UWr

University of Wrocław

Research University

University
of Wrocław

Research University

University of Wrocław – rational, open, diverse

The University of Wrocław is unique. On the one hand, it is rooted in the tradition of the Jesuit university founded by Emperor Leopold I in 1702 in Breslau. However, on the other hand, its heritage was brought by Polish scientists in 1945 who once worked at Jan Kazimierz University in Lviv, established in 1661. The fusion of these two academic cultures led to a community characterised by the cultivation of rationality and intellectual discipline in the pursuit of the truth. Nevertheless, no less important to us are the concepts of innovation and openness, and the development of international cooperation for the civilisational and cultural development of humanity.

At the University of Wrocław, we focus our research on areas of crucial importance to the modern world. For example, we search for effective therapies in the face of the growing number of civilisation and cancer diseases; we try to predict and prevent the effects of natural disasters and biodiversity degradation; we cooperate on the development of the mathematical foundations of artificial intelligence, and we research the development of new materials that meet the needs of industry and support the growth of civilisation. Finally, we analyse the functioning of multicultural communities in order to formulate recommendations and policies for the public sector. We collaborate with the world's leading universities in all these fields.

Additionally, promoting cultural and social development in our near and distant surroundings is also very important to us. As part of our mission, we cooperate closely with museums, cultural centres and schools. We take care of the heritage of the previous generations entrusted into our care by providing access to architectural and artistic monuments, both in the virtual and real world. We cooperate with the surrounding social organisations, NGOs and local governments to support the building of a rational, open and democratic society.

Our teaching is closely linked to these activities. Students work closely with lecturers in the framework of their current research. As a result, under the guidance of their teachers, they acquire knowledge resulting from their exposure to the latest research techniques. Moreover, at the same time, we emphasise enabling them to apply their skills and knowledge in the professions they aspire to work in. In university teaching, the latest research is the starting point for educating young people who are open to the future, who know the world and who are prepared to work in it for the benefit of us all.

The University of Wrocław aspires to be a research university. However, only in the sense described above – a community focused on conducting top-quality research for the benefit of the entire environment. Thus, at our university, research, teaching, and cooperation with the environment are intertwined to form a multi-coloured picture, a reflection of our community's multicultural and multi-ethnic past and present.

Professor Przemysław Wiszewski
Rector of the University of Wrocław

Beginnings of the University of Wrocław

The University of Wrocław was established thanks to the Jesuits and the Austrian emperor Leopold I. On 21 October 1702, the emperor signed the foundation document, the so-called *Aurea bulla fundationis Universitatis Wratislaviensis*. The university began its activities on 15 November of the same year, on the name-day of its patron. Initially, it was a two-faculty university, with the Faculty of Catholic Theology and the Faculty of Philosophy. After the conquest of Silesia by Prussia, King Frederick II guaranteed the continued existence of the university. However, he was not satisfied with the level of education – the university did not keep up with the changes brought by the Enlightenment. Similarly, the city's Protestant inhabitants were bothered by the existence of the Jesuit university and finally, in 1776, after the dissolution of the Society of Jesus, the Leopoldine Academy was nationalised.

In 1811, the Prussian king Friedrich Wilhelm III moved the decrepit Protestant university from Frankfurt to Wrocław. Viadrina University merged with the University of Wrocław, creating a new university where young people of different nationalities and religions studied at five faculties. The following faculties functioned at the university at the time: the Faculty of Catholic Theology, the Faculty of Protestant Theology, the Faculty of Law, the Faculty of Medicine and the Faculty of Philosophy. The last one included the new disciplines such as geography, history, Sanskrit, modern languages, music, science and agricultural sciences. In 1841, the next ruler, Frederick William IV, also established a Chair of Slavic Languages and Literature "to give Polish students an opportunity to excel in their mother tongue". In the academic year 1893/1894, a Polish scholar, a Slavist, professor Władysław Nehring, became the rector of the university

In 1911, on the 100th anniversary of the founding of the state university, it was renamed Frederick William University of Silesia. At that time, world-famous scholars and future Nobel Prize winners cooperated with the university. Interestingly enough, women also appeared among the students and lecturers. In 1900, Clara Immerwahr, a chemist, was the first woman to receive a doctoral degree from the university. However, the end of the interwar period marked the beginning of the German university's crisis.

On the night of 15/16 February 1945, Festung Breslau was surrounded by Soviet troops. The siege lasted 80 days. However, just a few days after the capitulation, scholars from Lviv arrived in Wrocław to establish a Polish university. The Science and Culture Group was led by professor Stanisław Kulczyński, former rector of Jan Kazimierz University in Lviv, who became rector of both the University and Polytechnic in Wrocław. On 24 August, the Government of National Unity decided to transform the former German universities of Wrocław into Polish state academic schools. The first lectures were delivered in autumn 1945 by professor Ludwik Hirszfeld at the University and by professor Kazimierz Idaszewski at the Polytechnic. As a result, six faculties were created at the University: the Faculty of Humanities, the Faculty of Law and Administration, the Faculty of Natural Sciences, the Faculty of Agriculture, the Faculty of Veterinary Medicine, the Faculty of Medicine and the Faculty of Mathematics, Physics and Chemistry, which was common to both universities.

In 1949, the Medical Academy became independent and eventually turned into the Piasts of Silesia Medical University, from which the present University of Physical Education also emerged. In 1950, on the basis of the two university faculties, the Higher School of Agriculture was established. It became the University of Life Sciences. In the academic year 1951/1952, Wrocław University of Science and Technology became an autonomous university.

In 1989, a new beginning for Poland also became a new beginning for the University of Wrocław. The university has been growing ever since, with more students, academics and research projects. Today, it is the largest university in Lower Silesia, with almost 30,000 students and employees at ten faculties and two inter-faculty units.

Aula Leopoldina is the most representative part of the main building of the University of Wrocław. It is a valuable and unique secular monument of the late Baroque. The auditorium, which was built in the years 1728-1732, along with the entire university building complex, owes its name to the founder of the University, Emperor Leopold I. During the subsequent wars and sieges of the city, Aula Leopoldina did not suffer any significant losses. In 2015, major restoration work began, which is expected to end this year.

About the University of Wrocław

The cultural and geographical location of the University of Wrocław on the Polish, German and Czech border justifies its aspiration as an open, tolerant and world-oriented institution. The overall aim of the university's internationalisation strategies is to prepare students to thrive in a multicultural community and information society. This means political, economic and social consolidation and cooperation.

The University of Wrocław has a rich history of more than three centuries of education. It is a public university and one of Poland's most significant research and education centres in Poland, with over 1,900 members of academic staff and over 23,000 students, including 1,400 international ones. It is placed among the top research universities in Poland. It prides itself on world-class research teams and facilities in science, natural and social sciences and the humanities. The results of its research are published, patented and used in various studies and technical descriptions. In recent years, the University of Wrocław has participated as a partner or coordinator in numerous international research and development projects within the European and international research programmes, such as: the Sixth and the Seventh Framework Programme (FP6 and FP7) Horizon 2020, DG Employment, the Social Affairs and Inclusion; Justice Programme; the Rights, Equality and Citizenship Programme; LIFE+; the European Foundation for the Improvement of Living and Working Conditions; the Polish-Norwegian Research Programme; the Polish-German Foundation for Science; the International Visegrád Fund and the Rothschild Foundation. In addition, our researchers actively participate in many national projects funded by the National Science Centre (NCN), National Centre for Research and Development (NCBiR), Polish National Agency for Academic Exchange (NAWA) and the Foundation for Polish Science.

The University of Wrocław also actively participates in international and national educational projects (mainly under ERASMUS+ and NAWA). Research activities and international mobilities at the University of Wrocław are supported by central administration offices, including the Office of International Projects, International Relations Office, Research Department, Human Resources Department, Internal Audit Office and the Bursar's Office.

Participating in diverse research and numerous mobilities is very much in line with our strategy of internationalising the university by increasing opportunities for students and staff mobility as well as exposing students to global perspectives through an international curriculum and pursuing dual degree opportunities. Our policy is to develop international collaboration in research, teaching and student exchanges.

Our university cooperates with many universities in and outside the EU based on bilateral agreements involving research and teaching. Each year, we admit around 600 students from across Europe and send almost 500 students abroad to study and conduct research at prestigious higher schools in Germany, France, Italy, Spain, Belgium, Great Britain, the Netherlands and Scandinavian countries. Outside the EU, the University of Wrocław has signed bilateral agreements with Russia, Ukraine, Kazakhstan, the USA and numerous other countries worldwide.

In recent years, the University of Wrocław has been actively participating in large European exchange programmes such as Erasmus Plus, Erasmus Mundus Joint Master Degrees, CEEPUS as well as in ISEP American exchange programme.

2019 was a ground-breaking year in the history of the University of Wrocław. That year, the university became a laureate of the contest organised by the Ministry of Science and Higher Education – *Excellence Initiative – Research University* (IDUB). As a result, the University of Wrocław will implement a project aimed at developing the institution and reaching the status of a research university, competitive to European and global higher education schools, in the years 2020-2026. Furthermore, thanks to the contest, the University of Wrocław is going to receive additional financial funds for implementing the project.

The objective of the highly rated programme of changes at the University of Wrocław are:

- supporting "the areas of excellence" in research that have been operating up to date (Priority Research Areas), strengthening their impact both in the community of the University of Wrocław and internationally;
- creating new research teams that actively participate in the global academic community and responding to the needs of the social environment with their research;
- developing individualised methods of teaching students and doctoral students that give them access to the most current global knowledge in order to promote their future participation in academic life;
- establishing close relationships with the university's external stakeholders, particularly with business entities and cultural centres;
- actively promoting a culture of quality in HR policy and introducing an efficient management system oriented towards clearly defined strategic goals.

The University of Wrocław endeavours to conduct top-quality research, modernise the educational system and influence sustainable social growth by transferring key solutions to the external environment. Participation in international projects is an essential condition for the development of any academic centre in terms of building up scientific as well as human capital. Through cooperation with the local, national and international environment, our university becomes a socially responsible institution, which – according to the best traditions of academia and modern understanding of democracy and human rights – takes a firm stand against exclusion based on gender, age, race, origin and cultural and economic capital.

good to know more

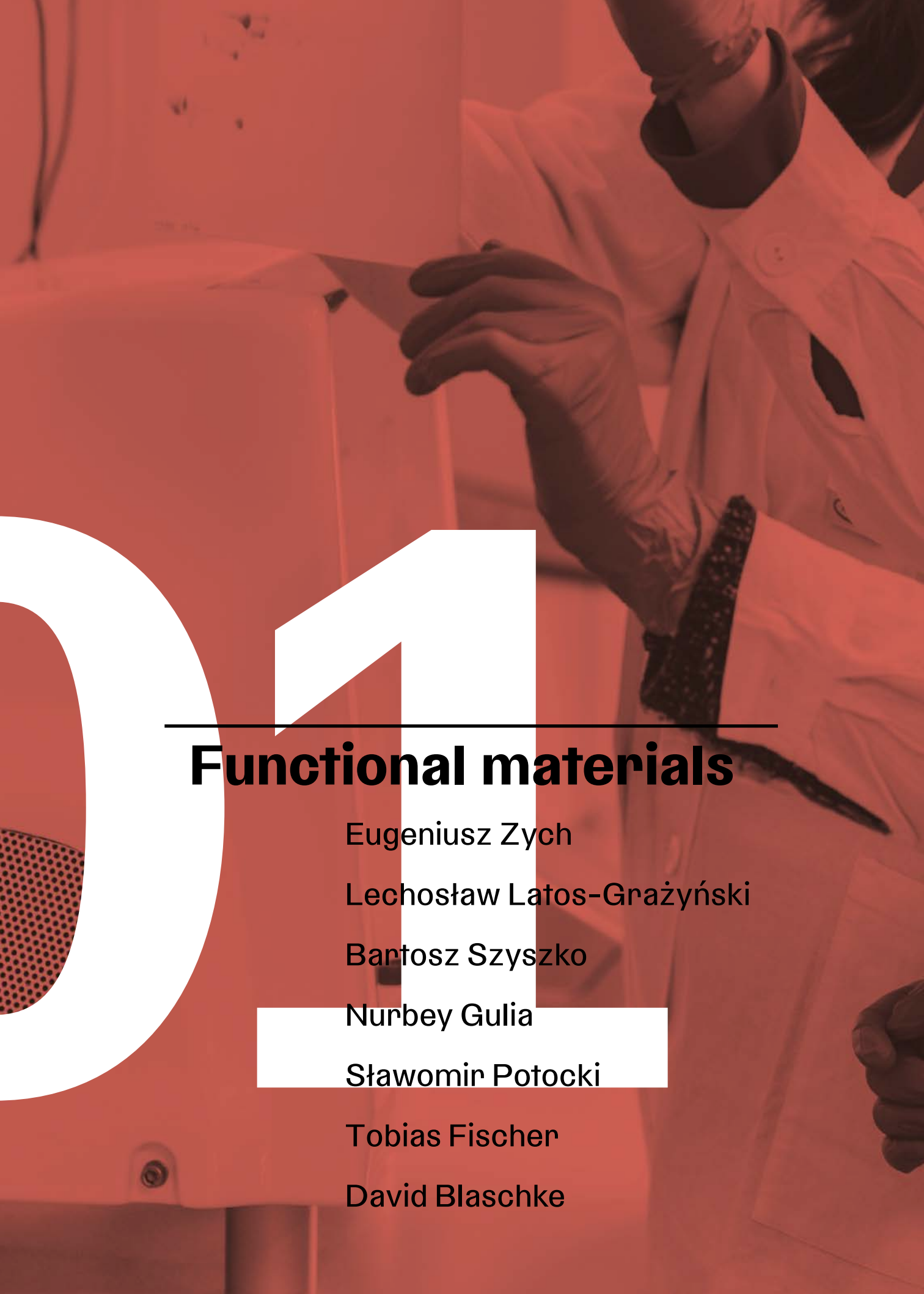
Library of the University of Wrocław

The Library of the University of Wrocław is considered an extraordinary academic library because, in addition to the universal research and teaching book collection it holds, it has excellent special collections, which are its great asset. Among these rich resources of cultural heritage, there is the largest collection of richly illuminated medieval manuscripts and the largest collection of old prints in Poland. In addition, the pride of this library is its great musical items, cartography as well as graphic collections, among which there are unique items of global importance. One also cannot ignore the rich resources of the regions of Wrocław, Silesia, and Lusatia.

The University Library extensively uses the latest technological solutions, which allow it not only to expand the offer of resources for the university with electronic sources of information and tools facilitating their use but also to develop better remote information about collections and offer access to digital copies of source materials (Digital Library, Repository) using specialised tools (*e.g.* streaming based on the IIIF standard). These modern technological solutions can be widely implemented thanks to the high professional competence of library's staff and a rich hardware base.

As of 2020 the University Library offers visitors its resources in a modern building, where - in addition to the virtual space - its physical space can be properly arranged. In order to improve the user service in the Library, the RFID system has been implemented (gates, self-checks and a book drop box) and free access to the newest collections has been launched.

The University of Wrocław is one of the ten best universities in Poland - we are a Research University. We receive additional financing, thanks to which we can especially take care of students and research staff. We create scholarship programmes, fund grants, we expand the offer in English and reduce the number of people during classes - all to teach, co-create and discover even better.



01

Functional materials

Eugeniusz Zych

Lechosław Latos-Grażyński

Bartosz Szyszko

Nurbey Gulia

Sławomir Potocki

Tobias Fischer

David Blaschke

Web of Science subject categories

- Chemistry, Analytical - Chemistry
- Applied - Chemistry
- Multidisciplinary - Chemistry
- Organic - Chemistry
- Physical

Scopus ASJC (all science journal classification) categories

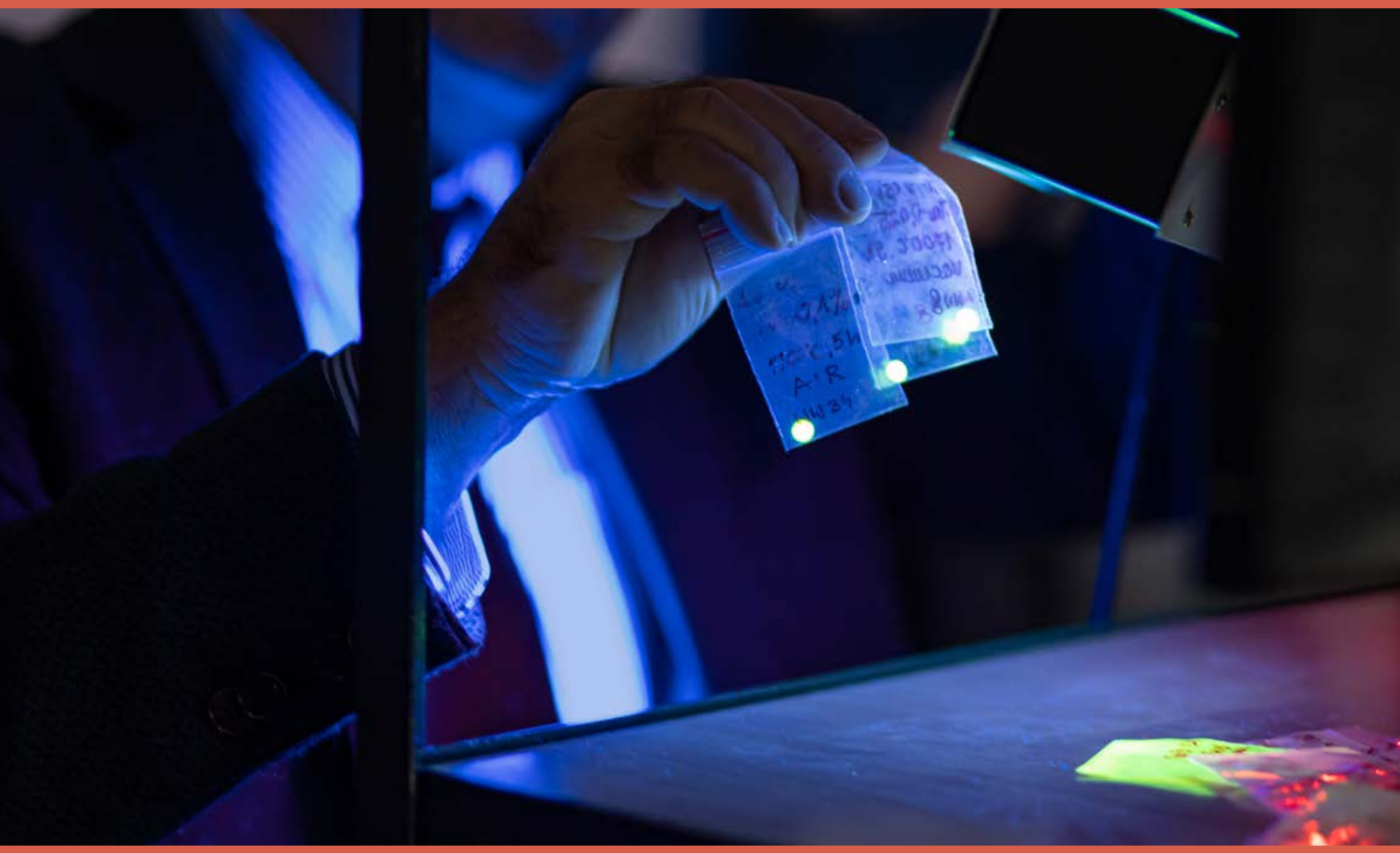
- General Biochemistry
- Genetics and Molecular Biology
- Chemical Engineering (miscellaneous)
- Chemistry (miscellaneous)
- Analytical Chemistry
- Inorganic Chemistry
- Organic Chemistry
- Materials Chemistry

Fields of study

Chemistry

This priority research area focuses mainly on fundamental properties of matter but the results provide a conceptual framework for designing new materials. Leading areas of investigation in recent years have covered various aspects of modern materials science: • Structure and reactivity of coordination, organic and organometallic compounds with applications in bioorganic and bioinorganic chemistry. Design of new supramolecular materials and materials with spin-crossover characteristics. • Chemistry and stereochemistry of organic compounds, including the synthesis, reactivity and molecular structure of porphyrins and porphyrinoids, aromatic and heterocyclic compounds, peptides and proteins, peptidomimetics, bioconjugates, polyynes and halopolyynes, bis- and polyazoles. • Design and testing of homogeneous, heterogenized and nanoparticle catalysts, reactions involving ionic liquids and molten salts. • Design, theoretical calculations and synthesis of biologically active compounds, including drugs, peptides, aminosugars and their derivatives. Research on the role of metal ions in biological systems and interactions of metal ions with humic substances. • Preparation and characterisation of the properties of new phosphor materials, ferroelectrics, magnetic materials, molecular crystals, molecular-ionic and liquid crystals.

If you want to know more about ongoing research at the University of Wrocław in this priority area, scan the QR code.



Using advanced sometimes sophisticated instruments, scientists try to assess the potential of materials produced in their laboratories.

Eugeniusz Zych

The Luminescent Material Research Group, led by prof. dr hab. Eugeniusz Zych, work with light-emitting materials and chemical compounds. Such materials, often termed phosphors, convert one type of electromagnetic radiation (visible, ultraviolet, X- or gamma-rays and others) into another type of radiation, often just visible photons as well as infrared or UV radiation. Using advanced, sometimes sophisticated instruments, scientists try to assess the potential of materials produced in their laboratories. For such purposes, the fabricated phosphors are sometimes frozen to the temperature of liquid helium, 4.2 K (about -269.2 °C) or heated up to 1000 °C. This helps in determining and understanding their properties and, more importantly, defining ways of designing materials of required properties for novel lighting, safe medical diagnosis, precise temperature measuring, efficient catalysis of industrial processes and many other for which controlled light generation is needed.

Although UV or infrared radiation is invisible to the human eye, it is of great interest for potential use in medical and biological applications. One such application is the precise measurement of the temperature of cancerous tissues. Due to the high metabolism that takes place in them, cancer cells have their temperature elevated. Currently, a methodology is being developed to locally increase the temperature of these cells to a value that destroys them (*e.g.*, 60 °C) without damaging the healthy cells in the vicinity of those diseased ones. The simultaneous generation of UV and infrared photons within the cancerous cells, successfully realised by the group recently, using a single phosphor, gives a chance to develop phosphors that kill tumour cells (photons from the UV-C range) and allow imaging (IR photons) at the same time, using the same luminescent nanoparticles.

The researchers of the Luminescent Material Research Group are thus developing solutions that both show where the cancer cell is and destroy this cell by using radiation from the so-called ultraviolet C (UV-C) range, *i.e.*, the most energetic part of the ultraviolet. Research conducted by chemists from the University of Wrocław, led by Eugeniusz Zych, is therefore heading towards developing a non-invasive method of destroying cancer cells that will possibly have a substantial impact on the medicine application.

Lechosław Latos-Grażyński

Everyone has heard of haemoglobin. The haeme found in it is a porphyrin-iron compound named ferroporphyrin. Ferroporphyrins are also involved in respiration or in limiting the toxicity of substances harmful to our bodies. Prof. dr hab. Lechosław Latos-Grażyński studies their biochemistry; he studies how they bind oxygen, how they participate in the processes related to the synthesis of new compounds and what degradation processes they undergo. He is one of the world's leading experts in organic chemistry. He is the author of almost 300 publications on porphyrins, which have appeared in world-renowned chemical journals and have been cited over 12,000 times (Google Scholar). In addition, he is the winner of the Prize of the Foundation for Polish Science (the so-called "Polish Nobel Prize") (1998) as well as the Prize of the Minister of Education and Science for the overall research achievements (2021).

Lechosław Latos-Grażyński is a founder of the Department of Porphyrin and Metalloporphyrin Chemistry at the University of Wrocław, which he has managed since 1990. His scientific interests include the analogues of porphyrins, with particular emphasis on their synthesis and coordination chemistry, the biomimetic chemistry of porphyrins and their analogues, the NMR of the paramagnetic complexes of metalloporphyrins and the use of porphyrinoids in the photodynamic therapy (PDT). The most significant achievements of Latos-Grażyński's team include, first of all, the discovery of the so-called "reversed porphyrin" and the development of the coordination chemistry of this compound, the generation of a new class of macrocyclic compounds – carbaporphyrinoids as well as the first porphyrinoid showing Möbius aromaticity.

Currently, there are many expanded and contracted porphyrins known for unusual structures, topologies and magnetic and coordination properties. However, obtaining them would not be possible without changing the commonly accepted way of thinking about oligopyrrole systems. Today, Latos-Grażyński's team examine systems in which pairs of porphyrins join together to transfer the electrons or photons of light! Hypotheses are being tested that such oligoporphyrins could serve as elements in molecular electronics, *e.g.*, storing or transmitting information. Perhaps, they will replace the silicon crystals being used today in some applications. Another trend is to obtain the dynamic porphyrinide systems showing the features of molecular motors.

Latos-Grażyński received the prestigious award of the Foundation for Polish Science, Maria Skłodowska-Curie Award of the Polish Academy of Sciences, the Polish Prime Minister's Award for Scientific Achievements (2010) and the Lifetime Achievement Award granted in 2021 by the Minister of Education and Science for his scientific achievements. He is a full member of the Polish Academy of Sciences, Chairman of the Scientific Council of the Institute of Structural Research and Low Temperatures of the Polish Academy of Sciences and scientific councils of two research institutes of the Polish Academy of Sciences. He was also a member of the Central Commission for Academic Degrees and Title.

Latos-Grażynski's scientific career is closely tied to the Faculty of Chemistry, where he was awarded the title of professor in 1991. An important role in his scientific activities has been cooperation with the Faculty of Chemistry at the University of California (Davis) for over twenty years. He is one of the most cited chemists working in Poland. His research has entered the canon of world scientific literature and he has been honoured by the international community with numerous awards: the Alexander von Humboldt Research Award (2005) and the Japan Society for the Promotion of Science Invitation Fellowship for Research in Japan (2010), among others. In 2014, the Polish Chemical Society awarded him Jędrzej Śniadecki Medal, which is given for outstanding scientific achievements of global significance in chemistry.

Today, Latos-Grażyński's team examine systems in which pairs of porphyrins join together to transfer the electrons or photons of light!

This unusual design led to a group of fascinating molecules named aceneporphyrins which demonstrated the unusual properties and transformations unknown to the isolated components.

Bartosz Szyszko

Dr hab. Bartosz Szyszko defended his doctoral dissertation in 2014, working in the Porphyrin Chemistry Group under the supervision of Lechosław Latos-Grażyński. His research at that time focused on the construction of molecules merging the structural features of two fundamental classes of organic molecules, *i.e.* porphyrins and polycyclic aromatic hydrocarbons. This unusual design led to a group of fascinating molecules named aceneporphyrins which demonstrated the unusual properties and transformations unknown to the isolated components.

A striking example of such peculiar reactivity was the benzene contraction reaction detected for palladium(II) and gold(III) complexes of p-benziporphyrin and 1,4-naphthiporphyrin. Both articles describing the so-called "magic contraction" were highlighted on the covers of top, general audience chemistry journals – *Angewandte Chemie* and *Chemistry* – A European Journal. After graduating in 2015, Szyszko moved to Cambridge University for a postdoctoral fellowship in the group of professor Jonathan Nitschke, a world-renowned expert in the field of supramolecular chemistry. After returning to Wrocław, Szyszko has focused on constructing large porphyrin analogues which incorporate carbon atoms in their cavities. The most important results of this research line included the synthesis of helicenophyrins – hybrids of helicenes (helical hydrocarbons) and porphyrins and diphenanthrioctaphyrin – the example of extremely rare organic molecules that can exist in two very stable conformations (shapes), which presented very different stereochemical behaviour.

Bartosz Szyszko's research interests focus on broadly understood macrocyclic chemistry and organic supramolecular chemistry, which includes designing new acene-porphyrin hybrids and expanded carbaporphyrinoids. Thanks to the funding granted by the National Science Centre (SONATA BIS grant), he is setting up a new research group at the Faculty of Chemistry and launching a new research programme with the focal point being the application of subcomponent self-assembly method to the construction of molecular links and knots – fascinating compounds which can be treated as the manifestations of macroscopic knotted objects (*e.g.,* sailing knots) at a molecular level.

Sławomir Potocki

A significant increase in antibiotic-resistant bacterial strains has become one of the major health problems of the modern world. The World Health Organization (WHO) data alarming: in 2016, 10.4 million people contracted tuberculosis (TB), of whom 1.8 million people died. The treatment of M. tuberculosis infections is long and often requires a combination of several drugs. To help control deadly bacterial infections, scholars need a more detailed knowledge of bacterial cell biology, especially of resistance mechanisms. The lack of new, effective antibiotics has prompted the scientific community to search for new antimicrobial strategies – one of them is the use of the antibacterial properties of metals.

The development of M. tuberculosis is possible within the macrophages of the infected host. The most significant skill of M. tuberculosis serving survival within the macrophage is the efficient management of the homeostasis of metal ions essential for survival and replication in the phagosome. This project is inspired by the recent and fascinating discovery that one of the responses of the mammalian immune system to the M. tuberculosis infection is to elevate the concentrations of zinc and copper in the phagosome to such concentrations, which are highly toxic to bacterial cells. This opens up new opportunities for understanding host-pathogen relationships and designing antimicrobial therapies (using metals or metal homeostasis pathways) that complement the existing drugs. The scientific goal of the project is to elucidate, at the molecular level, the interaction of Zn(II) ions with the bacterial SmtB protein of the ArsR family (Mycobacterium tuberculosis), which is a transcriptional regulator induced by the toxic concentrations of zinc. Tubercle bacillus (Latin: *Mycobacterium tuberculosis*) is a weak Gram-positive bacterium that is the etiological agent of a dangerous infectious disease – tuberculosis. Our project focuses on the SmtB protein as well as on BigR4 – a recently identified homologue from M. smegmatis – a model non-pathogenic organism commonly used for biological research. The main goal is to answer the questions: how do mutations in the zinc-binding domain of the SmtB protein affect the protein itself, its ability to bind zinc and its binding to bacterial DNA?

Our study will use both zinc-binding domains and native proteins to determine the thermodynamic properties of zinc complexes, the structural-dynamic behaviour of the protein when exposed to zinc as well as the binding sites of

the SmtB protein to the bacterial chromosome (DNA). This genuinely interdisciplinary approach will allow us to describe in detail the processes involved in maintaining zinc homeostasis in Mycobacterium strains. We will begin our project by studying zinc complexes with binding domains to meticulously describe their thermodynamic properties. The next step will be to focus on the expression of SmtB/BigR4 proteins using E. coli strains; these proteins will be used in both thermodynamic and NMR studies. With the magnetic resonance spectroscopy results, we hope to obtain the first structure of the SmtB protein (or BigR4, whichever proves more stable after the optimisation process) that has never before been published. The final stage will involve the microbiological studies using genetically modified strains of M. smegmatis. To ensure the full feasibility of the project thus composed, we will execute it in close collaboration with the Faculty of Biotechnology of the University of Wrocław and the University of Warwick. Using different yet entirely complementary scientific disciplines in the project will allow us to fully describe the SmtB/BigR4 system in the dangerous human pathogen – in *Mycobacterium tuberculosis*.

To help control deadly bacterial infections, scholars need more detailed knowledge of bacterial cell biology, especially of resistance mechanisms.


WD 29
A-W4
EA

Nurbey Gulia

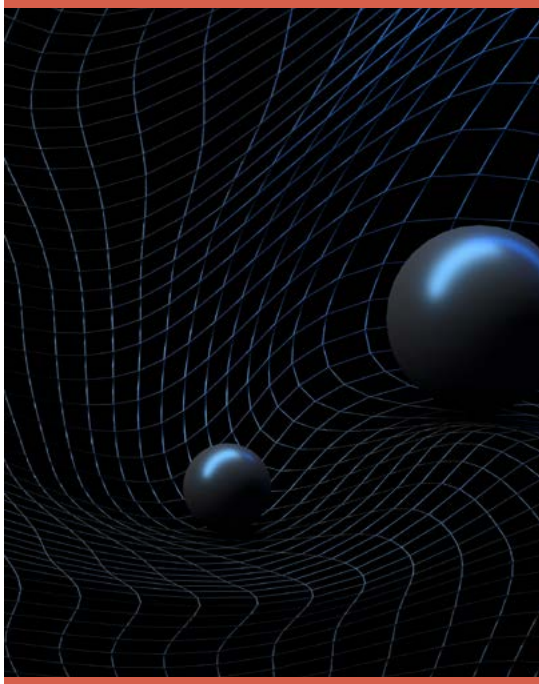
The synthesis of new chemical compounds is always a big challenge. At first glance, simple molecular structures often require multi-step synthesis. However, for organic compounds so rich in C-H bonds, its direct modification is undoubtedly the shortest possible route leading to its functionalisation. In this light, the replacement of classical coupling methods requiring the use of previously modified compounds by C-H functionalisation seems to be a natural evolutionary pathway for organic synthesis.

For organic molecules having multiple C-H bonds, selectivity is an extremely important issue. Using pre-coordination, it can be controlled by the so-called directing group. An extremely rare reaction of C-H bond functionalisation in beta position of aliphatic amines became the object of our interest. It should be noted that a structural motif having functional groups (*e.g.*, phenyl, hydroxyl) in this position is often found in compounds of great pharmaceutical interest. Using direct C-H functionalisation, such compounds can be obtained from simple aliphatic amines such as ephedrine and amphetamine from isopropylamine, salbutamol and synephrine from ethylamine.

The main objective of our research is to develop a general method for C-H functionalisation of primary aliphatic amines in beta position. The method is not intended to replace the traditional methods of obtaining known pharmaceuticals that have been used for years. Instead, the methodology under development opens a unique synthetic route leading to a wealth of new compounds with a high diversity of structural motifs, which may be important in the context of drug discovery. An example of the use of such methodology is the method we have developed for the synthesis of phenethylamine derivatives from primary amines and the functionalisation of *N*-arylpyrazoles (*Angew. Chem. Int. Ed. 2017, 56, 3630.; J. Org. Chem. 2018, 83, 5844.; J. Org. Chem.* 2021, 86, 14, 9353.).

The synthesis of new chemical compounds is always a big challenge. At first glance, simple molecular structures often require multi-step synthesis.

Tobias Fischer

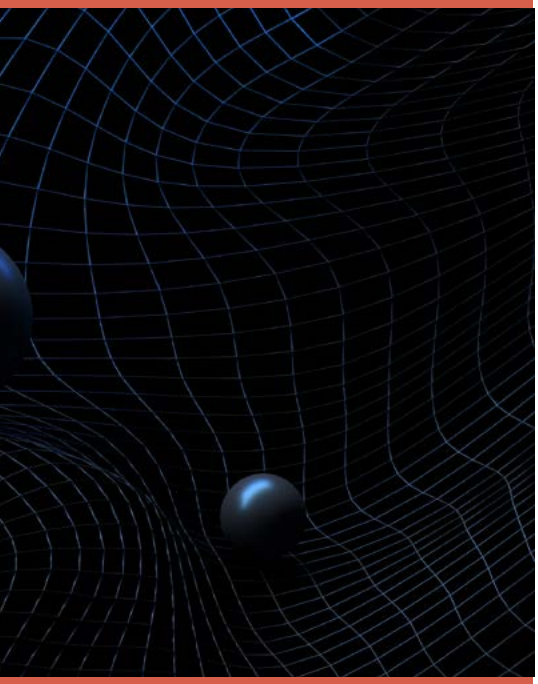


Dr hab. Tobias Fischer, professor of the University of Wrocław, has been working at the university since 2012. Before that he was a post doc for three years at GSI Helmholtzzentrum fuer Schwerionenforschung GmbH Darmstadt, Germany. Today his main research areas are Computational astrophysics, high-energy astrophysics phenomenology and Boltzmann neutrino transport.

The research grants from which Fischer benefits are both international and Polish. Especially interesting was the Swiss grant "Core collapse supernovae of massive stars as laboratories to probe matter at extreme conditions" funded by the SNF (Swiss National Science Foundation)-120 000 CHF host institution: GSI Hemlmoltzzentrum für Schwrionenforschung GmbH, Darmstadt (Germany). Fischer attracted attention with his research: "Massive star explosion as signals of extreme states of matter". The development of a novel multi-purpose equation for state of hot and dense matter for astrophysical application, featuring a hadron-quark matter phase transition, to the discovery of a novel explosion mechanism for massive stars; the neutrino signal from such supernova explosions as smoking gun-signature for the presence of quark matter at high densities, complementary to the gravitational wave signature from binary neutron star mergers.

Previously, he worked for three years on a research grant "Probing massive star explosions with neutrinos". With the development of updated weak interaction rates, with leading order medium modifications relevant for astrophysical studies, it became possible to study systematically the long-term evolution of core-collapse supernovae and the resulting nucleosynthesis, with particular focus on physics beyond the standard model, such as neutrino flavour oscillations and the emission of axions.

Today, the primary spaces in which Fischer conducts research and publishes work are the development of the computational methods for multi-dimensional neutrino transport, including the collisions integral; equation of state for hot and dense matter with QCD phase transition and last but not least: nuclear physics aspects for the development of weak interaction rates consistent with the nuclear equation of state.



David Blaschke

In his own words: My path of life is determined by the quest for uncovering basic laws and principles governing the phenomena of matter appearance. In particular, to make predictions about phase transitions in the system which might occur in response to extreme conditions of, *e.g.* temperatures, densities and strong fields provided in laboratory experiments or in the Cosmos.

He is currently working on several major international projects. Among them it is worth mentioning his work on nuclear matter under extreme conditions at the NICA energies. The project is devoted to investigate matter under extreme conditions in heavy ion collisions and in the interior of compact stars. Within the framework of the project, models of the quark-hadron matter equation of state will be constructed, their properties and characteristic observational effects for experiments at energies achievable on the NICA complex will be studied. A project that he recently completed was „Matter under extreme conditions in heavy-ion collisions and neutron stars". This project was devoted to systematic investigations of the equation of state (EoS) and phase diagram of strongly interacting matter under extreme conditions of temperature, density and isospin asymmetry on the basis of a field theoretical modeling of low-energy, strong coupling QCD in the nonperturbative regime. A new approach based on methods of Bayesian analysis for the investigation of quark-hadron hybrid matter was proposed and realised whereby the unknown model parameters could be estimated which characterize the phases of warm, dense matter.

Today he is particularly involved in a project based on funding from the polish National Science Centre: „Neutron stars: birth, structure and mergers". The purpose of this project is the understanding of basic properties of neutron stars, from their birth till their very end in the unified context of astrophysics, fundamental interactions, and newest experimental data. Another important research area for me is Quantum kinetics of particle production in strong fields. This project was devoted to going beyond the stage of thermodynamic equilibrium studies of the equation of state and phase structure of strongly interacting matter and step into the nonequilibrium domain as a necessary basis for dealing adequately with nonstationary situations met in heavy-ion collisions as well as in high-intensity laser colliders.

Currently his main research areas are quantum field theory for matter under extreme conditions of high temperatures, densities and strong fields; formation and dissociation (Mott effect) of bound states and quantum condensates under extreme conditions; investigation of the phase diagram of dense hadronic matter and QCD phase transitions in heavy-ion collisions and in Astrophysics and last but not least: pair production (Schwinger mechanism) in strong fields and applications to high-intensity lasers.

02

Human – city – environment

Małgorzata Werner

Tomasz Niedzielski

Mateusz Strzelecki

Adam Rajsz

Aleksandra Samecka

Katarzyna Kajdanek

Marek Kasprzak

Mariusz Orion Jędrysek

Adam Mrozowicki

Sylwester Kołomański

Web of Science subject categories

- Cultural Studies
- Engineering, Environmental
- Engineering, Geological
- Environmental Sciences
- Environmental Studies
- Geochemistry & Geophysics
- Geography
- Geography, Physical
- Geology
- Geosciences Multidisciplinary
- International Relations
- Political Science
- Sociology
- Urban Studies
- Meteorology & Atmospheric Sciences

Scopus ASJC (all science journal classification) categories

- Tourism, Leisure and Hospitality Management
- General Earth and Planetary Sciences
- Earth and Planetary Sciences (miscellaneous)
- Atmospheric Science
- Computers in Earth Sciences
- Earth-Surface Processes
- Economic Geology
- Geochemistry and Petrology
- Geology
- Geophysics
- Geotechnical Engineering and Engineering Geology
- Palaeontology
- General Environmental Science
- Environmental Chemistry
- Global and Planetary Change
- Nature and Landscape Conservation
- Waste Management and Disposal
- General Social Sciences
- Social Sciences (miscellaneous)
- Geography, Planning and Development
- Sociology and Political Science
- Communication
- Cultural Studies
- Political Science and International Relations
- Urban Studies

Fields of study

Geology

Spatial management

Geoinformatics and cartography

Atmospheric Sciences

Political science – public policy

Public administration, sociology

The interdisciplinary Priority Research Area integrates scientists in the field of earth and environmental sciences as well as sociology. The development of civilisation forces people to face the problems of rapidly dwindling natural resources, accelerating climate changes, and increasing environmental pollution. As 80% of the EU population will be living in cities by 2050, a comprehensive approach to the relationship between the changing environment and the quality of life and adaptation to the changing environment in the economic and social area is necessary. PRA responds to the key challenge of the Horizon Europe programme, including increasing the resilience of society and infrastructure to climate change and environmental pollution. It examines the effects of processes such as climate change, migrations, changing water resources, soil pollution, air quality and noise, taking into account cultural heritage and social aspects for the process of sustainable development. The PRA deals with current, priority scientific problems of interdisciplinary nature, the solution of which requires the cooperation of scientists from the earth and environmental sciences and social sciences.

If you want to know more about ongoing research at the University of Wrocław in this priority area, scan the QR code.

A strong collaboration between policy-makers and physicians provides a better understanding of their needs and supports developing tools that can be used for air pollution management.

photo: M. Korzystka-Muskała

Małgorzata Werner

Dr hab. inż. Małgorzata Werner, professor of the University of Wrocław, is a member of the Atmospheric Sciences Team which developed an advanced system of atmospheric process modelling and monitoring operated in the Department of Climatology and Atmosphere Protection at the University of Wrocław. This system is an integrated tool; optimised for analysing the processes taking place in the atmospheric boundary layer, with a particular emphasis on air pollution concentrations. State-of-the-art atmospheric chemical transport models are used to provide air pollution forecasts and are made available for a large community on the website: prognozy.uni.wroc.pl. The forecasting system is being constantly developed to meet the expectations of decision-makers, health specialists and stakeholders and to provide the best possible quality of temporal and spatial distribution of air pollution concentrations. Modelling at a very high spatial resolution of tens of meters, modelling allergenic pollen and data assimilation techniques from surface and satellite observations are the most urgent research tasks that are currently being undertaken by Maciej Kryza and Małgorzata Werner. A strong collaboration between policy-makers and physicians provides a better understanding of their needs and supports developing tools that can be used for air pollution management.

The monitoring system at the Department, led by Tymoteusz Sawiński and Anetta Drzeniecka-Osiadacz, covers measurements of stationary and mobile (drone and electric car) meteorological and air pollution parameters. A flying platform (drone) is equipped with an environmental head that can measure air pollution concentrations (*e.g.* particulate matters, ozone) as well as meteorological parameters such as air temperature, humidity and atmospheric pressure. Another essential feature of the monitoring system is the remote-sensing measurements by means of sodar (and in the nearest future also lidar, sun and lunar photometers). In addition, the Department coordinates a large number of research projects funded by national and European institutions and collaborates with leading institutions in air pollution research, *e.g.* Meteorological Synthesizing Centre West (MSC-W, EMEP), Imperial College London, UK Centre for Ecology and Hydrology, University of Worcester. The ongoing investment process, funded by the POIR programme, will make our station the best-equipped facility for meteorological and aerosol observation in this part of Europe.

photo: M. Korzystka-Muskała

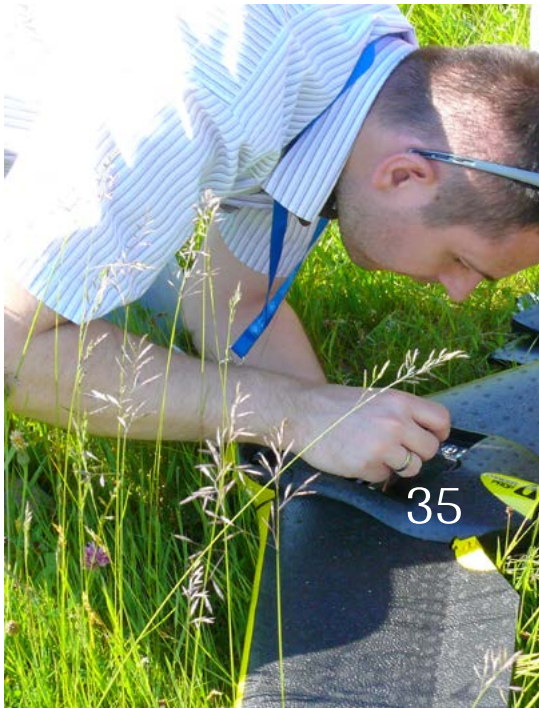
Tomasz Niedzielski

The work of scientists from the Institute of Geography and Regional Development proves that utilising the latest IT opportunities in science gives amazing results. The scientists combined geographical knowledge with IT skills to make a real difference to people's health, lives and safety. They created the revolutionary SARUAV system which inaids the rescue of missing persons as well as the innovative HydroProg system that alerts to floods.

Cold, wind, darkness, illness, injury and fear – especially in open areas – are just a few of the factors that make missing persons vulnerable to rapid loss of health or life. In such cases, the time needed for rescuers to reach the injured and provide them with the necessary assistance is of crucial importance. To shorten this time, the SARUAV (Search and Rescue Unmanned Aerial Vehicle) system was developed. Its purpose is to support search operations of the police, fire brigades, border guards and mountain and maritime rescue units.

At the core of this innovative technology is a special algorithm that analyses hundreds of aerial photographs, with great speed and efficiency in order to locate missing persons. Work with SARUAV consists of two stages: during the first one, an area where a missing person is likely to be found is delineated. Then, the drone takes aerial photographs, which are at the next stage processed by an algorithm. The result is an estimation of coordinates of the specific location where rescuers will find the person they are looking for so that they can provide them with assistance.

The prototype of the SARUAV system was created at the University of Wrocław and then further developed and implemented by a spin-off technology company, SARUAV sp. z o.o., operating under the auspices of the university. The system has already had its first successful operational use. At the end of June, a man went missing in the Low Beskids, and the search operation lasted twenty-four hours. SARUAV indicated the location of the missing person in aerial photographs taken by the drone. An analyst verified the place and then sent the rescuers of the Bieszczady Mountain Volunteer Search and Rescue team (GOPR) to the indicated area. The missing person was found in time and provided with medical assistance. Thus, the usefulness of the scientific idea was proven in practice and, above all, the person's life was saved.



Increasingly frequent heavy rainfall as well as storms and melting snow are amongst the causes of sudden floods and flooding. Mountainous and near-mountainous areas are most severely affected. It is in such areas that the geoinformatics specialists from the University of Wrocław have successfully tested their innovative technology – the HydroProg system – for several years.

The system is a tool designed to provide early and fully automated flood warnings. It is based on the so-called ensemble forecast, which is the prediction based on several hydrological models. The scientists also developed it with a network of proprietary hydrometeorological gauging stations. Together with them, it is a tool that will effectively alert to floods on rivers.

Both systems successfully passed all test stages and were introduced onto the market. The systems have received a lot of positive feedback from Polish and foreign specialists, who praise not only the speed and effectiveness of the innovative solutions but also their transparency and ease of use. Everyone unanimously confirms that both SARUAV and HydroProg have a chance of achieving a great international success.

photo: Jan Krupski

photo: Jan Krupski

Researchers have developed the revolutionary SARUAV system that aids the rescue of missing persons and the innovative HydroProg system alerts to floods.

Matt Strzelecki's recent research concentrates on the effects of tsunamis and storms on the paraglacial coastal environments of Arctic and sub-Arc-tic regions and the prediction of which sites are most vulnerable to their im-pact in a warmer future.

Mateusz Strzelecki

Since his undergraduate studies, dr hab. Matt C. Strzelecki was curious about the role of the Arctic coastal zone in paraglacial sediment cascades unleashed by rapid glacier retreat. To complete his doctoral studies, he left Poland and moved to the United Kingdom to study the mechanism controlling the development of paraglacial coasts of Svalbard at Durham University. His doctoral thesis provided the first detailed description of gravel-dominated barrier and spit-system evolution since the termination of the Little Ice Age (LIA) in Svalbard. It led to the development of one of the most precise Holocene relative sea-level curves for central Spitsbergen.

In addition, he was a pioneer in investigations of weathering processes along Arctic rocky coasts exposed by the retreat of tide-water glaciers. This led to his involvement as one of the lead authors of a state-of-the-art review of Arctic coastal change published by the Geological Society of London Special Publications. His research stays and postdoctoral positions at Alfred Wegener Institute in Potsdam and University Centre in Svalbard, followed by the prestigious National Science Centre Postdoctoral Fellowship, allowed him to continue research on Late Holocene sea-level change and post-LIA coastal evolution in Svalbard. As a result, he became a key expert in the studies on the impact of rapid deglaciation on the formation of barrier coasts of Svalbard. Aside from sedimentary coastal system studies, he has established himself as a leading researcher in polar rock coast studies. He led several field campaigns on the islands of Scandinavia, Svalbard, Greenland and the Antarctic region, concentrating on geomorphological processes operating on rocky cliffs and shore platforms. Achievements in rock coast studies resulted in a nomination for the Co-Chair of Rocky Coasts Working Group of International Association of Geomorphologists.

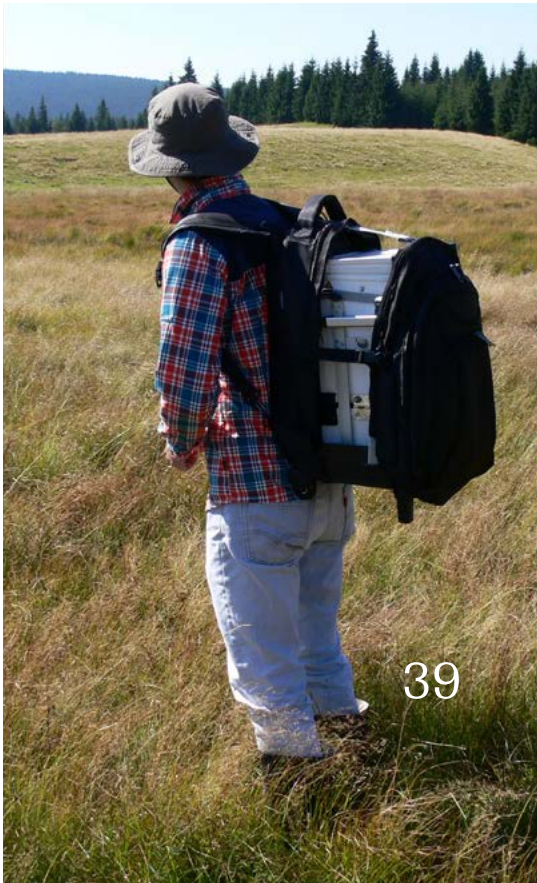
After his return to Wrocław, he also led an EU-supported project focused on the impact of coastal changes on the safety of community infrastructure in Svalbard. His expertise in polar coastal systems led him to be granted nine national research projects where he acted as a principal investigator and appointment as the scientific head of Stanisław Baranowski Polar Station of the University the Wrocław in Spitsbergen and the initiator of Alfred Jahn Cold Region Research Programme at University of Wrocław designed to strengthen our excellence in permafrost and periglacial research.

Matt Strzelecki's recent research concentrates on the effects of tsunamis and storms on the paraglacial coastal environments of Arctic and sub-Arctic regions and the prediction of which sites are most vulnerable to their impact in a warmer future. These ambitious objectives will result in a state-of-the-art study of the extreme processes shaping cold region coasts, which – in addition to the progress of paraglacial coastal research – will transfer new knowledge to help Arctic communities reduce the geohazard risk as most of their activities are concentrated along the coast.

Adam Rajsz

A water bath is a device present in almost every laboratory, necessary for many chemical and biological analyses. Dr Adam Rajsz has just developed a portable version.

When it is necessary to defrost samples properly, incubate bacterial cultures or conduct a chemical reaction at a strictly defined temperature, a water bath is indispensable. Water baths, also known as laboratory thermostats, are relatively simple devices. The main element is a container with water (or another heat mediator) and an electronically controlled heating/cooling element. The task of this type of device is to maintain the desired water temperature in which the samples are immersed so that they reach precisely the same temperature as the surrounding water. There are many laboratory water baths of various sizes on the market – from small two-litre ones to huge ones with a capacity of over 45 litres. In a stationary laboratory, the use of such devices, regardless of their size, is not a problem. Usually, there is no need to move them and they are powered from a 230V socket. Problems begin when there is a need to incubate samples directly in the field, especially in hard-to-reach places such as the ecosystems located high in the mountains. Typical laboratory devices cannot be used outdoors due to the inability to power them from the mains, sensitivity to weather conditions and considerable weight and dimensions. In particular, these complications increase when there is a need to move throughout the research day between multiple, widely spaced sampling points. In many fields of environmental research (*e.g.*, plant ecophysiology, environmental microbiology or environmental chemistry), many analyses require the incubation of samples at strictly controlled temperatures. Due to the lack of equipment enabling such incubations directly in the field, researchers are forced to collect samples and immediately transport them to the laboratory for further analysis using a water bath. Of course, this delays the entire process and the collected samples. In particular, the fragments of living plant tissues begin to degrade during this time, which has a tangible impact on the results.



The inventors of the water bath from the University of Wrocław deal with each of these problematic issues. Biologists Adam Rajsz and professor Bronisław Wojtuń from the University of Wrocław, working at the Department of Ecology, Biogeochemistry and Environmental Protection at the Faculty of Biological Sciences, investigate the ecology of plant communities in the high-mountain ecosystems of the Karkonosze Mountains, not only in the laboratory but also *in situ*. When measuring the activity of one of the enzymes involved in nitrogen metabolism in plants, nitrate reductase, they need to incubate plant fragments immersed in test tubes with a buffer at a strictly defined temperature and darkness level. Transporting plant samples from the Karkonosze Mountains to the laboratory, *e.g.* on ice, does not make much sense. Several hours after collection, the measured enzyme activity does not correspond to the actual values found at the original site. In order to be able to achieve the assumed research goals, Adam Rajsz constructed a portable water bath, with which researchers can carry out *in situ* the determination of nitrate reductase activity – directly in the place of the natural occurrence of the studied plants at altitudes of over 1,400 m above the sea level.

A water bath is a device present in almost every laboratory, necessary for many chemical and biological analyses. Adam Rajsz has just developed a portable version.

The biologists' water bath at the University of Wrocław looks more like a rectangular white safe with switches and a display on one of the four sidewalls. However, the design is very well thought out and has a modular design. The main module contains a stainless-steel incubation bowl with a capacity of 2 litres of water, an electronic control system and a small water pump. The power module contains a battery and can be easily connected and disconnected from the main module. Both modules are thermally insulated with five-centimetre-thick expanded polystyrene and covered with white cladding to reflect strong sunlight. To heat and cool water, the scholar used a Peltier module at the bottom of the bowl – a semiconductor element that serves both the heating and cooling of water, depending on whether the ambient temperature is higher or lower than the desired incubation temperature. Since lower temperature water has a slightly higher density than warmer water, on cooling from the bottom of the tank, cold water would remain at the bottom, causing an uneven temperature distribution in the sample tank. In order to achieve an even temperature distribution, a small electric pump has therefore been placed inside the device, forcing water to circulate. Everything is powered by a 12V battery located in the power module. With a battery and water inside, the portable water bath weighs just eight kilograms and is about the size of a medium-sized backpack. The constructed bath can heat water up to a maximum of +90° C and cool it down to +7° C.

"In order to test his idea in natural conditions, Rajsz installed the invention on a specially constructed backpack and set off for the Karkonosze Mountains to plant communities above the tree line. On the spot, they determined nitrate reductase activity in tussock grass and the leaves of alpine coltsfoot – two species found at high altitudes in the Giant Mountains. Measurements were made at several different locations, separated by at least three kilometres. The samples were incubated in a portable water bath for two hours at 26° C. A diazotisation reaction was then performed, resulting in stable dye formation. There was enough time to calmly go back to the lab and measure the dye absorbance with the spectrophotometer. The nitrate reductase activities obtained in this way for individual sites did not show any significant deviations – despite the changing weather and temperature conditions during the field incubation. Thus, the full usability of the constructed device was proven. Will a prototype from Wrocław go into production? It is not known, although there are companies interested in the invention. Above all, there are questions from colleague biologists on how to make such a device.

Aleksandra Samecka-Cymerman

Researchers from the Department of Ecology, Biogeochemistry and Environmental Protection, under the leadership of prof. dr hab. Aleksandra Samecka-Cymerman, examine the ecological phenomena of common and endangered aquatic and terrestrial plants. The methods used in the projects include biotests, bioindication and ecotoxicological models applied to the most effective bioindicators of environmental pollution. The results of the chemical and ecological plant investigations are evaluated with sophisticated statistical programmes (neural networks, data mining, multivariate exploratory techniques), published in international indexed journals and applied environmental protection practices.

Changes to the environment resulting from chemical pollution can be evaluated thanks to the data (background values for metals in bryophytes) collected from the areas which are relatively free from pollution, such as Svalbard, Switzerland, Spain and the Netherlands. During both field studies and laboratory experiments, scientists examine common, invasive, rare and endangered species, contributing to the extension of knowledge of their biogeochemistry as well as habitat requirements and tolerance. The results of their studies are then computed using advanced statistical analyses (such as neural networks, data mining, multivariate exploratory techniques and redundancy analysis) and ecological modelling. Additionally, they are interested in testing and developing novel indices. Some of the results can be practically applied and may be utilised in the biomonitoring of trace metal pollution as well as in the application of macrophytes in phytoremediation. They also form the basis for the effective actions in environmental protection.

In the Mountain and Polar Ecosystems Laboratory, researchers study high mountain and polar ecosystems, particularly Svalbard and the Sudety Mountains. The studies, led by Bronisław Wojtuń, Adam Rajsz and dr hab. Tomasz Szymura, professor of hte University of Wrocław, focus on the reasons behind the progressive degradation of biodiversity in various habitats as well as the extent to which it occurs, with particular emphasis on the diversity of mountain mires and the ecology of peat mosses (*Sphagnum*). The main objects of interest are:

1. the influence of global changes to the environment on the transformations and functioning of terrestrial ecosystems in the Arctic as represented by the Svalbard archipelago;
2. the identification of the main nitrogen sources across various types of tundra which enable the estimation of the contributions of different nitrogen pools: nitrogen primary fixation, atmospheric deposition, bird droppings, and organic decomposition;
3. the biomonitoring of terrestrial tundra ecosystems using different organisms (mosses, vascular plants, lichens, algae);
4. nutrient cycles; nitrogen in particular, and the impact of its increased anthropogenic deposition on polar and high-mountain ecosystems;
5. water, soil and plant analyses in terms of nitrogen, carbon and phosphorus content;
6. plant ecophysiology (nitrate reductase activity, photosynthesis rate *etc.*) in changing environmental conditions of high mountain ecosystems;
7. the modelling of environmental and socio-economical drivers of plants distribution and species richness;
8. the ecology and management of plant invasions;
9. the ecology and management of grasslands including urban lawns;
10. landscape ecology.

The research is especially important in the face of the current environmental changes that are related to climate change. Therefore, such research must continue to be carried out to better understand the consequences of climate change on a global level.

Katarzyna Kajdanek

Dr hab. Katarzyna Kajdanek, professor of the University of Wrocław, is a holder of a doctoral degree in urban sociology (2008) and an associate professor at the Institute of Sociology at the University of Wrocław. She is interested in the social aspects of the urbanisation processes in urban and rural areas. She has researched suburbanisation, rural revival and re-urbanisation, from a comparative Central Eastern European perspective. She analyses urbanisation as a decision-making process by people in changing conditions defined by the governance strategies of municipalities and market actors responsible for housing provisions. She focuses on the concurring nature of suburbanisation and re-urbanisation and points to the role of the quality of urban life and suburban life as essential triggers for the decision to move in or out of the city and as the basis to formulate specific expectations regarding urban and suburban life. Using qualitative methods for her research, she offers a comparative perspective of individual life stories and macrostructural processes in cities in various socio-cultural and economic contexts. Moreover, she can point out the specificity of suburbanisation (and now re-urbanisation) in Poland.

She analyses urbanisation as a decision-making process by people in changing conditions defined by the governance strategies of municipalities and market actors responsible for housing provisions.

She has been the principal investigator or the main researcher in five projects funded, among others, by the National Science Centre in Poland, *e.g.* "Reviving rural areas in Lower Silesia Kłodzko region"; "Away from the inner-city? Suburbanisation and functional relations between small and medium-sized towns and their suburban zones from a sociological perspective – case of Lower Silesia, PL". She is also interested in applied social sciences. In addition, she has carried out many projects in cooperation with local municipalities (*e.g.,* the evaluation of the impacts of the European Capital of Culture Wrocław 2016, Social Diagnosis of Wrocław 2010, 2014, 2017; initial reports of the urban renewal process in Leszno).

Marek Kasprzak

The change of climate conditions is due to a significant transformation of the natural environment. This is reflected by numerous intense and extreme events as well as in a change in the character of secular processes, which occurs more slowly, but over a longer period and on a larger scale. Environmental researchers' attention is being drawn to polar and mountain areas, where the effects of climate warming are most strongly visible. The tradition of studying polar and mountain areas is deeply ingrained in the University of Wrocław. Research projects used to be led by geography professors - Aleksander Kosiba (1901-1981) and Alfred Jahn (1915-1999), who came from Jan Kazimierz University in Lviv and who participated in the expedition to Greenland in 1937 and made a significant contribution to the creation of the Polish Arctic research programme.

One of the topics most intensively developed here was periglacial geomorphology concerning land forms and geological processes in the cold zone at the foreland of glaciers and ice sheets. The studies focused on the functioning of permafrost, *i.e.* perennially frozen ground and the active layer, which thaws during Arctic summers. Permafrost, which covers one-fifth of the northern hemisphere's land surface, is now drastically shrinking, releasing greenhouse gases trapped in the lithosphere into the atmosphere.

Dr hab. Marek Kasprzak's research into the periglacial zone and permafrost is part of his work as a geomorphologist educated at the University of Wrocław. In his work, he uses modern geophysical equipment, including electrical resistivity tomography (ERT). ERT measurements, based on determining the electrical resistivity of a rock mass, make it possible to accurately determine the spatial extent of permafrost and the depth of summer thawing on the ground, supporting thermal reconnaissance of subsoil traditionally carried out in a few boreholes. This changes the perspective of perceiving permafrost as a frozen monolith. It also became possible to determine its shape in the sea coast zone, where the land is affected by relatively warm seawater during the summer. The intrusion of seawater into the land is of considerable significance for thawing the permafrost floor (bottom part), which yet has not been discussed in scientific literature due to lack of reliable observations.

Marek Kasprzak in the window of polar station. Far beyond the Arctic Circle.

Polar research done by the scientists from the Institute of Geography and Regional Development is fostered by obtaining grants and having access to a research polar station in the far North (parallel 77° N). The university station was established in 1971 on Wedel Jarlsberg Land in the southwestern part of Spitsbergen, the largest of the Svalbard islands. The small facility, commonly known as Baranówka, was built at the influx of rivers draining two different catchments – the glaciated one occupied by the Werenskiold Glacier and the unglaciated one of the Brattegg Valley – which facilitates thematically diverse studies of the High Arctic. The study of topoclimatic conditions, deglaciation, hydrochemistry, groundwater flow within the permafrost, changes in ground thermics and gas emissions to the atmosphere are just a few of the topics that are being dealt with here.

Geophysical measurements by electrical resistivity tomography are used to identify the features of permafrost and its active layer.

The university polar station was established in 1971 on Wedel Jarlsberg Land in the southwestern part of Spitsbergen, the largest of the Svalbard islands.

Summer in the Arctic. Research reconnaissance in the Horn fjord.
photos: Marek Kasprzak

Mariusz Orion Jędrysek

The scientists from the Department of Applied Geology, Geochemistry and Environmental Management focus on three main research paths:

1. methane fermentation and biogas production from semi-natural meadow biomass, in parallel: as a way for waste management and provision of raw materials for local agricultural biogas plants;
2. the emission of carbon dioxide and methane from meadows and lake sediments, including the analysis of carbon isotope composition in CO_2 and CH_4;
3. soil and lake sediment respiration and enzymatic activity.

Led by prof. dr hab. Mariusz Orion Jędrysek, the team analyses the influence of various factors, *e.g.* the degree of biomass maturity, the fibre content and the method of biomass pretreatment on the biogas yield as well as the methane content in it. They are the authors of a patent concerning the method of preparing meadow biomass for biogas production (PAT.231362). They also use the isotopic approach to study the quantitative and qualitative dynamics of greenhouse gases emitted from meadows in relation to the microbial activity of the soil. The faculty's laboratory is well equipped with:

1. Several bioreactors of different capacities and 30 small batch reactors for fermentation studies.
2. Picarro analysers for stable carbon isotope composition in CO_2, CH_4 and organic matter and O and H in water and IRMS used for more precise stable isotope analysis.
3. GC and GC-IRMS for gas analysis.
4. WTW Oxitop soil respiration measurement set. The researchershave much experience in the analysis of the isotope composition of light elements: C, N, O, H in organic matter, gases and water.

Adam Mrozowicki

Dr hab. Adam Mrozowicki, a professor of the University of Wrocław, is a principal investigator of the project entitled "COV-WORK: Socio-economic awareness, work experiences and coping strategies of Poles in the context of the post-pandemic crisis" (funded by the National Science Centre, OPUS competition (19th edition). It will be carried out within a consortium led by the Institute of Sociology of the University of Wrocław and partnered by the Institute of Philosophy, Sociology and Economic Sociology of the Warsaw School of Economics (head: Jan Czarzasty, PhD) from 2021 to 2024. The project will also involve cooperation with the team of professor Valeria Pulignano from the Centre for Sociological Research of the Catholic University of Leuven that is implementing the ERC project ResPecTMe (Researching Precariousness across the Paid/Unpaid Work Continuum).

The COV-WORK project will explore the socio-economic consequences of the COVID-19 pandemic and the post-pandemic crisis on the world of work in Poland, with a particular focus on the workers' perspective. Sociologists and socio-economists will analyse the socio-economic consciousness of Poles in the (post-)pandemic situation, biographical experiences and coping strategies of workers in education, health care, social care and logistics as well as conflicts and social dialogue and the ways the pandemic was represented in media discourse during and after the pandemic.

Adam Mrozowicki's research interests include the sociology of work, the sociology of the economy, comparative research on collective labour relations, research on precarity, critical social realism and biographical research methodology. In the last few years, he has focused on comparative industrial relations in Central and Eastern Europe. His most recent research project concerned young, precarious workers and the socio-economic consequences of the pandemic (in Poland).

Sylwester Kołomański

Light pollution is one of the research and public outreach areas at the Institute of Astronomy of the University of Wrocław. A network of automatic stations, named ALPS (All-sky Light Pollution Survey), was created for this task.

Artificial light is one of the most important inventions and an element of modern civilisation. However, artificial light at night (ALAN), especially in outdoor spaces, is also a form of environmental pollution. ALAN introduction into the environment causes serious adverse effects, affecting the essential behaviour and processes of living organisms, including humans. (Research in various fields of science has shown that darkness is also necessary for the proper functioning of ecosystems.) This new form of pollution is called *light pollution*.

Light pollution also brightens the night sky, reducing the visibility of astronomical objects. This makes astronomical observations difficult or even impossible. It also deprives all of us of the starry sky, which has been inspiring humans since prehistoric times. Thus, the dark night sky is both an important scientific resource and a cultural heritage of humankind.

Interdisciplinary research is needed to understand better how ALAN endangers the environment and limits access to the night sky. Moreover, it is essential to monitor the level of light pollution constantly and to identify its sources. Finally, it is equally important to raise public awareness of light pollution.

ALPS is a network of automatic stations designed, built and operated by the Institute of Astronomy and dedicated to continuous sky monitoring. Data collected from each station enable scientists to determine the level of sky brightness (taking meteorological conditions into account) and to track changes and sources of light pollution. Currently, there are four ALPS stations and two are being prepared. Most of the stations are located in Polish astronomical observatories, where monitoring light pollution and night sky quality is crucial.

ALPS website: alps.astro.uni.wroc.pl

Light pollution also brightens the night sky, reducing the visibility of astronomical objects. This makes astronomical observations difficult or even impossible.

03

Humans between nature and culture

Zuzanna Drulis-Kawa

Maciej Karwowski

Bogusław Pawłowski

Piotr Sorokowski

Agnieszka Sorokowska

Izabela Lebuda

Anna Oleszkiewicz

Mirosław Masojć

Piotr Plichta

Marta Kandracka-Szala

Anna Brytek-Matera

Wojciech Małecki

Web of Science subject categories

- Anthropology
- Immunology
- Microbiology
- Neurosciences
- Physiology
- Psychology
- Psychology, Experimental
- Psychology, Multidisciplinary

Scopus ASJC (all science journal classification) categories

- Multidisciplinary
- Ecology, Evolution, Behaviour and Systematics
- Arts and Humanities (miscellaneous)
- Physiology
- Human-Computer Interaction
- General Immunology and Microbiology
- Cognitive Neuroscience
- Psychology (miscellaneous)
- Social Sciences (miscellaneous)
- Education
- Anthropology
- Cultural Studies

Fields of study

Psychology

Human biology

Interrelations between nature and culture in humans — on different levels and from different disciplinary perspectives, from cells to societies and from biology to psychology. Until recently, scholarly research was based on the presumption that some aspects of human life belong exclusively to nature while some others to culture and that the research methods valid for one of those domains are invalid for the other. Today, it is agreed that such presumptions are untenable and that interdisciplinary research demands transgressing the narrow theoretical and methodological confines of particular disciplines. The Priority Research Area (further PRA) Humans Between Nature and Culture contributes to this by showing interrelations between nature and culture in such fundamental dimensions of human life as sensory and chemosensory perception, sexuality, morality, creativity, communication, education, literature and art. Taking into account theories of cultural, biological and cultural-genetic evolution, the PRA shows those interrelations on various levels and from various perspectives: from cells to individuals and entire societies and from biology to psychology and literary studies.

If you want to know more about ongoing research
at the University of Wrocław in this priority area, scan the QR code.

Bacteriophages are extremely precise weapons against bacteria as they attack only specific species, thus protecting the human microbiota when applied as a therapeutic agent.

Zuzanna Drulis-Kawa

The Department of Pathogen Biology and Immunology is a modern and dynamic research and teaching unit, which can boast an impressive number of publications and an unparalleled number of national and international grants and collaborations. The young and active team, led by prof. dr hab. Zuzanna Drulis-Kawa, deals with the most clinically relevant drug resistance aspects in bacterial pathogens. The DPBI members conduct their research in microbiology, immunology and virology, encompassing the biology of dangerous bacterial species from the ESKAPE group and potential methods of their control with particular emphasis on bacteriophages and other non-traditional antimicrobials.

Bacteriophages are extremely precise weapons against bacteria as they attack only specific species, thus protecting the human microbiota when applied as a therapeutic agent. The DPBI is currently working on the antibacterial activity of phage-derived enzymes such as endolysins and depolymerases, which can kill bacteria in seconds (or effectively “disarm” pathogens), helping our immune system fight infection. Furthermore, phages and their enzymes can be successfully used along with traditional antibiotics, which is confirmed by experimental therapies that have already been implemented.

Studies to better understand the predator-prey or parasite-host interactions are also being carried out by the department, shedding new light on the mechanisms involved in the co-evolution of the phages, bacteria and the immune system.

Fully aware that the pathogenicity of microorganisms is a result of the effectiveness of their virulence factors and the action of the human immune system, the DBPI team also studies the impact of phages and other non-traditional antimicrobials on pathogen infectivity and virulence.

Maciej Karwowski

Scholary interests and achievements of dr hab. Maciej Karwowski, professor of the University of Wrocław, focus on the psychology of creativity, especially on studies showing the importance of beliefs about people's creative abilities for undertaking (or abandoning) creative activity. Karwowski is not only the author of frequently used tools to measure beliefs about people's creativity and meta-analyses showing the relationship between creativity, self-image and personality but– most importantly – he is also the creator of a theoretical model capturing creativity as a causal activity, the main author of a concluding chapter on this topic published in the recent *Cambridge Handbook of Creativity* and, finally, the editor of a monograph summarising the current state of knowledge of the regulatory role of beliefs (Karwowski and Kaufman, eds., 2017, Academic Press). Paying attention to the role of (motivational) beliefs and proposing a coherent and initially empirically validated theoretical model is an important contribution to the scientific understanding of the mechanisms behind initiating, performing and temporarily abandoning creative activity.

The second strand of research in this area is the study of the importance of intelligence for creative activity, especially the empirical demonstration that intellectual ability acts as a necessary but insufficient condition for creative ability and achievement. Karwowski is the lead author of a massive series of studies (totalling over 12,000 subjects) that form the basis for the article published in the journal *Intelligence* in 2016 and another one published a year later in the same journal, which presents the results of a unique longitudinal study which showed how childhood intelligence predicts achievement after 40 years. He has also co-authored two recent meta-analyses on the importance of intelligence for creative ability and achievement. Although the importance of intelligence for creativity has been one of the key areas analysed in the last five decades, the research carried out by Maciej Karwowski makes it possible to understand and resolve at least some of the controversies to date.

The third area of Karwowski's scientific achievements is related to analysing the role of creative abilities in functioning in school conditions – especially their importance in the learning process. One of the extensive research projects funded by the Sonata Bis programme of the National Science Centre, which includes a unique massive longitudinal study, is dedicated to this. The results of this research have been widely presented internationally. It has also involved publishing papers in the most prestigious scientific journals in the discipline (*e.g., Journal of Educational Psychology*).

The fourth area of Maciej Karwowski's activity and scientific achievements within the psychology of creativity includes the studies on the possibilities of developing the creative abilities of children and adolescents. Karwowski is a co-author of original solutions in this field, the effectiveness of which has been demonstrated in international publications.

Bogusław Pawłowski

Evolutionary biologists, prof. dr hab. Bogusław Pawłowski being among them, believe that physical traits perceived as attractive in humans are largely biologically (and not just culturally) determined. The research that Pawłowski and his team are concerned with attempts to answer the question of whether sexual selection shaped our judgments of facial attractiveness, body build and voice in the evolutionary process because certain features were valuable biological signals for the opposite sex.

The team investigates whether the distribution of body fat or the type of body fatness, body or facial symmetry or the degree of sexual dimorphism (masculinisation and feminisation levels) are related to the biological condition of the individual. This condition is studied by analysing the state of health, the level of sex hormones associated with fertility, the parameters of the immune system and the antioxidant capacity of the body. This research also allows verifying the hypothesis related to the correlation of physical characteristics with the quality of the immune system ("Immunocompetence Handicap Hypothesis") in humans. Previous results do not confirm that the physical characteristics of healthy, non-obese individuals in Western societies are significantly related to physiological fitness parameters. It is possible that under such good ecological conditions in which modern Western societies live, the allocation of energy for the development of various traits is well buffered and hence there is lack of association of many morphological traits perceived as attractive with the quality of the immune system and sex hormone levels.

Pawłowski has also dealt with the evolutionary aspects of fertile period signalling in the menstrual cycle, mechanisms and constraints on the evolution of selected morphological traits in humans, *e.g.* the cost of brain growth in human evolution, the distribution of adipose tissue or the evolution of mammary gland fatness in women. Together with dr Agnieszka Żelaźniewicz, he has recently published a new hypothesis on the mechanisms of breast formation in human evolution. According to this hypothesis, breasts may have arisen as a side effect of an increase in subcutaneous fat in Homo 1.2 million years ago and then only in some populations did breasts secondarily become a sexual attractant as well. Another stream of research includes the preference of body height of the sexual partner and the influence of this feature on the reproductive success of men as well as the works on the preference of the degree of sexual dimorphism of body height between partners depending on one's own body height (these are some of the best-cited works of Pawłowski). He has also worked with psychologists on the evolutionary significance (effects on reproductive success) of romantic love in humans. With literary scholars and a psychologist, he has analysed the effects of fictional narrative on the relationship between humans and animals.

Since 2019, the professor has been the President of the *European Human Behaviour & Evolution Association* (EHBEA). He is also co-founder of the only evolutionary scientific society in this part of Europe – *Polish Society for Human and Evolution Studies* (PTNCE), of which he is the President for the second term.

Evolutionary biologists believe that physical traits perceived as attractive in humans are largely biologically (and not just culturally) determined.

Piotr Sorokowski

Dr hab. Piotr Sorokowski, professor of the University of Wrocław, is a holder of a doctoral degree in psychology, professor of psychology at the University of Wrocław, and the head of the Department of Experimental Social Psychology at this university. He specialises in cultural evolution and the methodology of science. He has published over 100 research articles (GS: 3288 citations, HI: 30, including publications in *Nature, Nature Human Behavior, Philosophical Transactions of the Royal Society B*) related to evolutionary, cultural, biological and social psychology, human ethology, anthropology and human-computer interactions. He is one of a few psychologists to conduct periodic studies of traditional cultures in Africa (2008, 2014, 2015, 2017), the Amazon (2012), West Papua (2009, 2016, 2019), and the Pacific Region (2013, 2018). His field studies in nonindustrial societies (Hadza and Datoga of Tanzania, Tsimane' of Bolivia, Yali of Papua) focused on the relationships between the cultural and individual predictors of various psychological mechanisms. The results of his research have shed new light on the interplay between evolution and culture on social and reproductive success (including publication in Psychonomic Bulletin & Review, Science of the Total Environment, Evolution and Human Behavior). Together with Agnieszka Sorokowska, he is a co-founder and leader of the Cross-Cultural Research group — one of the largest cross-cultural research groups in the world (collaborators from 70 countries, including publications in *Psychological Science, Proceedings of Royal Society B., Journal of Sex Research*).

His study on, unmasking the mechanisms of board members' selection in scholarly journals, was published in Nature (P. Sorokowski, E. Kulczycki, A. Sorokowska, K. Pisanski, "Predatory journals recruit fake editor", Nature, 2017, 543, 481–483) and led to an international debate on the topic widely covered by the popular media (BBC, Time, New York Times, New Yorker, Scientific American). The study contributed to a change in the methods of indexing and evaluating scholarly journals used by over a dozen international and domestic academic organisations. The study currently has 233 citations (GS) and has an Almetrics index of 2215, which made it one of the most popular and high-impact scholarly publications in the history of the index (527th place of over 13 million papers).

Piotr Sorokowski has been a principal investigator of grant projects regarding mechanisms of sexual selection, voice perception and voice analysis, functions of romantic love, perception of elderly people in indigenous societies and – recently – evolutionary origins of arts. Since 2019, he has been a member of PlosOne Editorial Board.

Piotr Sorokowski actively collaborates with and provides support to young researchers. His doctoral students publish internationally and receive grants and international fellowships. Every year, he organises *Spring School of Evolutionary Psychology*. In 2017, he was an academic and organisational board member for the *Summer Institute* of the *International Society for Human Ethology* (Boise, USA)

From 2016 to 2020 he reformed the Institute of Psychology at the UWr, quadrupling the number of scientific publications in journals indexed on the JCR list among his employees. Since 2018 he has been a Member of the Board of the University of Wrocław.

The study of Piotr Sorokowski contributed to a change in the methods of indexing and evaluating scholarly journals used by over a dozen international and domestic academic organizations.

Agnieszka Sorokowska

Dr hab. Agnieszka Sorokowska, professor of the University of Wrocław, works at the Institute of Psychology (University of Wrocław) where she is a head of the Smell and Taste Research Lab. Her previous affiliations include Technische Universitaet Dresden and Stockholm University. She is an author or coauthor of 105 publications in international scientific journals (including Nature, Cognition, Personality and Social Psychology Bulletin and Psychological Science; Scopus h Index 22). Invited speaker at prestigious conferences (*e.g.*, International Congress of Psychology), she has recently been indexed at a normalized list of top 2% of best cited world scientists. Agnieszka Sorokowska has been a principal investigator in eight research grants funded by Polish and international organizations and received scientific awards for her research, *e.g.*, the International Society for Human Ethology's Linda Mealey Award.

Multidisciplinary research program of Agnieszka Sorokowska and her team relates mostly to sensory perception, cross-cultural and cognitive psychology, although many of her studies also combine other disciplines, like anthropology or neuroscience. She conducted studies in West Papua, Bolivian Amazon Pacific Islands. Together with Piotr Sorokowski, she is a leader of the Cross-Cultural Research Group that comprises over 100 scientists from all over the world and regularly publishes the outcomes of their studies in top scientific journals. One of her greatest scientific achievements was a recently completed recent research series on sensory compensation and blindness. She designed and conducted several studies exploring olfactory sensitivity of the blind people as compared to the sighted individuals, and comparing these two groups in the context of processing of non–visual information potentially important for social functioning. The research enabled collecting important data that can be used in broad analyses of the importance and usage of functioning modalities following visual loss. The results can support the understanding of sensory compensation mechanisms and can help determine which cognitive mechanisms enhance the sensory processing in functioning modalities. In her current research, conducted within two grants funded by Polish National Science Centre, Agnieszka Sorokowska focuses on sensory components of food neophobia in children and on developmental changes in psychological traits during transition to parenthood.

Izabela Lebuda

Creativity, defined as generating novel and effective ideas, elevates cultural progress and as a basis for innovation, is crucial for enhancing economic competitiveness and strengthening society. Moreover, on a personal level, creativity increases well-being, and plays an essential role in learning.

In her research, dr Izabela Lebuda focuses on the determinants of creative development and achievements. She is an author of many articles and chapters dedicated to creativity and co-editor of The Palgrave Handbook of Social Creativity Research.

Izabela Lebuda has a significant research funding record, including many successfully finished projects with tracks of publications. Recently she received the Maria Skłodowska-Curie Postdoctoral Fellowship from the European Commission in Program Horizon 2020. The project will examine creative metacognition accuracy and regulation facets from a behavioral and neuroscientific perspective. Using advanced techniques to study creative metacognition could shed new light on the chosen problem and address the extension of research topics in creative neuroscience.

Izabela Lebuda is a part of many international networks devoted to creativity research: Creative Life Research Center at the University of Northern Iowa, the USA, and Webster Center for Creativity & Innovation at Webster University Geneva, Switzerland. In addition, she closely collaborates with the Creative Cognition Lab at Graz University (Austria) and the Quality of Life Research Centre at Claremont Graduate University (USA).

photo: Angelika Marcioch

Several scientific studies have confirmed the great importance of the human sense of smell, phylogenetically the oldest sense, for ordinary human physical, mental and social functioning.

Anna Oleszkiewicz

In her work, dr Anna Oleszkiewicz aims to understand the human olfactory function in health and disease. Several scientific studies have confirmed the great importance of the human sense of smell, phylogenetically the oldest sense, for ordinary human physical, mental and social functioning. The basic premise for this relationship is neuroanatomy. Olfactory signals are transformed from chemical to electrical stimuli at the level of the nasal epithelium and then travel *via* the olfactory bulb to the piriform cortex, the amygdala (responsible for emotional processes in humans) and the hippocampus (memory). The psychological effects of olfactory loss are very severe – people with olfactory deficits are more likely to suffer from depression, and complain of the reduced quality of life and interpersonal relationships. The loss of smell is also an early sign of neurodegenerative diseases such as: Alzheimer's disease and Parkinson's disease.

The loss of the sense of smell affects about 5% of the population while another 10-15% have severe deficits related to smell sensation. However, society is not making sufficient efforts to minimise the adverse effects of the total or partial olfactory deficit. In addition, there is lack of expertise, clinical programmes and psychological interventions to support patients in their rehabilitation and return to full health and efficient psychosocial functioning.

Oleszkiewicz's research aims to fill this gap in the knowledge of the olfactory system and the clinical methods of its rehabilitation. Her research efforts take on particular importance in a post-pandemic reality in which we will be confronted with long-term odour perception disorders on an unprecedented scale, still difficult to quantify today. To advance her research on olfactory training as a method of olfactory rehabilitation with potential beneficial effects on human cognitive and emotional processes, Anna Oleszkiewicz won a grant from the National Science Centre.

The team studying the function and importance of the olfactory system works at the Institute of Psychology at the University of Wrocław in cooperation with physicians from the Department of Otolaryngology, Head and Neck Surgery at Wroclaw Medical University. The team also permanently cooperates with research units from Germany, Italy, France, Sweden, the USA, China, Japan, Australia, Iran, Argentina and Mexico. Initiating such cooperation aims to create the first interdisciplinary olfactory research centre in Poland, where knowledge from medicine, physiology or psychology will be combined. Furthermore, to consolidate the cooperation network, the scholars obtained funding (also from the National Science Centre) for a research project investigating olfactory sensitivity on a global scale. This project will allow a better understanding of individual and social differences in the olfactory sensitivity of people living in different parts of the world. Thanks to the consolidation of the network of partner laboratories, according to one of the grant application reviewers, Anna Oleszkiewicz has "a chance to permanently place the University of Wrocław in the constellation of world-leading laboratories studying the human sense of smell".

Mirosław Masojć

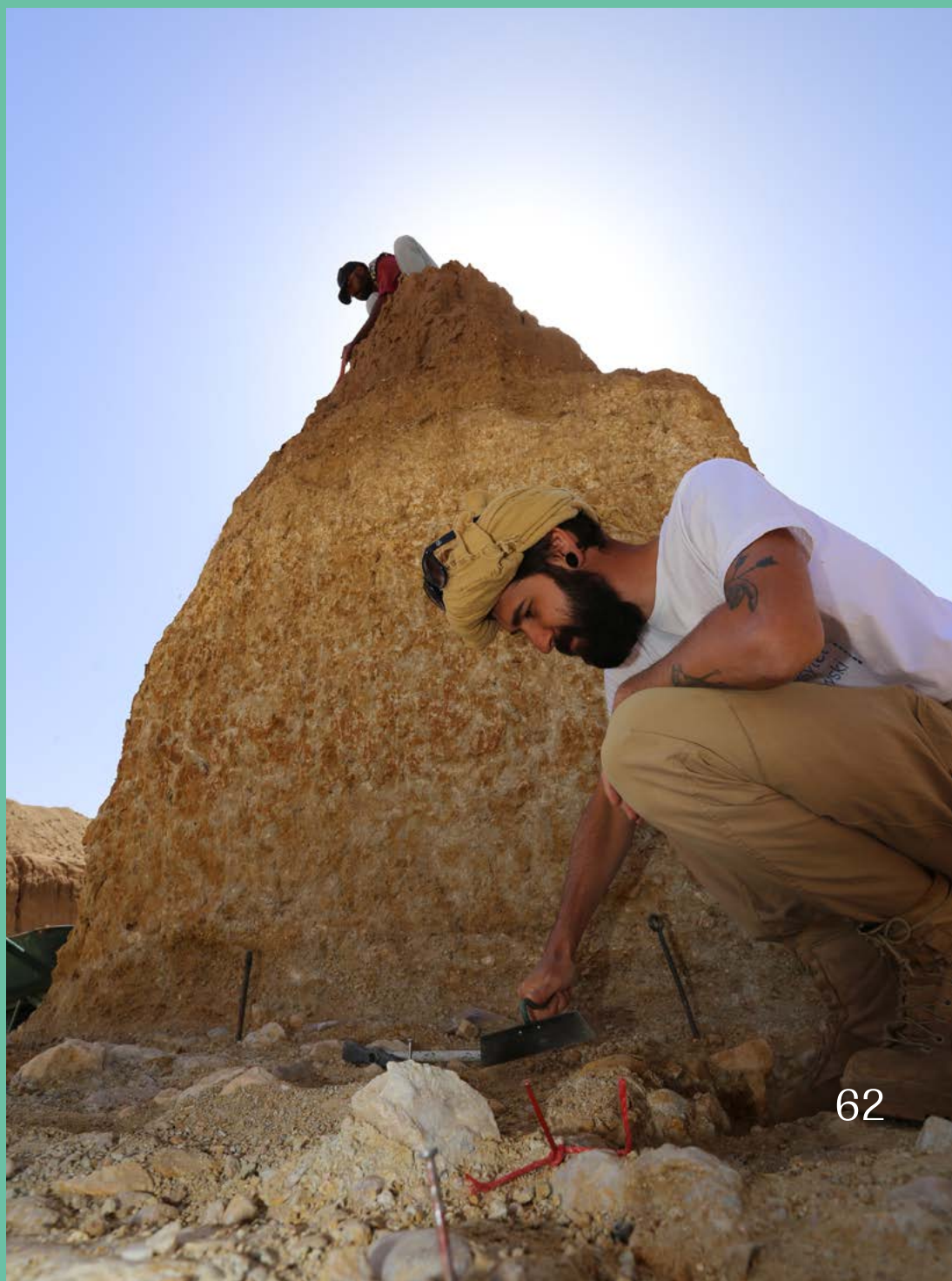
In the eastern part of the Sahara, in Sudan, the research team of dr hab. Mirosław Masojć, professor of the University of Wrocław from the Institute of Archaeology discovered numerous stone tools made and used by *Homo erectus*. They may even be over 700 thousand years old. Such ancient evidence of the human presence in the region had not yet been discovered.

In the opencast mines of Africa today, people are searching for gold. Exposing successive layers, the miners came across massive stones with a transverse "sharpened" edge. These are typical prehistoric monuments known from the present-day areas of Ethiopia and Kenya. The site of the discovery is likely to have been a place where these tools were made hundreds of thousands of years ago. Masojć and co-workers found both finished "products" as well as splinters created during their making. These are traces of the presence of an African species of *Homo erectus*– the ancestor of modern humans (*Homo sapiens*), who appeared in Africa about 1.8 million years ago.

The sediments in which the monuments were discovered were examined using optically stimulated luminescence (OSL). It turned out that they are older than 400 thousand years. However, on the basis of the style of making the tools, it was established that they could be significantly older, even up to 700,000 years old.

So far, the researchers from the international team led by Masojć have found almost 200 sites with Palaeolithic stone objects. Some of them are in mines, others in the desert. In the places which are dry and desert-like today, several hundred thousand years ago, there were periods when it rained and the predecessors of homo sapiens lived. This is yet another intriguing aspect of this research project. The research shows different climatic episodes in a given area so it is interesting not only for archaeologists but also for palaeoecologists and palaeogeographers. The team carrying out the research includes Polish, Sudanese and Korean archaeologists, geomorphologists, geophysicists, geologists, sedimentologists and astrophysicists.

The research team of Mirosław Masojć discovered numerous stone tools made and used by Homo erectus. Such ancient evidence of the human presence in the region had not yet been discovered.



Marta Kandracka-Szala

"Yellow Submarine", "We are the World", the theme from the Pink Panther – these are the songs that are well-known among children of pre-school and early school age. Research on the importance of popular music in the education of pre-school children, both in Poland and abroad, is conducted by dr Marta Kondracka-Szala. She is an assistant professor at the Department of Early School and Preschool Education.

Dr Marta Kondracka-Szala works with researchers and teachers from the United States. The research has two stages. The first consists of focus group interviews with teachers of children aged 4-6 from Poland and the USA. The second phase involves the research with those children themselves. During the study, she uses a participative and mosaic approach, which is rare in research with children in Poland. During the experiment, Polish and American teachers first talked about how they use popular music in their work with children and identified the pop songs they use in their work with children. Polish teachers mentioned the following songs: The Beatles – "Twist & Shout", Vangelis – "West across the Ocean Sea", Alvaro Soler – "La Cintura", Queen's songs or the melody from the film The Pink Panther. On the other hand, the American teachers mainly chose: The Beatles – "Yellow Submarine", Dolly Parton – "9 to 5", USA for Africa – "We are the World".

Currently, Kondracka-Szala wants to learn about children's preferences regarding popular music, their responses as well as their perception of this music – children talk about music, draw and dance to it. The research will help, for example, in the creation of innovative programmes of the musical education of pre-school children and in the training of future teachers based not only on classical music. Additionally, it will also help to look for answers regarding the differences in music perception between children from Poland and the USA.

Piotr Plichta

Dr hab. Piotr Plichta focuses on the use of ICT devices in the education of children and persons with disabilities and special educational needs in the Department of Education of People with Disabilities at the Institute of Pedagogy.

"New media in education and rehabilitation offer a great opportunity for children as well as for older people with disabilities. When used by sensitive practitioners, they can respond to special educational needs, such as intellectual disabilities. On the one hand, it is a chance to eliminate inequalities and limit digital exclusion. On the other hand, new technologies also bring challenges and risky situations that need to be recognised and effectively counteracted", explains Piotr Plichta.

Piotr Plichta is currently involved in several scientific national and international projects. He focuses on how to prevent digital exclusion through digital tools, not only in times of crisis. He is the co-author of the first free handbook in Poland published by EduAkcja just after the pandemic outbreak in April 2020: "Education in the time of the COVID-19 pandemic. With distance about what we are doing now as teachers (edited by J. Pyżalski)". The publication has been downloaded over 100,000 times. Plichta is a member of a team looking at the learning and psychological needs of students (25,000 from 8 countries) in the pandemic, which is part of a larger international initiative coordinated by the researchers at the University of Vienna.

His research interests also include other social contexts of using new technologies (cyberbullying, online image, problematic use of the Internet) as well as stress and burnout in helping professions. In addition, he cooperates with various educational institutions, *e.g.* the "School with Class" Foundation, the "Center for Citizenship Education" and is a member of COST international scientific networks.

Anna Brytek-Matera

Dr hab. Anna Brytek-Matera, professor of the University of Wrocław, works at the Institute of Psychology. She serves as Head of the Nutritional Psychology Unit and leads EAT Lab (Eating Behavior Laboratory). Brytek-Matera represents the scientist-practitioner model (of clinical psychology). Besides her scientific activity, she is experienced in the therapeutic treatment with patients with eating disorders and obesity since 2013. She is a cognitive-behavioural therapist. She has been selected as the French Government Scholarship laureate (Cotutelle) and she earned her doctoral degree at Paul Verlaine University - Metz, France.

Throughout her career, Brytek-Matera has been involved with research around eating disorders, maladaptive eating behaviour and weight-related behaviour. Her research has been supported by grants and awards from the National Science Center, Ministry of Science and Higher Education, Foundation for Polish Science, Fondation Maison des Sciences de l'Homme (France). She has led several international studies in the field of eating disorders, eating behaviour and orthorexia (*e.g.,* cooperation with researchers at Sapienza University of Rome, Chinese University of Hong Kong, Holy Spirit University of Kaslik).

Brytek-Matera has held research visits in several foreign institutions (*e.g.*, KU Leuven, University of Pavia, University of Bordeaux). She has also been invited to deliver guest lectures at foreign universities as well (*e.g.,* Stanford University, University of West London, University of Padova).

She is the author of over 120 peer reviewed publications (in Polish, English and French) on nutritional psychology, including several books (*e.g.,* the first Polish-language handbook on Psychodietetics). Her work is published in prestigious international journals (*e.g.,* Nutrients, Eating and Weight Disorders).

Anna Brytek-Matera has received recognition through being invited to review book proposals (*e.g.,* Cambridge University Press, Springer) and manuscripts for numerous international journals in the field of psychology, nutrition and dietetics as well (*e.g.*, Appetite, Eating Behaviors, Nutrition Journal). She currently serves on the editorial board for BMC Psychiatry (section Eating Disorders), Eating and Weight Disorders and Journal of Health Psychology and on the reviewer board for Nutrients. She has been Guest Editor for International Journal of Environmental Research and Public Health (the Special Issue: Psychology of Eating: Understanding of Eating Behaviours). She also serves as Independent expert consultant (the Project Peer Reviewer) of the Science Fund of the Republic of Serbia and National Agency For Academic Exchange.

Anna Brytek-Matera is recognized internationally for her work in the area of eating disorders and orthorexia nervosa. She has made pioneer contributions to orthorexia nervosa in Poland and advanced level of currently conducted research into this pathological eating behaviour in the world.

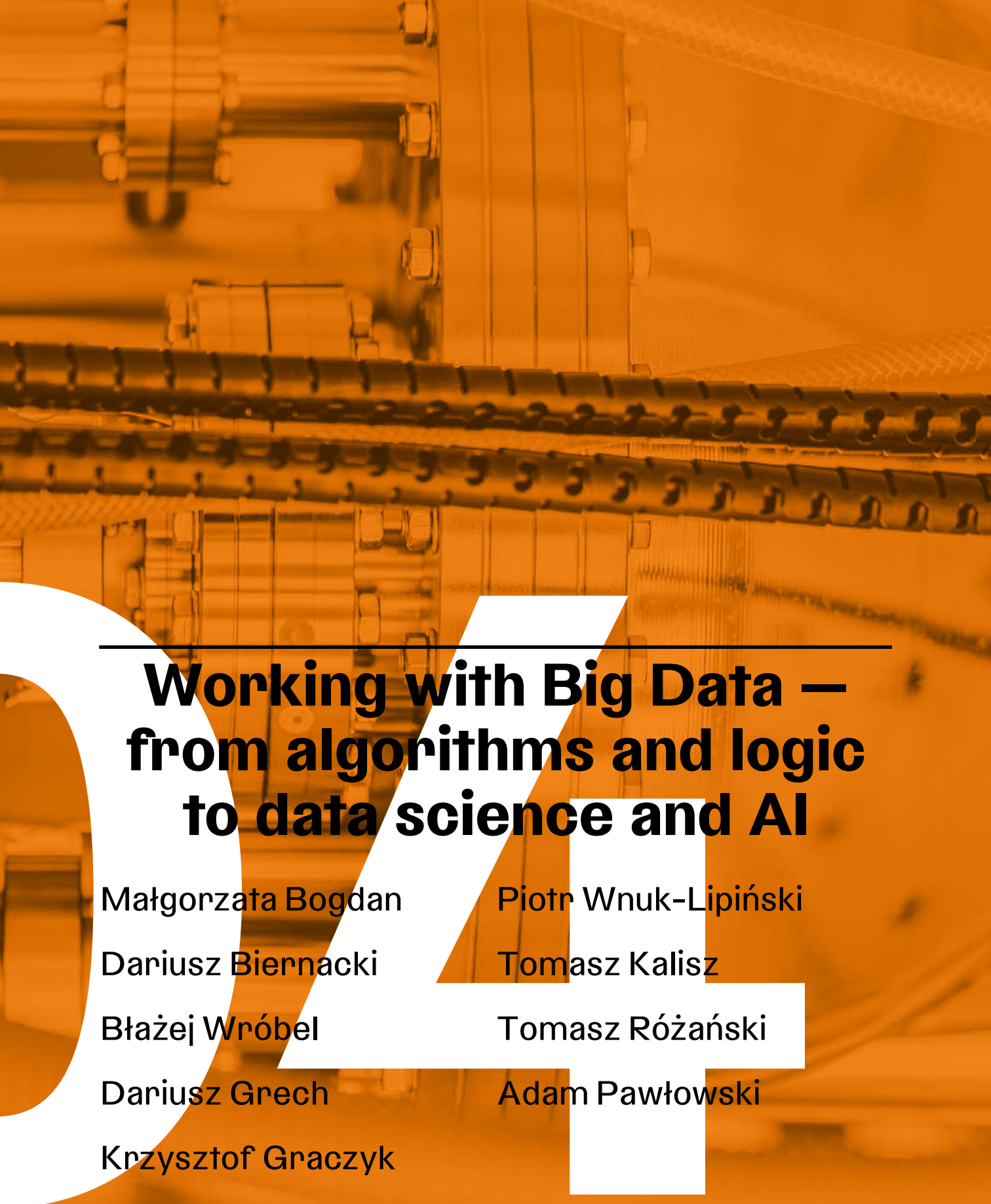
She is committed to research that results in a better understanding of maladaptive eating behaviour. Her current research focuses on the impact of negative affect on eating behaviour in laboratory and ecological settings, as well as on characteristics of dietary patterns and health-related behaviours in the field of orthorexia nervosa.

Wojciech Małecki

Dr hab. Wojciech Małecki is associate professor of literary theory at the Institute of Polish Philology. His work how various forms of communication, narratives in particular, could help change public attitudes, perceptions, and behavior related to important social issues.

Wojciech Małecki is currently working on research projects concerning the impact of narratives on attitudes toward extinction and climate change.

For instance, it has been claimed for decades by various scholars, activists, and writers, including such greats such as Thomas Hardy and Leo Tolstoy, that literature can make us more concerned about non-human animals and their welfare. In order to investigate this claim, Małecki and his team of scholars representing fields as different as social psychology (Piotr Sorokowski, Anna Oleszkiewicz), biological anthropology (Bogusław Pawłowski), and literary history (Marcin Cieński), conducted a series of over a dozen studies involving a few thousand participants and a number of literary texts representing various genres and national literatures. Their results were published in internationally recognized journals such as *Poetics* and *PLOS ONE*, and in a book titled *Human Minds and Animal Stories: How Narratives Make Us Care about Other Species* (Routledge 2019). These publications have not only been cited in leading journals in various fields, but also featured in the media, including in newspapers and magazines such as *Newsweek* and *Psychology Today*, and on radio shows and blogs. They also contributed to the emergence of a new field called empirical ecocriticism, dedicated to the empirical study of environmental narratives. Currently, empirical ecocriticism involves scholars from all around the world, including Singapore, Austria, the Netherlands, the USA, Denmark, and others. Together with some of these scholars, most importantly Matthew Schneider-Mayerson (Yale-NUS) and Alexa Weik von Mossner (University of Klagenfurt), Małecki edited a special issue of a leading environmental humanities journal ISLE on empirical ecocriticism (Spring 2020) and is currently working on research projects concerning the impact of narratives on attitudes toward extinction and climate change. Another extension of his work on animal narratives is his current project, with Piotr Sorokowski, that concerns the evolutionary factors behind narrative impact and the human propensity for narrative in general.



Working with Big Data — from algorithms and logic to data science and AI

Małgorzata Bogdan

Dariusz Biernacki

Błażej Wróbel

Dariusz Grech

Krzysztof Graczyk

Aneta Firlej-Buzon

Piotr Wnuk-Lipiński

Tomasz Kalisz

Tomasz Różański

Adam Pawłowski

Web of Science subject categories

- Computer Science, Artificial Intelligence
- Computer Science, Cybernetics
- Computer Science, Information Systems
- Computer Science, Interdisciplinary Applications
- Computer Science, Software Engineering
- Computer Science, Theory & Methods
- Mathematics
- Mathematics, Applied
- Mathematics, Interdisciplinary Applications
- Statistics and Probability

Scopus ASJC (all science journal classification) categories

- General Computer Science
- Computer Science (miscellaneous)
- Artificial Intelligence
- Computational Theory and Mathematics
- Computer Networks and Communications
- Hardware and Architecture
- Human-Computer Interaction
- Information Systems
- Signal Processing
- Software
- Mathematics: Applied Mathematics
- Computational Mathematics
- Statistics and Probability

Fields of study

Computer science

Data science

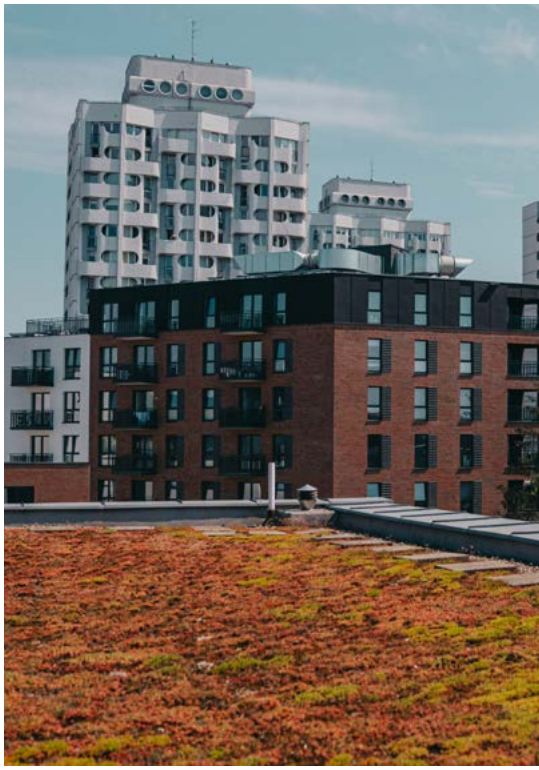
ISIM

This Priority Research Area covers fundamental research concerning handling large data. The word "fundamental" has to be understood broadly: the distance between basic research and applications is shorter in Computer Science than in any other discipline — even Google's empire started with a purely theoretical algorithmic discovery. For the last twenty years, the University of Wrocław has gained wide international recognition in algorithmics and logical foundations of computer science. However, if it wishes to keep up with changes in the field, it must (while not losing what it has already achieved) extend competence over the most novel branches, data science and artificial intelligence.

If you want to know more about ongoing research at the University of Wrocław in this priority area, scan the QR code.

Małgorzata Bogdan

The Data Science Team at the Faculty of Mathematics and Computer Science, led by prof. dr hab. Małgorzata Bogdan, works on developing novel statistical methods for the analysis of high dimensional data. They focus mainly on different techniques for the dimensionality reduction of supervised and unsupervised learning. The scientists have developed several techniques that allow identifying important patterns in high dimensional data while controlling the number of false discoveries, *i.e.*, random patterns that arise due to the high dimensionality of the data. They analyse new methods using mathematical theory, computer simulations and real-life examples.

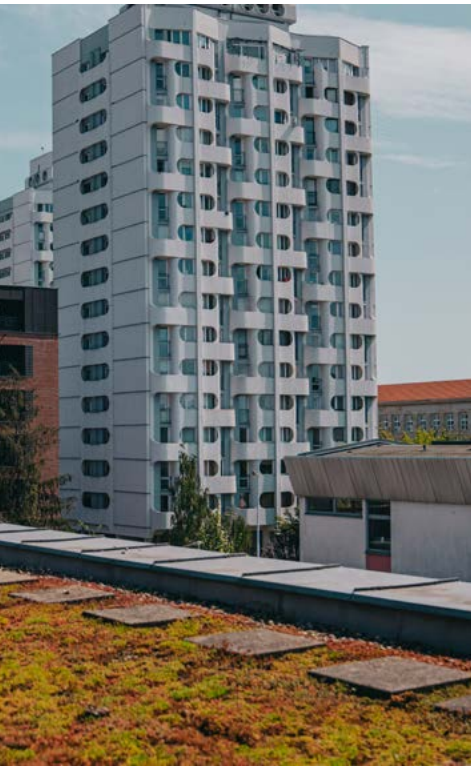


They also develop software available to the public, in which they have implemented their methods. This often requires the solving of difficult optimisation problems. Recent developments include:

1. the novel regularisation technique SLOPE (Sorted L-One Penalized Estimator), which the researchers use to identify important predictors in large databases,
2. the identification of outlying observations and estimating the unsupervised graphical models for describing the relationship between variables in large databases,
3. VARCLUST algorithm for clustering variables in the subspaces of low dimensions and Rank LASSO (Rank Least Absolute Shrinkage and Selection Operator) – an efficient tool for robust regression analysis.

The team applies these techniques to the analysis of medical, genetic, astronomical and financial data. They publish articles in the core statistical and machine learning journals as well as in prominent magazines in genetics, finance, medicine or astrophysics. In addition, the Faculty has a strong collaboration with scientists in the USA (Stanford, Harvard, Carnegie-Mellon, University of Pennsylvania, University of Chicago, Indiana University), Europe (Ecole Polytechnique in Paris, Medical University of Vienna, Bologna University, Lund University) and Israel (Tel Aviv University, Hebrew University).

The scientists have developed several techniques that allow for the identification of important patterns in high dimensional data while controlling the number of false discoveries.



His research projects revolve around the applications of mathematical logic to the formal semantics of modern higher-order programming languages, with the practical goals of advancing the field of program analysis, transformation and verification.

Dariusz Biernacki

Dr hab. Dariusz Biernacki, professor of the University of Wrocław, is a computer scientist whose research centres on the theory and implementation of programming languages. He obtained his doctoral degree in computer science from Aarhus University (BRICS PhD School). He has had long-term research stays at leading research institutions such as Carnegie-Mellon University and Inria Futurs.

His research projects revolve around the applications of mathematical logic to the formal semantics of modern higher-order programming languages, with the practical goals of advancing the field of program analysis, transformation and verification, and thus of enhancing the construction of safe and robust software. Dariusz Biernacki is a co-author of several research articles presented at the most prestigious international conferences, including the annual Symposium on Principles of Programming Languages, and has published in international journals devoted to programming language theory. He is also a co-founder of one of the most active research teams within the area of programming languages in Poland, with an established and continuously growing international position. In addition, he maintains an active international collaboration with research institutions in Europe and primarily with the French Inria.

Błażej Wróbel and his colleagues deal with issues related to high-dimensional problems in mathematical analysis. They face the "curse of dimensionality" on a daily basis.

Błażej Wróbel

We all live in a three-dimensional space. This means that three coordinates are enough to specify any point in our surroundings. Similarly, a sheet of paper is two-dimensional. Indeed, two coordinates suffice to specify any point on it. One may ask if there is any need for a concept of a dimension larger than three. Since the work of Albert Einstein, it has been known that for objects in the universe that are either very fast (close to the speed of light) or very massive (of the masses of stars or larger), the appropriate dimension is four. Time becomes an extra coordinate adding to the three spatial coordinates. Well, then, are dimensions larger than four of any use in science? The answer is yes – high dimensional objects frequently appear in computer science, statistics and mathematics. Here, the dimension is understood as the minimum number of coordinates needed to specify an object of our interest. Let us give three examples where the underlying dimension may be very large.

As an example from computer science, let us consider a computer file of size 1 kilobit. Such a file may be coded as a sequence of a thousand 0 and 1. Thus a 1-kilobit file is an object of a 1000-dimensional space. It is noteworthy that the number of all possible 1-kilobit files is equal to 2 raised to the power 1000 and this number exceeds the estimated number of all atoms in the universe.

Another example might be from statistics of a biological origin. A single linear molecule of human DNA consists of at least 50 million nucleotides in length. Thus, such a molecule may be regarded as an object from a space of dimension 50 million. Each nucleotide is either adenine (A), cytosine (C), guanine (G) or thymine (T). In particular, the number of all possibilities for a single DNA molecule is the astonishing 2 raised to the power 50 million. Moreover, sampling even a single DNA chain is a complicated process. One may easily imagine a situation where the number of available samples is much smaller than 50 million. This causes problems for many available methods of data analysis.

Finally, the last example is from mathematics. A square of unit length is the Cartesian product of two-unit intervals. It has 2x2=4 vertices. Similarly, a cube of unit side length is the Cartesian product of three-unit intervals and it has 2x2x2=8 vertices. The d-dimensional hypercube is defined as the Cartesian product of d unit intervals. Note that such an object is impossible to imagine when d is greater than 3; however, it makes perfect mathematical sense. The number of vertices of a d-dimensional hypercube is then 2 raised to the power d. Like in the previous examples, this becomes huge already when d=1000.

In all the examples above, even moderately large dimensions d=1000 or d=50 million caused the quantities of interest to become extremely large. A common term for such phenomena has been coined – “the curse of dimensionality”. At the Institute of Mathematic, dr hab. inż. Błażej Wróbel, professor of the University of Wrocław, and his collaborators have been working on questions related to high-dimensional problems in mathematical analysis, Part of their work was conducted jointly with giants of contemporary mathematics from Princeton – Jean Bourgain and Elias M. Stein. A unifying feature of their mathematical findings are the so-called dimension-free estimates. It turns out that many objects of interest in mathematical analysis (and, in particular, in harmonic analysis) stay relatively small even when the dimension is growing to infinity. In this way, the curse of dimensionality is broken for such objects.

Dariusz Grech

Prof. dr hab. Dariusz Grech obtained his PhD in Applied Mathematics at the University of Sydney (Australia). He received DSc degree and Professor in Science title for his research on novel methods detecting properties of time series and complex systems with applications in econophysics, physics and big data analysis. His scientific interests include application of statistical physics and complex systems theory for description of phenomena in financial markets and in economics, fractal and multifractal analysis of complex systems, theory of time series and random matrices with their use in physics and multidisciplinary applications.

Econophysics is the hybrid field that can be roughly defined as quantitative approaches using ideas, models, conceptual and computational methods of statistical physics and complex systems science applied to economic phenomena.

The origin of modern econophysics dates to 1991 when Rosario N. Mantegna (doctoral student of H. Eugene Stanley) published a pioneering paper titled *Levy walks* and enhanced diffusion in *Milan Stock-Exchange* by discovering the breaking of the central limit theorem on the stock market. Mantegna's discovery has opened the eyes of the physics community to non-Gaussian processes on financial markets, in particular, concerning the multiscale and scale-free properties of complex systems such as financial markets. More precisely, we know now that the central limit theorem is present on the financial market away from a crash while the theorem is not applicable to the time series containing the crash. Instead, in the latter case, a scale invariance or data collapse is observed because the Gaussian statistics were replaced by the scale-free distribution, *i.e.* the power law. Apparently, the beginning of modern econophysics is directly connected with the physical analysis of financial markets focused on the non-Brownian or non-Wiener random walks. Currently, almost all major physical journals already accept econophysical works. It was during this period that an avalanche of econophysical publications set off.

There are many very attractive possibilities of research on nonlinear phenomena on the financial market inspired by statistical physics and complexity science. They are *e.g.*, scale invariance, multiscaling and multifractality of data, random matrix approach to the investigation of the statistical properties of big data, log-periodic oscillation phenomena or complex network analysis. Nowadays, an increasing role in the understanding of phenomena

in complex systems is played by numerical simulation on a lattice of nonlinear interactions insight the complex system and information flow in it. The main purpose of market modelling (agent-based modelling) is to reveal the laws and underlying processes of market behaviour, supplying (as one of the results) some signatures or warnings of upcoming extreme events or crashes. The hallmark of agent-based modelling is the coupling of the individual and collective degrees of freedom of the analysed system, that is, its micro- and macroscales. The former is represented by individual agents while the latter one by the system as a whole (or its macroparts). A significant category of models describing the behaviour of financial markets, and inspired by models drawn from physics, are primarily Ising-like complex networks, whose prominent example is the Iori numeric model. The agent is represented here by three state spin vector where state +1 means buying a stock, -1 selling while 0 means inactive state.

It must be clearly stated that we live in an increasingly risky society that is particularly vulnerable to extreme types of risk (both market and systemic). As regards to the financial sector, among all possible extreme phenomena, crashes are indeed presumably the most striking events with an impact and frequency that has been increasing in the last two decades, extremely increasing the risk of market activity. Therefore, understanding what is happening as well as risk control and management is an urgent challenge for investors and researchers alike. Econophysics is, at present, the scientific approach providing the most profound and most exhaustive analysis of phenomena on stock and financial markets. The Faculty of Physics and Astronomy at the University of Wrocław and Econophysics and Time Series Analysis Group (ETSA) actively participate in all leading research directions in econophysics mentioned above. Therefore, we *do* invite all interested researchers to join us in this activity.

Krzysztof Graczyk

Some great examples of the use of artificial intelligence in physics are dr hab. Krzysztof Graczyk's, professor of the University of Wrocław, three projects: an application of the Bayesian methods to the analysis of lepton-nucleon and lepton-nucleus scattering data; a study on the properties of fluid dynamics with deep learning systems; and an investigation of the connections between deep learning systems and quantum field theoretical models.

In all three projects, machine learning (ML) models are developed and adapted in different application contexts. The first project concerns the analysis of the scattering data. Hence it is a rather custom ML application. In the second project, the deep learning systems are utilized to optimise the process of getting the fundamental quantities, which characterise the porous media. The last project is the most theoretical and concerns studies of the fundamental relations between deep learning systems and quantum models.

The first project requires the adaptation of Bayesian neural networks to study the neutrino-nucleon and electron-nucleon scattering data. The goal is to obtain information on the electroweak structure of the nucleon. Some of the results of investigations have already been published in leading physical journals, such as Physical Review C, Journal of High Energy Physics, etc. The Bayesian Neural Network (BNN) approach allowed to extract the information about so-called two-photon exchange correction from the electron scattering data. With the Bayesian objective algorithm, the most optimal model of TPE has been chosen. The BNN approach has been developed to study the proton radius problem, too, as there was a significant discrepancy between the estimates of the radius of the charge distribution inside the proton obtained based on the spectroscopic and scattering data analysis. The goal of physics was to understand the source of disagreement. With the BNN approach, we received model-independent information about the value of the proton radius, showing that without an objective algorithm, one can obtain the predictions of the proton radius, which are self contradicted. Lastly, the BNN approach has been utilized to study the weak structure of the nucleon. We showed that analysis of the currently available data does not indicate the deviations of the axial form factor from the dipole form. The next natural next step of this project is to adapt and develop the methods of the Gaussian process. With the new approach, Graczyk plans to analyse the neutrino scattering data to obtain information about the axial form factor of the nucleon and weak nucleon-resonance excitations.

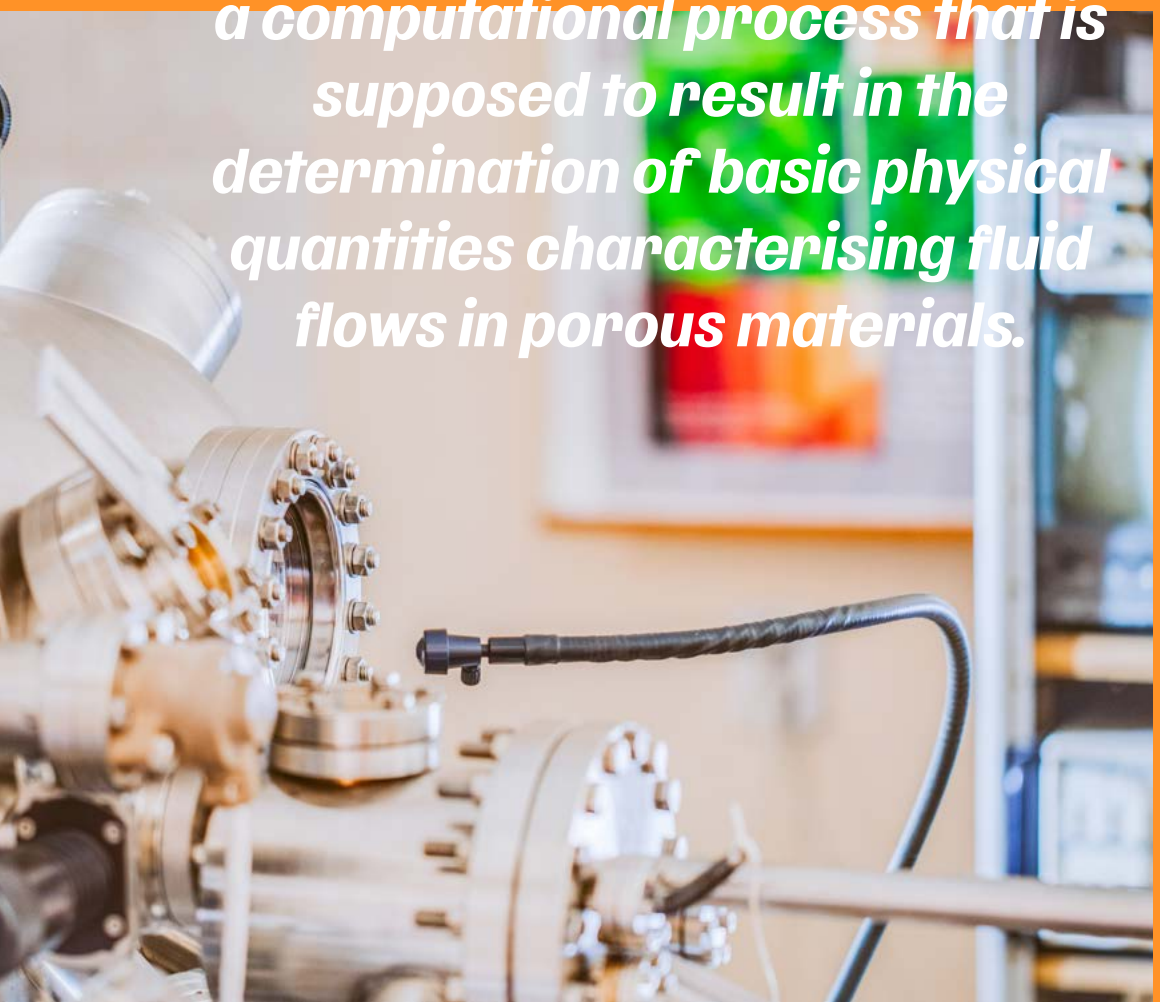
The first project has been conducted in cooperation with dr Cezary Juszczak (Institute of Theoretical Physics at the University of Wrocław), dr Sulej, and dr Płoński (Technical University of Warsaw), and dr Alvarez-Ruso and dr Saul-Sal from Valencia University.

In his second project, Krzystof Graczyk develops deep learning tools to study the fundamental properties of fluid dynamics in porous media. The project is done in collaboration with dr hab. Maciej Matyka, professor of the University of Wrocław (Institute of Theoretical Physics at the University of Wrocław). The main idea is to obtain the system that will predict the fundamental macroscopic quantities, such as permeability and tortuosity,

based on the analysis of the configuration of the obstacles in the medium. The first results have already been published in Scientific Reports and were presented during the InterPore 2021 conference.

The third project concerns the study of the fundamental properties of neural networks. The conjecture shows that there are similarities between the correlation functions in the neural network systems and theoretical field models. This project is underway, and we expect the first results in the following years.

Krzysztof Graczyk reaches for the possibilities of artificial intelligence in physics. For instance, he uses deep neural networks to optimise a computational process that is supposed to result in the determination of basic physical quantities characterising fluid flows in porous materials.



Aneta Firlej-Buzon

The Institute of Information and Library Science is a modern institution that specialises in research on scientific information. Interests and research tradition are connected with a unique documentation and information specialisation launched in the mid-1970s. It included work on the project of a macrosystem of information, research on books and scientific information in the then socialist countries. Our research initially focusing on scientific studies took on a new meaning when the methods of collecting, processing and compiling data became commonplace in the digital age. Thus, the staff of the institute are interested in (among other things) the following topics: problems of collecting, processing and analysing data in order to read the description of the changes taking place, making scientific data available and presenting them, the issue of the digitalisation of archival data and unique resources of scientific literature, the attempts to determine and process large data sets, the problem of the visualisation and presentation of scientific data and the volumetrics of collected data.

Our research confirms that the world of science is closely dependent on access to data and that the data itself is an inexhaustible and wonderful resource with unlimited practical applications. We know that progressive digitalisation is transforming contemporary humanities and social sciences. However, the new technological possibilities are accompanied by previously unknown problems and the progressing quantification of reality does not always reduce the scale of human ignorance.

The project called *Big Data in humanities and social sciences* is a result of critical reflection on issues in the area of big data, which was faced by researchers coming from major Polish scientific centres, representing various research areas: social communication and media, cultural studies, linguistics, law as well as museology and library science. We are interested in the theoretical problems and practical use of big data technologies in humanities and social sciences. We also do not forget about the pioneers who carried out pioneering research based on searching large, dynamically growing data sets as well as scientific contexts within the scope of big data interests.

Piotr Wnuk-Lipiński

The Computational Intelligence Research Group, under the leadership of dr hab. Piotr Wnuk-Lipiński, works on solving problems using a data-driven approach. The team's scientists specialize in three areas:

1. modeling complex systems, especially related to high frequency multi-dimensional time series, using Evolutionary Algorithms and data mining techniques,
2. language and speech processing using modern deep learning techniques,
3. artificial Intelligence for Games.

Their research on complex systems includes: mining frequent patterns in sequential or temporal data (such as ultra-high frequency time series), learning hidden states models for temporal data, enhancing multidimensional time series prediction by Evolutionary Algorithms, and solving high dimensional optimization problems by using Evolutionary Algorithms, especially Estimation of Distribution Algorithms, with dimensionality reduction improvements.

The Research Group remains a strong contender in speech and language processing. It has pioneered the use of attention-based speech recognition, collaborating with the MILA (*Montreal Institute for Learning Algorithms*) Lab in Montreal and the Google Brain team. The team currently works on algorithms for feature extraction from unlabeled data, concentrating on unit discovery in speech and handwriting. To achieve this goal, they work with quantizing auto-encoding neural networks and contrastive learning approaches. The Group also works on classical Speech Recognition and Natural Language processing, often competing in challenges such as the Airbus Speech Recognition Challenge, BSNLP Shared Task or annual PolEval competitions.

Part of the group works on tasks related to General Game Playing, simulation-based algorithms (Monte Carlo Tree Search, Rolling Horizon, Evolutionary Algorithm), and Procedural Content Generation. Working with the students, the group successfully participated in CodinGame AI contests, winning school track, four times in a row. The group developed Regular Boardgames, based on the automata theory, being currently the most efficient universal general game playing language. It also developed programming collectible card game Legends of Code and Magic used for Strategy Card Game AI Competition organized by the group members since 2019 with IEEE CEC and IEEE COG conferences. Its research in that matter focuses on usage of Evolutionary Algorithms for optimizing draft-phase choices and learning of game evaluation functions.

The Virtual Crime Room is part of a comprehensive project to develop virtual reality (VR) technology in education. In the simulated reality, the participants have to determine and correctly secure traces inside and outside the building.

Tomasz Kalisz

Dr hab. Tomasz Kalisz, professor of the University of Wrocław, is the head of the Virtual Reality Technology Centre operating at the Faculty of Law, Administration and Economics at the University of Wrocław. Tomasz Kalisz and a team of his associates – Damian Mroczyński, Karol Greinert, dr Rafał Cieśla, dr Sylwia Skubisz-Ślusarczyk, dr Iwona Zieniewicz – deal with the professional application of virtual reality in various areas such as education, the improvement of manual skills, the simulation of extreme situations and events and the use of artificial intelligence to manage litigation data and legal information.

The latest result of the work of Tomasz Kalisz and his team is the creation of a professional teaching "tool" in the form of the Virtual Crime Room. The Virtual Crime Room is part of a comprehensive project to develop virtual reality (VR) technology in education. The Virtual Crime Room offers the latest professional technological and methodological solutions that can be applied to the educational process. Its central element is an event simulator, recreating different variants of murders, suicides and accidents with different traces. In the simulated reality, the participants have to determine and correctly secure traces inside and outside the building (in three weather variants). At present, there is work on extending the module with the possibility of using odour generators. The developed solutions aim to equip students/trainees in this system with the manual skills to perform complex visual inspection procedures (*i.e.,* static and dynamic phases, marking traces, taking photographs, identifying and securing traces). At the same time, four individuals can participate in this, which is a number corresponding to the number of the team members securing the crime scene.

In this activity, the participants attempt to unravel a case and analyse the evidence collected in a VR world that mirrors the crime scene. Professional simulation scenarios provide the opportunity to use real tools and accesso-

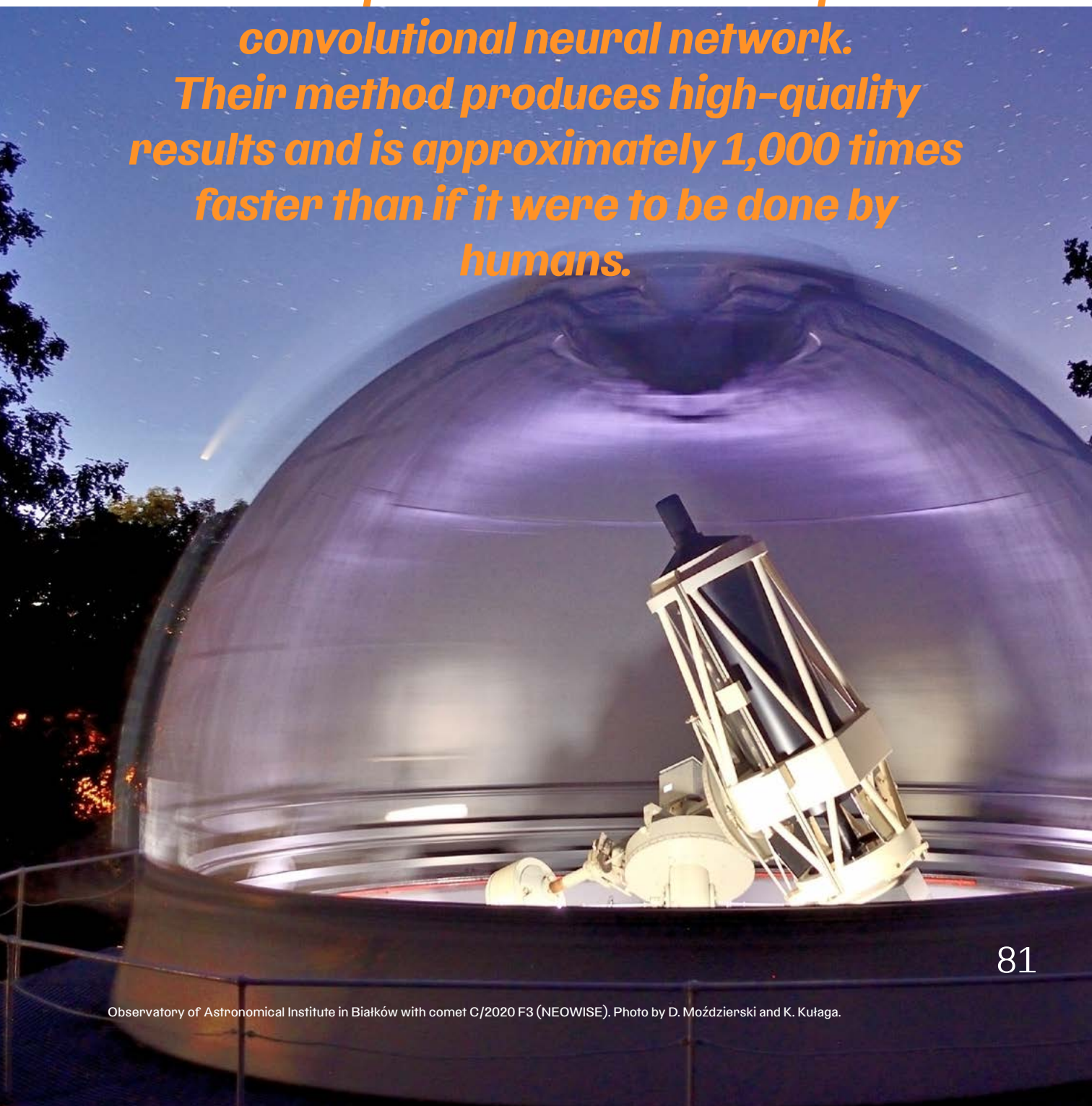
ries in VR to document and collect all the traces that may have been left during a hypothetical crime. An essential element is to make the situation realistic while keeping the participants safe. From the technological perspective, the VR system consists of the components that make up the server; a camera system with tracking markers, VR goggles, motion controllers, specialised software and a developed teaching methodology for using VR techniques.

The social functions of virtual reality and the immersion of the younger generation in modern technologies seem to be the main reasons why the power of immersive technologies will grow. This is undoubtedly the future in the area of education and the acquisition of specific skills.

The advantage of VR in the teaching process is the possibility of developing spatial orientation, perceptiveness and motor/manual skills. Therefore, it is worth combining learning through simulation and artificial VR environments with real dimension education, *i.e.* using the hybrid education method (tool-assisted teacher). Using VR teaching methods, we eliminate the destruction or depletion of authentic equipment and recreate the events that students, and often the teacher himself/herself, cannot usually participate in (such as crime scene inspection, *etc.*).

VR means higher quality instruction and increased hands-on skills for the students. Education in this model also significantly reduces the cost of acquiring specific skills necessary in the labour market, thereby providing the possibility of multiple repetitions and practice of hands-on skills in conditions similar to the real ones.

One of the achievements of the astronomers from the University of Wrocław is the development of an effective method for the normalisation of star spectra based on a deep convolutional neural network. Their method produces high-quality results and is approximately 1,000 times faster than if it were to be done by humans.



Observatory of Astronomical Institute in Białków with comet C/2020 F3 (NEOWISE). Photo by D. Moździerski and K. Kułaga.

Ewa Niemczura

Spectroscopy provides the most abundant source of information on astrophysical objects emitting electromagnetic radiation. Thanks to its development, it was possible to conclude that the entire universe is made of the same elements and chemical compounds. Spectroscopy has also helped us understand the chemical evolution of our galaxy and find many of the known exoplanets. It is also expected that the spectroscopic methods will form the basis for the discoveries regarding biosignatures on exoplanets.

There are new challenges in the analysis of spectra. As dr Ewa Niemczura and mgr inż. Tomasz Różański explain, due to their number reaching millions, analysing them manually and drawing conclusions based on them are more and more demanding. With new observatories equipped with spectrographs and numerous scientific projects, this trend will continue and the efficient handling of spectral data will become even more important.

A group of scientists from the Institute of Astronomy are working to address these problems, using machine learning techniques, deep learning in particular. This relatively new field has emerged due to a similar flood of data in the field of image and natural language processing and the development of highly parallel graphical processing units (GPUs) may now prove to be the key to new results in the field of stellar spectroscopy.

One of the achievements of the astronomers from the University of Wrocław is the development of an effective method for the normalisation of star spectra based on a deep convolutional neural network. Stellar spectrum normalisation is a necessary step for detailed spectral analysis but it is a time-consuming task. Their method produces high-quality results and is approximately 1,000 times faster than if it were to be done by humans.

The group is currently working on applying deep learning to classic astrophysics issues such as classifying stars and determining their atmospheric parameters and is exploring the intersection of machine learning and standard numerical modelling.

The scale of the longstanding and profound processes leading to gender equality is revealed by the analyses of large data sets that consistently and synthetically reflect the situation over long periods. The proportion of female authors is a very good measure of gender equality and proof of social justice.

Adam Pawłowski

Good examples of the application of digital technology in the humanities are the three projects led by prof. dr hab. Adam Pawłowski and his team from the Faculty of Letters. There were used Deep Learning techniques, Artificial Intelligence and big data.

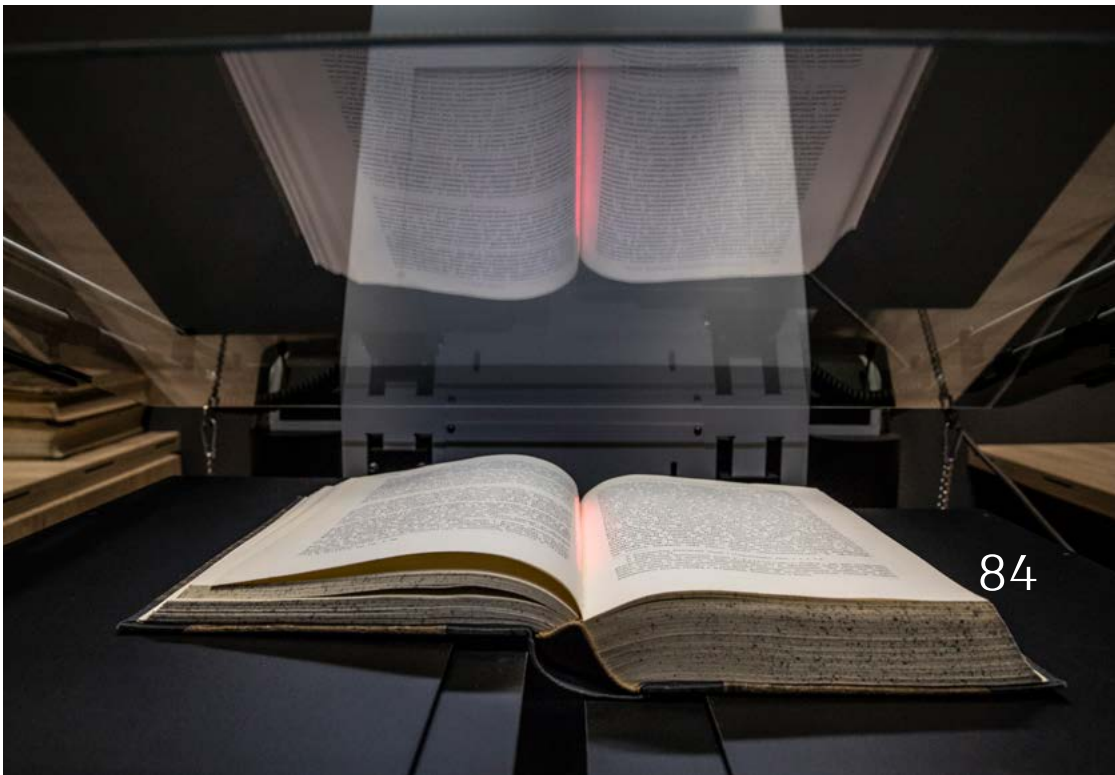
In their first project, "Methods and tools of corpus linguistics in the study of bibliographies of Polish publications from 1997-2017", the researchers created a corpus of publication titles. Then, they carried out its multifaceted informatological and stylostatistical analysis. The data for the study were generated from the bibliographic resources of the National Library, which records all publishing production within Poland. The analysis of the bibliography included a comprehensive stylistic analysis of titles, automatic identification of the author's gender, analysis of the spatial distribution of place names (places of publication, geographical names in titles) and automatic classification of genres based solely on titles. This research employed, among other things, the methods of micro-text taxonomy. Most of the NLP (Natural Language Processing) tools used in the project are based on a deep learning technique widely used in various artificial intelligence algorithms. One of the parts of the project was an automatic classification of publications on the basis of titles (recognition of disciplines, genres, subgenres) and the automatic detection of the gender of the author based on titles only. The results of the analysis were further verified with the actual situation.

Adam Pawłowski's second project is a "bibliographic satellite map". Every large bibliographic database consists of hundreds of thousands or even millions of records that contain a field for the place of publication. Pawłowski and his team conducted an experiment in which these records were assigned geographical coordinates, making it possible to project the bibliography onto a map. The bibliographic records were generated from the general catalogue

of the National Library and sufficient data were provided after 1918, *i.e.* during the existence of Poland as a sovereign state. Before that year, the data are incomplete because no institution kept a systematic record of published books. Some NLP tools produced by the CLARIN-PL consortium (Common Language Resources & Technology Infrastructure) were used for the project. Following the assignment of geographical coordinates, the next stage was to create a dynamic visualisation of hundreds of thousands of points, displayed on a fragment of a map of Europe visible on a computer screen or mobile device. This task can be considered a model example of digital humanities: it involves the processing of multi-format linked open data, takes into account the time dimension, is advanced in terms of programming and finally allows for cognitively valuable interpretations.

The third project is "Chronological distribution of the gender of authors as a measure of gender equality". The scale of the longstanding and profound processes leading to gender equality is revealed by the analyses of large data sets that consistently and synthetically reflect the situation over long periods (an approach referred to in quantitative historiography as *longue durée*). The authorship of books can be considered an example of such data without undue risk of error. In order to become an author of a scientific monograph, a manual a handbook or a literary work, one must have education and knowledge and represent a high intellectual level.

The chart available here: www.phc.uni.wroc.pl/ncn_opus12/ was generated based on the contents of 1,264,295 bibliographicrecords between 1801 and 2020 from the National Library's general catalogue. Due to the large volume of data, the entire analysis was carried out automatically. In 2020, the author proportions in the group of book authors registered by the National Library were: men (53.4% – 4,742 authors), women (38.4% – 3,415 authors), unrecognised persons (8.2%).



05

Health – from gene analysis to drug design

Dariusz Rakus

Artur Krężel

Łukasz Opaliński

Gabriela Bugla-Płoskońska

Dorota Nowak

Joanna Piskorz

Barbara Maciejewska

Tomasz Olszak

Web of Science subject categories

- Biochemistry & Molecular Biology
- Biotechnology & Applied Microbiology
- Cell & Tissue Engineering
- Cell Biology
- Immunology
- Microbiology
- Physiology
- Toxicology

Scopus ASJC (all science journal classification) categories

- General Biochemistry, Genetics and Molecular Biology
- Biochemistry, Genetics and Molecular Biology (miscellaneous)
- Biochemistry
- Biophysics
- Biotechnology
- Cancer Research
- Cell Biology
- Developmental Biology
- Molecular Biology
- Physiology
- Structural Biology
- General Chemical Engineering
- Chemical Engineering (miscellaneous)
- Bioengineering
- General Immunology and Microbiology
- Immunology and Microbiology (miscellaneous)
- Applied Microbiology and Biotechnology
- Microbiology
- Infectious Diseases
- Microbiology (medical)

Fields of study

Biotechnology

Medical biotechnology

Genetics and experimental biology

This priority research area is focused on advanced biomedical technologies and advanced research at the molecular level. The aim of research in this field is to gain knowledge of basic mechanisms responsible for the processes leading to the disturbance of human health, to indicate molecular targets and subsequently utilise this knowledge to design novel diagnostic and therapeutic methods. Research conducted in the field of molecular biology, cell biology, biochemistry, genetics, molecular microbiology, biomedical engineering should result in the characterisation of the molecular bases of human diseases, particularly rare genetic diseases, systemic diseases, cancer, infectious and immune diseases. In the future, these data may be used to design novel therapeutic strategies used in the treatment of cancer, rare genetic diseases, diabetes, infectious and immune diseases, neurodegenerative diseases. Research conducted in the aforementioned fields will focus on designing novel drugs and their carriers as well as on discovering drug activity mechanisms, allowing for the efficient assessment and improvement of human health.

If you want to know more about ongoing research at the University of Wrocław in this priority area, scan the QR code.

The scientists have discovered the mechanism through which the disruption of the non-metabolic role of ALDOA glycolytic enzyme leads to the death of cancer cells.

Dariusz Rakus

The research at the Department of Molecular Physiology and Neurobiology is focused on the molecular mechanisms by which enzymes of basic energy metabolism affect brain plasticity and cancer cell biology. Some enzymes of glycolysis and gluconeogenesis not only catalyse enzymatic reactions but also regulate in a non-metabolic through manner interactions with other cellular components and a variety of essential biological phenomena such as cell proliferation, migration, and response to stress stimuli and formation of synaptic connections.

The scientists from the Department have discovered the mechanism through which the disruption of the non-metabolic role of ALDOA glycolytic enzyme leads to the death of cancer cells. The same effect may be achieved by stimulating the non-enzymatic function of FBP2 gluconeogenic enzyme. The researchers have also demonstrated that a proper mode of FBP2 interaction with its binding partners is a prerequisite for synaptic plasticity. In both cases – cancer cells and neurons – the proper mode of FBP2 interaction with binding partners (also with ALDOA) depends on its quaternary structure, which is regulated by metabolic signals produced by adjacent, non-cancerous and non-neuronal cells.

Recently, in collaboration with the scientists from Göttingen, Jena and Cologne, it has been uncovered that disturbances in the proper arrangement of FBP2 quaternary structure, and hence the ability of the enzyme to interact with its binding partners, cause the development of pathological conditions such as remitting leukodystrophy.

The researchers also investigate the following issues: the effects of ageing on the expression of metabolic enzymes, the organisation of cell-to-cell crosstalk in the brain and within tumours and the mechanisms that regulate interactions of FBP2 and ALDOA with their cellular/protein partners (and hence affecting memory formation and the susceptibility of cells to neoplastic changes).

This research aims to move the findings from a molecular/cellular level to the treatment of neurodegenerative and cancer diseases.

Artur Krężel

Prof. dr hab. Artur Krężel is a professor of biochemistry specialising in inorganic biochemistry, chemical biology and analytical biochemistry. During his postdoctoral training at the University of Texas Medical Branch in Galveston, he worked with Wolfgang Maret on the mechanisms of cellular zinc homeostasis, which led to the discovery of the properties of metallothioneins that buffer zinc ions, which are key to understanding the role of these regulatory proteins. At the same time, he was a scientific consultant for NeuroBioTex Incorporation, where he co-developed miniaturised equipment to measure free zinc concentrations in the brain and biological fluids.

He received his habilitation degree on the basis of a collection of papers entitled *Transition metal ions in biological systems: homeostasis and applications in biotechnology*. A year later, he became the head of the newly established Laboratory of Biological Chemistry. Finally, at the age of 38, he was awarded the title of professor of biological sciences.

His current research work focuses on several areas of inorganic biochemistry, biophysics and chemical biology. He is particularly interested in the metal-dependent regulation of proteins, their structure and stability. His research group aims to answer how metalloproteins obtain their metal ions under cellular conditions and how these ions regulate their function. The research group also focuses on developing new fluorescent chemical tools for regioselective and multifunctional protein labelling, new analytical methods to monitor metal ion fluctuations in the cell and methods to study the stability of metalloproteins. The researchers answer fundamental questions using a combination of tools and techniques, including protein engineering, synthetic chemistry, structural mass spectrometry, biophysical analysis, molecular and structural biology and computational methods.

In 2010, he was the winner of the *Polityka* weekly "Stay with us" competition, in which scientists who would constitute the strength of Polish science in the coming years were sought out. The magazine explained that it was necessary at all costs to keep in the country those who would set directions in Polish science. Subsequent awards and scholarships confirmed the scientific potential of the biochemist from Wrocław. He received the Prime Minister's Award and the Wiktor Kemula Prize awarded by the Polish Chemical Society. He is a grant holder of Academia Europea, a member of the Biotechnology Committee at the Polish Academy of Sciences. In addition, he is a multiple winner of scholarships and grants awarded by the Foundation for Polish Science, National Science Centre and Ministry of Science. For years, he has been an active member of the International Society for Zinc Biology. His publications include more than 100 articles published in scientific journals from the JCR list cited more than 5000 times.

"I could say that I am a chemist, although life experience has added the prefix "bio" not only to my education but also to my profession. Today I can safely say that I am involved in biological chemistry or chemical biology, *i.e.*, using chemical tools to peep at or learn more effectively about the living world. Examples of such molecular tools are organic compounds that change their properties upon recognising specific proteins inside and outside the cell, giving them new and valuable characteristics. When we add to this regioselective compound the elements that bind specific metal ions or are sensitive to pH changes, we obtain multifunctional molecular "toys" for biological research. Besides, I am fascinated by zinc, a metal that affects how we live, feel and how much we remember or have children. In our work, we study how this metal regulates cellular and extracellular processes. To do so, we use, among other things, natural or slightly altered proteins that bind zinc ions, altering their properties, thereby forcing them into specific biotechnological applications".

The research group of Artur Krężel research group aims to answer how metalloproteins obtain their metal ions under cellular conditions and how these ions regulate their function.

This method is now considered the future of anti-cancer therapies and the ADC market is one of the most rapidly growing branches of this type of treatment.

Łukasz Opaliński

What is the cause of rapid multiplication of cancer cells? What role do specific proteins play in this process? How can you increase the effectiveness of targeted anti-cancer therapies? The biotechnologists from the Department of Protein Engineering are looking for the answers. The results of their research may revolutionise the knowledge of the causes of the rapid multiplication of cancer cells and, consequently, will make it possible to create more effective anti-cancer therapies.

Proteins are the most important macromolecules in living organisms. It is estimated that a single human cell contains as many as tens of thousands of different proteins, and these, in turn, exist in many millions of copies. As a result, there are over 100 billion protein molecules in just one cell. University biotechnologists focus on the FGF and FGFR proteins. The function of these macromolecules is to participate in the processes of the division, migration and death of cells in living organisms. They are also used by cancer cells to uncontrollably stimulate their own division and increase their ability to migrate. This manifests itself in tumour growth and metastasis.

The biotechnologists are searching for new partner proteins that can regulate the FGF/FGFR system. Using high-throughput techniques, they have identified a number of such proteins and, at the same time, discovered a mechanism, completely unknown before, that impacts the transmission of signals by FGFR and their transport into cells.

So far, more than a dozen proteins from the galectin family have been identified in the human body and proven to have many important functions. In the case of cancer, they may help tumours to escape recognition and destruction by our immune system. They can also drive the division and movement of cancer cells. The FGF/FGFR system and galectins have so far been largely treated as two unrelated groups of proteins. However, the research findings suggest that these proteins may work together, both in regulating signal transmission in the cell and in modulating protein transport. The hypothesis put forward by the scientists explains the rapid multiplication of cancer cells and allows us to understand how they develop resistance to some of the currently used therapies. If approved, it may facilitate the design of new targeted therapies in oncology.

The scientists have already made a name for themselves with their pioneering discoveries in how to construct cytotoxic ADC drug conjugates to target tumours that overproduce FGFR proteins. The greatest advantage of the ADC approach is primarily its selectivity: the therapy, unlike conventional chemotherapy, spares healthy cells. This method is now considered the future of anti-cancer therapies and the ADC market is one of the most rapidly growing branches of this type of treatment.

Gabriela Bugla-Płoskońska

The researchers from the Department of Microbiology at the Faculty of Biological Sciences of the University of Wrocław, under the leadership of prof. dr hab. Gabriela Bugla-Płoskońska, investigate bacteria. The scope of their research projects is wide and concerns, among other things, bacterial antigens interactions of bacteria with the immune system of vertebrates and antimicrobial compounds. In recent years, the faculty has received funding from numerous grants.

When conducting their analysis, the researchers use elaborate methods, such as experimental and computational prediction, phenotypic, molecular, genetic, proteomic and immunoenzymatic techniques.

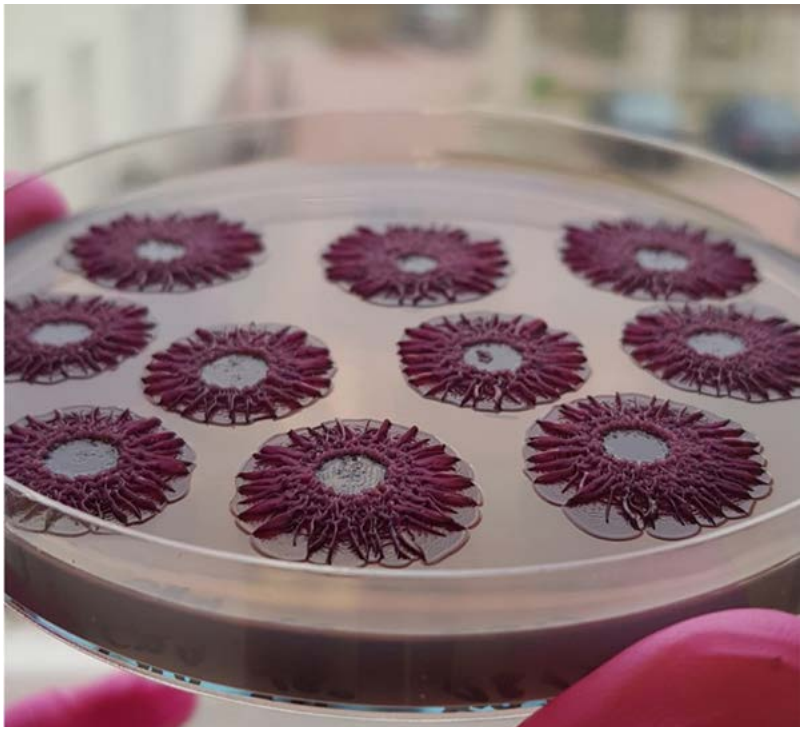


photo: Michał Małaszczuk

The most notable research projects resulting from the funding include:

1. the cytotoxicity and antibacterial activity of different antibacterials (including biocides, nanomaterials) and serum against aerobic and anaerobic bacteria;
2. the biodiversity of bacterial microbiota (aerobic and anaerobic bacteria) isolated from different sources;
3. the analysis of the mode of action of antibacterials (including nanomaterials like silver nanoformulations, graphene and biocides);
4. the analysis of the mechanism of resistance to antibacterials (including nanomaterials like silver nanoformulations);
5. the determination of the influence of various biological and chemical factors on a simple model organism (*Galleria mellonella*);
6. the study of the participation of bacterial surface structures in response to environmental factors;
7. the analysis of proteome and genome of selected microorganisms;
8. the analysis of the microbiological purity of products (fluids, cosmetics and others).

When conducting their analysis, the researchers use elaborate methods, such as experimental and computational prediction, phenotypic, molecular, genetic, proteomic and immunoenzymatic techniques.The results of the above-mentioned projects are numerous scientific publications and scientific cooperation, both with international and other Polish research centres. In the team of the Department of Microbiology also work dr Bartłomiej Dudek, dr Bożena Futoma-Kołoch, dr Katarzyna Guz-Regner, dr Anna Kędziora, dr Kamila Korzekwa, dr Aleksandra Pawlak and doctoral students.

Dorota Nowak

Cancer is the second highest cause of death in Poland. In the future, it will undoubtedly take the infamous first place – mainly because of the ageing population. The struggle with cancer is one of the most important challenges to be faced by contemporary medicine and, more generally, by health care policy in Poland and in the world. The problem of cancer treatment has been tackled for several years by the employees of the Faculty of Biotechnology.

Skin melanoma represents only 4% of skin cancers but it is considered to be one of the most life-threatening. Its research is carried out by the team led by dr hab. Dorota Nowak. Social campaigns promoting knowledge of melanoma and the need to control pigmented lesions using the ABCDE algorithm (A: Assymetry, B: Border, C: Colour, D: Diameter, E: Evolving) have significantly reduced the number of patients coming to the doctor with advanced stages of cancer.

The low survival rate among patients is due to the high variability, diversity and extraordinary invasiveness of this cancer. This last factor was the focus of Dorota Nowak's team, who has been working on melanoma since 2015, having received more than PLN 600,000 as part of an OPUS grant from the National Science Centre. The researchers focused on two receptors: EGFR, the epidermal growth factor receptor, and c-Met, the hepatocyte growth factor receptor, under whose influence invadopodia are formed. Literature data suggest that their elevated levels are often observed in melanoma.

When researching the mechanisms of melanoma resistance, the team has already achieved considerable success. They have managed to derive a very interesting melanoma cell line for further research with high drug resistance. These cells have some characteristics of cancer stem cells, which are extremely invasive and usually constitute about 1-5% of the tumour population. They can survive cancer therapy and remain dormant for years (if cancer does not return after five years of treatment, the patient is considered cured; if it recurs, however, it is usually a very aggressive and progressive form of cancer).

The researchers have high hopes for further studies on the cultured, aggressive melanoma line, aiming to get closer to the molecular basis of the drug resistance of this cancer. During the next stage of the study, for which the researchers received another OPUS grant funded by the NCN in the amount of nearly PLN 1.5 million, they decided to take a closer look at the tumour microenvironment. The microenvironment is a complex and multicomponent system specific to each type of cancer. It consists of both normal cells surrounding the tumour focus (*e.g.,* keratinocytes, fibroblasts, adipocytes or fat cells, endothelial and immune cells) as well as proteins and growth factors from normal and tumour cells.

When a primary cancerous focus occurs, a "dialogue" between normal and malignant cells begins. The cancer cells transform the normal cells in such a way that they begin to release their own growth factors into the intercellular environment. This results in the additional stimulation of melanoma cells. Normal cells begin to transform, *e.g.* fibroblasts become the so-called CAFs – cancer-associated fibroblasts.

Melanoma cells – just like normal cells – need food, which is delivered through blood vessels. However, due to tumour growth, at some point, the host vessels are no longer sufficient and hypoxia develops. Our body has mechanisms that can combat this. Angiogenesis, the formation of vessels, is a physiological phenomenon but it is pathological in the case of cancer. New vessels are formed, which are more fragile and permeable but they allow the tumour to be nourished. This is another example of the tumour environment being altered in such a way that it stimulates the centre of the disease. This is why oncology and experimental medicine are increasingly discussing that the microenvironment should not be overlooked.

At the first stage of the experiments, the researchers take a closer look at the factors released by cells in the melanoma microenvironment and see how they are affected by the inhibitors of key receptors already selected. Then, they look at the effect of cells in the microenvironment on the sensitivity of melanoma to the drugs used. They expect that the environment may have a negative effect on such a targeted therapy. They would be most pleased to conclude that the "dialogue" between normal cells will not weaken it. However, conclusions are far from being reached.

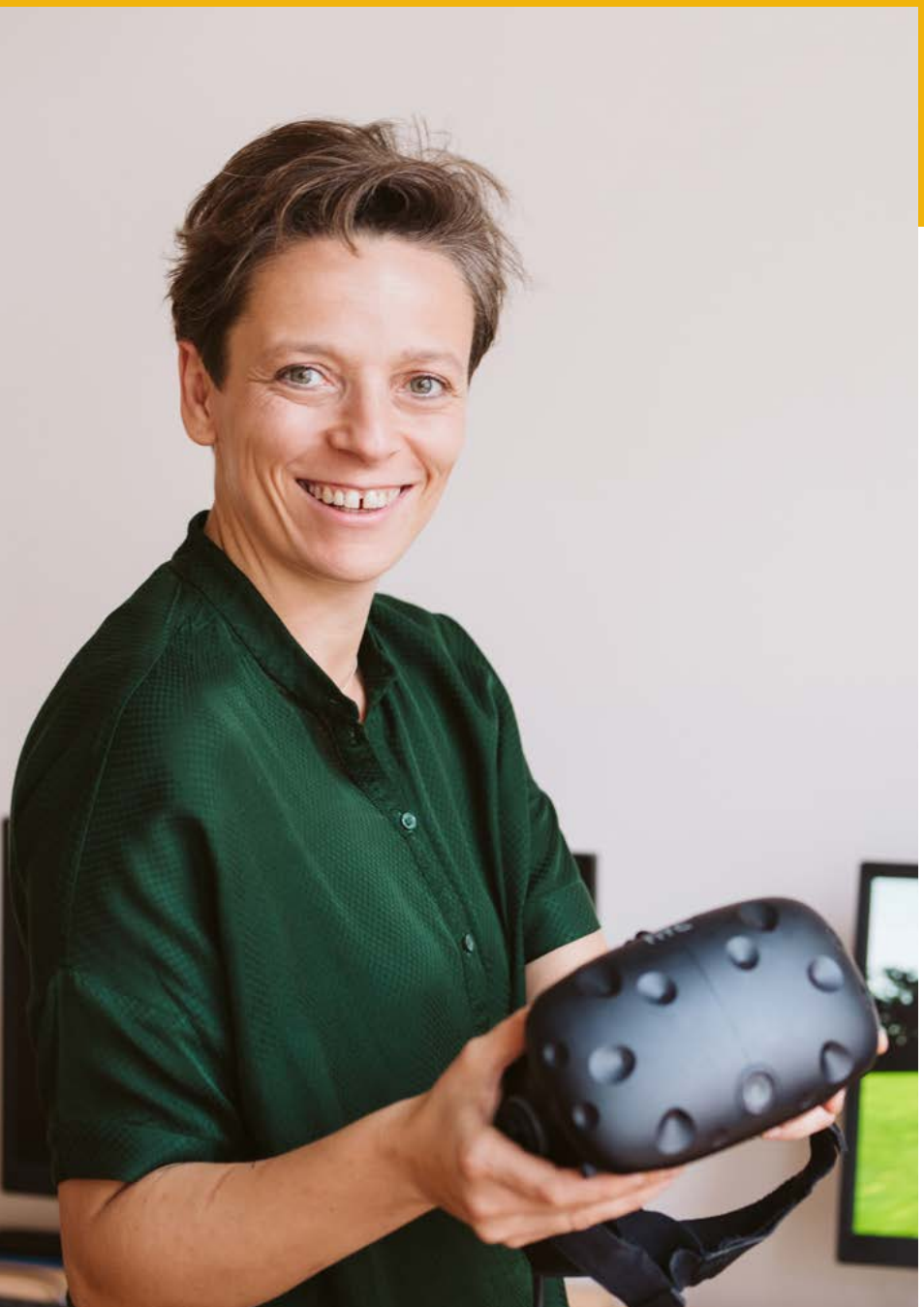
Currently, the team members are at the stage of modelling conditions for co-cultures – duos consisting of melanoma cells and normal cells – fibroblasts, keratinocytes or adipocytes. This is obviously a very simplified model of the microenvironment but one has to start somewhere. Cultures are conducted in the optimal medium for both types of cells; they can be isolated and molecularly examined, checked what they secrete, compared in terms of what is the composition of the environment of normal cells and what is the one of those grown with melanoma cells. The key to further research is to properly model and establish reproducible conditions for running these cocultures. Without this, it is difficult to draw correct conclusions.

Where get the cells for this type of research from? Cell lines come from banks operating in the US, UK or Germany. The advantage of such cells is that they are well defined; it is known where they come from, from the primary lesion or from the metastasis - unfortunately, melanomas "like" to form metastases, *e.g.* to the eyeball, mucous membranes or lymph nodes. The scientists can therefore test how cells from different sources react to the same inhibitors. Furthermore, thanks to the cooperation of the Faculty with clinical partners in Wrocław, cancer cells also come from biopsies of patients suffering from melanoma.

The research that Nowak is currently conducting together with clinicians from Wrocław may provide answers to many questions regarding the targeted therapy for melanoma.

The struggle with cancer is one of the most important challenges to be faced by contemporary medicine and, more generally, by health care policy in Poland and in the world.

At the University of Wrocław, laboratory experiments on pain were first carried out and the mechanisms of pain generation were studied before proceeding to the clinical testing phase.



Joanna Piskorz

For several years now, the psychologists from the University of Wrocław have been researching pain or, more precisely, ways to divert attention from it. For now, they have focused on reducing pain during short but uncomfortable medical procedures in children.

Taking blood and administering injections are a very stressful, unpleasant and sometimes even traumatic experience for many children (and not only them). They can also be a challenge for carers and healthcare professionals, who, on the one hand, would like to carry out the procedure and, on the other, would like to minimise the unpleasantness and not discourage the child from future medical procedures.

At the University of Wrocław, laboratory experiments on pain were first carried out and the mechanisms of pain generation were studied before the clinical testing phase. One of the better-known coping mechanisms is to divert attention away from pain, which is exactly the aspect the researchers focused on. Children who had to undergo a brief but unpleasant injection with a needle were offered to play a game set in virtual reality. Others were allowed to watch a video similar to the game. Both groups reported significant reductions in stress and pain, with those playing the game seeing a reduction in pain of up to around 60% and stress of over 70%.

What is this due to? First, the game required a high level of attention. It was designed around the principle of multi-object tracking, which engages attention more than other games and requires it continuously without distraction. It also required paying attention to multiple objects at the same time. The young patients were so absorbed in it that they no longer had the ability to focus on anything else, the stress and pain of the medical procedure that is. In a sense, they "suggested" to their bodies that pain was not that important when they could pay attention to something else. The perception of short-term pain is a complex process with a sensory and emotional component. By modifying one of these, we influence the other so if we reduce the emotional dimension, we also influence the overall perception of pain.

Children of all ages can use the game. It involves remembering a few briefly flashing items and then finding them among other moving objects. The game consists of several scenes. Each scene has a different background and number of flying objects to sustain the child's interest in each level and increase the chance of distraction from pain.

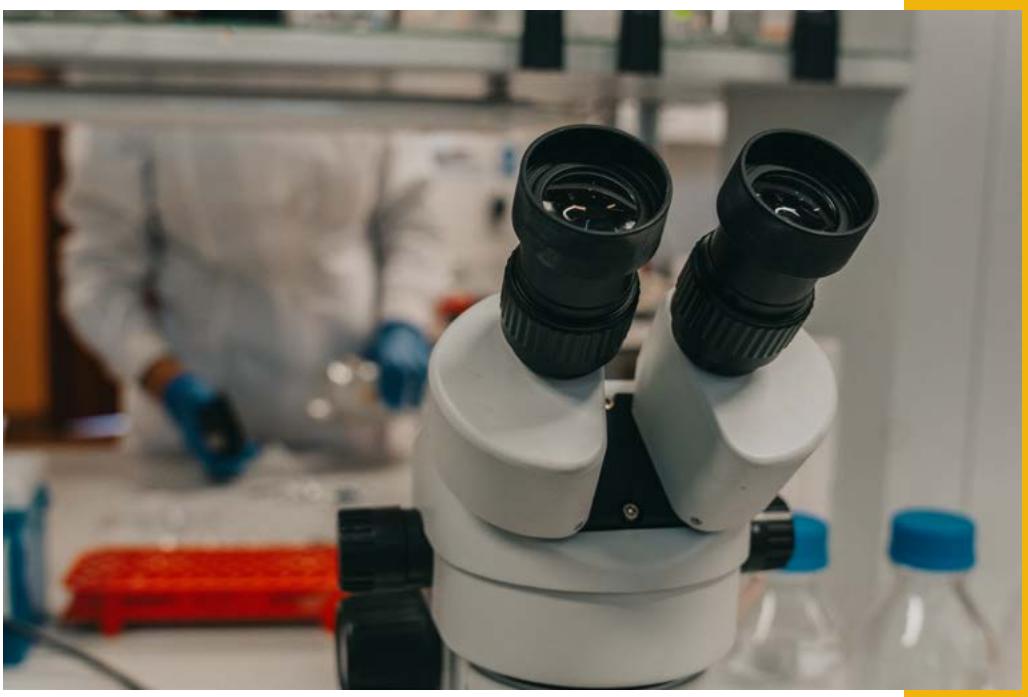
The researchers are also planning further tests of the game outside Poland. In the future, they would also like to focus on using virtual reality to reduce long-term pain. As pain perception is generated in the brain and it is not sufficient to switch off pain signals in the body's periphery to stop feeling it, this will be an even more difficult challenge.

Barbara Maciejewska
Tomasz Olszak

The alarming rise in antibiotic resistance among bacteria is inevitably bringing humanity closer to the point where all antibiotics will fail and some (especially hospital-acquired) bacterial infections will become untreatable. Dr Barbara Maciejewska and dr Tomasz Olszak, as the members of Department of Pathogen Biology and Immunology are involved in the extremely important research, which could lead to breakthroughs in the treatment of severe infections caused by multidrug-resistant bacteria, especially from the group of ESKAPE pathogens.

Barbara Maciejewska is a specialist in molecular biology and microbiology. She is working on recombinant phage enzymes that break down the bacterial cell wall envelopes (lysins and capsule depolymerases). Using synthetic biology methods and genetic engineering, she is discovering novel proteins with antibacterial potential.

Tomasz Olszak is a specialist in microbiology and the biology of bacteriophages. His research interests are focused on the phage resistance emergence in the model of *Pseudomonas aeruginosa*. This issue covers both the assessment of genetic and phenotypic variations, including the effect of phage resistance on pathogen virulence. His studies shed new light on the mechanisms involved in the co-evolution of bacteria and phages, while also revealing how these processes are impacting the effectiveness of phage treatment - an appealing tool in clinics and veterinary areas.



The alarming rise in antibiotic resistance among bacteria is inevitably bringing humanity closer to the point where all antibiotics will fail and some bacterial infections will become untreatable.

Multiculturalism – cooperation and its structures

Marcin Wodziński

Krzysztof Nawotka

Dariusz Adamski

Przemysław Wiszewski

Mirosław Kocur

Adam Chmielewski

Patrycja Matusz

Dominika Grzesik

Web of Science subject categories

- Archaeology
- Ethnic Studies
- History
- Humanities, Multidisciplinary
- Law
- Literature
- Social Sciences, Interdisciplinary

Scopus ASJC (all science journal classification) categories

- Arts and Humanities (miscellaneous)
- History
- Archaeology
- Classics
- Literature and Literary Theory
- Museology
- Archaeology
- Law
- Sociology and Political Science
- Anthropology
- Communication
- Cultural Studies
- Gender Studies
- Political Science and International Relations
- Urban Studies

Fields of study

Archaeology

Ethnology and cultural anthropology

History

Art history cultural studies

Law

Sociology

Among the main challenges we face today is overcoming barriers that separate representatives of different cultures existing within one political community or within a given structure of interests (economic, political, *etc.*). However, already in antiquity, there were attempts to find ways of cooperation between members of different cultures. One aim of the interdisciplinary research on multicultural societies conducted at the University of Wrocław is to increase our knowledge of such attempts by studying their examples from different historical periods and regions. Another aim of this research is to present both the circumstances of cultural conflicts and ways of solving them by analysing the conditions of permanence and change in intercultural relations. In undertaking their studies, researchers react to tensions and the needs of the social environment they belong to, seeing the tightening interactions between societies formed in different cultures as a cognitive challenge. They also focus on the systemic processes that are currently taking place in Europe and which are shaping its future. While each of the historians, art historians, philologists, sociologists, political systems scholars and lawyers who belong to the Priority Research Area works within the boundaries of his or her respective field, they all take the achievements of other fields into consideration.

If you want to know more about ongoing research at the University of Wrocław in this priority area, scan the QR code.

Marcin Wodziński

Historical Atlas of Hasidism, published in cooperation between a historian (prof. dr hab. Marcin Wodziński) and a cartographer (dr hab. Waldemar Spallek), is a perfect example of how modern digital technologies can be applied to research in the field of humanities. Published in 2018 by Princeton University Press, it won several awards, including the National Jewish Book Award and the Judaica Reference Award; the *Financial Times* put the atlas on its list of the 14 most important books of 2018.

The work is the first spatial analysis of Hasidism and, in fact, the very first cartographic representation of any mystical religious movement. It discusses the rise and expansion of Hasidism, its institutional forms, twentieth-century emigration to the New World, the crisis of two world wars and the Holocaust and, finally, the revival of Hasidism after 1945. The 74 large-format, full-colour maps and accompanying text, 99 illustrations, charts and tables present the spatial, physical and visual dimensions of the mystical Hasidic movement in a visually appealing, easy-to-understand format. The atlas demonstrates how geography informed the social organisation of Hasidism as well as its culture, spirituality and types of religious leadership. It is innovative in moving the focus of analysis from the leaders to the thousands of rank-and-file followers and investigating Hasidism in its historical entity from its emergence in the eighteenth century until today. It also applies an extensive and diversified source basis and the contemporary GIS tools (Geographic Information System) to arrive at a fully comprehensive picture of Hasidism. The atlas is a visually compelling and intellectually fascinating read. As one of the reviewers noted, the atlas "demonstrates that a photo is worth a thousand words and a map millions".

photo: Miłosz Poloch

Krzysztof Nawotka

Prof. dr hab. Krzysztof Nawotka is ancient historian whose research concentrates on four areas: the history and government of Miletus, the great Greek city on the south-western coast of Asia Minor, the history and legend of Alexander the Great, the application of quantitative methods to epigraphic studies and the history of Greek cities on the western coast of the Black Sea. Unlike the works of many of his predecessors, the research of Krzysztof Nawotka focuses on the Hellenistic and Roman periods, and not on the archaic age when Miletus was the main centre of Greek colonisation and the birthplace of world science (Ionian philosophy of nature).

The aim of the study of the history of Miletus in the Hellenistic and Roman periods is to trace the political and social transformations of the Greek city in confrontation with the great territorial powers – the Hellenistic monarchies, the republic and the Roman Empire. These studies show, among other things, that the period of the greatest spread and vitality of Greek democracy was the Hellenistic rather than, as many believe, the Classical age. Furthermore, they seek to link the process of degeneration and decline of democracy to the influence of Rome, which – in various ways – supported the rule of a wealthy oligarchy in Greek cities.

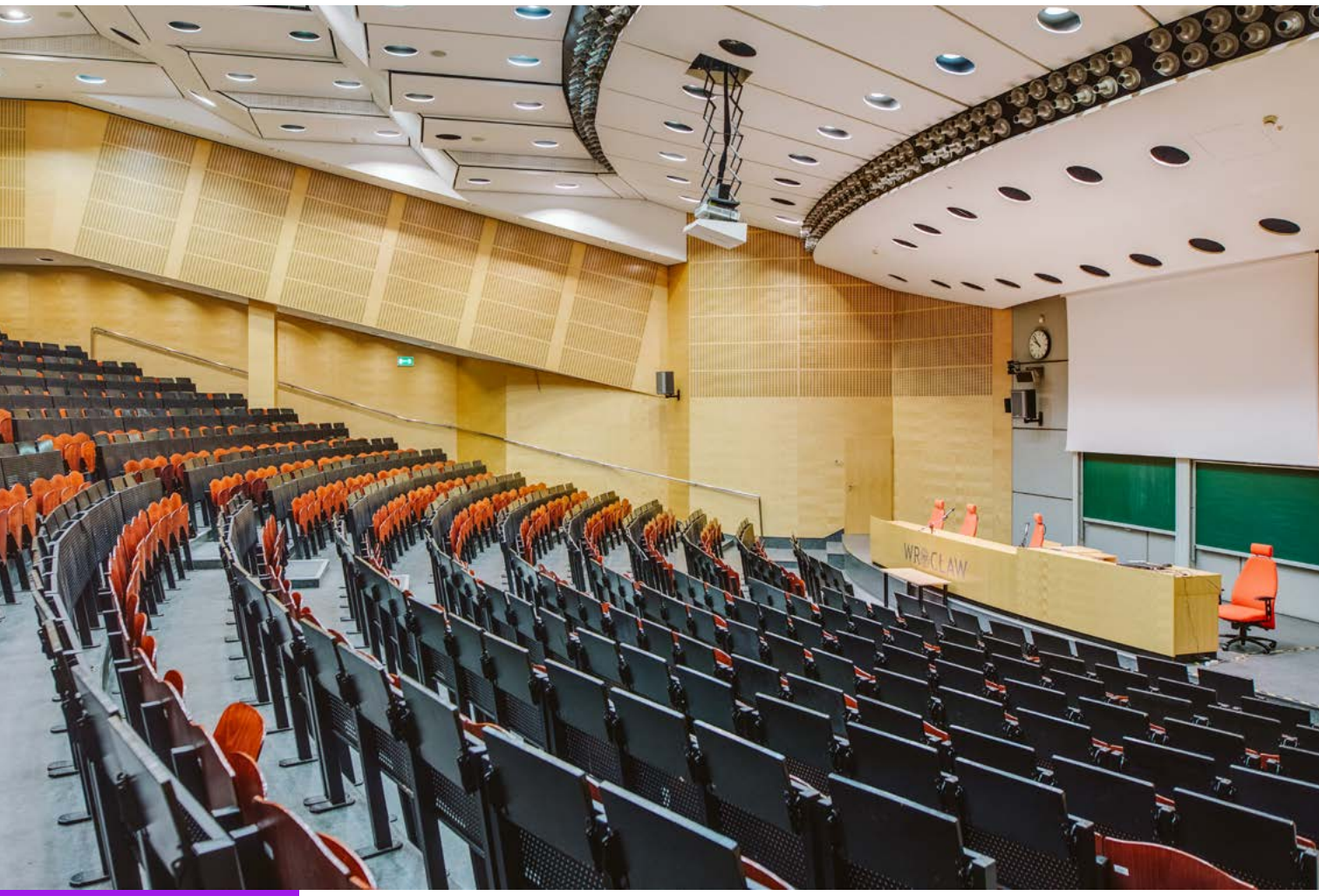
Krzysztof Nawotka's research into the history and legend of Alexander the Great has focused in recent years on the anonymous, late *Alexander Romance*. His commentary on this work demonstrates the far greater source and intellectual complexity of the *Alexander Romance* than is commonly assumed and its dependence on eastern sources (Egyptian, Babylonian, and Iranian), not just on the classical authors who preceded it. This research contributes to the rehabilitation of *Alexander Romance* in modern historiography and significantly expands the weak source base in the study of Alexander the Great.

With his research team, Krzysztof Nawotka is working on inscriptions, primarily Greek, from the eastern Mediterranean in antiquity, using quantitative methods. It is the largest and most complex project of its kind in the world, showing significant chronological fluctuations in the number of stone inscriptions produced on average per year, in their various categories, in the area stretching from the Black Sea through mainland Greece to Asia Minor and the Levant. Furthermore, it seeks to trace the causes of this phenomenon such as political variation, the influence of pre-Greek cultures and their cultural traditions as well as the influence of territorial monarchies on the evolution of the Greek city.

Dariusz Adamski

Prof. dr hab. Dariusz Adamski's research focuses on the legal underpinnings of public policies. It aims to ascertain how legal rules influence the economy and society as well as what conclusions as to their optimal shape can be drawn from it. Untypically of legal research, this approach treats legal norms and court judgments only as a starting point for further analysis based on the methods used by other disciplines.

Energy policy and healthcare policy are based on a complicated set of legal norms, are partly determined by EU law in Poland. However, in order to determine their consequences, one has to ascertain how they influence various sectors and social groups as well as take e their political backdrop into account.



Two areas – energy policy and healthcare policy – can serve as examples here. Both are based on a complicated set of legal norms, which are partly determined by EU law in Poland. However, in order to determine their consequences, one has to ascertain how they influence various sectors and social groups as well as take their political backdrop into account. As a result of this approach, one can identify – based on empirical research – the strengths and weaknesses of the legal rules governing individual public policies. In the context of the two abovementioned examples, the approach makes it possible to identify the economic consequences of the green transition for various economic sectors and social groups as well as how these consequences can be optimised with legal rules. Based on the available data, it allows for determining the practical consequences of the current healthcare policy and the desired modifications to its legal framework, upon the analysis of its efficiency, identified loopholes and side effects.

Mirosław Kocur

Prof. dr hab. Mirosław Kocur develops a historical approach to performance studies, researching the origins of theatre and ritual arts. In his comprehensive research, he connects theatre studies with archaeology, neuroscience and performance studies. He surveys the performative agency of artistic and ritual behaviours. He also researches the social efficacy of rituals and cultural performances worldwide (Bali, Tanzania, Tibet, Madagascar, USA, in plans Amazonia, Vanuatu). Furthermore, he applies ground-breaking methodologies – Performance-as-Research and Practice-as-Research – to advance a new understanding of "practice" and explore the scientific dimension of artistic events.

Kocur successfully integrates science and art. He graduated from Wrocław University of Science and Technology (1976) and the Drama Directing Department at the Academy of Theatre Arts (AST, 1986). His scientific hypotheses are tested in artistic projects with University and AST students. He currently works on the Polish history and theory of performing arts, including seminal achievements and discoveries of Polish artists in the 20th and 21st centuries and the Middle Ages, when Poles rarely wrote original dramas. However, they lived and breathed theatre on an everyday basis. Thus, Polish contribution to European theatre was not through texts but performative strategies. This area of research is particularly neglected in recent scholarship, dominated by Anglo-Saxon scholars whose theories and practices are of little value in interpreting Polish art. A preliminary study by Kocur will be published by Cambridge University Press in 2022 (Staropolska: Theatres of Identity).

A two-time recipient of American scholarship (California Arts Council 1990-1994, Fulbright 2005), Kocur published in English *On the origins of Theater* (2016), *The Second Birth of Theatre: Performances of Anglo-Saxon Monks* (2017), *The Power of Theater: Actors and Spectators in Ancient Rome* (2018).

Adam Chmielewski

Prof. dr hab. Adam J. Chmielewski is a professor of philosophy, social activist, translator, literary critic and political columnist. He studied philosophy and social sciences in Wrocław, Oxford, New York and Edinburgh. He works in the philosophy of science, ethics and the philosophy of politics. He has authored, among others, *Popper's Philosophy* (1996), *Incommensurability, Untranslatability, Conflict* (1998, 2014), *Open Society or Community?* (2001), *The Viennese Waltz and the European Waltz* (2001), *Two Concepts of Unity* (2006), *Psychopathology of Political Life* (2009).

He has published over a dozen philosophical and literary translations, including works by Karl Popper, Bertrand Russell, Alasdair MacIntyre, Richard Shusterman, Slavoj Žižek, D.H. Lawrence and Pearl S. Buck. Since 2005, he has been the editor-in-chief of the quarterly *Studia Philosophica Wratislaviensia*. He is the author of the successful candidacy of Wrocław for the title of the European Capital of Culture. He is the author of the following blogs: Interventions: Philosophical and Political; Contra-Dictions; and Meetings Downtown.

On one of his blogs, he writes:
"I have made up my mind not so much to become a philosophical polyglot as to avoid remaining a monoglot and, above all, to avoid being an echo of a monoglot even if he is a genius and a friend". This quote from Gilbert Ryle, the well-known 20th-century Oxford philosopher, is particularly important to me because it indicates the value and importance of independent thinking in philosophy and is a call to it. I am a professor at the Institute of Philosophy, of the University of Wrocław, and I work with doctoral students at the Doctoral School of Philosophy. I conduct research in the area of social and political philosophy. I comment on the latest events in Polish and international politics from the perspective of my own, consistently agonistic conception of society and politics.

Chmielewski explains to his students that he deals with philosophy because being a philosopher gives the freedom of thought that no other academic discipline can offer. At the same time, it imposes the strictest requirements that discipline even the most free ideas. When working with students, it is essential to stimulate them to choose their own research problem and consider it.

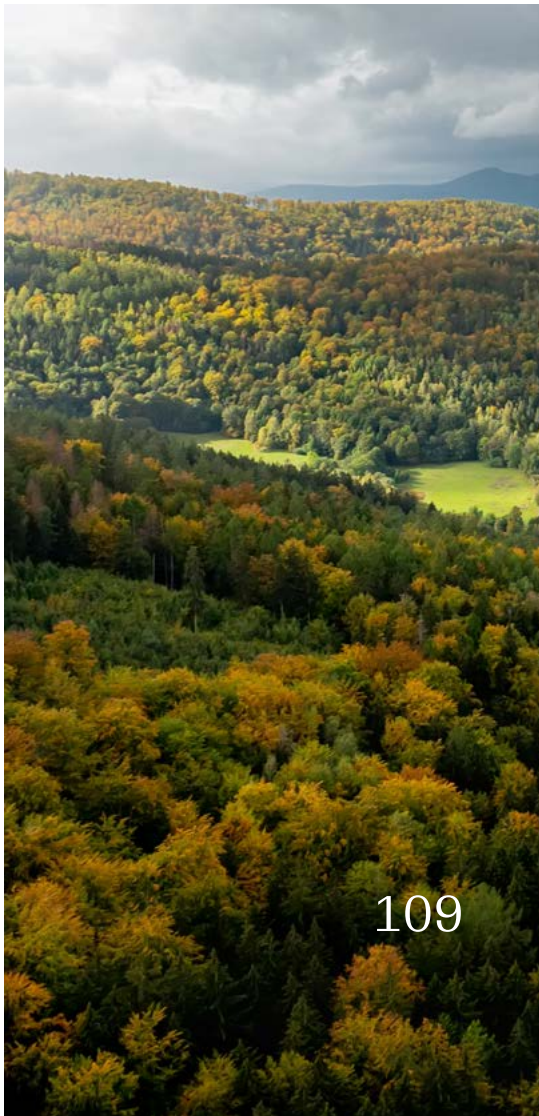
In his most recent writings, Adam Chmielewski addressed the problems of post-truth and negative aspects of the pandemic upon social life. Presently, he works on the problem of the relationship between political aesthetics and social exclusions.

Przemysław Wiszewski

Prof. dr hab. Przemysław Wiszewski's research interests focus on the identity of heterogeneous social groups and forms of communication among members of these groups. In his research, he puts particular emphasis on values as factors that define and bind groups and information circulation that enables making and growing of social groups. For many years, he has been conducting research on the history of regional and local communities of medieval and early modern Silesia. From the mediaeval times to 1945, this borderland region was populated by Czech, German and Poles. The diversified cultural, legal and historiographical tradition of the regional society enabled a detailed analysis of factors that bound or disintegrated multi-ethnic societies in the medieval and modern eras.

His special point of interest is cultural and social changes in multi-ethnic border societies of mediaeval and early modern Central Europe. He coordinates the work of the Polish team of the project "Cuius Regio. An analysis of the cohesive and disruptive forces determining the attachment and commitment of (groups of) persons to and the cohesion within region" funded by the European Science Foundation. The fruit of the work was a synthesis consisting of five volumes of changes in regional identity and regional cohesion in Silesia (10th-20th centuries). He directed the project "Motherland Silesia. The history of local communities in the context of regional, state and national identity (12th-21st centuries)". The project focused on analysing the local history of several small towns and surrounding villages to trace the differences and similarities of these local trends in the history of the multi-ethnic region of Silesia. He manages the project "Mechanisms of building cohesion in multi-ethnic communities, 10th-21st centuries" with an international team of researchers from Spain, Portugal, Italy, Great Britain, the Czech Republic, Romania, Hungary, Lithuania, Russia, Japan and Poland in search for the reasons for the peaceful existence of multi-ethnic political communities/states "on the periphery" of medieval and early modern Europe. His last project is "Lexicon of Silesian artists and handicraft artists/Künstlerlexikon Schlesien" – dictionaries of artists-craftsmen from selected communes of Lower Silesia published in Polish and German.

The fruits of his studies were monographs devoted to the values on which the image of power in the full Middle Ages was based (Brill 2010), the history of medieval Central Europe (together with Nora Berend and Przemysław Urbańczyk, Cambridge University Press 2013), the history of German-Polish relations in the Middle Ages (Wissentschaftliches Buchgesselschaft 2020) and the cohesion of multi-ethnic political communities in the Middle Ages and the modern era (Brepols 2020).



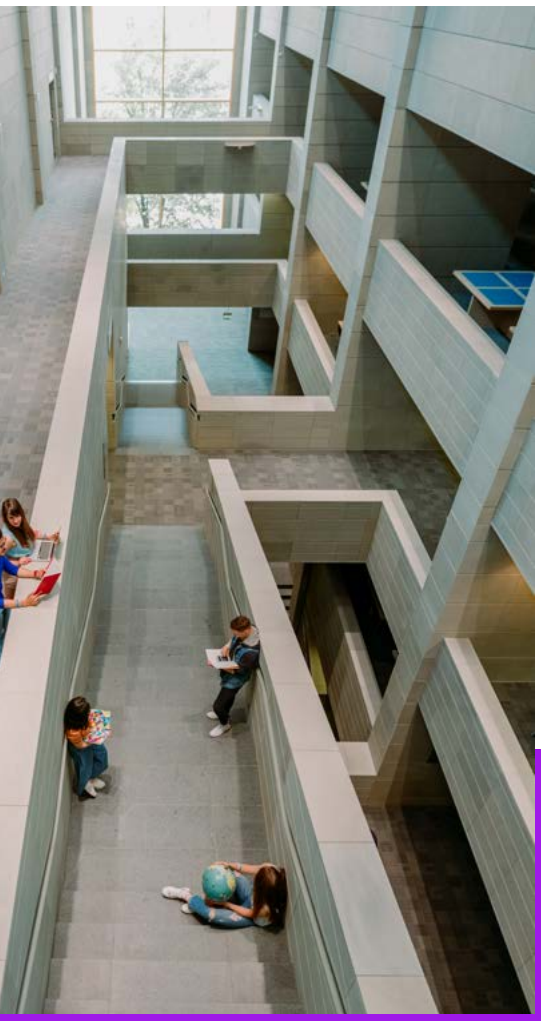
From the mediaeval times to 1945, this borderland region was populated by Czech, German and Poles. The diversified cultural, legal and historiographical tradition of the regional society enabled a detailed analysis of factors that bound or disintegrated multi-ethnic societies in the mediaeval and modern era.

Patrycja Matusz

Europe has a long history of migratory movements. These processes have been changing the societies of the European states. However, over the last few years, the EU member states have received unprecedented numbers of migrants and asylum seekers, often in an unorderly way. This process has impacted the relations between migrants and receiving societies and challenged the whole governance of migration and integration. Migration studies is a multidimensional and interdisciplinary field that includes diverse disciplines of science. As a political scientist, dr hab. Patrycja Matusz, professor of the University of Wrocław, focuses on the multilevel governance of migration and integration, relations between migrants and local communities, local integration strategies and education of children with a migratory background.

Currently, Patrycja Matusz has been involved in two Horizont2020 projects. The first one is ADMIGOV (Advance Alternative Migration Governance) This international research team searches for alternative approaches to migration governance, which can be better designed and put into practice. ADMIGOV studies the reality of existing policies and practices on the ground (fieldwork in various locations) to improve migration governance and propose recommendations for the future.

Europe has a long history of migratory movements. However, over the few last years, the EU member states have received unprecedented numbers of migrants and asylum seekers, often in an unorderly way.



The second Horizont2020 project – Whole-COMM (Exploring the Integration of Post-2014 Migrants in Small and Medium-Sized Towns and Rural Areas from a Whole of Community Perspective) – seeks to address these issues through an innovative Whole-of-Community research approach which conceives migrant integration as a process of community-making that: takes place in specific local contexts characterised by distinct configurations of structural factors; is brought about by the interactions of multiple actors with their multilevel and multi-situated relations; and is open-ended and can result in either more cohesive or more fragmented social relations. Whole-COMM contributes to filling a serious gap in the existing research and policy debates that have been concerned primarily with big cities.

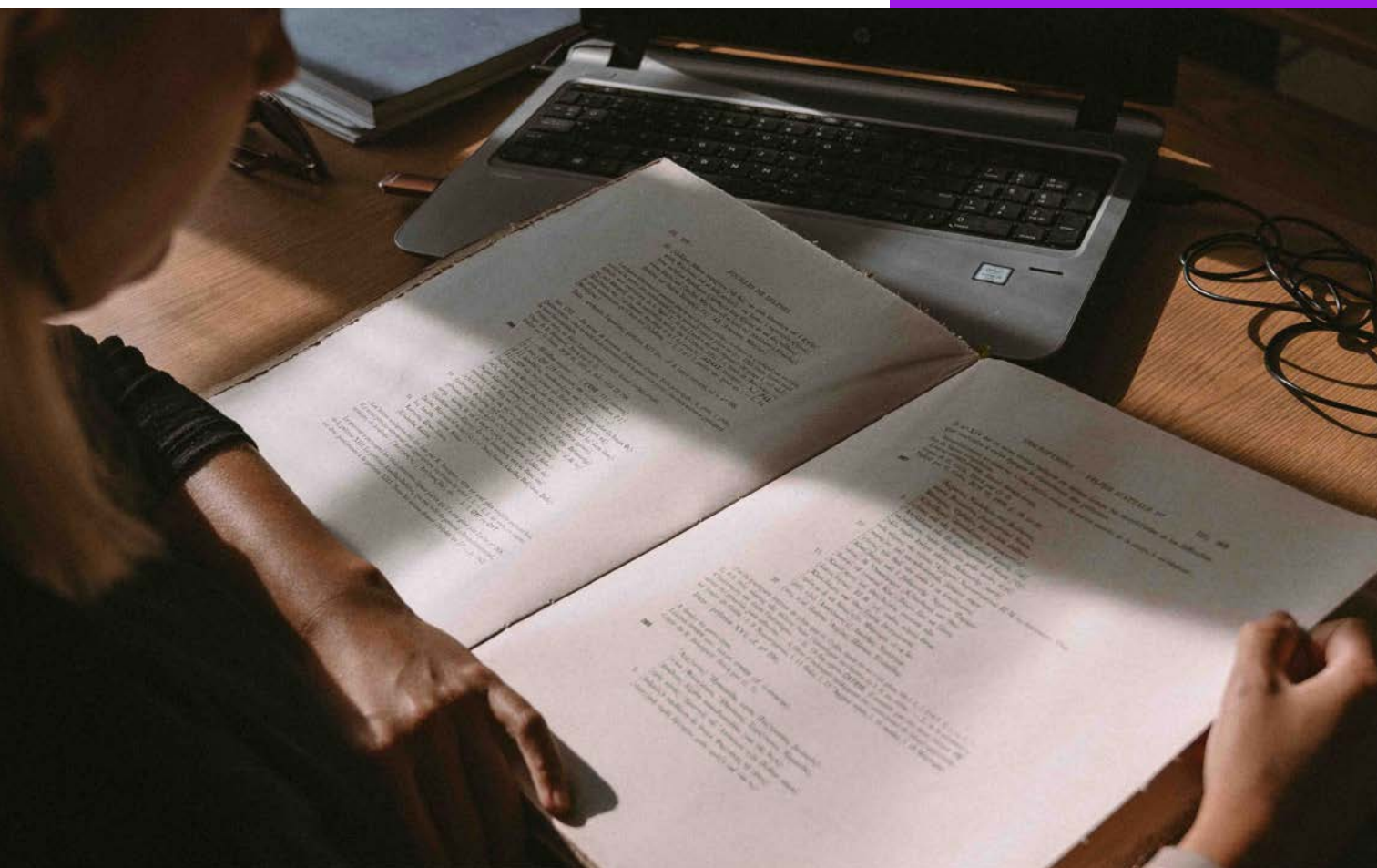
Patrycja Matusz researches the integration of migrants in Poland, mainly at the level of cities. Currently, she works for various institutions at the local, national and European level, implementing research, creating and evaluating integration policies and activities.

Dominika Grzesik

Dr Dominika Grzesik is a holder of a PhD degree in history (2015). In 2011 she joined the international MPD project founded by the Foundation for Polish Science "The Eastern Mediterranean from the 4th c. BC until late antiquity", carrying out research on "Delphi throughout the Hellenistic and Roman periods. Honors and privileges in Delphic decrees" under the supervision of Krzysztof Nawotka from the University of Wrocław and prof. Graham Oliver from the University of Liverpool.

Currently, Grzesik is an assistant professor at the Department of Ancient History (University of Wrocław), where she conducts the NCN Sonata grant ('Epigraphy in the landscape: topography of honorific inscriptions in Delos, Athens, Delos and Oropos'). Grzesik's research concerns the Greek epigraphic habit, honorific culture and the influence that inscriptions had on the topography of Greek cities. Dominika Grzesik is the author of numerous publications, including articles in Historia: Zeitschrift für Alte Geschichte, Zeitschrift für Papyrologie und Epigraphik, and Antichthon. Grzesik's monograph was published in Brill (Brill Studies in Greek and Roman Epigraphy), winning the Géza Alföldа - Publication Grant 2021.

Grzesik is a leader of two NCN grants (Preludium and Sonata), she was also granted with a scholarship the Kommission für Alte Geschichte und Epigraphik in Munich, START-stipend funded by the Foundation for Polish Science and a scholarship from the Minister of Science and Higher Education for outstanding young scientist.



Dominika Grzesik's research concerns the Greek epigraphic habit, honorific culture and the influence that inscriptions had on the topography of Greek cities

The Mathematical Tower is a former Astronomical Observatory, built at the end of the 18th century. It was founded in 1791 by the ex-Jesuit Longinus Anton Lorenz Jungnitz, professor of Wrocław Leopoldina University, an avid naturalist, physicist and astronomer. Currently, the tower houses the exhibition halls of the Museum of the University of Wrocław and the observation deck offers the opportunity to admire the panorama of the old town. The only preserved merdian in Poland is located in the Mathematical Tower. It is a meridian line, which in the 19th century was used to determine the astronomical south.

Academic Excellence Hubs

Academic Excellence Hubs connect teams of researchers led by an expert, providing them with funding to conduct research on an international scale. This initiative not only aims to yield a certain number of grants and publications but, first and foremost, it also aims to promote the culture of quality in less developed fields. As a result, the inequality in research opportunities across disciplines at the University of Wrocław will decrease.

Academic Excellence Hubs are created in those disciplines which are not sufficiently internationalised but involve individuals and teams that conduct high-quality research.

We introduce eight Excellence Hubs, aiming to visibly improve the disciplines characterised by poorer publication records and lower internationalisation. Each of the newly established teams is coordinated by an internationally established researcher selected through a competition conducted by an independent board of experts representing leading foreign research facilities.

Super(dense) Fluid Dynamical Simulations – SuperFluiDS

dr Pasi Huovinen

At extreme temperatures and densities, matter no longer consists of atoms and their nuclei, but of their constituents: quarks and gluons. Such a state of matter was prevalent immediately after the Big Bang and can be formed in collisions of heavy ions. At the Centre for Simulations of Superdense Fluids, we develop models to describe these collisions. Through comparisons with experimental data, we can deduce the properties of matter formed in these collisions.

Meta-Research Centre of Scientific Excellence

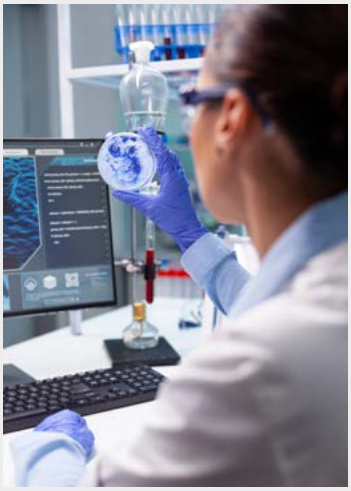
dr Bartosz Helfer

This Hub will establish a Meta-Research Centre, which will investigate research methods and practices to understand how to reduce biases in science and thereby deliver more reliable and secure conclusions from important scientific studies. M-C will critically evaluate scientific data (both published and unpublished) and synthesise evidence to assess how much we can trust the findings and what aspects of the research process could be improved to increase its value and reduce the waste of research resources. M-C will apply the meta-research toolbox to a variety of disciplines (psychology, public health, nutrition as well as biology or ethics) and in an innovative way to provide constructive criticism and future-oriented improvement.

Being human – bridge-building between the humanities and ethology

dr Stewart Craig Roberts

What does it mean to be human? How do we form relationships or make decisions about what is right or wrong? Why do we perform and create? This hub programme seeks to answer these core questions about human nature by establishing a new interdisciplinary team of scholars that bridge diverse perspectives from the humanities and human ethology.



The scientific Excellence Hub – DNA Repair and Replication Research Centre will explore an under-investigated area in biology: the SUMO homeostasis (Small Ubiquitin-like Modification) and its impact on genome stability in yeast Schizosaccharomyces pombe. Fission yeasts are an excellent model organism to study DNA metabolism due to the high conservation of basic cellular processes from unicellular Eukaryotes to humans.

Decoding SUMO-interactions at replication stress sites mechanisms and the consequences for genome maintenance SUMOFork

dr Karol Kramarz

Digitalization of Criminal Justice

dr Karolina Kremens

The digital Justice Hub aims to comprehensively research and analyse the complex interactions between new technologies and the criminal justice system. Three areas are to be explored. First, issues related to collecting information for the purpose of criminal proceedings will be investigated. Electronic devices facilitate the gathering of information while posing a danger of mass surveillance and the eradication of privacy. Second, new technologies facilitating the course of investigation and trial will be analysed. The COVID-19 pandemic brings a new perspective to the idea of the live-streaming of criminal trials. However, audio and video links might not be enough to guarantee accurate fact-finding and the moral legitimacy of the criminal justice system. Third, the belief that achieving justice assumes being evaluated by fellow citizens will be scrutinised. Recent developments in psychology undermined the faith in the human assessment of guilt and the ability to punish. A critical insight into the applicability of Artificial Intelligence (AI) technology designed for criminal justice aims to reveal whether algorithms may be used in decision-making processes to produce justice and be accepted by the public.

Non-Equilibrium Flare Radiation from Infrared to X-rays

dr hab. Arkadiusz Berlicki, prof. UWr

The main aim of the proposed hub is to make significant progress in the area of non-equilibrium plasma spectroscopy and the modelling of flares and other active phenomena observed in the Sun and active stars (project acronym: NEFRIX). In our research, we will use high-quality observations of solar and stellar active events obtained from ground-based and orbital observatories and advanced numerical codes which will be used for the interpretation and simulation of the observational data. The principal outcome of the project will be the formation of a top-level research team capable of performing very complex studies of solar and stellar flares, CMEs and other active phenomena as most violent eruptions potentially affecting our planet and extrasolar planets orbiting around other stars.

New computational and experimental methods in research on semantic micro-typology of Slavic and Baltic languages

prof. dr hab. Bożena Rozwadowska

Slavicus is viewed as a future center of studies on variations among Slavic languages and its main goal is to create a large parallel corpus of 11 Slavic, two Baltic languages and English as a reference language, equipped with a user-friendly interface as well as sophisticated retrieval mechanisms. We will also extend translation mining and multidimensional scaling to the area of semantic universals. This project will bridge theoretical and computational linguists and open vast research domains for syntacticians, semanticists, morphologists, translators and lexicographers.

Stories of Loneliness

prof. dr hab. Dariusz Galasiński

The centre will be researching stories of difficult, traumatic and extreme experiences, first focusing on loneliness, often described as the "silent epidemic" of the 21st century. It aims to combine perspectives from social science and other disciplines, hoping to create new knowledge and translate it into helping people deal with their difficulties.


MilliQ H2O
ÄKTA pure
AKTA
1 2 3 4 5 6
11 12 13 14 15 16 17 18 19 20
AKTA

Selected patents of the University of Wrocław

The Centre for Technology Transfer (CTT) is a unit responsible for supporting the scientific and technological potential of the University of Wrocław and the transfer of research results to the economy. This is achieved, in particular, through direct commercialisation. The role of the CTT is to help scientists in the process of acquiring funds for innovative research, to help in the organisation of formal conditions for cooperation with the industry and to help in the commercialisation and the promotion of research results.

The CTT manages the process of direct commercialisation of the computer software "Internet Recruitment of Foreigners" (IRC). The IRC is an innovative tool created at the University of Wrocław to serve foreign candidates applying to the University. It is the result of combining the long-standing experience of the staff of the University of Wrocław with the analytical approach as well as technical and programming skills. The IRC computer software has been successfully implemented to support recruitment processes at the Wrocław University of Science and Technology as well as at the University of Wrocław itself.

As part of technology transfer to the economy, the University of Wrocław also initiated the process of the indirect commercialisation of the SARUAV (Search and Rescue Unmanned Aerial Vehicle) system. The solution was created at the Faculty of Earth Sciences and Environmental Management. It is an innovative geoinformatic system supporting the search for missing persons in undeveloped areas with the use of unmanned aerial vehicles. The system, managed by a spin-off technology company, is successfully operating and growing in the market.

The CTT also provides organisational support for processes related to one of the most popular forms of cooperation between scientific units and business. This involves commissioning specialist scientific and research services to universities and research institutes. The CTT undertakes activities aimed at establishing cooperation with companies, seeks scientists interested in research, supports the creation of a research offer and assists in the process of negotiating contract terms and signing a contract with a business entity.

Method of obtaining helenalin and dihydrohelenalin and esters of these substances from *in vitro* cultures of Arnica

Patent No. 237808

Assignee: Wroclaw Medical University

Inventors: Krystyna Kromer, Agata Kierasińska, Jerzy Wiśniewski, Dorota Porutała, Andrzej Gamian

Arnica montana is a highly valued medicinal plant. Its flowers contain compounds with anti-inflammatory, anti-rheumatic, antithrombotic, antivascular properties, accelerating wound healing and haematoma resorption. The active components of the raw material are sesquiterpene lactones (0,2-0,8%) – helenalin, 11α-, 13-dihydrohelenalin and their esters.

Due to its properties, Arnica is a highly sought after species and widely used in the cosmetic and pharmaceutical industry. The taxon is under legal protection in Poland and most European countries; it is included on the European Union's list of endangered species (CITES list). Due to its protected status and risk of extinction, harvesting the flowers from natural sites is prohibited. Therefore, the only alternative is the cultivation of a few varieties or the production of these valuable compounds in plants cultivated *in vitro*.

Patent No. 237808 describes the conditions created for the biosynthesis of pharmacologically active compounds in the leaves of *in vitro* cultivated plants to be ten times greater than in flowers. The prerequisite is a harmonious supply of mineral nutrients and the application of high light intensity.

Artificial sandstone obtained in result of agglomeration of metallurgical wastes, preferably the wastes after the steel-making processes

Patent No. 413544

Inventors: Andrzej Vogt, Stanisław Strzelecki, Adam Adamczyk, Sławomir Szafert

One of the most important problems in waste management is the disposal of fine-grained waste from all types of industrial/production activities, which contain easily leachable components (*e.g.* various types of salts). As a result of precipitation, the leached compounds enter the environment causing its contamination and degradation; therefore, there arises the need for the safe storage of such waste. One of the methods is the special consolidation of such waste in such a way that it does not leach easily soluble compounds, which is not an easy task. The Faculty of Chemistry has developed such a method, which has already been used in one of the waste incineration plants in the country (very dusty, difficult to manage and highly saline waste is then produced). In general, the method is based on the use of a polysilicate acid network, starting from a very cheap and easily accessible substance, *i.e.* sodium silicate, or a polysulphur network formed from elemental sulphur or/and the so-called polymerised sulphur which is a product of the reaction of elemental sulphur with unsaturated hydrocarbons, *e.g.* styrene. This method has been patented and has indirectly included the fusion of materials such as:

- sands (even with high salt content and therefore also desert sands);
- granulates produced in the process of the thermal utilisation of municipal or industrial waste;
- loose, water-insoluble chemical products such as borides, carbides, nitrides, oxides, metal sulphides, etc., resistant to high pH;
- all water-insoluble metal salts resistant to high pH;
- mineral granulates and powders;
- metallic granulates and powders, *etc*.

The patent itself covers mainly mixed waste materials from metallurgical processing, *i.e.* mainly iron oxides and iron carbonate as well as metallic iron itself in the form of scales, filings or powders. Thanks to this method, it is possible to produce, for example, sand bricks or other sand-based building products.

Method for the preparation of meadow biomass for biogas production

Patent No. 231362

Inventors: Beata Biega,
Adriana Trojanowska-Olichwer,
Mariusz Jędrysek

Meadow biomass with a humidity of 50%, freeze (temperature –27 ° C for 90 days), is an improved substrate for a biogas plant. Due to freezing, biogas production is increased by 90% compared to fresh biomass and the methane content above 50% enables its energy use. Other benefits are the possibility of storing the substrate for biogas plants and the management of biodegradable waste, such as meadow biomass.

The use of biomass is associated with rational waste management. In the past, meadows were a source of fodder for farm animals; now, with the decline in their numbers, a significant part of the meadows is no longer used for grazing animals. However, to maintain their environmental values, the regular mowing of meadows is supported by subsidies from agro-environmental programmes. Therefore, meadow owners regularly mow them but rarely make use of mowing residues. Such mowed meadow biomass can be an attractive substrate for the production of biogas, which is currently not used on a large scale in Poland. A preliminary economic analysis of the development of meadow biomass in biogas plants shows that although the yield of biogas from meadow biomass was slightly lower than from the popular maize silage, it turned out to be much cheaper to produce and more environmentally friendly. Currently, the scientists from the Institute of Geological Sciences and the Botanical Garden of the University of Wrocław are implementing a project financed by the Provincial Fund for Environmental Protection and Water Management in Wrocław, the aim of which is to select areas worth locating biogas plants. The analyses include the area and productivity of meadows and the biogas potential of specific plant species. The project fits the economic context and the strategy for the development of renewable energy in Poland.

Pseudofactin derivatives, a method of synthesising pseudofactin derivatives and their use

Patent No. EP3000821
Patent No. EP3000822

Inventors: Anna Krasowska, Marcin Łukaszewicz,
Daria Grzywacz, Wojciech Kamysz

Biosurfactants are a group of surface-active agents obtained in microbial biosynthesis processes, mainly by bacteria and fungi. Their properties are similar to those of commercially used synthetic surfactants included in washing powders or dishwashing liquids. Their advantage is that they are readily biodegradable. The range of possible uses of biosurfactants is vast and they can act as antimicrobial agents or anticancer drugs. Their use is increasing in industry and medicine and, currently, the aim is to reduce the share of synthetic surfactants in favour of biosurfactants. One of the biosurfactants discovered at the Department of Biotransformation at the University of Wrocław is lipopeptide pseudofactin. It is produced by the bacterial strain *Pseudomonas fluorescens*, isolated from a water sample taken in Spitsbergen by the employees of the Faculty of Earth Sciences and Environmental Management. Pseudofactin exhibits antibiotic (against pathogenic fungi and bacteria), anticancer and antiadhesive properties but current extraction methods are unable to meet the demand for this substance and do not meet purity requirements. A method for the chemical synthesis of pseudofactin with high efficiency and purity was developed at the University of Wrocław in collaboration with the Medical University of Gdańsk. The obtained pseudofactin showed a strong inhibitory effect on the formation of bacterial and yeast biofilms under aerobic conditions. The experiments conducted indicated a very strong reduction (90 to 95%) of biofilm formation on plastic, glass and silicone surfaces.

Unmanned aerial vehicle with a differential air pollution sensor

Patent No. Pat.234716

Assignee: OPTIMUM - TYMIŃSKI
I S-KA Spółka Jawna
Inventors: Dariusz Tymiński, Grzegorz Polak, Mateusz Zych,
Mariusz Kłonica, Radosław Bielawski, Bogdan Grenda,
Anetta Drzeniecka-Osiadacz, Tymoteusz Sawiński

Air pollution is nothing new. Progressive urbanisation, industrial development and the widespread burning of fossil fuels have caused many negative phenomena, which undoubtedly include poor air quality. We have already managed to deal with industrial pollution to a large extent in our country. The so-called "low emissions", *i.e.* mainly pollutants emitted from our homes and means of transport, are now the leading issue. For many years, a team of scientists at the Department of Climatology and Atmosphere Protection of the University of Wrocław have been measuring air quality, using both reference methods and modern solutions that are likely to become standard in the future. The search for new solutions became the basis for cooperation with OPTIMUM-TYMIŃSKI I S-KA and, consequently, for the implementation of solutions enabling the measurement of pollutant concentrations with the use of drones. Due to the need to identify emission sources, a solution was developed, which enables the measurement of the pollution concentration in the immediate vicinity of the emission source (chimney). It also enables the identification of these sources. For this purpose, a differential method has been applied. In this method, the measurement takes place from the side of the emission source and on the opposite side of the drone, providing the possibility of identifying individual sources. The invention consists of a system of two air intakes (sampling systems), which are mounted to the underside of the drone, rotatable about a vertical axis (the position of the intake can be changed). The device consists of a system of two inlets (sampling systems), which are located at a distance from each other so that the air can be sampled undisturbed by the movement of the rotors. By installing two inlets with independent sensors, it is possible to determine the direction of the inflow of pollutants quickly. In addition, the position of the intake vents can be remotely controlled without having to land, allowing for the precise location of the emission source. The modular nature of the solution allows using different types of sensors for both dust and gas pollution measurement.

Application of the waste acid KH_2PO_4 potassium phosphate to the production of a granular multi-component fertiliser

Patent No. 413459

Inventors: Andrzej Vogt, Stanisław Strzelecki,
Sławomir Szafert, Mirosław Rakow, Stanisław Klesyk

A very interesting method of utilising waste acid potassium phosphate (KH_2PO_4) generated during the chemical recycling of the so-called glycerine fraction has been developed at the Faculty of Chemistry. This waste was used to produce a granulated compound fertiliser containing dolomite and/or calcium or magnesium carbonates and oxides and plant nutrients, especially phosphorus, potassium and trace elements as well as the ash generated from the combustion of straw and/or biomass, with both potassium and phosphorus coming mainly from KH_2PO_4 acid potassium phosphate.

The glycerine fraction in question is post-production waste from the process of making methyl/ethyl biodiesel (FAME/FAEE) from various vegetable or animal fats or from used or health-promoting ethyl esters of higher fatty acids obtained from linseed oil according to the simplest, and therefore cheapest, technology in the world. This technology was also developed at the Faculty of Chemistry and has been patented as an original technology guaranteeing the lowest possible cost of ester production while maintaining the highest product quality standards thanks to several innovative technological, process and technical solutions.

The glycerine fraction itself is made up of glycerol emulsified with ethyl or methyl esters of higher fatty acids and, where the glycerine fraction is derived from the processing of vegetable oils, of various bioactive additives such as vitamins, phytosterides, phospholipids, *etc.*

Separating crude glycerine waste yields:

a) solid acid potassium phosphate KH_2PO_4 slightly wetted with technical glycerol,
b) a fraction containing waste ethyl ester, the so-called energy fraction, with about 55-60% free fatty acids dissolved in it, which is an excellent diesel fuel that can be used for the cogeneration of electricity and heat,
c) crude technical bio-glycerine (95-98%).

The invention in question refers to the agricultural use of a valuable KP-type (Potassium-Phosphorous) component for plants, *i.e.* acid potassium phosphate KH_2PO_4.

In addition, various substances containing microelements are added to the product thus created. This type of fertilisers have already been manufactured by a company from Morawica near Kielce, under the name KOMPLEKSOR®, and they are considered to be the first "intelligent fertilisers" releasing particular elements into the soil in quantities compliant with the needs of the fertilised plant.

Method for the drainage of absorbable objects with simultaneous antimicrobiological effects and the device for the execution of this method

Patent No. 413565

Inventors: Andrzej Vogt, Stanisław Strzelecki, Sławomir Szafert

We all know that paper or non-durable materials (fibres, leather, *etc.*), including valuable documents, deteriorate slowly. Paper turns yellow, letters fade and text becomes unreadable over time. Fibres slowly weaken and disintegrate. In museums and archives the most important exhibits are protected but there are unforeseen circumstances when, for example, as a result of flooding, documents or valuable book collections are flooded and begin to deteriorate rapidly. In such cases, it is necessary to act quickly and effectively. The Faculty of Chemistry has developed a fast and effective method of:

- drainage,
- drying,
- disinfection,
- protection against the influence of micro-organisms,

of the objects made of paper, cardboard and other absorbent substances such as leather, textiles, wood, *etc.*, that have been flooded with water or other aqueous solutions and destroyed by microbiological pathogens (fungi including mould, bacteria).

The idea of the invention and technology was conceived and implemented during the flood of 1997 when it became necessary to rescue the flooded, silted and infected stock (several thousand volumes) of the University Library of the University of Wrocław. As a result, virtually all flooded and affected volumes not only were rescued but – in cooperation with bookbinders – they also regained new life.

The extraordinary effectiveness of this method was also demonstrated during the process of rescuing documents and evidence objects from three district prosecutor's offices in Wrocław.

Conjugate of a mutant variant of fibroblastic growth factor FGF1 and its applications

Patent No. 227502

Inventors: Anna Szlachcic,
Katarzyna Pala,
Małgorzata Zakrzewska,
Piotr Jakimowicz, Jacek Otlewski

Cytostatic agents are a group of drugs used in cancer treatment. Unfortunately, many of them are highly cytotoxic and cannot be used alone due to their harmful systemic effects and the fact that they cause a wide range of side effects. The latest cancer treatments are based mostly on targeted therapies, which use specific proteins on the surface of cancer cells that are absent (or present in significantly smaller numbers) in healthy cells. Their use enables a more selective and effective distribution of the drug to the affected area. However, this is not an ideal system; antibodies are relatively large, making their modification difficult. Moreover, they often show affinity to more than one molecular target, thus reducing the specificity of therapy. In the Department of Protein Engineering at the Faculty of Biotechnology, under the leadership of professor Jacek Otlewski, an alternative method of drug delivery to tumour cells has been developed. It uses a conjugate of a mutated variant of fibroblastic growth factor FGF1. Increased expression of fibroblastic growth factor receptors has been observed in many cancers, including breast, prostate, bladder as well as lung cancer. The use of specific ligands for FGF receptors creates an opportunity to develop diagnostic or therapeutic methods in these tumours. Growth factors are highly selective and, in addition, are smaller in size than antibodies, which means that they may have greater potential as targeting molecules than immunoglobulins.

Use of the composition of 3-bromopyruvate as a second application of a medicament for the treatment of fungal infections

Patent No. 219802

Inventors: Mariusz Dyląg, Paweł Lis,
Young H. Ko, Peter L. Pedersen,
Andre Goffeau, Stanisław Ułaszewki

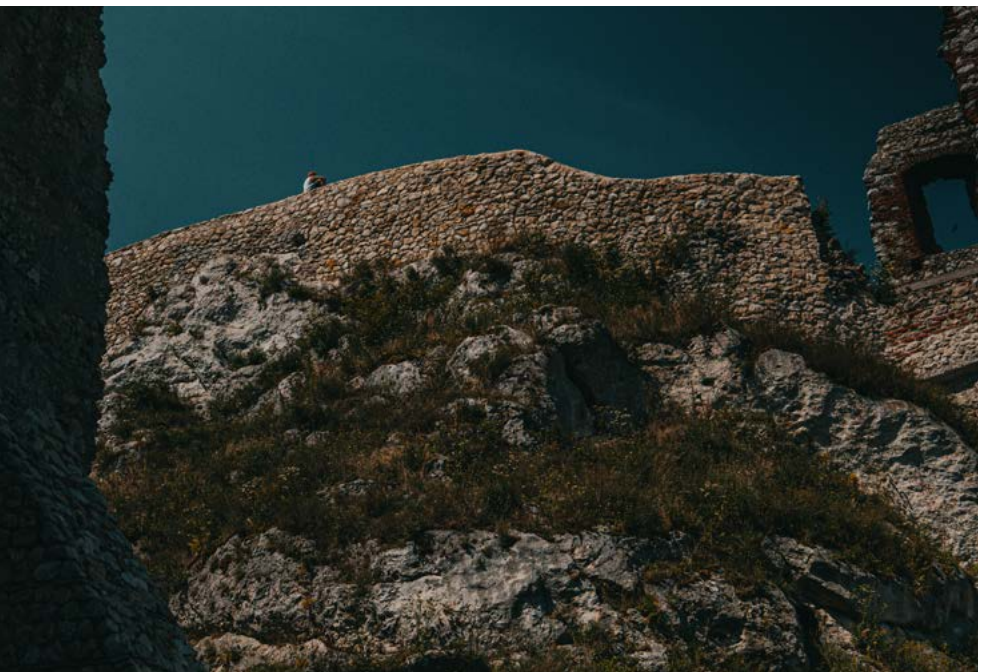
According to the statistical data published by WHO, 19,292,789 cases of cancer were diagnosed only in 2020, of which less than 10 million were fatal. In turn, cryptococcosis, which has been in the area of our interest since 2013, is diagnosed annually in approximately 1 million patients, among whom 600,000 deaths are found each year. Many currently available drugs are ineffective in the eradication of both disease entities or are associated with significant toxicity. For this reason, finding new solutions both in the treatment of cancer and cryptococcosis is becoming an urgent problem. 3-bromopyruvate (3BP) as an analogue of a key cellular metabolite may be an alternative solution both in the treatment of cancer and cryptococcosis. The first research on this compound was initiated at Johns Hopkins University in Baltimore (MA, USA) by professor P.L. Pedersen and dr YH. Ko, who were the originators and pioneers of 3BP research. Further studies on the molecular level, conducted in close cooperation with a team led by professor S. Ułaszewski, including dr M. Dyląg and dr P. Lis from the University of Wrocław, have shown that this compound particularly easily enters cancer cells as well as the cells of pathogenic fungi of the genus *Cryptococcus*. This is mainly due to the presence of specific proteins transporting carboxylic acids and their derivatives through the cell membrane, thanks to which this compound reaches high and therapeutically effective intracellular concentrations. This compound, even in concentrations many times lower than those in which it causes a complete inhibition of cell growth and proliferation, leads to a drastic decrease in intracellular ATP concentration and, consequently, effectively disturbs the cell's energy management. As we have shown in our research, 3BP differentiated activity against cells of various fungal species as well as mammalian healthy and cancer cells results in differences on the level of the intracellular accumulation and uptake of this compound into the cell. The lack of cytotoxic and mutagenic activity of 3BP demonstrated in the studies on mammalian cell lines became the basis for proposing pharmaceutical compositions of this compound effective *in vitro* in the eradication of tumours (patent no.: US 10,500,175 B2) and cryptococcosis (patent no.: PAT. 219802).

Method of assessing the threat and predicting gas and rock outbursts in geological space

Patent No. 235596

Inventors: Mariusz Jędrysek

Working in a mine involves a number of risks to the miner's health and life. Operating heavy machinery and equipment, lack of light, high dust levels and excessive noise are just some of the dangers faced by miners. Particularly dangerous are the natural phenomena related to the movement of rock mass such as the collapse of rock or gas and rock outbursts. In order to minimise the risk of accidents in a mine, professor Mariusz Jędrysek from the Faculty of Earth Sciences and Environmental Management has developed a method of risk assessment and prediction of gas and rock outbursts in geological space. First, for a given space, the geochemical-isotopic composition of a gas mixture is measured. Then, the ratio of the content of the heavier isotope to the content of the lighter isotope of the studied element in gases released in the space is determined. Even a small leak and the migration of gases with different isotopic characteristics along the fracture zones and the discontinuities formed cause a measurable isotopic effect and changes in gas concentrations. This means that underground work crews can be warned with a high degree of probability that they are approaching rock zones with extremely high gas saturations that could lead to a catastrophic outburst of gases, rock and dust. If the defined limit values are exceeded, an alarm signal is triggered so that the miners have time to leave their workplaces. Further observations of changes occurring in geochemical and isotopic parameters are the basis for making decisions on the resumption of mining work.



Oral formulations intended to be released in the colon, containing N-substituted benzisoselenazol-3(2H)-one

Patent No. 234646

Assignee: Wrocław University of Science and Technology

Inventors: Anna Jaromin, Magdalena Piętka-Ottlik

One of the most convenient and effective methods of drug consumption is through oral administration. Unfortunately, most of the currently available and newly synthesised compounds exhibiting biological activities are characterised by poor or very poor solubility in the aquatic environment. A direct consequence of this fact is, therefore, their low bioavailability. Some drugs also require delivery to a specific section of the gastrointestinal tract. Therefore, modern medicine seeks to improve clinical efficacy by developing suitable carrier systems. One of the most interesting examples of such carriers is self-emulsifying drug delivery systems (SEDDS), which are one of the research areas of dr Anna Jaromin from the Department of Lipids and Liposomes. These are mixtures of, for example, natural or synthetic oils and surfactants. They are used, among other things, to create transport systems for drugs in order to improve their absorption after oral administration. The developed solid carrier for one of the organ selenium compounds is dedicated to oral administration and release in the colon. Thanks to this solution, the encapsulated compound can reach the target and be absorbed much better.

Modern phosphors – light sources of the future

Patent No. 216169
Inventors: Eugeniusz Zych,
Anna Dobrowolska

Patent No. 220075
Inventors: Jerzy Sokolnicki,
Eugeniusz Zych

Patent No. 220185
Inventors: Jerzy Sokolnicki,
Eugeniusz Zych

LED lamps shining continuously for 100,000 hours, glowing paint on pedestrian crossings or bicycle paths, glowing road signs – these are the light sources available today with the help of phosphors. Phosphors are chemical compounds that emit light upon proper stimulation. In the Luminescent Materials Team at the Faculty of Chemistry, led by professor Eugeniusz Zych, these compounds have been studied and improved for years. The result of these developments are modern luminophores, which are used, among other things, in LED lamps and are characterised by a wide range of light emissions. The use of luminophores is an energy-efficient, economical and environmentally friendly solution. Lamps using luminophores are also user-friendly, providing the full spectrum of sunlight, which significantly reduces eyestrain and ill-health. LED lamps are considered to be the lighting materials of the future, replacing tungsten and energy-saving incandescent and fluorescent lamps. This is due to the fact that they are much more energy-efficient, do not contain toxic mercury and have a longer lifetime. The work of the Luminescent Materials Team has resulted in numerous patents and scientific publications covering research on modern phosphors.

Use of chiral ionic liquids containing (1R,2S,5R)-(-)-menthol derivative

Patent No. 232404

Assignee: Wrocław University of Science and Technology

Inventors: Anna Krasowska, Jakub Suchodolski, Joanna Feder-Kubis

Fungal infections have become an increasingly common clinical problem in recent years, especially among people with immune deficiencies. The use of the same drug groups repeatedly leads to high drug resistance in fungi, which consequently makes the treatment of mycoses more difficult. The most common etiological agent of fungal infections is the *Candida* species, especially *Candida albicans*. *C. albicans* is a natural microflora of the human body as it has great living conditions in humans, including appropriate humidity, temperature and an abundance of food. The problem is that there is increasing resistance of *C. albicans* to previously used antifungal drugs, which makes most therapies ineffective. This leads to a search for new, alternative antifungal drugs that would reduce the need for antibiotics that destroy good bacterial flora. In collaboration with Wrocław University of Science and Technology, the Department of Biotransformation has developed a new application of chiral ionic liquids containing menthol derivatives to produce an agent for the treatment or prevention of fungal infections caused by *Candida albicans*. It was found that after the application of the developed ionic liquids, the process of the morphological transformation of fungi to the virulent form was inhibited in 100% of cases, which confirms the effectiveness of the applied method.

Method of producing water-dispersible quantum dots

Patent No. 233884

Inventors: Jakub Cichos,
Mirosław Karbowiak

In recent years, the near-infrared (NIR) fluorescence imaging technique has developed into a method that allows in vitro/in vivo imaging of biological structures. Biological tissues are most transparent in the 700-900 nm range. However, it has recently been shown that when using quantum dots (QDs) for in vivo imaging, an even more favourable range is the spectral range from 1000 to 1400 nm. This is due to that range having reduced photon scattering, deeper tissue penetration and significantly improved signal-to-noise ratio. PbS quantum dots belong to the group of fluorophores showing the most promising properties as emitters in this range. A significant factor limiting the use of quantum dots, including PbS, in life sciences, however, is that the most efficient synthesis methods lead to QDs with surfaces stabilised by hydrophobic ligands. Such QDs are not dispersible in water. Therefore, for biological applications, it is necessary to obtain a hydrophilic surface of QDs while introducing reactive functional groups, which can then be used to conjugate QDs with various molecules to give them bio-functionality. Professor Mirosław Karbowiak and dr Jakub Cichos from the Department of Inorganic Chemistry have developed a method to produce water-dispersible quantum dots of a core/shell type, stabilised by a layer of hydrophilic surface ligand. Here, the core consists of PbS nanocrystals, the shell of CdS layer and dithiocarbamate surface ligands while maintaining photoluminescence.

Method of transforming polyhedric oligomeric silsesquioxane (POSS) of T8 type into T10 type compounds

Patent No. 413463

Inventors: Sławomir Szafert,
Mateusz Przemysław Janeta, Łukasz John

Compounds containing silicon atoms are among the most widespread in our environment. Probably every one of us played in a sandpit as a child but far fewer of us know what sand is, chemically speaking. Naturally, it is a complex mixture of various compounds but the dominant one is silica, which is an important raw material in many processes. Silicon compounds are also used in more advanced technologies. Silicon itself forms the basis of microelectronics but pure and properly prepared silica is used, for example, for the precise separation of chemical substances produced in the pharmaceutical industry. Thanks to them, we can obtain many medicinal substances in a very pure form, which is necessary for them to fulfil their function and not to exhibit side effects. There are many interesting and commercially important silicon compounds. Much attention has recently been given to those with a precisely defined cage structure.

The compounds presented here are the so-called Polyhedral Oligomeric Silsesquioxanes (POSS) described by the general formula $(RSiO_{1,5})_n$ where the symbol R stands for a hydrogen atom or other functional group that gives the compound certain properties. Such properties can be designed quite precisely and the resulting compound can then be used, for example, in chemical or even medical analysis.

At the Faculty of Chemistry in the group of Organometallic Chemistry and Functional Materials, scientists are engaged in preparing the above-described compounds and investigating the transformations they undergo under the influence of various factors. Among others, they have developed a very effective method for converting T8-type polyhedral oligomeric silsesquioxanes (POSS) into T10-type compounds using an acidic catalyst. This method has been patented in Poland and the USA, one of the largest (if not the largest) producers of organosilicon compounds.

Liposome statin preparation, guided by means of antibodies and its application

Patent No. 236106

Inventors: Lucyna Matusewicz,
Aleksander Franciszek Sikorski

Mammary gland cancer ranks first in terms of new cancer cases detected and second in terms of deaths in women. The statistics for prostate cancer are no better: among men, prostate cancer ranks first in terms of new cases detected and third in terms of deaths. A high cholesterol diet is increasingly identified as one of the factors predisposing to the development of both these diseases and numerous genetic and environmental determinants. Therefore, statins have been considered a promising anti-cancer drug since the 1990s. The reduction of the cholesterol pool as a result of the use of statins represents a significant hindrance to intensely proliferating cells such as cancer cells, for which it is an important component of cell membranes. However, orally administered statins are largely eliminated in the liver, which significantly reduces their bioavailability and the possibility of intravenous administration is limited. Another obstacle to using statins in cancer therapy is that these drugs show anti-cancer activity at very high doses, which causes numerous side effects such as liver damage or muscle weakness. The solution to the problems presented above is an antibody-guided liposome preparation of statins developed by professor Aleksander Sikorski and dr Lucyna Matusewicz. The use of a guided liposome form of statins allows them to be delivered directly to cancer-affected cells, thus not only solving the problem of bioavailability but, above all, limiting the side effects caused by exposing the entire body to high doses of statins required in cancer treatment. This preparation makes it possible to carry large doses of statin drugs through a relatively small number of lipid carriers and protect them from premature metabolism in the liver. It is possible to encapsulate different statins in liposomes and attach different molecules to the liposome capsule, which ensures its versatility.

Virtual Researcher's Workroom at the University of Wrocław

It is hard to imagine an Internet user who in the 21st century will be satisfied with a digital copy of scientific publications, cultural heritage objects and source materials (manuscripts, archives, museum collections, library resources) in the form of an image. Readers today expect much more – they not only want to read a digital version of a publication in a graphic form but also to search a document (by phrase or expression) with just one word. However, before addressing readers' expectations, we first want to take care of the scientists, the authors of scientific publications. After all, it is from them that the whole creative process begins.

First of all, we want the researchers from the University of Wrocław to be able to convert the digital image of a scientific publication (a scan) into a digital text and then to publish it, thereby increasing its visibility on the Internet and, consequently, its citation rate. This is why the University of Wrocław is working on the Virtual Transcription Laboratory, integrated with the Aggregator of Academic Works (ADN) and the Repository of the University of Wrocław. These three interconnected digital services will create a Virtual Researcher's Workroom. Researchers will be able to prepare digital publications for online presentation and teach using source materials such as archives, manuscripts, old prints, *etc.*, as well as publish their work and make it available to readers in Poland and abroad.

Faculty of Biological Sciences

About the faculty

The prospective areas of the activity of the faculty include research and teaching. Producing work of the highest quality highest quality is the goal of both the authorities and the entire community of the faculty. All the aforementioned currents correspond in their level to world trends so that researchers, doctoral students and students may be considered equal members of the universal scientific and university community. The concern for the internationalisation of research and education is accompanied by a closer relationship with Wrocław, the region, and the country, for which the faculty is an open and inspiring centre of scientific and intellectual life. This aspect of our activity is part of the programme to build an enlightened, civic state and a knowledge-based society.

The scientists conduct research in the field of human biology, biogeochemistry, environmental biology, conservation biology, ecology, genetics, immunology, microbiology, parasitology, developmental biology, botany, mycology, zoology, paleozoology and neurobiology and physiology.

The faculty is characterised particularly by renowned and age-diversified academic staff, a wide range of scientific disciplines enabling interdisciplinary research, high quality of research and education, unique units belonging to the faculty (Natural History Museum, Museum of Man, Botanical Garden, Ecological Station in Karpacz, Ornithological Station in Ruda Milicka), good relations with external stakeholders as well as a broad educational offer. The employees conduct interdisciplinary teaching in fields of study such as biology, human biology, genetics and experimental biology, microbiology and management of the natural environment.

Organisational structure

Department of Animal Developmental Biology
Department of Behavioural Ecology
Department of Biodiversity and Evolutionary Taxonomy
Department of Botany
Department of Ecology, Biogeochemistry and Environmental Protection
Department of Evolutionary Biology and Conservation of Vertebrates
Department of Genetics and Cellular Physiology
Department of Human Biology
Department of Invertebrate Biology, Evolution and Conservation
Department of Microbial Ecology and Acaroentomology
Department of Microbiology
Department of Mycology and Genetics
Department of Paleozoology
Department of Parasitology
Department of Pathogen Biology and Immunology
Department of Physicochemistry of Microorganisms
Department of Plant Developmental Biology
Department of Plant Molecular Physiology
Department of Molecular Physiology and Neurobiology
Laboratory of Forest Biology

The Botanical Garden of the University of Wrocław was founded in 1811 on a post-fortification area of the so-called Springstern, at the foot of the Gothic churches of Ostrów Tumski. It was donated to the university by Frederick William III, King of Prussia. It is among the leading botanical gardens in Europe in terms of the number of plant collections and the way they are exhibited. In an area of about 7.5 hectares, including 1870 square metres under glass, about 12 thousand plant species and varieties from all over the world have been gathered.

Faculty of Biotechnology

About the faculty

The Faculty of Biotechnology is the dynamically developing, youngest faculty (established in 2006) at the University of Wrocław. Within 15 research groups – 12 departments and 2 laboratories, 78 researchers conduct research in the field of medical and industrial biotechnology, cell biology, biomedicine, biochemistry, bioinformatics, microbiology and immunology, currently carrying out nearly 70 research projects (financed from NCNN, NCBiR, FNP and EU funds). In successive evaluations, continuously since 2013, we have obtained the prestigious scientific category A+. In 2014-2018 we were the leader of the consortium "Wrocław Biotechnology Centre", which received the status of KNOW (National Scientific Leading Centre). Within the Faculty of Biotechnology, there is the Editorial Board of the international scientific journal *Cellular and Molecular Biology Letters* (*CMBL*), which has the highest Impact Factor among all scientific journals published in Poland. In the ranking of the educational portal "Perspektywy" in 2021, the faculty was ranked third among biotechnology faculties in Poland, just behind Warsaw University and Jagiellonian University.

Studies at the Faculty of Biotechnology are conducted in Polish and English. Our students can participate in innovative research projects carried out at the faculty and laboratory classes conducted in small groups from the first semester of studies. We have new infrastructure and well and modernly equipped didactic laboratories. Students have the opportunity to go to foreign research units as part of exchange programmes. Professional internships for our students are organised in biotechnological companies, which guarantee very good preparation for work in research, clinical and industrial laboratories. Our educational offer also includes a series of lectures and experimental classes for junior high and high school students. The tradition of the faculty is to organise lectures and classes as part of the Lower Silesian Science Festival.

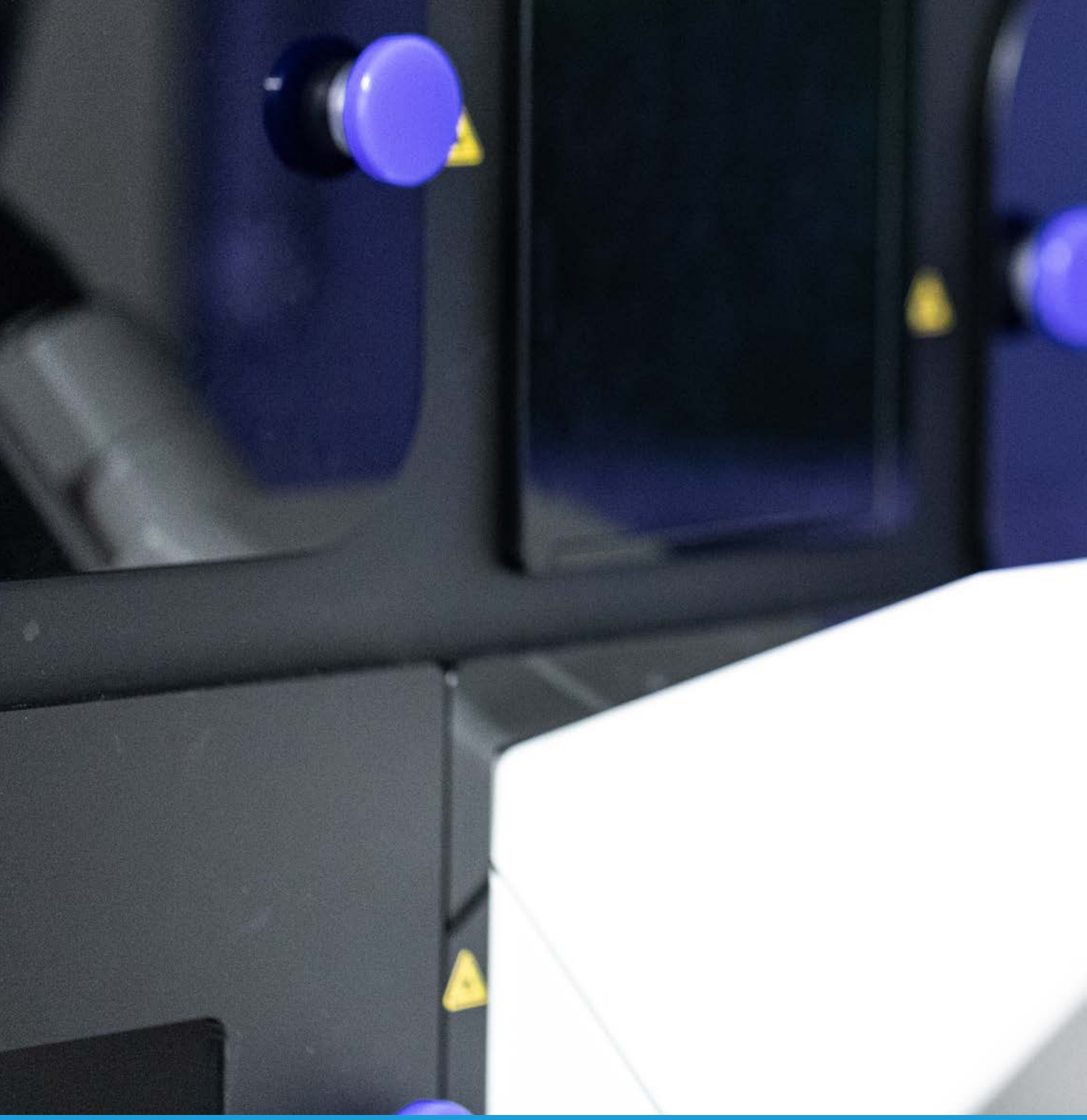
The Faculty of Biotechnology is the smallest faculty at the university; however, it is the most successful unit at the University of Wrocław in terms of receiving research grants. The faculty employees conduct basic and applied research, also in cooperation with industrial partners, in the field of biotechnology, biochemistry, bioinformatics, microbiology, immunology, virology, cell biology and plant physiology. A lot of effort is put into medicine-related research. To name a few, the faculty's scientists study fibroblast growth fac-

tors and their receptors to establish new anti-cancer therapies, develop innovative drug carriers, study gum diseases and rare genetic disorders, *e.g.* muscular dystrophies. Some of our researchers search for new antibiotics and new antibiotic targets. Among the applied research projects are those aiming at improving crop plants, *e.g.* flax and potatoes leading to the development of novel biocomposites and materials for dressings effective in treating slow healing wounds. They are also interested in biofuels, biosurfactants and food oriented biorefineries as well as in cellular organelles, *e.g.* plastids and mitochondria, particularly their evolution. Within the basic research areas, the researchers investigate protein structure and function, chromosome organisation and regulation of gene expression and other key cellular processes like glycosylation or photosynthesis.

Generally speaking, the employees conduct interdisciplinary research in the field of biotechnology, biochemistry, bioinformatics, microbiology, immunology, virology, cell biology, genetics or plants physiology. They cooperate with a wide range of scientific centres and companies in Poland and abroad.

Organisational structure

Department of Biochemistry
Department of Genetic Biochemistry
Department of Biophysics
Department of Bioinformatics and Genomics
Department of Cell Molecular Biology
Department of Protein Biotechnology
Department of Biotransformation
Department of Biological Chemistry
Department of Cytobiochemistry
Department of Protein Engineering
Department of Lipids and Liposomes
Department of Molecular Microbiology
Department of Cell Pathology



Researchers from the Faculty of Biotechnology of the University of Wrocław use the only microscope in Poland worth PLN 6.5 million. There are only 160 such microscopes in the entire world. The microscope, or rather the whole system of high-resolution microscopy, was manufactured by Zeiss and Leica. It was purchased from the competition funds designated for Research Universities – a group of the ten best Polish universities. Physicists, chemists and biologists will use it.

To be able to examine microscopic slides using the device, a laser beam is emitted, which is then detected by special detectors. Usually, in "ordinary" microscopes, sunlight or artificial lamp lighting is used to illuminate the slides. The microscope also has an incubator-like module. Thanks to it, it is possible to observe living cells, which is of great importance for biologists' research. In addition, the microscope is so precise that it can be used to look at individual molecules of human hair.

The Faculty of Biotechnology is very strongly research-oriented. It employs 76 university teachers and conducts 70 research projects. In order to be awarded more research grants, the Faculty has to be ahead of others; the distinguished A+ scientific category is not enough. In order to compete with biotechnological competition from all over the world, high-quality, advanced equipment is required. That is why the decision was made to purchase a microscope.

The specialists from Zeiss and Leica have conducted a series of training sessions on the equipment they developed at the request of the University of Wrocław. To help the scientists use the equipment, the Faculty has also hired a microscope operator. The equipment is already being used to study the structures of new potential drugs. The scientists are also observing the cellular localisation of individual molecules, using the module that demonstrates the lifespan of fluorescence.

Faculty of Chemistry

About the faculty

According to the mission statement of the Faculty of Chemistry, one of the most important goals "is to strive for excellence in both research and teaching. Student education is based on the results of contemporary scientific research and enables students to use the best research tools. Our mission is to provide the students of all degrees the opportunity to acquire expert knowledge in chemistry and to develop critical, independent thinking skills". Therefore, specialisation classes have been developed, considering the research topics carried out at the faculty, which guarantees a high scientific level of classes and a strong connection with scientific research.

During the development and periodic verification of the programmes, the opinions and suggestions of the representatives of the socio-economic environment cooperating with the faculty were taken into account. This translates into the employment of the graduates of the Faculty of Chemistry by local companies and enterprises in the broadly defined chemical industry. The study programme includes English-language classes and modules of classes in English. In addition, the students have the opportunity to attend lectures delivered by guest lecturers from abroad. All these activities help prepare the students to take part in studies in foreign centres within the framework of international exchange programmes and open up the possibility for the graduates to take up professional work abroad. The education programme also includes the possibility for the students to participate in specialised courses organised by external companies. Thus, it is possible to achieve additional competences important for future professional work.

Organisational structure

Department of Applied Computer Science in Chemistry
Department of Analytical Chemistry
Department of Biological and Medical Chemistry
Department of Chemical Technology
Department of Chemistry Didactics
Department of Chemistry Fundamentals
Department of Crystallography
Department of Inorganic Chemistry
Department of Instrumental Analysis
Department of Organic Chemistry
Department of Physical Chemistry
Department of Theoretical Chemistry

In front of the buildings of the Faculty of Chemistry of the Universityof Wrocław, on the side of the Odra River, there is a sculpture entitled “Atom” made of concrete. It was unveiled in 1975 and its artist is Roman Pawelski, a graduate of the State Higher School of Fine Arts in Wrocław, later a professor at the Faculty of Architecture of the Wrocław University of Science and Technology.

Faculty of Earth Sciences and Environmental Management

About the faculty

Although the Faculty of Earth Sciences and Environmental Management started its operations on 1 September 2006, it originates from the Faculty of Natural Sciences of the University of Wrocław. As a result, the developing natural sciences – biology, biochemistry and biotechnology, geography and geology – became independent and formed separate faculties.

The strength of the faculty lies in the high level of its academic staff, thanks to whom the graduates are successful at home and abroad. Teaching is linked to research practice through close cooperation with global scientific and research institutions. The study programmes have been adapted to the requirements of the labour market. They are designed to provide a complete education, enabling the students to gain a profession while – at the same time – providing them with the opportunity to develop their individual interests. The main aim of education is to equip the students with knowledge, skills and social competences.

Organisational structure

Institute of Geography and Regional Development
Institute of Geological Sciences

University of Wrocław

Faculty of Earth Sciences and Environmental Management

photo: Magdalena Marcula

photo: Barbara Schutty

photo: Marek Kasprzak

The Mineralogical Cabinet was established in 1811. The initial collection was an incomplete collection of minerals from the State Mining Authority in Wrocław. In 1815 an excellent collection was purchased from the collector, Mender of Freiberg. Over the following years, the collection expanded with collections of minerals, rocks and fossils, mainly from Lower Silesia. At the end of World War II, in order to protect the collections, they were taken from Wrocław and deposited in churches in Strzegom and Świerzawa. Currently, the collections of the Mineralogical Museum include about 30,000 specimens of minerals from around the world. Their basis is the collection collected before 1945. The post-war years brought about supplementing and enriching the collection with new specimens, collected mainly from the territory of Poland.

Faculty of Historical and Pedagogical Sciences

About the faculty

The Faculty is a unit that unites institutes and chairs conducting research and teaching activity in the field of historical, cultural and psychological foundations of society functioning and the ways of shaping its members' worldview through education. What has always been in the centre of interest of the Faculty's researchers and students has been human beings as individuals and members of society. Hence, an open, modern anthropological and humanistic view of the surrounding world is a value that the Faculty has a duty to promote within the university and in society

The faculty's mission is to support the rational search for the truth about the human past and the psychological and cultural conditions of its activity, development and education as well as to participate in shaping culture to support sustainable social development. The basic values implemented in the course of research and education are freedom of research, teaching and expression of opinions, not restricted by political or religious considerations. In order to pursue these values, the faculty supports research of the highest quality, individual and collaborative, interdisciplinary and international, provides research and teaching staff of the highest quality, ensuring appropriate conditions for their development, conducts education through close contact between students and top-class researchers, emphasising the importance of the unity of science and education, actively engages in the social and cultural life of the regional, national and world community.

Organisational structure

Institute of Archaeology
Institute of Art History
Institute of Cultural Studies
Institute of History
Institute of Musicology
Institute of Pedagogy
Institute of Psychology
Chair of Ethnology and Cultural Anthropology


48

The Museum of the University of Wrocław has in its collections: scientific instruments (15th-20th centuries), sculptures (18th-19th centuries), furniture (18th-20th centuries), arts and crafts (18th-20th centuries), paintings (18th-20th centuries), graphics (19th-20th century), photography (19th-20th century) and leaflets related to the history of the university - from the 18th century to the present day. The most valuable museum objects include the scepters of the rector and of the theological faculty, which are made of repoussed silver, partially gilded, and decorated with rock crystal and turquoise by Wrocław goldsmiths E. Grische and Ch. Plackwitz in 1702.

Oratorium Marianum, founded in 1731, designed by Johannes Petner, is one of the representative interiors in the main building of the University of Wrocław. Oratorium Marianum served primarily as a concert hall. They performed here, among others Brahms, Liszt, Paganini and Wieniawski. The oratory is decorated with frescoes depicting scenes from the life of Mary painted by Jan Krzysztof Handke in the first half of the 18th century and recreated in 2014 by the Dresden painter and portraitist Christoph Wetlz.

Faculty of Law, Administration and Economics

About the faculty

The Faculty of Law, Administration and Economics at the University of Wrocław is one of the oldest and best faculties of this kind in Poland. Its history and tradition draw on the achievements of the universities of Jan Kazimierz in Lviv and Stefan Batory in Vilnius.

The excellent teaching conditions and opportunities have resulted in the faculty remaining at the top of national rankings for years. The faculty's prestigious, highest Category A+ confirms the high level of its scientific and research activity, which has been maintained for years.

The faculty is a leader in Poland, among other faculties, in terms of the number of scientific articles published annually in journals from the JCR Journal Citation Reports list, the so-called Philadelphia list. In addition, publications by faculty members are essential in terms of the internationalisation of research results. More than a dozen scientific journals are published here. All are available online free of charge.

Extensive national and international cooperation is evidenced by the fact that the Faculty of Law, Administration and Economics has signed over 100 agreements with other law faculties in Poland and abroad. In addition to long-standing agreements with foreign universities, including Cambridge, Groningen, Bari, Sofia, Moscow, Lviv, Buenos Aires, Chicago, St. Petersburg, Prague, Grodno and Cologne, the faculty has signed nearly 100 agreements with law faculties at partner universities.

The faculty employs over 200 distinguished research and teaching staff, including a significant number of professors. Many of them hold prominent positions in the legislative, executive and judicial branches and run their law firms.

The reputation of our faculty is also confirmed by the fact that every year the employees of the Faculty of Law, Administration and Economics obtain many research grants, both domestic and international.

Several thousand students study here and every year many high school graduates from Poland, Europe and all over the world declare their desire to study here. Consequently, the didactic offer is dynamically adapted to the requirements of the labour market and new, attractive and unique specialisations are launched.

The high level of the faculty is also confirmed by the podium places occupied for 10 years in prestigious rankings of law faculties in Poland, organised by renowned newspapers and magazines. The scientific potential, staff and quality of education are particularly appreciated. Moreover, the University Legal Clinic at the University of Wrocław carries out essential activities, e.g. the students of the Clinic under the supervision of the academic staff provide professional legal advice to those interested.

Faculty members do not confine themselves within the walls of the university. They continuously cooperate with schools, high schools, vocational training centres and cultural institutions. They popularise knowledge among others during the Open Doors and Lower Silesian Science Festival.

Organisational structure

Institute of Administrative Sciences
Institute of Economics
Institute of Civil Law
Institute of State and Law History
Chair of Constitutional Law
Chair of Criminal Proceedings
Chair of Criminal Punishment Law
Chair of Criminology and Criminal Economic Law
Chair of Financial Law
Chair of Forensic Sciences
Chair of International and European Law
Chair of Law Theory and Philosophy
Chair of Petty Offences And Fiscal Criminal Law
Chair of Substantive Criminal Law
Centre for the Research of Electronic Communication Legal and Economic Issues

Olga Tokarczuk Ex-Centre

Winner of the Nobel Prize at the University of Wrocław. Olga Tokarczuk Ex-Centre. The Centre for Academic Research.

Olga Tokarczuk, the winner of the 2018 Nobel Prize in Literature, is on board the University of Wrocław.

On 2 July 2021, an agreement was signed between the University of Wrocław and Olga Tokarczuk Foundation, under which the Centre for Academic Research was established at the Faculty of Letters. Olga Tokarczuk Ex-Centre is a new research centre that will organise seminars, conferences and publishing activities. During the press briefing, Olga Tokarczuk stated: "My task is to look for non-obvious points of view, to stick my head out of the familiar horizon. I hope that the Ex-Centre at the University of Wrocław will allow us to stick our heads out of the sphere of fixed views and will be ex-centric in its nature and it will address topics we haven't dreamt of so far".

Cooperation between the Foundation and the University may be crucial for Polish humanities. Olga Tokarczuk Ex-Centre will bring together students and lecturers - not only those who wish to conduct research into gender equality, animal rights and the socio-cultural causality of literature but also those who wish to focus on as of yet undiscovered, ex-centric fields; fields that require a non-conventional perspective.

Olga Tokarczuk Ex-Centre. The Centre for Academic Research pursues its goals through, among other things, individual tutoring by the Nobel Prize winner herself, conferences, research programmes, seminars, publishing and critical translation projects as well as series of masterclasses given by guests and residents of the Foundation.

Academic Research Centre Olga Tokarczuk Ex-Centre at the University of Wrocław will be looking for non-obvious points of view and will be eccentric by its nature, tackling the subjects we have never dreamed of.

Faculty of Letters

About the faculty

The Faculty of Letters is the largest and most diverse faculty of the University of Wrocław. It employs almost half a thousand scholars specialising in various disciplines of the humanities (linguistics and literary studies) and social sciences (social communication and media studies) and working in twenty different languages of their specialisation (from English and Spanish to Yiddish and Sanskrit).

Among the most active units of the faculty are The Cognitive Research Center for Language and Communication, The Centre for Interdisciplinary Studies of Relations between Oral and Written Tradition, The Research Center for Postcolonial and Posttotalitarian Studies and The Centre for Research on Children's and Young Adult Literature, whose scholars in recent years alone have published many books in prestigious foreign publishing houses (*e.g.* Justyna Deszcz-Tryhubczak, Irena Barbara Kalla (eds.), *Rulers of Literary Playgrounds: Politics of Intergenerational Play in Children's Literature, Routledge*, New York, 2021) and prestigious academic journals (special issue of *History of Education and Children's Literature*, volume 15, number 2, 2020). Within the faculty, it has also been active for a short time Olga Tokarczuk Ex-Centre. The Centre for Academic Research, whose main objective will be supporting research on topics present in the works of our Nobel Prize Winner.

Organisational structure

Institute of Classical, Mediterranean and Oriental Studies
Institute of English Studies
Institute of German Studies
Institute of Information and Library Science
Institute of Journalism and Social Communication
Institute of Polish Studies
Institute of Roman Studies
Institute of Slavic Studies
Chair of Jewish Studies
Erasmus Chair of Dutch Studies


THE
FIFTIETH
GATE
LIKUTEY
TEHILOT


ROMANISTYKA

On the wall of the building of the Mathematical Institute of the University of Wrocław there is a ceramic mosaic called ”Mathematics in the pool”. The mosaic was created in 1971. The artist is a resident of Wrocław born in 1931 in Bydgoszcz, a well-known painter and sculptor - Anna Szpakowska-Kujawska, a graduate of the Wrocław State Higher School of Fine Arts. She also created mosaics on the building of the University of Life Sciences at pl. Grunwaldzki and a well-known plafond in the Provincial Library in the Market Square.

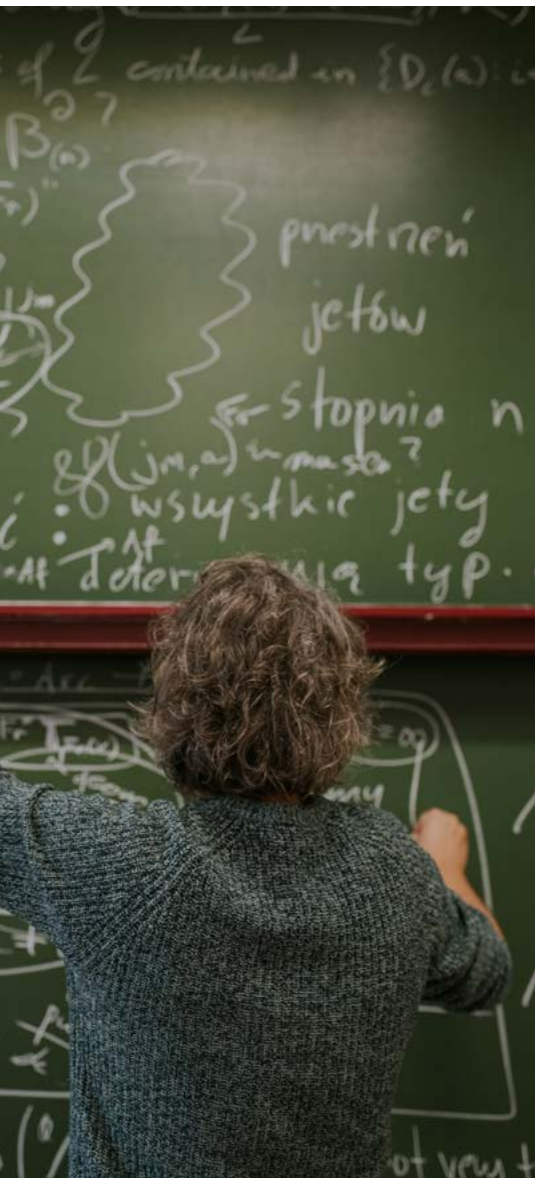
Faculty of Mathematics and Computer Science

About the faculty

Although the faculty was established in 1996, it can be traced back as far as to the very beginning of the university in 1702. Today, it is an interdisciplinary unit with over 120 academics, affiliated with two institutes.

The research done at the Institute of Computer Science spans from classical fields such as algorithms, logic, or database theory, to cutting-edge challenges of artificial intelligence and big data.

The study of algorithms and data structures helps to design efficient solutions to complex computational problems. Some of the current approaches include distributed, online, approximation, and randomized algorithms, which contribute to solving practical problems in networking (*e.g.*, server problems/wireless networks), resource allocation, or scheduling. An important class of problems are those arising in big data processing, such as streaming or sketching, that involve massively distributed algorithms.



Logic in computer science focuses on problems related to the design and analysis of formal inference systems, such as their expressibility or decidability. Closely related to it is the field of semantics and formal methods developed to design and study software systems. This research is driven by applications in the design and reasoning about programming languages, and in formal verification of safety-critical software and hardware.

Database research aims to solve problems related to storing and processing data, especially when the data is large, with particular emphasis on relational and graph scenarios.

Artificial intelligence, machine learning and data science deal with problems that are often impossible to solve using classical techniques. Notable examples are natural language processing, recognition and synthesis of speech, handwriting analysis or design of game playing bots.

The following topics are studied in the Institute of Mathematics from both theoretical and applied viewpoints.

Harmonic analysis deals with abstract construction of the development of functions into series and/or integrals. This sounds very theoretical, yet the approximation methods developed by harmonic analysis tools are being applied in areas such as telecommunication (cellular phones), image processing and coding. They can also potentially be used in large data analysis within biology when relevant information must be promptly extracted from a tremendous amount of data.

The study of partial differential equations theory is motivated by the following important models in physics: hydrodynamics (a description of complex fluid motions), the interaction of massive or charged particles (models in astrophysics; semiconductors and electrolytes). Other motivations stem from medicine and biology when models proposed by physicians need to be adequately formulated in mathematical language.

The theory of probability is a mathematical expression of processes in the fields of economy and insurance (stock exchange fluctuations, risk estimation, queueing theory) as well as in statistics, data analysis, biology and computer science (random walks, branching processes).

Geometry - the most ancient part of mathematics - is still alive and continues to blossom. For instance, the geometric group theory studies beautiful mathematical structures which are of essential use in computational complexity and thus are important in computer science.

The model theory, the most abstract aspect of mathematical logic, perhaps closest to philosophy, is rigorous and nice on its own but also indispensable when scientists look into computation processes.

Organisational structure

Institute of Computer Science
Institute of Mathematics

The Białków Observatory of the Institute of Astronomy of the University of Wrocław has a chance of becoming a central monitoring station of the solar radio emission in 10.7 cm and 30 cm bands for the entire European Union.

Research into the physics of the Sun and the so-called Space Weather is dynamically developing. Understanding various high-energy processes occurring on the Sun is crucial for mitigating the consequences from the disturbances of the propagation of electromagnetic waves in the atmosphere and ionosphere of the Earth. This research is also crucial in understanding the transport of energy through transmission lines as well as the most fundamental challenges, like the mechanisms of global warming, because all these phenomena are subjects to influence by the Sun. Heliophysical research, which focuses on solar physics, is of great importance not only to astronomers but it can also be applied in common life and economics.

The Consortium of the University of Wrocław and the ITTI firm in Poznań collaborate with the European Space Agency (ESA) (the European equivalent of NASA). The cooperation may result in a state-of-the-art global observing system designed for monitoring the solar radio-spectra and radio-fluxes in 10.7 cm and 30 cm bands with high time resolution. In the future, the university observatory may become the central hub of a global network of radio observatories that monitor the solar radio emission 24-hours a day. The data will be of great importance in various areas, like space weather, electronic recognition and surveillance, energetics, navigation, data transfer and many more. Currently, the University of Wrocław is building new observational facilities needed for these projects.

The cooperation between the University of Wrocław and the European Space Agency may turn out to be a big step forward in the development of technology and data analysis.

Faculty of Physics and Astronomy

About the faculty

In 1945, the Faculty of Mathematics, Physics and Chemistry was established. In 1995, it was then divided into two faculties: the Faculty of Chemistry and the Faculty of Mathematics and Physics. From the structure of the latter, the institutes of Mathematics and Computer Science were separated in 1996 to form the Faculty of Mathematics and Computer Science. After these institutes had separated, the former Faculty of Mathematics and Physics was renamed the Faculty of Physics and Astronomy.

The research conducted at the Faculty of Physics and Astronomy is organised around three subfields: astronomy, experimental physics and theoretical physics.

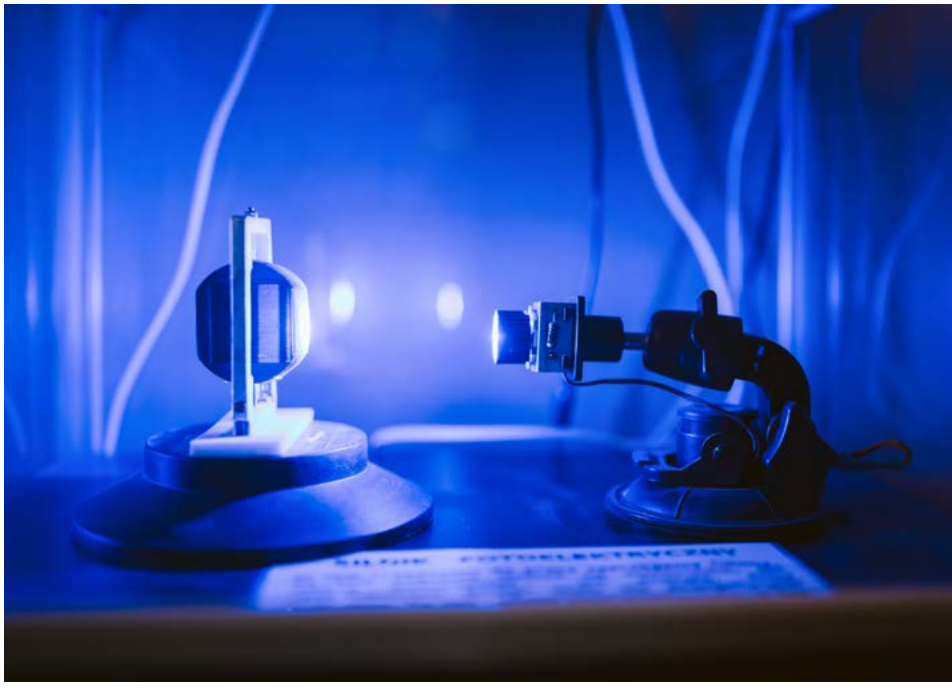
The scientific study topics at the Institute of Astronomy cover heliophysics (which concerns the Sun) and astrophysics (which concerns other stars). The research projects include: sounding interiors of stars by means of asteroseismic methods, big data analyses with the use of neuron networks and monitoring the light pollution and its influence on ecosystems in the framework of the ALPS project (All-sky Light Pollution Survey). Furthermore, the University of Wrocław has recently collaborated with the European Space Agency and this offers new opportunities for technological development in this field.

The Institute of Experimental Physics has a particular interest in experimental solid-state physics, atomic and molecular physics, nuclear physics, physics of medium and high energy and the methodology of educational physics. The recent research projects focus on understanding the behaviour of high-temperature superconductors and on the elucidation of the mechanism of high-temperature superconductivity. This includes studies on the properties of high-entropy alloys, which are new materials of unique microstructure. Other studies concern new approaches to mitigating iron corrosion, which may pave the way to a more efficient exploration of new environments or even space. Many recent projects are carried out in close cooperation with leading international laboratories, such as CERN.

The research carried out at the Institute of Theoretical Physics covers subjects ranging from atomic and nuclear physics, through physics of condensed matter, cosmology, gravitation and black holes, to the phenomenology of elementary particles and fields. Computer simulations are essential in research of this kind as they help model and predict the development of physical processes.

Organisational structure

Astronomical Institute
Institute of Experimental Physics
Institute of Theoretical Physics



The Willy Brandt Centre for German and European Studies (CSNE) is an interdepartmental and interdisciplinary institution of the University of Wrocław. It was founded in 2002 as a joint project between the University of Wrocław and the German Academic Exchange Service (DAAD). The most important goal of CSNE is to initiate, organise and popularise research on German and European issues as well as on Polish-German relations. The CSNE is part of a global network of 20 research institutes supported by the DAAD.

CSNE's activity is based on three pillars that intertwine and complement one another. These are research, teaching and public outreach. Research is focused on five thematic areas: the visions of Europe in the 19th and 20th centuries; nationalism, religions and European integration; culture, literature and memory in Polish-German relations; German history and Polish-German controversies; and Poland and Germany in a united Europe.

The Wrocław institution has received numerous national and international grants and has organised many conferences and panel discussions. In addition, it participates in an extensive network of cooperating academic and non-academic institutes.
The results of the Centre's research are published in several publication series both at home and abroad.

The importance of the Centre is proven by the fact that its employees are invited to join numerous scientific councils of foundations, museums, associations and research institutes. They are also often appointed as experts for the evaluation of research projects and for the scientific evaluation of university and non-university institutes.

Another important area of activity is public space. The Centre organises regular popular science conferences, discussions and meetings for teachers, exhibitions and book promotions. Together with the F. Ebert Foundation, it co-organises a lecture commemorating the Centre's patron, Willy Brandt once a year. As a university institution, it offers its expertise to Polish and German politicians and social activists and advises various domestic and foreign non-governmental organisations.

Since its inception, CSNE has received financial and organisational support from various institutions, including the Foundation for Polish-German Cooperation, the Deutsche Forschungsgemeinschaft, the Konrad Adenauer Foundation, the Friedrich Ebert Foundation, the Volkswagen Foundation, the Robert Bosch Foundation and the German National Foundation. They have co-financed selected lectures, conferences, publications and scholarships. This has significantly expanded the resources available to the Centre under the agreement between its two founders, UWr and DAAD.

Professor Krzysztof Ruchniewicz, Director of the CSNE, took part in an international evaluation commission whose task was to review the work, make an assessment and formulate recommendations for one of the most renowned and valued German research institutes dealing with contemporary history, the Institut für Zeitgeschichte in Munich. The Wrocław historian was the only representative from Central and Eastern Europe among the foreign members of the commission (other foreign members included professors from Dublin and Oxford). The IfZ was established in 1949 and has over 200 employees. Its annual budget amounts to 13 million euros. Professor Krzysztof Ruchniewicz specializes in the history of Europe and European integration, Germany and Polish-German relations in the 20th and 21st centuries.

photo: Krzysztof Ruchniewicz

Faculty of Social Sciences

About the faculty

Consisting of four institutes and two chairs, the Faculty of Social Sciences is one of the largest faculties at the University of Wrocław. It has a long history of offering bachelor's, master's and doctoral study programmes in Polish and English. Among the offered programmes are the Erasmus Mundus programmes: *Global Studies – the European Perspective* and *MITRA* as well as a number of double-degree programmes together with partner universities abroad.

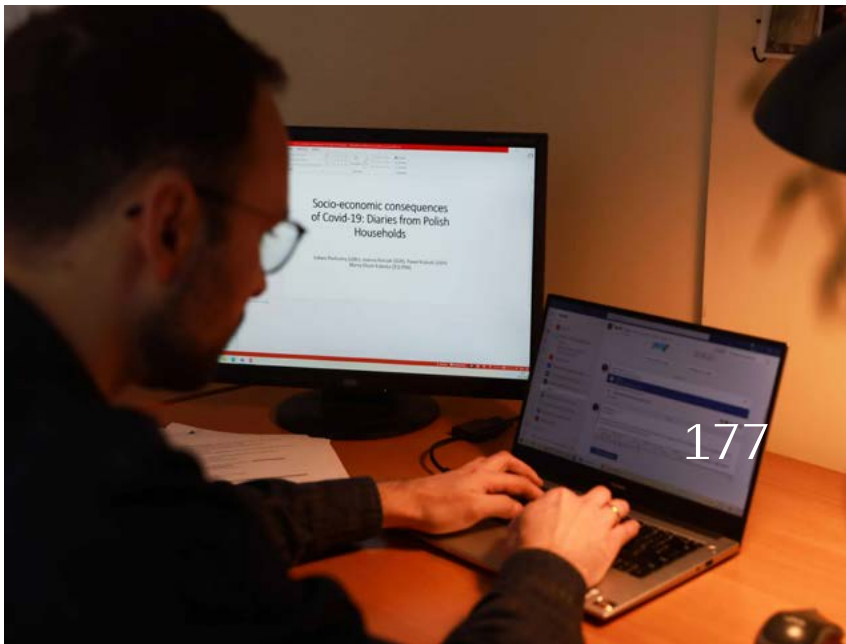
Research at the Faculty of Social Sciences is conducted by researchers in four institutes – the Institute of International Studies, the Institute of Political Sciences, the Institute of Sociology and the Institute of Philosophy and two chairs – the Chair of European Studies and the Chair of Logic and Science Methodology. They cover a broad range of areas in the field of social sciences, *i.e.*, research in political science, social policy, international relations, international security, global studies, European studies and international communication. In addition, in the field of empirical and theoretical sociology, research is conducted concerning various problems of sociology. In the discipline of philosophy, the focus is on Christian, modern, classical, German and contemporary philosophy.

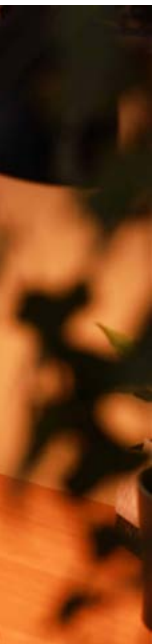
The Faculty members are part of many national and international associations, committees, expert teams, and editorial boards. They receive numerous research grants and organize and participate in many conferences and congresses. The Institute cooperates in many research projects and exchange programs with international institutions from Europe, Asia, the USA, and Canada.

International cooperation and studies in English are the most recognisable feature of the department.

Organisational structure

Institute of International Studies
Institute of Philosophy
Institute of Political Science
Institute of Sociology
Chair of European Studies
Chair of Logic and Science Methodology





There is a legend that the naked man with the sword was the creator of the sculpture himself, professor of the Berlin Academy of Fine Arts, Hugo Lederer, who, after coming to Wrocław, joined by students, lost not only money, but also his own clothes at cards.

This publication has been prepared by
the Communication Department of the University of Wrocław.

translation and proofreading
Marcin Walczyński, Dariusz Tomaszczyk, Caroline Budny, Maria Kozan

photos
Alina Metelytsia, Dominika Hull, Magdalena Marcula,
Freepik and the photo archives of the University of Wrocław

managing editor
Wojciech Głodek

project
Iwona Matkowska

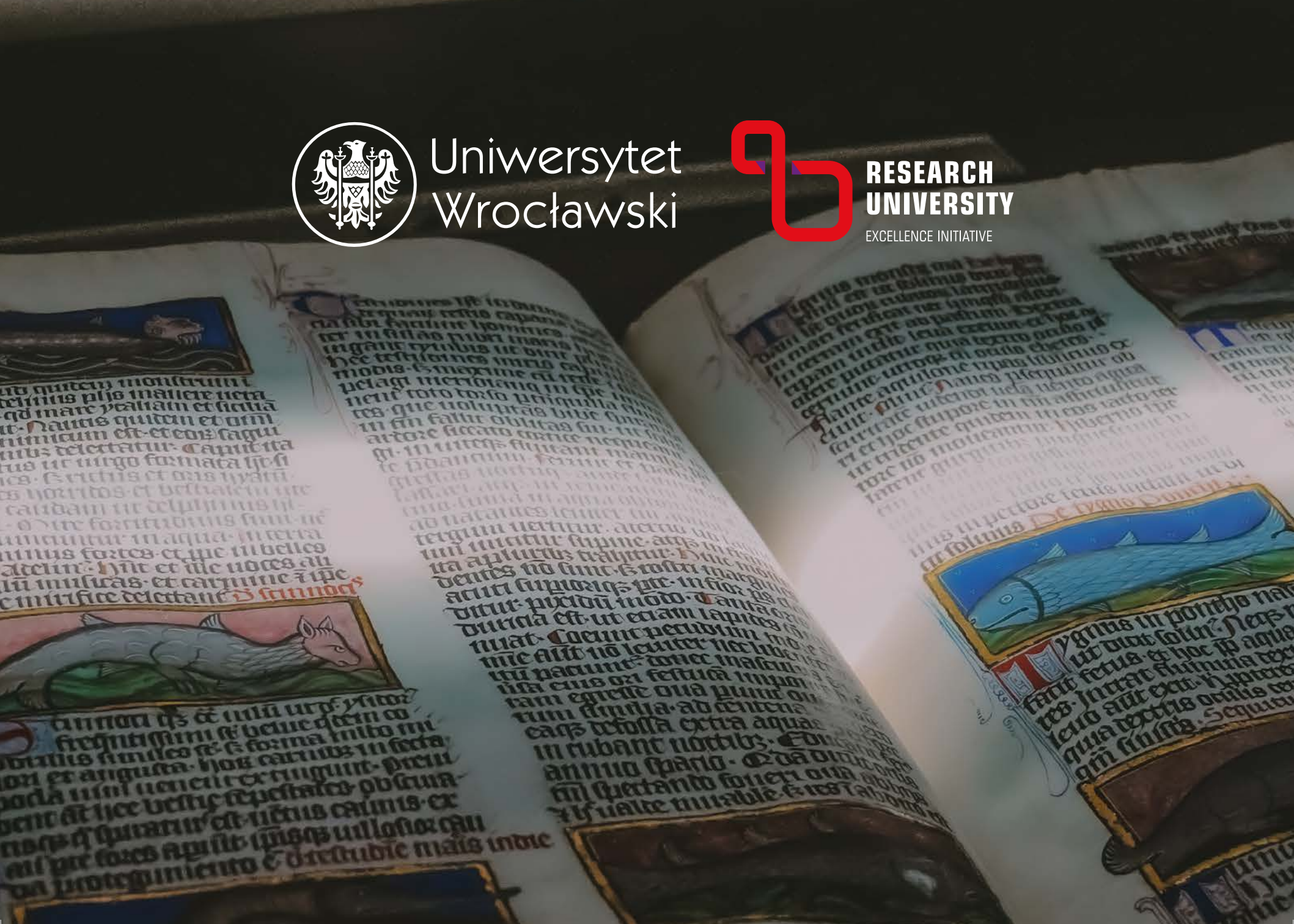
ISBN 978-83-962418-0-1

Wrocław, 2021

On the cover:

1. The picture shows the scanning head and table, of a scanning tunneling microscope placed in an apparatus under ultra-high vacuum, which works at the Institute of Experimental Physics. This microscope is used to study the surface of metals and semiconductors and thin layers of other materials (metals, oxides, organic molecules) embedded on them in the nanoscale and it even allows imaging the surface of such systems with atomic resolution.

4. A fragment of the chapter *De monstris marinis* (*e.g.* at the top left the monster Scylla known from Homer's *Odyssey* and at the bottom right the sea turtle) of the encyclopaedia of the 13th-century theologian Thomas of Cantimpré entitled *Liber de natura rerum*. The encyclopaedia is a review of the contemporary knowledge being a compilation of information from ancient authors with the views of the Fathers of the Church and scholars of the Middle Ages. The photograph comes from a richly illuminated 14th-century parchment manuscript currently stored in the University Library in Wrocław under the shelfmark R 174 (ff. 123v-124r). The extraordinary value of the Wrocław code is evidenced by the fact that out of approximately one hundred preserved manuscripts with the text of the encyclopaedia of the Flemish theologian, which was very popular in the late Middle Ages, only eleven have illuminations.



Uniwersytet Wrocławski

RESEARCH UNIVERSITY

EXCELLENCE INITIATIVE