Annual Report 2020

IST AUSTRIA

Institute of Science and Technology

The people of IST Austria

Nationalities on campus

Scientists as well as administrative and technical support staff come from all over the world to conduct and back research at IST Austria. As of December 31, 2020, a total of 76 nationalities were represented on campus.

IST Austria administrative and technical support staff by nationality

Austria	60.3%
Germany	5.8%
Hungary	3.1%
Italy	3.1%
Poland	2.5%
Czech Republic	1.8%
UK	1.8%
France	1.5%
Romania	1.5%
Syria	1.2%
Spain	1.2%
Russia	1.2%
Other	14,8%

North America

Canada
Cuba
El Salvador
Mexico
USA

Europe

Albania
Andorra
Armenia
Austria
Belarus
Belgium
Bosnia and Herzegovina
Bulgaria
Croatia
Cyprus
Czech Republic
Denmark
Finland
France
Georgia
Germany
Greece
Hungary
Ireland
Italy
Latvia
Lithuania
Luxembourg
Macedonia
Malta
Netherlands
Norway
Poland
Portugal
Romania
Serbia
Slovakia
Slovenia
Spain
Switzerland
Turkey
UK
Ukraine

Asia

Afghanistan
Bangladesh
China
South Korea
India
Indonesia
Iran
Israel
Japan
Jordan
Kazakhstan
Lebanon
Nepal
Philippines
Russia
Singapore
Syria
Taiwan
Thailand
Turkmenistan
Vietnam

Africa

Egypt
Benin
Kenya
Libya
Nigeria

IST Austria scientists by nationality

Austria	13.4%
Germany	10.3%
Italy	7.3%
India	6.2%
Russia	5.8%
China	4.3%
Spain	3.9%
Slovakia	3.5%
USA	3.4%
UK	3%
Czech Republic	2.8%
Hungary	2.8%
Other	33,4%

South America

Argentina
Brazil
Chile
Colombia
Peru
Uruguay

Oceania

Australia

Content

Foreword

Thomas A. Henzinger
President, IST Austria

Science, and basic research in science, play a key role in the well-being of individuals and the development of societies. The coronavirus pandemic has served as a stark reminder of this fact, as well as of the importance of building public trust in science. We are proud of the dedication and adaptability shown by all the Institute's employees this year—and every other—as we seek to be a role model and contribute on all levels, from pushing the boundaries of scientific knowledge to reaching out and making science accessible to the public.

A growing campus
From the beginning, we have recruited around five professors per year; with 65 under contract, we are on track to reach 90 research group leaders by 2026 and 150 by 2036. This year, six new professors joined the faculty, and three assistant professors received tenure: computer scientist Bernd Bickel, mathematician Jan Maas, and evolutionary biologist Beatriz Vicoso. To meet the needs of our growing and diversifying community, several projects are at various stages of construction and planning. The fifth laboratory building will open in 2021, and plans for a visitor center in the center of campus, a further laboratory building and a seminar center are underway. The services and state-of-the-art equipment provided by our Scientific Service Units also continue to expand. The technology park adjacent to the Institute, IST Park, has developed rapidly since opening last year. Ten companies are now present at the Park, including three start-ups that are based at least partly on Institute research.

Recognizing excellence
The faculty was awarded three new European Research Council (ERC) grants, bringing the total number of ERC grants awarded to IST Austria to 50, for 41 professors. In the single largest research grant to the Institute so far, the Werner Siemens Foundation decided to support Maria Ibáñez, who explores the properties of thermoelectric materials, with eight million Euro. The achievements of our graduate students further evidence the high standards on campus. In 2020, four students were awarded ÖAW DOC fellowships, and Aglaja Kopf received the PhD Award of the Austrian Association of Molecular Life Sciences and Biotechnology. To support emerging leaders at the postdoctoral level, IST Austria and the NOMIS Foundation have created a new fellowship program focused on interdisciplinary research.

On the right track
In December 2019, an international panel of top scientists chaired by Nobel Laureate Serge Haroche visited IST Austria to review the progress and outlook of IST Austria. The resulting report was released in early 2020 and lauds the Institute as an example for other countries wishing to foster "blue sky" research based on excellence. Not only have we achieved world-class accomplishments in science, but we have also laid the foundation for a world-class research institute.

While positive about the Institute's current state and future development, the evaluation report has left no doubt that a renewed long-term commitment from the government and the state of Lower Austria is essential to our goal of becoming and staying a global leader in basic research. Following this recommendation, we have received a promise from Federal Minister Heinz Faßmann and Governor Johanna Mikl-Leitner that the Institute will continue to grow beyond 2026, which used to be our planning horizon. We thank them, as well as our many other stakeholders and donors, for their dedication and generosity on our journey so far, and we invite all our partners to continue their support in the future.

Statements

Iain Mattaj
Chair of the Executive Committee

I first got to know IST Austria in summer 2016, and in quick succession joined its Board of Trustees and Executive Committee. I was attracted to accept these tasks by the obvious vibrancy of the Institute. Visitors to research centers can very quickly identify those that have the shared excitement of people pushing their limits. But such institutes are fragile. Top-quality research functions only when researchers have the freedom to operate, and this requires that institute management itself has independence in taking organizational, recruitment and scientific decisions.
The tasks of the Boards include protecting that independence as well as advising management on how to meet challenges. Today, based on its extraordinarily successful first 10 years, IST Austria is changing from a young start-up to a mature, large research center. Inevitably, this requires change in the structure and function of IST Austria. I look forward to helping IST Austria. navigate this period as painlessly as possible, without losing anything of its excitement.

Michael Sixt
Executive Vice President

The Scientific Service Units (SSUs) are one of the Institute's assets, combining top technical expertise and logistics to provide research groups with access to cutting-edge technology and instrumentation. We constantly grow and adapt the SSUs to cover the needs of the research groups on campus and to accommodate the newcomers. This year we added a variety of experimental services including a mass spectrometry unit and a virus production service. Another area of constant innovation is IT. Scientists produce a rapidly increasing amount of precious data that need to be stored, administered, and processed, while the need for high-performance computing facilities is steeply increasing.
It was a difficult year and I want to thank all those who ensured that scientific services remained active and took care of our animals, cultures, samples, and equipment. Without their dedication, many experiments would have been set back significantly.

Georg Schneider
Managing Director

The first few months of 2020 went according to plan. The construction of Lab Building 5 progressed well. We finalized the plans for Lab Building 6 and scheduled its construction to start in spring 2021. The planning of the Science Experience Center is underway, and we laid the groundwork for the pedestrian bridge between the main campus and the adjacent technology park. 2020 also saw the establishment of an independent company that bundles all the Institute's technology transfer activities while simplifying procedures and allowing for greater versatility.
However, the year 2020 also brought many unexpected challenges, first and foremost the coronavirus pandemic which led to lockdowns, school closures, and a sudden switch to remote work. Nevertheless the campus community held together and showed resilience, flexibility, and creativity in coming up with new modes of work and communication.
Through this, I have gained even more confidence in our preparedness to overcome upcoming challenges and our ability to take advantage of future opportunities.

At a Glance

IST Austria in numbers

The Institute of Science and Technology Austria (IST Austria) is a PhD-granting research institution dedicated to cutting-edge research in the physical, mathematical, computer, and life sciences.

Student admissions in 2020

Applications	1'927
Student offers made	103
Student offers accepted	62*

Faculty recruiting in 2020

Applications	1'766
Faculty offers made	7
Faculty offers accepted	4

531 scientists

(as of December 31, 2020)

PhD students	250
Postdocs	185
Professors	59
Scientific interns	32
Staff scientists	5

*including one student who will start in fall 2021

Research grant funding (numbers are rounded)

	2020
Werner Siemens Foundation (WSS)	€8'000'000
European Research Council (ERC)	€6'226'000
Austrian Science Fund (FWF)	€3'214'000
NOMIS Foundation	€1'800'000
Wellcome Trust	€1'161'000
Swiss National Science Foundation (SNF)	€1'138'000
Simons Foundation	€993'000
EU other	€600'000
Chan Zuckerberg Initiative (CZI)	€517'000
Austrian Academy of Sciences (ÖAW)	€424'000
European Molecular Biology Organization (EMBO)	€408'000
NÖ Forschung und Bildung (NFB)	€203'000
Deutsche Forschungsgemeinschaft (DFG)	€185'550
Agency for Education and Internationalisation (OEAD)	€29'000
German Academic Exchange Service (DAAD)	€17'000
Austrian Federal Ministry of Education, Science and Research (BMBWF)	€13'000
Austrian Research Promotion Agency (FFG)	€2'000
Others	€7'000
Total	**€24'936'550**

Founding principles

IST Austria was established in 2006 by the Federal Government of Austria and the Government of Lower Austria. The campus opened in 2009 in the city of Klosterneuburg, on the outskirts of Vienna. The Institute was founded based on a set of principles that were first formulated by Haim Harari, Olaf Kübler and Hubert Markl, who distilled them from the most successful systems and ideas in the world for the governance of research institutes.

Curiosity-driven research

Scientists pursue their interests without constraints or predefined research topics, supported by state-of-the-art infrastructure.

International

IST Austria brings together scientists and staff from all over the world; employees use English as their working language.

Multidisciplinary

IST Austria brings together researchers from all major scientific disciplines; communication and collaboration are encouraged across scientific fields.

PhD-granting

IST Austria awards doctoral degrees in a structured graduate program with central admissions.

Supporting careers

Professors are hired early in their careers on a tenure-track system, providing them with independence, a research budget, and a career perspective.

Independent boards

Trustees oversee the Institute; more than half are international scientists. Guidance is also provided by the international Scientific Board.

Exploiting results

Globally competitive basic research leads to unforeseen but useful and valuable discoveries; intellectual property and technology transfer are important objectives.

Diverse funding sources

IST Austria is publicly and privately financed. Scientists acquire third-party funds; donations to the Institute and revenues from intellectual property are transferred to an endowment fund.

Core missions

The founding principles of IST Austria remain valid today and continue to guide the growth and development of the Institute as it works towards excelling in its core missions:

- **to perform world-class basic research,**
- **to train the next generation of scientific leaders,**
- **to support science education and technology transfer, and**
- **to implement best practices in science management.**


A PLACE
OF GROWTH

On a Positive Trajectory

The Institute's third evaluation

Serge Haroche
Chairman of the 2019 IST Austria international review panel; Nobel laureate 2012 in Physics

It has been one year since I visited IST Austria as the chairman of its international review panel. It was in December 2019, a few weeks before the start of the pandemic, which was going to affect our means to do research and to teach, putting us in front of formidable challenges. Unaware of what was coming, I enjoyed with a carefree mind the pleasure to interact with colleagues, students, and postdocs on the IST Austria campus, sharing with them our common passion for science. I have been impressed by the spirit of this very special academic institution, whose unique goal is to provide the best possible working conditions for scientists to pursue their ambitious research projects. Selected solely on the basis of their excellence, they are given exceptionally good working conditions, with adequate funding and top-notch technical facilities. As a physicist, I could appreciate directly the quality of the research carried out in my own field. I could also feel that a similar quality was achieved in other areas – in computer science, mathematics, neuro- and life sciences – which was confirmed by the comments of my colleagues on the panel who were experts in those fields. Excellence could be felt intuitively, from the communicative enthusiasm of the students and from the clear presentations of the principal investigators, able to explain their goals and to share with us their insatiable curiosity about nature. The science carried out at IST Austria is first and foremost "blue sky" science, performed for the sake of creating new knowledge. And, at the same time, the IST Austria scientists are eager, if the opportunity arises, to translate their fundamental research into promising applied technologies. Visiting the campus, its research labs, teaching areas, and technical facilities has left in me an impression of dynamism and faith in the future of science and society.

Reminding myself about this visit after one year, which has been difficult for all academic institutions around the world gives me an opportunity to reflect about the importance of science and about the roles that institutions like IST Austria must play in the challenging times lying ahead of us. Science is more than ever essential to help humanity solve the global crises we are facing. The exceptionally fast development of novel vaccines, arising from fundamental research in biology made during the last decades, is a striking example of the essential role science is playing today. The climate change is another looming big crisis, which has been announced by scientists for several decades. Here again, we will need science to meet the challenge of increasing temperatures and its effects to the environment. We must not forget that inventive novel technologies always come from basic science, often in very unexpected ways. By doing fundamental research in physical, life and computer sciences as well as in mathematics, IST Austria is at the outpost in areas which will be critical to solve the problems that humanity will have to face. IST Austria's excellence and relatively small size will allow it to adjust more easily than bigger institutions to rapidly and unexpectedly changing conditions. This flexibility will be an asset in the challenging times ahead. I am eager to follow the promising development of IST Austria in the years to come.

"The initial vision was the right one and IST Austria is an example to follow for other countries wishing to develop 'blue sky' science based on excellence."

In December 2019, a committee led by Professor Serge Haroche, a 2012 Physics Nobel Laureate, came to IST Austria to evaluate the Institute on its development and research output during the period 2016-2019. The panel, which comprised seven internationally renowned scientists with considerable experience in science management, spent two days assessing the campus and interviewing staff and scientists of all levels—and in the end, drew a very positive conclusion:

"The initial vision was the right one and IST Austria is an example to follow for other countries wishing to develop 'blue sky' science based on excellence."

The report further recommended that the federal Austrian government and the state of Lower Austria, home to the Institute, renew their long-term financial commitments and continue to allow IST Austria complete academic freedom to select its research areas and strategies. Also highlighted and praised were the speed with which the Institute has developed and the Institute's efforts to recruit top students.

"IST Austria should keep increasing at the present pace, by about five research groups per year, to reach the milestones of 90 research groups by 2026 and 150 research groups by 2036."

This was the third review of the Institute, and it focused on the scientific achievements, the general development, the hiring strategy of the Institute, its research portfolio, the graduate school, the scientific and administrative support structures, efforts in technology transfer and science education, as well as its internal organization and plans for the future.

The report was delivered to the Institute's Board of Trustees as well as to the Austrian government and parliament, before being unanimously accepted by parliament in July 2020.

Committee members
Professor Serge Haroche, Collège de France (Chair)
Professor John Ball, Heriot-Watt University
Professor Maria Leptin, EMBO
Professor Helmut Schwarz, TU Berlin
Professor Robert Tarjan, Princeton University
Professor Richard Tsien, New York University
Professor Ada Yonath, Weizmann Institute of Science

From Scientific Results to Market Impact

Technology transfer at IST Austria

The Technology Transfer Office (TTO) plays a key role in developing the broader innovation ecosystem at IST Austria. As a “one-stop shop”, the TTO’s mission is to raise awareness about the business dimension of intellectual property (IP) in academia, and consequently, to provide IP consulting and IP protection, license technologies developed at the Institute, nurture and finance spin-off projects, inspire and educate future founders, and liaise with industry. Despite the challenges of 2020’s global pandemic, the TTO has continued to pursue its long-term agenda and reached several significant milestones on its roadmap.

Inspired by best practice examples of successful international institutions, such as the Yeda technology transfer subsidiary of the Weizmann Institute of Science, at the end of 2020 the IST Technology Transfer Office was spun out into the TWIST Research Transfer and Development GmbH, a subsidiary company wholly owned by IST Austria.

More information: www.twist.co.at

TWIST Fellowships and prototype grants

The TWIST Fellowship program aims to evaluate and improve the marketability of results from basic science. It provides consulting, funds, and infrastructure to selected graduates for up to one year. Early explorative projects can obtain funding and support as TWIST prototype grants.

Neurolentech
In 2020, TWIST Fellows Joana Enes and Karin Stecher, working with Melanie Pieraks, combined genetic and cell-based analyses to provide diagnostic information to doctors treating patients with autism and epilepsy. The findings from these analyses will be fed into a precision medicine pipeline to identify new therapeutic targets for these indications, and are hoped to lead to the development of new therapeutic strategies for patients for whom no treatment options are currently available. As the TWIST Fellowship project draws to a close, preparations are underway to establish Neurolentech as an IST Austria spin-off company; the team has successfully obtained AWS Pre-Seed funding for this endeavor.

Spin-off companies

The following projects were (co-)founded by scientists at IST Austria, and have meanwhile been established as technology companies with growing teams. Located at IST Park, they tap into the state-of-the-art office and life science facilities of the technology park that opened its doors in fall 2019.

Ribbon Biolabs
The team around Harold Vladar, a former IST Austria postdoc, aims to revolutionize the production of synthetic DNA, combining chemistry with computer science to yield a highly automated workflow. This will serve the growing need for synthetic DNA as a fundamental component for innovation in biotechnology and biopharma, providing customers with rapid access to DNA molecules of sub-genomic size and in thousands of variants, enabling them to create visionary solutions and to engineer novel products.
More information: www.ribbonbiolabs.com

Solgate
Solgate is a start-up company based on a collaboration between the Center for Molecular Medicine (CeMM) of the Austrian Academy of Sciences and IST Austria. Solgate develops a proprietary discovery platform for drugs targeting solute carrier proteins, with a focus on the role of these proteins in neurological diseases, metabolic disorders, and cancer. The company was co-founded by several researchers from CeMM and Professor Gaia Novarino from IST Austria.

An ecosystem for innovation

The IST Technology Park
Officially opened in September 2019, IST Park houses technology-based companies that benefit from the proximity to the IST Austria campus. IST Park is a joint initiative of ecoplus and IST Austria, providing state-of-the-art office and life science lab space to its tenants.
Currently, IST Park houses six tech-based small- and medium-sized enterprises, and the IST cube incubator and venture fund together with three of its portfolio companies, as well as the TWIST fellows. While the first building is almost fully booked, IST Park remains open for requests concerning coworking desks, office rooms, life science lab space, as well as custom facilities for technology companies.
More information: www.istpark.at

The eLab Entrepreneurship Lab
IST Austria’s Entrepreneurship Lab (eLab) is an interactive annual lecture series that teaches the basics of technology entrepreneurship. Starting its fourth season, eLab is currently conducted as an entirely online learning course due to the pandemic—making a virtue out of necessity, this year a record of 20 participants joined the course. In addition to the interactive sessions, eLab now offers the possibility of taking the complementary *p2i – Postdocs to Innovators* course run by the University of Cambridge.

The IST cube seed fund

IST cube is a seed fund focusing on deep-tech and science-based start-up companies. Not only is IST cube located at IST Park, close to IST Austria's campus, it also draws upon the expertise of the Institute's technology transfer team. IST cube is another development fulfilling the TTO's mission to foster entrepreneurship at IST Austria, while also targeting non-IST Austria-based technology start-ups to have a significant impact on the translation of science results into businesses in Austria.
The fund leads investment rounds in pre-seed and seed stages with the ability for follow-up investments. IST cube not only supports its portfolio companies with equity investment, but also with its know-how and network. Finally, IST cube also operates a coworking space located at IST Park.
In 2020, the young fund has made several significant steps: in addition to relocating to the newly-opened premises at IST Park, IST cube has led three investment rounds and successfully closed its second fundraising, resulting in a significant extension of its fund size.
More information: www.ist-cube.com

New investments in 2020

Sarcura
Founded in 2019 by a visionary, interdisciplinary team, Sarcura combines microfluidics and silicon chip technology in order to transform industrial manufacturing of personalized cell therapies. The company's office and laboratory are located at IST Park. In the €2.5 million seed round, IST cube led a group of European venture capital investors, including Nina Capital and Axilium Capital.
More information: www.sarcura.com

VALANX Biotech
VALANX Biotech was founded in 2017 by Michael Lukesch, to develop a novel technology platform for the cost-effective production of defined protein-drug conjugates in the pharmaceutical industry. VALANX uses both the office and lab facilities at IST Park for their research and development work, aiming to empower applications in drug development, diagnostics, and bio-sensorics based upon their patented approach. The six-figure investment round took place in May 2020, with IST cube acting as a lead investor among a syndicate including tecnet equity and SOSV.
More information: www.valanx.bio

G.ST Antivirals
G.ST was spun out from the Medical University of Vienna in 2019 and focuses on the development of antiviral drugs. Their innovative approach builds on a strategy to interrupt the virus' supply of essential building blocks within the human host cell. The company focuses on the development of products against respiratory viruses that cause the common cold. The six-figure seed round was led by IST cube in May 2020. With the freshly raised capital the company will extend its pipeline while preparing to enter a phase I clinical trial with its first drug candidate, 2-deoxyglucose.
More information: www.gst-antivirals.com

Further IST cube portfolio companies

VitreaLab www.vitrealab.com
Prewave www.prewave.ai
ContextFlow www.contextflow.com
Ribbon Biolabs www.ribbonbiolabs.com

Training the Next Generation

PhD students at IST Austria

Educating PhD students is a core mission of IST Austria. The Institute's Graduate School offers a multidisciplinary PhD program that supports students in becoming experts in their fields while fostering communication and collaboration across research groups and disciplines.

In the ten years since its founding, the IST Austria Graduate School has grown and developed enormously, incorporating best practices with its own unique twist. Gifted, promising students recruited from all over the world now have access to a rigorous curriculum featuring a wide course selection and structured rotations in research groups, in addition to the opportunity to collaborate with top scientists and work in state-of-the-art facilities. Their scientific training is rounded out with workshops and lectures organized by the Institute's career development program and Technology Transfer Office, and by multiple outreach opportunities. The Graduate Student Association further ensures that each student is supported by their peers, and represents the interests of the students to the campus community.

Growing numbers
Graduate students are a vital part of the IST Austria community, and one of the fastest growing groups on campus. Up from just seven students in 2010, this year's cohort of 61 new students brings the total to 250 on campus. Unlike previous years, actually getting the students to campus from their 27 different home countries represented a significant challenge and the new students' welcome had a rather different form. Still, the well-being of our new students—and of all doctoral students—is a top priority for the Graduate School: regular meetings as well as a buddy system have been set up, ensuring that new students receive support and are integrated into the campus community.

Towards a combined MS+PhD program
The Graduate School works to improve its ability to attract and train talented young scientists. One longtime goal was the right to award master's degrees on the way to a PhD. Last summer, a change in the legislation governing IST Austria was passed by the Austrian Parliament: the Institute may now establish a combined Master's+PhD program. This will enabling us to better recruit outstanding students that want to enter a research career directly from a completed bachelor's program. A working group of faculty, students, and administration has begun the process of establishing the guidelines for a flexible and individually tailored MS+PhD program.

Awards and recognition
Outside organizations have lauded the achievements of IST Austria graduate students with best paper awards, fellowships, and other recognitions. As a highlight of 2020, Aglaja Kopf received the PhD Award from the Austrian Association of Molecular Life Sciences and Biotechnology for her doctoral work. Completed under the supervision of Professor Michael Sixt, her thesis explores how cells feel their way through tissue. Also this year, Amir Goharshady, a PhD student in the Chatterjee group, received the Institute of Electrical and Electronics Engineers (IEEE) Computer Society Best Student Paper Award for his paper "Modular Verification for Almost-Sure Termination of Probabilistic Programs". This already is the second time he has received this award. Besides recognizing excellent research, external funding schemes also have positive effects on promising young researchers. Planning a multi-year research project and presenting it in a proposal are crucial skills for a scientist. This year, four PhD students received highly competitive DOC stipends from the Austrian Academy of Sciences. The award, which is worth €38'000 per year per stipend, will fund their PhD research for up to three years. The 2020 awardees were Max Aubry (Cremer group), for his project "Brushing off pathogens: structure and function of the antennal cleaner in ants"; Dario Porley (Schur group), for his project "Structural characterization of Spumavirus capsid assemblies to understand conserved ortervirales assembly mechanisms"; Gemma Puixeu Sala (Vicoso/Barton groups), for her project "Sexual conflict: resolution, constraints and biomedical implications"; and Wojciech Rzadkowski (Lemeshko group), for his project "Analytic and machine learning approaches to composite quantum impurities".

An interdisciplinary experience

Cross-disciplinary thinking becomes increasingly important, and many of today's top scientific questions and discoveries are the result of research and collaborations that cross traditional boundaries between areas. The Graduate School at IST Austria helps students develop the skills necessary to take advantage of this trend, as well as providing an environment that allows interdisciplinary ideas to flourish. Two graduate students with highly interdisciplinary projects are Kseniia Khudiakova and Michele Nardin.

Q1: What research question is currently most fascinating to you?

Q2: How has the multidisciplinary research environment at IST Austria impacted your PhD work?

Kseniia Khudiakova
Barton and Maas groups

Q1: My PhD project will be devoted to the problem of contamination of the genome by very slightly deleterious mutations, i.e. mutations that decrease fitness. As is often the case when we take the stochasticity of the evolutionary process into consideration, genuinely beautiful, puzzling, and paradoxical phenomena emerge. Strongly deleterious mutations are kept at low frequencies by natural selection. Slightly deleterious mutations, on the other hand, evolve stochastically and can reach high frequencies just by chance. Thus, such mutations would accumulate in a population and—due to a strong cumulative effect—eventually lead to its extinction. It is an open question how organisms can sustain the cumulative pressure of very slightly deleterious mutations. In fact, it turns out that the least deleterious mutations produce the most damage, and looking at how exactly this paradoxical behavior happens is something I find fascinating.

Q2: First, the double affiliation with mathematics and biology groups would hardly be possible at any other place, and I feel that this is a perfect combination for me personally. Second, many people at IST Austria share an interest in interdisciplinary research, and I am happy to be among like-minded people. For instance, together with my friend Raimundo Saona, I organize the stochastic seminar, where we focus on interdisciplinary communication. Not only is this interesting in and of itself, but we also hope that it helps people to look at their own projects from a different angle.

Michele Nardin
Csicsvari group

Q1: Much is known about the fine biological details of neurons, but surprisingly little about how those neurons cooperate to allow us to think, feel, decide, etc. Many of these questions can be phrased mathematically, and a mathematical description of brain functions would be a huge step forward. Currently, I research various topics, from learning dynamics to the efficiency of neural representations. For me, the most fascinating challenge is to understand how the brain does what it does from a theoretical perspective.

Q2: At first, it was completely overwhelming. Nothing prevents you from studying anything, starting collaborations, or developing interests in other fields, but that also means that you have to succeed with less guidance and find your own path. In my opinion, the only solution is to let curiosity drive your day-to-day scientific life. In doing so, I found myself reading diverse papers and books, which extended my knowledge to other fields, broadened my interests, and finally brought me into the realm of questions that lay between math and neuroscience. Talking to scientists from many different fields helped a lot in this, and thankfully, there are many at IST Austria! I learned that many of the questions I was asking had been already asked, and sometimes answered, in other fields. That is quite humbling, but is also one of the many manifestations of the fact that science moves forward thanks to community efforts, and that cooperation across fields—especially between theoreticians and experimentalists—is key.

IST AUSTRIA CAREERS

A Global Community

IST Austria's alumni network

Staying connected despite physical distance is one of the important aspects of the IST Austria alumni network. Many of the Institute's alumni leave Austria when they are finished with their studies or with their postdoc position in Klosterneuburg. They go out into the world to pursue their careers in various sectors, be it in academia, industry, or the public sector. The list of institutions and companies that IST Austria alumni have joined is long, and still growing. Around two thirds have continued in academia, many of them in top international institutions such as Harvard University, Stanford University, MIT, ETH Zurich, the Weizmann Institute, and the Max Planck Institutes. Nearly ten percent of alumni are engaged in industry research activities at companies such as Google, Microsoft, and Roche, among many others.

Even though the Institute's alumni are spread all over the world, they still have a connection to IST Austria. They return to give career talks—this year only virtually—that inform and inspire current Institute scientists. They foster fruitful collaborations in many areas, from scientific spin-offs to outreach projects. As the alumni network grows in both size and impact, and as the alumni themselves broaden their experience and develop personally, they enrich the campus community as well as their new institutions, businesses, and organizations.

Chris Pull

University of Oxford, United Kingdom

Chris Pull studied zoology and completed a master's in scientific research with Professor Mark Brown at Royal Holloway University of London before joining IST Austria in 2012 as a PhD student in Professor Sylvia Cremer's group. He spent the next five years investigating social immunity in ants, then defended his thesis and returned to Royal Holloway to study the evolution of cognition in bumblebees. In August 2020, he started a position as departmental lecturer at the University of Oxford. Pull: "I am excited about the opportunity to begin my independent research program and to start teaching bright, engaged students at Oxford. My time at IST Austria helped prepare me for this role by providing important teaching experience early on in my career. I also benefited greatly from the curiosity-driven research environment, which allowed me to pursue exciting scientific questions in animal behavior. I am thankful to my colleagues at IST Austria, especially my PhD supervisor Professor Sylvia Cremer, who continues to be a huge supporter of my career."

Hildegard Uecker

Max Planck Institute for Evolutionary Biology, Germany

After earning a diploma degree in physics from the University of Göttingen, Hildegard Uecker did her PhD in biomathematics at the University of Vienna. She then completed two postdocs, first at IST Austria in Professor Nick Barton's group, then at ETH Zurich. Since 2017, she has been a group leader at the Max Planck Institute for Evolutionary Biology. Her research focuses on adaptation in populations that are severely challenged by environmental change (natural populations) or by exposure to drug treatment (pathogen populations). She is also active in science education, and continues to collaborate with the IST Austria outreach team and other alumni. This year, they created the educational game "Virus Alert in Bleibhausen" for children. This game helps teachers and parents explain how a virus spreads, and has already been translated into three languages. Uecker: "We quickly realized that the pandemic wouldn't be over soon, and that it is important to explain the situation to children. As theoretical biologists, we set up, analyze, and simulate models to understand the dynamics of biological systems. The game is also a simulation, which lets children make observations on the spread of a virus and the effect of control measures."

New Professors to Join IST Austria in 2021*

Vadim Kaloshin

Can you reconstruct the shape of a drum from its sound? This question, and others in spectral rigidity, are among the questions mathematician Vadim Kaloshin seeks to answer. In general, Kaloshin specializes in dynamical systems, with his primary interests lying in both deterministic and stochastic dynamics. He earned his PhD from Princeton University, USA, in 2001, and has since held positions at the Courant Institute at New York University, Massachusetts Institute of Technology (MIT), California Institute of Technology, and Pennsylvania State University, all in the USA, and since 2007 has held the Michael Brin chair and a professor position at the University of Maryland, USA. At IST Austria, Kaloshin aims to prove local spectral rigidity for convex planar domains, as well as in the context of Riemannian manifolds. He will further work to develop a mathematical theory to explain the stochastic behavior of gaps in the asteroid belt, as well as the shape of the distribution of these gaps.

Vadim Kaloshin joined IST Austria in January 2021.

Lefteris Kokoris-Kogias

Lefteris Kokoris-Kogias is a computer scientist who seeks to increase the digital trust of online information and processes, especially those that impact the physical world. After earning his PhD in 2019 from the École Polytechnique Fédérale de Lausanne (EPFL), Switzerland, he spent several months as a visiting researcher in the VMware Research Group in Silicon Valley, working on distributed key generation for resilient consensus. Kokoris-Kogias then returned to Switzerland to work at EPFL and the Web3 Foundation on interoperability of blockchain systems. In June 2020, he joined Facebook as a research scientist to work on Novi, where he is building a new global payment system for the connected world. At IST Austria, Kokoris-Kogias' group aspires to contribute to the rapidly evolving digital world by designing and building secure scalable decentralized systems with real-world impact. The driving force and inspiration of the group's research focus stems from both the technical challenges presented in existing systems, as well as the socio-technical barriers faced by conventional institutions.

Lefteris Kokoris-Kogias will join IST Austria in September 2021.

Caroline Muller

The Institute's first earth scientist, Caroline Muller is primarily interested in geophysical fluid dynamics and climate science. She is particularly interested in the study of oceanic and atmospheric processes that are too small in space and time to be explicitly resolved in the General Circulation Models (GCMs) used for climate prediction. Muller's background is in mathematics and engineering: she received master's degrees in both aerospace engineering and mathematics before completing her PhD in applied mathematics at New York University (NYU), USA, in 2008. Her next step was a postdoc at the Massachusetts Institute of Technology (MIT), USA, after which she became a researcher at Princeton University, USA, then at the Centre National de la Recherche Scientifique (CNRS) in France. Since 2015, she has held a joint appointment as a CNRS researcher in the Dynamic Meteorology Laboratory and as an École Normale Supérieure lecturer. At IST Austria, Muller will focus on several projects, including internal wave breaking in the ocean and cloud processes in the atmosphere. Her goal is to improve our fundamental understanding of those small-scale processes, and in so doing better current model projections for climate change.

Caroline Muller will join IST Austria in September 2021.

Jérémie Palacci

How can one control the behavior of a material by powering it from within? The natural world is populated by mesmerizing examples of those living materials: cells organize into functional organs, wounds heal or bacteria assemble in biofilms more resistant to antibiotics. Still, unveiling the guiding principles of non-equilibrium systems that consume energy remains a fundamental challenge. This is the frontier of physics that the Palacci group is addressing, using active particles to control matter and ultimately achieve man-made materials that rival with nature. Palacci completed a PhD in soft matter physics at the Université de Lyon, France, in 2010, then joined New York University (NYU), USA, for a four-year postdoc. He finished this period as a visiting professor of mathematics, also at NYU, before joining the University of California San Diego, USA, as an assistant professor of physics in 2015, where he received tenure and became associate professor in 2020.

Jérémie Palacci will join IST Austria in September 2021.

Paul Schanda

Physical chemist Paul Schanda develops methods for nuclear magnetic resonance (NMR) spectroscopy to characterize the role of dynamics for protein function. Schanda began working with NMR during his undergraduate studies in chemistry at the University of Vienna, Austria, and continued this work during his master's at the same institution. Following his time in Vienna, he moved to the Joseph Fourier University in Grenoble, France, for his PhD, which he received in 2007 for the development of fast multidimensional solution-state NMR methods. In 2008, he began a postdoctoral fellowship at ETH Zurich and then returned to the Structural Biology Institute (IBS) in Grenoble in 2010 as the team lead of the solid-state NMR group. In 2017, Schanda took over as head of the NMR group. At IST Austria, he will seek to characterize increasingly complex protein systems and complexes, in particular chaperones and enzymes, through multifaceted approaches based in structural biology and biochemistry.

Paul Schanda will join IST Austria in September 2021.

* contracts signed as of December 31, 2020

RESEARCH

Biology

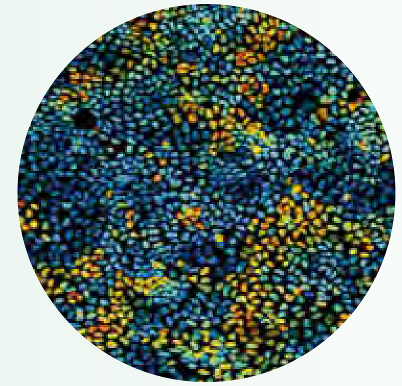
Biology, the study of life and living organisms, encompasses a range of fields—from cell biology to evolution, from genetics to development. Similarly, biology research at IST Austria covers a wide range of areas and involves many collaborations both inside and outside the immediate subject area.

In 2020, biologists at IST Austria explored questions including: How do ants fight disease and what role does "grooming" by nestmates play? How are certain cells within our body able to move through different tissues? And how do cells know where to go in order to heal a wound?

Grooming shapes disease outcome

Cremer group

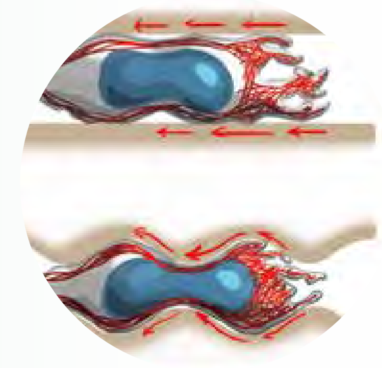
Solitary species have to fight disease alone. In contrast, in groups of social species like bees or ants, nestmates often assist infected individuals by providing sanitary care, thereby reaching colony-wide "social immunity". Professor Sylvia Cremer and her team discovered that if an ant is infected by multiple pathogens, competition between the pathogens is shaped not only by the immune system of the individual but also by the social sanitary care provided by its nestmates. Moreover, depending on the germination speed of the different pathogen strains, the grooming of nestmates differs in its efficiency and hence shifts the balance of the competing pathogens. "If one pathogen species takes longer to germinate, this gives the ants more time and increases their chances of grooming it off," explains Cremer. Therefore, social sanitary care not only benefits the pathogen-exposed colony members, it also alters the pathogen composition in the ants' environment.



Wound healing waves

Hannezo group

Many cells in our bodies are on the move. But how do they know where to go? This question is key to understanding phenomena such as the normal renewal of cells throughout our lives, the invasive migration of cancer cells, and especially wound healing. Edouard Hannezo and his group, in collaboration with Kyoto University, propose a new model of information transfer in which cells generate and utilize long-distance traveling waves to figure out which cells should migrate towards a wound to close it. The researchers built a mathematical model to describe the interactions within a layer of cells on a substrate, similar to a layer of skin. These cells contain chemical signalers that allow them to sense other cells around them. The scientists found that the interplay of cell movement, sensing of the environment, and states of protein activation within the cells combine to create mechanical and chemical traveling waves that contain directional information. The waves could be a communication tool, allowing cells far away from a wound to sense which way to go.



Cells in "off-road" mode

Sixt group

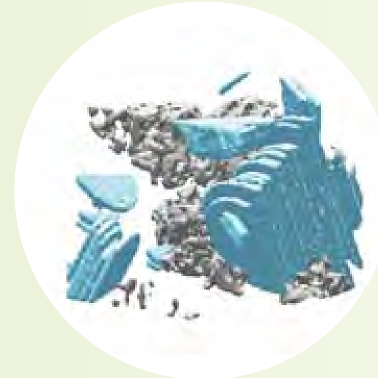
Cancer cells and white blood cells are able to move through tissue and organs quickly. Usually, cells bind to their surroundings using specific adhesion receptors that are present on their plasma membrane. As the universal "glue" between cells and their surroundings, these adhesion receptors serve as anchors as the cell climbs through tissue. But how can certain types of cells crawl through tissues that do not necessarily match the adhesion receptors? Together with colleagues from France, Professor Michael Sixt and his group solved this mystery: Actin—the building material of the cell's cytoskeleton—flows from the front end of the cell to the tail end. This "retrograde actin flow" is the force within the cell that, once coupled to the environment, drives the cell body forward. Furthermore, the retrograde flow generates intracellular shear forces that push against the channel walls whenever there is a bump. As the fine structure of tissues is geometrically very complex, amoeboid cells can always rely on this "off-road" mode of locomotion.

Faculty Evolutionary Genetics NICK BARTON | Plant Developmental Biology EVA BENKOVÁ | RNA-based Gene Regulation CARRIE BERNECKY | Social Immunity SYLVIA CREMER | High-Resolution Optical Imaging for Biology JOHANN DANZL | Genes, Circuits, and Behavior MARIO DE BONO | Developmental and Cell Biology of Plants JIŘÍ FRIML | Systems and Synthetic Biology of Genetic Networks CĂLIN GUET | Physical Principles in Biological Systems EDOUARD HANNEZO | Morphogenesis in Development CARL-PHILIPP HEISENBERG | Genetic Dissection of Cerebral Cortex Development SIMON HIPPENMEYER | Tissue Growth and Developmental Pattern Formation ANNA KICHEVA | Evolutionary Genomics FYODOR KONDRASHOV | Self-organization of Protein Systems MARTIN LOOSE | Medical Genomics MATTHEW ROBINSON | Structural Biology of Membrane Protein Complexes LEONID SAZANOV | Structural Biology of Cell Migration and Viral Infection FLORIAN SCHUR | Neuroimmunology in Health and Disease SANDRA SIEGERT | Invasive Migration DARIA SIEKHAUS | Morphodynamics of Immune Cells MICHAEL SIXT | Evolution, Development and Function of Motor Circuits LORA SWEENEY | Theoretical Information Processing in Biological System GAŠPER TKAČIK | Sex-Chromosome Biology and Evolution BEATRIZ VICOSO

Chemistry

Chemistry is thought of as a central science because of its many applications to life, materials, and our environment. The scope of the field is enormous, but at its heart, chemistry is the study of atoms, molecules, and ions—how they are composed, what their structure and properties are, and how they behave and change during reactions with other substances.

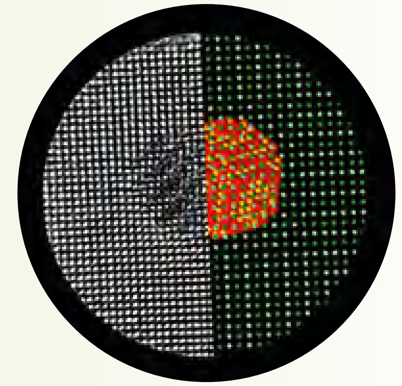
At IST Austria, chemistry research currently focuses on materials electrochemistry, biochemistry and functional nanomaterials; another group studying biomolecular mechanisms using nuclear magnetic resonance spectroscopy will join in fall 2021. Questions explored by these groups include: How can we improve electrochemical energy storage in terms of quantity, cost, and ecological footprint? What effect does nanocomposite design have on thermoelectric performance? And what exactly does the enzyme that generates the chemical ATP, the fuel that powers all life, look like?



Storing electrons in insulators

Freunberger group

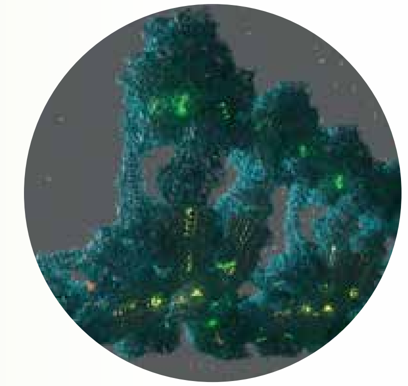
Electron transfer reactions are at the heart of energy storage in living nature, and humankind has learned to harness such reactions for electrochemical energy storage such as in batteries. Boosting them beyond the limits of current lithium-ion batteries, the best performing system so far, has become a societal demand and moreover requires venturing into new scientific grounds. The shift from transition metals to main group elements such as oxygen, sulfur, or phosphorous is of central importance. However, the materials that store charges in these cases are typically highly insulating, which makes electron and ion transfer—the key processes in electrochemistry—difficult. The Freunberger group works broadly on mechanisms of electron transfer reactions with insulators, their chemical reactions, and suitable electron and ion conductors. Moreover, they elucidate mechanisms of parasitic reactions, which degrade device performance and lifetime. To do so, the group is developing a suite of operando characterization based on spectroscopy, diffraction, and microscopy. Recent achievements include detailing the mechanisms of singlet oxygen formation in oxide electrochemistry and reversible electrodeposition of oxides or iodine.



Precise design of nano-crystal building blocks

Ibáñez group

Nanocrystals are composed of several hundred to several thousand atoms. The final organization of those atoms (composition, crystallographic phase, size, and shape) determines the nanocrystals' (NC) physical properties. Advances in synthetic methods have allowed for the precise control of those properties for single-component NCs, as well as heterostructured ones with a topologically defined distribution of their composition. One of the main activities in the Ibáñez group is the development of precise chemical synthesis to produce core-shell nanoparticles of different semiconductors (e.g. PbTe@PbS, a lead-tellurium core with a lead-sulfur shell) or metal-semiconductor (Cu@PbS, FePt@PbTe, etc.) and to understand the mechanism behind nanocrystal formation. Once those heterostructured nanoparticles are formed, the group uses them as artificial atoms to build up metamaterials. This refined control provides the means to tune material properties to target a diversity of applications, such as electronics, plasmonic, catalysis, and thermoelectricity.



The world's smallest turbine

Sazanov group

The chemical ATP, adenosine triphosphate, is found in all known forms of life, where it provides energy to drive muscle contraction, impulse propagation and chemical synthesis. Despite ATP's central role, the structure of the enzyme generating ATP, F1Fo-ATP synthase, in mammals, including humans, has not been known so far. Together with his group, Leonid Sazanov was able to reveal the complete structure of the mammalian F1Fo-ATP synthase for the first time. Thereby, the researchers shed light on a controversy in biochemistry: how and where the so-called permeability transition pore opens. This pore is linked with cell death, and opens for example during strokes and heart attacks. So far, it was known that the pore forms in response to high levels of calcium. Using the fully solved structure of F1Fo, Sazanov and his group can now describe how the pore forms in F1Fo-ATP synthase. When calcium binds to the F1 domain, a large conformational change is induced. The complex has to accommodate this change, and in doing so, pulls out a lipid plug on the bottom side of the Fo domain, initiating pore opening.

Faculty RNA-based Gene Regulation CARRIE BERNECKY | Materials Electrochemistry STEFAN FREUNBERGER | Functional Nanomaterials MARIA IBÁÑEZ | Self-organization of Protein Systems MARTIN LOOSE | Structural Biology of Membrane Protein Complexes LEONID SAZANOV | Structural Biology of Cell Migration and Viral Infection FLORIAN SCHUR

Computer Science

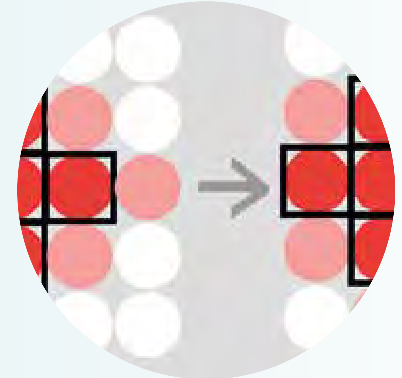
Computer science at IST Austria stands out in two particular ways: First, all computer science groups share an appreciation for foundational thinking and build their research on a mathematically rigorous base. New insights are made and new algorithms and formalisms developed, based on mathematical concepts and computational thinking. Second, the groups work to foster interdisciplinarity, strengthening the ties between life sciences, physics, mathematics, and computer science—one of IST Austria's signature characteristics.

Among other advances this year, IST Austria's computer scientists introduced a new class of impossibility proofs, studied how to prevent replay attacks in private contact tracing, and developed a novel scheme for detecting objects of various sizes and densities in images.

Geometry meets time

Bickel group

Previously, the Bickel group looked at flat sheets that transform themselves into smooth-surfaced free-form 3D objects. But is it possible to take time into account, and ensure that each part of the structure folds at a defined rate? By encoding both time and geometry, a world of new, more complex shapes becomes possible.
This year, the Bickel group developed a mechanism that does just this, as well as an algorithm that "programs" the material and automatically creates templates for the 2D sheets to be transformed.
The team's idea was to use a series of brackets of varying thicknesses to compose the flat sheets specified by the software. When exposed to a warm water bath, the thickness defines how quickly the bracket folds. First, they experimentally measured at what rate each thickness folds, and used these measurements to build a data-driven model that serves as the basis for the software algorithm. After importing a 3D image into the software, users can "paint" a time landscape onto the target object, specifying when each piece should reach its final shape. The team used the program to define the morphing rates for shapes resembling flowers, a tight spiral, and others, all avoiding collisions.



Digital cryptography against a physical virus

Pietrzak group

Contact tracing poses a perfect use case for applied cryptography to contain the pandemic. Smartphone apps for that purpose need to be simple, efficient and safe against malicious attacks. With current protocols, security issues have been identified. The Pietrzak group reacted to these concerns and proposed an improvement to prohibit large-scale false alerts.
In a replay attack for instance, a hacker records a legitimate Bluetooth signal from a phone at one spot and replays it somewhere else, such that all the phones at the new site seem to have been in touch with the legitimate device at spot one.
If the legitimate phone user is reported Covid-positive, the notification would send many people falsely into quarantine. As broadcasting a tag that authenticates the time of contact would compromise privacy, the new protocol proposed by the Pietrzak group relies on a scheme called "delayed authentication". Here, the receiving device can verify the tag later, once the sender is diagnosed, while none of the devices must ever store the sensitive time of contact. Also, the cryptographic simplicity facilitates the desired efficiency, which is necessary for implementation.

Yarn and thread

Wojtan group

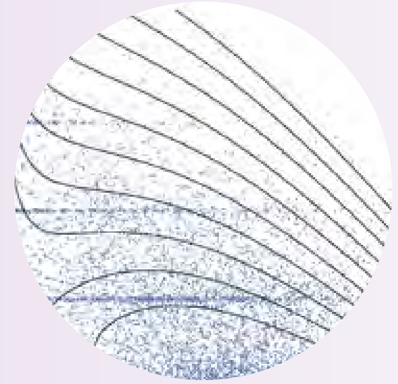
The feel, stretch, and bends of a pullover or sock depend only on the pattern and quality of its stitches. At first glance simple, stitches and patterns are mathematically fascinating—how can they be simulated efficiently? If each interacting thread is simulated, this would take enormous computational power. Another approach would be to treat fibers as an averaged effective material and not individually. This is more efficient, but finding a model that matches the original cloth is complicated. Now, the Wojtan group and a researcher from the Indian Institute of Technology Delhi have developed a new method for finding realistic material models for fabrics. In it, hundreds of simulations of interacting yarns are precomputed, and a computer model is created that reproduces these effects. This model is then incorporated into a cloth simulator. With this technique, a material's properties are derived directly from its geometry: no real-world experiments or measurements are necessary. This is the first use of numerical homogenization to animate woven and knitted fabrics, and the technique is capable of reproducing common textile phenomena such as anisotropy, area preservation, and curling.

Faculty Distributed Algorithms and Systems DAN ALISTARH | Computer Graphics and Digital Fabrication BERND BICKEL | Computer-aided Verification, Game Theory KRISHNENDU CHATTERJEE | Algorithms, Computational Geometry, and Computational Topology HERBERT EDELSBRUNNER | Design and Analysis of Concurrent and Embedded Systems THOMAS A. HENZINGER | Discrete Optimization VLADIMIR KOLMOGOROV | Machine Learning and Computer Vision CHRISTOPH LAMPERT | Data Science, Machine Learning, and Information Theory MARCO MONDELLI | Cryptography KRZYSZTOF PIETRZAK | Discrete and Computational Geometry and Topology ULI WAGNER | Computer Graphics and Physics Simulation CHRIS WOJTAN

Mathematics

Mathematics allows us to distill ideas and observations, to abstract things to their fundamentals and precisely define concepts, objects, and the connections between them. It provides a language to formalize quantitative aspects of the natural sciences and a way of thinking that is useful across a wide spectrum of research fields. Mathematicians at IST Austria have a deep understanding of their research areas and combine this with the ability and openness to communicate with scientists in other disciplines. They are interested in a variety of areas—from analysis to topology, from combinatorics to mathematical physics and beyond.

This year, the Institute's mathematicians studied isomorphisms between different algebras, characterized solutions of quasilinear heat equations, and examined intersection patterns of planar sets, among numerous other projects.



The adaptation of species

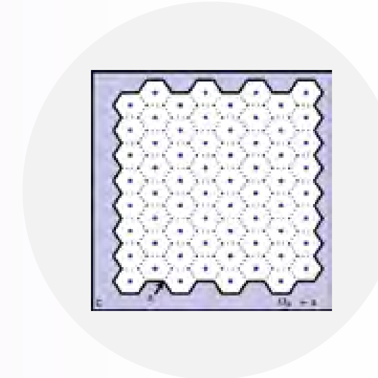
Barton group

In order to survive, species need to adapt to changes in their environment—to changing weather or food resources, for instance. This year, Enikő Szép, Himani Sachdeva, and Nick Barton used mathematical models to find out how genetic adaptations to local conditions can be maintained despite the exchange of genes with other populations. The researchers assumed an idealized "metapopulation" consisting of many subpopulations, each in a distinct environment, yet connected to the others via migration. The coupling between population size and gene frequencies can lead to extinction: As a population becomes less well-adapted, it becomes smaller, and so even less able to adapt. Their stochastic model follows the joint evolution of population size and gene frequencies, and shows how this feedback makes adaptation to rare habitats much more difficult. This novel framework can be used to investigate how populations evolve either as generalists, i.e. adapting to a range of local environments, or split into distinct and well-isolated species.

When is necessary sufficient?

Browning group

Polynomials with integer coefficients and their integer solutions have long been studied, and continue to fascinate researchers to this day. Moreover, the very existence of solutions is an important part of this field. In 1900, Hilbert famously challenged researchers to design an algorithm that could tell them whether a polynomial equation with integer coefficients has an integer solution or not. We now know that this is in general impossible. However, we can say that if integer solutions exist, two conditions must hold, one having to do with solutions that are real numbers, the other with divisibility by integers. A central conjecture in number theory suggested that if the number of variables (call this number n) of a polynomial is greater than the degree (d), then passing these two tests almost always means there exists an integer solution. This year, Tim Browning and his coauthors proved the conjecture to be true in all cases except when n=4 and d=3, a family known as cubic surfaces. Their result provides the key to creating an algorithm—of the kind Hilbert wanted—for nearly all polynomials whose number of variables is greater than their degree.



Unifying definitions of jellium

Seiringer group

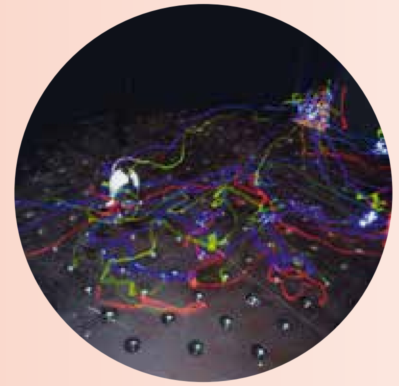
Jellium, or the homogeneous electron gas, is a fundamental system in quantum physics and chemistry, for instance useful in describing the deep interiors of white dwarfs and the valence electrons in alkaline metals. It was originally defined as an infinite gas of electrons in a positively charged uniform background, and the thermodynamic limit of the system was established rigorously. Another system, the uniform electron gas, is similar, but there is no background and the electron density is constant. In yet another system, electrons interact with periodic images of themselves. It was proposed in the 1980s that the ground state energies of these three systems coincide in the thermodynamic limit, but establishing this in a rigorous manner remained elusive, until recently. Using a novel "floating crystal" trial state, Robert Seiringer and his coauthors were able to show that these three systems are the same. Their argument involves "melting" a layer of crystal close to the boundary, then replacing it by an incompressible fluid. This allowed them to compensate for the charge fluctuations that occur at the system boundaries.

Faculty Evolutionary Genetics NICK BARTON | Analytic Number Theory and its Interfaces TIM BROWNING | Algorithms, Computational Geometry, and Computational Topology HERBERT EDELSBRUNNER | Mathematics of Disordered Quantum Systems and Matrices LÁSZLÓ ERDŐS | Theory of Partial Differential Equations, Applied and Numerical Analysis JULIAN FISCHER | Geometry and its Interfaces TAMÁS HAUSEL | Stochastic Analysis JAN MAAS | Mathematical Physics ROBERT SEIRINGER | Discrete and Computational Geometry and Topology ULI WAGNER

Neuroscience

Neuroscientists study the nervous system to understand how our brains work. Neuroscience is a highly multidisciplinary field of science, combining physiology, molecular biology, developmental biology, and cognitive science, with links to mathematics, computer science, and physics. Accordingly, the research backgrounds of neuroscientists at IST Austria are diverse.

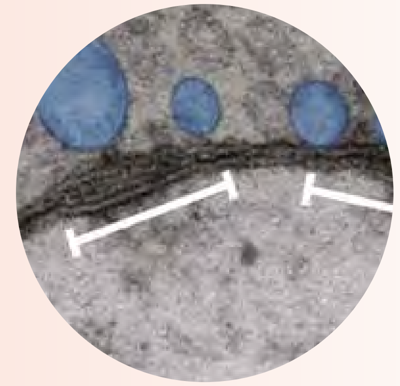
In 2020, neuroscientists at IST Austria investigated questions such as: What is the role of the hippocampus in the formation of memory and how does replaying neuronal activity help rats to find a treat? How does a defect in a specific gene associated with autism change the structure of a brain region? And where exactly is our short-term memory located in our brains?



The librarian of memory

Csicsvari group

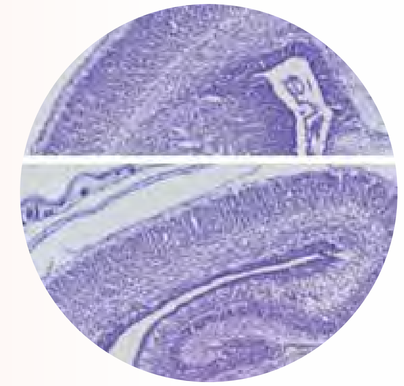
When rats learn where scientists have been hiding treats for them, certain hippocampal neurons, so-called place cells, are active when the animal is at those reward locations. During sleep, the same combination of place cells becomes active—the neuronal activity is replayed. To gain further insights into the role of replay in memory formation, Jozsef Csicsvari and his group selectively disrupted the replay related to some reward locations. After sleep, the rats' ability to find rewards at these locations was impaired. "With our procedure, we were able to influence which memories the animal was able to recall," explains Csicsvari. As the rat relearned where the reward was hidden, the same combination of place cells as before encoded for the reward location. Hence, the memory was not erased, but the rats were no longer able to recall it. "There needs to be a librarian to remember where the memory is. The hippocampus is this librarian," Csicsvari concludes.



Physical traces of our memory

Jonas group

How do we remember a movie we just watched? In the twentieth century, the idea of an "engram," a physical substrate of a memory, was introduced: As an animal learns, information is stored in an engram in the brain. Later, the animal retrieves this information. But where are these engrams? In order to answer this question, postdoc David Vandael of the Jonas group studied single synapses in the hippocampus, the brain area required for learning and memory. In his experiments, he recorded what happens as a granule cell sends a signal to the pyramidal cell with which it is connected. When a granule cell fires, it induces a type of synaptic plasticity that strengthens communication between granule cell and pyramidal cell for several minutes. "After a granule cell is active, more vesicles containing neurotransmitters are stored at the pre-synaptic terminal," explains Vandael. During learning, when the granule cell is active, vesicles are pushed into this pool at the active zone. Thus, short-term memory might be activity stored as vesicles that are later released.



Understanding autism spectrum disorder

Novarino group

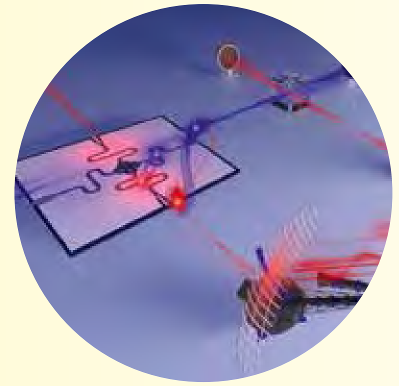
Within the European Union alone, approximately three million people are affected by an autism spectrum disorder (ASD). Hundreds of different genes can be responsible for this. However, it is still largely unclear how exactly the underlying processes at the molecular and cellular level work. With her research group, neuroscientist Gaia Novarino examined the function of a high-risk autism gene, Cullin 3, using a mouse model. They discovered that a defect in Cullin 3 causes brain cells to migrate more slowly to their intended location after their formation, changing the structure of the cerebral cortex. The mice with a partially deactivated Cullin 3 gene demonstrated, among other things, behavioral abnormalities such as sensory hyper-reactivity, similar to people with this type of ASD. The Novarino group was able to show that Cullin 3 plays an important role, especially during the early phase of brain development, highlighting the critical temporal window for the treatment of this form of ASD.

Faculty Systems Neuroscience JOZSEF CSICSVARI | High-resolution Optical Imaging for Biology JOHANN DANZL | Genes, Circuits, and Behavior MARIO DE BONO | Genetic Dissection of Cerebral Cortex Development SIMON HIPPENMEYER | Cellular Neuroscience PETER JONAS | Neuroethology MAX JÖSCH | Tissue Growth and Developmental Pattern Formation ANNA KICHEVA | Genetic and Molecular Basis of Neurodevelopmental Disorders GAIA NOVARINO | Molecular Neuroscience RYUICHI SHIGEMOTO | Neuroimmunology in Health and Disease SANDRA SIEGERT | Evolution, Development, and Function of Motor Circuits LORA SWEENEY | Information Processing in Biological Systems GAŠPER TKAČIK | Computational Neuroscience and Neurotheory TIM VOGELS

Physics

Physics is one of the oldest and most fundamental disciplines, and at IST Austria, scientists have approached questions in and inspired by this field from many different perspectives, using both experimental and theoretical methods. The diverse interests of the physics groups have led to advances in the performance of stimulated emission depletion nanoscopy, the utilization of optical cavity-generated spin-squeezed states in free space atomic fountain clocks, and the observation of zero field splitting within germanium hut wire quantum dots, among other developments.

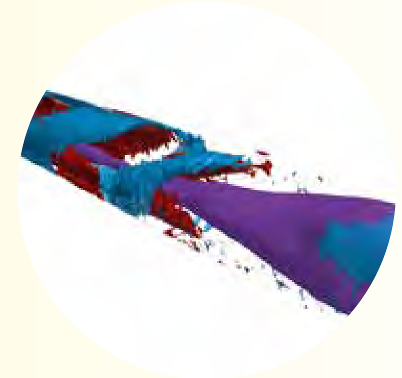
Research in physics often leads to technological advances, as scientists design new materials and machines to test their ideas and discoveries lead to novel applications. Physicists at IST Austria push boundaries in both aspects, and their research has led to developments in optical imaging, physical principles in biological systems, nanoelectronics, and more.



New quantum radar prototype

Fink group

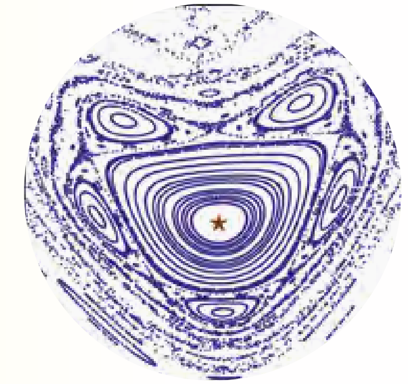
Quantum entanglement is a physical phenomenon where two particles remain interconnected, sharing physical traits regardless of the distance between them. The Fink group and their collaborators were able to harness this phenomenon for use in a new type of detection technology known as “microwave quantum illumination”. The prototype, also called a “quantum radar”, is able to detect objects with ultra-low power signals in noisy thermal environments where classical radar systems often fail. Instead of using conventional microwaves, the team entangled two groups of photons: “signal” and “idler” photons. The signal photons are sent out towards the object of interest, while the idler photons are measured in relative isolation, free from interference and noise. When the signal photons are reflected back, true entanglement is lost, but a small amount of correlation remains, creating a signature or pattern that describes the existence or absence of the target object—irrespective of noise within the environment.
While the current experiment relies on post-processed correlations, potential future applications will require the development of analog receivers with high quantum efficiency.



Turbulence in blood flow

Hof group

Blood flow in the human body is generally assumed to be smooth, due to its low speed and high viscosity. Flow instabilities are often believed to be connected to cardio-vascular diseases. For example, fluctuating stresses at the vessel walls can lead to plaque buildup and to the narrowing of arterial pathways, one of the leading causes of death worldwide. However, the source of this unsteadiness is not well understood. This year, the Hof group and collaborators explored this question using both theory and experiments. They found that when the flow of pulsating blood slows down (e.g. in between heartbeats), turbulence is created by a previously unknown instability mechanism. This happens especially in areas with geometric irregularities, such as bends or those caused by plaque buildup. Once the flow accelerates again (e.g. with the beat of the heart), it becomes smooth and turbulence free. Thus, if a blood vessel is not ideally shaped or has geometric irregularities, more turbulent flow is likely to occur with each pulse cycle or heartbeat. This research could have implications for the study of blood flow-related diseases in the future.



The beginning defines the end

Serbyn group

Chaos is a familiar idea in the classical world: We see many examples of irregular and unpredictable behavior in complex systems—weather, planetary motion, and turbulence, among others. Chaos limits our ability to predict the future behavior of these systems even when the theoretical model is well known. Quantum systems show behavior that is similar in many aspects, but not much is known about the relevance of classical chaos to interacting quantum systems. This year, the Serbyn group and their collaborators were able to build a specific link between classical chaos and quantum systems. In particular, they connected the “least chaotic” initial conditions in classical systems to initial states in quantum systems that give the slowest relaxing behavior. This connection could provide an avenue for generalizing few-body chaos to many-body quantum systems. In addition, the team provided a method for finding the configurations most resilient to chaos and give specific examples that can be tested in future experiments.

Faculty Condensed Matter and Ultrafast Optics ZHANYBEK ALPICHSHEV | High-resolution Optical Imaging for Biology JOHANN DANZL | Mathematics of Disordered Quantum Systems and Matrices LÁSZLÓ ERDŐS | Quantum Integrated Devices JOHANNES FINK | Materials Electrochemistry STEFAN FREUNBERGER | Theoretical and Computational Soft Matter CARL GOODRICH | Physical Principles in Biological Systems EDOUARD HANNEZO | Condensed Matter and Quantum Circuits ANDREW HIGGINBOTHAM | Nonlinear Dynamics and Turbulence BJÖRN HOF | Quantum Sensing with Atoms and Light ONUR HOSTEN | Functional Nanomaterials MARIA IBÁÑEZ | Nanoelectronics GEORGIOS KATSAROS | Theoretical Atomic, Molecular, and Optical Physics MIKHAIL LEMESHKO | Thermodynamics of Quantum Materials at the Microscale KIMBERLY MODIC | Mathematical Physics ROBERT SEIRINGER | Condensed Matter Theory and Quantum Dynamics MAKSYM SERBYN | Information Processing in Biological Systems GAŠPER TKAČIK | Soft and Complex Materials SCOTT WAITUKAITIS

Supporting Science

Scientific Service Units at IST Austria

From supercomputing to microscope imaging to 3D printing, scientists across the board frequently require expertise and equipment that they do not have within their research groups, and often, multiple groups have similar needs. At IST Austria, this diverse machinery and knowledge is organized centrally at the Scientific Service Units (SSUs). Each SSU is led by a manager and staffed with a team of experts that maintains the equipment and supports scientists with know-how, customized development, and training.

Currently, there are eight SSUs on campus:

- Bioimaging Facility
- Electron Microscopy Facility
- Library
- Lab Support Facility
- Miba Machine Shop
- Nanofabrication Facility
- Preclinical Facility
- Scientific Computing Facility

In addition, five staff scientists are associated with the SSUs: two in the Bioimaging Facility and one each in Electron Microscopy, Nanofabrication, and Preclinical Facilities. Staff scientists are highly qualified researchers who work closely with various research groups on campus as well as advance their own projects. Read more about IST Austria's staff scientists on pages 74-75.

Quantitative (bio) imaging: from images to numbers

Bioimaging Facility

Microscopy and image analysis are central tools for investigating the cellular and molecular mechanisms that underlie various biological processes. Microscopy is best used to describe and compare biological observations in a quantitative manner.
Recent investments in the Bioimaging Facility equipment park include several technological innovations: For instance, a flexible multi-modal spinning disk microscope allows multi-color 3D imaging of large samples, which can be combined with super-resolution technologies. Additional setups enable Fluorescent Lifetime Imaging Microscopy—a technology that can be used to probe the micro-environment of a fluorophore. The data acquired can be analyzed and quantified on high-end workstations equipped with a variety of image analysis software programs, which rely in part on machine learning. These workstations are now remotely accessible to accommodate new needs.
The Bioimaging Facility hosts and maintains an elaborate high-end machine park, and provides project-based image analysis and optical development solutions, to allow researchers at IST Austria to focus on the investigation and required quantification of their research project.

Innovative set-up to measure universal values

Hof group and Miba Machine Shop

The transition to turbulence in the most basic fluid flows—such as those through pipes, channels or in the gap between two rotating, concentric cylinders (circular Couette flow)—have remained unresolved for over a century. The main reason this question has remained open for all this time is the difficulty in creating the experimental set-ups necessary to take measurements—even the longest pipes built in the lab were too short for turbulence to reach the appropriate equilibrium state. Together, the Hof group and the Institute's Machine Shop overcame this problem by thinking in circles: After seven years of designing and refining prototypes, they created a set-up in which turbulence travels azimuthally around an inner cylinder, allowing it to reach the appropriate state and to remain in it indefinitely. Using their machine, they were able to test a prediction made by statistical mechanics, which states that the transition is described by three "critical exponents". The team's experiment is the first that could determine these universal numbers for Couette flow.

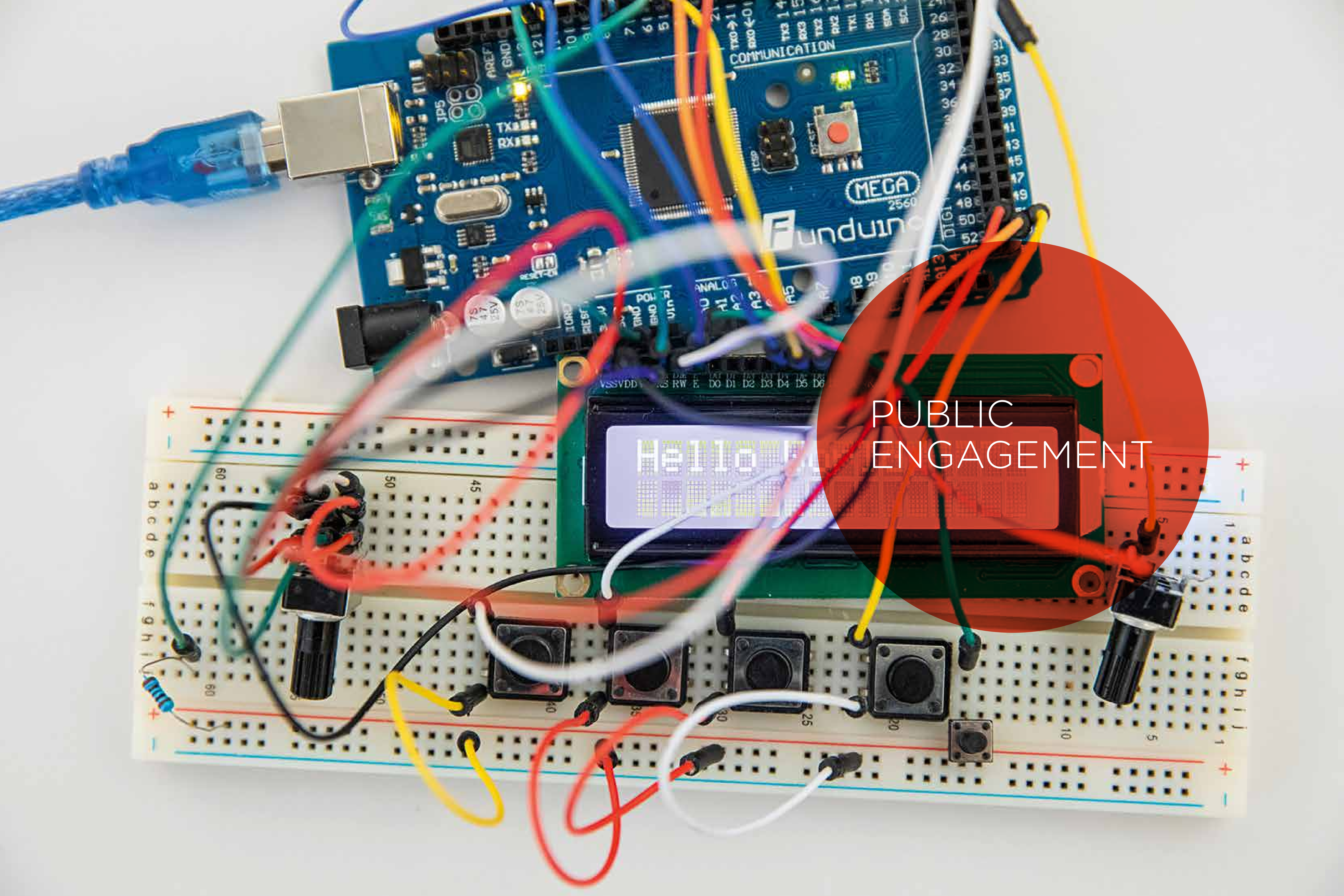
Viruses as effective gene delivery tools on campus

Virus Services (Lab Support Facility)

In the past decades, viruses have been widely used as research tools for gene delivery in living cells and organisms. Neuroscientists, for example, employ specific viruses to map as-of-yet unknown brain connections while cell biologists use other viral systems to study protein function, localization, and interaction within the wider protein network of the cell.
Fully operational since January 2020, IST Austria's "Virus Services" assists research groups with the efficient use of virus vectors, including vector design, molecular cloning, and viral production. For the Sixt group, Virus Services has produced various viruses expressing cytoskeletal regulators in different flavors to allow for the genetic manipulation of dendritic cells. Then, for the Novarino group, the team designed an "all-in-one" viral vector that allowed for specific gene activation using the CRISPR system. Staff expertise has also been invaluable to the Cremer group in the work involving ant immunity from virus pathogens. In general, centralized virus know-how allows groups to quickly establish their most appropriate viral system by providing expert advice and a wide pool of reagents to test.

Facility Managers Bioimaging Facility GABRIEL KRENS | Electron Microscopy Facility LUDEK LOVICAR | Library PATRICK DANOWSKI | Lab Support Facility MATTHIAS NOWAK | Miba Machine Shop TODOR ASENOV | Nanofabrication Facility SALVATORE BAGIANTE | Preclinical Facility MICHAEL SCHUNN | Scientific Computing Facility STEPHAN STADLBAUER
Staff Scientists Bioimaging Facility ROBERT HAUSCHILD, CHRISTOPH SOMMER | Electron Microscopy Facility WALTER KAUFMANN | Nanofabrication Facility JACK MERRIN | Preclinical Facility SATISH ARCOT JAYARAM

PUBLIC ENGAGEMENT



Communicating Science

Outreach and science education at IST Austria

Despite the challenges of running an outreach program during a lockdown and, later, with physical distancing, IST Austria remained committed to engaging a variety of audiences with science and the excitement of research. Science education is one of the Institute's key missions, and this year in particular highlighted the vital role science plays in society, as well as how important, in particular, people's trust in science and scientists is.

Not only did the Institute preserve and adapt outreach measures from previous years, this year—as a result of the extraordinary situation—several new outreach programs were initiated. In doing so, IST Austria explored new formats and was able to reach a wider audience. The measures included general audience science talks, a collective diary to map social experiences during the pandemic, and even a board game that explores how a virus spreads.

From Pop-Up Science to Zoom a Scientist
When Austria was placed under lockdown and schools moved to online teaching, the employees at IST Austria put their heads together to brainstorm how the Institute could continue to engage students. One week later, "Pop-up Science" was launched. The project lasted almost 16 weeks and involved 18 different scientists from a wide range of fields. Each week's program consisted of a worksheet, a video describing an experiment or activity that could be done at home, and a video interview with an IST Austria scientist. Also created during this time were three "Supergscheit!" videos, which featured "super clever" questions such as "How bright is dark?" and "How powerful is air?", and sought to explore everyday phenomena and their connection to cutting-edge research. Teachers received Pop-Up Science enthusiastically, incorporating the material into their distance learning programs, and children (and their families) enjoyed the opportunity to explore science from their living rooms. Moreover, with the new science education program "Zoom a Scientist", classes can sign up for an online video session with an IST Austria scientist based on their interests. This allows students to get to know the people behind the science and learn how science is done at an international research institute.

Science for everyone
How our social contact behavior did and continues to change in response to the Corona pandemic is a question IST Austria is analyzing in a citizen science project. Since March 2020, an online questionnaire was open to create the collective CoKoNet (Corona Contact Network) diary, reflecting the change of our social interaction networks. To date, more than 3.500 anonymized diary entries have been contributed. The analyzed data will be presented back to the public.

Another way to engage with a broader public is the new "IST Austria Science Talks", a series of online lectures given by IST Austria professors in German. So far, four professors have presented, with topics ranging from the role of cryptography in the pandemic and climate change to how microglia keep our brains in shape. The talks have been received very well, with large audiences eager to ask questions.

Summer science camps
Once again, IST Austria invited elementary and high school students to participate in the Institute's summer science camps: Sommercampus and Talentesommer. To comply with Corona regulations, both camps had fewer students than in previous years, but no less excitement. During Sommercampus, four different tracks—biology, computer science, physics, and art—featured several days of experiments and free exploration.

The Talentesommer (run in cooperation with the Niederösterreichische Talenteschmiede) was aimed at high school students. Under the motto "Design your own research lab!" students met IST Austria scientists and asked questions about their work. Following a discussion of gender in science, the students interviewed two scientists on their experiences. Furthermore, students came up with their own research questions and used 3D-design software to create the future lab where they could explore these questions. They even used 3D printers to bring their buildings to life! In doing so, they began to recognize the importance of creativity and asking new questions in research.

Empowering Knowledge

Enabling research and education on campus



The importance of scientific knowledge has become extremely tangible over the course of the past year. Assisted by an ever-growing number of patrons, IST Austria continues to ensure that its scientific research is at the forefront of global developments.

This rendering shows what the Science Experience Center in the heart of the IST Austria campus will look like.

The past months have posed significant challenges to society at large, emphasizing the paramount role cutting-edge science holds in our daily lives. With foresight, IST Austria's supporting network has given weight to science through generous contributions towards basic research and state-of-the-art facilities in the past, which allowed the continued acquisition of new knowledge on campus also during a challenging year. IST Austria is extremely grateful to its patrons who, in this manner, have permanently attached their names to the Institute's mission.

Part of this mission is encompassed by a new Science Experience Center that will be built in the middle of the IST Austria campus. With a planned opening date in the near future, it is IST Austria's designated aim to educate, raise awareness, and let science and reason take center stage in this unique venture—in short: to give hope. In order for the Institute to fulfill this ambitious objective, a comprehensive campaign to win over patrons from all parts of society and paths of life is being initiated. Now, as in the past, stakeholders' support is paramount to the creation of an ever-evolving, improved world for future generations.

More information: www.ist.ac.at/donors

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Content

Facts & Figures

Professors at IST Austria
(under contract as of December 31, 2020)

Dan Alistarh Distributed Algorithms and Systems
Zhanybek Alpichshev Condensed Matter and Ultrafast Optics
Nick Barton Evolutionary Genetics
Eva Benková Plant Developmental Biology
Carrie Bernecky RNA-Based Gene Regulation
Bernd Bickel Computer Graphics and Digital Fabrication
Tim Browning Analytic Number Theory and its Interfaces
Krishnendu Chatterjee Computer-Aided Verification, Game Theory
Sylvia Cremer Social Immunity
Jozsef Csicsvari Systems Neuroscience
Johann Danzl High-Resolution Optical Imaging for Biology
Mario de Bono Genes, Circuits, and Behavior
Herbert Edelsbrunner Algorithms, Computational Geometry, and Computational Topology
László Erdős Mathematics of Disordered Quantum Systems and Matrices
Johannes Fink Quantum Integrated Devices
Julian Fischer Theory of Partial Differential Equations, Applied and Numerical Analysis
Stefan Freunberger Materials Electrochemistry
Jiří Friml Developmental and Cell Biology of Plants
Carl Goodrich Theoretical and Computational Soft Matter
Călin Guet Systems and Synthetic Biology of Genetic Networks
Edouard Hannezo Physical Principles in Biological Systems
Tamás Hausel Geometry and its Interfaces
Carl-Philipp Heisenberg Morphogenesis in Development
Thomas A. Henzinger Design and Analysis of Concurrent and Embedded Systems
Andrew Higginbotham Condensed Matter and Quantum Circuits
Simon Hippenmeyer Genetic Dissection of Cerebral Cortex Development
Björn Hof Nonlinear Dynamics and Turbulence
Onur Hosten Quantum Sensing with Atoms and Light
Maria Ibáñez Functional Nanomaterials
Peter Jonas Cellular Neuroscience
Maximilian Jösch Neuroethology
Vadim Kaloshin* Dynamical Systems, Celestial Mechanics, and Spectral Rigidity
Georgios Katsaros Nanoelectronics
Anna Kicheva Tissue Growth and Developmental Pattern Formation
Lefteris Kokoris-Kogias* Secure, Private, and Decentralized Systems (SPIDERS)
Vladimir Kolmogorov Discrete Optimization
Fyodor Kondrashov Evolutionary Genomics
Christoph Lampert Machine Learning and Computer Vision
Mikhail Lemeshko Theoretical Atomic, Molecular, and Optical Physics
Martin Loose Self-Organization of Protein Systems
Jan Maas Stochastic Analysis
Kimberly Modic Thermodynamics of Quantum Materials at the Microscale
Marco Mondelli Data Science, Machine Learning, and Information Theory
Caroline Muller* Atmosphere and Ocean Dynamics
Gaia Novarino Genetic and Molecular Basis of Neurodevelopmental Disorders
Jérémie Palacci* Materiali Molli
Krzysztof Pietrzak Cryptography
Matthew Robinson Medical Genomics
Leonid Sazanov Structural Biology of Membrane Protein Complexes
Paul Schanda* Biomolecular Mechanisms from Integrated NMR Spectroscopy
Florian Schur Structural Biology of Cell Migration and Viral Infection
Robert Seiringer Mathematical Physics
Maksym Serbyn Condensed Matter Theory and Quantum Dynamics
Ryuichi Shigemoto Molecular Neuroscience
Sandra Siegert Neuroimmunology in Health and Disease
Daria Siekhaus Invasive Migration
Michael Sixt Morphodynamics of Immune Cells
Lora Sweeney Evolution, Development and Function of Motor Circuits
Gašper Tkačik Information Processing in Biological Systems
Beatriz Vicoso Sex-Chromosome Biology and Evolution
Tim Vogels Computational Neuroscience and Neurotheory
Uli Wagner Discrete and Computational Geometry and Topology
Scott Waitukaitis Soft and Complex Materials
Chris Wojtan Computer Graphics and Physics Simulation
Daniel Zilberman* Epigenetics and Chromatin

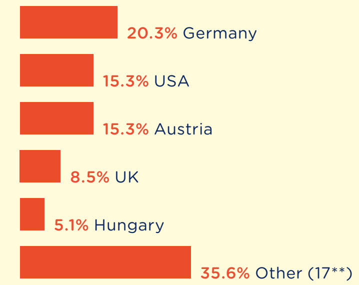
* joining IST Austria during 2021 or 2022 (see also pages 22-23)

Total number of professors under contract: 65

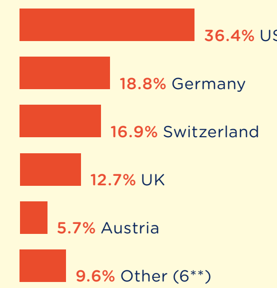
Total number of professors on campus: 59

Gender among professors*

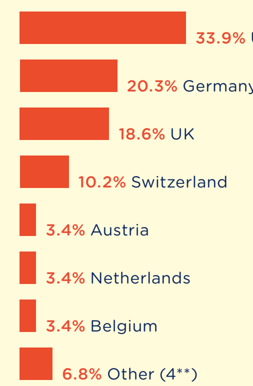
Country of nationality*



Country of PhD institution*



Country of previous institution*



* Data refer to 59 professors on campus as of December 31, 2020; percentages are rounded
** Number of countries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Dan Alistarh

Distributed Algorithms and Systems

Distribution has been one of the key trends in computing over the last decade: processor architectures are multi-core, while large-scale systems for machine learning and data processing can be distributed across several machines or even data centers. The Alistarh group works to enable these applications by creating algorithms that scale—that is, they improve their performance when more computational units are available.

The shift to distributed computing opens exciting questions: How do we design algorithms to extract every last bit of performance from the current generation of architectures? How do we design future architectures to support more scalable algorithms? Are there clean abstractions to render high-performance distribution accessible to programmers? The group seeks to answer these questions, and focuses on designing efficient, practical algorithms for fundamental problems in distributed computing, understanding the inherent limitations of distributed systems, and on developing new ways to overcome these limitations.

Current projects Distributed machine learning | Concurrent data structures and applications | Molecular computation

Career
- since 2017 Assistant Professor, IST Austria
- 2016 – 2017 "Ambizione" Fellow, Computer Science Department, ETH Zurich, Switzerland
- 2014 – 2016 Researcher, Microsoft Research and Morgan Fellow, University of Cambridge, UK
- 2012 – 2013 Postdoc, MIT, USA
- 2012 PhD, EPFL, Lausanne, Switzerland

Zhanybek Alpichshev

Condensed Matter and Ultrafast Optics

To understand a complex system, it is often useful to bring it out of equilibrium: the recovery dynamics will reveal a great deal about its inner workings. The Alpichshev group uses ultra-fast optical methods to understand the physical mechanisms underlying some of the extremely complicated phenomena in many-body physics.

A key problem in modern physics is to understand the behavior of a large number of strongly interacting particles. Such systems often feature unique properties such as high-temperature superconductivity, but the origin of these behaviors is unclear. The main difficulty is that these "strongly correlated" properties arise in the context of a large number of competing phases, which makes it difficult to determine the role of each factor. The Alpichshev group circumvents this problem by using ultra-short laser pulses to selectively perturb and probe the individual degrees of freedom in a strongly correlated material and study the system in the resulting transient state. The resulting information can be used to reconstruct the microscopic mechanisms behind complex phenomena.

Current projects Determining the role of rattling modes of organic cations on the transport of photo-carriers in hybrid lead halide perovskites | Exciton dynamics in frustrated Mott insulators | Ultrafast dissipative processes in correlated electron systems below Planckian level

Career
- since 2018 Assistant Professor, IST Austria
- 2017 – 2018 Visiting Scientist, Max Planck Institute for the Structure and Dynamics of Matter, Hamburg, Germany
- 2012 – 2017 Postdoctoral Associate, Massachusetts Institute of Technology, Cambridge, MA, USA
- 2012 PhD, Stanford University, Palo Alto, USA

Nick Barton

Evolutionary Genetics

The Barton group develops mathematical models to probe fundamental issues in evolution: For example, how do new species form, what limits adaptation, and what shapes the genetic system?

Nick Barton and his group study diverse topics in evolutionary genetics. The main focus of their work is the effects of natural selection on many genes and the evolution of populations that are distributed across space. They develop statistical models for the evolution of complex traits, which depend on the combined effects of very many genes. Working with other groups at IST Austria, they study the evolution of gene regulation, using a thermodynamic model of transcription factor binding. A substantial component of the group's work is a long-term study of the hybrid zone between two populations of snapdragons (*Antirrhinum*) that differ in flower color. This combines detailed field observation with genetic data to estimate population structure and fitness variation over multiple scales and serves as a test-bed for developing ways to infer selection and demography from DNA sequence.

Current projects Evolution of complex traits | Analysis of selection experiments | Understanding genealogies in space and at multiple loci | Inference from DNA sequence | Population structure and hybridization in *Antirrhinum*

Career
- since 2008 Professor, IST Austria
- 1990 – 2008 Reader and Professor, University of Edinburgh, UK
- 1982 – 1990 Lecturer and Reader, University College London, UK
- 1980 – 1982 Demonstrator, Cambridge University, UK
- 1979 PhD, University of East Anglia, Norwich, UK

Eva Benková

Plant Developmental Biology

True to their name's Greek roots, plant hormones "set in motion" a myriad of physiological processes that influence and modulate each other in an intricate network of interactions. The Benková group seeks to untangle this network and understand its molecular basis.

Local heterogeneities in water and nutrient availability, sudden changes in temperature, light or other stressors trigger dramatic changes in plant growth and development. Multiple hormonal signaling cascades interconnected into complex networks act as translators of these exogenous signals in plant adaptive responses. How the hormonal networks are established, maintained, and modulated to control specific developmental outputs is the focus of the Benková group. Lately, the researchers primarily focused on dissecting molecular mechanisms underlying the establishment of hormonal networks directing plant development. Thus, the group's work contributed to understanding how plant development is internally regulated by plant hormones. Furthermore, it led to the identification of several important mechanisms that connect individual hormonal pathways into a complex regulatory network and mediate interaction with environmental inputs.

Current projects Convergence of auxin and cytokinin hormonal pathways | Identification of hormonal cross-talk components by genetic approaches | Hormonal crosstalk driven nutrient-dependent root development

Career
- since 2016 Professor, IST Austria
- 2013 – 2016 Assistant Professor, IST Austria
- 2011 – 2013 Group Leader, Central European Institute of Technology (CEITEC), Brno, Czech Republic
- 2007 – 2013 Group Leader, Flanders Institute for Biotechnology, Ghent, Belgium
- 2003 – 2007 Habilitation position, University of Tübingen, Germany
- 2001 – 2003 Postdoc, Center for Plant Molecular Biology, Tübingen, Germany
- 1998 – 2001 Postdoc, Max Planck Institute for Plant Breeding, Cologne, Germany
- 1998 PhD, Institute of Biophysics of the Academy of Sciences of the Czech Republic, Brno, Czech Republic

Carrie Bernecky

RNA-Based Gene Regulation

The regulated expression of genetic material is one of the most basic processes of a cell, affecting everything from organism development to environmental response. Through structural studies of the involved complexes, the Bernecky group works to unravel the gene expression regulatory networks that employ RNA as an intermediate.

RNA is an important focal point for the regulation of gene expression. Both protein-coding and noncoding RNAs are integral components of diverse regulatory pathways and often act together with protein cofactors. Despite their importance, an understanding of the mechanisms of action of the involved RNA-protein complexes is lacking. Many of these RNA-containing complexes are flexible, modular and lowly abundant. For such challenging targets, cryo-electron microscopy has emerged as a particularly powerful tool for the determination of near-atomic structures while simultaneously providing insight into their dynamics. Using this and related methods, the Bernecky group aims to understand how RNA-protein complexes assemble and regulate cellular RNA metabolism.

Current projects Molecular basis of transcriptional regulation | Regulation of mammalian transcription by noncoding RNA | Substrate recognition by RNA modifying enzymes | Roles of A-to-I editing in dsRNA recognition

Career
- since 2018 Assistant Professor, IST Austria
- 2011 – 2017 Postdoc, Ludwig Maximilian University Munich and Max Planck Institute for Biophysical Chemistry, Göttingen, Germany
- 2010 – 2011 Postdoc, University of Colorado Boulder, USA
- 2010 PhD, University of Colorado Boulder, USA

Bernd Bickel

Computer Graphics and Digital Fabrication

We are currently witnessing the emergence of novel, computer-controlled output devices that provide revolutionary possibilities for fabricating complex, functional, multi-material objects and metamaterials with stunning optical and mechanical properties.

Bernd Bickel is a computer scientist interested in computer graphics and its overlap with animation, biomechanics, material science, and digital fabrication. His group seeks to push the boundaries of how functional digital models can be efficiently created, simulated, and reproduced. Given the digital nature of the process, three factors play a central role: computational models and efficient representations that facilitate intuitive design, accurate and fast simulation techniques, and intuitive authoring tools for physically realizable objects and materials. Accordingly, the work of the Bickel group focuses on two closely related challenges: (1) developing novel modeling and simulation methods, and (2) investigating efficient representation and editing algorithms for materials and functional objects.

Current projects Computational synthesis of metamaterials | Soft robotics | Interactive design systems | Design of cyber-physical systems

Career
- since 2020 Professor, IST Austria
- 2015 – 2020 Assistant Professor, IST Austria
- 2012 – 2014 Research Scientist and Research Group Leader, Disney Research Zurich, Switzerland
- 2011 – 2012 Visiting Professor, TU Berlin, Germany
- 2011 – 2012 Postdoc, Disney Research Zurich, Switzerland
- 2010 PhD, ETH Zurich, Switzerland

Tim Browning

Analytic Number Theory and its Interfaces

What is the connection between adding and multiplying whole numbers? This is a surprisingly deep question with several interpretations. One natural extension studies the sequence of integers that arise as solutions to a polynomial equation with integer coefficients, i.e. a Diophantine equation. The Browning group works on understanding such sequences, using a blend of analytic, geometric, and algebraic methods.

Low-dimensional Diophantine equations have been heavily used in cryptography, but the properties of higher-dimensional Diophantine equations remain largely mysterious. Hilbert's 10th problem asks for an algorithm to decide if a given Diophantine equation has integer solutions. Mathematical logic has revealed this to be an impossible dream, but does such a procedure exist if we just seek rational solutions? Moreover, when solutions are known to exist, there are deep conjectures that connect their spacing to the intrinsic geometry of the equation. The Browning group is involved in actively expanding the available toolkit for studying these problems and their generalizations.

Current projects Moduli space of rational curves on hypersurfaces of low degree | Rational points on Fano varieties | Manin's conjecture for orbifolds | Motivic arithmetic statistics | Integral points of bounded hight | Equidistribution of lattices

Career
- since 2018 Professor, IST Austria
- 2012 – 2019 Professor, University of Bristol, UK
- 2008 – 2012 Reader, University of Bristol, UK
- 2005 – 2008 Lecturer, University of Bristol, UK
- 2002 – 2005 Postdoctoral Research Fellow, University of Oxford, UK
- 2001 – 2002 Postdoctoral Research Fellow, Université de Paris-Sud, Orsay, France
- 2002 PhD, Magdalen College, University of Oxford, UK

Krishnendu Chatterjee

Computer-Aided Verification, Game Theory

Life is a game—at least in theory. Game theory has implications for the verification of correctness of computer hardware and software, but also in biological applications, such as evolutionary game theory. The Chatterjee group works on the theoretical foundations of game theory, addressing central questions in computer science.

Game theory studies interactive problems in decision-making, and can be used to study problems in fields from logic to biology. The Chatterjee group is interested in the theoretical foundations of game theory, its application in formal verification, and evolutionary game theory. Game theory in formal verification involves the algorithmic analysis of various forms of games played on graphs, where the graph models a reactive system. This framework allows for the effective analysis of many important questions and helps to develop robust systems. The Chatterjee group also works on algorithmic aspects of evolutionary game theory on graphs, where the graph models a population structure. Here, their goals are to better understand games and to develop new algorithms.

Current projects Quantitative verification | Stochastic game theory | Modern graph algorithms for verification problems | Evolutionary game theory

Career
- since 2014 Professor, IST Austria
- 2009 – 2014 Assistant Professor, IST Austria
- 2008 – 2009 Postdoc, University of California, Santa Cruz, USA
- 2007 PhD, University of California, Berkeley, USA

Sylvia Cremer

Social Immunity

Social insects fight disease as a collective. Together, they prevent and treat infections and alter their social behaviors to prevent epidemics. The Cremer group studies how collective protection arises at the colony level from individual behaviors and social interactions in ants.

Like all social groups with frequent and close social interactions, social insects run the risk of high transmission of infectious disease through their colony. Ants effectively counteract this threat by reducing the pathogen load in their colonies by prophylactic nest disinfection, immediate sanitary care of pathogen-exposed colony members, as well as treatment of established infections. They further effectively prevent epidemics by social distancing: Both, the contagious individuals themselves, as well as their “peers” that engage in the same tasks and hence regularly engage with the contagious individuals, reduce the social interactions to other colony members, which strongly lowers disease spread between the different peer groups and hence the whole colony.

Current projects Collective hygiene in ant societies | Social interaction networks and epidemiology | Disease resistance and tolerance | Costs and benefits of social immunization

Career
- since 2015 Professor, IST Austria
- 2010 – 2015 Assistant Professor, IST Austria
- 2010 Habilitation, University of Regensburg, Germany
- 2006 – 2010 Group Leader, University of Regensburg, Germany
- 2006 Junior Fellow, Institute of Advanced Studies, Berlin, Germany
- 2002 – 2006 Postdoc, University of Copenhagen, Denmark
- 2002 PhD, University of Regensburg, Germany

Jozsef Csicsvari

Systems Neuroscience

Memory formation is crucial for learning. This process of encoding, storing, and ultimately recalling memories involves complex interactions between various brain regions and neurons in embedded circuits that form complex codes to encode these memory traces. The Csicsvari group studies how learning is implemented in the brain.

During learning, new memories are acquired and then consolidated to ensure their successful later recall. The Csicsvari group focuses on understanding how learning leads to memory formation in neuronal circuits by investigating the neuronal system mechanisms of memory formation and stabilization. The researchers also investigate the mnemonic role of neuronal populations and their interactions in brain areas involved in spatial memory processing. The group seeks to understand how neuronal circuits process information and form spatial memories by recording the activity of many neurons in different brain regions during spatial learning tasks and sleep. Using optogenetic methods, the researchers selectively manipulate neuronal activity in different brain areas.

Current projects Oscillatory interactions in working memory | Role of hippocampal formation in spatial learning | Activation of brain structures using light sensitive channels to study memory formation

Career
- since 2011 Professor, IST Austria
- 2008 – 2011 MRC Senior Scientist (tenured), MRC Anatomical Neuropharmacology Unit, University of Oxford, UK
- 2003 – 2008 MRC Senior Scientist (tenure-track), MRC Anatomical Neuropharmacology Unit, University of Oxford, UK
- 2001 – 2002 Research Associate, Center for Behavioral and Molecular Neuroscience, Rutgers University, New Brunswick, USA
- 1999 – 2001 Postdoctoral Fellow, Center for Behavioral and Molecular Neuroscience, Rutgers University, New Brunswick, USA
- 1999 PhD, Rutgers University, New Brunswick, USA

Johann Danzl

High-Resolution Optical Imaging for Biology

How can we decode the molecular architecture of biological systems? How can we analyze living cells and tissues across spatial and temporal scales? The central aim of the Danzl lab, an interdisciplinary team of physicists, biologists, computer scientists, and neuroscientists, is to shed light on problems of biological and medical relevance by developing and using a set of advanced light microscopy tools.

The Danzl group explores and extends the possibilities of optical imaging, including approaches that enable resolution better than the optical diffraction limit of about half the wavelength of light or 200 nm. With resolution reaching into the nanometer range and the capability to analyze cells in their native tissue context, the group aims to extract new information from biological specimens. To this end, they work toward the development of novel imaging approaches, building on their expertise in physics and high-resolution imaging integrated with state-of-the-art technologies to manipulate cells and tissues, label them, and extract the most information from the imaging data.

Current projects Deep-tissue nanoscale imaging | Minimally perturbing high-resolution imaging | Decoding of synapse nano-architecture | High-content analysis of tissue microarchitecture

Career
- since 2017 Assistant Professor, IST Austria
- 2012 – 2016 Postdoc, Department of NanoBiophotonics, Max Planck Institute for Biophysical Chemistry, Göttingen, Germany
- 2010 – 2011 Postdoc, Institute for Experimental Physics, University of Innsbruck, Austria
- 2010 PhD, University of Innsbruck, Austria
- 2005 MD, Medical University of Innsbruck, Austria

Mario de Bono

Genes, Circuits, and Behavior

The de Bono group seeks to discover and then dissect basic molecular mechanisms that underpin the functions of neurons and neural circuits. Neurons are highly specialized cells and many fundamental questions about their organization, function, and plasticity remain unaddressed.

The group initiates many of their studies in the roundworm *C. elegans*, because of its advantages for molecular and cellular neuroscience. Each neuron of this animal can be identified and visualized *in vivo* by selectively manipulating it using transgenes and monitoring its activity with genetically-encoded sensors. Powerful genetics and advanced genomic resources make high-throughput forward genetics and single neuron profiling possible. Genetics are complemented with biochemistry to get at molecular mechanisms that are usually conserved from worm to human. The group aims to take discoveries made in the worm into mammalian models.

Current projects Global animal states | The neural unknome | Neuroimmune signaling

Career

- since 2019 Professor, IST Austria
- 1999 – 2019, Programme Leader, MRC Laboratory of Molecular Biology, Cambridge, UK
- 1995 – 1999, Postdoc, UCSF, San Francisco, USA
- 1990 – 1995, PhD, University of Cambridge, UK

Herbert Edelsbrunner

Algorithms, Computational Geometry, and Computational Topology

Understanding the world in terms of patterns and relations is the undercurrent in computational geometry and topology, the broad research area of the Edelsbrunner group.

While geometry measures shapes, topology focuses on how shapes are connected. There are however deep connections, such as Crofton's formula in integral geometry, which blur the difference. The Edelsbrunner group approaches the subject from a mathematical as well as computational point of view, keeping connections to applications in the sciences in mind. Candidate areas for fruitful collaborations include structural molecular biology, astrophysics, and—more generally—machine learning and data analysis.

Current projects Discretization in geometry and dynamics | Topological data analysis in information space | Alpha shape theory extended

Career

- since 2009 Professor, IST Austria
- 2004 – 2012 Professor of Mathematics, Duke University, Durham, USA
- 1999 – 2012 Arts and Sciences Professor for Computer Science, Duke University, Durham, USA
- 1996 – 2013 Founder, Principal, and Director, Raindrop Geomagic
- 1985 – 1999 Assistant, Associate, and Full Professor, University of Illinois, Urbana-Champaign, USA
- 1981 – 1985 Assistant, Graz University of Technology, Austria
- 1982 PhD, Graz University of Technology, Austria

László Erdős

Mathematics of Disordered Quantum Systems and Matrices

How do energy levels of large quantum systems behave? What do the eigenvalues of a typical large matrix look like? Surprisingly, these very different questions have the same answer!

Large complex systems tend to develop universal patterns that represent their essential characteristics. A pioneering vision of Eugene Wigner was that the distribution of the gaps between energy levels of complicated quantum systems depends only on the basic symmetry of the model and is otherwise independent of the physical details. However, this has never been rigorously proved for any realistic physical system. The Erdős group took up the challenge to verify Wigner's vision with full mathematical rigor. Starting from the simplest model, a large random matrix with independent identically distributed entries, the group can now deal with arbitrary distributions and even matrices with correlated entries. The mathematics developed along the way will extend the scope of random matrix theory and will likely be used in many applications beyond quantum physics such as wireless communications and statistics.

Current projects Self-consistent resolvent equation and application in random matrices | Next order correction in the form factor for Wigner matrices | Local spectral universality for random band matrices | Spectral statistics of random matrices with correlated entries | Quantum spin glasses

Career

- since 2013 Professor, IST Austria
- 2003 – 2013 Chair of Applied Mathematics (C4/W3), Ludwig Maximilian University of Munich, Germany
- 1998 – 2003 Assistant, Associate, Full Professor, Georgia Institute of Technology, Atlanta, USA
- 1995 – 1998 Courant Instructor/ Assistant Professor, Courant Institute, New York University, USA
- 1994 – 1995 Postdoc, ETH Zurich, Switzerland
- 1994 PhD, Princeton University, USA

Johannes Fink

Quantum Integrated Devices

The Fink group's research is positioned between quantum optics and mesoscopic condensed matter physics. The team studies quantum physics in electrical, mechanical, and optical chip-based devices with the goal of advancing and integrating quantum technology for simulation, communication, metrology, and sensing.

One of the Fink group's goals is to develop a microchip-based router that will be able to convert a microwave signal to an optical signal with near unity efficiency. With such devices, the researchers seek to perform quantum communication with superconducting circuits and telecom wavelength photons. In one project, the group uses a qubit to create a single photon state. With the router, this microwave photon is converted into an optical photon, which can then be transmitted over long distances using low-loss optical fiber. The group will also use this technique to entangle microwave and optical photons—an important step toward realizing worldwide quantum networks.

Current projects Quantum electro- and optomechanics | Quantum microwave photonics | Ultra-high impedance physics for hardware protected qubits | Multi-qubit quantum electrodynamics | Resonant nonlinear optics

Career

- since 2016 Assistant Professor, IST Austria
- 2015 – 2016 Senior staff scientist, California Institute of Technology, Pasadena, USA
- 2012 – 2015 IQIM Postdoctoral Research Scholar, California Institute of Technology, Pasadena, USA
- 2011 – 2012 Postdoctoral Research Fellow, ETH Zurich, Switzerland
- 2010 PhD, ETH Zurich, Switzerland

Julian Fischer

Theory of Partial Differential Equations, Applied and Numerical Analysis

Diverse phenomena such as the motion of fluids or elastic objects, the evolution of interfaces, or the physics of quantum mechanical particles are described accurately by partial differential equations. The Fischer group works on the mathematical analysis of partial differential equations that arise in the sciences, also connecting to areas like numerical analysis or probability.

Partial differential equations are a fundamental tool for the description of many phenomena in the sciences. The Fischer group works on the mathematical aspects of partial differential equations. One of the group's main themes is the mathematical justification of model simplifications. For example, an elastic material with a highly heterogeneous small-scale structure may be approximated as a homogeneous material, or a fluid with low compressibility as ideally incompressible. To justify such approximations, the group derives rigorous estimates for the approximation error. The techniques they employ connect the analysis of PDEs with adjacent mathematical areas like numerical analysis and probability.

Current projects Effective behavior of random materials | Evolution of interfaces in fluid mechanics and solids | Structure of fluctuations in stochastic homogenization | Entropy-dissipative PDEs

Career

- since 2017 Assistant Professor, IST Austria
- 2014 – 2016 Postdoc, Max Planck Institute for Mathematics in the Sciences, Leipzig, Germany
- 2013 – 2014 Postdoc, University of Zurich, Switzerland
- 2013 PhD, University of Erlangen-Nürnberg, Germany

Stefan Freunberger

Materials Electrochemistry

Life uses electron transfer reactions to—among other things—store or retrieve energy and to produce useful chemicals and materials. The Freunberger group works on electrochemical materials sciences with broadly similar goals.

The group's primary research interest lies in the fundamental science of electron and ion conducting and redox active materials (inorganic, organic, and polymeric) as well as their mutual interactions in the working environment of electrochemical devices. They focus on energy storage devices such as rechargeable batteries, and their results find use in clean, efficient and sustainable energy sources. The foundations of the group's research are (1) the synthesis of new conducting and redox active materials and a fundamental understanding of charge-carrier transport and electrochemical reactions, (2) advanced physico-chemical and spectroscopic investigations to understand the mutual behavior of the materials in their working environment as well as surface and interface processes, and (3) the application in electrochemical devices.

Current projects Oxygen redox chemistry and singlet oxygen | Sulphur electrochemistry | Non-aqueous electrolytes and interphases | Organic mixed conductors | Electrosynthesis | Operando spectroscopy

Career

- since 2020 Assistant Professor, IST Austria
- 2012 – 2020 Researcher and Group leader, TU Graz, Austria
- 2014 Visiting Professor, University of Montpellier, France
- 2008 – 2012 Postdoc and Early Career Fellow, University of St Andrews, UK
- 2007 PhD, ETH Zurich, Switzerland

Jiří Friml

Developmental and Cell Biology of Plants

When conditions get tough, animals typically fight or flee, but plants are rooted in their environment, and have thus become remarkably adaptable. The Friml group investigates the mechanisms underlying plants' adaptability during embryonic and postembryonic development.

Plants are highly adaptive and able to modify development and physiology to environmental changes; they can easily regulate growth, initiate new organs or regenerate tissues. Many of these developmental events are mediated by the plant hormone auxin. The Friml group investigates the unique properties of auxin signaling, which can integrate both environmental and endogenous signals. Employing methods ranging from molecular physiology to mathematical modeling, the group focuses on auxin transport, cell polarity, endocytic recycling as well as non-transcriptional mechanisms of signaling. The researchers gain insights into the mechanisms governing plant development and have shown how signals from the environment are integrated into plant signaling and result in changes to plant growth and development.

Current projects Polar auxin transport | Cell polarity and polar targeting | Endocytosis and recycling | Non-transcriptional mechanisms of signaling

Career

- since 2013 Professor, IST Austria
- 2007 – 2012 Full Professor, University of Ghent, Belgium
- 2006 Full Professor, University of Göttingen, Germany
- 2002 – 2005 Group Leader, Habilitation, University of Tübingen, Germany
- 2002 PhD, Masaryk University, Brno, Czech Republic
- 2000 PhD, University of Cologne, Germany

Carl Goodrich

Theoretical and Computational Soft Matter

How can materials dynamically control or remodel their own internal structure to affect their behavior? How can the statistics of structural disorder be biased to produce non-trivial properties? Such questions are a key step in the development of synthetic biology, where non-biological materials and nanoscale machines operate with a complexity and functionality found only in biology.

To this end, the Goodrich group uses computational and theoretical tools to discover basic soft matter principles that could one day lead to new functional materials as well as deepen our understanding of complex biological matter. The goal is first to understand general assembly mechanisms, and then work with experimentalists to test these ideas. The group deploys and develops a number of numerical techniques, from molecular dynamics to machine learning. Specifically, the researchers are at the forefront of the development of differentiable physics models, which provide a new and powerful way to explore high-dimensional systems and discover complex, non-trivial phenomena.

Current projects Self-assembly of disordered materials | Kinetic/functional assembly | Differentiable physics models | Highly parameterized systems

Career

- since 2020 Assistant Professor, IST Austria
- 2015 – 2020 Postdoctoral Scholar, Harvard University, Cambridge, USA
- 2015 PhD, University of Pennsylvania, Philadelphia, USA

Călin Guet

Systems and Synthetic Biology of Genetic Networks

Living systems are characterized by connections and interactions across many scales—from genes to organelles, from cells to ecologies—as parts of networks. What basic rules, if any, do these networks follow? The Guet group studies the molecular biology and evolution of gene regulatory networks by analyzing both natural and synthetic networks.

Genes and proteins constitute themselves into bio-molecular networks in cells. These genetic networks are engaged in a constant process of decision-making and computation from timescales of a few seconds to the time it takes a cell to divide and beyond. By studying existing networks and constructing synthetic networks in living cells, the group works to understand how molecular mechanisms interact with evolutionary forces that ultimately shape each other. They use a variety of classical and modern experimental techniques that enable them to construct any imaginable network in living bacteria and thus study the network dynamics from the single-cell level all the way to the level of small ecologies, in which bacteria interact with bacteriophages.

Current projects Information processing and evolution of complex promoters | Single-cell biology of multi-drug resistance | Biology, ecology, and evolutionary dynamics of restriction-modification systems

Career

- since 2018 Professor, IST Austria
- 2011 – 2018 Assistant Professor, IST Austria
- 2009 – 2010 Postdoc, Harvard University, Cambridge, USA
- 2005 – 2008 Postdoc, University of Chicago, USA
- 2004 PhD, Princeton University, USA

Edouard Hannezo

Physical Principles in Biological Systems

During embryo development, cells must "know" how to behave at the right place and at the right time. The Hannezo group applies methods from theoretical physics to understand how these robust choices occur.

The Hannezo group is particularly interested in design principles and processes of self-organization in biology at various scales and in close collaboration with cell and developmental biologists. Their methods include tools from solid and fluid mechanics, statistical physics as well as soft matter approaches. Examples of problems that the group is working on—at three different scales—include: (1) How do cytoskeletal elements, which generate forces within cells, self-organize to produce complex spatio-temporal patterns?, (2) How do cells concomitantly acquire identities and shape a tissue during development?, and (3) How does complex tissue architecture derive from simple self-organizing principles, for instance during branching morphogenesis (in organs such as the kidneys, mammary glands, pancreas, and prostate) as a prototypical example.

Current projects Stochastic branching in mammalian organs | Active fluids and cell cytoskeleton | Models of fate choices of stem cells during homeostasis and embryo development

Career

- since 2017 Assistant Professor, IST Austria
- 2015 – 2017 Sir Henry Wellcome Postdoctoral Fellow, Gurdon Institute, Cambridge, UK
- 2015 – 2017 Junior Research Fellow, Trinity College, University of Cambridge, UK
- 2014 Postdoc, Institut Curie, Paris, France
- 2014 PhD, Institut Curie and Université Pierre et Marie Curie, Paris, France

Tamás Hausel

Geometry and its Interfaces

How can we understand spaces too large for traditional analysis? Combining ideas from representation theory and combinatorics, the Hausel group develops tools to study the topology of spaces arising from string theory and quantum field theory.

Suppose you have many particles, and consider the space of all the ways each particle can move between two points. Now, play the same game with more complicated objects, such as vector fields. The resulting spaces are too large to analyze, but it is possible to simplify them along structural symmetries, giving rise to moduli spaces that are finite-dimensional, but non-compact—again, defying traditional methods. The Hausel group studies the topology, geometry, and arithmetic of these moduli spaces. One question is the number of high-dimensional holes of the spaces. Using methods from representation theory and combinatorics, Hausel and his team are able to give results and conjectures that have previously been described by physicists and number theorists in other terms, thus connecting a wide variety of fields and ideas.

Current projects Geometry, topology, and arithmetic of moduli spaces arising in supersymmetric quantum field theories | Representation theory of quivers, finite groups, Lie and Hecke algebras

Career

- since 2016 Professor, IST Austria
- 2012 – 2016 Professor and Chair of Geometry, EPFL, Lausanne, Switzerland
- 2007 – 2012 Tutorial Fellow, Wadham College, Oxford, UK
- 2007 – 2012 University Lecturer, University of Oxford, UK
- 2005 – 2012 Royal Society University Research Fellow, University of Oxford, UK
- 2002 – 2010 Assistant, Associate Professor, University of Texas, Austin, USA
- 1999 – 2002 Miller Research Fellow, Miller Institute for Basic Research in Science, University of California, Berkeley, USA
- 1998 – 1999 Member, Institute for Advanced Study, Princeton, USA
- 1998 PhD, Trinity College, University of Cambridge, UK

Carl-Philipp Heisenberg

Morphogenesis in Development

The elaborate shapes of multicellular organisms—the orchid blossom, the lobster's claw—all start off from a simple bunch of cells. This transformation is a common and fundamental principle in cell and developmental biology and the focus of the Heisenberg group's work.

To gain insights into the critical processes in which the developing organism takes shape, the Heisenberg group focuses on gastrulation in zebrafish and ascidians, a process in which a seemingly unstructured blastula is transformed into an organized embryo. The group uses a transdisciplinary approach, employing a combination of genetic, cell biological, biochemical, and biophysical tools. Using these, the group addresses how the interplay between the physical processes driving cell and tissue morphogenesis and the gene regulatory pathways determining cell fate specification control gastrulation. Insights derived from this work may ultimately have implications for the study of wound healing and cancer biology, as immune and cancer cells share many morphogenetic properties of embryonic cells.

Current projects Cell adhesion | Actomyosin contraction | Cell and tissue morphogenesis | Cell polarization and migration

Career

- since 2010 Professor, IST Austria
- 2001 – 2010 Group Leader, Max Planck Institute of Molecular Cell Biology and Genetics, Dresden, Germany
- 1997 – 2000 Postdoc, University College London, UK
- 1996 PhD, Max Planck Institute of Developmental Biology, Tübingen, Germany

Thomas A. Henzinger

Design and Analysis of Concurrent and Embedded Systems

Humans and computers are similar: While the interaction between two actors may be simple, every additional actor complicates matters. The Henzinger group builds the mathematical foundations for designing complex hardware and software systems.

Software has become one of the most complicated man-made artifacts, making software bugs unavoidable. The Henzinger group addresses the challenge of reducing software bugs in concurrent and embedded systems. The former consist of parallel processes that interact with one another, whether in a global network or on a tiny chip. Because of the large number of possible interactions between parallel processes, concurrent software is particularly error-prone, and sometimes bugs show up after years of flawless operation. Embedded systems interact with the physical world; an additional challenge for this kind of software, such as autopilot software for aircraft, is to react sufficiently quickly to inputs. The Henzinger group invents mathematical methods and develops computational tools for improving the reliability of concurrent and embedded software.

Current projects Analysis and synthesis of concurrent software | Quantitative modeling and verification of reactive systems | Predictability and robustness for real-time and embedded systems | Formal methods for neural networks

Career
- since 2009 Professor, IST Austria
- 2004 – 2009 Professor, EPFL, Lausanne, Switzerland
- 1999 – 2000 Director, Max Planck Institute for Computer Science, Saarbrücken, Germany
- 1998 – 2004 Professor, University of California, Berkeley, USA
- 1997 – 1998 Associate Professor, University of California, Berkeley, USA
- 1996 – 1997 Assistant Professor, University of California, Berkeley, USA
- 1992 – 1995 Assistant Professor, Cornell University, Ithaca, USA
- 1991 Postdoc, University Joseph Fourier, Grenoble, France
- 1991 PhD, Stanford University, Palo Alto, USA

Andrew Higginbotham

Condensed Matter and Quantum Circuits

Quantum systems are fragile, constantly altered and disrupted by their environments. The Higginbotham group investigates electronic devices that are exceptions to this rule, aiming to understand the basic principles of their operations and develop future information-processing technology.

The Higginbotham group experimentally explores the boundaries between condensed-matter systems and quantum information processing. In practice, the group builds small electronic devices that combine superconductors, semiconductors, and mechanical oscillators. The central idea of their approach is that building rudimentary information-processing devices both teaches us about the physics of these interesting systems and advances technology such as quantum computing. Currently, the group is interested in using electromechanical and microwave measurement techniques to study quantities that are "invisible" to conventional electrical circuits.

Current projects Circuit electrodynamics of p-wave superconductors | Electromechanics across a quantum phase transition

Career
- since 2019 Assistant Professor, IST Austria
- 2017 – 2019 Researcher, Microsoft Station Q Copenhagen, Denmark
- 2015 – 2017 Postdoc, JILA, USA
- 2015 PhD, Harvard University, Cambridge, USA

Simon Hippenmeyer

Genetic Dissection of Cerebral Cortex Development

The human cerebral cortex, the seat of our cognitive abilities, is composed of an enormous number and diversity of neurons and glia cells. How the cortex arises from neural stem cells is an unsolved but fundamental question in neuroscience. In the pursuit of mechanistic insights, the Hippenmeyer group genetically dissects corticogenesis at unprecedented single cell resolution using the unique MADM (Mosaic Analysis with Double Markers) technology.

The Hippenmeyer group's current objectives are (1) to establish a definitive quantitative and mechanistic model of cortical neural stem cell lineage progression; (2) to dissect the cellular and molecular mechanisms generating cell-type diversity; (3) to determine the role of genomic imprinting, an epigenetic phenomenon, in cortex development. In a broader context, the group's research has the ultimate goal to advance the general understanding of brain function and why human brain development is so sensitive to disruption of particular signaling pathways in pathological neurodevelopmental diseases and psychiatric disorders.

Current projects Determining neuronal lineages by clonal analysis | Mechanisms generating cell-type diversity | Probing genomic imprinting in cortex development

Career
- since 2019 Professor, IST Austria
- 2012 – 2019 Assistant Professor, IST Austria
- 2011 – 2012 Research Associate, Stanford University, Palo Alto, USA
- 2006 – 2011 Postdoctoral Fellow, Stanford University, Palo Alto, USA
- 2004 – 2006 Postdoctoral Associate, University of Basel and Friedrich Miescher Institute for Biomedical Research, Basel, Switzerland
- 2004 PhD, University of Basel, Switzerland

Björn Hof

Nonlinear Dynamics and Turbulence

Most fluid flows of practical interest are turbulent, yet our understanding of this phenomenon is limited. The Hof group seeks to gain insight into the nature of turbulence and the dynamics of complex fluids.

Flows in oceans, around vehicles, and through pipelines are all highly turbulent. Despite its ubiquity, insights into the nature of turbulence are very limited. To obtain a fundamental understanding of the origin and the principles underlying it, the Hof group investigates turbulence when it first arises from smooth, laminar flow. The group combines detailed laboratory experiments with highly resolved computer simulations and applies methods from nonlinear dynamics and statistical physics, enabling them to decipher key aspects of the transition from smooth to turbulent flow and identify universal features shared with disordered systems in other areas of physics. The group actively develops methods to control turbulent flow. In addition, the group investigates instabilities in fluids with more complex properties, such as dense suspensions of particles and polymer solutions.

Current projects Revisiting the turbulence problem using statistical mechanics | Transition from laminar to turbulent flow | Dynamics of complex fluids | Control of fully turbulent flows | Cytoplasmic streaming | Instabilities in cardiovascular flows

Career
- since 2013 Professor, IST Austria
- 2007 – 2013 Research Group Leader, Max Planck Institute for Dynamics and Self-Organization, Göttingen, Germany
- 2005 – 2007 Lecturer, University of Manchester, UK
- 2003 – 2005 Research Associate, Delft University of Technology, The Netherlands
- 2001 PhD, University of Manchester, UK

Onur Hosten

Quantum Sensing with Atoms and Light

The first quantum revolution yielded lasers and transistors. Now, a second quantum revolution is coming, yielding new quantum-enhanced technologies. The Hosten group develops new protocols and techniques for quantum-enhanced sensing using cold atoms and light.

Onur Hosten is an experimental atomic and optical physicist. His group develops innovative techniques to control the quantum properties of atomic and optical systems. The experimental platform is many-atom cavity-quantum-electrodynamics (cQED), where large ensembles of atoms are laser-cooled, trapped inside of an optical cavity and made to interact strongly with light resonating inside the cavity. The Hosten group investigates the concepts of quantum entanglement, quantum measurement, and light-assisted atomic interactions to develop new sensing techniques. In the long term, the Hosten group is interested in applying the precision sensors they develop to explore challenging experimental questions such as the precise interplay between quantum mechanics and gravity or the nature of dark matter.

Current projects Design and construction of a traveling wave optical cavity with intra-cavity trapped cold atoms | Generation of spin-squeezed states of atomic ensembles | Mapping atomic spin correlations into motional degrees of freedom | Squeezed-state atom interferometry

Career
- since 2018 Assistant Professor, IST Austria
- 2015 – 2017 Research Associate, Stanford University, Palo Alto, USA
- 2010 – 2015 Postdoctoral Scholar, Stanford University, Palo Alto, USA
- 2010 PhD, University of Illinois, Urbana-Champaign, USA

Maria Ibáñez

Functional Nanomaterials

Understanding structure-property relationships as well as the development of materials for target applications is limited by our ability to control the nanostructure of solid state materials. One potential solution is through the use of nanocrystals, which can be used as artificial atoms to create metamaterials.

The Ibáñez group develops novel functional nanomaterials using precisely designed nanocrystals as building blocks and investigates their properties as function of their finely tunable nano-features. In this way, the researchers are able to create a new generation of complex materials in which components and functionalities can be defined in a predictable way. Beyond fundamental studies in nanocrystal synthesis, surface chemistry and assembly, the group also aims to provide high-efficiency cost-effective thermoelectric materials.

Current projects Syntheses of novel metal and semiconductor nanocrystals | Unravelling of nanocrystal surface chemistry | Nanocrystals assembly and consolidation | Transport properties of nanocrystal-based solids | Electrocatalytic CO_2 conversion | Bottom-up processed thermoelectric nanomaterials

Career
- since 2018 Assistant Professor, IST Austria
- 2014 – 2018 Research Fellow, ETH Zurich, Switzerland
- 2013 – 2014 Research Fellow, Catalonia Institute of Energy Research (IREC), Barcelona, Spain
- 2013 Visiting Researcher, Northwestern University, Evanston, USA
- 2013 PhD, University of Barcelona, Spain

Peter Jonas

Cellular Neuroscience

Synapses enable communication between neurons in the brain. The Jonas group investigates how signals pass through these vital interfaces—a major undertaking in the field of neuroscience.

Understanding the function of the brain is a major challenge in the 21st century. The human brain comprises about 10 billion neurons, which communicate through statt der Welle: some 10’000 synapses per cell. Excitatory synapses use glutamate as a transmitter, whereas inhibitory synapses release Gamma-Aminobutyric acid (GABA). The group addresses two major questions: (1) What are the biophysical signaling and plasticity mechanisms at glutamatergic and GABAergic synapses in the cortex? (2) How do specific synaptic properties generate higher network functions? In their work, the group combines nanophysiology, presynaptic patch-clamp and multi-cell recording, two-photon $Ca^{2}+$ imaging, optogenetics, functional anatomy (“flash and freeze” electron microscopy), *in vivo* recording, and modeling. One focus is hippocampal mossy fiber synapses and output synapses of parvalbumin-expressing GABAergic interneurons.

Current projects Biophysical mechanisms of synaptic plasticity at hippocampal mossy fiber synapses | Structural changes underlying transmission and plasticity at central synapses | Analysis of neuronal coding *in vivo* and in realistic network models

Career

- since 2010 Professor, IST Austria
- 1995 – 2010 Professor of Physiology and Department Head, University of Freiburg, Germany
- 1994 – 1995 Associate Professor, Technical University of Munich, Germany
- 1990 – 1994 Senior Postdoc, Max Planck Institute for Medical Research, Heidelberg, Germany
- 1988 – 1989 Postdoc, University of Giessen, Germany
- 1987 MD / PhD, University of Giessen, Germany

Maximilian Jösch

Neuroethology

The Jösch group is interested in understanding how the brain processes visual information at different stages and how the emerging computations influence behaviors. Using molecular and physiological approaches, they monitor brain activity during animal behavior to reveal the principles and motifs of neuronal computation.

Two different model organisms, the mouse and the fruit fly (*Drosophila melanogaster*) are used in parallel to gather a general, cross-phyla understanding of computational principles. Using a combination of awake-behaving imaging, electrophysiological and behavioral approaches in mice, the group studies the mechanisms used by the nervous system to send behaviorally relevant information from the eye to the brain, e.g., to detect a red apple in green foliage. With the fly, similar experimental approaches, combined with targeted genetic manipulations, are used to obtain a comprehensive understanding of the cellular basis of network computations, with an emphasis on course control.

Current projects Intrinsic population dynamics of the superior colliculus | Role of electrical synapses in sensory transformations | Mechanisms of visual saliency and attention | State-dependent modulation of sensory information | Colliculi-thalamic visual computations | Large-scale retinal recordings | Superior colliculus & ASD – a midbrain perspective on disease progression.

Career

- since 2017 Assistant Professor, IST Austria
- 2010 – 2016 Postdoc and Research Associate, Harvard University, Cambridge, USA
- 2009 Postdoc, Max Planck Institute of Neurobiology, Martinsried, Germany
- 2009 PhD, Max Planck Institute of Neurobiology, Martinsried, Germany and Ludwig Maximilian University, Munich, Germany

Georgios Katsaros

Nanoelectronics

It is impossible to picture modern life without the vast amount of microelectronic applications that surround us—a development made possible by the invention of the transistor in the 1950s. This—at the time—few centimeters large device and product of scientific curiosity led to a technological revolution. Now, the size of a transistor has shrunk to less than 14 nm and quantum physics comes into play. The Katsaros group investigates semiconductor nanodevices and studies quantum effects when these devices are cooled to -273.14 °C.

The spin degree of freedom can be used to create a two-level system, a quantum bit, or a qubit. While in classic computers, a bit can be in only one of two states, zero or one, in the quantum world, a qubit can be both zero and one at the same time. The group studies such qubits in Germanium. In addition, the group investigates hybrid semiconductor-superconductor devices seeking for Majorana fermions. These have been suggested as building blocks for a topological quantum computer in which quantum information would be protected from environmental perturbations.

Current projects Towards hole spin qubits and Majorana fermions in Germanium | Hybrid semiconductor-superconductor quantum devices | Hole spin orbit qubits in Ge quantum wells | Towards scalable hut wire devices | Topologically protected and scalable quantum bits

Career

- since 2016 Assistant Professor, IST Austria
- 2012 – 2016 Group Leader, Johannes Kepler University, Linz, Austria
- 2011 – 2012 Group Leader, Leibniz Institute for Solid State and Materials Research, Dresden, Germany
- 2006 – 2010 Postdoc, CEA, Grenoble, France
- 2006 PhD, Max Planck Institute for Solid State Research, Stuttgart, Germany

Anna Kicheva

Tissue Growth and Developmental Pattern Formation

Individuals of the same species can differ widely in size, but their organs have reproducible proportions and patterns of cell types. This requires the coordination of tissue growth with the generation of diverse cell types during development. The Kicheva group studies how this coordination is achieved in the vertebrate neural tube, the embryonic precursor of the spinal cord and brain.

Neural tube development is controlled by signaling molecules called morphogens. Morphogens determine what type of neuron a neural progenitor cell will become. They also control tissue growth by influencing the decisions of cells to divide or exit the cell cycle. The Kicheva group seeks to understand how morphogen signaling is controlled and interpreted by cells to determine cell fate and cell cycle progression. The group uses diverse quantitative experimental approaches, including the collection of high-resolution spatiotemporal datasets of signaling and gene expression in mouse and chick neural tube development. They collaborate with biophysicists to relate their experiments to theoretical frameworks.

Current projects Integration of opposing morphogen gradients | Morphogen control of tissue growth | Morphogen gradient formation

Career

- since 2015 Assistant Professor, IST Austria
- 2008 – 2015 Postdoc, National Institute for Medical Research, The Francis Crick Institute, UK
- 2008 PhD, University of Geneva, Switzerland, and Max Planck Institute of Cell Biology and Genetics, Dresden, Germany

Vladimir Kolmogorov

Discrete Optimization

When we step out into the street, we automatically judge the distance and speed of cars. For computers, estimating the depth of objects in an image requires complex computations. A popular approach for tackling this problem is to use discrete optimization algorithms—the research focus of the Kolmogorov group.

The work of Vladimir Kolmogorov’s group falls into three areas. The first is the development of efficient algorithms for inference in graphical models and combinatorial optimization problems. Some of the techniques developed in the group are well-known in the community, such as the “Boykov-Kolmogorov” maximum flow algorithm, the “Blossom V” algorithm for computing a minimum cost perfect matching in a graph, and the “TRW-S” algorithm for MAP-MRF inference in graphical models. The second focus is the theoretical investigation of the complexity of discrete optimization, in particular using the framework of valued constraint satisfaction problems and their variants. Finally, the group has worked on applications of discrete optimization in computer vision, such as image segmentation.

Current projects Inference in graphical models | Combinatorial optimization problems | Theory of discrete optimization

Career

- since 2014 Professor, IST Austria
- 2011 – 2014 Assistant Professor, IST Austria
- 2005 – 2011 Lecturer, University College London, UK
- 2003 – 2005 Assistant Researcher, Microsoft Research, Cambridge, UK
- 2003 PhD, Cornell University, Ithaca, USA

Fyodor Kondrashov

Evolutionary Genomics

How did living organisms become the way we know them today? The Kondrashov group is focused on understanding the natural world in an evolutionary context, typically focusing on studying genetic information due the abundance of DNA and protein sequence data.

Kondrashov and his group do not restrict themselves to specific functions or phenotypes; instead, a staple feature of their research is a focus on how functions and phenotypes change over time. Therefore, their research is inherently interdisciplinary, grounded in classical evolutionary fields of population genetics and molecular evolution while drawing from other fields, such as cell and molecular biology, bioinformatics, and biophysics. Recently, the group has become increasingly interested in the experimental assay of fitness landscapes. Combining experiments, theory and computational biology, they query how changes in the genotype affect fitness or specific phenotypes. In the near future, they hope to expand their experimental capabilities in order to investigate a wider range of interesting phenotypes in a high-throughput manner.

Current projects Empirical fitness landscapes | Protein evolution in the context of epistasis | Population genomics of the spoon-billed sandpiper

Career

- since 2017 Professor, IST Austria
- since 2012 Scientific Director, School of Molecular and Theoretical Biology
- 2011 – 2017 ICREA Research Professor, Centre for Genomic Regulation, Barcelona, Spain
- 2008 – 2017 Junior Group Leader, Centre for Genomic Regulation, Barcelona, Spain
- 2008 PhD, University of California, San Diego, USA

Christoph Lampert

Machine Learning and Computer Vision

The Lampert group performs research on how to make artificial intelligence methods more trustworthy. It investigates questions like: Can we understand not only what modern machine learning systems are doing, but also why? Can we give guarantees for their behavior? Can we build systems that learn and one day might become intelligent without sacrificing our rights to data protection and privacy?

Computers are becoming increasingly powerful at processing data, and they have learned to perform many tasks that were thought beyond their reach, such as making successful financial investments, diagnosing cancer from medical images, and even driving cars in traffic. So why don't we rely on them as financial advisors, oncologists, and chauffeurs? It is likely because we do not trust computers enough to let them operate important systems autonomously and outside of our control. Besides theoretical research, the group applies its results to applications in computer vision, such as image understanding, where the goal is to develop automatic systems that can analyze the contents of natural images.

Current projects Trustworthy machine learning | Transfer and lifelong learning | Theory of deep learning | Generative modeling in computer vision

Career

- since 2015 Professor, IST Austria
- 2010 – 2015 Assistant Professor, IST Austria
- 2007 – 2010 Senior Research Scientist, Max Planck Institute for Biological Cybernetics, Tübingen, Germany
- 2004 – 2007 Senior Researcher, German Research Center for Artificial Intelligence, Kaiserslautern, Germany
- 2003 PhD, University of Bonn, Germany

Mikhail Lemeshko

Theoretical Atomic, Molecular, and Optical Physics

"The whole is greater than the sum of its parts." Aristotle's saying holds true in many systems studied in quantum physics. Mikhail Lemeshko investigates how macroscopic quantum phenomena emerge in ensembles of atoms and molecules.

Most polyatomic systems in physics, chemistry, and biology are strongly correlated: their complex behavior cannot be deduced from their individual components. Despite considerable effort, understanding strongly correlated, many-body systems still presents a formidable challenge. For instance, given a single atom of a certain kind, it is hard to predict the properties of the resulting bulk material. The Lemeshko group studies how many-particle quantum phenomena emerge in ensembles of atoms and molecules, and in so doing, answers questions such as: How many particles are sufficient for a given property to emerge? How does an external environment modify the properties of quantum systems? The group's theoretical efforts aim to explain experiments on cold molecules and ultracold quantum gases, as well as to predict novel, previously unobserved phenomena.

Current projects Understanding angular momentum properties of quantum many-particle systems | Studying open quantum systems and understanding how dissipation acts at the microscopic scale | Many-body physics of ultra-cold quantum gases | Developing techniques to manipulate atoms, molecules, and interactions between them with electromagnetic fields

Career

- since 2019 Professor, IST Austria
- 2014 – 2019 Assistant Professor, IST Austria
- 2011 – 2014 ITAMP Postdoctoral Fellow, Harvard University, Cambridge, USA
- 2011 PhD, Fritz Haber Institute of the Max Planck Society, Berlin, Germany

Martin Loose

Self-Organization of Protein Systems

How are nanometer-sized proteins able to perform complex cellular functions on a much larger scale? The research interest of the Loose group is to understand how proteins self-organize into dynamic spatiotemporal patterns using an in vitro reconstitution approach.

Dynamic protein assemblies play an important role for the organization of the cell in space and time. They emerge from a complex interplay between many different cellular components. A mechanistic understanding of the underlying processes, however, is often still not available. In the interdisciplinary Loose group, scientists combine protein biochemistry, biomimetic membrane systems, fluorescence microscopy, and image analysis to understand the emergent properties of biochemical networks that give rise to the living cell. The group aims to rebuild and understand two fundamental biological processes: First, bacterial cell division, with a focus on the cytokinetic machinery of *Escherichia coli*. Second, intracellular compartmentalization and how regulatory networks the activity of small GTPases in space and time.

Current projects Self-organization of the bacterial cell division machinery | Emergent properties of small GTPase networks

Career

- since 2015 Assistant Professor, IST Austria
- 2011 – 2014 Departmental Fellow, Harvard Medical School, Boston, USA
- 2010 – 2011 Postdoc, TU Dresden and Max Planck Institute of Molecular Cell Biology and Genetics, Dresden, Germany
- 2010 PhD, TU Dresden and Max Planck Institute of Molecular Cell Biology and Genetics, Dresden, Germany

Jan Maas

Stochastic Analysis

Airplane turbulence and stock rate fluctuations are examples of highly irregular real-world phenomena subject to randomness, noise, or uncertainty. Mathematician Jan Maas develops new methods for the study of such random processes in science and engineering.

Random processes are often so irregular that existing mathematical methods are insufficient to describe them accurately. The Maas group combines ideas from probability theory, mathematical analysis, and geometry to gain insights into the complex behavior of these processes. Recent work was inspired by optimal transport, which deals with the optimal allocation of resources. The Maas group applies these techniques to diverse problems involving complex networks, chemical reaction systems, and quantum mechanics. Another focus is stochastic partial differential equations, which are commonly used to model high-dimensional random systems, such as bacteria colony growth and weather forecasting. The group develops robust mathematical methods to study these equations, which is expected to lead to new insights into the underlying models.

Current projects Homogenization of discrete optimal transport | Curvature-dimension criteria for Markov processes | Gradient flow structures in dissipative quantum systems

Career

- since 2020 Professor, IST Austria
- 2014 – 2020 Assistant Professor, IST Austria
- 2009 – 2014 Postdoc, University of Bonn, Germany
- 2009 Postdoc, University of Warwick, UK
- 2009 PhD, Delft University of Technology, The Netherlands

Kimberly Modic

Thermodynamics of Quantum Materials at the Microscale

From the stone tools of the Stone Age to the semiconductor devices of our modern information age, societies are defined by their materials. The next generation of materials, such as superconductors and spin liquids, will exploit the quantum mechanical nature of matter and drive future technologies, such as quantum computation.

The Modic group designs and builds experiments to enhance our understanding of quantum materials, and discover new ways to harness their power. They specialize in techniques that study the response of materials to strong magnetic fields, which can simplify complex material problems. Magnetic fields can be used to reduce the degrees of freedom that electrons can explore, or they can force materials to choose between a metallic or a superconducting state. These experiments provide guidance to construct theories of existing quantum materials and aid in the design of new technologies.

Current projects Identifying new phases of matter in topological semimetals | Determining broken symmetries in high-temperature superconductors | Exploring the dynamics of spin liquid excitations

Career

- since 2020 Assistant Professor, IST Austria
- 2016 – 2019 Postdoctoral Researcher, Microstructured Quantum Matter, Max Planck Institute for Chemical Physics of Solids, Dresden, Germany
- 2012 – 2016 Graduate Research Assistant, National High Magnetic Field Laboratory – Pulsed Field Facility, Los Alamos, USA
- 2015 PhD, University of Texas, Austin, USA

Marco Mondelli

Data Science, Machine Learning, and Information Theory

We are at the center of a revolution in information technology, with data being the most valuable commodity. Exploiting this exploding number of data sets requires addressing complex inference problems, and the Mondelli group works to develop mathematically principled solutions.

Inference problems arise in a variety of fields and applications; the Mondelli group focuses on two areas. In wireless communications, the goal is—given a transmission channel—to send information encoded as a message while optimizing certain metrics, such as complexity or bandwidth. In machine learning, the goal is to understand how many samples convey sufficient information to perform a certain task and to identify the optimal ways to utilize such samples. The Mondelli group is inspired by information theory, which leads to the investigation of fundamental questions: What is the minimal amount of information necessary to solve an assigned inference problem? Given this minimal amount of information, is it possible to design a low-complexity algorithm? What are the trade-offs between the parameters at play?

Current projects Fundamental limits and efficient algorithms for deep learning | Non-convex optimization in high-dimensions | Optimal code design for short block lengths

Career

- since 2019 Assistant Professor, IST Austria
- 2017 – 2019 Postdoc, Stanford University, Palo Alto, USA
- 2018 Research Fellow, Simons Institute for the Theory of Computing, Berkeley, USA
- 2016 PhD, EPFL, Lausanne, Switzerland

Gaia Novarino

Genetic and Molecular Basis of Neurodevelopmental Disorders

Gaia Novarino studies the genes underlying inherited forms of neurodevelopmental disorders such as epilepsy, intellectual disability, and autism. Neurodevelopmental disorders affect millions of people and are often refractory to treatments. Her group employs various techniques—from molecular biology to behavior—to identify common pathophysiological mechanisms underlying this group of disorders.

Neurodevelopmental disorders are caused by mutations in a plethora of genes, whose role in the brain is mostly unknown. Identifying the molecular mechanisms underlying the genetic forms of seizure, autism syndromes, and intellectual disability may hold the key to developing therapeutic strategies for this group of conditions. The Novarino group studies the function of epilepsy-, intellectual disability-, and autism-causing genes at the system, cellular, and molecular levels. The goal is to provide a framework for the development of effective pharmacological therapies and the background for the identification of new pathological genetic variants.

Current projects Molecular mechanisms underlying autism spectrum disorders | SETD5 gene in intellectual disability | Modeling epileptic encephalopathies and autism spectrum disorders in human brain organoids | Role of the autism-associated gene CHD8 in cortical development | The role of branched amino acid-dependent pathways in neurodevelopmental disorders

Career
- since 2019 Professor, IST Austria
- 2014 – 2019 Assistant Professor, IST Austria
- 2010 – 2013 Postdoc, UCSD (Joseph Gleeson Lab), La Jolla, USA
- 2006 – 2010 Postdoc, Center for Molecular Neurobiology, Hamburg, Germany and MDC/FMP, Berlin, Germany
- 2006 PhD, University La Sapienza, Rome, Italy

Krzysztof Pietrzak

Cryptography

The cryptography group works on theoretical and applied cryptography, the science behind information security. Current projects include:

Sustainable cryptocurrencies. Bitcoin is the first decentralized digital currency, and the most successful cryptocurrency to date. To achieve security, Bitcoin requires that huge amounts of computing power are constantly wasted. The cryptography group develops more sustainable "Bitcoin like" block chains that use disk space instead of computation to achieve security.
Group Messaging. Messaging applications like Signal or WhatsApp are hugely popular and provide surprisingly strong security guarantees. The team works on group messaging, which aims at developing messaging protocols that efficiently scale to large groups without giving up any of the strong security and privacy guarantees of existing solutions.
Leakage-resilient cryptography. The team constructs schemes that are provably secure against "side-channel attacks", where an attacker exploits information leaked during computation from a cryptographic device like a smart card.

Current projects MSustainable Cryptocurrencies | Leakage-, Tamper-, and Trojan-resilient cryptography | Group Messaging | Adaptive security

Career
- since 2016 Professor, IST Austria
- 2011 – 2016 Assistant Professor, IST Austria
- 2005 – 2011 Scientific Staff Member, Centrum Wiskunde & Informatica, Amsterdam, The Netherlands
- 2006 Postdoc, École Normale Supérieure, Paris, France
- 2005 PhD, ETH Zurich, Switzerland

Matthew Robinson

Medical Genomics

Common complex diseases such as type-2 diabetes, obesity, stroke, and cardiovascular disease are among the leading causes of mortality worldwide. Our limited understanding of how genetic variation and the environment affect health and disease makes it impossible to respond optimally, treat and ultimately prevent symptoms. The Robinson group develops statistical models and the computational tools required to implement these models for very large-scale human medical record data. The overall goal is to improve our understanding of how genetics and lifestyle shape our risk of disease.

Why people develop first symptoms at different ages, or why the severity of symptoms varies, is not well understood. The Robinson group works to better characterize the underlying pathways and relationships among diseases. Their goal is to improve our ability to predict not only an individual's overall risk of disease, but also when people are likely to become sick and how they might respond to different treatments.

Current projects Statistical models for the genetic basis of common complex disease | The genetic basis of age of onset | The genetics of ageing | Maternal health | Genomic prediction for personalized health

Career
- since 2020 Assistant Professor, IST Austria
- 2017 – 2020 Assistant Professor, University of Lausanne, Switzerland
- 2013 – 2017 Postdoc, University of Queensland, Brisbane, Australia
- 2009 – 2013 NERC Junior Research Fellow, University of Sheffield, UK
- 2008 PhD, University of Edinburgh, UK

Leonid Sazanov

Structural Biology of Membrane Protein Complexes

Membrane proteins are responsible for many fundamental cellular processes, including the transport of ions and metabolites and energy conversion, and are the target of about two thirds of modern drugs. However, membrane proteins, especially large complexes, are challenging to study and are thus underrepresented in structural databases. The Sazanov group is interested in the structural biology of membrane proteins.

The research focus of the group has been on complex I of the respiratory chain, a huge (~1 MDa) enzyme central to cellular energy production. So far, they have determined the first atomic structures of complex I, from bacterial to the more elaborate mammalian version. The structures suggest a unique mechanism of proton translocation, which they study using X-ray crystallography and cryo-electron microscopy. The group also investigates other, related membrane protein complexes with the goal of explaining the molecular design of some of the most intricate biological machines. Medical implications are multifaceted and the Sazanov group is interested in developing potential drug candidates.

Current projects Mechanism of coupling between electron transfer and proton translocation in complex I | Structure and function of mitochondrial respiratory supercomplexes | Structure and function of other membrane protein complexes relevant to bioenergetics

Career
- since 2015 Professor, IST Austria
- 2006 – 2015 Program Leader, MRC Mitochondrial Biology Unit, Cambridge, UK
- 2000 – 2006 Group Leader, MRC Mitochondrial Biology Unit, Cambridge, UK
- 1997 – 2000 Research Associate, MRC Laboratory of Molecular Biology, Cambridge, UK
- 1994 – 1997 Research Fellow, Imperial College, London, UK
- 1992 – 1994 Postdoc, University of Birmingham, UK
- 1990 – 1992 Postdoc, Belozersky Institute of Physico-chemical Biology, Moscow State University, Russia
- 1990 PhD, Moscow State University, Russia

Florian Schur

Structural Biology of Cell Migration and Viral Infection

The Schur group aims to understand the underlying structural principles that control cell migration, and the conservation of assembly mechanisms in different viruses. To this end they use and develop advanced cryo-electron microscopy and image processing methods to study the structure and function of protein complexes in situ.

One focus is the actin cytoskeleton, the key player allowing cells to move. The aim of the group is to obtain a detailed understanding of the structures in the dynamic environment of the actin cytoskeleton and its associated regulators in migrating cells, and in cases where pathogens exploit actin-related host mechanisms. In addition, they study pleomorphic viruses at resolution by improving the versatility of cryo-EM data acquisition and the image processing methods. Specifically, the group is interested in the conservation and diversity of retroviral capsid assemblies, as well as large DNA-viruses, which are also important model organisms to understand actin-mediated pathogen propulsion.

Current projects Cellular structural biology of the actin cytoskeleton and cell migration | Structural Conservation and Diversity of Retroviral Capsid | Cryo-electron tomography and image processing method development

Career
- since 2017 Assistant Professor, IST Austria
- 2016 – 2017 Postdoc, European Molecular Biology Laboratory, Heidelberg, Germany
- 2016 PhD, European Molecular Biology Laboratory, Heidelberg and University of Heidelberg, Germany

Robert Seiringer

Mathematical Physics

The Seiringer group develops mathematical tools for the rigorous analysis of many-particle systems in quantum mechanics, with a special focus on exotic phenomena in quantum gases, like Bose-Einstein condensation and superfluidity.

A basic problem in statistical mechanics is to understand how the same equations on a microscopic level lead to a variety of very different manifestations on a macroscopic level. Due to the intrinsic mathematical complexity of this problem, one typically resorts to perturbation theory or other uncontrolled approximations, whose justification remains open. The challenge is thus to derive non-perturbative results and obtain the precise conditions under which various approximations can or cannot be justified. For this, new mathematical techniques and methods are needed; these increase our understanding of physical systems. Concrete problems under investigation include the spin-wave approximation in magnetism, the validity of the Bogoliubov approximation in the description of dilute Bose gases, and the behavior of polaron systems at strong coupling.

Current projects Polaron models at strong coupling | The Heisenberg ferromagnet at low temperature and the spin-wave approximation | Validity of the Bogoliubov approximation

Career
- since 2013 Professor, IST Austria
- 2010 – 2013 Associate Professor, McGill University, Montreal, Canada
- 2005 Habilitation, University of Vienna, Austria
- 2003 – 2010 Assistant Professor, Princeton University, USA
- 2001 – 2003 Postdoc, Princeton University, USA
- 2000 – 2001 Assistant, University of Vienna, Austria
- 2000 PhD, University of Vienna, Austria

Maksym Serbyn

Condensed Matter Theory and Quantum Dynamics

How do isolated quantum systems behave when prepared in a highly non-equilibrium state? How can such quantum systems avoid ubiquitous relaxation to a thermal equilibrium? How can we gain novel insights into properties of quantum matter using modern non-equilibrium probes? These and other open questions in the field of quantum non-equilibrium matter are the focus of the Serbyn group.

The majority of isolated quantum systems thermalize, that is, reach thermal equilibrium when starting from non-equilibrium states. One research focus of the Serbyn group is to understand mechanisms of thermalization breakdown. Many-body localized systems present one generic example of thermalization breakdown due to the presence of strong disorder. The Serbyn group is studying the properties of many-body localized phase and phase transition into the thermalizing phase. Kinetically constrained models present another class of systems with some signatures of thermalization breakdown. The Serbyn group is actively working on non-equilibrium properties of quantum models with constrained dynamics.

Current projects Many-body localization | Quantum ergodicity breaking | Non-equilibrium probes of solids | Spin-orbit coupled materials

Career
- since 2017 Assistant Professor, IST Austria
- 2014 – 2017 Gordon and Betty Moore Postdoctoral Fellow, University of California, Berkeley, USA
- 2014 PhD, Massachusetts Institute of Technology, Cambridge, USA

Ryuichi Shigemoto

Molecular Neuroscience

Information transmission, the formation of memory, and plasticity are all controlled by various molecules at work in the brain. Focusing on the localization and distribution of molecules in brain cells, the Shigemoto group investigates their functional roles in higher brain functions.

The release of neurotransmitters from a nerve cell into the synapse, where they act on receptors of the connecting nerve cell, is the primary process of information transmission and computation in the brain. The Shigemoto group studies the localization of single neurotransmitter receptors, ion channels, and other functional molecules to understand the molecular basis of neuronal information processing. The group has pioneered several methods for studying the localization of functional molecules at an unprecedented sensitivity, detecting and visualizing even single membrane proteins in nerve cells using SDS-digested freeze-fracture replica labeling. They apply these methods to investigate the mechanisms of signaling and plasticity in the brain, with questions ranging from neurotransmission to learning.

Current projects New chemical labeling methods for high resolution EM visualization of single molecules | Ultrastructural localization and function of receptors and ion channels in the brain | Mechanisms of long-term memory formation | Left-right asymmetry of hippocampal circuitry

Career
- since 2013 Professor, IST Austria
- 1998 – 2014 Professor, National Institute for Physiological Sciences, Okazaki, Japan
- 1990 – 1998 Assistant Professor, Kyoto University Faculty of Medicine, Japan
- 1994 PhD, Kyoto University, Japan
- 1985 MD, Kyoto University Faculty of Medicine, Japan

Sandra Siegert

Neuroimmunology in Health and Disease

Identifying brain function has primarily concentrated on how environmental signals are encoded within a complex neuronal network—the impact of the immune system was mostly overlooked. The Siegert group focuses on how neurons and microglia interact with each other and how malfunctions within this relationship affect neuronal circuit formation and function in health and disease.

Microglia are the CNS-resident macrophages and continually sense their neuronal environment. They switch between functional states that may promote or counteract the removal of circuit elements. But how microglia decide when to alter circuit elements without inducing circuit malfunction is not known. Activated microglia are a feature of CNS pathologies such as glaucoma and Alzheimer's. Thus, it is important to study the contribution of these cells and to develop strategies for manipulating them in a beneficial manner. The Siegert group addresses this using the mammalian retina, which consists of morphologically well-defined cell types that are precisely mapped in their connection and functional properties.

Current projects Defining and manipulating microglial reactivity | Impact of microglia on neuronal function

Career
- since 2015 Assistant Professor, IST Austria
- 2011 – 2015 Postdoctoral Associate, Massachusetts Institute of Technology, Cambridge, USA
- 2010 PhD, Friedrich Miescher Institute for Biomedical Research, Basel, Switzerland

Daria Siekhaus

Invasive Migration

The ability of cells to migrate is crucial for their function in the immune system, the formation of the body, and the spread of cancer. The Siekhaus group investigates how cells move within the complex environment of an organism, using the genetic power of the fruit fly to interrogate this process and identify ways in which it is regulated.

Vertebrate immune and cancer cells need to squeeze between closely connected cells to disseminate in the body. Using techniques from imaging to biophysics, Daria Siekhaus and her group study how cells penetrate such tissue barriers, using the developmental movement of macrophages in the fruit fly *Drosophila melanogaster* as a model. They have found that a cytokine conserved in vertebrates facilitates tissue entry by reducing tension in surrounding tissues, and defined a novel program acting in disseminating and invading macrophages that alters glycosylation to aid invasion. They are currently investigating several programs that govern the invasion of leader cells, as well as how the state of surrounding tissues affects this process.

Current projects The role of cell division in regulating invasive migration | A novel transporter and its effect on metastasis | A conserved pioneer cell program that governs invasion through regulation of mitochondrial function and metabolism

Career
- since 2012 Assistant Professor, IST Austria
- 2003 – 2011 Research Scientist, Skirball Institute, New York University Medical Center, USA
- 1999 – 2003 Postdoctoral Fellow, University of California, Berkeley, USA
- 1998 PhD, Stanford University, Palo Alto, USA

Michael Sixt

Morphodynamics of Immune Cells

Immune cells zip through our bodies at high speeds to fight off infections and diseases. The Sixt group works at the interface of cell biology and immunology to investigate how cells migrate through tissues.

Most cells in our bodies are stationary, forming solid tissues and encapsulated organs. One exception are leukocytes, the cells mediating innate and adaptive immune responses to infections. Leukocytes migrate with extraordinary speed and are the Sixt group's favorite model system. The group seeks to identify basic mechanistic principles of how cells change shape, move the cell body, and interact with other cells. Principles, which are also important for processes such as embryonic development and cancer cell dissemination. The group also investigates how cells navigate along guidance cues, specifically how they orient their polarity axis in response to chemotactic gradients. In their work, they combine genetics, pharmacology, micro-engineering, surface chemistry, advanced imaging approaches as well as *in vivo* imaging techniques.

Current projects Environmental control of leukocyte migration | Cellular force generation and transduction | Interpretation of chemo-attractive gradients

Career
- since 2013 Professor, IST Austria
- 2010 – 2013 Assistant Professor, IST Austria
- 2008 – 2010 Endowed Professor, Peter Hans Hofschneider Foundation for Experimental Biomedicine
- 2005 – 2010 Group Leader, Max Planck Institute of Biochemistry, Martinsried, Germany
- 2003 – 2005 Postdoc, Institute for Experimental Pathology, Lund, Sweden
- 2003 MD, University of Erlangen, Germany
- 2002 Approbation in human medicine

Lora Sweeney

Evolution, Development, and Function of Motor Circuits

Movement is fundamental to nearly every animal behavior: to escape predators, to eat and breathe, animals must move. The Sweeney group aims to define the molecular, cellular, and neural circuit components that underlie differences in motor behavior, and to explore how such differences arise during an organism's development.

The group uses the *Xenopus* frog to address these fundamental questions. The frog undergoes metamorphosis, transitioning from a swimming tadpole to a walking frog during development. The Sweeney group explores this transition and categorizes, compares, and manipulates frog neurons at each stage. This allows the scientists to map variations in cellular properties and neural circuit structure onto differences in motor behavior. Knowledge about such cell-circuit-behavior relationships in the frog will provide a basis for comparing motor circuits between tetrapods, understanding how motor circuits evolved from swimming to walking during evolution, and pinpointing how motor circuits break down in movement disorders.

Current projects Single cell sequencing of tadpole versus frog neurons | Viral tracing of neural circuits for swimming and walking | Multiphoton imaging of calcium dynamics over metamorphosis

Career
- since 2020, Assistant Professor, IST Austria
- 2011 – 2020 Postdoc, Salk Institute for Biological Studies, San Diego, USA
- 2011 PhD, Stanford University, Palo Alto, USA

Gašper Tkačik

Information Processing in Biological Systems

How do networks built out of biological components—neurons, signaling molecules, genes, or even cooperating organisms—process information? In contrast to engineered systems, biological networks operate under strong constraints due to noise, limited energy, or specificity, yet still perform their functions reliably. The Tkačik group uses biophysics and information theory to understand the principles and mechanisms behind this remarkable phenomenon.

How can cells in a multicellular organism reproducibly decide what tissue they become? How do neurons in the retina cooperate to best encode visual information as neural spikes? How does the physics at the microscopic scale, which dictates how individual regulatory molecules interact with each other, constrain the kinds of regulatory networks observed in real organisms today, and how can such networks evolve? With the goal of developing theoretical ideas about biological network function and connecting these to high-precision data, the Tkačik group seeks to answer these and other questions through data-driven and theoretical projects.

Current projects Visual encoding in the brain | Genetic regulation during early embryogenesis | Collective dynamics | Evolution of gene regulation

Career

- since 2017 Professor, IST Austria
- 2011 – 2016 Assistant Professor, IST Austria
- 2008 – 2010 Postdoc, University of Pennsylvania, Philadelphia, USA
- 2007 Postdoc, Princeton University, USA
- 2007 PhD, Princeton University, USA

Beatriz Vicoso

Sex-Chromosome Biology and Evolution

Sex chromosomes, such as the X and Y of mammals, are involved in sex-determination in many animal and plant species. Their sex-specificity leads them to evolve differently from other chromosomes, and acquire distinctive biological properties. The Vicoso group investigates how sex chromosomes evolve over time and what biological forces are driving their patterns of differentiation.

The Vicoso group is interested in understanding several aspects of the biology of sex chromosomes, and the evolutionary processes that shape their peculiar features. By combining the use of next-generation sequencing technologies with studies in several model and non-model organisms, the researchers can address a variety of standing questions, such as: Why do some Y chromosomes degenerate while others remain homomorphic, and how does this relate to the extent of sexual dimorphism of the species? What forces drive some species to acquire global dosage compensation of the X, while others only compensate specific genes? What are the frequency and molecular dynamics of sex chromosome turnover?

Current projects Sex chromosome turnover and conservation | Dosage compensation in female-heterogametic species | Gene expression evolution in sexual and asexual species

Career

- since 2020 Professor, IST Austria
- 2015 – 2020 Assistant Professor, IST Austria
- 2009 – 2014 Postdoc, University of California, Berkeley, USA
- 2010 PhD, University of Edinburgh, Scotland, UK

Tim Vogels

Computational Neuroscience and Neurotheory

The Vogels group seeks to build models of neurons and neuronal networks that distill and re-articulate the current knowledge of how nervous systems compute at a mechanistic level. In particular, the group is interested in the neuronal interplay of excitatory and inhibitory activity in cortex and how these dynamics can form reliable sensory perceptions, stable memories, and motor outputs.

Work in the Vogels lab is divided into three main areas: (1) plasticity; (2) network dynamics and computation; and (3) ion channels and single-neuron biophysics. In the first, the group uses mechanistic models of synaptic plasticity to find the rules governing how the brain updates its synaptic connections in order to learn and adapt to a changing world. In the second, they seek to understand how neuronal networks process and transform sensory inputs, store and manipulate memories, and send motor outputs. In the third, they build detailed biophysical models of single neurons in order to understand the complex input-output relationships at the level of single neurons and their dendritic branches.

Current projects Machine learning guided searchess for synaptic plasticity in cortical neuron models | Spontaneous activity as a homeostatic controller of neuronal metabolism | Interdependent synaptic plasticity between excitatory and inhibitory neurons | Context dependent memory switching

Career

- since 2020 Professor, IST Austria
- 2016 – 2020 Associate Professor, University of Oxford, UK
- 2018 – 2020 Fellow, St. Peter's College, University of Oxford, UK
- 2014-2018 Fens Kavli Scholar
- 2013 – 2018 Sir Henry Dale Wellcome Trust & Royal Society Research Fellow, University of Oxford, UK
- 2014 – 2017 Hayward Junior Research Fellow, Oriel College, University of Oxford, UK
- 2010 – 2013 Marie Curie Postdoctoral Fellow, École Polytechnique Fédérale de Lausanne, Switzerland
- 2007 – 2010 Patterson Trust Postdoctoral Fellow, Columbia University, New York City, USA
- 2007 PhD, Brandeis University, Waltham, USA

Uli Wagner

Discrete and Computational Geometry and Topology

How and when can a geometric shape be embedded in n-dimensional space without self-intersections? The Wagner group's research program focuses on combinatorial and computational geometry and topology.

A simplicial complex is a description of how to represent a geometric shape by joining points, edges, triangles, and their n-dimensional counterparts in a "nice" way. Simplicial complexes are a natural way to represent shapes for computation and algorithm design, and the Wagner group explores both their topological properties as well as what can be proved about their combinatorics—e.g., bounds on the number of simplices—given particular constraints. They take classical topological questions and consider them from a combinatorial point of view, and conversely, they use techniques and ideas from topology to approach questions in combinatorics. They are moreover interested in the computational aspects of these problems, such as question of decidability and complexity like: Does an algorithm exist? And if so, what are the costs in terms of time or space?

Current projects Embeddings of simplicial complexes | Topological Tverberg-type problems and multiple self-intersections of maps | Discrete isoperimetric inequalities and higher-dimensional expanders

Career

- since 2018 Professor, IST Austria
- 2013 – 2018 Assistant Professor, IST Austria
- 2012 – 2013 SNSF Research Assistant Professor, Institut de Mathématiques de Géométrie et Applications, EPFL, Lausanne, Switzerland
- 2008 – 2012 Senior Research Associate, Institute of Theoretical Computer Science, ETH Zurich, Switzerland
- 2006 – 2008 Postdoctoral Researcher, Institute of Theoretical Computer Science, ETH Zurich, Switzerland
- 2004 – 2006 Postdoc, Einstein Institute for Mathematics, The Hebrew University of Jerusalem, Israel
- 2004 Postdoc, Univerzita Karlova, Prague, Czech Republic
- 2003 Postdoc, Mathematical Sciences Research Institute, Berkeley, USA
- 2004 PhD, ETH Zurich, Switzerland

Scott Waitukaitis

Soft and Complex Materials

Scott Waitukaitis leads an experimental physics lab whose research lies at the intersection of soft matter physics, materials science, and chemistry. Under this umbrella, the group addresses a variety of topics from the nanoscale to the macroscale, using experimental techniques ranging from atomic force microscopy to high-speed imaging.

One focus at smaller scales is tribocharging—the exchange of electrical charge between materials during contact. Although known to occur since ancient Greece, the underlying mechanism remains poorly understood. Recent results suggest adsorbed water layers could play a critical role, donating hydroxide ions through minute 'liquid bridges'. Using atomic force microscopy to characterize adsorbed water and a variety of techniques to measure charge exchange, a major goal is to validate or nullify this hypothesis. Work at larger scales the group considers the non-Newtonian dynamics that arise when colloidal-sized solid particles are suspended in liquids. The group will use such systems to create 'metafluids' whose flow response can be tailored with external stimuli.

Current projects Mesoscale charging statistics with acoustic levitation | Macro-charging of oxide nanolayers on soft polymer substrates | *In situ* charge adsorption/desorption events with optical tweezers | Active chiral Quincke spinners | Elastic and charged Leidenfrost effects

Career

- since 2019 Assistant Professor, IST Austria
- 2016 – 2018 NWO Veni Recipient and Postdoc, AMOLF, Amsterdam, The Netherlands
- 2013 – 2016 Postdoc, Leiden University, The Netherlands
- 2007 – 2013 PhD, University of Chicago, USA

Chris Wojtan

Computer Graphics and Physics Simulation

Computer simulations of natural phenomena are indispensable for modern scientific discoveries, modern engineering, and the digital arts. The Wojtan group uses techniques from physics, geometry, and computer science to create efficient simulations and detailed computer animations.

Natural phenomena like flowing fluids and shattering solids are both beautifully chaotic and overwhelmingly complex. This complexity makes them extremely difficult to compute without the aid of a supercomputer. The Wojtan group overcomes this complexity by combining laws of motion from physics, geometric theories from mathematics and algorithmic optimizations from computer science to efficiently compute highly complicated natural phenomena on consumer-grade computing hardware. Their research achieves some of the world's fastest and most detailed simulations through a deeper understanding of the underlying mathematical models and inventing novel computational techniques.

Current projects Efficient simulation of fluid dynamics | Geometry processing of time-dependent foam structures | Numerical homogenization of knitted and woven materials | Numerical and geometric algorithms for solving partial differential equations | Algorithms for re-using simulation data | Computational physics applied to motion pictures, video games, and virtual reality

Career

- since 2015 Professor, IST Austria
- 2011 – 2014 Assistant Professor, IST Austria
- 2010 PhD, Georgia Institute of Technology, Atlanta, USA

Staff Scientists at IST Austria

Satish Arcot Jayaram

Pre-Clinical Facility

Arcot Jayaram is experienced in providing comprehensive support to researchers who want to explore the technology of genome editing to generate transgenic animals. He likes to collaborate with researchers performing comparative genomics especially for genes of unknown function.

Laboratory model organisms like fruit fly, zebrafish and rodents play a crucial role in studying biological processes such as cell migration, lineage mapping, gene expression and function. Mutations that affect expression and/or function of a gene could cause human pathologies. Research groups prefer to generate *in vivo* mutant model organisms while trying to understand the molecular basis of human disease. Introduction of exogenous sequences like fluorescent proteins is pivotal for scientists who study gene expression and lineage mapping. Precise genome modification of respective model organisms could be achieved with advanced technology like CRISPR and its associated protein Cas9. Representing the transgenic unit, Arcot Jayaram aims to fill the gap by keeping up with the latest genome engineering technologies and to aid IST researchers with the best genetically engineered models for their research.

Current projects Generating knock-in and knock-out mice for specific projects in the Novarino and Shigemoto groups.

Career
- since November 2020 Staff Scientist, IST Austria
- 2019 – 2020 Senior scientific officer, CRUK-MI, University of Manchester, UK
- 2015 – 2019 Postdoc, University of Oxford, UK
- 2010 – 2014 Postdoc, MRC-Laboratory of Molecular Biology, Cambridge, UK
- 2010 PhD, Stockholm University, Sweden

Robert Hauschild

Bioimaging Facility

Robert Hauschild brings expertise in imaging, optical engineering, automation, and image analysis to IST Austria. Affiliated with the Bioimaging Facility, he collaborates with scientists from different fields to develop innovative solutions for unique microscopy problems, including designing and building new equipment and software.

State-of-the-art microscopy not only involves the physics of imaging, it also incorporates automation, system control, and entire image analysis pipelines. Which methods are best suited to a particular project is not always clear, and Hauschild provides IST scientists with valuable expertise in cutting-edge microscopy techniques. This has many aspects, from the evaluation of commercially available equipment to custom modifications of hardware and software. An illustrative example for this is a UV ablation system that has been used by many IST Austria researchers and several academic visitors. Originally devised to study stress in tissue, it has since found application in a diverse array of assays, from wound healing to cell migration.

Current projects Development of tools that help other researches utilize their microscopes to the fullest extent. These tools concern hardware for sample manipulation and environmental control, among other purposes, and automation software. | Image analysis and quantification of a wide range of systems from morphodynamics of immune cells, bacteria in mother machines, to the structure of lymph nodes.

Career
- since 2010 Staff scientist, IST Austria
- 2007 – 2010 Engineer for laser scanning, light sheet, and two photon microscopes, Zeiss MicroImaging, Jena, Germany
- 2006 – 2007 Postdoc, Karlsruhe Institute of Technology, Germany
- 2006 PhD, Karlsruhe Institute of Technology, Germany

Walter Kaufmann

Electron Microscopy Facility

When scientists at IST Austria are interested in applying advanced electron microscopy in their work, but are unsure how to go about it—for instance, what techniques to use or which analysis to employ—they talk to Walter Kaufmann, staff scientist with the Electron Microscopy (EM) Facility on campus.

Kaufmann's focus is on the ultrastructural analysis of biological tissues and cells and the high-resolution localization of transmembrane proteins. He investigates their cell-type specific expression, subcellular localization and association with micro- and nanodomains, applies state-of-the-art electron microscopy techniques and develops new sample preparation procedures. Key methodologies performed are pre- and post-embedding immunogold EM, 3D serial section TEM, electron tomography (3D STEM), high-pressure freezing plus freeze-substitution, platinum-replica EM, and freeze-fracture replica labeling. Main current collaborations are within the fields of structural and molecular neurosciences, immune cell morphodynamics, cell biology of plants and morphogenesis in development.

Current projects Ultrastructural analysis of voltage-gated calcium channels in relation to vesicle fusion sites at fast and slow neuron synapses by comparison (Shigemoto and Jonas groups) | High-resolution localization of TPLATE and role of actin in clathrin-mediated endocytosis (Friml group) | 3D structural analysis of peripheral lymph node conduits and associated cell populations (Sixt group) | Electron tomography of clathrin-coated vesicles (Friml group) | Freeze-fracture replica labeling of calcium effectors and sensors at human brain synapses (Shigemoto and Siegert groups)

Career
- since 2013 Staff scientist, IST Austria
- 2013 Habilitation in Neurosciences, Innsbruck Medical University, Austria
- 2004 – 2013 Research Scientist, Innsbruck Medical University, Austria
- 2002 – 2004 Postdoc, Centre for Molecular Biology and Neuroscience, Oslo, Norway
- 1997 – 2002 Postdoc, Innsbruck Medical University, Austria
- 1997 PhD, Leopold Franzens University Innsbruck, Austria

Jack Merrin

Nanofabrication Facility

Microfluidics involves the experimental manipulation of fluids and objects, such as live cells, at small scales of length. Nanofabrication Facility staff scientist Jack Merrin develops novel and innovative systems to study diverse biophysical phenomena together with various groups at IST Austria.

Transparent microfluidic devices are ideal for analyzing single cells, as well as cell culture and micro-environmental control, all of which can be done while performing microscopy. In one project, Merrin designed a set-up that allowed scientists to change the chemical environment in seconds, revealing that the rapid growth rate response of plant roots to auxin hormone is faster than transcription. In another, chemotaxis studies involving dendritic cells showed how cells can respond either to immobilized or diffusible gradients. Using various geometries, Merrin and the Sixt group found that dendritic cells move through the path of least resistance to protect the nucleus and can also move by pushing off irregular geometries in the absence of cell adhesion.

Current projects Immobilization arrays, imaging, sorting, and stimulation of C. elegans (de Bono group) | Fluid handling for high resolution microscopy (Danzl group) | Spatiotemporal control of A. thaliana root growth (Friml group) | Single-cell lineage microfluidics of E. coli and image analysis (Guet group) | Measurement of mutation rates and chaotic behavior in bouncing silicone oil droplets (Hof group) | Optically transparent microwells for cell-cell contact developmental studies (Heisenberg group) | Micropatterned chrome grids on glass for in vitro membrane biochemistry (Loose group) | Spatiotemporal control of chemotactic gradients for neutrophils and dendritic cells, cancer cell migration in post arrays, migration and chemotaxis through obstacles and mazes (Sixt group)

Career
- since 2013 Staff scientist, IST Austria
- 2012 Postdoc, Memorial Sloan Kettering Cancer Center, New York, USA
- 2009 – 2011 Postdoc, The Rockefeller University, New York, USA
- 2007 – 2009 Postdoc, Joseph Fourier University, Grenoble, France
- 2006 PhD, Princeton University, New Jersey, USA

Christoph Sommer

Bioimaging Facility

Christoph Sommer is an expert in image analysis, especially in creating software to automate image analysis. His work focuses on the interface of computer science and biology, where he develops and establishes new technology for computer-aided image and video analyses.

Sommer's work has involved a variety of groups and experimental systems. With the Novarino group, he established multi-animal behavioral analysis, to quantify complex social behavior and interactions of mice. Working together with the Danzl and Friml groups, he demonstrated that super-resolution imaging of expanded plant tissue enables novel biological assays far beyond the diffraction limit. With the Loose group, he established a novel method for quantifying filament dynamics in in vitro experiments of treadmilling cytoskeletal proteins, which aids in the better understanding of protein (self-)organization. A tadpole project with the Sweeny group is underway as well—involving deep learning based body part detection and tracking. It will enable the study of many aspects in locomotor networks of developing Xenopus frogs.

Current projects Expansion microscopy in plants (Friml and Danzl groups) | Cell type identification (Novarino group) | Mouse behavioral analysis (Novarino group) | Image Enhancement (Danzl and Heisenberg group) | Treadmilling filaments (Loose group) | Tadpole locomotion analysis (Sweeny group)

Career
- since 2017 Staff scientist, IST Austria
- 2013 – 2017 Staff scientist, Institute of Molecular Biology Austria (IMBA), Vienna, Austria
- 2011 – 2013 Postdoc, ETH Zurich, Switzerland
- 2010 – 2011 Postdoc, Heidelberg Collaboratory for Image Processing (HCI), Germany
- 2010 PhD, University of Heidelberg, Germany

Interns at IST Austria
(throughout 2020; percentages are rounded)

ISTerns (summer interns)*

Total number of ISTerns: 11

Gender among ISTerns

- ♀ 45.5%
- ♂ 54.5%

Country of nationality

- 63.6% Austria
- 18.2% Croatia
- 9.1% Iran
- 9.1% Nigeria

Country of current institution

- 90.9% Austria
- 9.1% USA

Field of research at IST Austria

- 27.3% Biology
- 27.3% Chemistry
- 18.2% Neuroscience
- 18.2% Physics
- 9.1% Computer Science

Scientific interns at IST Austria

Total number of scientific interns: 73

Gender among scientific interns

- ♀ 41.1%
- ♂ 58.9%

Country of nationality

- 20.5% Austria
- 9.6% Italy
- 8.2% Russia
- 6.8% Germany
- 6.8% India
- 6.8% Iran
- 6.8% Spain
- 34.2% Other (18**)

Country of current institution

- 34.2% Austria
- 8.2% Russia
- 6.8% Italy
- 6.8% Germany
- 5.5% Spain
- 4.1% Czech Republic
- 34.3% Other (17**)

Field of research at IST Austria

- 26% Biology
- 23.3% Computer Science
- 20.5% Physics
- 17.8% Neuroscience
- 11% Chemistry
- 1.4% Mathematics

* Due to the Covid pandemic, IST offered a summer internship only to students who were located in Austria.
** Number of countries

PhD Students at IST Austria
(as of December 31, 2020; percentages are rounded)

Total number of PhD students: 250

Gender among PhD students

- ♀ 42.4%
- ♂ 57.6%

Country of nationality

- 17.7% Austria
- 8.5% India
- 7.8% Germany
- 6.8% Italy
- 5.6% Russia
- 4.5% Slovakia
- 4.2% Spain
- 44.7% Other (44*)

Country of previous (BS or MA) institution

- 18% Austria
- 10.4% UK
- 8.8% Germany
- 6.4% India
- 5.6% Italy
- 4.4% Czech Republic
- 46.4% Other (36*)

Field of research at IST Austria

- 26% Biology
- 14.8% Physics
- 12.4% Neuroscience
- 9.2% Computer Science
- 6.4% Mathematics
- 1.2% Chemistry
- 30% Unaffiliated**

Postdocs at IST Austria
(as of December 31, 2020; percentages are rounded)

Total number of postdocs: 185

Gender among postdocs

- ♀ 33%
- ♂ 67%

Country of nationality

- 10.8% Germany
- 8.6% Italy
- 8.1% China
- 5.9% Russia
- 5.4% Austria
- 5.4% India
- 4.3% Spain
- 51.4% Other (42*)

Country of PhD institution

- 16.8% Germany
- 15.7% Austria
- 9.2% USA
- 7.6% UK
- 5.4% France
- 4.9% Switzerland
- 4.9% China
- 35.7% Other (25*)

Field of research at IST Austria

- 31.9% Biology
- 20% Neuroscience
- 18.4% Physics
- 15.1% Mathematics
- 12.4% Computer Science
- 2.2% Chemistry

* Number of countries
** Freshman students, who joined IST Austria in fall 2020, usually need one year to pass a qualifying exam and be affiliated with a research group.

PhD Graduates 2020

This year, 32 students completed their PhDs, bringing the total number of graduates to 113. The 2020 graduates, with their group affiliations and dissertation titles, are listed below.

Serhii Avvakumov, *Wagner group*: “Topological methods in geometry and discrete mathematics”
Pradeep Bhandari, *Shigemoto group*: “Localization and functional role of CAV2.3 in the medial habenula to interpeduncular nucleus pathway”
Urban Bezeljak, *Loose group:* “In vitro reconstitution of a Rab activation switch”
Ximena Contreras Paniagua, *Hippenmeyer group*: “Genetic dissection of neural development in health and disease at single cell resolution”
Paulo Dos Santos Caldas, *Loose group*: “Organization and dynamics of treadmilling filaments in cytoskeletal networks of FtsZ and its crosslinkers”
Shamsi Emtenani, *Siekhaus group*: “Metabolic regulation of Drosophila macrophage tissue invasion”
Dominik Forkert, *Maas group*: “Gradient flows in spaces of probability measures for finite-volume schemes, metric graphs and non-reversible Markov chains”
Rok Grah, *Guet and Tkačik groups*: “Gene regulation across scales – how biophysical constraints shape evolution”
Ruslan Guseinov, *Bickel group*: “Computational design of curved thin shells: From glass façades to programmable matter”
Jakub Hajny, *Friml group*: “Identification and characterization of a molecular machinery of auxin-dependent canalization during vasculature formation and regeneration”
Huibin Han, *Friml group*: “Novel insights into PIN polarity regulation during Aradiopsis development”
Kristóf Huszár, *Wagner group*: “Combinatorial width parameters for 3-dimensional manifolds”
Stephanie Kainrath, *Guet group*: “Synthetic tools for optogenetic and chemogenetic inhibition of cellular signals”
Chethan Kamath Hosdurg, *Pietrzak group*: “On the average-case hardness of total search problems”
Domen Kampjut, *Sazanov group*: “Molecular mechanisms of mitochondrial redox-coupled proton pumping enzymes”
Bor Kavcic, *Tkačik group*: “Perturbations of protein synthesis: from antibiotics to genetics and physiology”
Bernhard Kragl, *Henzinger group*: “Verifying concurrent programs: Refinement, synchronization, sequentialization”
Josip Kukucka, *Katsaros group*: “Implementation of a hole spin qubit in Ge hut wires and dispersive spin sensing”
Xiang Li, *Lemeshko group*: “Rotation of coupled cold molecules in the presence of a many-body environment”
Simon Mayer, *Seiringer group*: “The free energy of a dilute two-dimensional Bose gas”
Zuzana Masárová, *Edelsbrunner and Wagner groups*: “Reconfiguration problems”
Jasmin Morandell, *Novarino group*: “Illuminating the role of Cul3 in autism spectrum disorder pathogenesis”
Katharina Ölsböck, *Edelsbrunner group*: “The hole system of triangulated shapes”
Amélie Royer, *Lampert group*: “Leveraging structure in computer vision tasks for flexible deep learning models”
Davide Scarselli, *Hof group*: “New approaches to reduce friction in turbulent pipe flow”
Cornelia Schwayer, *Heisenberg group*: “Mechanosensation of tight junctions depends on ZO-1 phase separation and flow”
Shayan Shamipour, *Heisenberg group*: “Bulk actin dynamics drive phase segregation in zebrafish oocytes”
Julia Steiner, *Sazanov group*: “Biochemical and structural investigation of the Mrp antiporter, an ancestor of complex I”
Enikő Szép, *Barton group*: “Local adaptation in metapopulations”
Joszef Tkadlec, *Chatterjee group*: “A role of graphs in evolutionary processes”
Isabella Tomanek-Leithner, *Guet group*: “The evolution of gene expression by copy number and point mutations”
Ran Zhang, *Bickel group*: “Structure-aware computational design and its application to 3D printable volume scattering, mechanism, and multistability”

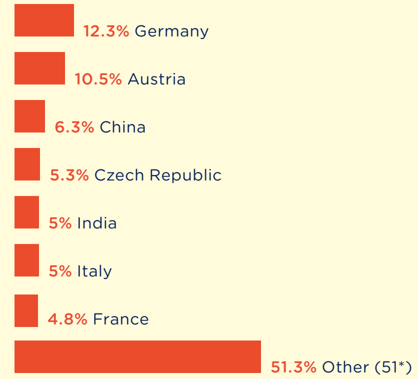
IST Alumni Network

(as of December 31, 2020; data are self-reported by members of the IST Austria alumni network, actual counts may be higher; percentages are rounded)

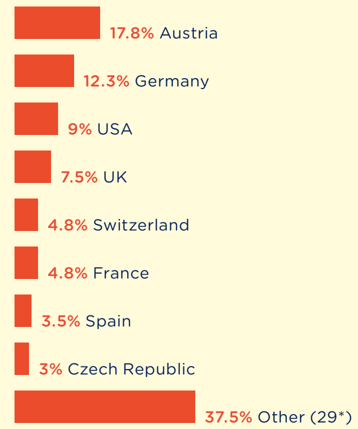
Total number of alumni: 400

PhD students/graduates	125
Postdocs (at least one year spent at IST Austria)	275

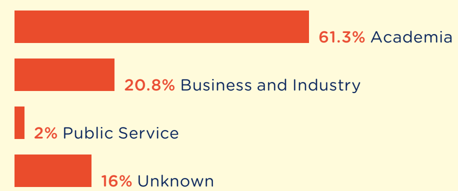
Country of nationality



Current country of employment



Alumni by employment sector



* Number of countries

Scientific Service Units at IST Austria

Scientific Service Units (SSUs) currently operational at IST Austria:

- Bioimaging Facility
- Electron Microscopy Facility
- Library
- Lab Support Facility
- Miba Machine Shop
- Nanofabrication Facility
- Preclinical Facility
- Scientific Computing Facility

Administration at IST Austria

Administration at IST Austria comprises the following areas:

- Academic Affairs
- Campus IT Services
- Campus Services
- Communications & Events
- Construction & Maintenance
- Environment, Health & Safety
- Executive Affairs
- Finance
- Graduate School Office
- Grant Office
- Human Resources
- Office of the President
- Technology Transfer Office

Technical Support at IST Austria

(Scientific Service Units and laboratory technicians as of December 31, 2020; percentages are rounded)

Total number of technical support staff: 129

Gender among technical support staff

♀ 54.3%
♂ 45.7%

Country of nationality

41.1% Austria
8.5% Germany
5.4% Italy
4.7% Hungary
3.1% Poland
3.1% France
34.1% Other (27*)

Administrative Staff at IST Austria

(as of December 31, 2020; percentages are rounded)

Total number of administrative staff: 196

Gender among administrative staff

♀ 60.2%
♂ 39.8%

Country of nationality

73% Austria
4.1% Germany
2% Poland
2% Hungary
1.5% Romania
1.5% UK
15.8% Other (22*)

* Number of countries

Grants 2020

(active or received in 2020; funding amounts are rounded)

Alistarh group
- Coordination in constrained and natural distributed systems, H2020 MSCA IF, €174'000, 6/19-5/21
- Elastic Coordination for Scalable Machine Learning, H2020 ERC StG, €1'494'000, 3/19-2/24
- Vienna Graduate School on Computational Optimization, FWF DK, €152'000, 3/20-2/24

Barton group
- Causes and consequences of population fragmentation, FWF Stand-alone, €61'000, 9/20-5/24
- The maintenance of alternative adaptive peaks in snapdragons, FWF Stand-alone, €404'000, 3/20-2/23
- Theoretical and empirical approaches to understanding Parallel Adaptation, H2020 MSCA IF, €166'000, 9/18-11/20
- Sex chromosomes and species barriers, FWF Meitner, €169'000, 6/18-5/20
- Rate of Adaptation in Changing Environment, H2020 MSCA IF, €166'000, 1/17-6/20

Benková group
- Mechanism of root system regulation by aromatic cytokinin derivatives, OeAD WTZ, €7'000, 1/21-12/22
- Plant tropisms, FFG FEMtech, €8'000, 1/20-7/20
- Hormonal regulation of plant adaptive responses to environmental signals, ÖAW DOC, €116'000, 9/18-8/21
- Molecular mechanisms of the cytokinin regulated endomembrane trafficking to coordinate plant organogenesis, ÖAW DOC, €116'000, 8/17-10/20

Bernecky group
- Roles of A-to-I editing in dsRNA recognition, FWF SFB, €244'000, 3/20-2/24
- Regulation of mammalian transcription by noncoding RNA, FWF Stand-alone, €400'000, 11/20-10/23

Bickel group
- MATERIALIZABLE: Intelligent fabrication-oriented Computational Design and Modeling, H2020 ERC StG, €1'498'000, 2/17-1/22
- Automatized Design of Injection Molds, H2020 ERC PoC, €150'000, 6/19-11/20

Browning group
- Between rational and integral points, EPSRC Research Grant, €114'000, 9/18-11/20
- Local-global principles and zero-cycles, H2020 MSCA IF, €174'000, 10/19-7/20
- New frontiers of the Manin conjecture, FWF Stand-alone, €362'000, 10/19-9/22
- EPSRC ad personam fellowship - Nicholas Rome, EPSRC PG scholarship, €11'000, 8/19-3/20
- A motivic circle method, H2020 MSCA IF, €186'000, 7/20-6/22

Chatterjee group
- Microsoft Research Faculty Fellowship, Microsoft Research Studio Award, €143'000, 4/11-3/21
- Efficient Algorithms for Computer Aided Verification, WWTF Cooperation project, €82'000, 3/16-6/21
- Quantitative Analysis of Probablistic Systems with a focus on Crypto-currencies, ÖAW DOC, €96'000, 6/19-1/21

Cremer group
- Epidemics in ant societies on a chip, H2020 ERC CoG, €1'992'000, 4/18-3/23
- Brushing off Pathogens: structure and function of the antennal cleaner in ants, ÖAW DOC, €116'000, 10/20-9/23

Csicsvari group
- Interneuro Plasticity During Spatial Learning, FWF International program, €299'000, 2/18-1/21
- The Brainstem-Hippocampus Network Uncovered: Dynamics, Reactivation and Memory Consolidation, H2020 MSCA IF, €174'000, 8/19-7/21

Danzl group
- Optical control of synaptic function via adhesion molecules, FWF International program, €287'000, 3/18-2/21
- High-speed 3D-nanoscopy to study the role of adhesion during 3D cell migration, HFSP LTF, €144'000, 7/18-6/21
- Molecular Drug Targets, FWF DK, €193'000, 3/19-2/23
- UltraX - achieving sub-nanometer resolution in light microscopy using iterative X10 microscopy in combination with nanobodies and STED, EMBO LTF, €81'000, 8/19-10/21
- High content imaging to decode human immune cell interactions in health and allergic disease, NFB Life Science , €279'000, 12/19-11/22

de Bono group
- Control of gene expression at the endoplasmic reticulum, EMBO LTF, €83'000, 10/19-11/21
- Molecular mechanisms of neural circuit function, Wellcome Trust Investigator Award, €1'223'000, 10/19-3/23

Edelsbrunner group
- Persistence and stability of geometric complexes, FWF International program, €154'000, 9/16-8/20
- Alpha Shape Theory Extended, H2020 ERC AdG, €1'678'000, 7/18-6/23
- The Wittgenstein Prize – Herbert Edelsbrunner, FWF Wittgenstein, €1'400'000, 7/19-6/24
- Algebraic Footprints of Geometric Features in Homology, FWF International program, €234'000, 10/19-9/22
- Discretization in Geometry and Dynamics, FWF International program, €290'000, 10/20-9/24

Erdős group
- Structured Non-Hermitian Random Matrices, FWF Meitner, €161'000, 1/17-1/20
- Geometric study of Wasserstein spaces and free probability, H2020 MSCA IF, €186'000, 10/19-9/21

Fink group
- Hybrid Optomechanical Technologies, H2020 Cooperation FET-Proactive, €548'000, 1/17-6/21
- Hybrid Semiconductor - Superconductor Quantum Devices, NOMIS Research Grants, €700'000, 9/17-8/21
- A Fiber Optic Transceiver for Superconducting Qubits, H2020 ERC StG, €1'500'000, 2/18-1/23
- Coherent on-chip conversion of superconducting qubit signals from microwaves to optical frequencies, ÖAW DOC, €96'000, 7/18-12/20
- Integrating superconducting quantum circuits, FWF SFB, €429'000, 3/19-2/23
- Controllable Collective States of Superconducting Qubit Ensembles, ÖAW DOC, €77'000, 10/19-9/21
- Quantum readout techniques and technologies, H2020 Cooperation FET-Open, €388'000, 11/19-10/22
- Quantum Local Area Networks with Superconducting Qubits, H2020 Cooperation FET-Open, €388'000, 9/20-8/23

Fischer group
- Bridging Scales in Random Materials, H2020 ERC StG, €1'143'000, 3/21-2/26

Friml group
- Körber European Science Prize, Körber Foundation, €41'000, 4/15-12/20
- Tracing Evolution of Auxin Transport and Polarity in Plants, H2020 ERC AdG, €2'410'000, 1/18-12/22
- RNA-directed DNA methylation in plant development, FWF Stand-alone, €352'000, 7/17-6/21
- Molecular mechanisms of endocytic cargo recognition in plants, FWF International program, €339'000, 2/18-1/22
- Cell surface receptor complexes for PIN polarity and auxin-mediated development, ÖAW DOC, €116'000, 3/19-12/20
- A Case Study of Plant Growth Regulation: Molecular Mechanism of Auxin-mediated Rapid Growth Inhibition in Arabidopsis Root, ÖAW DOC, €77'000, 10/19-9/21

Guet group
- CyberCircuits: Cybergenetic circuits to test composability of gene networks, FWF International program, €262'000, 4/19-3/22
- Biophysically realistic genotype-phenotype maps for regulatory networks, ÖAW DOC, €77'000, 9/18-7/20
- Bacterial toxin-antitoxin systems as antiphage defense mechanisms, FWF Richter, €230'000, 2/19-7/21
- Dynamics of large evolutionary steps at the level of the single cell, EMBO LTF, €136'000, 1/21-12/22

Hannezo group
- Active mechano-chemical description of the cell cytoskeleton, FWF Stand-alone, €339'000, 10/18-9/21
- Design Principles of Branching Morphogenesis, H2020 ERC StG, €1'453'000, 7/20-6/25
- EMBO Young Investigator Program, EMBO, €15'000, 1/20-12/23

Hausel group
- Algebro-Geometric Applications of Factorization Homology, FWF Meitner, €159'000, 9/19-8/21

Heisenberg group
- Control of epithelial cell layer spreading in zebrafish, FWF International program, €350'000, 2/17-1/20
- Interaction and feedback between cell mechanics and fate specification in vertebrate gastrulation, H2020 ERC AdG, €2'307'000, 7/17-6/22
- Control of embryonic cleavage pattern, FWF International program, €229'000, 5/18-4/21
- Nano-Analytics of Cellular Systems, FWF DK, €197'000, 3/18-2/22
- Coordination of mesendoderm fate specification and internalization during zebrafish gastrulation, HFSP LTF, €144'000, 9/18-8/21
- Tissue material properties in embryonic development, FWF Richter, €184'000, 2/19-11/20
- Mechanosensation in cell migration: the role of friction forces in cell polarization and directed migration, EMBO LTF, €78'000, 2/19-3/21
- Mesendoderm specification in zebrafish: The role of extraembryonic tissues, ÖAW DOC, €77'000, 6/19-5/21

Henzinger group
- Automated Tutoring System for Automata Theory, Microsoft Research Studio Award, €7'000, 1/11-12/21
- The Wittgenstein Prize – Thomas A. Henzinger, FWF Wittgenstein, €1'500'000, 1/14-6/21
- Formal Methods meets Algorithmic Game Theory, FWF Meitner, €153'000, 2/18-1/20

Higginbotham group
- Cavity electromechanics across a quantum phase transition, FWF Stand-alone, €406'000, 10/20-9/23

Hippenmeyer group
- Principles of Neural Stem Cell Lineage Progression in Cerebral Cortex Development, H2020 ERC CoG, €1'996'000, 12/17-11/22
- Molecular Mechanisms of Radial Neuronal Migration, ÖAW DOC, €116'000, 8/17-7/20
- Molecular Mechanisms Regulating Gliogenesis in the Cerebral Cortex, FWF Meitner, €166'000, 3/18-2/20
- Role of Eed in neural stem cell lineage progression, FWF Firnberg, €234'000, 12/18-11/21
- Molecular Mechanisms of Neural Stem Cell Lineage Progression, FWF SFB, €373'000, 3/20-2/24

Hof group
- Revisiting the Turbulence Problem Using Statistical Mechanics: Experimental Studies on Transitional and Turbulent Flows, Simons Foundation MPS Targeted Grants, €872'000, 9/19-8/23
- Instabilities in pulsating pipe flow of Newtonian and complex fluids, FWF International program, €356'000, 1/20-12/22

Ibáñez group
- HighTE: The Werner Siemens Laboratory for the High Throughput Discovery of Semiconductors for Waste Heat Recovery, WSS, €8'000'000, 9/20-8/28
- Bottom-up Engineering for Thermoelectric Applications, FWF Meitner, €162'000, 5/20-4/22
- Solar-Light-Driven Photoelectro-chemical System, OeAD WTZ, €8'000, 1/21-12/21

Jonas group
- Zellkommunikation in Gesundheit und Krankheit, FWF DK, €143'000, 1/16-9/20
- Biophysics and circuit function of a giant cortical glumatergic synapse, H2020 ERC AdG, €2'678'000, 3/17-2/22
- The Wittgenstein Prize – Peter Jonas, FWF Wittgenstein, €1'500'000, 10/17-9/22
- Structural plasticity at mossy fiber-CA3 synapses, FWF Richter, €113'000, 1/19-3/20
- Development of nanodomain coupling between Ca2+ channels and release sensors at a central inhibitory synapse, OEAW DOC, €77'000, 10/19-9/21
- Intracellular hippocampal attractor dynamics, FWF Firnberg, €239'000, 9/19-8/22
- Synaptic mechanisms of information processing in hippocampal microcircuits, EMBO LTF, €136'000, start date tbc

Jösch group
- Circuits of Visual Attention, H2020 ERC StG, €1'447'000, 12/17-11/22
- Neuronal networks of salience and spatial detection in the murine superior colliculus, HFSP LTF, €144'000, 9/18-8/21
- Evolutionary Optimisation of Neuronal Processing, DFG Priority Program, €185'550, 3/21-2/24 (grant received together with Fyodor Kondrashov)

Kaloshin group
- Spectral rigidity and integrability for billiards and geodesic flows, H2020 ERC AdG, €1'821'000, 3/21-2/26

Katsaros group
- Loch Spin-Qubits und Majorana-Fermionen in Germanium, FWF START, €200'000, 7/16-10/20
- Hybrid Semiconductor - Super conductor Quantum Devices, NOMIS Research Grants, €700'000, 9/17-8/21
- Hole spin orbit qubits in Ge quantum wells, FWF Stand-alone, €400'000, 2/18-1/22
- Majorana bound states in Ge/SiGe heterostructures, H2020 MSCA IF, €174'000, 4/19-9/20
- Topologically protected and scalable quantum bits, H2020 Cooperation FET-Open, €504'000, 12/19-11/22
- Towards scalable hut wire quantum devices, FWF Stand-alone, €407'000, 10/19-9/23
- Long-range spin exchange for 2D qubits architectures, FWF Meitner, €176'000, 11/20-12/20
- High impedance circuit quantum electrodynamics with hole spins, FWF International program, €399'000, 6/21-5/24

Kicheva group
- Coordination of Patterning and Growth in the Spinal Cord, H2020 ERC StG, €1'499'000, 7/16-6/21
- The role of morphogens in the regulation of neural tube growth, ÖAW DOC, €116'000, 10/18-2/22
- Morphogen control of growth and pattern in the spinal cord, FWF SFB, €375'000, 3/20-2/24
- The regulatory logic of pattern formation in the vertebrate dorsal neural tube, NFB Science Call Dissertationen, €60'000, 4/20-3/23

Kolmogorov group
- Discrete Optimization in Computer Vision: Theory and Practice, FP7 ERC CoG, €1'642'000, 6/14-11/20
- Vienna Graduate School on Computational Optimization, FWF DK, €152'000, 3/20-2/24

Kondrashov group
- Characterizing the fitness landscape on population and global scales, H2020 ERC CoG, €1'998'000, 1/19-12/23
- Evolutionary analysis of gene regulation, FWF International program, €395'000, 2/21-1/25
- Evolutionary Optimisation of Neuronal Processing, DFG Priority Program, €185'550, 3/21-2/24 (grant received together with Maximilian Jösch)

Lemeshko group
- Quantum rotations in the presence of a many-body environment, FWF Stand-alone, €318'000, 2/17-1/20
- Angulon: physics and applications of a new quasiparticle, H2020 ERC StG, €1'500'000, 2/19-1/24
- A path-integral approach to composite impurities, FWF Meitner, €169'000, 2/19-10/20
- Analytic and machine learning approaches to composite quantum impurities, ÖAW DOC, €77'000, 3/20-6/22

Loose group
- Self-Organization of the Bacterial Cell, H2020 ERC StG, €1'497'000, 4/16-3/21
- Reconstitution of cell polarity and axis determination in a cell-free system, HFSP Young investigators' grant, €300'000, 10/16-11/20
- EMBO Young Investigator Program, EMBO, €15'000, 1/20-12/23

Maas group
- Optimal Transport and Stochastic Dynamics, H2020 ERC StG, €1'075'000, 2/17-1/22
- Taming Complexity in Partial Differential Systems, FWF SFB, €328'000, 3/17-2/21
- Dissipation and Dispersion in Nonlinear Partial Differential Equations, FWF DK, €161'000, 3/17-2/21
- Singular Stochastic PDEs, FWF Meitner, €169'000, 10/18-2/20

Mondelli group
- Prix Lopez-Loretta 2019 - Marco Mondelli, Fondation Lopez Loreta, €1'000'000, 10/20-9/25

Novarino group
- Molecular Drug Targets, FWF DK, €223'000, 3/15-2/23
- Probing the Reversibility of Autism Spectrum Disorders by Employing in vivo and in vitro Models, H2020 ERC StG, €1'498'000, 10/17-9/22
- Identification of converging Molecular Pathways Across Chromatinopathies as Targets for Therapy, FWF International program, €357'000, 4/19-3/22
- Neural stem cells in autism and epilepsy, FWF SFB, €375'000, 3/20-2/24
- DAAD ad personam fellowship - Denise Haslinger, DAAD PG scholarship, €17'000, 2/20-8/20
- Critical windows and reversibility of ASD associated with mutations in chromatin remodelers, Simons Foundation Research, €993'000, 8/20-7/24

Pietrzak group
- Teaching Old Crypto New Tricks, H2020 ERC CoG, €1'882'000, 4/16-3/21
- Vienna Cybersecurity and Privacy Research Centers, WAW Struktur-impulsprogramm, €40'000, 7/19-6/23

Robinson group
- Improving estimation and prediction of common complex disease risk, SNF , €1'138'000, 5/20-10/24

Sazanov group
- Revealing the functional mechanism of Mrp antiporter, an ancestor of complex I, ÖAW DOC, €116'000, 8/17-9/20
- Structural characterization of E. coli complex I: an important mechanistic model, ÖAW DOC, €77'000, 12/19-11/21

Schur group
- Protein structure and function in filopodia across scales, FWF Meitner, €169'000, 7/18-6/20
- Structural conservation and diversity in retroviral capsid, FWF Stand-alone, €381'000, 10/18-9/21
- Structure and isoform diversity of the Arp2/3 complex, FWF Stand-alone, €401'000, 7/20-6/23
- Structural characterization of Spumavirus capsid assemblies to understand conserved ortervirales assembly mechanisms, ÖAW DOC, €116'000, 10/20-9/23
- Understanding the mechanism and dynamics of chromatin higher-order structure formation via cross-scale structural analysis, OeAD WTZ, €14'000, 8/20-6/23

Seiringer group
- Analysis of quantum many-body systems, H2020 ERC AdG, €1'498'000, 10/16-3/22

Serbyn group
- Non-Ergodic Quantum Matter: Universality, Dynamics and Control, H2020 ERC StG, €1'498'000, 2/20-1/25

Shigemoto group
- In situ analysis of single channel subunit composition in neurons: physiological implication in synaptic plasticity and behavior, H2020 ERC AdG, €2'481'000, 7/16-6/21
- Human Brain Project Specific Grant Agreement 2 (HBP SGA 2), H2020 Cooperation FET-Flagships, €223'000, 4/18-3/20
- Ultrastructural analysis of phosphoinositides in nerve terminals: distribution, dynamics and hysiological roles in synaptic transmission, H2020 MSCA IF, €178'000, 4/18-3/20
- Plasticity in the cerebellum: Which molecular mechanisms are behind physiological learning?, ÖAW DOC, €116'000, 9/18-12/21
- Recombinant Immunolabels for Nanoprecise Brain Mapping Across Scales, NIH U24, €235'000, 9/18-6/24
- LGI1 antibody-induced pathophysiology in synapses, FWF International program, €256'000, 1/20-12/22
- Novel model systems for studying the role of calcium channel subunits in brain disorders, NFB Life Science, €82'000, 1/21-12/23

Siegert group
- Microglia action towards neuronal circuit formation and function in health and disease, H2020 ERC StG, €1'500'000, 5/17-4/22
- Modulating microglia through G protein-coupled receptor (GPCR) signaling, ÖAW DOC, €116'000, 9/18-8/21
- How human microglia shape developing neurons during health and inflammation, NFB Science Call Dissertationen, €60'000, 10/20-9/23

Siekhaus group
- Tissue barrier penetration is crucial for immunity and metastasis, ÖAW DOC, €116'000, 8/17-7/20
- Investigating the role of the novel major superfamily facilitator transporter family member MFSD1 in metastasis, NFB Life Science, €251'000, 8/17-7/20

Sixt group
- Cellular navigation along spatial gradients, H2020 ERC CoG, €1'985'000, 4/17-3/22
- Mechanical adaptation of lamellipodial actin, FWF Stand-alone, €387'000, 3/17-2/20
- Nano-Analytics of Cellular Systems, FWF DK, €197'000, 3/18-2/22
- Decoding GPCR signaling to understand chemotaxis, FWF Firnberg, €239'000, 9/19-8/22
- Role of Dock8-dependent pericentriolar actin structure, FWF Meitner, €162'000, 10/20-11/22
- Bioelectric patrolling: the role of the local membrane potential in immune cell migration, EMBO LTF, €136'000, 1/21-12/22

Tkačik group
- Can evolution minimize spurious signaling crosstalk to reach optimal performance?, HFSP Program grant, €269'000, 12/18-11/21
- TUM stipend - Bor Kavčič, €5'000, 9/19-5/20
- Efficient coding with biophysical realism, FWF Stand-alone, €362'000, 12/20-11/23

Vicoso group
- Prevalence and Influence of Sexual Antagonism on Genome Evolution, H2020 ERC StG, €1'444'000, 3/17-2/22
- Sex Determination in Termites, FWF Meitner, €156'000, 5/18-7/21
- Sexual conflict: resolution, constraints and biomedical implications, ÖAW DOC, €116'000, 8/20-7/23

Vogels group
- Learning the shape of synaptic plasticity rules for neuronal architectures and function through machine learning, H2020 ERC CoG, €1'769'000, 8/20-5/24
- What's in a memory? Spatiotemporal dynamics in strongly coupled recurrent neuronal networks, Wellcome Trust Residual Award, €1'161'000, 8/20-1/24

Wagner group
- Algorithms for Embeddings and Homotopy Theory, FWF Stand-alone, €396'000, 5/18-4/22

Waitukaitis group
- The active dynamics of the elastic Leidenfrost effect, NWO Veni, €24'000, 8/19-5/20
- Tribocharge: a multi-scale approach to an enduring problem in physics, H2020 ERC StG, €1'494'000, 1/21-12/25

Wojtan group
- Efficient Simulation of Natural Phenomena at Extremely Large Scales, H2020 ERC StG, €1'500'000, 3/15-8/20

Abbreviations

DAAD … Deutscher Akademischer Austauschdienst / German Academic Exchange Service
    PG … Postgraduate
DFG ... Deutsche Forschungsgemeinschaft / German Research Foundation
    SPP ... Schwerpunktprogramm / Priority Program
EMBO … European Molecular Biology Organization
    LTF … Long-Term Fellowship
EPSRC … Engineering and Physical Sciences Research Council, UK
FFG … Österreichische Forschungsförderungsgesellschaft / Austrian Research Promotion Agency
FP7 … Seventh Framework Programme for Research and Technological Development 2007-2013, European Union
FWF … Fonds zur Förderung der wissenschaftlichen Forschung / Austrian Science Fund
    DK … Doktoratskolleg / Doctoral Programme
    SFB … Spezialforschungsbereiche / Special Research Programmes
H2020 … Horizon 2020, European Union*
    FET … Future and Emerging Technologies
    ERC … European Research Council, European Union
        AdG … Advanced Grant
        CoG … Consolidator Grant
        PoC … Proof of Concept
        StG … Starting Grant
    MSCA IF … Marie Skłodowska-Curie Individual Fellowship
HFSP … Human Frontier Science Program
    LTF … Long-Term Fellowship
MPS … Mathematical and Physical Sciences
NFB … NÖ Forschung & Bildung / Lower Austrian Research and Education, Austria
NIH … National Institutes of Health, USA
NWO … Nederlandse Organisatie voor Wetenschappelijk Onderzoek / Dutch Research Council
OeAD … Österreichischer Austauschdienst / Austrian Agency for International Cooperation in Education and Research
    WTZ … Wissenschaftlich-Technische Zusammenarbeit / Scientific & Technological Cooperation
ÖAW … Österreichische Akademie der Wissenschaften / Austrian Academy of Sciences
PG … postgraduate
SNF … Swiss National Science Foundation
tbc … to be confirmed
WAW … Wirtschaftsagentur Wien / Vienna Business Agency
WSS … Werner Siemens-Stiftung / Werner Siemens Foundation
WWTF … Wiener Wissenschafts-, Forschungs- und Technologiefonds / Vienna Science and Technology Fund, Austria

* Horizon 2020 equals FP8, the eighth Framework Programme for Research and Technological Development 2014-2020, European Union

Publications 2020

(joint publications involving several groups are listed multiple times)

Alistarh group
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- Censor-Hillel K, Dory M, Korhonen J, Leitersdorf D. 2020. Fast approximate shortest paths in the congested clique. Distributed Computing.
- Alistarh D-A, Aspnes J, Ellen F, Gelashvili R, Zhu L. 2020. Brief Announcement: Why Extension-Based Proofs Fail. Proceedings of the 39th Symposium on Principles of Distributed Computing. PODC: Principles of Distributed Computing, 54–56.
- Alistarh D-A, Fedorov A, Koval N. 2020. In search of the fastest concurrent union-find algorithm. 23rd International Conference on Principles of Distributed Systems. OPODIS: International Conference on Principles of Distributed Systems, LIPIcs, vol. 153, 15:1-15:16.
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- Brown TA, Prokopec A, Alistarh D-A. 2020. Non-blocking interpolation search trees with doubly-logarithmic running time. Proceedings of the ACM SIGPLAN Symposium on Principles and Practice of Parallel Programming. PPOPP: Principles and Practice of Parallel Programming, 276–291.
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- Alistarh D-A, Brown TA, Singhal N. 2020. Memory tagging: Minimalist synchronization for scalable concurrent data structures. Annual ACM Symposium on Parallelism in Algorithms and Architectures. SPAA: Symposium on Parallelism in Algorithms and Architectures, 37–49.
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- Li S, Tal Ben-Nun TB-N, Girolamo SD, Alistarh D-A, Hoefler T. 2020. Taming unbalanced training workloads in deep learning with partial collective operations. Proceedings of the 25th ACM SIGPLAN Symposium on Principles and Practice of Parallel Programming. PPoPP: Sympopsium on Principles and Practice of Parallel Programming, 45–61.
- Li S, Tal Ben-Nun TB-N, Nadiradze G, Girolamo SD, Dryden N, Alistarh D-A, Hoefler T. 2020. Breaking (global) barriers in parallel stochastic optimization with wait-avoiding group averaging. IEEE Transactions on Parallel and Distributed Systems, 3040606.
- Konstantinov NH, Frantar E, Alistarh D-A, Lampert C. 2020. On the sample complexity of adversarial multi-source PAC learning. ICML: International Conference on Machine Learning.

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Bernecky group
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Browning group

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Chatterjee group

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Events 2020*

Scientific conferences, workshops, and symposia (selection)

Date	Event name	Description
February 19-21	Austrian High Performance Computing Conference	Conference to present and learn about latest research results and exchange ideas between users and providers of high performance computing resources
February 28	Development and Stem Cells Regional Meeting	Meeting to initiate scientific dialogue, exchange knowledge of new technologies, and open opportunities for collaboration between groups and institutes around Vienna
May 15	YSS 20 – Climate Change	Young Scientist Symposium, organized by IST Austria students and postdocs, covering different research fields

Outreach and science education events (selection)

Date	Event name	Description
January 24	BR/BRG Klosterneuburg	School visit to IST Austria's Cryo-Electrone Microscopy facility to learn about ant colonies and the microscopy of fruit flies
February 18	HBLA Sitzenberg	School visit to IST Austria's Cryo-EM facility to learn about the visualization of virus particles
August 10-14	KinderUni (online)	A week of online videos and activities provided by IST Austria, including a lecture on "Chaos oder Zufall"
August 24-28	Sommercampus	One-week summer science camp for 6-to-12-year old schoolchildren
August 31 -September 4	Talentesommer	One-week summer science camp for teenagers
October 9	Lange Nacht der Forschung (online)	IST Austria presented results and ideas in math, cryptography, biology, and physics at the biennial research event
November 27	European Researchers Night (online)	Yearly event that takes place simultaneously in cities across Europe

Technology transfer talks

Date	Speaker and affiliation	Talk series and title
June 10	**Curt Bilby** Art Analysis & Research	TWIST Talk: "Technology Commercialization: An unconventional path for unconventional people"
September 16	**Vincent Linder** Calciscon AG	TWIST Talk: "From Post-doc to Biotech Entrepreneur"
November 10	**Heinz Faßmann** Federal Minister of Education, Science, and Research (video message); **Georg Knill** President of the Federation of Austrian Industries; **Matthias Evers** McKinsey	Science Industry Talk: "Bringing Science to Life"

Public lectures

Date	Speaker and affiliation	Talk series and title
January 15	**Johann Danzl** IST Austria	Wissenschaft. Klosterneuburg. Schafft Wissen: "Schärfer als die Physik erlaubt? - Mit hochauflösender Mikroskopie den Geheimnissen des menschlichen Körpers auf der Spur"
April 21	**Joachim Frank** Columbia University	IST Lecture: "Single-particle cryo-EM: Visualization of biological molecules in their native states"
May 13	**Florian Schur** IST Austria	IST Austria Science Talks: "Viren, zieht euch warm an! Wie uns „coole" Cryo-Elektronenmikroskopie hilft, die Schwachstelle von Viren zu finden"
June 17	**Krzysztof Pietrzak** IST Austria	IST Austria Science Talks: "Krypto gegen Krise – wie moderne Kryptografie im Kampf gegen die Pandemie und den Klimawandel mitmischt"
July 1	**Gaia Novarino** IST Austria	IST Austria Science Talks: "Von Genetik bis zu Hirn-Organoiden – auf der Suche nach Therapien für Autismus"
November 4	**Sandra Siegert** IST Austria	IST Austria Science Talks: "Klein, gefräßig, mysteriös – Wie Mikroglia unser Gehirn in Schuss halten"
November 19	**Ruth Wodak** Lancaster University and University of Vienna	IST Science and Society Lecture: "(Re)Nationalizing Europe? The Austrian case 1995-2015"

Institute colloquia

Date	Speaker and affiliation	Title
January 13	**Erich Bornberg-Bauer** University of Münster	"Breeding new proteins, the evolutionary way"
February 21	**Stefan Hell** MPI Göttingen and MPI Heidelberg	"MINFLUX nanoscopy and related matters"
May 4	**Andrea Liu** University of Pennsylvania	"Learning physics from machine learning"
June 8	**Markus Arndt** University of Vienna	"Universal matter-wave interferometry"
June 15	**Kim Nasmyth** University of Oxford	"How does the DNA replisome establish sister chromatid cohesion?"
June 22	**Manu Prakash** Stanford University	"That sinking feeling: Gravity and its role in how life navigates the oceans"
June 29	**Scott Boyd** Stanford University	"Human antibody responses to SARS-CoV-2: Personal and Public"
October 19	**Florence Bertails-Descoubes** INRIA	"Predictive simulation for films, fashion, and physics"
November 9	**Michael Shelley** Flatiron Institute	"Fluid dynamics of living cells"

* Due to the Covid pandemic, some of the planned events had to be cancelled. To comply with safety regulations, the summer camps had fewer students than in previous years. Wherever possible, events took place online.

IST Austria Scientific Awards and Distinctions 2020
(selection)

ERC Advanced Grant, European Research Council
Vadim Kaloshin
ERC Starting Grant, European Research Council
Julian Fischer, Scott Waitukaitis
Förderungspreis of the Austrian Mathematical Society
Julian Fischer
Highly Cited Researcher, Clarivate Analytics
Jiří Friml
Ignaz L. Lieben Award, Austrian Academy of Sciences (ÖAW)
Gašper Tkačik
Member of the Academia Europaea
Tamás Hausel
Member of the American Academy of Arts and Sciences
Thomas A. Henzinger
Member of the US National Academy of Sciences (NAS)
Thomas A. Henzinger
Member of the Young Academy (Austria)
Mikhail Lemeshko
PhD Award, Austrian Association of Molecular Life Sciences and Biotechnology (ÖGMBT)
Aglaja Kopf (Sixt group)
Best Student Paper Award, Institute of Electrical and Electronics Engineers (IEEE) Computer Society
Amir Goharshady (Chatterjee group)

Management of IST Austria

Thomas A. Henzinger President
Michael Sixt Executive Vice President
Georg Schneider Managing Director
Nick Barton Dean of the Graduate School
Simon Hippenmeyer Life Sciences Area Chair
Krzysztof Pietrzak Information and System Sciences Area Chair
Robert Seiringer Mathematical and Physical Sciences Area Chair

IST Austria Internal Awards 2020

Outstanding Scientific Achievement
Felipe Fredes, Ryuichi group
Outstanding Scientific Support
Alois Schlögl, Scientific Computing
Outstanding Administrative Support
Susanne Wertheimer-Wiegel, Environment, Health & Safety
Golden Chalk Award for Excellence in Teaching
Alan Marcelo Arroyo Guevara, Wagner group and
Mario de Bono, de Bono group
Golden Sponge Award for Excellent Teaching Assistance
Michele Nardin, Csicsvari group

Boards of IST Austria

Board of Trustees

The Board of Trustees consists of 17 members. Ten of them are internationally successful scientists, four are appointed by the Federal Government, and three are appointed by the Government of Lower Austria.

Chair: **Claus J. Raidl**, Former President, Oesterreichische Nationalbank, Vienna, Austria
Vice-Chair: **Olaf Kübler**, Former President of ETH Zurich, Switzerland
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Peter Chen, Professor, Laboratorium für Organische Chemie and Former Vice President for Research, ETH Zurich, Switzerland
Alice Dautry, Former President, Institut Pasteur, Paris, France
Elisabeth Engelbrechtsmüller-Strauß, CEO/CFO, Fronius International GmbH, Pettenbach, Austria
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Susan Gasser, Director emeritus, Friedrich Miescher Institute (FMI), Basel, Switzerland
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Pietro Perona, Allen E. Puckett Professor of Electrical Engineering and Computation and Neural Systems, California Institute of Technology, Pasadena, USA
Wolfgang Ruttenstorfer, Member of the Supervisory Board, RHI Magnesita, Vienna Airport
Elisabeth Stadler, CEO, Vienna Insurance Group, Vienna, Austria
Stefan Szyszkowitz, Spokesman of the Executive Board, EVN, Maria Enzersdorf, Austria

The Board of Trustees oversees the development of the Institute, while acting as its highest authority and ensuring that it adheres to its founding principles and vision. It provides guidance to the management and—among other tasks—is responsible for approving the statutes of the organization and its strategic direction; the budget and annual financial statements; the appointment of the President, the Scientific Board, and the Managing Director; and the procedures for academic appointments and the promotion of scientists.

Executive Committee of the Board of Trustees

Chair: **Haim Harari**
Vice-Chair: **Reinhard Jahn**
Elisabeth Engelbrechtsmüller-Strauß
Iain Mattaj
Claus J. Raidl
Wolfgang Ruttenstorfer

The Executive Committee is a subcommittee of the Board of Trustees and has, among others, the following rights and duties:

- Act on behalf of the Board of Trustees in all matters between the meetings of the Board of Trustees.
- Hold preliminary discussions on matters to be brought for approval to the Board of Trustees, such as the annual budget.

Scientific Board

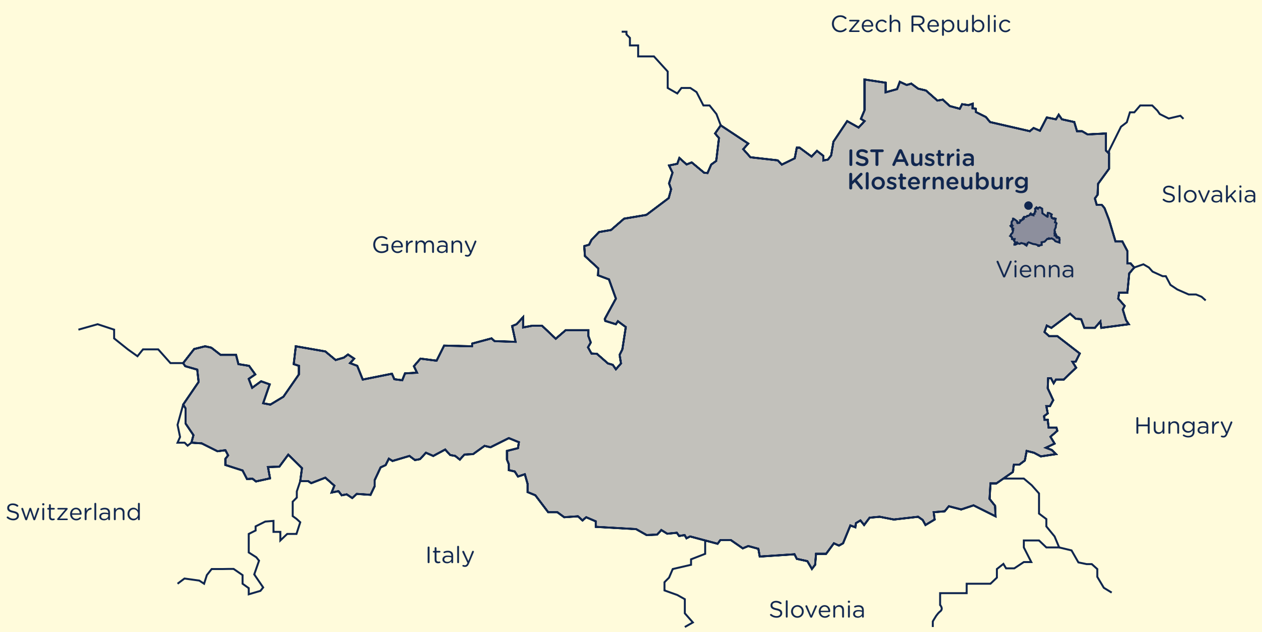
Chair: **Peter Fratzl**, Director, Max Planck Institute of Colloids and Interfaces, Potsdam, Germany
Vice-Chair: **Maria J. Esteban**, Professor, Centre de Recherche en Mathématiques de la Décision, University of Paris-Dauphine, France
Martín Abadi, Professor, Google AI, Mountain View, USA
Angelika Amon, Professor, Department of Biology, Massachusetts Institute of Technology (MIT), Cambridge, USA († October 29, 2020)*
Ben Feringa, Professor, Stratingh Institute for Chemistry, University of Groningen, The Netherlands
Tony F. Heinz, Professor, Department of Applied Physics, Stanford University, Palo Alto, USA
Hannah Monyer, Professor, Department of Clinical Neurobiology, University of Heidelberg, Germany
Andrew Murray, Professor, Department of Molecular and Cell Biology, Harvard University, Cambridge, USA
Gene Myers, Director, Max Planck Institute of Molecular Cell Biology and Genetics, Dresden, Germany
Bradley Nelson, Professor, Institute of Robotics and Intelligent Systems, ETH Zurich, Switzerland
Non-voting Member: **Claus J. Raidl**, Former President, Oesterreichische Nationalbank, Vienna, Austria

The Scientific Board prepares recommendations for the scientific direction of the Institute. It provides guidance to ensure a high degree of scientific productivity, and among other duties, it organizes internal evaluations of the various research fields. The Scientific Board consists of ten researchers who are recognized internationally at the highest levels and an additional (non-voting) member with outstanding management experience.

* Following her untimely passing during her second term, Angelika Amon's experience and steadfast support as a long-standing member of the Scientific Board will be very sorely missed.

Location & Campus Map

Visiting IST Austria
The Institute is located 18 km from the center of Vienna and can easily be reached via public transportation. The IST Austria Shuttle Bus 142 leaves from the U4 station Heiligenstadt. Additionally, a number of public buses connect IST Austria to Vienna.



01 Central Building
Guesthouse, Pub, Info
02 Raiffeisen Lecture Hall
03 voestalpine Building
04 Bertalanffy Foundation Building
05 Preclinical Facility
06 Lab Building East

07 Administration Building
Info
08 Science Experience Center (planned)
09 Memorial
11 Facility Management
12 Heating plant
13 Miba Machine Shop/ Central storage
Deliveries

16 Power control
21 Lab and Office Building West
22 Cafeteria
23 Lab Building 5 & Graduat School (under construction)
24 Lab Building 6 (planned)
27 Kindergarten
CO3 Multipurpose Research Facility

31–35 Apartments
37–45 Apartments
60 Tennis courts
61 Soccer field

28 Fire Station
36 Church
A1 Art/brut Center gugging
A2 House of Artists

Imprint
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Critical, quantitative thinking is essential for carrying out research, but it is also a skill crucial to an active, responsible population. Though 2020 served as a stark reminder of this fact, it has been and remains true, and I am particularly proud of IST Austria, which promotes the development of critical thinking skills on many levels. From the interns who visit during the summer, to the alumni who join the workforce and academic institutions worldwide, to the students and teachers who meet scientists and participate in the Institute's science education initiatives, IST Austria has left its mark on many and will continue to do so. It is an honor to be among IST Austria's partners, and we anticipate a fruitful relationship in the future.

Heinz Faßmann
Federal Minister of Education, Science and Research

Lower Austria has long recognized the importance of science and research, both for the energy and industry it brings to our state, and for the enormous, positive impact it has on our society—a fact that was particularly tangible this year. IST Austria is one of our region's success stories, and not only on the local level: nationally and internationally, it serves as an example for basic research and science management. We are proud to have supported the Institute on its journey so far, and look forward to our future cooperation and the further growth and development of IST Austria.

Johanna Mikl-Leitner
Governor of Lower Austria

Investment in research and innovation is the cornerstone of Europe's lead in science, protection of health and wellbeing of our citizens and achieving sustainability. Organisations such as IST Austria are important partners for achieving impact in the EU's current and future framework programs for research and innovation. IST Austria is a prime example of how the EU's funding for basic research supports Austrian excellence in science and contributes to European competitiveness.

Mariya Gabriel
European Commissioner for Innovation, Research, Culture, Education and Youth

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