ulbricht

Theroetical Chemistry
Professor Dr Georg Jansen
Professor Dr Eckhard Spohr

Environmental Microbiology and Biotechnology
Professor Dr Rainer Meckenstock
Professor Dr Alexander Probst
Professor Dr Bettina Siebers

Independent Junior Research Groups

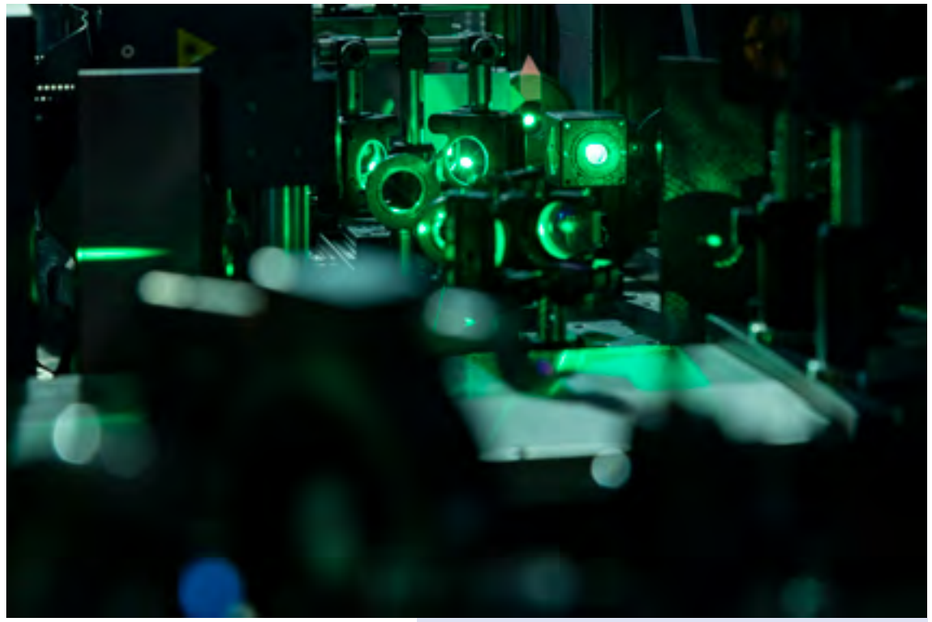
- Jun.-Professor Dr Michael Giese (Organic Chemistry)
  Endowed junior professorship financed by the Professor Werdelmann Foundation
- PD Dr Bilal Gökce (Technical Chemistry)
- Jun.-Professor Dr Jens Voskuhl (Organic Chemistry)

an overview of the GCP binding motif and its entire scope of application. It focuses especially on molecular recognition, (self-)assembly, material applications and biosupramolecular chemistry.

To this day, the enormous potential of powder-based 3D printing remains partially untapped, as many of the available materials are simply not suitable for 3D printers. PD Dr Bilal Gökce's project, funded under the Heisenberg Programme, seeks to facilitate 3D printing of new materials through the targeted addition of nanoparticles and improve the properties of 3D-printed polymer and metal components. His approach is as follows. Firstly, he studies ways of upscaling laser-based colloid synthesis and controlling the nanoparticles it produces. Secondly, he uses these nanoparticles to develop new powder for 3D-printing magnets, lenses or materials with special mechanical properties. With this comprehensive strategy, he aims to examine the entire process chain of 3D printing from the input material down to the finished component. Meanwhile, PD Dr Gökce has accepted a call to the chair of materials for additive manufacturing at the University of Wuppertal.

Dr Kai S. Exner holds a Feodor Lynen Scholarship in theoretical chemistry from the Alexander von Humboldt Foundation. His junior research group focuses on the theoretical description of electrically charged solid/liquid interfaces, which occur in batteries, fuel cells and electrolysers. The solid/liquid interface is particularly challenging to model, as it constitutes a dynamic, multi-scale problem which depends not only on the composition of the electrode material and the physical and chemical dynamics of the adjacent aqueous electrolytes but also on external parameters, such as pressure, temperature and, in particular, electrode potential. Realistic description, then, requires a combination of methods involving various time and length scales, density functional theory, molecular dynamic simulations, microkinetic models and screening techniques.

Dr Exner recently secured funding for a junior research group under the NRW academic returnee programme, which encourages highly qualified early-career researchers to continue their careers in North Rhine-Westphalia following extended stays abroad. In the funded project, the group examines the solid/liquid interface in metal-air batteries using a multi-scale model in order to gain understanding of the complex interplay of factors that influence efficient, bifunctional electrode materials for oxygen electrocatalysis in aqueous and non-aqueous electrolytes. Dr Exner plans to use the



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A green, pulsed laser beam used in two-colour sum frequency generation spectroscopy for examining molecular adsorbates.

funding to establish his research group at the Faculty of Chemistry based on a recent call for a tenure-track junior professorship in inorganic chemistry, which focuses on the structural analysis of inorganic materials. His call is a case in point for the increasing permeability of traditional discipline boundaries, in this instance between inorganic and theoretical chemistry.

Partnerships and international affairs

Many of the research projects outlined above are highly interdisciplinary. Nearly all research groups at the Faculty collaborate intensively with researchers from other faculties of our university (in particular, Biology, Medicine, Physics, Engineering Sciences and Education Sciences) and with other research groups in Germany and abroad. Our colleagues regularly stay at our international partner institutions as visiting scholars and guest professors, while many international researchers visit our faculty in similar capacities (e.g., as Alexander von Humboldt Research Fellows). The Faculty also maintains close partnerships with its neighbouring universities in Bochum and Dortmund and the universities of applied science in Krefeld and Gelsenkirchen. It collaborates at all levels of research with the Max Planck Institutes for Coal Research and Chemical Energy Conversion in Mülheim and the Max Planck Institute for Physiological Chemistry in Dortmund. Scientists from these institutes hold positions as professors, lecturers and adjunct professors at our faculty.

Within the scope of our ongoing strategic collaboration with Evonik Industries, the industry partner funds joint projects and events held at the Faculty. The Professor Werdelmann Stiftung funds a junior professorship, the 'Werdelmann Lecture' and dissertation projects at our faculty.

Members of the UDE's Faculty of Chemistry are highly regarded throughout Germany, and their membership of national expert associations and committees underscores their excellent reputation. Professor Sumfleth is a member of the review board for the educational sciences of the German Research Foundation (DFG); Professor Schmidt is a review board member in the DFG's chemistry expert forum; Professor Gutmann is a member of expert group no. 5 of the German Federation of Industrial Research Associations. Professor Schmidt is the current chairman of the Water Chemistry Society; Professor Rumann is the board spokesman of the German Society for Chemistry and Physics Education. Many members of our faculty hold positions on the editorial boards of scientific journals.

Awards

Researchers of our faculty are regularly lauded for their work nationally and internationally. We are particularly pleased that our young members have won many prizes and secured competitive external funding again this year. Three of our scientists have been accepted into the DFG Heisenberg Programme in a single year – an unprecedented achievement for any faculty of the University of Duisburg-Essen. The similarly competitive junior research groups awarded to Faculty members within the scope of the NanoMatFutur programme of the Federal Ministry of Education and Research and the academic returnee programme of the state of North Rhine-Westphalia underscore the great achievements of our early-career researchers. We have already talked about their work in the research highlights.

Alexander Probst, Professor of Aquatic Microbial Ecology, has been funded under the NRW academic returnee programme since 2018. He has been awarded the 2020 research prize of the Association for General and Applied Microbiology (VAAM) for his study of bacteria, archaea and viruses in Earth's crust.

Professor Reinhard Zellner has won the Carl-Duisberg-Plakette, one of the highest distinctions of the German Chemical Society (GDCh). The board of the GDCh awards the Plakette to chemists who have demonstrated outstanding commitment to promoting chemistry and the goals of the GDCh. Professor Zellner received the prize for his extensive contributions to the Society's Advisory Committee on Existing Chemicals (BUA) and his achievements in the fields of climate research and atmospheric chemistry.

The Polish Academy of Sciences's committee for analytical chemistry has awarded the 2019 Professor Andrzej Waksmundzki Medal to Professor Oliver J. Schmitz for his achievements in the field of analytical separation and chromatographic techniques, in particular.

Professor Elke Sumfleth and her colleagues at the University of Duisburg-Essen have jointly received the Society of Empirical Educational Research's (GEBF) prize for promoting interdisciplinarity in educational research. The jury highlighted that the awardees spent nearly 20 years systematically developing unique and innovative interdisciplinary structures in various projects and functions, which have significantly shaped the standards of interdisciplinary research.

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Success in research and teaching – three young scientists from the Faculty of Chemistry jointly received the UDE Teaching Award 2019.

Selected Publications

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Successful young scientists at the Faculty of Chemistry: Prof. Corina Andronescu, Dr. Kai S. Exner, Prof. Bilal Gökce, Prof. Jochen Niemeyer, Prof. Michael Giese (from left to right)

The first prize of the AVRiL 2019 competition, jointly organised by the German Informatics Society's group on VR/AR learning and the Stifterverband, went to Dr Sebastian Habig for his project 'Augmented Reality Chemistry', which is based at the University of Duisburg-Essen.

In 2019, Dr Holger V. Lutze received the Water Chemistry Society's prize for his work on oxidative processes in aqueous systems. The prize is funded by the Walter-Kölle-Stiftung and only awarded every two to four years.

In 2020, Dr Kai S. Exner was awarded the biennial Joachim Walter Schultze Prize of the Arbeitsgemeinschaft Elektrochemischer Forschungsinstitutionen (AGEF) for expanding the volcano concept in electrocatalysis by incorporating overvoltage and kinetic effects. The Joachim Walter Schultze Prize goes to early-career researchers who have achieved a discernible degree of academic independence through a significant contribution to an electrochemical field.

The LUKE project, an industry collaboration on purifying contaminated groundwater headed by PD Dr Ursula Telgheder, was lauded by the Federal Ministry of Economics and Technology as a model of success within the scope of the Central Innovation Programme for Small and Medium-sized Enterprises (ZIM) and is recommended for the German Environmental Award.

Junior Professor Michael Giese, Jochen Niemeyer and Junior Professor Jens Voskuhl won the 2019 UDE teaching prize for their outstanding contributions to teaching and their commitment to their students. The three early-career researchers work in the field of supramolecular chemistry with their research groups. They redesigned the master's lecture on functional supramolecular materials and delivered the new version for the first time in the 2018 summer semester. Their lecture received an ‚excellent' result in the student-led course evaluation. Beyond lectures, the three young academics demonstrated exemplary commitment to supporting their students.

Dr Stéphane Kenmoe, post-doctoral researcher in CRC/TRR 247 (theoretical chemistry), received the 2020 Diversity Leadership Award of the University of Duisburg-Essen.

Appointment at another institution is considered particularly potent proof of high achievements in academia. In the last two years, seven members of the Faculty of Chemistry received external calls. The current spokesman of CRC/TRR 247, Professor Malte Behrens, accepted an appointment to a renowned professorship of inorganic chemistry at the University of Kiel. Endowed junior professor André Gröschel, funded by Evonik Industries, has been appointed to a professorship of physical chemistry at the University of Münster. PD Dr Bilal Gökce has been appointed to a professorship of Materials in additive manufacturing at the University of Wuppertal. Dr Holger Lutze has been appointed to a professorship for environmental analytics and pollutants at TU Darmstadt.

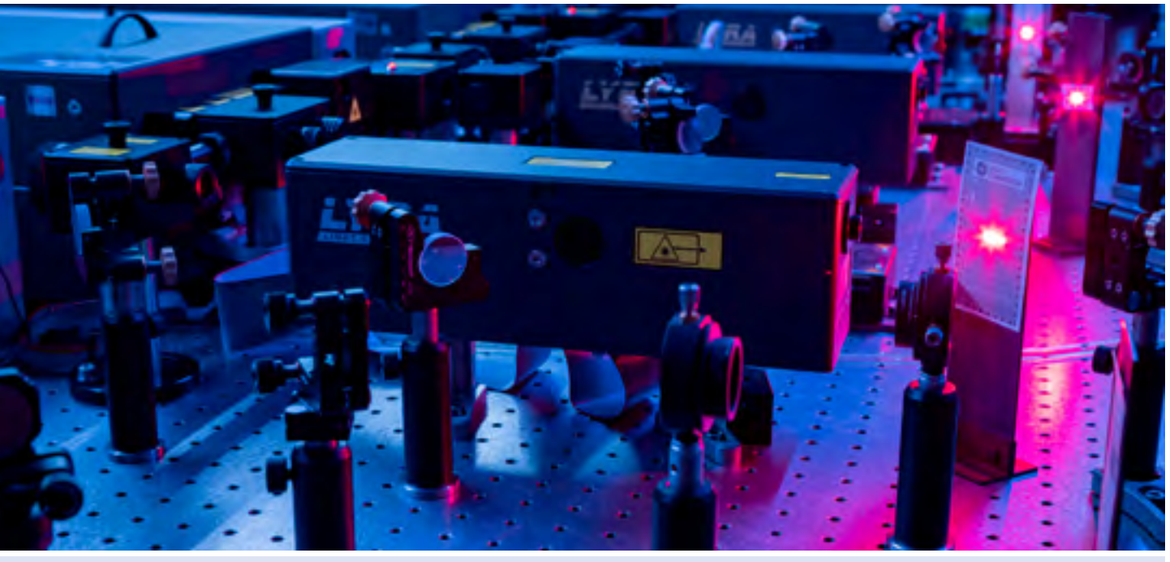
Professor Stephan Barcikowski received a call as Managing Director of the Institute of Technical Chemistry in conjunction with a professorship of technical chemistry at Leibniz University Hannover. Two members of our faculty, Professor Maik Walpuski and Professor Mathias Ropohl, took the first two spots on a list of potential candidates for a professorship of chemistry education at the University of Erlangen-Nuremberg. This high demand for our scientists underscores the excellent reputation of chemistry education at UDE. The Faculty is delighted that the University was able to match these three external calls and convince the colleagues to stay at UDE.

Transfer and sustainability

The Faculty of Chemistry takes an ecological, economic and social approach to sustainability. It attaches particular importance to the 17 Sustainable Development Goal of the United Nations. Its engagement with sustainability takes many forms:

Our researchers develop new active agents that can be used for transfection and to fight viral infections in completely new ways. They might even be effective against SARS-CoV-2, and an EU-funded research project started in 2020 to examine the potential of supramolecular ligands in this context. It is worth noting the highly advanced stage of development of those ligands, which are extremely effective in preventing pathological protein aggregation in animals. The researchers are hoping to optimise them into potential drugs to treat the currently incurable Alzheimer's disease and Parkinson's disease. Their work constitutes a clear contribution to Sustainable Development Goal no. 3: healthy lives and well-being for all. Many research groups in the University's new main research area of water research work towards SDG no. 6, access to water and sanitation for all, and SDG no. 15, protection of terrestrial ecosystems. Sustainability is a key element of the NRW Forschungskolleg 'Future Water', whose spokesperson is based at the Faculty of Chemistry. Our research in chemistry education pursues SDG no. 4, education for all, by contributing to the development of education standards at the Institute for Educational Quality Improvement (IQB). In partnership with the Leibniz Institute for Science and Mathematics Education at the University of Kiel, our scientists also study communities of practice.

Another transfer activity of our faculty, the ColFerroX spin-off from Professor Rainer Meckenstock's research group, has achieved



Laser output of three synchronised, non-linear, optical parametric amplifiers for time-resolved coherent anti-Stokes Raman scattering (CARS) spectroscopy, a non-linear Raman scattering technique for characterising rapid chemical processes.

© Foto: Daniel Schumann

extraordinary success. With its innovative method of using nanoparticles to purify groundwater contaminated with heavy metals, the young company came first in the Duisburg Pitch Battle in May 2019. It is an excellent example of start-up activities with a focus on water, which the planned FutureWaterCampus will promote and expand.

Outlook

The Faculty will continue to play an active, leading role in the aforementioned three main research areas of the University. This makes sense considering the interdisciplinary nature of chemistry. We focus on chemically motivated partnerships with biology and medicine, nanoresearch, the broad field of water, and empirical educational research. The ability of chemistry to combine multiple research topics is one of the discipline's greatest strengths. This is clearly visible in many projects, such as the WISNA professorship of nanomaterials in aquatic systems, the Alster research group, and the new research buildings that are currently in the application and construction phases. Both the University and the Faculty of Chemistry have welcomed several early-career researchers who have joined us under the Heisenberg Programme and the NRW academic returnee programme. While this underscores our high reputation as an attractive place to conduct research, it also raises several challenges regarding the development of long-term prospects. The integration of these young researchers into the existing and planned coordinated funding programmes, from research groups to Excellence Clusters, is a key component of the strategic evolution of our faculty. In particular, the development of the topic of smart materials is a connecting element: it fits perfectly into the UA Ruhr's Flagship Program Materials Chain and simultaneously offers great potential for incorporating the UDE's three main research areas to which the Faculty contributes.

Over the course of the next years, the Faculty of Chemistry will focus on extending the collaborative projects that are based at the Faculty of Chemistry or involve its researchers to a significant extent. This includes several strategic and structural measures launched at the Faculty during the past few years and will contribute to its sustainable development in the near future. Suitable academic appointments will establish a foundation for a joint application and the extension of the RESOLV Excellence Cluster in the next round of the Excellence Strategy. Dr Kai Exner has already been accepted into the current cluster as an associate member. The Faculty of Chemistry is participating in further applications within the scope of the Excellence Strategy, which are currently in preparation. If successful, they will have an effect on the strategic objectives, too.

Our successful, young scientists are already making great contributions to the Faculty with their new projects. They are expanding the Faculty's portfolio and will further strengthen its research profile, helping to continue the successful work of the Faculty in Essen.

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The influence of multiple stressors on aquatic ecosystems is a key issue in water research at the Faculty of Biology.

Faculty of Biology

The main research areas of the Faculty of Biology are divided into three fields: water and environmental research, medical biotechnology, and empirical research in education. They are closely linked to three research centres of the University, the Centre for Water and Environmental Research (ZWU), the Centre for Medical Biotechnology (ZMB), and the Interdisciplinary Centre for Educational Research (IZfB).

Research

With only 23 research groups, the Faculty of Biology is a relatively small faculty, but its three main research areas give it a very solid profile. The Faculty's groups are closely connected to various UDE research centres, and they collaborate intensively with the Faculty of Chemistry, the Faculty of Medicine, the Faculty of Engineering Sciences and various non-university research institutes. This allows its researchers to address a wide range of interdisciplinary and transdisciplinary topics. In its research as well as its teaching, the Faculty seeks to represent biology at all system levels: from biomolecules and cells to tissue, organisms and entire ecosystems.

Water and Environmental Research

The groups in the field of water and environmental research are closely linked to the Centre for Water and Environmental Research (ZWU). The majority of their work is on fundamental ecological and evolutionary topics, such as higher single-celled organisms (protists), and issues of applied ecotoxicology, environmental observation and long-term ecological research. They maintain a particularly close partnership in the study of the effects and detection of multiple stressors. In this field, they use a wide range of research methods ranging from traditional field studies to modern genomic analysis processes. The Genomics Core Facility (GCF) and the Central Collection of Algal Cultures (CCAC) provide infrastructural support to the groups working on water and environmental research.

The latter was transferred to the UDE's Faculty of Biology from the University of Cologne in 2020. It contains more than 7,000 strains of algae, making it one of the world's largest and most important algal collections. The University of Duisburg-Essen has established a modern infrastructure for cultivating algae, which includes cultivation rooms with light and temperature controls. Researchers all over the world have access to the large variety of algae taxa from freshwater and marine habitats held by the CCAC. Professor Michael Melkonian's senior professorship, which is closely associated with the CCAC, works on major genomic projects on the evolution of land plants. The new Phycology research group under Professor Bánk Beszteri was recently established in connection with the algae collection It focuses on diatoms, which are highly significant for global primary production and biomonitoring. The group has revealed how local genomic, ecophysiological and morphological differences can spread across diatom populations in different latitudes of the Southern Ocean despite existing migration opportunities.

Professor Jens Boenigk's Biodiversity research group examines the generalisability of ecological and evolutionary theories and hypotheses across various groups of organisms, also focusing on interdependencies between biodiversity and ecosystem functions. The researchers recently found evidence of geographical and ecological differentiation for microorganisms. Their main distribution ranges and regions with a high proportion of endemic species do no correspond to the pattern exhibited by plants and animals, however. Professor Micah Dunthorn's Eukaryotic Microbiology group also studies the applicability of theories and observations with a focus on protists in aquatic and terrestrial ecosystems, such as parasitic single-cell organisms. It uses modern molecular omics processes, bioinformatics and microscopy to understand microbial diversity from an ecological and evolutionary perspective.

Professor Florian Leese's Aquatic Ecosystems research group dedicates its work to the influence of multiple stress factors on aquatic animal populations and communities. It focuses on the impact of pesticides, salinisation, fine-sediment delivery and the fragmentation of rivers by transverse structures. The researchers use modern genetic methods to analyse the stressor effects. Within the scope of the EU COST Action DNAqua-Net (headed by Dr Leese) and other national and international projects (GeDNA and SCANDNAnet), researchers of the Faculty of Biology develop concepts for the standardised use of such processes in the context of EU-wide water monitoring initiatives.

Professor Daniel Hering's Aquatic Ecology research group also studies the effects of multiple stressors on freshwater ecosystems. His team creates data sets on the intensity of hydrological, morphological and material stressors affecting bodies of water across Europe and compares them to the ecological state of said surface waters. They have also accumulated original data from experiments and field work on multiple stressors

Researchers of the Faculty take water samples to determine the composition of an ecosystem in a non-invasive way using "environmental DNA".

© Foto: Till-Hendrik Macher (UDE).

from all of Europe and evaluated them to determine general patterns. Case studies on the effects of individual stressors, such as intensive leisure activity, dessication of bodies of water and intensive agricultural use, supplement the overview. Professor Bernd Sures's research group also studies aquatic ecology. Using a 'one-health approach', it focuses on the intactness and functioning of aquatic ecosystems and their inhabitants. The group examines the effect of biotic and abiotic (toxic) stressors in bodies of water in one of its projects. In particular, this involves assessing how the implementation of a fourth cleaning phase in water treatment plants, aimed at reducing micropollutant concentrations, could impact the biocenoses of connected flowing bodies of water. Research into diffuse pollution in flowing waters and its effect on local organisms is carried out in the Emscher basin and the North West province of South Africa. In the bodies of water of the Ruhr area and Sicily (in partnership with the Aquatic Ecosystems group), the Baltic Sea and the Levant, the group studies the distribution and effects of various groups of parasites.

Professor Peter Haase of the Senckenberg Research Institute oversees the River and Floodplain Ecology group, which carries out long-term ecological research. It is part of the global network International Long-Term Ecological Research (ILTER). Within this context, Professor Haase has headed a study on the loss of aquatic insects from a German nature reserve over the course of 42 years. Using the world's highest-resolution dataset, he was able to show that even significant losses in the number of organisms do not necessarily lead to a loss of biodiversity.

Professor Hardy Pfanz's Applied Botanics and Volcanic Biology research group examines the effects of the extreme volcanic release of carbon dioxide (mofetta) on local organisms. At the Laacher See in the Eifel mountains, of several European and German locations surveyed, the researchers were able to characterise a mofetta discharging large volumes of gas using conclusive soil parameters, such as water content, buffering capacity and soil gas concentrations.

Professor Ulrich Schreiber's (Geology) work also focuses on carbon dioxide. He researchers processes taking place at a depth of around 1,000 metres in fissures in the Earth's crust. On the early Earth, it contained all raw materials required for life to develop. Laboratory experiments emulating those conditions found that vesicles formed. Combining these results with amino acids, which emerge in hydrothermal conditions, they were able to prove the chemical evolution of peptides for the first time.

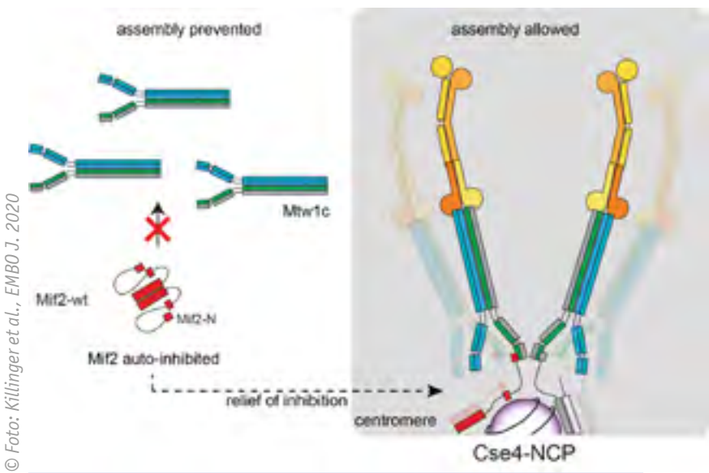
Medical Biotechnology

The research area of Medical Biotechnology is closely linked to the Centre for Medical Biotechnology (ZMB), which also incorporates research groups from the Faculty of Medicine and the Faculty of Chemistry. It is an interdisciplinary field that focuses on the mechanistic understanding of (patho)biological processes. Its insights can be transferred to medical practice. In this context, the research groups involved work on a range of topics in basic research and on the development of diagnostic approaches and new active ingredients. The Imaging Centre Campus Essen (ICCE), Imaging Centre Essen (IMCES) and the Analytics Core Facility (ACE) provide infrastructural support to this research area.

The ability of cells to divide and flawlessly to pass on their full genetic blueprint to the next generation is a fundamental requirement for life. Two research groups, Molecular Genetics I and II, study this consistency of genetic information across many generations. Professor Stefan Westermann's group focuses on mitosis. Using methods from molecular biology and biochemistry, the group has shown how cells ensure that a kinetochore can only assemble at a single point of a chromosome (FIGURE 1). Kinetochores are the structures at which chromosomes attach to the mitotic spindle; they are one of the most complicated molecular machines that exist in cells. Errors in this process may have serious consequences, such as the emergence of cancer cells. Professor Dominik Boos's research group studies how replication initiation, the process that forms the molecular machines which carry out DNA replication, is regulated. Using genetic manipulation and methods from bioinformatics, the group has been able to gain insights into the structure and functioning of the central regulatory platform, a complex composed of the proteins treslin and MTBP.

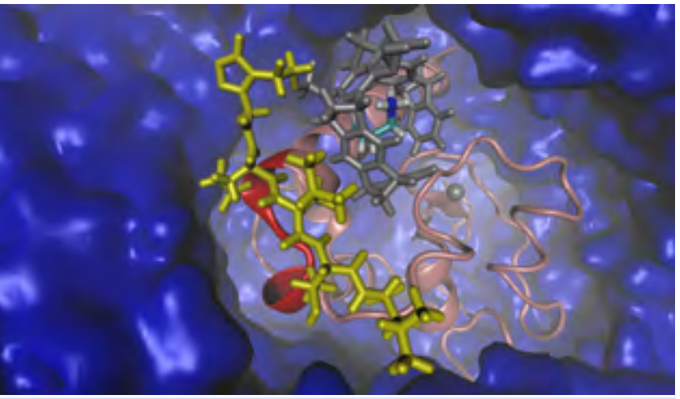
Professor Peter Bayer's Structural and Medical Biochemistry group also researches the structure and function of proteins. It focuses on peptidyl-prolyl isomerases. These enzymes are important for the functioning of other other proteins within the cell, enabling them to switch their activities on or off. In collaboration with chemistry groups, the researchers studied the interaction of molecular tweezers and guanidiniocarbonyl pyrrole ligands with proteins in CRC 1093 'Supramolecular Chemistry on Proteins'. Using spectroscopic methods such as nuclear magnetic resonance (NMR), they were able to detect binding sites on proteins such as survivin. Survivin is a protein that inhibits programmed cell death (apoptosis inhibitor). It is found in cancer cells. Professor Shirley Knauer (Molecular Biology II) also researches this enzyme and taspase 1. Her work focuses on the regulation of nucleo-cytoplasmic transport and its significance for the cell cycle. New insights into this process can help science understand the malignant transformation that occurs when cancer develops, for instance, Together with groups from the Faculty of Chemistry, Professor Knauer has identified

Dean: Professor Dr Philipp Schmiemann



© Foto: Killinger et al., EMBO J. 2020

Model for Mif2 regulation during budding yeast kinetochore assembly.



© Foto: Sanchez Garcia (UDE)

The protein survivin (red, pink) with artificial ligands (grey, yellow) in water (blue). Several research groups focus on survivin, including those of Professor Hoffmann, Professor Bayer, Professor Sánchez-García and Professor Knauer in collaboration with Professor Schrader from the Faculty of Chemistry (CRC 1093).

a specific ligand that inhibits the formation of survivin on histone H3 inside cells and prevents the proliferation of cancer cells. These results may potentially inform new therapeutic approaches.

While the absence of programmed cell death (apoptosis) is a problem in cancer cells, its occurrence can be similarly problematic in other contexts. Processes of ageing and other factors can damage the fragile components of cells, causing cell death and neurodegenerative disorders. Professor Hemmo Meyer's (Molecular Biology II) research group has successfully proven that the enzyme VCP/p97 plays an important role in the clearance of damaged lysosomes. Lysosomes are cell organelles containing digestive enzymes. They must be replaced by new, functional organelles regularly. In collaboration with international partners, the group has identified another important player in this process: the enzyme UBE2QL1 marks damaged lysosomes with the protein ubiquitin to ensure that VCP/p97 recognises them and initiates their clearance. Because mutations in VCP/p97 cause neural and muscular degeneration in humans, this is a significant step towards decyphering the molecular and cellular causes of degenerative disorders.

Professor Michael Ehrmann's (Microbiology) research group also focuses on the causes of degenerative disorders. The protease HTRA1, for example, plays an important part in the pathogenesis of age-related macular degeneration (AMD). Deliberate inhibition of this protease, then, could constitute a new approach in AMD therapy. In its pursuit of a selective and potent inhibitor, the research group works with partners from the Faculty and the private sector on analysing various classes of substances that may potentially be suitable. It has found that inhibitors can activate their target in certain conditions, which would not only cause therapy to fail but even lead to harmful results – a very important insight for the development of drugs.

Professor Perihan Nalbant's (Molecular Cell Biology) group studies the role of cell movement mechanisms in the development of tumour-relevant phenotypes. Using total internal reflection fluorescence microscopy (TIRFM), activity sensors and live-cell analyses, the researchers study signal networks that can regulate the temporal and spatial organisation of the actin cytoskeleton by creating dynamic, sub-cellular activation patterns of Rho proteins. The actin cytoskeleton is responsible for cell movement among other things.

Professor Andrea Vortkamp's Developmental Biology research group is interested in the molecular mechanisms causing degenerative musculoskeletal disorders such as osteoarthritis. The researchers focus on long-chain sugar molecules (heparan sulfates), which play a role in forming and sustaining the cartilage matrix. Experiments on mice have shown that certain changes to their structure slow the advance of osteoarthritis. In collaboration with researchers from France, the group examines how the structure of the sugar molecules controls the composition of the cartilage matrix and the activity of enzymes that cause cartilage degeneration.

Professor Doris Hellerschmied's Mechanistic Cell Biology research group is interested in cells under stress. It investigates the molecular mechanisms that control the stress response and protein quality control in human cells. At their centre lies an important cellular compartment, the Golgi apparatus: its functioning is crucial for the right modification and distribution of cellular proteins. Any dysfunction of the Golgi apparatus can lead to neurodegenerative disorders, which cause the cells of the nervous system gradually to die. The researchers examine this quality control mechanism in proteins by manipulating the folding state, i.e., the structure, of model proteins with chemical tools. Professor Barbara Saccà (Bionanotechnology) also focuses on the folding of biomolecules, or rather, THE biomolecule: DNA. Using DNA nanotechnology, the group can produce simplified models of complex biological objects with specific properties. They can be artificial viruses for gene or protein transfer or, as in this case, DNA. The researchers have shown that the further folding of biomolecules is decided at an early stage at germinal centres, i.e., regions along which a structure grows. The forces in play here, then, determine the future structural fate of complex structures.

Professor Markus Kaiser's Chemical Biology group designs and validates chemical probes for basic research in biology and as starting points for the development of pharmaceuticals. They are then used to solve a variety of biological issues. In particular, the researchers use target-oriented design concepts. They also work on decyphering the molecular mechanisms of action of bioactive substances.

Besides biochemical and cellular tools for experiments with molecules and cells, computer technologies and bioinformatics tools play an important role in modern biology. In collaboration with other researchers, Professor Daniel Hoffmann's (Bioinformatics and Computational Biophysics) group develops models for complex biomedical systems in order to analyse their data quantitatively. This includes models for the efficacy of cancer drugs and the protective effect of certain sugar chains against osteoarthritis. Not only does the group's work simplify access to complex models, it enables other researchers to develop their own models using specific tools. Professor Elsa Sánchez-García's Computational Biochemistry group focuses on the development and application of computer tools for examining biomolecules. These tools can, for instance, be used to understand the mechanism by which molecular tweezers disrupt the viral envelope. The corresponding molecules can then be established as broad-spectrum

Selected Publications

Bachvarova, V., T. Dierker, J. Esko, D. Hoffmann, L. Kjellen, A. Vortkamp (2020): *Chondrocytes respond to an altered heparan sulfate composition with distinct changes of heparan sulfate structure and increased levels of chondroitin sulfate. Matrix Biology 93, 43–59. doi: 10.1016/j.matbio.2020.03.006.*

Birk, S., D. Chapman […], B. Sures […], D. Hering (2020): *Impacts of multiple stressors on freshwater biota across spatial scales and ecosystems. Nature Ecology and Evolution 4, 1060–1068. doi: 10.1038/s41559-020-1216-4.*

Killinger, K., M. Böhm, P. Steinbach, G. Hagemann, M. Blüggel, K. Jänen, S. Hohoff, P. Bayer, F. Herzog, S. Westermann (2020): *Autoinhibition of Mif2/CENP-C ensures centromere-dependent kinetochore assembly in budding yeast. The EMBO Journal 39, e102938. doi: 10.15252/embj.2019102938.*

Koerver, L., C. Papadopoulos, B. Liu, B. Kravic, G. Rota, L. Brecht, T. Veenendaal, M. Polajnar, A. Bluemke, M. Ehrmann, J. Klumperman, M. Jäättelä, C. Behrends, H. Meyer (2019): *The ubiquitin-conjugating enzyme UBE2QL1 coordinates lysophagy in response to endolysosomal damage. EMBO Reports 20, e48014. doi: 10.15252/embr.201948014.*

Kosinski, R., A. Mukhortava, W. Pfedifer, A. Candelli, P. Rauch, B. Saccà (2019): *Sites of high local frustration in DNA origami. Nature Communication 10, 1061. doi: 10.1038/s41467-019-09002-6.*

Mambrey, S., J. Timm, J.J. Landskron, P. Schmiemann (2020): *The Impact of System Specifics on Systems Thinking. Journal of Research in Science Teaching 57, 1632–1651. doi: 10.1002/tea.21649.*

Pilotto, F., I. Kühn, R. Adrian […], P. Haase (2020): *Meta-analysis of multidecadal biodiversity trends in Europe. Nature Communications 11, 3486. doi: 10.1038/s41467-020-17171-y*

Postel, U., B. Glemser, K. Salazar Alekseyeva, S.L. Eggers, M. Groth, G. Glöckner, U. John, T. Mock, K. Klemm, K. Valentin, B. Beszteri (2020): *Adaptive divergence across Southern Ocean gradients in the pelagic diatom Fragilariopsis kerguelensis. Molecular Ecology 29, 4913–4924. doi: 10.1111/mec.15554.*

Vallet, C., D. Aschmann, C. Beuck, M. Killa, A. Meiners, M. Mertel, M. Ehlers, P. Bayer, C. Schmuck, M. Giese, S.K. Knauer (2020): *Functional disruption of the cancer-relevant interaction between Survivin and Histone H3 with a guanidiniocarbonyl pyrrole ligand. Angewandte Chemie International Edition 59, 5567–5571. doi: 10.1002/anie.201915400.*

Wang, S.B., […] M. Melkonian, H. Liu, H., X. Liu, (2020): *Genomes of early-diverging streptophyte algae shed light on plant terrestrialization. Nature Plants 6, 95–106. doi: 10.1038/s41477-019-0560-3.*

Professors

Medical Biotechnology
Professor Dr Peter Bayer
Professor Dr Dominik Boos
Professor Dr Michael Ehrmann
Professor Dr Doris Hellerschmied-Jelinek
Professor Dr Daniel Hoffmann
Professor Dr Christian Johannes
Professor Dr Markus Kaiser
Professor Dr Shirley Knauer
Professor Dr Hemmo Meyer
Professor Dr Andrea Musacchio
Professor Dr Barbara Saccà
Professor Dr Elsa Sánchez-García
Professor Dr Alexander Schug
Professor Dr Andrea Vortkamp
Professor Dr Stefan Westermann

Water and environmental research
Professor Dr Sabine Begall
Professor Dr Bank Beszteri
Professor Dr Jens Boenigk
Professor Dr Micah Dunthorn
Professor Dr Peter Haase
Professor Dr Daniel Hering
Professor Dr Florian Leese
Professor Dr Michael Melkonian
Professor Dr Hardy Pfanz
Professor Dr Ulrich Schreiber
Professor Dr Bernd Sures

Empirical research in education
Professor Dr Angela Sandmann
Professor Dr Philipp Schmiemann

antiviral drugs. The group also employs tools for predicting protein-protein interactions (PPI-Detect) and examining proteins using machine-learning methods (ProtDCal suite), which are highly popular with other researchers.

Subject-specific empirical research in education

Two research groups focusing on biology education make up the research area of subject-specific empirical research in education. They work on questions related to learning and teaching biology in schools and in education contexts outside of school. In partnership with other research groups from the field of subject-specific and general education research, they also focus on interdisciplinary issues. Both groups are integrated into the Interdisciplinary Centre for Educational Research (IZfB), which pools all research activities in this area.

The Lehr-Lern-Labor (Learning and Teaching Laboratory) gives school classes a professional environment for independent experimenting.

Professor Angela Sandmann's research group works on topics of digital and extracurricular learning, focusing primarily on the services of the Faculty's Bio-Innovativ Lehr-Lern-Labor (Innovative Biology Learning and Teaching Laboratory) and questions of teacher education and professional development. Its research interests are centred around the individual acquisition of proficiency in subject-specific and conceptual knowledge and the development of new insights in the natural sciences.

Professor Philipp Schmiemann's research group concentrates on the difficulties learners face in comprehending various fields of biology. It studies how learners understand biological systems, such as the feeding relationships in an ecosystem or the regulation of blood sugar levels. In partnership with the other research groups at the Faculty of Biology, Professor Schmiemann's group aims to support the learning experience of biology students and gain a better understanding of what causes students to quit their studies.

Awards

Doris Hellerschmied of the Faculty of Biology has won the Sofja Kovalevskaja Award, one of the most highly endowed research prizes in Germany. The Alexander von Humboldt Foundation is funding the Faculty's new research group on mechanistic cell biology with 1.65 million euros. This new group focuses on an important cellular sub-unit called the Golgi apparatus and how it handles stress and ensures the functioning of its proteins under normal and pathological conditions.

Transfer and sustainability

Due to the nature of the subject, sustainability plays an important role at the Faculty of Biology. Its research reflects this by addressing questions of sustainability directly. The research area of water and environmental research contributes to a better understanding of aquatic ecosystems, for example. Its insights can inform new measures for protecting our natural environment. This transfer of research results into practice also takes place in the areas of medical biotechnology and subject-specific empirical research in education. Insights from biomedical research, for instance, can constitute a basis for new ways of treating cancer and other conditions in future. In the area of subject-specific education research, the work of the Lehr-Lern-Labor and the available professional-development courses for biology teachers transfer expertise in the fields of biology and biology education into school-based teaching practice.

The Faculty's commitment to sustainability also includes the establishment of a research data management system, which facilitates the re-use of research data and the joint use of large scientific equipment in core facilities. This includes the CCAC algae collection. Not only does it contribute to the protection of the unique life forms, it grants all researchers worldwide access to its resources.

Outlook

The Faculty of Biology will continue to deepen and hone its key research areas in the coming years. CRC 1439, 'Multilevel Response to Stressor Increase and Release in Stream Ecosystems (RESIST)', will constitute a major focus in the area of water and environmental research. Various research groups based at the University of Duisburg-Essen and its partner institutions will spend an initial period of four years studying the impact of individual and combined stressors in flowing bodies of water on biodiversity and its functions. The project is funded with 12.3 million euros by the German Research Foundation (DFG) and headed by its two CRC spokesmen, Professor Bernd Sures and Professor Daniel Hering. It will focus on the three most harmful stressors: rising temperatures, salinisation and hydromorphological degradation. Its insights may inform models for describing and predicting the degradation and recovery of flowing bodies of water.

In the area of medical biotechnology, a CRC initiative involving an interdisciplinary approach of biology, molecular oncology and chemistry aims to make conceptual progress in the understanding of cell state transitions. The diverse, switch-like trigger mechanisms of the critical transitions between these states play an important role in processes such as carcinogenesis and treatment resistance. The initiative has already strengthened the profile of biomedical research and intensified the partnership between the involved disciplines considerably.

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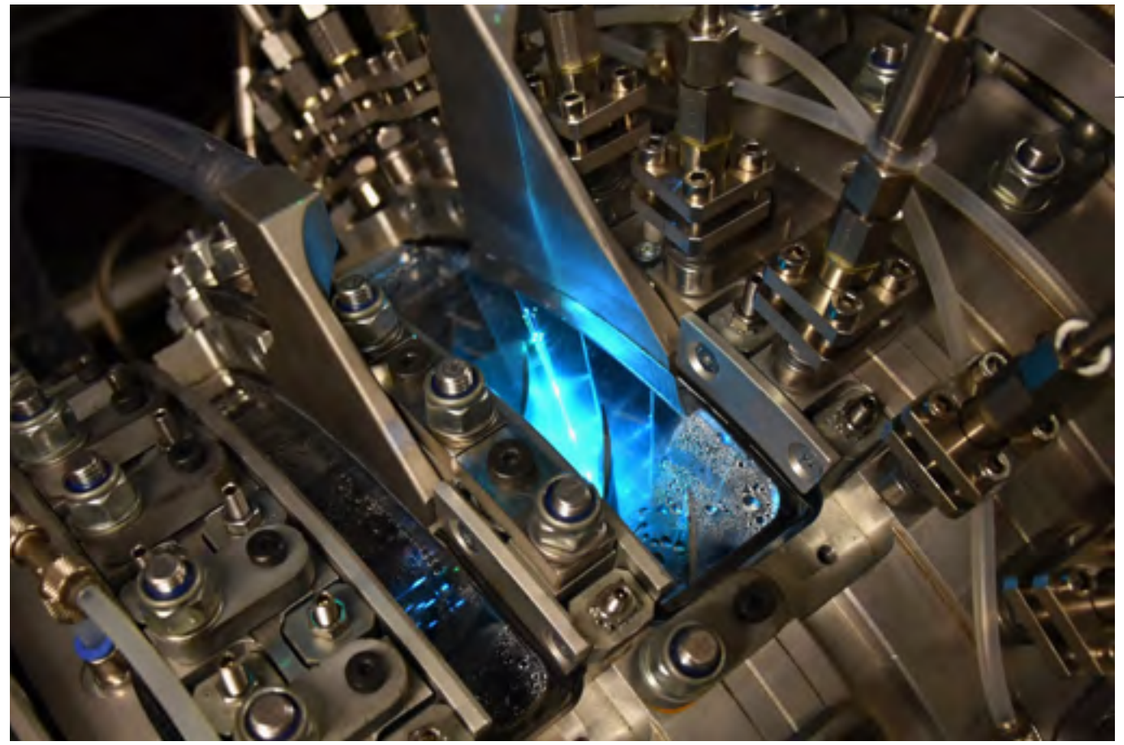


© Photo: Chair of Turbomachinery – Tobias Dörr

Blue laser light from flow measurements in a multi-stage axial-flow compressor with water injection

Faculty of Engineering

The Faculty of Engineering at the University of Duisburg-Essen is made up of four closely integrated departments, Civil Engineering, Electrical Engineering and Information Technology, Computer Science and Applied Cognitive Science, and Mechanical and Process Engineering. To ensure focused research despite the remarkable breadth of topics covered at the Faculty, the research activities of these departments are consolidated into four interdisciplinary research profiles: Tailored Materials, Human-Centred Cyber-Physical Systems, Smart Engineering, and Energy and Resource Engineering (https://www.uni-due.de/iw/de/forschung/psp.php). They are closely related to seven teaching units, in which the Faculty provides instruction at the highest level: our numerous internationally oriented bachelor's and master's degree programmes are currently host to around 10,800 young people from more than 110 countries. This large student body, combined with 92 professorships in 73 institutes and chairs, make the UDE's Faculty of Engineering one of the largest of its kind in Germany.

Supported by seven affiliated institutes and further collaborating organisations, the Faculty works with members of other national and international research institutions as well as players from business and industry to produce research results and effectively translate them into practice. It is not only for this reason that engineering at the University of Duisburg-Essen has an excellent global reputation in many subdisciplines. It occupies leading positions in nano-technology and combustion research and conducts toplevel research in automotive engineering, energy, environmental process engineering and solid-state electronics, optimisation of communications, radio and radar systems, energy grids, and optoelectronics and interactive media systems. In association with the Development Centre for Ship Technology and Transport Systems (DST), with which it is affiliated, the Faculty runs one of the largest university institutes for ship technology and ocean engineering in Germany. In Industrial Engineering, highly skilled graduates are trained at the interface of engineering and management with a focus on the automotive industry. Our Department of Civil Engineering occupies leading positions in the CHE ranking. At the University of Duisburg-Essen, cognitive scientists and psychologists are part of the Faculty of Engineering, too. No matter what technical advances are made, it is still people who control devices and programme machines, and human-machine interaction continues to be an important part of research in this field.

Mechanical and Process Engineering

The Department of Mechanical and Process Engineering (MBVT) comprises the teaching units of Mechanical Engineering and Industrial Engineering, whose 31 professors represent a diverse range of subjects in teaching and research. The internal institutes work closely with the UDE's affiliates: The Institute for Energy and Environmental Technology (IUTA e.V.), the IWW Water Centre, the Development Centre for Ship Technology and Transport Systems (DST e.V.) and the Fuel Cell Research Center (ZBT). Their direct collaboration promotes and underscores the applied nature of engineering research.

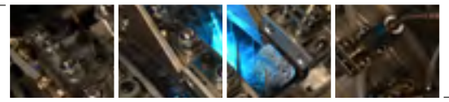
Research highlights

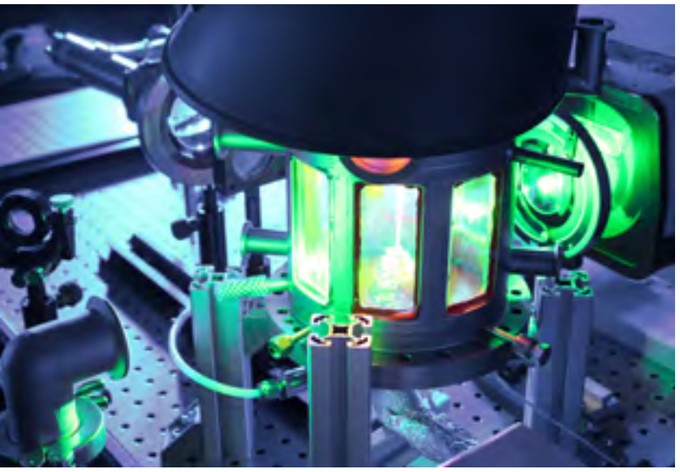
DFG Research Unit 1993, 'Multifunctional Conversion of Chemical Species and Energy' (spokesperson: Professor Burak Atakan, Chair of Thermodynamics), has entered its third phase. The group studies the use of reciprocating engines as chemical reactors in the production of basic chemicals. Through closely coordinated simulations and experiments, the researchers were able to shed light on the way additives behave in the fuel-rich conversion of methane to syngas. Their current research explores concepts for reducing the amounts of additives required and the chemical implementation and utilisation of CO2 in combustion engines. Another three renowned researchers recently joined the research unit as Mercator Fellows: Professor Eric Peterson (Texas A&M University, USA), Professor Sergey Cheskis (Tel Aviv University, Israel) and Professor Ali Güngör (Ege University, Turkey).

The Chair of Reactive Fluids focuses on fundamental research into combustion processes and particle synthesis in the gas phase. In the DFG Priority Programme 1980, 'SpraySyn', a group of researchers coordinated by Professor Christof Schulz examines the synthesis of functional materials in spray flames. Following a successful evaluation in 2020, the project has secured 7.6 million euros in funding for the next three-year period. Eight of the 18 funded periods are based at the Department of Mechanical and Process Engineering. Within the scope of this priority programme and Research Unit 2284, headed by Professor Schulz, the Faculty organised the 4th International Symposium on Gas-phase Synthesis of Functional Nanomaterials in 2020. The online event was attended by 180 visitors from around the world.

The recent appointment of Junior Professor Doris Segets plays an important role in the processing of said materials into functional layers for use in batteries and fuel cells, for example. Her specialism complements the department's existing range of research areas and strengthens the connection between material synthesis and applications.

Members of the Chair of Reactive Fluids have developed a new anode material for batteries based on carbon and silicon. In collaboration with Evonik Industries, the team is currently





Laser-induced breakdown spectroscopy

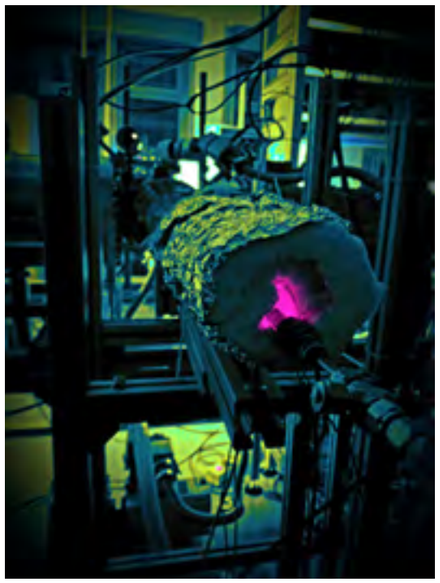
© Photo: Sacha Lau, Chair of Thermodynamics

working on advancing the manufacturing process and moving it to an industrial scale. The three-year project 'HOSALIB – High-Performance Silicon-Carbon Composite as Anode Material for Lithium-Ion Batteries' has secured 2.3 million euros in funding from the Federal Ministry of Economics and Technology. It focuses on manufacturing and processing the materials in question. The EU project Hyflexpower is dedicated to the study of another important aspect of future energy systems: led by Siemens, the consortium researches the use of hydrogen in gas turbines while building the world's first power-to-x-to-power demonstration plant with a hydrogen gas turbine. Within the scope of this project, the Chair of Reactive Fluids is developing ways of using endoscopic methods to measure flame positions and surface temperatures in the combustion chambers.

The Chair of Thermal Process Engineering focuses on fundamental research into the separation technique of adsorption. It secured three new DFG-funded projects in 2019 and 2020.

Supercritical carbon dioxide (sCO_2) is a fluid whose particular properties facilitate innovative solutions in heat and material transfer. CO2OLHEAT is the fourth project of Horizon 2020, the EU Framework Programme for Research and Innovation, that is based at the Chair of Turbomachinery. Its objective is to develop a sCO_2-based power plant and demonstrate its operational flexibility, reliability and suitability for temperatures above 350°C. The project team is working with industry partners to produce a prototype. CO2OLHEAT is based on similar EU-funded projects under UDE leadership, during which the basic concepts, proper functioning and sophistication of the system were proven both in theory and on the test bed. Another EU-funded project in the same field is 'sCO2-4-NPP'. It is dedicated to the development of an innovative, sCO_2-based heat removal system intended to improve the safety of nuclear power plants.

The Institute of Ship Technology, Ocean Engineering and Transport Systems (ISMT) focuses on numerical and experimental research of multiphase flows and fluid-structure interactions in the maritime context. Its members have carried out and published many studies into sloshing, cavitation and vortex-induced oscillations, including new methods of predicting cavitation-induced erosion. In partnership with the Department of Physics at Novosibirsk State University, the Institute has conducted experiments on passive cavitation control.



Hot tube-furnace reactor

© Photo: Dennis Kaczmarek, Chair of Thermodynamics

Inland shipping on rivers and canals is a competitive and sustainable transportation system that has always been a crucial location factor for industry in North Rhine-Westphalia and beyond. That is why the Department of Mechanical and Process Engineering (MBVT) has recently launched several major collaborative projects that will make inland vessels fit for the digital twenty-first century. The Chair of Mechatronics, the ISMT, and the Chair of Dynamics and Control collaborate closely with the DST and their international industry partners. Funding is provided by the State of North Rhine-Westphalia, the Federal Government and the European Union.

The team behind the project 'AutoBin – Simulation and Demonstration of Automated Driving in Inland Navigation' works on equipping an inland vessel with an extensive sensor and actuator system. ('AutoBin' is short for *autonomes Binnenschiff*, autonomous inland vessel.) Using a simulator, they are developing an AI-based navigation system that can safely steer a vessel from its point of departure to its destination. After training the AI in the simulator, the researchers test and demonstrate the navigation system using the fully equipped inland vessel.

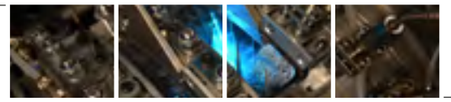
The 'FernBin' (remote-controlled, coordinated piloting in inland navigation) project team develops methods and assistance systems for controlling inland vessels remotely. They are also working on an onshore control station with interfaces to the vessel, operating elements and user interfaces. Not only are they using a real test vessel, they are simultaneously developing a digital twin ship, which faithfully mirrors the handling of the original. This digital twin will be used as an onshore control station for testing, development and ship crew training purposes.

The Test and Management Centre for Autonomous Inland Waterway Vessels (VeLAbi) at the Ministry of Transport of North Rhine-Westphalia was proposed and established in the context of this project. With a diameter of eight metres, the simulator is a 360° projection of a ship's bridge. It generates a seamless, stereoscopic 3D image on a projection surface of approximately 67 m^2. In addition to this projection technique, the researchers use virtual and augmented reality glasses enabling them to interact directly with the virtual environment.

Dean: Professor Dr –Ing. Dieter Schramm

The Chair of Energy Technology focuses on three key research areas. The first is dedicated to modelling and analysing energy systems, in particular, cogeneration and innovative heating networks. Its members have carried out various projects within the scope of the development of the large housing development of Duisburg-Wedau. In the second key research area, researchers carry out scientific analyses of the use of hydrogen, such as its storage as gas in high-pressure tanks or its storage as liquid ammonia. The third key research area revolves around the development of electrochemical energy converters – specifically, fuel cells and new battery technologies – in partnership with Grillo and Varta Microbattery.

The Chair of Environmental Process Engineering and Plant Design researches future energy supply systems and plants that use renewable



© Photo: Daniel Schumann

This is what entering the Duisburg port will look like in the river ship simulator.

energy sources to provide electricity, heat and consumables (fuels, basic chemicals). For the project 'Bicarb2Fuel', funded by the Federal Ministry of Economics and Technology, the Chair of Environmental Process Engineering and Plant Design collaborates with Mitsubishi Power Europe GmbH. Its objective is to demonstrate an energy-efficient method of carbon capture and subsequent methane and methanol synthesis. The members of the Chair are developing a pilot plant that carries out all required steps in the absorption–desorption process. At the same time, thermodynamic and reaction-kinetic data are captured in a laboratory in order to facilitate precise catalyst and process optimisation and model simulations.

The Chair of Materials Science and Engineering has been working with Professor Alexander Hartmaier of the Interdisciplinary Centre for Advanced Materials Simulation (ICAMS) at Ruhr University Bochum on researching deformation and failure mechanisms in austenitic steel under coupled compressive and torsional loading since 2020. This DFG-funded collaborative project uses high-resolution electron microscopy to examine damage at the microstructural level. Its insights inform micromechanical models that make the behaviour of austenitic steels under complex pressure significantly more predictable.

Awards

Shortly after joining UDE, Professor Doris Segets 2020 was admitted to the Junge Akademie at the Berlin-Brandenburg Academy of Sciences and Humanities and the German National Academy of Sciences Leopoldina. Professor Burak Atakan was conferred the lifetime honorific title of Fellow of T he Combustion Institute in 2020.

Several doctoral candidates of the Faculty have won awards for their outstanding dissertations:

- Dr Dennis Roskosch won the MegaWATT Award in 2019
- Dr Andreas Peters won the Georg Weinblum Award in 2020
- Dr Marcel Richter and Dr Florian Möllenbruck won the VGB Innovation Award in 2019 and 2020, respectively.

Prizes have been awarded for shorter formats presented at conferences, too:

- Sebastian Grimm won a prize for the best poster at Euro-CVD 2019 in Luxembourg
- Florian Möllenbruck won the Werner von Boie Award at the Power Plant Technology Congress 2019 in Dresden
- Jonas Ambrosy and his co-authors won the poster prize of the 2020 annual conference of the ProcessNet subject divisions of Fluid Separations, Extraction and Adsorption in Berchtesgaden.
- Christian Mauer and his co-authors won the poster prize of the 2020 annual conference of ProcessNet in Aachen.
- Qi Deng and her co-authors won the Student Paper Award of the IEEE Conference on Cognitive and Computational Aspects of Situation Management 2020, organised online by the University of Victoria (BC, Canada)
- Roland Boumann and his co-authors won the Best Research Paper Award of the 6th International Symposium on Robotics and Mechatronics 2020 in Taipei (Taiwan).

Partnerships and international affairs

In April 2020, Professor Dieter Schramm of the Chair of Mechatronics became a visiting professor at the Dalian University of Technology (China). Dr Frederic Kracht, also from the Chair of Mechatronics, is a visiting scholar at the same institution. The partnership is dedicated to research into the mechanical load on fuel cell vehicles as conditioned by driving dynamics and environmental factors. It also involves the development of a platform for designing vehicles and driving simulators based on digital twins.

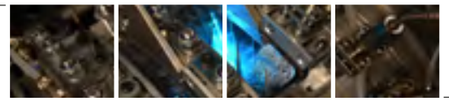
Members of the Faculty participate actively in their scientific communities and organise important conferences. In 2019, the VDI/ProcessNet Thermodynamics Colloquium took place at the University of Duisburg-Essen. More than 200 visitors attended the event, which featured early-career researchers from German institutions reporting on their research in thermodynamics. The Chair of General Business Administration and International Automotive Management organised the 11th Wissenschaftsforum Mobilität in 2019. Due to the immense growth of the forum, its 400 participants from the academic, business and political spheres gathered at the City Palais Duisburg, rather than the University, to discuss more than 80 contributions. For the first time since the inception of the event, an exhibition was set up in the city centre to educate the interested public about new approaches to mobility. The Institute of Ship Technology, Ocean Engineering and Transport Systems organised two international conferences: the Autonomous Inland and Short Sea Shipping Conference 2019 and the 14th OpenFOAM Workshop.

In a multidisciplinary consortium comprising the social sciences, economic sciences and engineering sciences, researchers of the University Alliance (UA) Ruhr explore ways of making mobility in the Ruhr Area sustainable. The 'InnaMoRuhr' project aims to improve the network between the four sites of the UA Ruhr without producing additional emissions in order to achieve a lasting, positive change in the mobility behaviour of its students and employees. The Ministry of Transport of North Rhine-Westphalia is funding the project with 2.4 million euros for a three-year period. From our faculty, the Chair of General Business Administration and International Automotive Management participates in InnaMoRuhr.

The virtual institute KWK.NRW is an important collaboration of the Chair of Energy Technology. In this project, the Gas- und Wärme-Institut Essen e.V., the Fuel Cell Research Center (ZBT) and several chairs of the University of Duisburg-Essen work on pooling cogeneration expertise from across the State of North Rhine-Westphalia. Many other university institutes, associations and companies support the virtual institute as affiliated partners.

Transfer and sustainability

Three employees of the Chair of General Business Administration and International Automotive Management, Dr Florian Knobbe, Stefan Sommer and Gregor Szybisty, have come together to offer smart, wireless charging systems. They founded a business named gapcharge, which won national and international start-up competitions.



Professors

Professor Dr Burak Atakan
Professor Dr rer. nat. Gerd Bacher
Professor Dr -Ing. Jan Balzer
Professor Dr Dieter Bathen
Professor Dr -Ing. Niels Benson
Professor Dr Carolin Birk
Professor Dr Joachim Bluhm
Professor Dr Daniel Bodemer
Professor Dr Matthias Alexander Brand
Professor Dr Dieter Brillert
Professor Dr Oliver Bernd Büttner
Professor Dr Mohamed Amine Chatti
Professor Dr -Ing. Andreas Czylwik
Professor Dr Rüdiger Deike
Professor Dr Johannes-Martin Denecke
Professor Dr -Ing. Bettina Detmann
Professor Dr -Ing. Steven X. Ding
Professor Dr Ferdinand Walter Dudenhöffer
Professor Dr Ellen Enkel
Professor Dr sc. techn. Daniel Erni
Professor Dr Dina Fattakhova-Rohlfing
Professor Dr Stefan Fletcher
Professor Dr Norbert Fuhr
Professor Dr Jutta Geldermann
Professor Dr Johannes Gottschling
Professor Dr rer. nat. Anton Franz Grabmaier
Professor Dr Klaus Görner
Professor Dr Wilhelm Heinrichs
Professor Dr Angelika Heinzel
Professor Dr Maritta Heisel
Professor Dr Holger Hirsch
Professor Dr -Ing. Axel Hunger
Professor Dr -Ing. Peter Jung
Professor Dr Sebastian Kaiser
Professor Dr -Ing. Thomas Kaiser
Professor Dr Tina Kasper
Professor Dr Andrés George Kecskeméthy
Professor Dr Andreas Markus Kempf
Prof. Dr-Ing. Thomas Kirchartz
Prof. Dr-Ing. Rainer Kokozinski
Professor Dr Wojciech Grzegorz Kowalczyk
Prof. Dr-Ing. Frank Einar Kruis
Professor Dr Nicole Claudia Krämer-Mertens
Professor Dr Jens Harald Krüger
Professor Dr Barbara König
Professor Dr Martin Lang
Professor Dr Frank Lobeck
Professor Dr Doru Constantin Lupascu
Professor Dr Alexander Neithardt Malkwitz
Professor Dr Maic Oliver Masuch
Professor Dr Jochen Menkenhagen
Professor Dr Kahdijeh Mohri
Professor Dr rer. nat. Franziska Muckel
Professor Dr -Ing Arun Nagarajah
Professor Dr André Niemann
Professor Dr Bernd Noche
Professor Dr Stefan Panglisch
Professor Dr Josef Pauli
Professor Dr Eugen Perau
Professor Dr Heike Proff
Professor Dr Gregor Alexander Schiele
Professor Dr Reinhard Schiffers
Professor Dr rer. nat. Roland Schmechel
Professor Dr Frank Schmidt
Professor Dr Martina Schnellenbach-Held
Professor Dr Dieter Schramm
Professor Dr Jörg Schröder
Professor Dr Christof Werner Schulz
Professor Dr -Ing. Doris Segets
Prof. Dr-Ing. Karsten Seidl
Professor Dr -Ing. Klaus Solbach
Professor Dr Stefan Uwe Stieglitz
Professor Dr Natalie Stranghöner
Prof. Dr-Ing. Andreas Stöhr
Professor Dr Dirk Söffker
Prof. Dr-Ing. Hendrik Vennegeerts
Professor Dr Holger Vogt
Professor Dr Janis Voigtländer
Prof. Nils Weimann, Ph. D.
Professor Dr Torben Weis
Professor Dr Renatus Widmann
Prof. Dr-Ing. Hans-Ingolf Willms
Professor Dr Markus Winterer
Professor Dr Gerd Witt
Professor Dr Dirk Wittowsky
Professor Dr Andreas Wömpener
Professor Dr -Ing. Torsten Zesch
Professor Dr Jürgen Ernst Ziegler
Professor Dr Ould Abdallahi el Moctar
Prof. Dr-Ing. Stefan van Waasen

A prototype of their charging system was released in May 2020; it already features some additional digital functions. In August 2020, gapcharge was accepted into the High-Tech.NRW accelerator programme. Its founders are poised to start serial production of their system in 2021. The Chair of Energy Technology has produced its first successful start-up, too: Lagom Energy GmbH provides energy system analyses.

The Chair of Turbomachinery actively promotes the productive, pioneering exchange and transfer of knowledge between industry and research. With the establishment of CoRE, the Center of Rotating Equipment, the University of Duisburg-Essen and Siemens Energy jointly created a globally unique research, education and training centre dedicated to turbomachinery. Their partnership boosts transfer and exchange activities between theory, practice and industry in turbomachinery, a field in which Germany has an outstanding density of resources that make it a leader at the global level.

Work involving industry standards often leads the way for new economic and technical developments. Professor Doris Segets of the Chair of Reactive Fluids coordinates the 'NoRu' project, which seeks to standardise the characterisation of carbon blacks for fuel cells and batteries. It is funded by the Federal Ministry of Economics and Technology. The researchers behind NoRu are developing the foundation of a DIN/ISO standard for carbon materials used in batteries and fuel cells. The Chair of Energy Technology, the Fuel Cell Research Center (ZBT) and the Berlin-based company LUM GmbH are members of the consortium.

Outlook

Due to the close relationship between issues in energy technology and issues in economics, the benefits of collaboration between the corresponding chairs are self-evident. The project initiated by Professor Christof Schulz, Professor Jutta Geldermann and Professor Angelika Heinzel in collaboration with partners from Ruhr University Bochum within the framework of the Clusters4Future initiative of the Federal Ministry of Education and Research constitutes a highly promising, concrete future opportunity in the field of functional materials The consortium has reached the final stage of the initiative's application process with its proposal 'WISDOM4E – Knowledge-based design of complex materials and systems for sustainable electrochemical energy storage and conversion'. The proposed research topic belongs to a field that is of strategic importance for UDE and the University Alliance (UA) Ruhr. It has received 500,000 euros in funding to prepare a full proposal. The final selection round will take place in 2021; the winning project will be funded for up to nine years with up to 5 million euros per year.

Professor Steven Ding's (EIT) and Professor Dirk Söffker's (MBVT) chairs focus on control systems and automation, in particular, error detection, damage diagnostics and prognoses of the behaviour of technical systems. It stands to reason that there should be a degree programme representing the research topics of both chairs. The new 'Automation and Safety' programme has been established with two separate pathways: 'Automation Control Engineering' and 'Safe Systems'.

Automated waterway traffic holds great potential, but acceptance of self-driving vehicles depends largely on inherent risks. Safety improvements over manual driving will be the main benchmark for future developments in this field, and they are the primary objective of the proposed project 'SafeBin'. It focuses on assessing the risks of (partially) automated inland vessels with regard to system malfunctions, any danger which automated systems may pose to humans and the environment, potential risk reduction measures, and ways of detecting and overcoming hazardous situations and malfunctions during operation.

The Chair of Turbomachinery operates a four-stage axial compressor to study wet compression. It has recently been granted approximately 1 million euros in funding for equipment to process the ambient air and injected water. This will allow the researchers to study the flow in axial compressors operating with water vapour at inlet temperatures of up to 100° C.

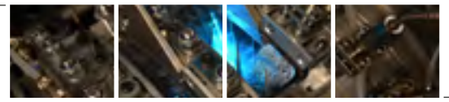
The Institute of Ship Technology, Ocean Engineering and Transport Systems plans to intensify its research activities in the fields of sloshing, cavitation and fluid-structure interactions. Multiple research proposals on these topics have been submitted. A laser laboratory for the experimental study of cavitation at the microscopic level will soon begin operations.

Electrical Engineering and Information Technology

The Department of Electrical Engineering and Information Technology focuses on five research areas: energy technology, medical technology, terahertz systems, mikroelektronics and photonics. Its 24 professors collaborate with the Fraunhofer Institute for Microelectronic Circuits and Systems (IMS) in Duisburg, Forschungszentrum Jülich, the German Aerospace Center (DLR) in Cologne and IMST GmbH in Kamp-Lintfort.

Research highlights

The department's most successful research activities in the field of medical technology include the development of an ultrabroadband, self-tuning high-frequency coil for functional 7-Tesla magnetic resonance imaging (MRI) by the Chair of General and Theoretical Electrical



Engineering. It is based on a leaky-mode approach and facilitates the simultaneous stimulation of nuclear magnetic resonances in multiple elements. The results have been accepted for publication in Nature Communications. The Chair of Electronic Components and Circuits has successfully developed a non-invasive, wearable sensor system that detects human moods. This project was part of the interdisciplinary research training group 'PAnalytics', which is funded by the Federal Ministry of Education and Research. The 'DeePPG' project team researches a depth-selective, light-based method for pulse transit time measurement at a single measuring position. Pulse transit time is a basic parameter of non-invasive mood and blood pressure measurement. Within the scope of the research profile on Tailored Materials , the 'EWALD' project researches innovative surface coating and structuring methods on the basis of atomic-layer deposition. These methods can influence the wetting properties of liquids electrically, allowing the researchers to manipulate minuscule amounts of liquids on surfaces, for example, in micro-laboratory diagnostics.

In the field of mobile radio and terahertz systems, the Chair of Communication Technology has developed wireless ad-hoc networks for emergency communications, researched security-relevant applications involving the wireless audio transmission of digital information, and measured the corresponding acoustic communication channel. The Chair of General and Theoretical Electrical Engineering has developed a robotised antenna measuring station for spherical millimetre waves within the scope of CRC/TRR 196 'MARIE'. It is the world's only site of its kind, and the project team intends to extend its capacity to support operation at 500 GHz in the medium term. The Chair of Optoelectronics has developed a terahertz imaging system based on photonic methods. This system exhibits the lowest level of phase noise of all known frequency range systems in the terahertz range and has won an IEEE Best Paper Award. The same researchers have demonstrated millimetre wave and terahertz radio systems with a spectral efficiency of approximately 8 bit/s/Hz, which has facilitated transmission rates of 100 Gbit/s in a frequency band that has already been licensed in the United States. Another development of the Chair of Optoelectronics is a milestone for future applications in terahertz communications: a terahertz beam control system with chip-integrated antenna elements.

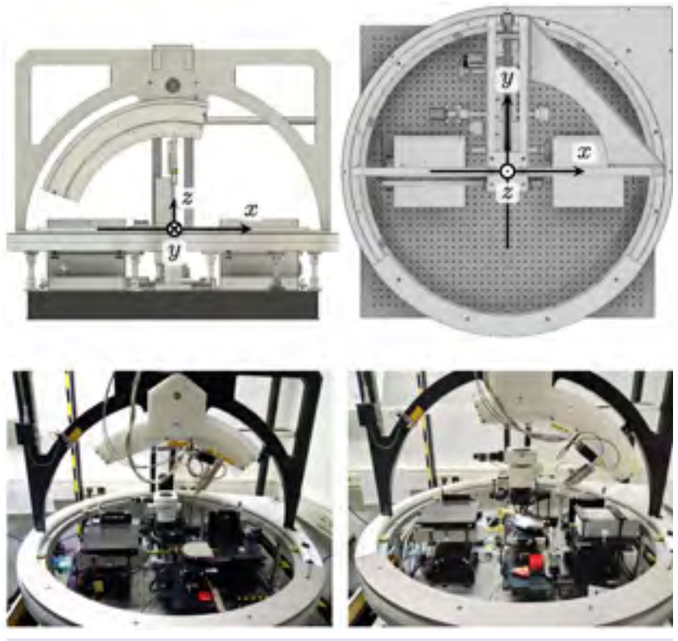
In the field of micro-, nano- and opto-electronics, the Chair of Electronic Materials and Nanostructures has appointed Franziska Muckel as the new junior professor of electroenergetic functional materials. Professor Einar Kruis of the Chair of Technology for Nanostructures (NST) spearheads various projects in the Research Unit FOR 2284 'Model-based scalable gas-phase synthesis of complex nanoparticle' and in the Priority Programme SPP 1980 'SpraySyn'. The Chair of Optoelectronics has successfully established TERAOPTICS, an European graduate school for research in terahertz photonics. It will be coordinated by the UDE's Centre for Semiconductor Technology and Optelectronics until 2023.

In the field of energy technology, the Chair of Electrical Energy Systems appointed Professor Hendrik Vennegeerts as its new head in 2019. For the 'NEXTGRID' project, a testing lab with power hardware-in-the-loop capability has been established at the chair in order to simulate future regulation and management concepts of the continental European electricity supply system. The project is funded by the Federal Ministry of Economics and Technology. This allows researchers to simulate large parts of the system in real time on a purpose-built computer; an amplifier interface is used to integrate scaled system components, such as wind turbines, photovoltaic systems and battery storage units. The system provides practical proof that the operational concepts and the regulations developed at the chair continue to work reliably in the event of communication latency or measuring errors. Through collaboration with the DLR in Cologne and a newly established junior professorship, the department is intensifying its activities in the field of thermoelectrics. Its members have produced a comparative study of the physical limits of high-temperature thermoelectrical concepts and thermophotovoltaics with the Faculty of Physics and the Chair of Technology for Nanostructures (NST). The 'EStroS' project, funded by the Federal Ministry of Education and Research and conducted by the Chair of Energy Transport und Storage in partnership with a medium-sized enterprise, has been completed successfully. Its objective was to develop and realise a highly precise measurement system for measuring large flows (6 kA) with frequencies of up to 100 kHz. The results facilitate improvements in the regulation and protection of high-voltage, direct-current electric power transmission system.

In the research profile on Smart Engineering, the Chair of Automatic Control and Complex Systems has intensified its focus on cyber-physical systems with embedded smart components and distributed system and information infrastructures. The Chair is successfully participating in the 'GreenEnergyFirst' research alliance, which develops novel concepts and methods for energy-optimised smart buildings.

Partnerships and international affairs

Members of the Department of Electrical Engineering and Information Technology work directly with many partners from research and



Characterization of antennas for millimetre waves with frequencies from 75 to 330 GHz – technical design drawings and photos from the actual experiment in the lab.

© Photo: Chair of General and Theoretical Electrical Engineering

Selected Publications

Okanimba Tedah, A., F. Maculewicz, D.E. Wolf, R. Schmechel (2019): *Thermoelectrics versus thermophotovoltaics: two approaches to convert heat fluxes into electricity. J. Phys. D: Appl. Phys. 52, 275501, doi: 10.1088/1361-6463/ab1833.*

Sievert, B., J.T. Svejda, D. Erni, A. Rennings (2020): *Spherical mm-Wave/THz Antenna Measurement System. IEEE Access. 8, 89680–89691, doi: 10.1109/ACCESS.2020.2993698.*

Atakan, B., S.A. Kaiser, J. Herzler, S. Porras, K. Banke, O. Deutschmann, T. Kasper, M. Fikri, R. Schießl, D. Schröder, C. Rudolph, D. Kaczmarek, H. Gossler, S. Drost, V. Bykov, U. Maas, C. Schulz (2020): *Flexible energy conversion and storage via high-temperature gas-phase reactions: The piston engine as a polygeneration reactor. Renewable and Sustainable Energy Reviews 133, 110264, doi: 10.1016/j.rser.2020.110264.*

Peters, A., O. el Moctar (2020): *Numerical assessment of cavitation-induced erosion using a multi-scale Euler–Lagrange method. Journal of Fluid Mechanics, 894, A19. doi:10.1017/jfm.2020.273.*

Hacks, A.J., S. Schuster, D. Brillert (2019): *Stabilizing Effects of Supercritical C02 Fluid Properties on Compressor Operation. International Journal of Turbomachinery, Propulsion and Power 4(3), doi: 10.3390/ijtpp4030020.*

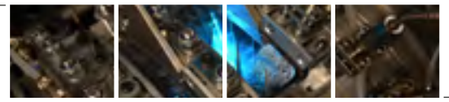
Sajjad, H.M., S. Hanke, S. Güler, H. ul Hassan, A. Fischer, A. Hartmaier (2019): *Modelling cyclic behaviour of martensitic steel with J2 plasticity and crystal plasticity. Materials 12(11), 1767, doi: 10.3390/ma12111767*

Gravenkamp, H., A.A. Saputra, S. Eisenträger (2020): *Three-dimensional image-based modeling by combining SBFEM and transfinite element shape functions. Computational Mechanics, doi: 10.1007/s00466-020-01884-4*

Uhlemann, J., F. Surholt, A. Westerhoff, N. Stranghöner, M. Motevalli, D. Balzani (2020): *Saturation of the stress-strain behaviour of architectural fabrics. Materials and Design 191 108584, doi: 10.1016/j.matdes.2020.108584.*

Schwittmann, L., M. Wander, T. Weis (2019): *Domain impersonation is heasible: a study of CA domain validation weaknesses. 4th IEEE European Symposium on Security and Privacy.*

Mirbabaie, M., D. Bunker, S. Stieglitz, J. Marx, C. Ehnis (2020): *Social media in times of crisis: Learning from Hurricane Harvey for the coronavirus disease 2019 pandemic response. Journal of Information Technology 35, 195-215, doi: 10.1177/0268396220929258.*



industry. They include the following domestic and international academic and industry players: Rohde & Schwarz, Deutsche Bahn, ESA, II-VI, VODAFONE, Nokia, CORNING, SIKLU, THALES, DAS Photonics and RAL. Based in Duisburg, the Department of Electrical Engineering and Information Technology coordinates the photonics developments for 5G in the European EUIMWP-COST network with more than 50 international partners. It also manages the UDE's first graduate school, which hosts 15 doctoral candidates who conduct research into terahertz photonics. The Centre for Semiconductor Technology and Optelectronics supports joint laboratories with the Ferdinand-Braun-Institut für Höchstfrequenzelektronik in Berlin, TU Darmstadt and the Fraunhofer Institute for Telecommunications. It also maintains research partnerships with ITMO University in Saint Petersburg (Professor Stanislav Glybovski), the University Medical Center Utrecht and TU Eindhoven.

Awards

- Professor Steven X. Ding was honoured as a 'highly cited researcher' by Clarivate Analytics in 2019 and 2020.
- Dr Franziska Muckel (now a junior professor) received the 2019 VDE Dissertation Prize for her dissertation on magnetic, solvent-based semiconductor quantum dots ('Magnetisch dotierte Halbleiter-Quantenpunkte aus lösungsmittelbasierter Herstellung: Von der Funktionalität zum Bauelement')
- Dr Benjamin Willsch received the Sparkasse am Niederrhein's 2020 Innovation Prize for his dissertation 'Integration of Physically Unclonable Functions (PUFs) in CMOS'.
- Sebastian Dülme won the IEEE Best Student Paper Award for his contribution to the International Microwave Photonics Conference 2019.
- Professor Andreas Stöhr was appointed to the technical committee on transmitting and receiving equipment for radiocommunications (TC103/WG6) as the German representative of the International Electrotechnical Commission (IEC).

© Photo: Chair of Opto-Electronics

Microscopic 3D analysis of a photo-lithographically produced structure in the clean room of the Centre for Semiconductor Technology and Opto-Electronics.

Transfer and sustainability

The company airCode UG was founded by members of the department in 2019. In this start-up, Marc Hoffmann, Professor Niels Benson, Professor Daniel Erni, Professor Thomas Kaiser and Professor Roland Schmechel develop flexible, printable, chip-less radio frequency identification tags with Schottky diodes based on silicon nanoparticles for operating frequencies in the multi-GHz range. A novel training device for the diagnosis and treatment of vestibular vertigo developed at the Chair of Electronic Components and Circuits in collaboration with the Fraunhofer Institute for Microelectronic Circuits and Systems, the otorhinolaryngologists' association of North Rhine-Westphalia and Gesellschaft für Elektronik und Design mbH was authorised as a medical product in 2020 following a development and certification period of several years. The story of this headphone-like product, which was initially funded by the Federal Ministry of Economics and Technology, from the initial idea to the final authorisation is a great example of successful technology and knowledge transfer.

Outlook

With the joint 'smartBeam' application, the contributing chairs of the Department of Electrical Engineering and Information Technology have successfully participated in the ForLab research tender, a part of the Federal Government's high-tech strategy. In January 2019, work began to expand the Centre for Semiconductor Technology and Optelectronics into Germany's central research laboratory for terahertz beam steering. The expansion project has attracted 3.9 million euros in funding. At the same time, the EU, the State of North Rhine-Westphalia and the University of Duisburg-Essen are providing 7.5 million euros in funding for the establishment of a novel terahertz integration centre in the same building. It will facilitate the integration of maximum-frequency electronic and photonic circuits in future.

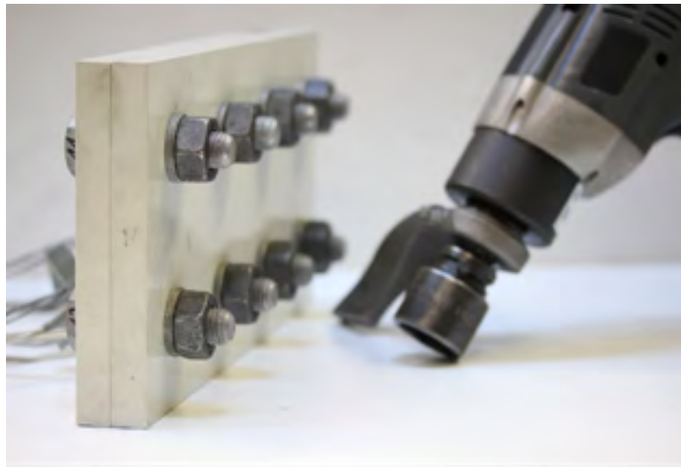
The Collaborative Research Centre/Transregio 196 'MARIE – Mobile Material Characterization and Localization by Electromagnetic Sensing' has been extended successfully. This opens up long-term research perspectives for the contributing chairs from the Department of Electrical Engineering and Information Technology and their collaboration partners.

Civil Engineering

In addition to its traditional tasks, the Department of Civil Engineering studies virtual and icy worlds. Through national and international projects, it has established and intensified multiple research partnerships. The department's research portfolio covers a great deal of ground from the robustness of small steel screws to the structure of the Antarctic ice sheet, from direct applications to the theoretical foundations of molecular structures.

Research highlights

The Chair of Mechanics will be coordinating the second funding period of the DFG Priority Programme SPP 1748 'Reliable Simulation Techniques in Solid Mechanics. Development of Non-standard Discretization Methods, Mechanical and Mathematical Analysis'. It also contributes two projects itself and is represented in two other Priority Programmes. In SPP 2013 'Targeted Use of Forming Induced Residual Stresses in Metal Components', the Chair researches the numerical representation of residual stresses in forging.



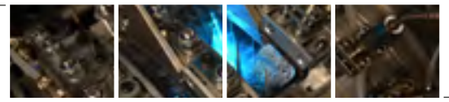
© Photo: Lukas Makevičius, FG IML

Power-coated test plates with screw joints for experiments on settling and creeping.

Within the scope of SPP 2020 'Cyclic deterioration of High-Performance Concrete in an experimental-virtual lab', the Chair advances computer-supported modelling of deterioration processes in fibre-reinforced high-performance concretes. Members of the Chair also contribute to projects in CRC/TRR 270, where they analyse magneto-mechanical meso structures produced through additive manufacturing, and SPP 2256, where they study homogenisation for the prediction of complex phenomena in micro-structural materials.

Within the scope of the Federal Ministry of Education and Research's funding programme for research into condensed matter and as part of the ISOPAC project, the Chair of Materials Science has been operating the solid-state beamline at the CERN's ISOLDE (Isotope mass Separator On-Line) facility for four years. Researchers at the beamline examine solid structures using the nuclear measurement method PAC (Perturbed gamma-gamma-Angular Correlation). They have recently secured 1.2 million euros in funding for a new measuring station for magnetically and electrically ordered crystals. Their research is highly relevant for data storage technologies.

Textile membranes in construction are one of the key research areas of the Chair of Metal and Lightweight Structures. In the past, the Chair has collaborated with the Chair of Continuum



Mechanics at Ruhr University Bochum in a DFG-funded project. The follow-up project now focuses on the development of adaptive numerical simulation methods and the history dependence and shear stiffness of architectural membranes. In another project funded by the DFG, members of the Chair are experimentally researching the mechanical load-bearing behaviour of sustainably produced ETFE films and structures. Preparations are currently underway for experiments on the roof of the UDE's Essen campus to examine the long-term weathering properties of membrane materials.

The Chair of Mobility and Urban Planning works on the topic of cities and mobility in two transdisciplinary projects. The project 'Spurwechsel Zollverein' of the Innogy Foundation investigates which forms of mobility people choose, why they make those choices, and how a lasting, socially just transformation of traffic in the north of Essen can be achieved. Today, the region between Duisburg, Düsseldorf, Wuppertal and the Rhine County of Neuss is already home to many competences that will be relevant to hydrogen-powered mobility in the near future. 'Kompetenzregion Wasserstoff – Düssel.Rhein.Wupper', the winning project in the state competition on hydrogen-powered mobility, is picking up speed. So far, the project team has established a developmental space for a comprehensive forecasting concept on the topic of hydrogen-based mobility.

At the Chair of Structural Concrete, the development and optimisation of high-performance materials and bearing structures constitute key research areas. The high-performance aerogel concrete (HPAC), a stable, heat-insulating, lightweight concrete developed in collaboration with the German Aerospace Center, has been optimised to suit building components under bending stress by testing reinforced HPAC test pieces for their moment and shear force bearing capacity. In a collaborative research project undertaken with the Chair of Theoretical Physics of the University of Cologne, members of the department are examining the setting behaviour of concrete in zero gravity. This endeavour will involve experiments on the International Space Station (ISS).

The Chair of Structural Analysis of Plates and Shells develops efficient methods of automating discretisation and calculation processes for structure-mechanical and multi-physical questions. These projects belong to two key research areas: Tailored Materials at the Faculty and Materials Chain at the UA Ruhr. The DFG funds the development of a radiation-based measuring system for characterising highly anisotropic, viscoelastic polymers. This project is conducted in partnership with the Chair of Measurement Engineering at Paderborn University. Another DFG-funded project focuses on the development of efficient methods of automated mesh generation and the simulation of wave propagation processes in three-dimensional, highly heterogeneous continua. Such processes are important when designing security-critical infrastructure and radiation-based processes for geological exploration.

The Chair of Structural Analysis and Design focuses on constructive glazing and fire risk assessments. In the former field, it studies extensions of the DIN 18008 glass standard that govern the bearing capacity and fitness for purpose of point-fixed glazing. As fire safety regulations become more complex, they also become more interesting to researchers. Building components that are subject to fire safety regulations must be tested experimentally. This leads to the development of more precise fire models, which take the impact of sprinkler systems into account, for example. In particular, they facilitate more economical assessments of delicate hall structures built from steel.

Transfer and sustainability

Among other endeavours, the Department of Civil Engineering transfers its knowledge through partnerships with local authorities and charitable organisations. The Chair of Urban Water and Waste Management has begun a collaborative project with the Emschergenossenschaft. It uses existing data to develop concepts for artificial intelligence and machine learning. The researchers aim to teach water treatment plants to detect patterns and use them to develop energy management solutions and forecasts. On behalf of the Federal Ministry of Transport and Digital Infrastructure, the Chair of Mobility and Urban Planning maintains the research information server for the field of integrated mobility services in urban areas. As of May 2019, the Deutsches Institut für Bautechnik (DIBt) officially recognises the Chair of Metal and Lightweight Structures as a monitoring body. It is now an inspection, monitoring and certification body (identification no. NRW71) as per the state building regulations.

Awards

- Dr Carina Nisters has been accepted to the Global Young Faculty.
- Dr Sarah Zydorczyk received an honour for the best dissertation in the engineering sciences in 2019.
- Sonja Uebing received the Best Poster Award – Second Prize of the German Association for Computational Mechanics in 2019.
- Christoph Abraham received the 'Heitkamp Ingenieur- und Kraftwerksbau' prize for his master's thesis in 2019.
- Lukas Makevicius received the audience prize of the International Association for Bridge and Structural Engineering (IABSE) for his presentation at the 6th Young Engineers Colloquium in 2019.
- The article 'Sprödbruchverhalten hochfester Schrauben großer Abmessungen bei tiefen Temperaturen' ('Brittle fracture of high-strength bolts of large diameters at low temperatures') by Professor Natalie Stranghöner et al. was among the 10% most frequently downloaded publications in the STAHLBAU journal between 2018 and 2019.

Partnerships and international affairs

Professor Jörg Schröder, Dr Carina Nisters, Tommy Mielke and Felix Paul (Chair of Mechanics and Chair of Materials Science) joined an expedition to the Antarctic on the South African research vessel Agulhas II. Their participation in this undertaking was doubtlessly one of the year's highlights in the area of international collaboration and research. It initiated a series of project proposals in partnership with the University of Cape Town. The research aims to examine and describe the mechanical properties of the Antarctic ice in a multi-scale process using methods from civil engineering.

Professor Jörg Schröder worked at the University of California, Berkeley as a visiting scholar in 2019. Professor Carolin Birk is collaborating with Professor Ean Tat Ooi of the Federation University in Ballarat, Australia on the project 'Computational modelling of multi-physics structural damage'. The Chair of Mechanics played a major role in planning the international conference 'European Congress on Computational Methods in Applied Sciences and Engineering (ECCOMAS) – Modern Finite Element Technologies 2019'.

Outlook

Professor Dirk Wittowsky now heads the Chair of Mobility and Urban Planning. Mobility in urban spaces will be a key research topic of the chair in future.

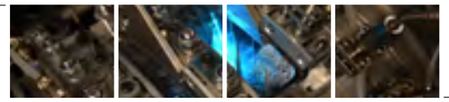
In collaboration with the Faculties of Biology, Chemistry, Engineering Sciences and Physics, Professor Jörg Schröder has submitted an application for around 7.3 million euros in funding to acquire a new, massively parallel high-performance computer with fast connectivity to the DFG and the State of North Rhine-Westphalia as per Article 91b GG.

As mentioned in the section on international affairs, the Department plans to establish and coordinate a new, pioneering field of research focusing on the sea ice of the Southern (Antarctic) Ocean in partnership with the University of Cape Town. The project team is currently applying for an international research training group.

The Chair of Urban Water and Waste Management under Professor Renatus Widman coordinates the project management, implementation and continuous optimisation of potential uses for the new building of the FutureWaterCampus. A funding recommendation and a recommendation for starting the project measures ahead of schedule have been issued. The Centre for Water and Environmental Research (ZWU) coordinates this interdisciplinary project.

Computer Science and Applied Cognitive Science

The Department of Computer Science and Applied Cognitive Science (INKO) comprises two teaching units that study computer systems from various perspectives and with various methods. Computer science focuses on technology, while the cognitive sciences concentrate on humans. This dual view of technology and



humans is highly relevant in a world like ours, where computers are ubiquitous and merge with the environment nearly imperceptibly. Rather than merely function, modern technical systems need to be accepted into society.

Research highlights

The team of Professor Maic Masuch's (Chair of Media Informatics) NRW flagship project 'VR-RLX – Virtual-Reality System for the Reduction of Children's Anxiety during MRI Scans' has developed a system that reduces stress and anxiety in children undergoing MRI scans. It has been funded by EFRE, and the publication of the project work has been honoured with the CHI Play Mention Award.

Professor Norbert Fuhr (Chair of Information Systems), Professor Nicole Krämer (Chair of Social Psychology) and Professor Torsten Zesch (Chair of Language Technology) participate in the recently approved DFG research training group GRK 2535/1 'Knowledge- and Data-driven Personalization of Medicine at the Point of Care'. It studies artificial intelligence and clinical decision support systems using malignant melanoma as an example. The application was submitted in partnership with the Dortmund University of Applied Sciences and Arts and the Faculty of Medicine at the University of Duisburg-Essen.

The Faculty has actively advanced the topic of research data management. In addition to various doctoral training programmes within the research training groups 'User Centred Social Media', the Department was granted various projects involving Professor Stefan Stieglitz (Chair of Professional Communication in Electronic Media). In the UNEKE project, funded by the Federal Ministry of Education and Research, a criteria-driven decision-making model for the structure of research data infrastructures was developed in collaboration with RWTH Aachen University. Further, the DFG currently funds the project 'sciebo Research Data Services (II)', which is carried out in collaboration with the University of Münster.

The Department was also awarded a large number of collaborative projects by the EU and the Federal Ministry of Education and Research. In late 2019, for example, the Federal Ministry of Education and Research granted it the KI-LiveS project. In it, the Chair of Embedded Systems of Computer Science and the Chair of Distributed Systems, both from the Department of Computer Science and Applied Cognitive Science, work on issues in artificial intelligence (AI) with the Faculty of Medicine, the Faculty of Business Administration and Economics, and TU Dortmund. The IMPACT project, funded by the Volkswagen Foundation, has been underway since 2019. Headed by Professor Nicole Krämer, the project is an interdisciplinary collaboration of psychology, computer science, ethics and law. It studies the impact of artificial-intelligence systems, such as voice services, on interpersonal communication and relationships.

Members of INKO also participate in major industrial research projects. They are providing scientific support in the digital transformation of the Evonik corporation under a recently concluded strategic agreement, for example. Four projects by Professor Nicole Krämer, Professor Daniel Bodemer (Chair of Research Methods in Psychology – Media-Based Knowledge Construction), Ulrich Hoppe (Chair of Collaborative Learning in Intelligent Distributed Environments) and Torben Weis (Chair of Distributed Systems) are funded in this context.

© Maic Masuch, Chair of Media Informatics / Entertainment Computing

The "Pingunaut Trainer" is a game-style virtual reality app that helps children prepare for an MRI examination

Awards

Professor Norbert Fuhr has been appointed a member of the Academy of the Special Interest Group Information Retrieval SIGIR, which was newly founded in June 2020. The SIGIR Academy honours researchers who have made significant cumulative contributions to the development of Information Retrieval as a field of research.

Partnerships and international affairs

The Department has been awarded the four-year project RISE_SMA 'Social Media Analytics for Society and Crisis Communication' within the scope of the EU programme 'Horizon 2020'. The project is headed by Professor Stefan Stieglitz. Its objective is to expand research methods for social-media contents and examine current phenomena, such as social bots and the impact of disinformation during the coronavirus pandemic, by collecting and evaluating data. It is a collaborative endeavour involving computer science, business information systems and media studies. Universities, authorities and companies from Germany, Norway, The Netherlands, Brazil, Indonesia and Australia are participating in it.

Transfer and sustainability

In collaboration with the North Rhine-Westphalia State Office for Central Police Services, the Department has developed a solution for securely storing data in the cloud and sharing it with other groups and authorities. The results of the SecureCloud research project, which was headed by Professor Torben Weis, have been licensed by a spin-off of the University of Duisburg-Essen, which will make the software fit for commercial operations. The foundation of the start-up RheinByteSystems GmbH was funded by the EXIST programme of the Federal Ministry of Education and Research and the European Social Fund.

Outlook

In mid-2021, the DFG will be establishing a new transregional research group, FOR 2974 'Affective and Cognitive Mechanisms of Specific Internet-Use Disorders'. Professor Matthias Brand, head of the Chair of General Psychology: Cognition, will be its head. The Department of Computer Science and Applied Cognitive Science will be involved in five sub-projects of the new research group, which examines the impact of stress on affective and cognitive processing capabilities in people with internet-use disorders.

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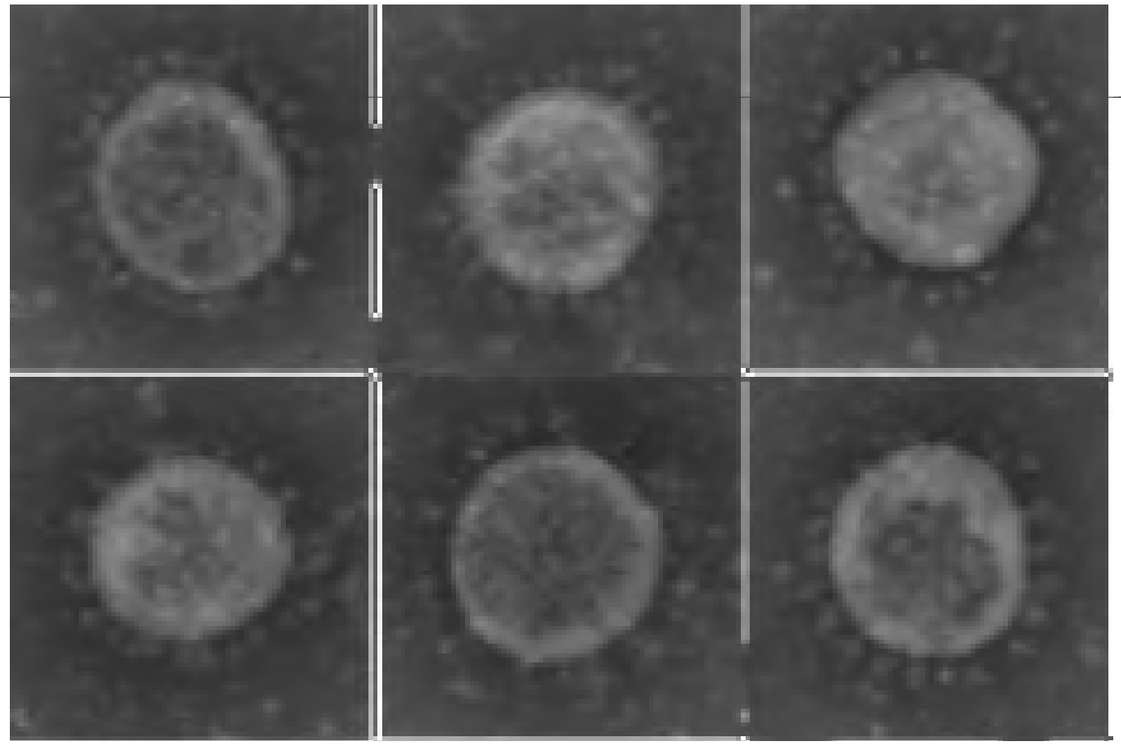


Source: Bernd Walkenfort and Dr. Mike Hasenberg from the Electron Microscopy Unit (EMU) of the Imaging Center Essen (IMCES) in collaboration with Maren Bormann, Lukas van de Sand, Leonie Schipper and PD Dr Adalbert Krawczyk of the Clinic for Infectious Diseases.

Transmission electron microscopy images of isolated SARS-CoV-2 virions

COVID-19 is a viral respiratory illness caused by the novel coronavirus SARS-CoV-2. Since it was first detected in late 2019, the virus has spread across the world. It is a global health problem that affects all parts of our lives. High-resolution transmission electron microscopy (TEM) imaging of SARS-CoV-2 provides important structural information about the morphology of the virus. These insights are valuable to researchers developing strategies for preventing and treating the illness.

Faculty of Medicine

The Faculty of Medicine employs 117 professors and more than 1,500 researchers. It has around 1,875 enrolled students. Its faculty building shares a campus with Essen University Hospital, so research and clinical care are closely interlinked, and new insights can be applied to practice as soon as they become available. In its research, the Faculty of Medicine focuses on several key priorities: cardiovascular medicine, oncology, transplantation, immunology, infectious diseases, and translational neuro- and behavioural sciences. Its 33 clinics and 28 institutes conduct scientific research at the highest level. With a remarkably high publication rate in relation to the number of professors employed here, the Faculty of Medicine is one of the most active publishers among all university hospitals in North Rhine-Westphalia.

In October 2019, the German Council of Science and Humanities lauded Essen as an emerging hub of university medicine in the federal state. Its statement particularly underscored the great potential of the city and the positive development which the Faculty of Medicine of the University of Duisburg-Essen (UDE) and Essen University Hospital underwent during the past years, emphasising the research achievements of the city's institutions.

Research

25.7 million euros for research: the DFG funds two collaborative research centres/Transregios at the Faculty of Medicine

The German Research Foundation (Deutsche Forschungsgemeinschaft, DFG) approved two CRC/TRR applications from Essen in early 2020. Professor Jan Buer, Dean of the Faculty of Medicine, commented: "We are extremely pleased with our success and consider it a clear sign of the strength of our research. It reassures us of the viability of our strategy, on which the German Council of Science and Humanities commented very favourably. We are also pleased that both collaborative research centres are headed by renowned female scientists. Essen is a leading centre of gender equality in academia, too."

The power of expectations: a new collaborative research centre/Transregio at the Faculty of Medicine

The transregional CRC/TRR 289, 'Treatment Expectation', examines the impact of expectations on efficacy of medical treatments. Headed by the University of Duisburg-Essen, the CRC/TRR approaches the topic from an interdisciplinary perspective. Professor Ulrike Bingel of the Faculty of Medicine at UDE is the spokesperson for the research alliance, which also includes Universität Hamburg and the University of Marburg. The DFG will be funding this CRC for an initial period of four years with approximately 12 million euros.

Local control of thyroid hormone action: a new collaborative research centre/Transregio at the Faculty of Medicine

The new CRC/TRR 296 will be researching local control of thyroid hormone action over the next four years. Professor Dagmar Führer, Director of the Faculty's Clinic for Endocrinology, Diabetes and Metabolism at Essen University Hospital, is the spokesperson of the research alliance. Its other contributors are the University of Lübeck and Charité – Universitätsmedizin Berlin. The DFG will be funding this CRC for an initial period of four years with 13.7 million euros.

New research unit on stroke – more than one million euros of DFG funding for researchers in Essen

The DFG is establishing FOR 2879, a new research unit on stroke, at the UDE's Faculty of Medicine. Managed from Essen University Hospital, the new alliance is a collaborative project of the University of Essen, the University of Munich, Universität Hamburg, and the University of Münster. Its objective is to study the role of the immune system in stroke and develop new treatment options.

The DFG funds research into autoimmune hepatitis

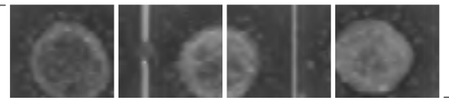
Autoimmune hepatitis is a rare chronic disease. A dysfunction in the body's immune system causes it to attack its own liver cells, which leads to hepatitis, i.e., inflammation of the liver. The DFG is funding the research project of the Clinic for Gastroenterology and Hepatology, which aims to develop new cellular therapies, with approximately 340,000 euros for an initial period of three years.

The DFG funds research into myocardial infarction

The DFG has allocated 470,000 euros in funding to a joint project by PD Dr Ulrike Hendgen-Cotta and Professor Tienush Rassaf, which aims to investigate the role of exogenic nitrite in protecting myocardial mitochondria during an acute myocardial infarction.

DFG-funded study: what role do our intestinal microflora and immune cells play in cerebral infarction?

Our gut flora affects our brain function. Imbalances in these microbiota may cause diseases, for example, stroke. Dr Vikramjeet Singh, a neuroscientist at UDE, researches the interrelation of intestinal microflora and immune cells and how it can affect cerebral infarction. In particular, he examines intestinal microbial diversity and neutrophils, the latter of which comprise the first line of immune response against pathogens. The DFG will be funding Dr Singh's study with 430,000 euros over the next three years.



750,000 euros in DFG funding against cancer

The German Research Foundation has allocated 750,000 euros in funding to two studies, one on melanoma and one on lung cancer, based at Essen University Hospital. Scientists of the UDE Faculty of Medicine are working on algorithms for imaging techniques that will allow their users to verify the success of cancer therapies faster and more precisely.

Worldwide university ranking: Essen's medical research scores top marks

The medical research of the University of Duisburg-Essen has achieved excellent results in the renowned 'Best Global Universities Rankings' published by the news magazine 'U.S. News & World Report'. It features prominently in the rankings for North Rhine-Westphalia, Germany and the world. For more than 30 years, the annual rankings have assessed the academic performance of nearly 1,500 universities, their faculties and departments.

The UDE's oncology research was particularly successful: it ranked second in Germany, first in North Rhine-Westphalia and 15th internationally. Oncology is one of five key research areas of the Faculty of Medicine. The Faculty's research into cardiovascular diseases also ranked first in North Rhine-Westphalia, came fourth in Germany and 57th worldwide. The radiology team has secured a place in the global top 100, occupying rank 70. Ranked eleventh in Germany and third in North Rhine-Westphalia, the researchers have achieved truly impressive results.

Better therapies for widespread conditions: the Institute of Transfusion Medicine researches anti-inflammatory extracellular vesicles

Within the scope of the international research project AutoCRAT, the Institute of Transfusion Medicine is developing new methods of using large quantities of extracellular vesicles (EVs) for therapeutic purposes. Stem-cell-derived EVs are a promising candidate for future therapies of widespread inflammatory diseases, such as arthritis. The EU is funding AutoCRAT to the tune of 760,000 euros for four years.

A new approach to stroke research: decoding signal pathways

Thromboinflammation has a decisive influence on the course of a stroke. This inflammatory response is triggered by an interaction of blood platelets and immune cells, which drives infarct growth in large parts of the brain. Researchers of the medical faculties and the University of Münster are currently researching the relation between these phenomena. The DFG is funding the project with approximately 500,000 euros.

Coronary artery calcification is partially hereditary

An interdisciplinary research unit at the UDE's Faculty of Medicine has been able to prove that lifestyle is not the only factor driving calcification of the coronary arteries. Genetic variations in the G-protein signalling pathway have an impact, too. The researchers spent five years analysing 3,108 randomly selected participants of the Heinz Nixdorf Recall Study. They have published their results in the journal Atherosclerosis.

A quantum leap in kidney research: the first explanation of kidney filtering disorders

Scientists of the UDE's Faculty of Medicine have worked with an international team of the CECAD Excellence Cluster in Cologne and various Institutes from Boston, Stockholm and Regensburg on a project that has led to the discovery of a previously unnoticed cause of kidney diseases. Their insights will aid and accelerate the development of targeted therapies. The renowned journal nature metabolism recently reported about their breakthrough discovery.

A boon for the mind: thyroid impact on brain function greater than assumed

Researchers from the UDE's Faculty of Medicine and the University of Edinburgh have discovered that thyroid hormones directly promote the formation of nerve cells in the part of the brain that control learning and memory. Their results will inform new approaches to improving mental performance. The renowned journal Stem Cell Reports reported on the discovery.

A study on malignant skin cancer: immune cells facilitate more accurate prediction of positive therapy outcomes

Merkel cell carcinoma is a malignant type of skin cancer that is often highly aggressive. Unfortunately, only half of patients benefit from conventional therapy. Scientists of the German Cancer Consortium (DKTK) at the UDE's Faculty of Medicine have explored potential methods of predicting the success of immunotherapy more effectively. Clinical Cancer Research reported on their work.

Hepatitis B viruses: liver cells are not defenceless

Once the hepatitis B virus enters the body, it causes a chronic infection of the liver in up to ten per cent of patients. To this day, we do not know how the pathogen overcomes the immune system. A recent discovery may help solve the riddle: a team of researchers of the Faculty of Medicine at the University of Duisburg-Essen have established how the immune system can successfully fight the virus.

Scavenger cells versus killer cells: interaction in the tumour tissue made visible

Neutrophil granulocytes, scavenger cells of the immune system, fight infection. But they are also suspected of promoting cancer. A UDE research team under Professor Sven Brandau of the Ear, Nose, and Throat Clinic at Essen University Hospital was able to prove this process in human tumour tissue for the first time.

Antiviral therapy: kidneys of hepatitis patients can be transplanted safely

There is still a severe shortage of donor organs in Germany. Medical researchers are developing methods to transplant organs that were previously considered unsuitable. An interdisciplinary team of the Faculty of Medicine has examined whether kidneys from deceased donors who carried the hepatitis C virus can help recipients without the virus.

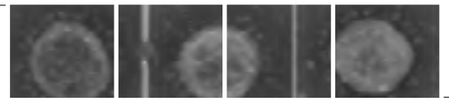
Polytherapy investigated in a phase-III study: a new life-prolonging treatment does not impact on the quality of life of glioblastoma patients

Glioblastoma are rapidly growing, highly aggressive brain tumours that are treated with surgery, radiation and chemotherapeutic agents. A team of researchers from several German university hospitals, including a medical doctor from the UDE's Faculty of Medicine, have taken a closer look at the efficacy of polytherapy involving two such chemotherapeutic agents. Any form of cancer therapy takes a toll on the patient. The researchers have analysed their condition after the polytherapy and found that quality of life is not impacted. Their study was published in Lancet Oncology.

Not just a mental-health issue: anorexia nervosa may be genetic

Anorexia nervosa is one of the most lethal psychiatric conditions. Within the scope of an international study, researchers of the Faculty of Medicine were able to show that the disorder can also be genetic. Nature Genetics has reported on their findings.

Dean: Professor Dr Jan Buer



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Professor Dr Sebastian Bauer
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Professor Dr Georgios Sotiropoulos
Professor Dr Andreas Stang
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Professor Dr Georg Täger
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Professor Dr Martin Teufel
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Professor Dr Jens Theyson
Professor Dr Matthias Thielmann
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Professor Dr Lale Umutlu
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Professor Dr Reza Wakili Noduschan
Professor Dr Jürgen Wasem
Professor Dr Frank Weber
Professor Dr Daniel Wendt
Professor Dr Gunther Wennemuth
Professor Dr Astrid Westendorf
Professor Dr Alexander Weymann
Professor Dr Benjamin Wilde
Professor Dr Oliver Witzke
Professor Dr Yuan Zhu

Improving organ transplants: with oxygen and slow temperature increases

How can we prepare sub-optimal liver transplants to give patients a new lease on life? Researchers of the Faculty of Medicine have studied the factors and processes involved in transplant quality and the long-term survival of transplant recipients. They have published their findings in two recent publications.

New approaches to fighting diabetes: CAR T cells

Autoimmune diseases are on the rise. As many as 300,000 people in Germany have type-1 diabetes. It is caused by an imbalance in the immune system, which attacks and kills the insulin-producing beta cells in the pancreas. Researchers of the Faculty of Medicine have attempted to restore the balance during laboratory experiments by artificially creating regulatory CAR T cells for type-1 diabetes.

Preventing hospital-acquired infection: growth factor inhibits natural killer cells

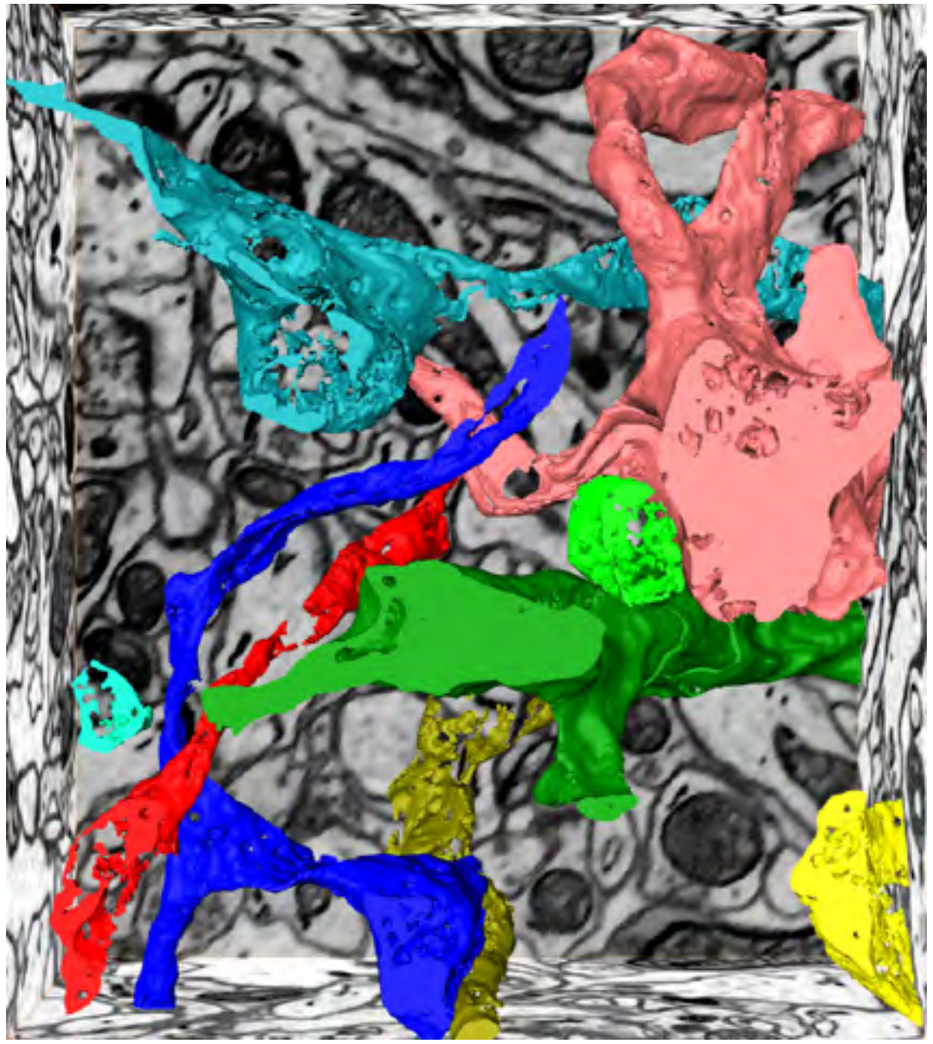
ICU patients often suffer from systemic inflammatory response syndrome, which them particularly vulnerable to hospital-acquired infections. Until recently, the reasons for this were entirely opaque. A team of researchers of the Faculty of Medicine has now discovered one of the causes: the natural killer cells of the immune system are compromised.

Discovery of a key enzyme that slows down collapse of the blood-brain barrier

After a stroke, it is imperative to restore blood flow through the brain. The blood clot is either dissolved by drugs or removed mechanically. In rare cases, however, the return of the blood supply (reperfusion) can lead to a collapse of the vital blood-brain barrier. Scientists of Maastricht University, the Faculty of Medicine at the University of Duisburg-Essen, and Essen University Hospital have investigated the causes of this phenomenon.

Newly discovered blood vessel system in bones

A team of researchers under Professor Matthias Gunzer and Dr Anja Hasenberg of the Institute of Experimental Immunology and Imaging at UDE's Faculty of Medicine has



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3D volume reconstructions of synaptic structures in the neocortex based on data obtained from animal testing

Capturing the ultrastructure of the brain in detail is essential for understanding its functional processes. Due to the large volumes of data involved and the complexity of the target structures, this endeavour still poses major challenges for cutting-edge imaging procedures. Many biomedical researchers worldwide are working on this sub-discipline of neurobiology. Professor Joachim Lübke's research group (Institute of Neuroscience and Medicine INM-10 at Forschungszentrum Jülich GmbH) has been studying the synaptic organisation of the neocortex and hippocampus for many years using transmission electron microscopy and quantitatively evaluable 3D models of synaptic structures. In collaboration with the Electron Microscopy Unit (EMU) of the Imaging Center Essen, managed by Dr Mike Hasenberg, the Faculty of Medicine at the University of Duisburg-Essen has successfully established the focused ion beam scanning electron microscopy (FIB-SEM) technique. This method allows researchers to produce high-resolution electron microscopy data stacks of the neocortex of rodents and, as of recent, humans. It also facilitates the reconstruction and quantification of 3D models of individual synaptic structures (specimens are colour-coded). Jacqueline Heinen-Weiler (doctoral candidate at the Clinic for Cardiology and Angiology – CardioScienceLabs in collaboration with the EMU) carried out the imaging and reconstruction process.

identified a previously overlooked network of extremely thin blood vessels which directly connects the bone marrow with the circulatory system under the periosteum. Their results have been published in Nature Metabolism

Research into COVID-19

SARS-CoV-2: Essen's researchers are working at full steam

Since SARS-CoV-2 and COVID-19 came into our lives, all eyes have been on science. The UDE's Faculty of Medicine has specialised in infectious diseases and immunology for many years. Since the spring of 2020, its researchers have been working at full steam to understand the novel coronavirus. Between then and late September, the ethics committee approved around 70 research applications, so the corresponding studies went underway immediately.

An important axis of science: Essen and Wuhan collaborate on research into COVID-19

The Faculty of Medicine operates a German-Chinese laboratory in the Chinese city of Wuhan. The Wuhan-Essen International Laboratory of Infection and Immunity was founded in 2017 by the University of Duisburg-Essen and the Huazhong University of Science and Technology in Wuhan. Their partnership can help advance research during the ongoing pandemic. Professor Ulf Dittmer, Director of the Institute of Virology at the UDE's Faculty of Medicine, believes that the large number of human samples from virus-bearing patients and the clinical data provided by the team in Wuhan constitute a particular advantage.

Coronaviruses: mouthwash can lower the risk of contagion

Certain brands of commercial mouthwash can deactivate SARS-CoV-2 viruses. That was the insight gained from a series of promising cell culture experiments conducted by researchers from six universities, including two members of the Faculty of Medicine at the University of Duisburg-Essen: PD Dr Adalbert Krawczyk from the Clinic for Infectious Diseases and Professor Jörg Steinmann from the Institute of Medical Microbiology. The laboratory results are yet to be verified in clinical studies. The research project was funded by Stiftung Universitätsmedizin Essen and the EU Horizon 2020 project.

A new test for analysing antiviral substances and neutralising antibodies for SARS-CoV-2

Neutralisation tests for the novel coronavirus are very complicated and require special laboratories. Researchers of the Faculty of Medicine have developed a faster, more economical method that is widely applicable. A pre-print of the study has been published to give the scientific community rapid access to the new method.

The Merkel phenomenon: a study into the significance of political communication

It was a historic speech that made an impact: in her TV address in March, Angela Merkel found the words we all needed to hear. COVID-19 does not just attack the respiratory system, it also takes a toll on our mental health. Clear political leadership and communication are incredibly important. The renowned journal Public Health reported on a study into the significance of political communication conducted by researchers of the UDE's Faculty of Medicine.

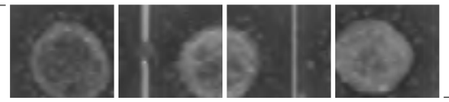
Early detection of severe COVID-19 cases

Many cases of COVID-19 are mild. Around ten per cent of patients, however, develop severe pneumonia and require intensive care. Identifying at-risk patients is an important step towards initiating the right treatment at an early stage. In partnership with the Wuhan Union Hospital, researchers from the Institute of Virology have found that the T cell population is a useful indicator. The study was preliminarily published online in The Lancet EBiomedicine.

Collaborations and international affairs

Research partnership initiated: Havana and Essen form a new axis of science

A new research partnership has been initiated in the Cuban capital of Havana. It involves the Medical University of Havana, the



International Center of Neurological Restoration (CIREN, Cuba's leading neurological research institute), and the Faculty of Medicine of the University of Duisburg-Essen. The partnership aims to facilitate exchange between students and researchers and establish collaborative research projects.

The Metropolitan Autonomous University (UAM) in Mexico City has entered into a collaboration agreement with the UDE's Faculty of Medicine.

The Alexander von Humboldt Foundation has appointed Professor Elke Cario of the Clinic for Gastroenterology and Hepatology to the selection committee for research scholarships. She joined the committee in January 2020.

Professor Dagmar Führer-Sakel, the Vice-Rector for Research, Career Development and Science Transfer and Director of the Clinic for Endocrinology, Diabetes and Metabolism, was appointed to the Permanent Senate Commission on Key Questions in Clinical Research of the German Research Foundation (DFG).

Professor Norbert Scherbaum has been appointed to the expert committee on the narcotics act of the Federal Ministry of Health again.

Professor Verena Jendrossek of the Institute of Cell Biology (tumour research) has been appointed to the Kompetenzverbund Strahlenforschung, an advisory committee of the Federal Ministry of Education and Research, as a representative of the German Society for Biological Radiation Research (DeGBS).

Prizes and awards

Scientists from Essen named on the global list of 'Highly Cited Researchers' in 2019

Every year, the Web of Science Group (a Clarivate Analytics company) identifies researchers all over the world who have published multiple academic works and whose publications are in the top one per cent of citations in their field. Three researchers of the UDE's Faculty of Medicine have made the list: Professor Gerd Heusch (Director of the Institute of Pathophysiology, research focus: heart attack), Professor Dirk Schadendorf (Director of the Clinic for Dermatology, research focus: skin cancer) and Antje Sucker (principal technical assistant at the Clinic for Dermatology).

Vordenker2020: Professor Michael Forsting

The Initiative Gesundheitswirtschaft, the B. Braun Foundation and the Bibliomed publishing house give out the Vordenker Award der Gesundheitswirtschaft. It honours individuals whose innovative ideas and projects have made pioneering improvements in healthcare. In 2020, the prize went to Professor Michael Forsting, the Director of Radiology and Head of IT at Essen University Hospital. The jury emphasised Professor Forsting's crucial contributions to the digital transformation of the hospital.

PD Dr Adalbert Krawczyk receives the G. D. Baedeker Prize 2020

The virologist PD Dr Adalbert Krawczyk, who teaches and researches at the Faculty of Medicine, University of Duisburg-Essen, has been awarded the 2020 Gottschalk Diederich Baedeker Prize. It honours his outstanding achievements at Essen University Hospital, where he works on developing a highly effective antibody to prevent and treat infection with the herpes simplex virus.

European Society of Cardiology honours researchers of the Clinic for Cardiology and Angiology

Four clinical and experimental researchers of the Clinic for Cardiology and Angiology, headed by director Professor Tienush Rassaf, have secured funding on the occasion of the annual conference of the European Society of Cardiology. Dr Lars Michel, Dr Raluca Mincu and Dr Simone Mrotzek were awarded the ESC Congress Educational Grant; Sebastian Korste (PhD candidate) won the ESC Basic Science Travel Award.

PD Dr Felix Nensa receives the Thieme Management Award 2018

The Thieme journal kma Klinik Management aktuell has honoured PD Dr Felix Nensa of Essen University Hospital as a 'high-flyer' in his field. He is the head of the research group on artificial intelligence at the Institute of

Selected Publications

Schwerpunkt Herz-Kreislauf

Merz, S.F., S. Korste, L. Bornemann, L. Michel, P. Stock, A. Squire, C. Soun, D.R. Engel, J. Detzer, H. Lörchner, D. M. Hermann, M. Kamler, J. Klode, Ulrike. B. Hendgen-Cotta, T. Rassaf, M. Gunzer, M. Totzeck (2019): *Contemporaneous 3D characterization of acute and chronic myocardial I/R injury and response. Nat Commun. 10(1):2312. doi: 10.1038/s41467-019-10338-2.*

Heusch, G. (2020): *Myocardial ischaemia-reperfusion injury and cardioprotection in perspective. Nat Rev Cardiol 17(12):773–789. doi: 10.1038/s41569-020-0403-y. Epub 2020 Jul 3.*

Schwerpunkt Onkologie

Liu, D., B. Schilling, D. Liu, A. Sucker, E. Livingstone, L. Jerby-Amon, L. Zimmer, R. Gutzmer, I. Satzger, C. Loquai, S. Grabbe, N. Vokes, C.A. Margolis, J. Conway, M.X. He, H. Elmarakeby, F. Dietlein, D. Miao, A. Tracy, H. Gogas, S.M. Goldinger, J. Utikal, C.U. Blank, R. Rauschenberg, D. von Bubnoff, A. Krackhardt, B. Weide, S. Haferkamp, F. Kiecker, B. Izar, L. Garraway, A. Regev, K. Flaherty, A. Paschen, E.M. Van Allen, D. Schadendorf (2019): *Integrative molecular and clinical modeling of clinical outcomes to PD1 blockade in patients with metastatic melanoma. Nat Med. 25(12), 1916–1927.*

Schuler, M., B.C. Cho, C.M. Sayehli, A. Navarro, R.A. Soo, H. Richly, P.A. Cassier, D. Tai, N. Penel, L. Nogova, S.H. Park, M. Schostak, P.Gajate, R. Cathomas, P. Rajagopalan, J. Grevel, S. Bender, O. Boix, H. Nogai, M. Ocker, P. Ellinghaus, M. Joerger (2019): *Rogaratinib in patients with advanced cancers selected by FGFR mRNA expression: a phase 1 dose-escalation and dose-expansion study. Lancet Oncol. 20(10), 1454–1466.*

Schwerpunkt Translationale Neuro- und Verhaltenswissenschaften

Masuda, T., R. Sankowski, O. Staszewski, C. Böttcher, L. Amann, Sagar, C. Scheiwe, S. Nessler, P. Kunz, G. van Loo, V.A. Coenen, P.C. Reinacher, A. Michel, U. Sure, R. Gold, D. Grün, J. Priller, C. Stadelmann, M. Prinz (2019): *Spatial and temporal heterogeneity of mouse and human microglia at single-cell resolution. Nature 56, 388–392.*

Hagenacker, T., C.D. Wurster, R. Günther, O. Schreiber-Katz, A. Osmanovic, S. Petri, M. Weiler, A. Ziegler, J. Kuttler, J.C. Koch, I. Schneider, G. Wunderlich, N. Schloss, H.C. Lehmann, I. Cordts, M. Deschauer, P. Lingor, C. Kamm, B. Stolte, L. Pietruck, A. Totzeck, K. Kizina, C. Mönninghoff, O. von Velsen, C. Ose, H. Reichmann, M. Forsting, A. Pechmann, J. Kirschner, A.C. Ludolph, A. Hermann, C. Kleinschnitz (2020): *Nusinersen in adults with 5q spinal muscular atrophy: a non-interventional, multicentre, observational cohort study. Lancet Neurol. 19, 317–325.*

Schwerpunkt Infektiologie und Immunologie

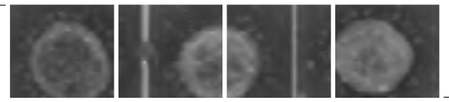
Lang, J., P. Bohn, H. Bhat, H. Jastrow, B. Walkenfort, F. Cansiz, J. Fink, M. Bauer, D. Olszewski, A.Ramos-Nascimento, V. Duhan, S.K. Friedrich, K.A. Becker, A. Krawczyk, M.J. Edwards, A. Burchert, M. Huber, J. Friebus-Kardash, J.R. Göthert, C. Hardt, H.C. Probst, F. Schumacher, K. Köhrer, B. Kleuser, E.B. Babiychuk, B. Sodeik, J. Seibel, U.F. Greber, P.A. Lang, E. Gulbins, K.S. Lang, J. Lang et al. (2020): *Acid ceramidase of macrophages traps herpes simplex virus in multivesicular bodies and protects from severe disease. Nat Commun. 11(1):1338.*

Grüneboom, A., I. Hawwari, D. Weidner, S. Culemann, S. Müller, S. Henneberg, A. Brenzel, S. Merz, L. Bornemann, K. Zec, M. Wuelling, L. Kling, M. Hasenberg, S. Voortmann, S. Lang, W. Baum, A. Ohs, O. Kraff, H.H. Quick, M. Jäger, S. Landgraeber, M.Dudda, R. Danuser, J.V. Stein, M. Rohde, K. Gelse, A.I. Garbe, A. Adamczyk, A.M. Westendorf, D. Hoffmann, S. Christiansen, D.R. Engel, A. Vortkamp, G. Krönke, M. Herrmann, T. Kamradt, G. Schett, A. Hasenberg, M. Gunzer (2019): *A network of trans-cortical capillaries as mainstay for blood circulation in long bones. Nat Metab. 1(2), 236–250.*

Schwerpunkt Transplantation

Minor, T., C. von Horn, A. Gallinat, M. Kaths, A. Kribben, J. Treckmann, A. Paul (2020): *First-in-man controlled rewarming and normothermic perfusion with cell-free solution of a kidney prior to transplantation, Am J Transplant. 20(4): 1192–1195.*

Radtke, S., A. Görgens, S. Vitoriano da Conceição Castro, L. Kordelas, A. Köninger, J. Dürig, M. Möllmann, P.A. Horn, B. Giebel (2019): *Human multipotent hematopoietic progenitor cell expansion is neither supported in endothelial and endothelial/mesenchymal co-cultures nor in NSG mice. Science Reports. 9(1): 12914.*



Diagnostic and Interventional Radiology and Neuroradiology, Faculty of Medicine, University of Duisburg-Essen.

Research prize for PD Dr Diana Klein

Verein Lungenfibrose e.V., an association that supports people with fibrosis of the lungs, has awarded a research prize to PD Dr Diana Klein, early-career research group leader at the Institute of Cell Biology (Tumour Research). She and her early-career research group work on radioprotection of normal tissue, focusing on how mesenchymal stem cells can be used to treat inflammatory and fibrotic tissue changes.

Transfer and sustainability

The research carried out at the Faculty of Medicine is as sustainable as it is pioneering. Its securing of additional collaborative research projects based in Essen, successful extension of existing funding, participation in new, externally funded projects, and acquisition of further external funding—from funding bodies such as the Federal Ministry of Education and Research—underscores this clearly.

More and more researchers of the Faculty of Medicine are appointed as reviewers. They contribute to the 'Excellence Initiative' of the German Federal Ministry of Education and Research and serve on the review board of the DFG and the editorial boards of major journals.

The transfer of research results to the public is a growing priority at the Faculty of Medicine. Its work in this field has paid off: the media, the academic community and the wider public are increasingly perceiving Essen as a high-profile centre of medical research in Germany.

Outlook

The Faculty of Medicine of the University of Duisburg-Essen and Essen University Hospital establish an Institute of Artificial Intelligence in Medicine (IKIM)

The UDE's Faculty of Medicine and Essen University Hospital have jointly founded a new Institute of Artificial Intelligence in Medicine. This innovative initiative seeks to analyse and leverage the opportunities of artificial intelligence in research, teaching and healthcare. "By establishing the IKIM, we are setting an inevitable strategic direction. Artificial intelligence will be an increasingly common tool to help researchers gain insight into the cause of diseases and develop new treatment methods. That is why we are establishing five professorships at the new institute from the start", Professor Jan Buer, Dean of the Faculty of Medicine, UDE, explained.

Bridge Institute for Experimental Tumour Therapy — West German Tumour Centre (WTZ) strikes new paths in cancer research

Essen University Hospital and the UDE's Faculty of Medicine have jointly established the Bridge Institute for Experimental Tumour Therapy (BIT). Professor Jens Siveke, Head of the German Cancer Consortium's Division of Solid Tumour Translational Oncology (DKTK) at the WTZ, is managing the new institute in the role of director. The BIT focuses on advanced research into imaging-based therapies, such as theranostics, alongside drug development and testing for innovative and personalised treatment methods.

New institute examines influence of urban planning on residents' health

The Faculty of Medicine of the University of Duisburg-Essen has established the new Institute of Urban Public Health (InUPH) at Essen University Hospital. It systematically and collaboratively explores how human health is influenced by urban environments and how the latter can be optimised. The Fritz und Hildegard Berg-Stiftung, a member of the Stifterverband, is funding the new institute with 750,000 euros over a five-year period.

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