Annual Report 2021

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, 2021, a total of 79 nationalities were represented on campus.

IST Austria administrative and technical staff by nationality

Austria	58.8%
Germany	5%
Hungary	2.9%
Italy	2.9%
Poland	2%
UK	2%
Romania	2%
Czech Republic	2%
France	1.8%
Syria	1.5%
USA	1.5%
Spain	1.2%
Other	16.8%

North America
Canada
Cuba
El Salvador
Mexico
USA

Europe
Albania
Andorra
Armenia
Austria
Belarus
Belgium
Bosnia and Herzegovina
Bulgaria
Croatia
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
India
Indonesia
Iran
Israel
Japan
Jordan
Kazakhstan
Lebanon
Nepal
Pakistan
Philippines
Russia
Singapore
South Korea
Syria
Taiwan
Turkmenistan
Vietnam

Africa
Benin
Kenya
Libya
Nigeria
South Africa

IST Austria scientists by nationality

Austria	13.8%
Germany	10.5%
India	7.4%
Italy	5.4%
Russia	5.1%
China	4.9%
Iran	3.7%
USA	3.4%
UK	3%
Slovakia	3%
France	3%
Czech Republic	2.9%
Other	33.9%

South America
Argentina
Brazil
Chile
Columbia
Ecuador
Uruguay

Oceania
Australia

Assistant Professor Maria Ibáñez and her group develop novel functional nanomaterials using precisely designed nanocrystals (purple). With her team, Assistant Professor Lora Sweeney studies the locomotor behavior of animals to gain insights into the functioning of the spinal cord and the entire nervous system (turquoise, inside). © IST Austria/Peter Rigaud

Content

Vice President for Science Education Gaia Novarino, Managing Director Georg Schneider, President Thomas A. Henzinger, Executive Vice President Michael Sixt, Dean of the Graduate School Eva Benková, Vice President for Technology Transfer Bernd Bickel (f.l.t.r).

Last fall, the Republic of Austria and the Federal State of Lower Austria committed 3.3 billion Euro to secure the further growth of IST Austria for the next 15 years. By 2036, IST Austria will no longer be an ambitious small institute, but a substantial Austrian hub in the global network of frontier science. I am grateful to Heinz Faßmann, former Federal Minister of Education, Science, and Research, and to Johanna Mikl-Leitner, Governor of Lower Austria, for their courageous and far-sighted commitment. I also thank all employees and supporters of IST Austria, because the decision for further growth was entirely based on your achievements over the past 15 years. Since our founding we have quickly reached world-wide visibility, but we are only half-way towards sustained recognition as a leading global player in all major disciplines of science.

Eight new professors joined IST Austria in 2021: mathematicians Vadim Kaloshin and Matthew Kwan, plant biologist Daniel Zilberman, soft-matter physicist Jérémie Palacci, biochemist Paul Schanda, computational material scientist Bingqing Cheng, computer scientist Eleftherios Kokoris-Kogias, and climate scientist Caroline Muller. Two young group leaders, quantum physicist Johannes Fink and cell biologist Martin Loose, were promoted to tenured professors. With Eva Benková, the Graduate School of IST Austria has a new Dean and awarded its 100th PhD degree in 2021. It also awarded its first Master's degree in a new program that lets students earn a Master on their way to a PhD. The newly opened Sunstone Building provides a home for the incoming students before they join various research groups on campus; it also hosts the Institute's library, a nuclear magnetic resonance facility, and state-of-the-art laboratories for fundamental research in chemistry and materials. In 2021, IST Austria put a special spotlight on "Women in Science", with a series of events, activities, and exhibits raising awareness about frequently stark gender imbalances, their causes, and ways to address them.

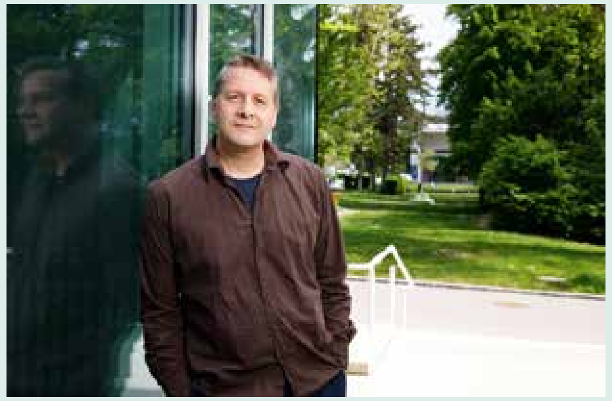
Over the next years, IST Austria will enhance its efforts in science education and in technology transfer to harvest the benefits of frontier science for society and industry. For this, two new Vice Presidents have been appointed: neuroscientist Gaia Novarino as VP for Science Education and computer scientist Bernd Bickel as VP for Technology Transfer. The aim of science education is to share the excitement for science and its importance for modern society through a large variety of activities, ranging from school programs and teacher trainings to summer camps and science olympiads; from traditional public lectures to new outreach formats such as "Zoom a Scientist". The aim of technology transfer is to translate, where possible, scientific results into commercial value, and to connect companies to the Institute. A new bridge will link, both physically and symbolically, the campus of IST Austria with the growing technology park IST Park. IST cube, the venture fund initiated by IST Austria, was oversubscribed and closed with 45 million euros from the European Investment Fund and private partners; it already invests in more than ten start-up enterprises, several of which are based on research from the Institute. Austria needs more scientists, especially female scientists, and more founders, especially technology founders, and IST Austria is committed to contribute to both goals.

I encourage you to visit and stroll around our campus, perhaps with your children or grandchildren. You may encounter researchers from all disciplines and corners of the globe, perhaps arguing vividly, perhaps contemplating silently. You may witness first-hand the passion, curiosity, and awe that is science, perhaps the noblest of all human endeavors. You may even ask how you can join us for a part of the journey. In this spirit, I would like to thank our many companions, old and new, for their support and their generosity.

Thomas A. Henzinger
President, IST Austria

Georg Schneider
Managing Director

With the approval of the new 15a agreement by the Federal Ministry of Education, Science and Research, the Federal Ministry of Finance and the State of Lower Austria, the Institute's growth to 150 research groups by 2036 has been secured. We see this courageous and far-sighted political decision as a clear mandate to continue the successful path of the past years and commit ourselves to further developing IST Austria and its organizational structures. Topics such as digitalization and sustainability are being addressed and will change the way we work in the future. In 2021, the new Sunstone Building was opened and the construction works for Lab Building 6 started. It will provide facilities for experimental sciences, offices, and a seminar center. We already developed a master plan for the further expansion of our campus until 2036 and we are looking forward to the ideas that the architectural competition for Lab Building 7, the first of these new projects, will generate. While the pandemic is not yet over, I am extremely proud of the resilience and determination that the campus community has shown and want to thank everyone for their excellent work.



Michael Sixt
Executive Vice President

With the opening of the chemistry-enabled Sunstone Building, we now have all major branches of the natural sciences on our campus. We develop the Scientific Service Units accordingly and are currently doing our best to bring the support for our chemists and physicists to the same level we provide for the life sciences. A milestone in 2021 was the opening of our new NMR facility, the ninth service unit at IST Austria. The new fully serviced, high-end instruments put IST Austria on the map in a new field and will certainly help us attract new outstanding research groups. Another exciting development is that our staff scientist community grew by three new members. With arrivals in the fields of animal behavior, animal genetics, and bioinformatics, we gained new top-level expertise that many of our researchers will profit from. These experts and our scientific services enable us to keep our research groups compact and flexible. They lower the threshold to tackle upcoming questions with new technology without having to build up all the expertise and equipment within a research group.

Bernd Bickel
Vice President for Technology Transfer

Technology Transfer plays a key role in transforming research findings into applications for the benefit of society. With IST Austria growing in size, we are seeing an increasing number of inventions that may have significant commercial potential. Our mission is to provide the necessary support to identify and realize these opportunities. To emphasize the importance of this undertaking, the new role VP for technology transfer was created, serving as a strong bond between the Institute, its inventors, and TWIST, our technology transfer program. The core activities of TWIST are to protect and commercialize intellectual property generated by IST Austria, coach and educate inventors, and manage the Institute's relationship with industry. Simple and transparent policies guide the handling of intellectual property and start-ups, with the goal to maximize success and secure a fair share for the Institute and the inventors. The generated income will fund future research endeavors. I am looking forward to working with you, helping to take our scientists' inventions to the next level.

Gaia Novarino
Vice President for Science Education

Education is the most important thing we can give our kids. Over the past two years, it has become clear that this is far more than an empty phrase. The coronavirus pandemic clearly showed the need for good science education so people can make informed choices. As Vice President for Science Education, it is especially important to me to reach children and young adults from diverse backgrounds. Together with the science education team, we are constantly working to develop our outreach program to connect with people from all parts of society. In addition to successful programs, such as Open Campus Day, “Zoom a Scientist” video calls for schools, and our summer camps, we have started a new lecture series for teachers and educators interested in the science behind learning. Furthermore, we launch an artist in residence program to bring people interested in art in contact with basic research and vice versa. Thanks to the great support of the researchers and other people at IST Austria, I am confident that we will inspire many people about science and resulting technological innovations.

Eva Benková
Dean of the Graduate School

One of IST Austria's core missions is to educate the next generation of excellent scientists. This goal can only be achieved if all people on campus, from research group leaders to administrative staff, work together. Nevertheless, the Graduate School, for which I have the privilege of serving as Dean since last fall, has a special role to play in this. It has developed very well in recent years, for which I would like to express my sincere thanks to my predecessor Nick Barton for his important contribution. Together with the highly motivated and devoted Graduate School team, we want to continue to create an environment for our students to follow their curiosity as researchers and develop into outstanding scientists. Today, this also involves learning to make their research accessible to a wider public by communicating with different audiences. During the corona pandemic, our students as well as professors have shown great creativity in reaching out to the public to share their knowledge. I look forward to continuing the Graduate School's successful path together.

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 2021

Applications	2'569
Student offers made	106
Student offers accepted	67

Faculty recruiting in 2021

Applications	1'530
Faculty offers made	10
Faculty offers accepted	4

584 scientists

(as of December 31, 2021)

PhD students	280
Postdocs	189
Professors	65
Staff scientists	7
Scientific interns	43

Research grant funding (numbers are rounded)

European Research Council (ERC)	€	8'844'000
European Union other	€	5'339'000
Austrian Science Fund (FWF)	€	4'122'000
NOMIS Foundation	€	1'650'000
Chan Zuckerberg Initiative (CZI)	€	822'000
Human Frontier Science Program (HFSP)	€	405'000
Austrian Academy of Sciences (ÖAW)	€	308'000
European Molecular Biology Organization (EMBO)	€	287'000
Department of Energy, USA	€	112'000
Federation of European Biochemical Societies (FEBS)	€	100'000
Boehringer Ingelheim Fonds (BIF)	€	59'000
Austrian Research Promotion Agency (FFG)	€	44'000
Brain Behaviour Research Foundation	€	30'000
Austrian Federal Ministry of Education, Science and Research (BMBWF)	€	12'000
Zimin Foundation	€	3'000
Others	€	48'000
Total	€	**22'185'000**

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.

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

Independent boards
More than half of the trustees who oversee the Institute are international scientists. Guidance is also provided by an international scientific advisory board.

Exploiting results
Globally competitive basic research leads to unforeseen but useful and valuable discoveries. Intellectual property and technology transfer are important objectives.

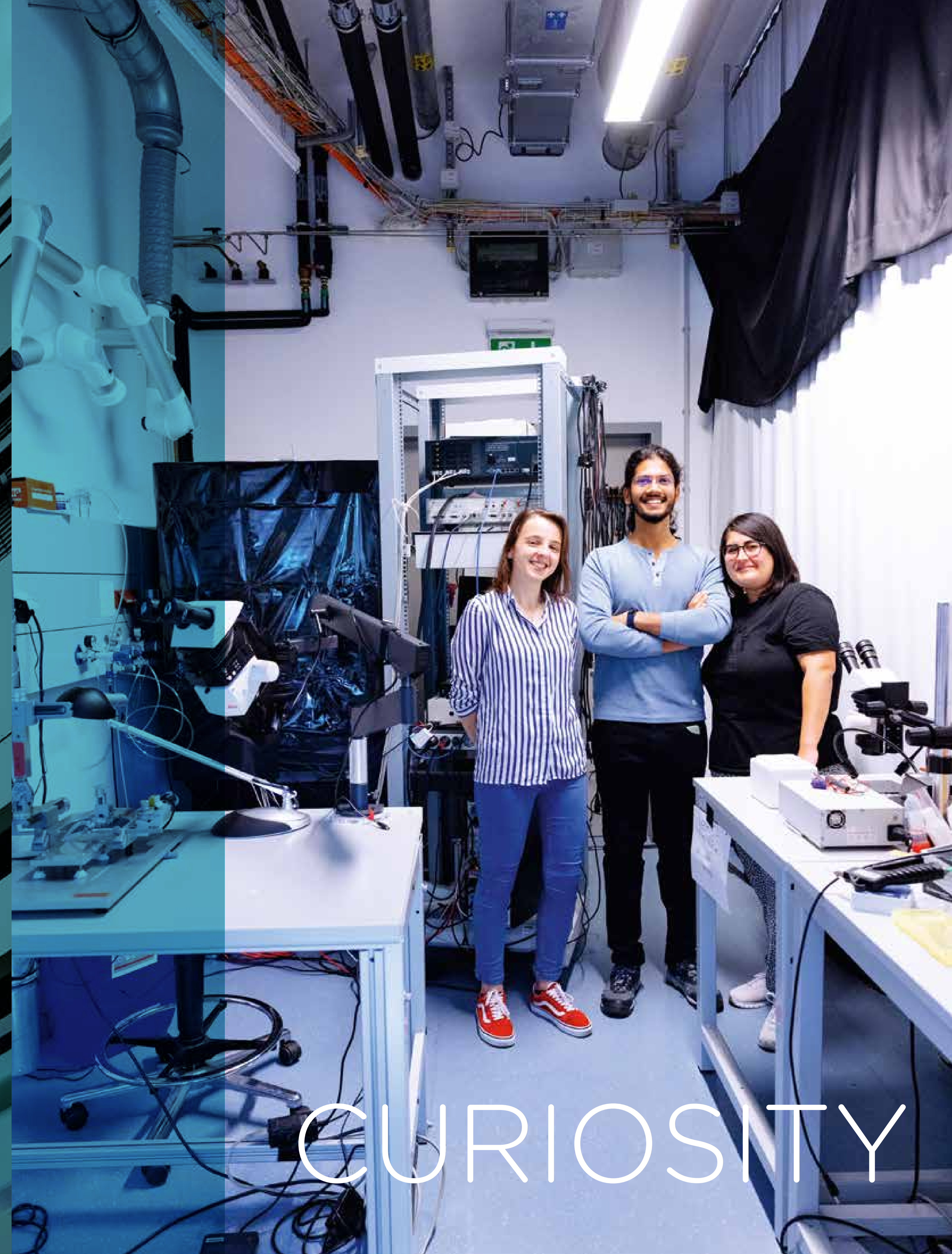
Diverse funding sources
IST Austria is publicly and privately financed. Scientists acquire third-party funds. Donations to the Institute and revenues from intellectual property are transferred to an endowment fund.

Core missions

The founding principles of IST Austria remain valid today and continue to guide the growth and development of the Institute in its second decade, as it works toward 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.**

UNBOUNDED



CURIOSITY

PhD students Eleonora Quiroli, Divyansh Gupta, and Ece Sönmez from the Jösch group study the neuronal basis of how sensory information is transformed into motor commands.

Learn How to Think like a Scientist

Shaping the future of science education

From misinformation about the dangers of vaccination to the basics about viruses and antibodies: The coronavirus pandemic showed how important good science education is for our everyday lives. It also revealed the skepticism of part of our society against science and scientists. In the fall of 2021, IST Austria has appointed two world-class female scientists to open the door to the world of cutting-edge science, especially for young people. Here, plant scientist Eva Benková, the new Dean of IST Austria's Graduate School, and neuro-scientist Gaia Novarino, Vice President for Science Education, talk about the important role young researchers play in communicating and regaining trust in science.

You are highly successful scientists leading your own research groups. Prof. Novarino, you even co-founded a spin-off company. What motivated you to take on this new responsibility?

Professor Gaia Novarino: One of the most important things my parents gave me was access to education. We are both mothers, Eva and I, and I realize the importance of education whenever I talk to my kids. It is about teaching children to approach the world in a critical manner. Doing research is still my major focus. In doing so, I'm always thinking about how my research can help others. Contributing to science education is another way for me to contribute to improving our society.

Professor Eva Benková: The Graduate School gives young people excited about science the opportunity to become scientists. At IST Austria students can explore, find the research topics they are interested in, and from there they start to develop their curriculum. I really like this concept so I think it's worth the effort!

What did the coronavirus pandemic teach you about the importance of science education?

Novarino: It made the lack of trust in scientists obvious. This is at least in part due to our own mis-communication – overselling scientific findings can be extremely dangerous. Apart from that, we were able to see how little knowledge about statistics there is and how much this can affect our health, our lives, the economy, etc.

Benková: There is a lot of information that people read as scientific but that really is not. Learning what information is trustworthy is very important. At the Graduate School we've been extremely privileged. Our students and faculty are very flexible and understand what the pandemic means on a scientific level. They proactively suggested ideas to protect themselves, the Institute, and beyond.

Never before have there been so many people in our society with a scientific degree. Nevertheless, there is a lot of skepticism about science. How can we regain trust?

Benková: We thought we were doing enough as a society but we don't. People don't trust because they don't know whom to trust. We need to educate people about how to identify reliable sources. Good education is when you start to think like a scientist. It's not only about facts, it's about a way of thinking.

Novarino: We also have to become better at communicating science to different groups in our society. That is why we try to address educators in particular with our outreach programs. It is also crucial to include and learn from more diverse people and backgrounds. Unfortunately, the children that would really profit from more science education and that could help us become better educators are usually the ones we don't reach.

What role does the next generation of world class scientists play in this?

Benková: When I started my PhD, it was all about working in the lab. Communicating science to the public was not even secondary. That has changed. Therefore, learning to present your research to different audiences is an important part of the curriculum of the Graduate School. Students have to present their work to scientists within and outside of their field of research. Furthermore, they have to present their research to the public, be it at the annual Open Campus Day or at a "Zoom a Scientist" session where pupils can talk to scientists in a live video call. Getting this immediate feedback and realizing that a presentation at a conference is completely different from talking to kids in school is very important.

Novarino: The young scientists here at IST Austria are a crucial part of the future of basic research, technology development, and science education. We have to make more effort in developing these fields in parallel because they are equally important. Together with the Graduate School, we want to offer a course in science education in the future. In 2022, we will also launch the VISTA Fellowship for PhD graduates of IST Austria and postdocs who want to transition to science education.

What are your goals for the future of the Graduate School and IST Austria's science education program?

Benková: A top scientist nowadays has to be open-minded, creative, and motivated as well as a progressive researcher. On the other side, it's equally important to be attentive to what is going on outside the lab, the problems of the world, and to contribute to society. Our main mission is to help young people to become the next generation of excellent scientists in that sense. I personally would be very glad if our students look back one day with the feeling that IST Austria is their true alma mater.

Novarino: It's difficult to measure our success in helping people make the right decision for their life based on a better understanding of the world. We want to contribute to empower as many people as possible to take an active, informed role. I hope that in five years we will have several examples of people that made different decisions because they had access to good science education.

Becoming a World Class Scientist

Devoted studies, startling discoveries, and a curious community

The Graduate School of IST Austria offers a unique PhD program that supports multidisciplinary training and research. Educating students across research groups and disciplines is a core mission of the Institute, now enhanced by a combined Master's-PhD degree. Take a look, how the first day as a student at IST Austria feels like.

Welcome to IST Austria! Today is your first day of your five-year PhD program at the Institute. You arrived last week, settling into your student accommodation directly on campus. Through the windows, the whole palette of rustling autumn colors greets you in the morning. Engaged in lively discussions, people stroll around the pond with a few drowsy ducks between the modern research facilities. You enjoy the connection to ambient nature, which makes studying at IST Austria even more special. It really is a place to breathe, focus, and think clearly – you already realized this at your visit earlier this year. The spirit amongst staff, scientists, and students made it clear: You wanted to come here and then the offer arrived!

Encouraging exchange across fields

On Saturday, you have already had an evening out in Vienna, only one shuttle bus ride away, with a dozen of the other 66 new students from your cohort. Chatting with them showed that they applied to IST Austria because of its international reputation and their own multifaceted curiosity. They are like-minded people from all kinds of scientific fields, who are equally looking forward to their first-year rotations in various research groups. Although you majored in computer science, you want to dive into neuroscience for some months. Who knows, you might even change fields! Some of your new colleagues expressed a clear wish to join a certain research group, others will wait for an inspiration to sprout – one year is time enough to decide your affiliation with a research group.

A combined Master's-PhD program

You were surprised to learn that twenty percent of the new PhD students only have a Bachelor's degree like yourself. You therefore receive more time for affiliation at IST Austria and the new combined Master's-PhD program that just started in 2021 allows you to get the Master's degree on your way to the PhD as well. You are seriously considering this. Certainly, this means more courses and writing a Master's thesis, but it could prove useful to gain a Master's with a neuroscience focus despite your aspired PhD in data science. You know yourself: Such an intermediate milestone stirs your ambition and provides an achievement along the way to the PhD. You like the flexibility too, because it broadens your range of expertise for later research positions.

Teaching and being taught

On the way to your first course, you run into your buddy. She is a third-year PhD student in a data science group who helped you integrate into the campus community by inviting you to last Friday's Think&Drink talk, where people from different fields share insights into their research, followed by drinks and snacks. One of the four PhD students, who got awarded the Doc Fellowship by the Austrian Academy of Sciences in 2021, presented their doctoral project – in such an understandable way that you could even raise your hand and ask a question. Right now, your buddy is heading to a class for which she is a teaching assistant as part of her curriculum. You take the liberty to ask her the directions to your own core class for the neuroscience track. It is close enough that she can bring you there herself. The class consists of 14 students and the professor interacts immediately on equal footing with each of you. Such a mentoring ratio is not at all comparable to your previous degree. Since IST Austria's faculty is still growing, also more students are accepted each year, while the educational quality is sustained. You look out of the window of your seminar room and wonder when you will teach your first class here, when you will publish your first journal paper, and how many insights and discoveries are waiting along the way leading to your PhD graduation. Then you will have become part of the next generation of excellent scientists.

Promoting science through dialogue

The days when science has been conducted in ivory towers are long past. At IST Austria, all researchers, from students to professors, are encouraged to spread their knowledge and engage in a dialogue, not only with each other, but particularly with other parts of society. The two PhD students Laura Burnett and Thomas Werner explain why they are passionate about science outreach and how, for them, it is equally about listening and sharing their knowledge.

Q1: How would you explain your research project to your parents?

Q2: Why do you consider scientific outreach to be so important?

Laura Burnett
Jösch group

Q1: I am interested in how the brain detects important and potentially dangerous things within our environment and rapidly generates an appropriate behavioral response. I am making use of an innate defensive behavior – the collision avoidance response – that is so fundamental to survival it has been conserved across evolution. Specifically, I show mice a simple visual stimulus of an expanding dark disc that mimics an approaching predator. This generates a reflexive escape behavior towards a nearby shelter. To dissect the contributions of specific neural circuits to this behavior, I use a range of experimental techniques to both record and manipulate neural activity in the related brain regions. I am particularly interested in the ability of these circuits to perform optimally and their effects in human individuals with attentional difficulties.

Q2: Scientific outreach is a great way of meeting and talking to people outside of IST Austria's "science bubble". It's both stimulating and rewarding to communicate with individuals from all walks of life that are enthusiastic about science. Because of their natural curiosity and enthusiasm, I especially like to interact with the younger generation. Taking part in the IST Fakebuster's Bootcamp this summer was a great opportunity to discuss optical illusions with local teenagers and how our brains can be tricked and misled by what we see. It also provided the chance to share more generally what a career in science entails and the different entry paths available from school to university and beyond.

Thomas Werner
Fink group

Q1: I think quite some researchers have tried that multiple times – some more, some less successful. I would go for the analogy of a coin that shows heads and tails on the same side and allows you to solve specific equations way faster depending on how many coins you have. A classical computer would use conventional coins that have two different sides. A quantum computer would use these special coins. As such coins don't exist, we use small, extremely cold structures to simulate them. To retrieve information from these small structures, we need highly elaborate methods. This is what I am currently working on. Amongst other things, my colleagues work on designing and manufacturing those structures and sending the information using light signals.

Q2: I am convinced there are many people who'd be interested in science, once they know what kind of variety it possesses, despite the general public's mistrust in science. It's about sharing our motivation and fascination for it, about encouragement to look behind things, and it's about showing the public: What we do is no black magic! Method and reason are guiding us. Furthermore, as scientists we directly benefit from outreach. When I listen to and think about the questions from someone outside my scientific field, it helps me to rethink my approach and I reflect on the preconceptions I inevitably have.

The Scientific World Around Us

Science outreach at IST Austria

Societal challenges like the pandemic or the climate crisis stress the importance of scientific literacy and science education. IST Austria has a tradition of opening its campus and laboratories to the public, yet the colorful palette of outreach activities continued to gain new successful formats during the time of Covid.

Arhana is 15 years old, attends the Ryan international high school in Patiala, India, and has always been interested in science. When her older brother, a student of mechanical engineering, discovered "Zoom a Scientist" on the online channels of IST Austria, she was immediately enthusiastic to connect to a real scientist through this program. It was her motivation that culminated in a lively conversation between computer scientist Chris Wojtan and Arhana's school class in India.

Zoom a Scientist

The program was established during Corona lockdowns to connect school classes directly to scientists. Nobody had expected though that it would bridge not only physical distancing but even continents. By late 2021, more than 30 sessions of "Zoom a Scientist" had been carried out, in which classes of all grades got to know the people behind science during an informal video call and learned how research is done at a multidisciplinary, international institute. Particularly, the Girls' Special created a safe space for young women to ask early-career scientists about their life, path, and struggles. With female role models still outnumbered by their male colleagues, the Zoom a Scientist: Girls' Special seeks to inspire exactly those young minds who will become the next generation of scientific leaders.

Beating the epidemic: a fast evolving game

Another virtue has been made of necessity in the fall of 2020. Since then, Austrian living rooms have been turned into epidemiological research centers by numerous children playing the board game "Virus Alert in Stayhompton", which had been developed by scientists around IST Austria and the Max Planck Institute for Evolutionary Biology. The game uses a fictitious small town, Stayhompton, with 100 inhabitants to make it tangible how viruses spread and what we can do to stop them. Following real-world developments, the game had to evolve fast. For the third edition in February 2021, vaccinations were added to the game scenarios letting families and school classes experience how they can curb epidemic spreading. Originally in English and German, further translations into Polish and Slovakian made the board game, which was also highlighted by the official Austrian vaccination campaign, accessible to a broader public.

Both, the board game and "Zoom a Scientist", come along with carefully curated teaching material that aims to support teachers in their lessons leading up to the respective activities. Since IST Austria recognizes teachers as vital multipliers in science education, the Science Education Day once again invited them for practical workshops and networking with this year's focal point being digital learning. Another seminar series for teachers is in preparatio further expanding the Institute's efforts to have science and society interact. Many of these programs invite the public to enter the campus, the research facilities, and laboratories. In 2021, these activities were revived and received more interest than ever before.

Experiencing science on campus

Enthusiastic children's laughter on IST Austria's campus usually means one thing: The summer camps are taking place. Three formats for different age groups are enjoying great popularity, the bestseller being the Sommercampus Kids. It offers a one-week program for 60 kids in primary school on biology, physics, or computer science, as well as the arts or history. Together with the College of Teacher Education in Lower Austria, the nearby Museum Gugging, and the Klosterneuburg Abbey, IST Austria encourages children to develop their basic scientific intuition for the world around them in a fun, hands-on environment.
The pupils from middle school instead embarked on a journey into the microscopic. Starting point of the Sommercampus Juniors were biological systems, from which the program charted through chemistry and deeply into physics. Their travel logs were exhibited at the end of the week when the Sommercampus Junior concluded in a ceremonial graduation. Closer to real graduation are the high school students, whose camp focused on science as a method of creating reliable knowledge. The Fakebusters' Bootcamp gave them the opportunity to fact-check common, but sometimes misleading assumptions.

The highlight of our annual campus schedule is the Open Campus. With over 2,000 guests, it was evident that a hunger for science had piled up during the previous year. The program of science slams, research exhibitions, and laboratory tours fascinated guests of all ages leading up to an award ceremony for a school competition. The most impressive drawings about science from preschoolers, the most innovative natural science projects from middle schoolers, and the best pre-scientific theses (VWA) from high-school seniors were honored. As prizes, the oldest students would spend one day in a research group of their choice, for example doing brain cell microscopy and learning about stem cells.

Beyond institutional outreach

All these activities would not work without passionate scientists, who strive to spread the beauty and functionality of science. Beyond the institutional programs, Professor Mikhail Lemeshko cooperated with the Science Center Network in Vienna for an online video competition named #ForschenStattFaken (engl.: fact, not fake). Postdoc Nicole Amberg and a whole team of IST Austria researchers initiated the program "Wissen schafft's", centered on video animations and a children's book with educational scientific content in multiple languages. The work of alumni Barbora Trubenova, who is now working at the ETH Zurich, prove that such activities have a long-lasting impact. Her annual science competition for Slovakian pupils invites the winners to IST Austria, building stable and much needed bridges between the public sphere and the scientific world.

INCLUSIVE

OPENNESS

“Show how to empower!”: students, postdocs, and professors reflected on gender equity and biases in silent interviews.

WoMen in Science: Change the World!

Supporting women and diversity at IST Austria

Scientific talent is equally distributed – you never know where you find it. To exclude any part of the population is to exclude talent. Nevertheless, the academic community, particularly in STEM fields (science, technology, engineering, and mathematics), does not do justice to our diverse society. Women are still drastically under-represented. With its campaign "WoMen in Science: Change the World!" IST Austria has put a spotlight on the problem and intensified its efforts for more diversity and inclusion in science.

Never before have there been more female students. At the beginning of their career, they share the lecture hall in fairly equal numbers with their male colleagues across universities. In some research areas, like medicine, women even outnumber their male counterparts. Looking up the scientific career ladder, the picture changes. Among postdocs, men overtake women, and when it comes to professorships, female professors are a clear minority – a phenomenon called the leaky pipeline. In fields like mathematics, engineering, computer science, and physics, the situation is even more dramatic. "In addition to the leaky pipeline, the number of women in these fields is very low from the beginning," says computer scientist and IST Austria president Tom Henzinger. "This sacrifices half the talent, which is an enormous sacrifice for absolutely no reason."

Sending signals and taking action

To raise awareness for this important topic and discuss solutions, IST Austria launched a yearlong campaign to promote women and diversity in science. In addition to signing the ALBA Declaration on Equity and Inclusion and establishing a respective working group, the Institute started the year by celebrating the UN International Day of Women and Girls in Science in February. It continued with a lecture series focusing on science done by women and the challenges they face. Guest speaker at the first event was Professor Christa Schleper, a German microbiologist known for her work on evolution and ecology.

Under the motto "Show how to empower!" students, postdocs, and professors alike reflected on gender equity and biases in silent interviews captured by photographer Peter Rigaud. The photo exhibition is on display online and on campus. Another piece of art that invites us to discuss and think outside the box is the large poster titled "She makes her body glitch" by artist Barbara Kapusta. It can be viewed on the external wall of the Raiffeisen Lecture Hall. In the Institute's successful outreach program "Zoom a Scientist", the focus in 2021 was on inspiring girls to pursue careers in STEM fields. Through video calls with female IST researchers, they were able to satisfy their curiosity and possibly discover new role models for their own future careers.

A very first step

The highlight of the campaign was a panel discussion in which researchers from several top universities shared their professional expertise and personal experiences on the benefits of gender balance in science, and what institutions can do to achieve and maintain it. "Looking at the numbers of our faculty of 54 male and 13 female professors, we understand very well that raising awareness can only be a very first step," says Tom Henzinger. Therefore, IST Austria has established a faculty recruiting committee that actively approaches potential candidates to increase the number of female professors in areas where women are strongly underrepresented.

To make scientific careers compatible with family life, IST Austria offers high-quality daycare for children between three months and six years of age directly on campus. Additionally, the Institute helps with finding other childcare services and schools, as well as job opportunities for professorial partners. "We need to do everything we can as an institute to ensure that researchers of all genders can balance a successful scientific career with a fulfilling family life," says Henzinger, himself a father of three girls. "Furthermore, we need to make ourselves aware of our unconscious biases and fight them." To create a welcoming and inclusive environment, IST Austria's administrative staff as well as researchers on all levels are encouraged to participate in cultural awareness trainings, talks, and workshops about respectful communication and the importance of diversity, especially gender equality. As a next step, IST Austria is developing a Gender Equality Plan with concrete measures tailored to the Institute.

Committed to equality and inclusion

Besides the efforts the Institute is taking and will continue to take, Henzinger sees an urgent need for action in society as a whole. "Daycare at an early age is often discouraged in Austria and one is considered a bad parent for choosing this option. Also, starting from kindergarten and elementary school all the way to high school, we need to present and teach science in a way that inspires female pupils and does not turn them away."

The diverse experiences and perspectives of people of all genders, as well as all social and cultural backgrounds, enrich science. Diverse teams where everyone feels valued maximize the range of potentially useful ideas and ensure that all group members can give their best. The road to reaching equality and inclusion is long and certainly requires much patience and persistence. As a research institute that also wants to act as a role model for society, IST Austria is aware of its responsibility and will continue its efforts towards this goal.

GLOBAL SPIRIT

Professor Nick Barton and his team members, PhD students Oluwafunmilola Olusanya and Michal Hledik, develop mathematical models to answer questions about evolution, such as how new species form.

Discovering New Horizons

IST Austria's alumni network

Upon graduating or finishing their research work at IST Austria, PhD students and postdocs move on to universities and research institutions in other parts of Austria and around the globe. They join the ranks of professors, start leading their own research group or company, or continue their research as postdocs. Others become senior scientists or department heads at international companies. The IST Austria Alumni Relations team maintains an active relationship with the ever-growing network of currently more than 449 alumni.

Two of our alumni are biologist Nicoletta Petridou and physicist Bernat Corominas-Murtra, who also holds degrees in mathematics and linguistics. During their time at IST Austria, they joined forces to shed light on a puzzling phenomenon. Now they are following their curiosity at other top institutions in Germany and Austria, reaching the next stage in their careers.

To get to the bottom of the processes of life, one scientific discipline is often not enough. During her time as a postdoc at IST Austria's Heisenberg group, Nicoletta Petridou faced such a challenge. The team discovered that when a zebrafish embryo develops from a few cells into a more complex organism, its tissues suddenly change from a solid to a liquid state. "The viscosity drops by ten times – it fluidizes," says Petridou who attained her PhD in Molecular Biology from the University of Cyprus. "On the other hand, we found that the connectivity of the cells doesn't change that much." While a single cell previously is connected to four to five neighboring cells, it has one connection less at the onset of fluidization. Could this small change really lead to the dramatic change of the tissue's material properties the scientists observed? This system behavior resembled a physics phenomenon – phase transitions. To explore this possibility, Nicoletta secured the Elise Richter research grant by the Austrian Science Fund to initiate an interdisciplinary project: Do embryonic tissues undergo phase transitions? "This was, when physics was there to give us a framework that made sense," says the biologist.

Finding a common language

"To link what is going on at the microscopic level with what you observe at the macroscopic level is a key point of physics," explains Bernat Corominas-Murtra, who got his PhD at the Universitat Pompeu Fabra, Barcelona. Before they could solve the puzzle, however, the two researchers had to learn each other's language. "We spent a lot of time talking about things you consider obvious and you realize that they are not obvious at all. Creating this common language is something that takes a lot of time, but is very rewarding," says Corominas-Murtra. Together, they broadened their scientific horizon and came up with a framework that explained the changes Petridou had previously observed. Like ice melting into liquid water, the embryonic tissues really does undergo a phase transition. "It is unique to have a real living system where you are able to trace all the expected properties of a phase transition," explains mathematician and physicist Corominas-Murtra.

Further climbing the career ladder

After finishing her postdoc at IST Austria, Nicoletta Petridou moved to Heidelberg, Germany, where she is leading her own research group at the European Molecular Biology Laboratory (EMBL). The Petridou group aims to understand how complexity emerges during early embryo development, focusing on the role of critical points and transitions. Bernat Corominas-Murtra continues his highly successful career in Austria. In 2021, he was appointed Assistent Professor at the Institute of Biology at the University of Graz within the field "Complexity of Life in Basic Research and Innovation". With his newly created group, he studies how complexity arises in living systems.

→ If you want to know more about how their research could help finding new forms of cancer treatment, please go to page 33.

New Professors to Join IST Austria in 2022

Contracts signed as of December 31, 2021

Anđela Šarić
Whenever needed, proteins assemble into nanoscale structures that generate the molecular machinery of life. In the context of neurodegenerative disease, on the other hand, proteins aggregate in an uncontrolled way. Understanding the physical mechanisms underlying these biological processes is what Anđela Šarić is aiming for. Therefore, the Croatian-born physicist uses computational simulations as well as methods of soft matter and statistical physics. Šarić earned her PhD from Columbia University, New York, in 2013, after which she moved to the University of Cambridge for a postdoctoral fellowship and later became an Emmanuel College Research Fellow there. Since 2016, she has been a junior group leader, research fellow, and later associate professor at the University College London (UCL), England. At IST Austria, Šarić will focus on several projects, including pathological protein misfolding, how biological nano-machinery cuts and reshapes cell membranes, and how protein assemblies form and dissolve far from thermodynamic equilibrium.

Anđela Šarić joined IST Austria in January 2022.

Hryhoriy Polshyn
Our ability to understand and control the behavior of electrons in metals and semiconductors is at the heart of modern electronics and technology. However, if the electrons are constrained to two dimensions and forced to strongly interact with each other, they can assume novel states with fascinating emergent behaviors. In these states, the motions of electrons are inherently correlated with each other, which under the right circumstances could endow the states with exotic topological properties. Not only are such electronic states fundamentally interesting, but they could also become the platform for the next-generation electronic devices and topologically-protected quantum bits. Hryhoriy Polshyn is an experimental condensed matter physicist who focuses on the investigation of such novel electronic phenomena. At IST Austria, he will use heterostructures of graphene and other 2D materials to engineer and study correlated and topological electronic states. Polshyn earned his PhD in physics from the University of Illinois Urbana-Champaign, USA, in 2017. After that, he worked as a postdoc at the University of California, Santa Barbara.

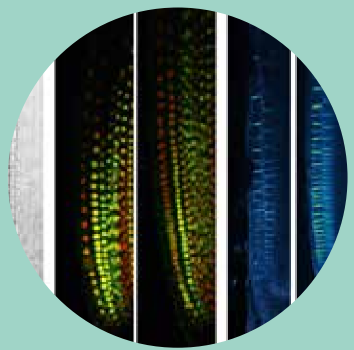
Hryhoriy Polshyn will join IST Austria in June 2022.

PhD students Laura Bocanegra (left) and Stefanie Rus (right) from Assistant Professor Anna Kicheva's research group (center) are interested in understanding how cell diversification and tissue growth are controlled during development.

Biology

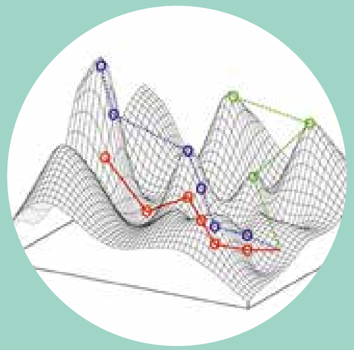
Biology research at IST Austria covers a wide range of areas and involves many collaborations with other scientific fields. In 2021, biologists at the Institute explored questions including: How does a plant adapt to differences in the availability or the form of nutrients in the soil? How do we quantify the adaption of a species to its ecological niche? How can we explain the fluidization of embryonic tissues shortly after fertilization and is there a connection to tumor growth?

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 Systems GAŠPER TKAČIK | Sex-Chromosome Biology and Evolution BEATRIZ VICOSO | Epigenetics and Chromatin DANIEL ZILBERMAN



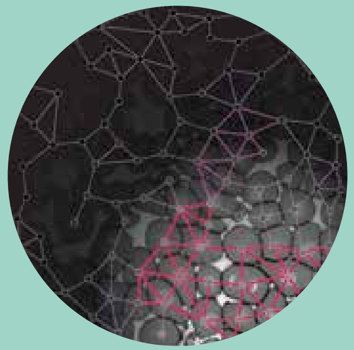
A plant's way to its favorite food
Benková group

Like any other plant, *Arabidopsis thaliana* or mouse-ear cress needs nitrogen to survive and thrive. Its preferred form of this key macronutrient is nitrate, allowing it to grow better on nitrate rich soil. If the concentration or the availability of the different forms of nitrogen fluctuate, plants have to adapt quickly. Understanding how the machineries within a plant cope with their changing environment is one of the research questions of Eva Benková and her team and an important topic for agriculture. Provided with ammonium, a form of nitrogen *Arabidopsis* is not so fond of, the meristematic zone of the cress produced less cells. Instead, they very quickly elongated. "Once we moved the plants to the nitrate, suddenly the meristem became bigger, more cells were produced and there was a different kinetics in cell expansion," says Krisztina Ötvös from Benková's team. Whether the plant invests in cell proliferation or cell elongation is instructed by the level of the plant hormone auxin. The researchers were able to identify the PIN2 protein, which transports auxin through the plant, as the main factor to set up the balance between cell division and cell elongation.



Can evolution be predicted?
Tkačik group

Evolution often finds clever solutions to challenges posed by different environments, from how to survive in the dark depths of the oceans to creating intricate organs such as an eye or an ear. But can we predict any of those outcomes? Working at the intersection of biology, physics, and data science, the Tkačik group developed a statistical framework that uses experimental data from complex biological systems to rigorously test and quantify how well such systems are adapted to their environment. The established models represent adaptation as a movement on a landscape with mountains and valleys. The features of an organism determine where it is located on this landscape. As the organism adapts to its ecological niche, it climbs towards the peak of one of the mountains. The new framework allows the researchers to turn this conceptual picture into a statistically rigorous procedure to quantify how well the organisms are adapted to their niche – that is, how close to optimal performance and under what biophysical constraints they function.



Embryonic tissue undergoes phase transition
Heisenberg & Hannezo groups

While looking at zebrafish embryos a few hours after fertilization, Carl-Philipp Heisenberg and his group discovered a sudden change in the viscosity of the embryonic tissue – a measure of a tissue's resistance to deformation. Simultaneously, the embryo starts changing its shape for the first time. Together with Edouard Hannezo's group, they looked into what is happening at the cellular level. The interdisciplinary team found that before fluidization an individual cell is connected to four to five of its neighboring cells. At the onset of fluidization, however, it has only three to four connections left. Using an analogy with material science, they were able to show that the fluidization of the tissue displays features of a phase transition. The transition is essential for the further development of the embryo. These findings could also play a key role in tumor metastasis, where it has been proposed that abrupt changes from solid to liquid material properties could allow cancer cells to move around more easily. Identifying this critical point of phase transition could therefore open ways to manipulate it.

Chemistry

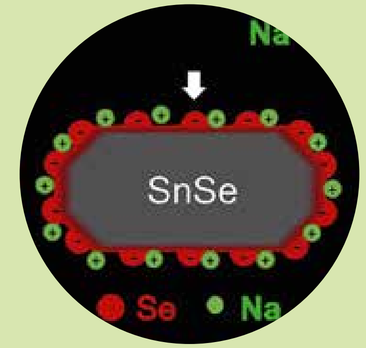
The scope of chemistry as a research field is enormous. At IST Austria, several research groups currently focus on electrochemistry, biochemistry, and functional nanomaterials, often working at the interface with (structural) biology and other fields. They were recently joined by another group studying biomolecular mechanisms using nuclear magnetic resonance spectroscopy. Questions explored by these groups include: How is the energy conversion process within our cells optimized? How can we reduce the amount of waste energy that is lost during energy production? And how do viruses protect their genetic information?

Faculty RNA-Based Gene Regulation CARRIE BERNECKY | Computational Materials Science BINGQING CHENG | Genes, Circuits, and Behavior MARIO DE BONO | Materials Electrochemistry STEFAN FREUNBERGER | Functional Nanomaterials MARIA IBÁÑEZ | Self-organization of Protein Systems MARTIN LOOSE | Structural Biology of Membrane Protein Complexes LEONID SAZANOV | Biomolecular Mechanisms from Integrated NMR Spectroscopy PAUL SCHANDA | Structural Biology of Cell Migration and Viral Infection FLORIAN SCHUR

Boosting the cell's power house

Sazanov group

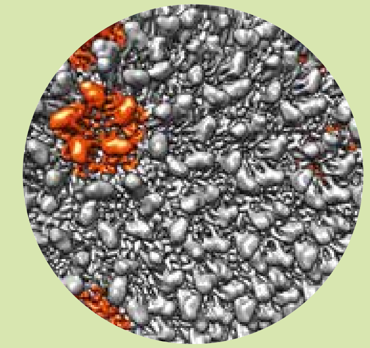
In order to fulfill their many tasks, cells need energy. In the cell's power plants, known as mitochondria, the energy contained in our food is converted into the molecule ATP. It serves as a kind of fuel that drives most cellular processes – from muscle contraction to the assembly of our DNA. In 2021, Professor Leonid Sazanov and postdoc Irene Vercellino showed for the first time the structure of a protein complex essential for their work. Supercomplex CIII2CIV pumps protons through the mitochondrial membrane, which is needed to start the energy conversion process in the cells. So far, it has only been described in plant and yeast cells, where it takes on a very different form. Looking closely at animal cells, the researchers discovered that a small molecule is connecting the two protein complexes that together form the supercomplex. Like a fishhook, the molecule enters complex III while being attached to complex IV. Being assembled into a supercomplex speeds up their chemical reactions and optimizes the cellular metabolism. It has been shown that mice and zebrafish missing the molecule are significantly smaller, less fit, and less fertile.



Turning heat to electricity more efficiently

Ibáñez group

More than 60 percent of all the energy produced is lost as waste heat. Therefore, the conversion of thermal energy to electricity and vice versa through thermoelectric devices is very important to harvest energy and control temperature. However, the production of thermoelectric materials is costly and their efficiency is not competitive enough with other technologies. An alternative way to produce thermoelectric materials at a much lower cost is by consolidating solution-processed particles. The synthesis of particles in solution involves the presence of additional molecules or ions to enable solubility and/or regulate particles' nucleation and growth. These ions, however, can end up in the particles as surface adsorbates and interfere in the material properties. Maria Ibáñez and her team show that ionic adsorbates are electrostatically adsorbed in tin selenide particles synthesized in water and play a crucial role in directing the material nano- and microstructure during thermal processing. Furthermore, they also determine the transport properties of the material. The team's work fills an important gap in solution process thermoelectrics.



How retroviruses become infectious

Schur group

Viruses are perfect molecular machines. Their only goal is to insert their genetic material into healthy cells and thus multiply. Understanding every step in the life cycle of a virus is crucial for identifying potential targets for treatment. Florian Schur and his team have come closer to this goal: Together with their collaborators, they were able to show how a virus from the retrovirus family – the same family as HIV – protects its genetic information and becomes infectious. When a new virus particle buds from the cell, it is in an immature, non-infectious state. It then forms a protective shell, a so-called capsid, around its genetic information and becomes infectious. The team discovered that a small molecule called IP6 plays a major role in stabilizing the protein shell within the Rous sarcoma virus, a virus causing cancer in poultry. Furthermore, the researchers were able to show how variable the shapes formed by capsid proteins are. The question now is what the virus adapts to by changing the shape of its capsid. And whether changed capsid shapes could be an indication of differences in the infectivity of the virus particles.

Computer Science

Computer science at IST Austria stands out in that all its research groups share a passion for foundational thinking and actively engage in multidisciplinary approaches, strengthening the ties between various research fields. Among other advances this year, IST Austria's computer scientists improved convergence rates for labeling problems in machine learning programs, proved the existence of pathways from one optimum to another in neural networks, and developed a novel method to model bending beams for architectural design.

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 | Secure, Private, and Decentralized Systems (SPiDerS) LEFTERIS KOKORIS-KOGIAS | Discrete Optimization VLADIMIR KOLMOGOROV | Combinatorics and Probability MATTHEW KWAN | Computer Vision and Machine Learning 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

Optimized optimizations
Kolmogorov group

How can a computer find the right pixels that correspond to one 3D element in an image? Such labeling problems frequently arise in the fields of machine learning and computer vision. One way to tackle them is by discrete optimization, the focus of the Kolmogorov group. Here, optimization, meaning searching for minima in a function, is done with variables that are not continuous but stem from a discrete set of values.
A common approach for tackling optimization problems with discrete variables is to solve their convex relaxation, where non-convex integrality constraints are replaced with relaxed constraints that are convex. This often gives a good solution to the original optimization problem. The relaxed problem is usually solved via an iterative technique that converges to the optimum of the relaxation.
Developing such techniques has received a lot of attention.
In a recent publication, the group was able to improve known convergence rates by casting the problem as a saddle point problem and then iteratively applying a Frank-Wolfe algorithm, one of the classical algorithms for constrained convex optimization.

Foundations of neural networks
Mondelli group

Training a neural network is a problem that exhibits spurious and disconnected local minima, which can lead to a computer program that is still suboptimal after optimization. Yet, in practice neural networks with millions of parameters are successfully optimized using methods that walk the network gradually towards a solution. Mondelli and his group investigated the underlying reason why these so-called gradient descent methods are functioning.
A novel proof shows in the case of many neurons the existence of low-loss paths. This means that there is a whole set of possible network configurations which solve the given problem with low error and are all connected by incremental changes of the parameters. These paths not only allow computational flexibility by choosing a solution out of several, but they give rise to the more general understanding of gradient descent methods. Proving rates of convergence – how fast gradient descent is approaching the best existing result – with regards to the dataset size and the number of neuronal layers is an ongoing endeavor of the computer scientists.

Designing with elastic structures
Bickel group

Active bending is an economic method to build intriguing, curved structures from flat elements for architecture and design. Digital fabrication allows beams with variable stiffness, which expands the design space attained by active bending. But what shapes can be produced this way? In a recent study, the researchers showed that the design space is governed by a simple geometric rule: A plane curve can be attained as the equilibrium state of a slender beam if and only if there is a line that intersects the curve exactly in its inflection points and nowhere else. The blueprints for building a curved structure are then designed by a computer program within a fraction of a second. Using 3D prints and cardboard models, the scientists built the results to validate their simulations.
The results serve two primary functions: The geometric rule guides designers to only draft structures that are physically viable. Second, the computations give rise to form-finding algorithms that improve on existing designs in a matter of seconds.

Mathematics

Mathematics allows us to distill ideas, to abstract things to their fundamentals and precisely define concepts. 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. In 2021, mathematicians at IST Austria applied this mindset to discover counterintuitive dynamics of vaccine-resistant Covid strains, the emergence of indirect cooperation in humans, and they developed a model to predict the onset of diseases from DNA data.

Faculty Mathematical Models of Evolution NICK BARTON | Analytic Number Theory and its Interfaces TIM BROWNING | Computer-Aided Verification, Game Theory KRISHNENDU CHATTERJEE | 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 | Dynamical Systems, Celestial Mechanics, and Spectral Rigidity VADIM KALOSHIN | Combinatorics and Probability MATTHEW KWAN | Stochastic Analysis JAN MAAS | Medical Genomics MATTHEW ROBINSON | Mathematical Physics ROBERT SEIRINGER | Discrete and Computational Geometry and Topology ULI WAGNER

The tip of the mathematical iceberg
Hausel group

Mathematics may strike you as less adventurous than a polar expedition, but the beauty of this conquered abstract iceberg could change your mind. The pioneers of the quest, Tamás Hausel and Nigel Hitchin, collaborated at the crossroads of differential and algebraic geometry, connecting the distant fields of physics and number theory. An analogy with a floating iceberg shows the significance of their mathematical expedition. The iceberg is attached to a Lie group: Most of its characteristics lie hidden beneath the surface. Down there, the interesting useful properties reside. Their elegant construction uses an abstract mathematical object from the Lie group in question, a so-called nilpotent cone of Higgs bundles. The nilpotent cone refers to the iceberg. Fortunately, the tip of its structure is completely understandable in terms of weight diagrams, which serve as visual representations of the characteristic notions of the Lie group. From the tip, they can infer knowledge about the mysterious bottom, and may even reconstruct the whole representational theory of Lie groups from it.

The emergence of cooperation
Chatterjee group

Cooperation has evolved in both nature and human society, but understanding its emergence is a difficult quest. Mathematicians around Laura Schmid from the Chatterjee group have created a new model that shows how cooperative strategies among humans develop. The results clearly counter the narrative that only the strongest and most selfish flourish and survive. While direct reciprocity would mean, “I'll scratch your back if you scratch mine”, indirect reciprocity means, “I'll scratch your back because I saw you scratch Peter's back”. Their model explores the fundamental dynamics of how cooperative strategies evolve and stabilize. Once the virtual players in the simulation adopt an ideal strategy, none of them has an incentive to divert from it, because it would only compromise their own benefits. One of the key insights is that the amount of cooperation and the kind of reciprocity chosen depend on the environment, that is how often players interact and whether they know their partner's reputation. The findings shed light on early societal formation and on the applied field of rating systems in online stores.

Predicting the onset of diseases
Robinson group

A myriad of genetic factors can influence the onset of diseases like high blood pressure, heart diseases, and type 2 diabetes. If we were to know how the DNA influences the risk of developing such diseases, we could shift from reactive to more preventive care not only improving patients' quality of living by individualized treatment but also saving resources in the health care system. Scientists from the Robinson group developed a new mathematical model that improves the predictive quality gained from large sets of patient genomic data. They put forward a solid statistical model that reliably works on very large datasets and detects connections between the DNA and the disease onset. It has to work on several hundred thousand genetic markers – short parts of the DNA sequence – from each of the several hundred thousand patients. To guarantee this functionality, the model allows trackable computations, in contrast to commonly used “black-box” approaches, where the inner workings lay hidden. The research results are relayed back to patients, whose anonymized data was analyzed, through the Estonian health care system.

Neuroscience

Neuroscientists study the nervous system to understand how our brains work. It is a highly multidisciplinary field of science, combining physiology, molecular biology, developmental biology, and cognitive science. In 2021, neuroscientists at IST Austria amongst other things investigated how neurons prevent an information overload in subsequent neurons and how flickering light makes the brain sensitive to new input. Furthermore, they found new ways to study stem cell behavior during brain development.

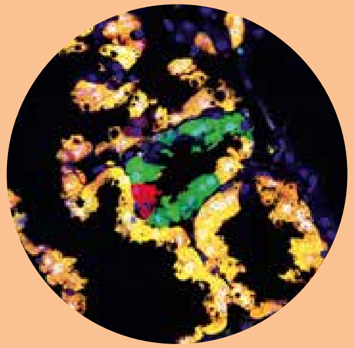
Faculty Systems Neuroscience JOZSEF CSICSVARI | High-resolution Optical Imaging for Biology JOHANN DANZL | Genes, Circuits, and Behavior MARIO DE BONO | Genetic Dissection of Cerebral Cortex Development SIMON HIPPENMEYER | Cellular Neuroscience PETER JONAS | Neuroethology MAX JÖSCH | Tissue Growth and 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

Smart teachers
Jonas group

Information flows in a well-defined direction in the brain: Chemical and electrical signals are passed from one neuron to the other across the synapse, from the pre-synaptic to the post-synaptic neuron. As Peter Jonas and his research group discovered, information also travels in the opposite direction at a key synapse in the hippocampus, the brain region responsible for learning and memory. Previously, the hippocampal mossy fiber synapse was assumed to be a ‘teacher synapse’ that induces firing in the post-synaptic neuron. “Instead, we find that this synapse acts like a ‘smart teacher’, who adapts the lessons when students are overloaded with information. Similarly, the pre-synaptic mossy fiber terminal detects when the post-synaptic neuron can’t take in more information,” explains Jonas. Synaptic transmission is plastic, meaning that a variable amount of chemical signal, the so-called neurotransmitter, is released into the synapse. When activity increases in the post-synaptic neuron, the pre-synaptic neuron reduces the extent of plasticity, in order not to overwhelm the post-synaptic neuron.

The twinkle and the brain
Siegert group

There are critical periods during development in which the brain learns profound cognitive routines and then locks the information in an extracellular structure called the perineuronal net. These perineuronal nets envelop certain neurons, stabilizing the existing connections between them and preventing new ones from forming. Researchers around neuroscientist Sandra Siegert discovered two methods to reopen the brains plasticity. They found that microglia cells in mice become very reactive after they anesthetized animals with the drug ketamine. The reactive microglia started eating away the perineuronal net. As the researchers learned, the same effect can be achieved with 60-hertz light flickering. Once the blockage of the perineuronal net is reduced, neurons are again sensitive to new environmental input and new connections can be formed. Both treatments are minimally invasive and could open new therapeutic approaches in humans. By re-establishing plasticity, one could potentially overwrite traumatic experiences and treat post-traumatic stress disorder.



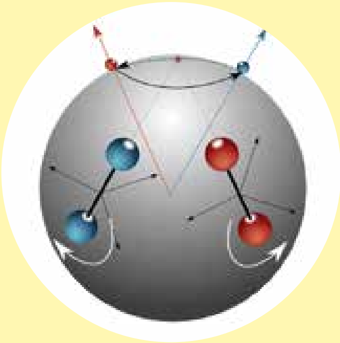
Boost for mouse genetic analysis
Hippenmeyer group

To understand what role an individual gene plays, scientists are using a trick of nature: While in principle, the genome in all cells of an organism is the same, mutations arise in individual cells. These mutations make a cell different from its neighbors and the organism forms a “genetic mosaic”. In 2021, Simon Hippenmeyer and his group advanced genetic mosaic analysis, making 96 percent of all genes in the mouse genome accessible to single-cell genetic mosaic analysis. Their experimental approach is called Mosaic Analysis with Double Markers (MADM), in which genes are mutated in individual cells while, at the same time, the mutated cells are labeled in fluorescent colors. By altering a gene in a single cell, while keeping the remaining cells unchanged, scientists can follow what happens to the mutated single cell and gain insight into the role and function of the mutated gene. With the expanded capabilities of MADM, neuroscientists can, for example, study stem cell behavior during brain development and the mechanisms ensuring that brains develop to the correct size.

Physics

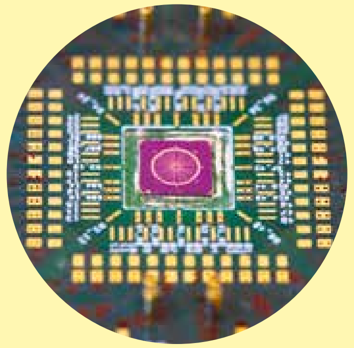
Physicists at IST Austria embody the foundational aspiration of the field, while at the same time contributing to technological progress. The diverse interests and open-minded curiosity of the physics groups have led to advances in both the theoretical and experimental handling of topological quantum bits, a promising approach to quantum computing. One conceptualized a novel avenue to create anyons, another one empirically refuted a widely held misconception about signals in nanowires. Among these and other developments, unanswered mysteries about electrical charges that puzzled humans for millennia are investigated to finally yield conclusive theories.

Faculty Non-linear and Time-resolved Optical Spectroscopy of Strongly Correlated Electron Systems ZHANYBEK ALPICHSHEV | Computational Materials Science BINGQING CHENG | High-resolution Optical Imaging for Biology JOHANN DANZL | Mathematics of Disordered Quantum Systems and Matrices LÁSZLÓ ERDŐS | Quantum Integrated Devices JOHANNES FINK | Soft Matter Theory and Materials Design 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 | Materiali Molli JÉRÉMIE PALACCI | Mathematical Physics ROBERT SEIRINGER | Condensed Matter Theory and Quantum Dynamics MAKSYM SERBYN | Theoretical Biophysics and Neuroscience GAŠPER TKAČIK | Soft and Complex Materials SCOTT WAITUKAITIS



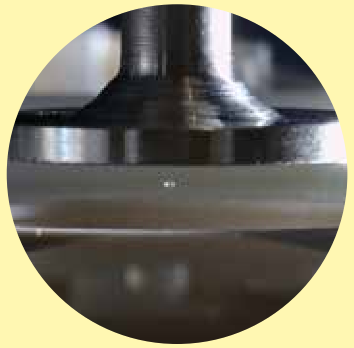
Dancing molecules
Lemeshko group

Besides the particles of our everyday world – protons, electrons, or photons – physicists can mathematically describe the emerging collective behavior of certain forms of matter as quasiparticles. Anyons are such quasiparticles living in an imagined two-dimensional world. This means that there exist real physical things in our 3D world that under the right circumstances behave collectively like these 2D anyons. The exciting thing about anyons is that exchanging the position of two of them twice does not lead to the original configuration. Such a swap encodes the history of the exchange and could serve as stable information carrier for a topological quantum computer (see text on the right). The researchers devised a new theoretical method of constructing such anyons. It consists of two molecules of two atoms each that are suspended in a tiny droplet of cold helium at almost zero temperature. When exposing these molecules to a magnetic field they start to rotate and to affect each other. What the scientists found is that the rotation and interactions of these molecules correspond to anyons moving on the two-dimensional surface of an imagined sphere.



Unfinding a Majorana zero mode
Katsaros group

Quantum computers promise great advances in many fields. Yet, which physical system works best to build the underlying quantum bits is still an open question. One approach bets on topological qubits (see text on the left), which no one has ever definitely found though. An international team of researchers around Marco Valentini from the Katsaros group examined a setup which was predicted to produce so-called Majorana zero modes – the core ingredient for a topological qubit. When the scientists did not find the right signal, they were puzzled. This was evidence against published results from other groups. They then decided to perform a systematic series of experiments. The researchers realized that when in the tunnel junction of the nanowire, instead of the expected Majorana zero mode a so-called quantum dot was formed, its electrons mimicking the signal of the Majorana zero modes. This unexpected conclusion shows how careful scientists must be in their experiments, and how the cycle of discovery and critical examination is central to the advancement of knowledge.



Solving one of the oldest problems in physics
Waitukaitis group

Already the ancient Greeks knew about tribocharging. This phenomenon happens for example when a rubber balloon exchanges electrical charges with the hair of a cat and afterwards sticks to the pet, often to its dismay. Despite how common this effect is, how it actually works has evaded scientists until today. In one avenue of research, the Waitukaitis group is trying to explain this puzzling effect. One of their experiments investigates the exchange of charges between two super-flat surfaces made of the same ultra-smooth plastic. Touching them together in controlled environments and using an electron microscope, the scientists are testing the hypothesis that tiny “islands” of water on the surface might be responsible for the effect. In another experiment, they are bouncing a small glass sphere on a glass surface using ultrasonic levitation (see image). This experiment is also meant to test the “water island” hypothesis and offers exquisite precision with a hands-free methodology. Ultimately, the group hopes that their efforts will solve this fundamental physics mystery, and perhaps even lead to novel technologies.

Facilitating Science

Scientific Service Units at IST Austria

Even the best scientists need a support structure that provides them with the necessary facilities and technical expertise. At IST Austria, the facilities and staff scientists are grouped into the Scientific Service Units (SSUs). They provide a centralized and effective means to collaboratively share the resources for research. Each SSU is led by a manager and staffed with a team of experts that maintains the equipment and supports scientists with know-how, custom solutions, and training.

Currently, there are nine SSUs on campus:

- Electron Microscopy Facility
- Imaging and Optics Facility
- Library
- Lab Support Facility
- Miba Machine Shop
- Nanofabrication Facility
- Preclinical Facility
- Scientific Computing Facility
- Nuclear Magnetic Resonance Facility since 2021

In addition, there are seven staff scientists associated with the SSUs: two in the Imaging and Optics Facility, two in the Pre-Clinical Facility, and one each in Electron Microscopy, Nanofabrication, and Scientific Computing. They are highly qualified scientists working closely with the research groups while also conducting research on their own projects. Read more about our staff scientists on pages 82-83.

An indispensable kitchen
Media and Cleaning Kitchen

One central support structure for the experimental work in many fields of biology at IST Austria is the Media and Cleaning Kitchen. As part of the Lab Support Facility, it provides a great variety of substrates for microbiology, cell cultures, and biochemistry. The Kitchen's team produces custom culture media, plates, and solutions. These include buffers, petri dishes with Agar substrates, and chemically competent E. coli bacteria for rapid DNA transformation, as well as plates with apple juice for breeding fruit flies. Each scientist at the Institute can order specific products to meet their individual needs through a central online system. Commonly used reagents are also kept in stock and are available to the researchers 24/7. Additionally, every day the Kitchen team collects and cleans all kinds of glass and plastic ware used in the laboratories. For this, they have several autoclaves and dry heat sterilization machines. They also collect and dispose biological waste of different danger levels by sterilizing it following strict procedures.

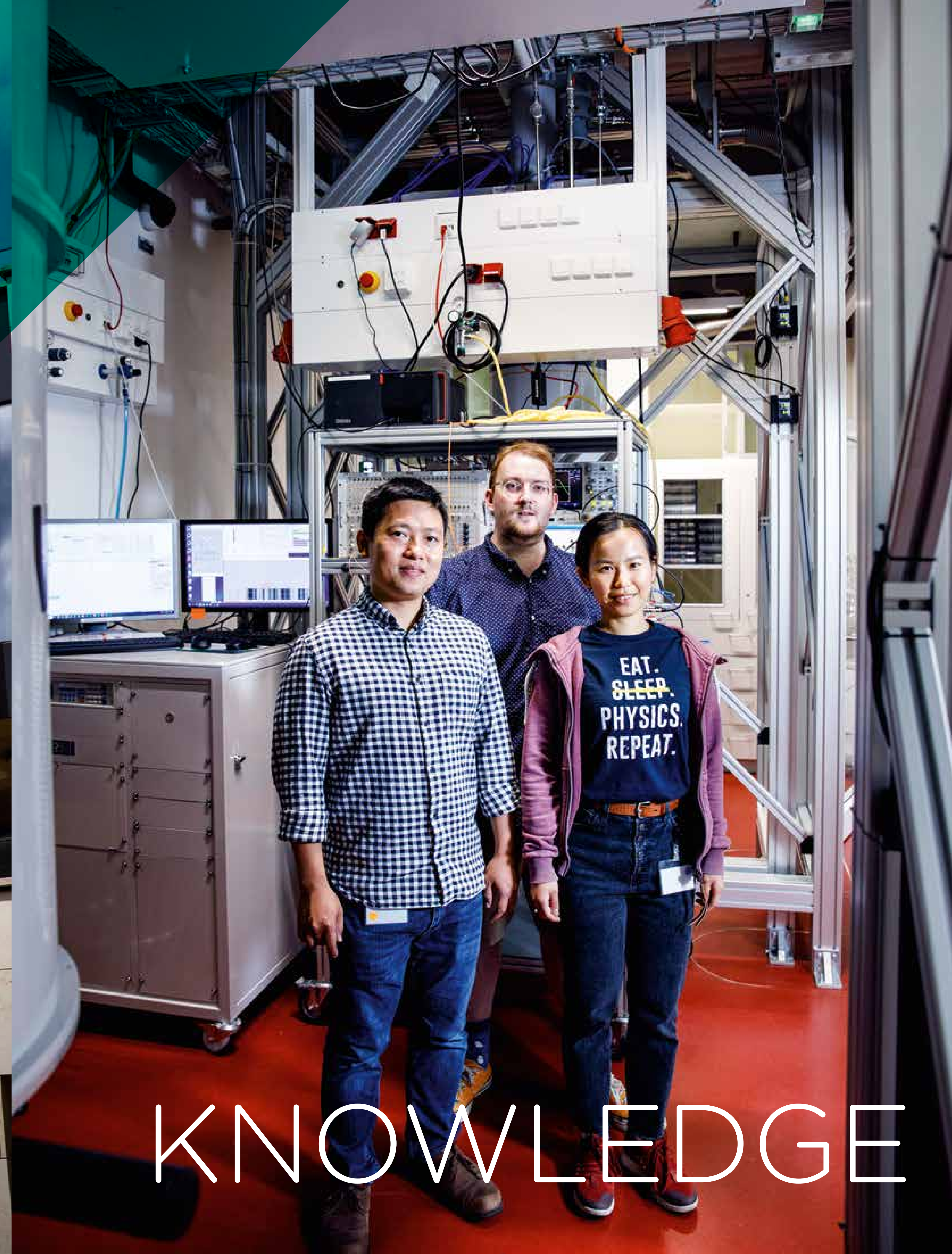
Opening access to knowledge
Library

The library is one of the core systems supporting scientists at IST Austria to do world-class research. In 2021, the library with its more than 2,000 books moved into the newly opened Sunstone Building. Apart from physical books, it provides electronic access to over 150,000 digital books, more than 9,000 scientific journals, and several citation databases in all fields relevant to the research at IST Austria. The library team also administers research data management as well as the in-house publication repository, the IST Austria Research Explorer. There, most publications coming from IST Austria are collected and made accessible for other researchers and the public. This approach of open access – the unrestricted access to scientific publications – is an ongoing trend in the scientific community. IST Austria supports these efforts by contributing to the Austrian Transition to Open Access 2 project as a partner together with many other Austrian research institutions. Additionally, IST Austria provides special funding for open access publishing and negotiates publisher agreements.

A blooming garden for science
Plant Facility

In vivo experiments are crucial to biological research. At IST Austria, the Plant Facility supports the scientists by maintaining specific species of plants. This includes cultivating the seedlings and plants in several rooms and incubators. These are fully climate-controlled and the provided light is tuned for optimal growth. The seeds are catalogued in a seed bank with over 5,000 different genetic lines. Hosting up to 15,000 individual plants, the facility is led by a laboratory technician who oversees the strict protocols for handling the specimens, coordinates the involved researchers, and takes part in handling the plants themselves. Over 30 scientists from the Benková, Friml, and Zilberman groups are working with the Plant Facility to grow and study genetically modified *Arabidopsis* and *Tobacco* species. They investigate how plants find nitrogen in the soil, how they heal their wounds, or how they can feel gravity. Additionally to supporting the researchers, the Plant Facility and its team contribute to the science communication efforts of IST Austria by helping school children do their own plant growing experiments.

SHARING KNOWLEDGE



As part of the Higginbotham group, PhD student Duc Phan, postdoc Jorden Senior, and scientific intern Sue Shi study problems in condensed-matter physics and develop future information-processing technology.

Technology Transfer at IST Austria

From science to business

The TWIST Research Transfer and Development GmbH, IST Austria's technology transfer organization, is developing the broader innovation ecosystem at the Institute. As a one-stop shop, its mission is to raise awareness about the business dimension in academia, and consequently, to provide consulting and protection concerning intellectual property, license technologies developed at the Institute, nurture and finance spin-off projects, inspire and educate future founders, and liaise with applied research organizations and industry. In 2021, the Spin-off Austria initiative honored IST Austria's technology transfer programs and facilities supporting entrepreneurship by awarding IST Austria the first place as "Leading Institution" in the category "Research Institutions".
More information: www.twist.co.at

TWIST Fellowships and Prototype Grants

The TWIST Fellowship program evaluates and improves the marketability of results from basic science. It provides consulting, funds, and infrastructure to selected graduates or postdocs for up to one year. Early explorative projects can obtain funding and support as TWIST Prototype Grants.
Current projects are:

AutoMold
The team of Thomas Auzinger and Ruslan Guseinov is preparing the foundation of a software start-up that automatizes the decomposition of molds to make the mass-production of injection-molded plastic parts more affordable, filling the gap between expensive mold-based mass-production and slow, individual 3D printing. Their approach builds upon years of groundbreaking research in computational design and digital fabrication.

A novel approach to treating urinary tract infections
Kathrin Tomasek, a PhD student associated with the Sixt and Guet labs, identified an interaction between a cellular receptor protein and a bacterial protein that may be the key to understanding why the immune system is not very effective at combatting urinary tract infections (UTIs). Kathrin Tomasek is testing specific compounds in assays she has developed to see whether disrupting the protein-protein interaction could boost the body's response to a UTI.

Spin-off companies

The following projects were (co-)founded by scientists at IST Austria and have since established themselves as technology companies with growing teams. They have successfully received a seed investment from IST cube and other private investors.

Neurolentech
Formerly a TWIST Fellowship, this project has been successfully incorporated into the spin-off company Neurolentech GmbH, which focuses on developing technologies to aid drug discovery for neurodevelopmental disorders like autism or epilepsy. This facilitates new therapeutic strategies for patients to whom no treatment options are currently available.

Ribbon Biolabs
The team around Harold Vladar aims to revolutionize the production of synthetic DNA, combining chemistry with computer science. Within the past years, the team has made significant advancements in synthesizing long DNA molecules that will serve the growing need for synthetic DNA as a fundamental component for innovation in biotechnology and biopharma.

Solgate
Solgate is a start-up company based upon a collaboration between CeMM 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.

IST cube

IST cube is a seed fund enabling the growth of deep-tech and science-based start-ups and spin-offs. IST cube taps into the experience of IST Austria’s tech transfer team and is located at IST Park, providing its investees with a state-of-the-art lab and office environment. The fund looks for deep-tech start-ups in an early investment stage and is able to provide follow-on investments, with a geographic focus on the Austrian region. In 2021, IST cube successfully closed an oversubscribed financing round of 45 million EUR and invested in five technology start-ups.
IST cube is supported by InnovFin Equity, with the financial backing of the European Union under Horizon 2020 Financial Instruments and the European Fund for Strategic Investments ("EFSI") set up under the Investment Plan for Europe. The purpose of EFSI is to help support financing and implementing productive investments in the European Union and to ensure increased access to financing.

<u>IST cube portfolio companies</u>
New investments in 2021: Solgate, MyMind (mymind.life), VitreaLab (vitrealab.com), Cutanos (cutanos.com), Neurolentech (neurolentech.com). Further portfolio: Sarcura (sarcura.com), VALANX Biotech (valanx.bio), G.ST Antivirals (gst-antivirals.com), Ribbon Biolabs (ribbonbiolabs.com), Prewave (prewave.com), Contextflow (contextflow.com).

IST Park

IST Park, a joint initiative of ecoplus and IST Austria, provides state-of-the-art infrastructure such as lab and office space to startups, SMEs, and research divisions of larger companies that benefit from this unique location right next to IST Austria.

Currently, IST Park houses eight tech-based companies, the IST cube spin-off fund together with five of its portfolio companies, as well as the TWIST fellows. Despite the first building being currently almost booked out, IST Park remains open for requests concerning coworking desks, small office rooms, large individual offices, life science lab space, as well as custom facilities for technology companies.

Enabling Frontier Research

IST Austria’s support network

Discovering how the world around us works in detail holds value in itself. The ongoing pandemic shows how important fundamental research is for all of us as it is the basis of all medical and many other innovations. Thanks to our supporters, researchers at IST Austria can give their best and contribute to science and society with their findings.

After the challenging year of 2020, building and enhancing IST Austria‘s support network continued in 2021. Several dinners and events took place to connect IST Austria’s supporters to its scientists, enabling stimulating dialogue. IST Austria is extremely grateful to its private and corporate patrons in Austria and abroad for their continued dedication and significant contributions.

Donations to IST Austria are accumulated in a foundation that was established in 2016 with the goal to fund IST Austria’s own future endowment, thus emphasizing the long-term nature of operations at the Institute. Philanthropy provides crucial support to independent research and has the power to provide the freedom truly groundbreaking science requires.

The fundraising activities are supported by the Strategic Advisory Council to the President, which plays a vital role in the expansion of the Institute’s network of supporters. In this forum, IST Austria joins forces with accomplished professionals across the societal spectrum who make their expertise available for the cause of the Institute.

IST Austria Donors Club

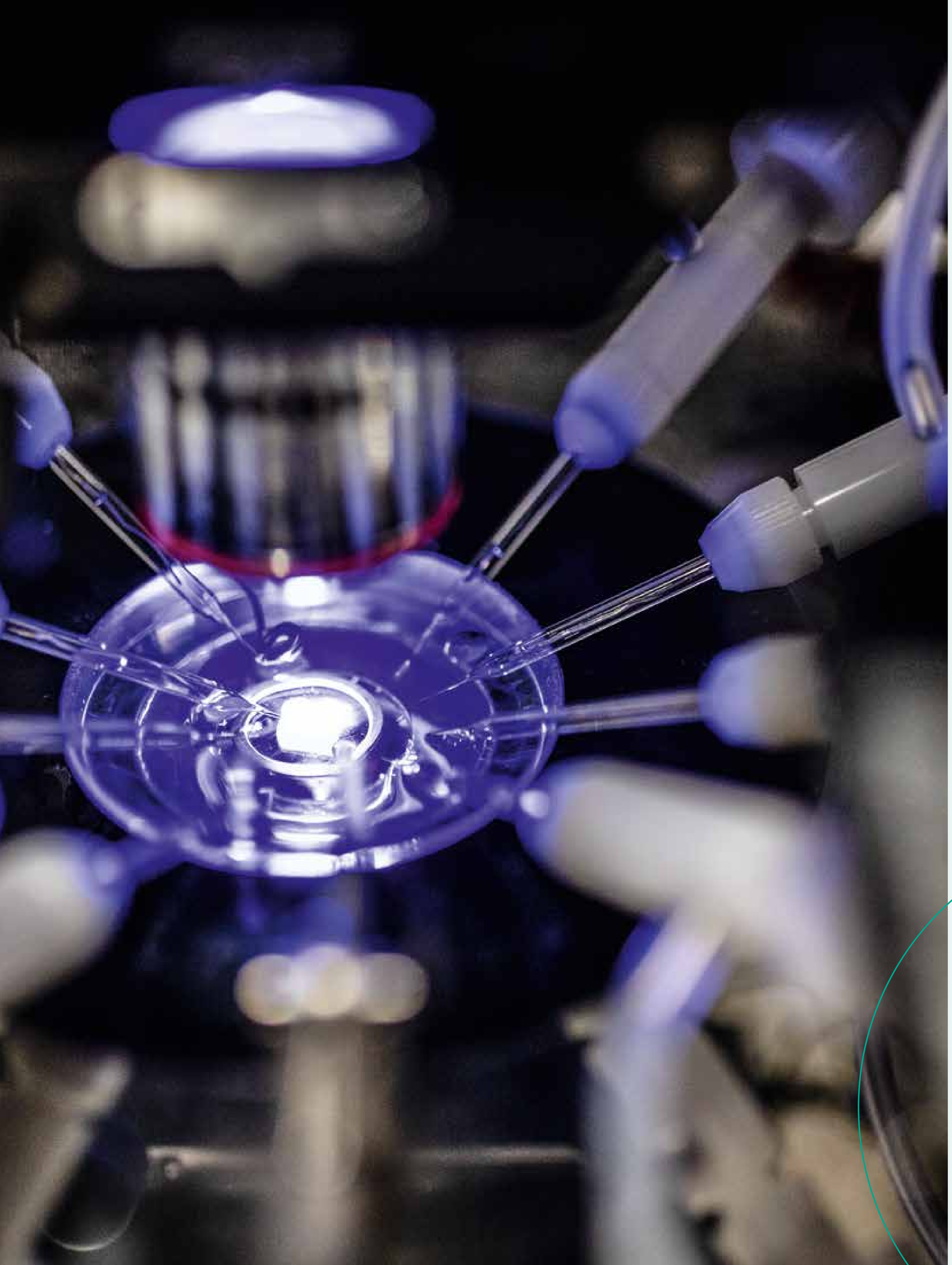
<u>Platinum Club</u>
Invicta Foundation

<u>Gold Club</u>
Mondi AG, OMV AG, Karl Wlaschek Privatstiftung, Raiffeisen Group, voestalpine AG, Allholding Beteiligungsverwaltungs GmbH

<u>Silver Club</u>
Berndorf AG, Steven Heinz, Miba AG, Oberbank AG, Prinzhorn Holding GmbH, Schoeller Bleckmann AG, W. Hamburger GmbH, DI Klaus Pöttinger, EMACS Privatstiftung

<u>Donor Club</u>
Alcatel-Lucent-Austria AG, Allinvest Unternehmens-beteiligungs GmbH, Gebrüder Weiss GmbH, Kapsch AG, CHROMA-PHARMA GmbH

<u>Strategic Advisory Council to the President</u>
Hermann Hauser, Steven Heinz, Therese Niss, Ursula Plassnik, Rudolf Scholten, Veit Sorger, Franz Viehböck, Stefan Weber, Laurence Yansouni



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Professors at IST Austria
(under contract as of December 31, 2021)

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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
Bingqing Cheng Computational Materials Science
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
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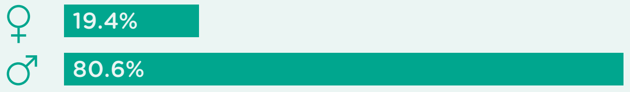
Uli Wagner Discrete and Computational Geometry and Topology
Scott Waitukaitis Soft and Complex Materials
Chris Wojtan Computer Graphics and Physics Simulation
Daniel Zilberman Epigenetics and Chromatin

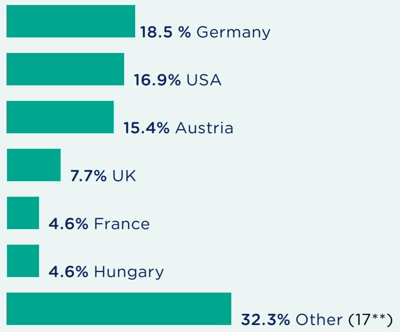
* joining IST Austria during 2022 (see also page 29)

Total number of professors: 67*

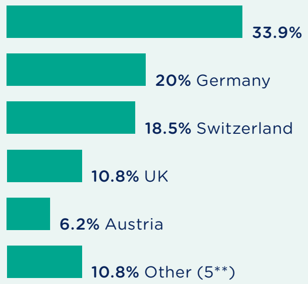
Gender among professors*



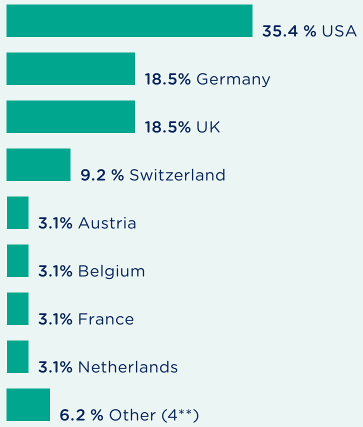
Country of nationality



Country of PhD institution



Country of previous institution



* including two on maternity leave
** Number of countries


Stbl3
25.8.2021

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, Massachusetts Institute of Technology, Cambridge, 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 ultrashort 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 Nonlinear response in hybrid lead halide perovskites | Nonlinear THz spectroscopy of Quantum Spin Liquids | 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, 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. The group’s work contributed to understanding how plant development is internally regulated by plant hormones and identified several important mechanisms that connect individual hormonal pathways into a complex regulatory network underlying plant adaptation to 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, Centre 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: developing novel modeling and simulation methods, and 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 height | 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

Bingqing Cheng

Computational Materials Science

The building blocks of matter are electrons and atomic nuclei, whose behavior follows the laws of quantum mechanics. By solving the Schrödinger equation, one can predict the properties of any material, including existing or novel compounds yet to be synthesized. However, there is a catch.

As the number of electrons and nuclei increases, the complexity involved in solving the equation soon becomes intractable even with the fastest supercomputers. In fact, atomistic simulations based on quantum mechanics are still unaffordable for systems with more than a few hundred atoms, or for a time period longer than a nanosecond. The Cheng group is particularly interested in developing methods to extend the scope of atomistic simulations, in order to understand and predict materials properties that are hard to access. The group deploys and designs a combination of techniques encompassing machine learning, enhanced sampling, path-integral molecular dynamics, and free energy estimation. The systems of study include energy materials, aqueous systems, and matter under extreme conditions.

Current projects Machine-learning potentials for functional materials | Transport phenomena at the microscale | Efficient statistical learning of materials properties | Developing advanced methods for statistical mechanics and atomistic simulations

Career
- Since 2021 Assistant Professor, IST Austria
- 2020 – 2021 Departmental Early Career Fellow, University of Cambridge, UK
- 2019 Junior Research Fellow, Trinity College, University of Cambridge, UK
- 2014 – 2019 PhD in Materials Science, EPFL, Switzerland

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 uses ants as a model to study how collective protection arises at the colony level from the interplay between individual immunity and social interactions.

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 collectively performed sanitary care behaviors, but also by their individual immune defenses. Similar to the immune memory found in vertebrates, insects can be protected against disease after previous exposure to the same pathogen, and can even protect their offspring via transgenerational immune priming. As social insect colonies are formed by the offspring of the queen, such immunological protection of the mother to her offspring can have enduring beneficial effects for the health of the complete 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 nanometers. 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 Analysis of brain tissue across spatial scales | Optical imaging of cell and tissue ultrastructure | Minimally perturbing high-resolution imaging

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 | Algebraic footprints of geometric features in homology | 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 2021 Professor, IST Austria
- 2016 - 2021 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 the synthesis of new conducting and redox active materials and a fundamental understanding of charge carrier transport and electrochemical reactions, 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 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

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, The 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? (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, 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 errorprone, 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 | Monitoring the safety, security, and fairness of software

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, and are 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.

Current projects Circuit electrodynamics of p-wave superconductors | Electromechanics across a quantum phase transition | Stabilizing superconducting excitons in a hybrid circuit

Career
- since 2019 Assistant Professor, IST Austria
- 2017 – 2019 Researcher, Microsoft Station Q Copenhagen, Denmark
- 2015 – 2017 Postdoc, Joint Institute for Laboratory Astrophysics, Boulder, 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 to establish a definitive quantitative and mechanistic model of cortical neural stem cell lineage progression, to dissect the cellular and molecular mechanisms generating cell-type diversity, and 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 Determine 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 uses many-atom cavity-quantum-electrodynamics (cQED) and laser-cools large ensembles of atoms trapping them inside of an optical cavity. There, they are 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 Development of precision laser stabilization methods | Generation of spin-squeezed states of atomic ensembles | Mapping atomic spin correlations into motional degrees of freedom | Squeezed-state atom interferometry | Milligram scale opto-mechanical oscillatorsy

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 at 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 nanoparticles, which can be used as precursors 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, consolidation and sintering | Transport properties of nanocrystal-based solids | 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 approximately 100 billion neurons, which communicate through about 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: What are the biophysical signaling and plasticity mechanisms at glutamatergic and GABAergic synapses in the cortex? 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. The main focus is on 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, 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

Vadim Kaloshin

Dynamical Systems, Celestial
Mechanics, and Spectral Rigidity

"Can you hear the shape of a drum?" Essentially, this question (and title of a famous paper by M. Kac) asks if the sound of a drum determines its shape—an open question with deep mathematical roots. Vladimir Kaloshin and his group explore how deformations of a drum deform its sound, and if it is possible to change the shape of a drum without changing the sound.

In particular, they study the Laplace spectrum of convex, planar domains, and work to show that these eigenvalues determine such domains locally. Another focus of the Kaloshin group is stochastic behavior in our solar system. Between the orbits of Mars and Jupiter, there are nearly two million asteroids with diameters greater than one kilometer. Astronomers observed that the distribution of these asteroids with respect to semi-major axis has gaps, known as Kirkwood gaps. The Kaloshin group seeks to achieve two goals: to develop a mathematical theory of stochastic behavior at these gaps and to explain the shape of the distribution of these gaps.

Current projects Spectral rigidity for chaotic geodesic flows | Rigidity of planar convex domains | Can domains of constant width possess another rational caustic?

Career
- Since 2021 Professor, IST Austria
- 2011 – 2021 The Brin Chair in Mathematics, University of Maryland, USA
- 2008 – 2011 The Brin Chair in Mathematics, University of Maryland & Distinguished Professor of Mathematics, Penn State University, USA
- 2005 – 2006 Associate Professor, California Institute of Pasadena, USA
- 2002 – 2004 Member IAS, AIM Research Fellow, and Associate Professor at California Institute of Pasadena, USA
- 2001 – 2002 C.L.E. Moore Instructor, Massachusetts Institute of Technology and AIM Research, Cambridge, USA
- 2001 PhD Princeton University, New Jersey, USA

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 50s. 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 nanometers 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 combines quantitative *in vivo* analysis of the mouse and chick neural tube with in vitro assays based on organoids, stem cell differentiation and embryonic explants. They develop biophysical models to guide experimental design and the interpretation of data.

Current projects Role of cell cycle dynamics in spinal cord patterning and morphogenesis | Morphogen control of tissue growth | Morphogen gradient formation | Interpretation of combined signaling inputs

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

Lefteris Kokoris-Kogias

Secure, Private, and Decentralized Systems (SPiDerS)

In the last decades, computing enabled society to interconnect transcending physical limits. Trust is often sacrificed in the name of efficiency and speed. Our fast and interconnected digital world brings great challenges: our systems are left vulnerable to potential adversaries that exploit the security weaknesses unnoticed by developers while trying to cope with the ferocious demand for speed.

The SPiDerS group copes with the challenge of speed and trustworthiness by exploring decentralized trust technologies. It focuses on Byzantine Fault Tolerant systems and algorithms, where various interesting research questions have emerged: How can the current financial ecosystem integrate scalable decentralized systems? How can we scavenge randomness from multiple semi-trustworthy players to run publicly verifiable lotteries or audit elections? The group's driving force stems from the technical challenges in existing systems, as well as the socio-technical barriers faced by conventional institutions. The SPiDerS group aspires to contribute to this rapidly evolving digital world by designing and building secure scalable decentralized systems with real-world impact.

Current projects Performance and Incentives for Decentralized Systems | Cryptographically Secure Distributed Randomness Generation | Theory and Practice of Scalable Blockchains and Interoperability | Decentralized Private Data Management

Career
- since 2021 Assistant Professor, IST Austria
- 2020 – now Research Scientist, Facebook Research/Novi, London, UK
- 2020 – 2020 Research Scientist, Web3 Foundation, Zug, Switzerland
- 2019 – 2020 Postdoc, École Polytechnique Fédérale de Lausanne, Switzerland
- 2019 – 2019 Visiting Scientist, VMware Research, Palo Alto, CA, USA
- 2018 – 2018 Intern, IBM Research, Zurich, Switzerland
- 2015 – 2019 PhD, École Polytechnique Fédérale de Lausanne, Switzerland

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 based 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

Matthew Kwan

Combinatorics and Probability

Combinatorics is the area of mathematics concerned with finite structures and their properties. This subject is enormously diverse and has connections to many different areas of science: for example, objects of study include networks, sets of integers, error-correcting codes, voting systems, and arrangements of points in space.

Kwan's group studies a wide range of combinatorial questions, with a particular focus on the interplay between combinatorics and probability. On the one hand, surprisingly often it is possible to use techniques or intuition from probability theory to resolve seemingly non-probabilistic problems in combinatorics (this is the so-called probabilistic method, pioneered by Paul Erdős). On the other hand, combinatorial techniques are of fundamental importance in probability theory, and there are many fascinating questions to ask about random combinatorial structures and processes.

Current projects Perfect matchings in random hypergraphs | Subgraph statistics in Ramsey graphs | Discrete random matrices | Partitioning problems in graphs and hypergraphs | Random designs | Transversal bases in matroids | Extremal problems on extension complexity of polytopes | Polynomial Littlewood–Offord problems | Ordered embedding problems

Career
- since 2021 Assistant Professor, IST Austria
- 2018 – 2021 Szegő Assistant Professor, Stanford University, USA
- 2018 DSc., ETH Zurich, Switzerland

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 ultra-cold 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 control 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 April 2021 Professor, IST Austria
- 2015 – 2021 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 the 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 tradeoffs 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

Caroline Muller

Atmosphere and Ocean Dynamics

What is the response of the hydrological cycle to global warming? What are the physical processes responsible for the organization of tropical clouds? And what is the contribution of internal waves to ocean mixing? These are just a few questions the Muller group is trying to answer.

The research activities of the Muller group lie in the fields of geophysical fluid dynamics and climate science. The team is particularly interested in processes, which are too small in space and time to be explicitly resolved in coarse-resolution Global Climate Models (GCMs) used for climate prediction. Important examples are internal waves in the ocean, and clouds in the atmosphere. These small-scale processes need to be parametrized, that is, modeled with simple equations, in GCMs in order to improve current model projections of climate change. The group's overall goal is to improve our fundamental understanding of these small-scale processes of our climate, using theoretical and numerical tools, as well as *in situ* and satellite measurements.

Current projects New theoretical perspectives on self-aggregation of clouds | Tropical energetics in a warming climate | Tropical cyclone formation and intensification | Ocean-atmosphere interactions

Career
- since 2021 Assistant Professor, IST Austria
- 2015 – 2021 CNRS researcher & Lecturer at Ecole Normale Superieure, Paris, France
- 2012 – 2015 CNRS researcher, Ecole Polytechnique, Paris, France
- 2010 – 2012 Research Scholar, Princeton University/GFDL, Princeton, USA
- 2008 – 2010 Postdoc, Massachusetts Institute of Technology, Cambridge, USA
- 2008 PhD, New York University, Courant Institute of Mathematical Sciences, New York, USA

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

Jérémie Palacci

Materiali Molli

Nature evolved to assemble complex architectures from simple building blocks consuming energy: bacteria form colonies, cells reshape, and muscles contract. The general physical principles that lead to those remarkable and robust phenomena remain, however, to be unveiled.

The Palacci group, aka Materiali Molli Lab, aims at unlocking the organization mechanisms of such systems that consume energy. The group's research is experimental and curiosity-driven, primarily focused on systems at the colloidal scale—a microscopic scale just one hundredth of the thickness of a human hair. The researchers investigate how to control materials by powering them from within and understand how to achieve order from noise. They are also exploring the design of modular microbots, carrying the physical and computational power to perform programmed dynamics without external control or feedback. Ultimately, the Materiali Molli Lab aims to emulate the fidelity and tunability of materials and organisms observed in nature using human-made or biomimetic materials.

Current projects Emergent behavior in Active Matter | Materials powered from within | Smart Materials | Metamachines, machines made of machines

Career
- since 2021 Assistant Professor, IST Austria
- 2021 Adjunct Professor, University of California, San Diego, USA
- 2020 – 2021 Associate Professor (with tenure), University of California, San Diego, USA
- 2015 – 2020 Assistant Professor, University of California, San Diego, USA
- 2010 – 2015 Postdoc Center for Soft Matter Research, NYU, NYC, USA
- 2010 PhD, Université de Lyon, France

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 Sustainable 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

Paul Schanda

Biomolecular Mechanisms from Integrated NMR Spectroscopy

Life is in motion. While one immediately realizes the dynamics of living organisms on the macroscopic level, it is clear that ultimately it is the jiggling and wiggling of the atoms within molecules, and their interactions with each other, that allow life to unfold.

The Schanda group is particularly interested in understanding how proteins perform their tasks, and how their structural dynamics govern their functions. They study puzzling questions like, how proteins transport other proteins. By investigating their structure, how they move and interact, the team deciphers how cells are able to transport large and highly aggregation-prone polypeptides across the cell and ultimately refold them into their native environment. Furthermore, the group is interested in how motions around the active site of an enzyme control its function and how exactly the side chains and main chain of proteins move. Therefore, the Schanda group uses nuclear magnetic resonance (NMR) spectroscopy, which they further develop and combine with other biophysical, biochemical, *in silico* and *in vivo* methods.

Current projects Mitochondrial import machinery | Dynamics of enzymatic assemblies | New NMR methods to probe protein dynamics | Integration of NMR with various structural techniques for high-resolution structure determination

Career
- Starting in September 2021 – Professor, IST Austria
- 2017 – 2020 Head of the NMR group, Institut de Biologie Structurale (IBS), Grenoble, France
- 2011 – 2021 Research team leader, IBS Grenoble, France
- 2008 – 2010 Post-doc, Dept. of Chemistry and Applied Biosciences, ETH Zürich, Switzerland
- 2004 – 2007 PhD student, Univ. Joseph Fourier Grenoble (IBS), including research at Weizmann Institute (2005)

Florian Schur

Structural Biology of
Cell Migration and Viral Infection

The Schur group aims to understand the structural and functional principles that control cell migration. In other projects the group tries to elucidate evolutionary conserved assembly and maturation mechanisms in retroviruses. 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.

In the field of cell migration, the group focuses on the actin cytoskeleton, the key player allowing cells to move. Here they aim to obtain an understanding how cells dynamically and productively adapt the actin cytoskeleton to move in defined directions, by varying the activity of a large number of regulatory proteins.
In the field of virology, the group studies the structure of pleomorphic viruses 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, and why retroviruses developed a dependence on charge-compensatory molecules for assembly and maturation.

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. In addition, systems with quantum many-body scars avoid thermal equilibrium, however, only when prepared in specific initial condition. The Serbyn group is actively studying the properties of quantum many-body scars and their potential applications.

Current projects Many-body localization | Quantum ergodicity breaking | Non-equilibrium probes of solids | Multilayer graphene

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. So far, it is not known how microglia decide when to alter circuit elements. However, this information is critical since misinformed microglia can disconnect circuits leading to a disease outcome. Highly reactive microglia are for example a feature of various neurodegenerative diseases such as retinal degeneration and Alzheimer's. The Siegert group addresses microglia function across the cortex as well as in 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

Cell migration is crucial for immune system function, the formation of the body, and the spread of cancer. The Siekhaus group studies how cells move within the complex environment of an organism, using the genetic power of the fruit fly to interrogate this process and identify its regulators.

Vertebrate immune and cancer cells squeeze between closely connected cells to disseminate in the body. The emerging field of immuno-oncology requires immune cells to infiltrate into tumors for their elimination. Using techniques from imaging to biophysics, Daria Siekhaus and her group study how cells penetrate such tissue barriers. They have recently defined a conserved novel program in macrophages that boosts mitochondrial energy output to enable pioneer cell invasion. They have also identified a new pathway that enhances cortical actin, buffering the nucleus and enabling macrophage advancement despite surrounding tissue resistance.

Current projects Cell division regulation of invasive migration | A novel transporter required for metastasis | Developmental specification of macrophage subsets

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 and communicate in 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 to coordinate their behavior. Principles, which are also important for processes such as embryonic development, regeneration 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, biochemistry, pharmacology, microengineering, surface chemistry, advanced imaging, and theoretical approaches.

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: plasticity, network dynamics and computation, and 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 heavy focus 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 is currently working toward use such systems to create “metafluids” whose flow can be controlled by the motion of active constituents.

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 Quincke rollers for flow control | Elastic and charged Leidenfrost effects

Career

- 2021 Member of the Young Academy of the Austrian Academy of Sciences
- 2020 ERC Starting Grant, *Tribocharge: A multiscale approach to an enduring physical puzzle*
- 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

Daniel Zilberman

Epigenetics and Chromatin

Most of the information that passes across generations is encoded in the DNA sequence. However, there is increasing appreciation that cells and organisms also receive inherited information through other mediums, known collectively as epigenetic. The Zilberman group studies cytosine DNA methylation, a key epigenetic mechanism in plant and animal cells.

Cytosine methylation can carry epigenetic information because it is precisely copied when the DNA is replicated. Methylation regulates gene expression, and accurate reproduction of DNA methylation patterns during cell division is therefore essential for plant and animal development, efficient agriculture, and human health. The enzymes that maintain DNA methylation must work within chromatin, and particularly to contend with nucleosomes—tight complexes of DNA and histone proteins. The Zilberman group combines genetic, genomic, biochemical, and evolutionary approaches to understand the maintenance and function of DNA methylation within chromatin using the flowering plant *Arabidopsis thaliana* as the primary model.

Current projects Regulation of DNA methylation patterns by chromatin remodelers and linker histones | Influence of DNA methylation on nucleosome properties | Mathematical modeling of DNA methylation inheritance | Evolution of eukaryotic DNA methylation pathways | Epigenetic inheritance as a mechanism of phenotypic diversification in natural populations

Career

- since 2021 Professor, IST Austria
- 2017 – 2021 Group Leader, John Innes Centre, Norwich, UK
- 2013 – 2017 Associate Professor, University of California, Berkeley, USA
- 2007 – 2013 Assistant Professor, University of California, Berkeley, USA
- 2004 – 2007 Postdoc, Fred Hutchinson Cancer Research Center, Seattle, USA
- 2004 PhD, University of California, Los Angeles, USA

Staff Scientists at IST Austria

Satish Arcot Jayaram

Pre-Clinical Facility

Arcot Jayaram is experienced in providing comprehensive support to research groups who would like to apply the technology of genome engineering to generate transgenic rodents. He likes to collaborate with labs who perform comparative genomics, especially for genes of unknown function.

Because of genomic similarities, researchers use animals, mostly rodents, as genetic models to understand mammalian gene function. By manipulating their genome, researchers try to understand complex processes such as gene function, cell migration, and lineage mapping. Precise genome modification is a multilayered, complex, and error-prone process. It involves design and safe delivery of CRISPR reagents and its associated protein Cas9 into the zygote. Representing the transgenic unit of the Pre-Clinical Facility, Arcot Jayaram offers advice to researchers and carries out the entire process from micromanipulation to identification of animals with modified genomes. The unit aims to keep up with the latest genome engineering technologies and to aid IST researchers with the best transgenic models for their research.

Current projects Generating large knock-in and knock-out mice to study neurodevelopmental disorders (Novarino group). | Knock-in mice with epitope tags for in-vivo labeling of neurotransmitters (Shigemoto group). | Generation of floxed alleles to study comparative genomics (De Bono group). | Tissue-specific and temporally expression of mutant genes with FLEx mice and transgenic rats (Hippenmeyer group).

Career

- since 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

Imaging and Optics Facility

Robert Hauschild brings expertise in imaging, optical engineering, automation, and image analysis to IST Austria. Affiliated with the Imaging and Optics 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 an entire image analysis pipeline. 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: From the evaluation of commercially available equipment to custom modifications of hardware and software. An illustrative example of his work 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, and automation software. | Accessories and protocols to evaluate and maintain microscope performance. | 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 trans-membrane 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 localization of voltage-gated calcium channels in cortical neuron synapses of the human brain (Shigemoto and Siegert groups) | Role of the TPLATE complex in plant clathrin-mediated endocytosis (Friml group) | Structural adaptations of amoeboid cells to mechanical loads when crawling in 3D (Sixt group) | Electron tomography of clathrin-coated vesicles (Friml group) | Freeze-fracture replica labeling of presynaptic calcium channels and the coupling stoichiometry to vesicle release sensors at central neuron synapses (Shigemoto and Jonas 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 length scales. 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. Merrin and the Friml group used a set-up allowing rapid change of the chemical environment around plant roots, revealing a rapid growth response to auxin hormone important for gravitropism. Merrin and the Sixt group found that dendritic cells move through obstacles along the path of least resistance to protect the nucleus and can also move by pushing off irregularly shaped walls in the absence of surface adhesion.

Current projects Microfluidic sorting of *C. elegans* (de Bono group) | Cell patterning with stencils (Kicheva group) | Spatiotemporal control of *A. thaliana* root growth (Friml group) | Single-cell lineage analysis of E. coli with mother machines (Guet group) | Microfluidic measurement of mutation rates (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 immune cells, cancer cell migration in post arrays, and cell migration 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

Mary Wanjiku Muhia

Pre-Clinical Facility

Mary Muhia collaborates with various groups at IST Austria to offer expertise in designing and implementing behavioral studies in animal models. She develops and establishes rodent paradigms at the Pre-Clinical Facility to evaluate behavioral functions, including motivation and emotion, cognition, and sensory processes.

Research in behavioral neuroscience has improved our understanding of various human conditions and led to the availability of tools necessary to understand the neural basis of cognitive processes such as learning and memory. Muhia works with the Novarino group, which studies the genetic and molecular basis of human disorders such as autism, epilepsy, and intellectual disability using mouse models. She collaborates with researchers interested in combining behavioral paradigms with optical techniques. With the Shigemoto group, she is working to establish *in vivo* calcium imaging to understand the temporal dynamics by which neuronal ensembles mediate the retrieval of fear memories. A project with the Jonas group involves optogenetic manipulation to quantify the specific ensemble of hippocampal neurons necessary for fear expression.

Current projects Behavioral evaluation of mouse models of autism, epilepsy, and intellectual disability (Novarino group) | In vivo calcium imaging coupled with optogenetic manipulation to link neural circuit activity and memory formation (Shigemoto and Novarino groups) | in vivo optogenetic reactivation to map quantitatively hippocampal neuron populations sufficient for recall of specific memories (Jonas group)

Career
- since 2021 Staff scientist, IST Austria
- 2011 – 2020 Postdoc, Center for Molecular Neurobiology, Hamburg, Germany
- 2010 – 2011 Postdoc, ETH Zurich, Switzerland
- 2010 PhD, ETH Zurich, Switzerland

Christoph Sommer

Imaging and Optics 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 and Cremer groups, he established multi-animal behavioral analysis, to quantify complex social behavior and interactions of mice and ants. 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 Sweeney group is underway as well—involving deep learning based body part detection and tracking. It will enable the study of many aspects in neural 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 (Sweeney group) | EM vesicle segmentation (Friml and Novarino 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

Jake Yeung

Scientific Computing

With the rapid developments in single-cell sequencing technologies, it is now possible to routinely interrogate the genomes, epigenomes, and transcriptomes of thousands to tens of thousands of cells. Many of the technical challenges of certain single-cell sequencing experiments have therefore been pushed to the realm of statistics, machine learning, and data science.

Scientists at IST Austria can discuss with Jake how to design their sequencing experiments so that they are optimized for inference and to get a global view of the unique analysis challenges to answer their biological questions. He focuses on the design and analysis of single-cell sequencing experiments to uncover gene regulatory principles underlying cellular decision-making. Therefore, he uses widely available single-cell assays (e.g., scATAC-seq and scRNA-seq) as well as more bespoke assays (e.g., scChIC-seq to target histone modifications) to sample large numbers of individual cells across multiple regulatory layers. He also works with computational groups to connect models to single-cell sequencing data.

Current projects Shared and distinct neuronal differentiation dynamics across species (Sweeney group) | Spatially-resolved transcriptomics in the habenula (Shigemoto group) | Sex chromosome expression dynamics in germ cells (Vicoso group)

Career
- since September 2021 Staff scientist, IST Austria
- 2021 Machine Learning Team Leader, Wellcome Sanger Institute, Cambridge, UK
- 2019 – 2021 Human Frontiers Science Program Fellow, Hubrecht Institute, Netherlands
- 2014 – 2019 PhD in Computational Biology, EPFL, Lausanne, Switzerland

Interns at IST Austria
(throughout 2021; percentages are rounded)

ISTerns (summer interns)

Total number of ISTerns: 47

Gender among ISTerns

- ♀ 51.1%
- ♂ 48.9%

Country of nationality

- 14.9% Austria
- 10.6% Ukraine
- 8.5% UK
- 6.4% Romania
- 6.4% Russia
- 4.3% Poland
- 4.3% Portugal
- 44.7% Other (22*)

Country of current institution

- 29.8% UK
- 12.8% Austria
- 10.6% Russia
- 10.6% USA
- 8.5% Ukraine
- 4.3% Poland
- 4.3% Portugal
- 2.1% India
- 17% Other (8*)

Field of research at IST Austria

- 25.5% Physics
- 19.2% Biology
- 19.2% Neuroscience
- 14.9% Mathematics
- 12.8% Computer Science
- 8.5% Chemistry

Scientific interns at IST Austria

Total number of scientific interns: 90

Gender among scientific interns

- ♀ 42.2%
- ♂ 57.8%

Country of nationality

- 15.6% Austria
- 14.4% Russia
- 12.2% Iran
- 8.9% India
- 7.8% Spain
- 5.6% Italy
- 4.4% Greece
- 31.2% Other (22*)

Country of current institution

- 18.9% Austria
- 14.4% Russia
- 11.1% UK
- 11.1% Iran
- 6.7% Spain
- 6.7% India
- 5.6% Switzerland
- 5.6% Germany
- 18.9% Other (11*)

Field of research at IST Austria

- 23.3% Biology
- 23.3% Computer Science
- 18.9% Physics
- 17.8% Neuroscience
- 11% Chemistry
- 5.6% Mathematics

* Number of countries

PhD Students at IST Austria
(as of December 31, 2021; percentages are rounded)

Total number of PhD students: 280

Gender among PhD students

- ♀ 43.2%
- ♂ 56.8%

Country of nationality

- 17.5% Austria
- 9.6% Germany
- 8.2% India
- 6.1% Russia
- 5.4% Italy
- 3.9% Slovakia
- 3.6% China
- 45.7% Other (47*)

Country of previous (BS or MA) institution

- 18.2% Austria
- 9.6% UK
- 9.6% Germany
- 6.4% India
- 5.7% Russia
- 3.6% Italy
- 3.2% Czech Republic
- 3.2% USA
- 40.4% Other (36*)

Field of research at IST Austria

- 24.3% Biology
- 14.1% Physics
- 13.9% Neuroscience
- 10.7% Computer Science
- 5.7% Mathematics
- 1.79% Chemistry
- 27.5% Unaffiliated**

Postdocs at IST Austria
(as of December 31, 2021; percentages are rounded)

Total number of postdocs: 189

Gender among postdocs

- ♀ 33.9%
- ♂ 66.1%

Country of nationality

- 10.6% Germany
- 9% China
- 7.4% Italy
- 6.9% India
- 5.3% France
- 4.2% Russia
- 4.2% UK
- 45.5% Other (43*)

Country of PhD institution

- 17.5% Germany
- 13.2% Austria
- 7.9% USA
- 6.9% France
- 4.6% UK
- 5.8% China
- 4.8% Switzerland
- 3.7% Italy
- 33.9% Other (28*)

Field of research at IST Austria

- 31.2% Biology
- 19.1% Neuroscience
- 19.1% Physics
- 18.5% Mathematics
- 9% Computer Science
- 3.2% Chemistry

* Number of countries

** Freshman students, who joined IST Austria in fall 2021, usually need one year to pass a qualifying exam and be affiliated with a research group.

PhD Graduates 2021

This year, 23 students completed their PhDs, bringing the total number of graduates to 136. The 2021 graduates, with their group affiliations and dissertation titles, are listed below.

Amir Kafshdar Goharshady, *Chatterjee group*: “Parameterized and algebro-geometric advances in static program analysis”
Giorgio Cipolloni, *Erdős group*: “Fluctuations in the spectrum of random matrices”
Georg Fritz Osang, *Edelsbrunner group*: “Multi-cover persistence and Delaunay mosaics”
Karla Huljev, *Heisenberg group*: “Coordinated spatiotemporal reorganization of interstitial fluid is required for axial mesendoderm migration in zebrafish gastrulation”
Bui Thi Mai Phuong, *Lampert group*: “Underspecification in deep learning”
David Kleindienst, *Shigemoto group*: “2B or not 2B: Hippocampal asymmetries mediated by NMDA receptor subunit GluN2B C-terminus and high-throughput image analysis by deep learning
Silvia Caballero Mancebo, *Heisenberg group*: “Fertilization-induced deformations are controlled by the actin cortex and a mitochondria-rich subcortical layer in ascidian oocytes”
Nishchal Agrawal, *Hof group*: “Transition to turbulence and drag reduction in particle-laden pipe flows”
Matilda Peruzzo, *Fink group*: “Geometric superinductors and their applications in circuit quantum electrodynamics”
Andi Harley Hansen, *Hippenmeyer group*: “Cell-autonomous gene function and non-cell-autonomous effects in radial projection neuron migration”
Dario Feliciangeli, *Seiringer group*: “The polaron at strong coupling classical and quantum behavior”
Lukas Hoermayer, *Friml group*: “Wound healing in the Arabidopsis root meristem”
Sebastian Hensel, *Fischer group*: “Curvature driven interface evolution: Uniqueness properties of weak solution concepts”
Lorenzo Portinale, *Maas group*: “Discrete-to-continuum limits of transport problems and gradient flows in the space of measures”
Karen Klein, *Pietrzak group*: “On the adaptive security of graph-based games”
Daniel Jirovec, *Katsaros group*: “Singlet-Triplet qubits and spin-orbit interaction in 2-dimensional Ge hole gases”
Lanxin Li, *Friml group*: “Rapid cell growth regulation in Arabidopsis”
Hana Semeradova, *Benková group*: “Molecular mechanisms of the cytokinin regulated endomembrane trafficking to coordinate plant organogenesis”
Viktor Toman, *Chatterjee group*: “Improved verification techniques for concurrent systems”
Laura Schmid, *Chatterjee group*: “Evolution of cooperation via (in)direct reciprocity under imperfect information”
Rashed Abualia, *Benková group*: “Role of hormones in nitrate regulated plant growth”
Kathrin Tomasek, *Guet group*: “Pathogenic Escherichia coli hijack the host immune response”
Giorgi Nadiraze, *Alistarh group*: “On achieving scalability through relaxation”

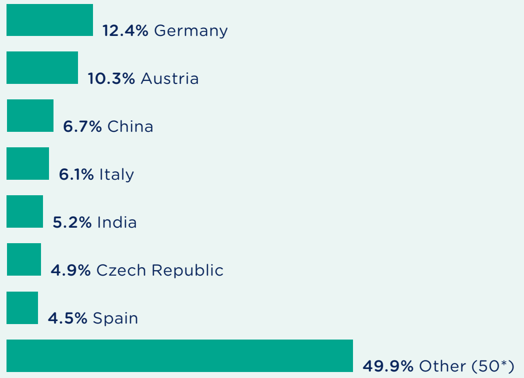
IST Austria Alumni Network

(as of December 31, 2021; data are self-reported by members of the IST Austria alumni network, actual counts may be higher; percentages are rounded)

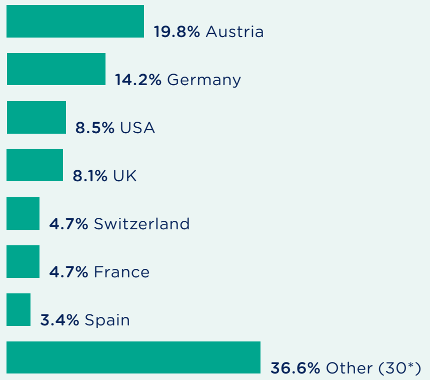
Total number of alumni: 444

PhD students/graduates	103
Postdocs (at least one year spent at IST Austria)	341

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:

- Electron Microscopy Facility
- Imaging and Optics Facility
- Library
- Lab Support Facility
- Miba Machine Shop
- Nanofabrication Facility
- Preclinical Facility
- Scientific Computing Facility
- Nuclear Magnetic Resonance 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
- Stakeholder Relations
- Technology Transfer Office

Technical Support at IST Austria

(Scientific Service Units and laboratory technicians; as of December 31, 2021; percentages are rounded)

Total number of technical support staff: 140

Gender among technical support staff

♀ 54.3%

♂ 45.7%

Country of nationality

40% Austria

7.1% Germany

6.4% Italy

5% Hungary

3.6% Poland

2.9% Croatia

37.3% Other (29*)

Administrative Staff at IST Austria

(as of December 31, 2021; percentages are rounded)

Total number of administrative staff: 202

Gender among administrative staff

♀ 58.9%

♂ 41.1%

Country of nationality

71.8% Austria

3.5% Germany

2.5% Romania

2% Poland

2% UK

1.5% Czech Republic

16.8% Other (23*)

* Number of countries

Grants 2021

(active or received third-party funding in 2021; funding amounts are rounded)

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

Barton group
- The maintenance of alternative adaptive peaks in snapdragons, FWF Stand-alone, €404'000, 3/20-2/23
- Dynamics of Wolbachia Spread in Rhagoletis cerasi, FWF Stand-alone (Partner, Awardee: Christian Stauffer), €83'000, start date tbc
- Causes and consequences of population fragmentation, FWF Stand-alone (Partner, Awardee: Jitka Polechova), €61'000, 9/20-5/24
- Integration of speciation research (IOS), ESEB Special Topic Network, €20'000, 9/21-8/23

Benková group
- Post-Translational Control of CRFs in Plant N Signalling, FWF ESPRIT, €288'000, 2/22-1/25
- Hormonal regulation of plant adaptive responses to environmental signals, ÖAW DOC, €116'000, 9/18-8/21
- A Role for Auxin-Cytokinin Synergism in Phosphate Starvation and Plant-Fungal Mutualism, ÖAW DOC, €77'000, 12/21-11/23
- Plant Hydrotropism - How roots seek water: Molecular mechanism of hydrotropism, FFG Femtech, €8'000, 12/21-5/22
- Mechanism of root system regulation by aromatic cytokinin derivatives, OeAD WTZ, €7'000, 1/21-12/22

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

Bickel group
- MATERIALIZABLE: Intelligent fabrication-oriented Computational Design and Modeling, H2020 ERC StG, €1'498'000, 2/17-1/22
- Perception-Aware Appearance Fabrication, FWF Meitner, €164'000, 12/21-12/23
- MyBreathMask, FFG Klipha-Covid19, €12'000, 12/20-1/21

Browning group
- New frontiers of the Manin conjecture, FWF Stand-alone, €362'000, 10/19-9/22
- A motivic circle method, H2020 MSCA IF, €186'000, 7/20-1/22

Chatterjee group
- Formal Methods for Stochastic Models: Algorithms and Applications, ERC CoG, €1'998'000, 1/21-12/25
- Quantitative Analysis of Probablistic Systems with a focus on Crypto-currencies, ÖAW DOC, €96'000, 6/19-1/21
- Efficient Algorithms for Computer Aided Verification, WWTF Cooperation project, €82'000, 3/16-6/21

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, €310'000, 2/18-1/21
- The Brainstem-Hippocampus Network Uncovered: Dynamics, Reactivation and Memory Consolidation, H2020 MSCA IF, €174'000, 8/19-7/21
- Respiratory-Mediated Regulation Of Hippocampal-Cortical Dynamics In Emotional Memory Reactivation, BBRF Young Investigator Grants, €30'000, 1/22-1/23

Danzl group
- CryoMinflux-guided in-situ visual proteomics and structure determination, CZI Visual Proteomics, €427'000, 8/21-1/24
- Optical control of synaptic function via adhesion molecules, FWF International program, €287'000, 3/18-2/21
- High content imaging to decode human immune cell interactions in health and allergic disease, NFB Life Science , €279'000, 12/19-11/22
- Molecular Drug Targets, FWF DK, €214'000, 3/19-2/23
- High-speed 3D-nanoscopy to study the role of adhesion during 3D cell migration, HFSP LTF, €128'000, 7/18-4/21
- UltraX - achieving sub-nanometer resolution in light microscopy using iterative X10 microscopy in combination with nanobodies and STED, EMBO LTF, €89'000, 8/19-10/21
- Studying Organelle Structure and Function at Nanoscale Resolution with Expansion Microscopy, ÖAW DOC, €77'000, 8/21-7/23

De Bono group
- Molecular mechanisms of neural circuit function, Wellcome Trust Investigator Award, €1'223'000, 10/19-3/23
- Role of IL-17 signaling effectors MALT-1 and NFKI-1, FWF Meitner, €178'000, 2/22-1/24
- Control of gene expression at the endoplasmic reticulum, EMBO LTF, €105'000, 10/19-2/22

Edelsbrunner group
- 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
- Discretization in Geometry and Dynamics, FWF SFB, €290'000, 10/20-9/24
- Algebraic Footprints of Geometric Features in Homology, FWF International program, €234'000, 10/19-9/22
- Learning and triangulating manifolds via collapses, FWF Meitner, €178'000, 6/21-5/23

Erdős group
- Random matrices beyond Wigner-Dyson-Mehta, ERC AdG, €1'912'000, 10/21-9/26
- Geometric study of Wasserstein spaces and free probability, H2020 MSCA IF, €186'000, 10/19-9/21

Fink group
- A Fiber Optic Transceiver for Superconducting Qubits, H2020 ERC StG, €1'500'000, 2/18-1/23
- Hybrid Semiconductor - Superconductor Quantum Devices, NOMIS Research Grants, €700'000, 9/17-8/21
- Protected states of quantum matter, NOMIS Research Grants, €550'000, 2/22-1/26
- Hybrid Optomechanical Technologies, H2020 Cooperation FET-Proactive, €558'000, 1/17-6/21
- Integrating superconducting quantum circuits, FWF SFB, €429'000, 3/19-2/23
- Quantum readout techniques and technologies, H2020 Cooperation FET-Open, €388'000, 11/19-4/23
- Quantum Local Area Networks with Superconducting Qubits, H2020 Cooperation FET-Open, €388'000, 9/20-8/23
- Controllable Collective States of Superconducting Qubit Ensembles, ÖAW DOC, €77'000, 10/19-9/21

Fischer group
- Bridging Scales in Random Materials, H2020 ERC StG, €1'143'000, 3/21-2/26
- Taming Complexity in Partial Differential Systems, FWF SFB, €203'000, 3/21-2/25

Freunberger group
- Elucidating the mechanism of Li-S batteries, FFG Femtech, €7'000, 4/21-8/21

Friml group
- Tracing Evolution of Auxin Transport and Polarity in Plants, H2020 ERC AdG, €2'410'000, 1/18-12/22
- Molecular mechanisms of endocytic cargo recognition in plants, FWF International program, €339'000, 2/18-1/22
- RNA-directed DNA methylation in plant development, FWF Stand-alone, €179'000, 7/17-6/21
- A Case Study of Plant Growth Regulation: Molecular Mechanism of Auxin-mediated Rapid Growth Inhibition in Arabidopsis Root, ÖAW DOC, €73'000, 10/19-8/21

Guet group
- CyberCircuits: Cybergenetic circuits to test composability of gene networks, FWF International program, €262'000, 4/19-3/23
- Bacterial toxin-antitoxin systems as antiphage defense mechanisms, FWF Richter, €243'000, 2/19-7/21
- Dynamics of large evolutionary steps at the level of the single cell, EMBO LTF, €136'000, 1/21-12/22
- Bacterial cytoplasm glass transition: passive physiological switch or active survival strategy, EMBO LTF, €136'000, 8/21 - 7/23
- Bistability of the marRAB operon expression in different E. coli back grounds in non-induced and induced condition, FFG Femtech, €8'000, 3/21 - 9/21

Hannezo group
- Design Principles of Branching Morphogenesis, H2020 ERC StG, €1'453'000, 7/20-6/25
- Active mechano-chemical description of the cell cytoskeleton, FWF Stand-alone, €339'000, 10/18-9/22
- Biomechanics of stem cell fate determination, EMBO LTF, €136'000, 8/21-7/23
- EMBO Young Investigator Program, EMBO, €15'000, 1/20-12/23

Hausel group
- Algebro-Geometric Applications of Factorization Homology, FWF Meitner, €165'000, 9/19-12/21
- Branes on hyperkähler manifolds, ÖAW DOC, €77'000, 10/21-9/23

Heisenberg group
- 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, 5/18-4/22
- Nano-Analytics of Cellular Systems, FWF DK, €197'000, 3/18-8/23
- Dissecting the mechanisms underlying cytoplasmic reorganization and embryo patterning in ascidians, HFSP LTF, €194'000, 7/21-6/24
- Coordination of mesendoderm fate specification and internalization during zebrafish gastrulation, HFSP LTF, €144'000, 9/18-2/22
- Tissue morphogenesis driven by feedback regulations between fluidization and kinase activation, JSPS ORF, €100'000, 4/21-3/23
- Mechanosensation in cell migration: the role of friction forces in cell polarization and directed migration, EMBO LTF, €86'000, 2/19-3/21
- Mesendoderm specification in zebrafish: The role of extraembryonic tissues, ÖAW DOC, €76'000, 6/19-5/21
- Dissecting the mechanisms underlying cytoplasmic reorganisation and embryo patterning in ascidians, MSCA IF, €29'000, 3/21-6/21

Henzinger group
- Vigilant Algorithmic Monitoring of Software, ERC AdG, €2'451'000, 1/22-12/26
- The Wittgenstein Prize – Thomas A. Henzinger, FWF Wittgenstein, €1'528'000, 1/14-6/21
- Design of Autonomous Cyber-Physical Systems with Learning and Complex Problem-Solving Capacities, Simons Berkeley Fellowship, €24'000, 1/21 - 5/21

Higginbotham group
- Protected states of quantum matter, NOMIS Research Grant, €550'000, 2/22-1/26
- Cavity electromechanics across a quantum phase transition, FWF Stand-alone, €406'000, 10/20-9/23
- Surface Charge and Tunneling Multi-Mode Imaging, ÖAW DOC, €77'000, 8/21-7/23

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 Neural Stem Cell Lineage Progression, FWF SFB, €373'000, 3/20-2/24
- Role of Eed in neural stem cell lineage progression, FWF Firnberg, €234'000, 12/18-11/21
- 3D-Animationsvideo und Virtual Reality-App zur Anwendung der "Mosaik-Analyse mit Doppel-Markern" in der Stammzellforschung, FWF Wissenschaftskommunikationsprogramm, €50'000, 3/22-8/22

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
- Mediated Biphasic Battery, EIC Pathfinder Open, €380'000, start date tbc
- Bottom-up Engineering for Thermoelectric Applications, FWF Meitner, €162'000, 5/20-4/22
- Solar-Light-Driven Photoelectro-chemical System, OeAD WTZ, €8'000, 1/21-10/22
- Exploring novel nanostructure materials for energy applications, FFG Prakitika für SchülerInnen, €1'000, 7/21-7/21

Jonas group
- Biophysics and circuit function of a giant cortical glumatergic synapse, H2020 ERC AdG, €2'678'000, 3/17-8/22
- The Wittgenstein Prize – Peter Jonas, FWF Wittgenstein, €1'500'000, 10/17-9/22
- Intracellular hippocampal attractor dynamics, FWF Firnberg, €239'000, 9/19-8/22
- Synaptic computations of the hippocampal CA3 circuitry, MSCA IF, €174'000, 1/22-12/23
- Development of nanodomain coupling between Ca2+ channels and release sensors at a central inhibitory synapse, ÖAW DOC, €77'000, 10/19-9/21

Jösch group
- Circuits of Visual Attention, H2020 ERC StG, €1'447'000, 12/17-11/22
- Evolutionary Optimisation of Neuronal Processing, DFG Priority Program, €186'000, 3/21-2/24 (grant received together with Fyodor Kondrashov)
- Neuronal networks of salience and spatial detection in the murine superior colliculus, HFSP LTF, €144'000, 9/18-8/21
- Determining the Molecular Logic of Direction-Selective Wiring Program, BIF PhD Fellowship, €59'000, 1/22-12/23
- The developmental role of electrical synapses Drosophila melanogaster's visual system, FFG Femtech, €3'000, 7/21-8/21

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

Katsaros group
- Hybrid Semiconductor - Superconductor Quantum Devices, NOMIS Research Grants, €700'000, 9/17-8/21
- Protected states of quantum matter, NOMIS Research Grant, €550'000, 2/22-1/26
- Topologically protected and scalable quantum bits, H2020 Cooperation FET-Open, €504'000, 12/19-8/23
- Towards scalable hut wire quantum devices, FWF Stand-alone, €411'000, 10/19-9/23
- Hole spin orbit qubits in Ge quantum wells, FWF Stand-alone, €410'000, 2/18-1/22
- 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
- Morphogen control of growth and pattern in the spinal cord, FWF SFB, €375'000, 3/20-2/24
- The role of morphogens in the regulation of neural tube growth, ÖAW DOC, €114'000, 10/18-2/22
- The regulatory logic of pattern formation in the vertebrate dorsal neural tube, NFB Science Call Dissertationen, €60'000, 4/20-3/23

Kolmogorov group
- 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, 3/21-2/25
- Evolutionary Optimisation of Neuronal Processing, DFG Priority Program, €234'000, 3/21-2/24 (grant received together with Maximilian Jösch)
- Zimin Foundation SMTB Alumni Summer Research Programme, €3'000, 7/21-9/21

Lemeshko group
- Angulon: physics and applications of a new quasiparticle, H2020 ERC StG, €1'500'000, 2/19-1/24
- 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
- Understanding bacterial cell division by in vitro reconstitution, FWF Stand-alone, €389'000, 9/21-8/24
- EMBO Young Investigator Program, EMBO, €15'000, 1/20-12/23
- Characterization of FtsA mutants in the context of bacterial cell division, FFG Femtech, €6'000, 10/21-1/22

Maas group
- Optimal Transport and Stochastic Dynamics, H2020 ERC StG, €1'075'000, 2/17-7/22
- Taming Complexity in Partial Differential Systems, FWF SFB, €531'000, 3/17-2/25
- Reaching consensus in heterogeneous random opinion dynamics, FWF Meitner, €164'000, 11/21-10/23
- Curvature-dimension in noncommutative analysis, FWF Meitner, €164'000, 12/21-11/23
- Dissipation and Dispersion in Nonlinear Partial Differential Equations, FWF DK, €161'000, 3/17-8/22

Modic group
- Unraveling the mysteries of 1T-TaS2, FWF Stand-alone, €404'000, start date tbc

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

Muller group
- Organization of Clouds, and Implications of Tropical Cyclones and for the Energetics of the Tropics, in Current and Warming Climate; ERC StG, €719'000, 9/21-5/24

Novarino group
- 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
- Critical windows and reversibility of ASD associated with mutations in chromatin remodelers, Simons Foundation Research, €993'000, 8/20-7/24
- Neurobiology of anxiety in autism spectrum disorders, FWF FG, € 616'000, start date tbc
- Neural stem cells in autism and epilepsy, FWF SFB, €375'000, 3/20-2/24
- Molecular Drug Targets, FWF DK, €370'000, 3/15-2/23
- Identification of converging Molecular Pathways Across Chromatinopathies as Targets for Therapy, FWF ERA-NET, €357'000, 4/19-3/23
- Molecular interactors of kaptin; a brain regulator of S6 phosphorylation during neurodevelopment, FFG Femtech, €8'000, 7/21-12/21

Palacci group
- Design, Synchronization and Collective Dynamics of Colloidal Oscillators, FWF Stand-alone, €400'000, 2/22-1/25
- Active Noise to Control and Direct Self-Assembly, DOE Basic Research Award, €112'000, 9/21-6/22

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

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

Sazanov group
- Structure and mechanism of respiratory chain molecular machines, ERC AdG, €1'781'000, 9/21-8/26
- Wittgenstein Preis (Partner, Awardee: Michael Wagner), FWF Wittgenstein, €152'000, 7/21-6/23
- Structural characterization of E. coli complex I: an important mechanistic model, ÖAW DOC, €76'000, 12/19-11/21

Schanda group
- AlloSpace. The emergence and mechanisms of allostery, FWF International program, €414'000, 2/22-1/26

Schur group
- CryoMinflux-guided in-situ visual proteomics and structure determination, CZI Visual Proteomics, €419'000, 8/21-1/24
- Structure and isoform diversity of the Arp2/3 complex, FWF Stand-alone, €401'000, 7/20-6/23
- Structural conservation and diversity in retroviral capsid, FWF Stand-alone, €390'000, 10/18-9/21
- 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
- Integrated visual proteomics of r eciprocal cell-extracellular matrix interactions, FEBS Excellence Awards, €100'000, 3/22-2/25
- EMBO Young Investigator, EMBO Young Investigators Program, €15'000, starting 1/22

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
- Simulating nonergodic matter in high entanglement regime, PRACE, 20Mi CPU hours 21-22

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, 7/16-6/22
- LGI1 antibody-induced pathophysiology in synapses, FWF International program, €256'000, 1/20-12/22
- Recombinant Immunolabels for Nanoprecise Brain Mapping Across Scales, NIH U24, €235'000, 9/18-6/24
- Plasticity in the cerebellum: Which molecular mechanisms are behind physiological learning?, ÖAW DOC, €116'000, 9/18-12/21
- 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, 5/17-10/22
- 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

Sixt group
- Cellular navigation along spatial gradients, H2020 ERC CoG, €1'985'000, 4/17-3/22
- Decoding GPCR signaling to understand chemotaxis, FWF Firnberg, €239'000, 9/19-8/22
- Bioelectric patrolling: the role of the local membrane potential in immune cell migration, HFSP LTF, €211'000, 7/21-6/24
- Nano-Analytics of Cellular Systems, FWF DK, €157'000, 3/18-8/23
- Role of Dock8-dependent pericentriolar actin structure, FWF Meitner, €40'000, 10/20-5/21
- Bioelectric patrolling: the role of the local membrane potential in immune cell migration, EMBO LTF, €34'000, 1/21-6/21

Sweeney group
- Development and Evolution of Tetrapod Motor Circuits, HE ERC StG, €1'500'000, start date tba
- Development of Viral Vectors for Amphibian Gene Delivery and Manipulation, NSF EDGE grant, €190'000, 09/21-08/24

Tkačik group
- Efficient coding with biophysical realism, FWF Stand-alone, €362'000, 12/20-11/23
- Can evolution minimize spurious signaling crosstalk to reach optimal performance?, HFSP Program grant, €286'000, 12/18-11/22
- Functional Advantages of Critical Brain Dynamics, FWF Meitner, €178'000, 5/22-4/24

Vicoso group
- Prevalence and Influence of Sexual Antagonism on Genome Evolution, H2020 ERC StG, €1'444'000, 3/17-2/22
- Mechanisms and Evolution of Reproductive Plasticity, FWF ESPRIT, €288,000, 2/22-1/25
- Sex Determination in Termites, FWF Meitner, €149'000, 5/18-6/21
- Sexual conflict: resolution, con straints 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
- Spectra and topology of graphs and of simplicial complexes, FWF Meitner, €164'000, 7/22-6/24

Waitukaitis group
- Tribocharge: a multi-scale approach to an enduring problem in physics, H2020 ERC StG, €1'494'000, 1/21-12/25

Zilberman group
- Quantitative analysis of DNA methylation maintenance with chromatin, ERC CoG, €480'000, 7/21-3/23
- Evolution of DNA Methylation Machinery and Function across Time, Swedish Research Council Vetens kapsrådet (VR), €309'000, 10/21-9/24
- Epigenomic analysis toward quantitative understanding of mechanisms for ectopic DNA methylation, JSPS ORF, €44'000, 10/21-8/22

Abbreviations

BIF: Boehringer Ingelheim Fonds
BMBWF: Bundesministerium für Bildung, Wissenschaft und Forschung
BBRF: Brain Beha viour Research Foundation
CZI: Chan Zuckerberg Initiative
DFG: Deutsche Forschungsgemeinschaft
DOE: Department of Energy (USA)
EIC: European Innovation Council
EMBO: European Molecular Biology Organization
ERC: European Research Council
FEBS: Federation of European Biochemical Societies
FFG: Forschungsförderungsgesellschaft
FWF: Fonds zur Förderung der wissenschaftlichen Forschung
HFSP: Human Frontier Science Program
HRSM: Hochschulraum-Strukturmittel-Projekte
H2020: Horizon 2020, European Union*
JDRF: Juvenile Diabetes Research Foundation
JSPS: Japan Society for the Promotion of Science
MSCA: Marie Skłodowska-Curie Actions
NFB: Niederösterreich Forschung und Bildung
NIH: National Institutes of Health
OeAD: Österreichischer Austauschdienst
ÖAW: Österreichische Akademie der Wissenschaften
PRACE: Partnership for Advanced Computing in Europe
SNF: Schweizer Nationalfonds
WAW: Wirtschaftsagentur Wien
WSS: Werner Siemens Stiftung
WWTF: Wiener Wissenschafts-, Forschungs-, und Technologiefonds

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

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(joint publications involving several groups are listed multiple times)

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Pre-Clinical Facility

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Scientific Data 2021

Barton group

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Higginbotham group

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Jonas group

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Katsaros group

- Jirovec D. 2021. Research data for 'A singlet-triplet hole spin qubit planar Ge', IST Austria, 10.15479/AT:ISTA:9323.
- Katsaros G. 2021. Raw transport data for: Enhancement of proximity induced superconductivity in planar germanium, IST Austria, 10.15479/AT:ISTA:9291.
- Valentini M. 2021. Research data for 'Non-topological zero bias peaks in full-shell nanowires induced by flux tunable Andreev states', IST Austria, 10.15479/AT:ISTA:9389.

Schanda group

- Schanda P. 2021. Data to 'Functional control of a 0.5 MDa TET aminopeptidase by a flexible loop revealed by MAS NMR', IST Austria.

Vicoso group

- Vicoso B. 2021. Data from Hyulmans et al 2021, 'Transitions to asexuality and evolution of gene expression in Artemia brine shrimp', IST Austria, 10.15479/AT:ISTA:9949.

Wojtan group

- Sperl G, Narain R, Wojtan CJ. 2021. Mechanics-Aware Deformation of Yarn Pattern Geometry (Additional Animation/Model Data), IST Austria, 10.15479/AT:ISTA:9327.

Selected Events 2021

Scientific conferences, workshops and symposia (selection)

Date	Event name	Description
September 20	Austrian Cryo-EM (ACE) Symposium	Symposium to highlight exciting research involving cryo-EM, including the latest developments in the field as well as their application to biological questions.
September 29-30	Future Directions in Chemistry: From Biology to Advanced Materials (Chemistry Symposium)	Workshop to get an overview of some of the latest developments in chemistry. Topics include active research areas in catalysis, chemical biology, energy, organic chemistry, and polymer/supramolecular chemistry.
November 9	Autism in Austria	Austrian Symposium for Autism to bring together researchers and clinicians interested in the field of autism.

Outreach and science education events (selection)

Date	Event name	Description
March 24	Science Education Day	Science Education Day 2021 was targeted towards teachers interested in including scientific topics in their curriculum. This year's topic was "STEM teaching after 2020 - Challenge or chance?"
May 28	Zoom a Scientist Girls' Special	Zoom a Scientist is a science outreach program developed by IST Austria to connect school classes with IST Austria scientists in online meetings.
August 16-20	Sommercampus Kids	One-week summer camp for 6-10-year old school children.
August 17-19	Sommercampus Juniors	Three-days summer camp for 11-14-year old school children.
August 23-25	Fakebusters Bootcamp	One-week summer camp for teenagers.
September 19	Open Campus	IST Austria opened its campus for people to discover basic research in the hands-on exhibition, visit our laboratories and solve the ice tiger quiz.
September 19	Opening Ceremony Sunstone Building	The Sunstone building was opened in the presence of the Governor of Lower Austria, Johanna Mikl-Leitner.
November 10	WoMen in Science: Change the World!	The Institute has this year started its campaign "WoMen in Science", highlighting the importance of gender balance in research and innovation. During a panel event, the following questions were addressed: Why do we need gender balance? How can we reach and maintain it? And what can science institutions do?
November 26	Student Open Day	Each year, the Institute opens its doors to give prospective PhD and internship candidates an insight into what it is like to study and do research at the Institute.
December 7	Science × Education Seminar (SESI)	Kick-off event of a regular seminar series for teachers: "Lesen am Bildschirm – Textverständnis im Digitalen Zeitalter" (Talk in German Language) with Hajo Boomgaarden – University of Vienna

Technology transfer talks

Date	Speaker and affiliation	Talk series and title
April 7	**Alexander Belcredi** and **Lorenzo Corsini** – Phagomed	TWIST Talk: "Building a biotech: what we've learned so far"
November 17	**Jonas Zeuner** – VitreaLab GmbH	TWIST Talk: "How I created a science based startup in Vienna"
November 30	**Heinz Faßmann**, Federal Minister of Education, Science and Research; **Peter Koren**, Deputy Secretary General, Federation of Austrian Industries; **Simon Johnson**, MIT Sloan School of Management & Global Entrepreneurship Lab (GLAB)	Science-Industry Talk: A panel event featuring talks, video interviews and panel discussions was hosted covering the topic "Translating Science into Business – Lessons from an Emerging Ecosystem"

Public lectures

Date	Speaker and affiliation	Talk series and title
March 11	**Michael Sixt** – IST Austria	IST Austria Science Talk: "Wie Zellen durch unseren Körper wandern" (Talk in German Language)
April 15	**Julia Ebner** – Institute for Strategic Dialogue	IST Science and Society Lecture: "The new age of disinformation and radicalization"
June 2	**Verena Winiwarter** – BOKU Vienna	Special Colloquium: "Mortgaging the future: Cold War and other legacies and sustainable development"
June 10	**Rainer Weiss** – Massachusetts Institute of Technology	IST Lecture: "The beginnings of gravitational wave astronomy: current state and future"
June 17	**Tim Vogels** – IST Austria	IST Austria Science Talk: "Was passiert beim Denken?" (Talk in German Language)
September 21	**Gero Miesenböck** – University of Oxford	IST Lecture: "Mechanisms for balancing sleep need and sleep"
November 23	**Carolyn Bertozzi** – Stanford University	ÖAW - IST Austria Lecture: "Therapeutic Opportunities in Glycoscience"

Institute colloquia

Date	Speaker and affiliation	Title
January 11	Tom Mrsic-Flogel – Sainsbury Wellcome Centre	"Neural correlates of belief updates in the mouse secondary motor cortex"
January 18	Rong Li – National University of Singapore	"Actin-based forces in asymmetric meiotic cell division"
March 1	Asya Rolls – Israel Institute of Technology	"The brain as a central regulator of immunity"
March 15	Nuno Maulide – University of Vienna	"When chemistry asks biological questions"
April 19	Wade Regehr – Harvard Medical School	"New insights into cell types and circuitry of the cerebellar cortex"
April 26	Irene Miguel-Aliaga – Imperial College London	"Hungry brains and clever guts"
May 10	Katia Bertoldi – Harvard University	"Multistable structures - from deployable structures to robots"
May 17	Christina Marchetti – UCSB	"Active Topology"
June 21	Michel Devoret – Yale University	"Correcting decoherence errors in quantum superconducting circuits"
September 13	Brad Ramshaw – Cornell University	"The Planckian Limit: a Fundamental Bound on Electron Scattering"
October 4	Shohini Ghose – Wilfrid Laurier University	"The Quantum Revolution"
October 11	Vidya Madhavan – Univ. of Illinois Urban-Champaign	"Chiral edge modes in the heavy fermion superconductor UTe2"
October 18	Lillian Pierce – Duke University	"Counting problems: open questions in number theory"
November 15	Yang Dan – UC Berkeley	"A motor theory of sleep control"
December 6	Aviv Regev – Massachusetts Institute of Technology	"Design for Inference in Biology: How to learn the convolutions of life"

IST Austria Scientific Awards and Distinctions 2021

(selection)

ERC Advanced Grant, European Research Council
László Erdős, Leonid Sazanov, Thomas Henzinger
ERC Starting Grant, European Research Council
Lora Sweeney
Erwin Schrödinger Prize, Austrian Academy of Sciences (OEAW)
László Erdős
FEBS Excellence Award
Florian Schur
Ferran Sunyer i Balaguer Prize
Tim Browning
Grand Decoration of Honor in Silver of the Republic of Austria
Haim Harari
Information Theory Society Paper Award
Marco Mondelli
Keilin Memorial Medal and Lecture, Biochemical Society (UK)
Leonid Sazanov
Peter Seeburg Integrative Neuroscience Prize
Peter Jonas
Volker Heine Young Investigator Award
Bingqing Cheng
Harold M. Weintraub Graduate Student Award
Shayan Shamipour (Heisenberg group)
PhD Award, Austrian Association of Molecular Life Sciences and Biotechnology (ÖGMBT)
Domen Kampjut (Sazanov group)
PhD Award, European Association for Programming Languages and Systems (EAPLS)
Amir Kafshdar Goharshady (Chatterjee group)
Fellow of the American Mathematical Society
László Erdős
FENS-Kavli Scholar
Lora Sweeney
Member of the Young Academy (Austria)
Scott Waitukaitis
Member of the Academia Europaea
Mario de Bono, Vadim Kaloshin, Robert Seiringer
Member of the EMBO Young Investigator Programme
Florian Schur

Management of IST Austria

Thomas A. Henzinger President
Michael Sixt Executive Vice President
Georg Schneider Managing Director
Eva Benková Dean of the Graduate School
Gaia Novarino Vice President for Science Education
Bernd Bickel Vice President for Technology Transfer
Simon Hippenmeyer Area Chair, Life Sciences
Robert Seiringer Area Chair, Mathematical and Physical Sciences
Krzysztof Pietrzak Area Chair, Information and System Sciences

IST Austria Internal Awards 2021

Outstanding Scientific Achievement
Irene Vercellino, Sazanov group
Outstanding Scientific Support
Verena Mayer, Aquatics facility
Outstanding Administrative Support
Yvonne Kuderna-Fiegl, Controlling
Outstanding PhD Thesis
Amir Kafshdar Goharshady, Chatterjee group
Golden Chalk Award for Excellence in Teaching
Tobias Meggendorfer, Chatterjee group
Beatriz Vicoso, Vicoso group
Golden Sponge Award for Excellent Teaching Assistance
Guillaume Dubach, Erdős group
Bor Kavcic, Tkačik 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, Österreichische Nationalbank, Vienna, Austria
Vice-Chair: **Olaf Kübler**, Former President of ETH Zurich, 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
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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: **Iain Mattaj**
Vice-Chair: **Reinhard Jahn**
Elisabeth Engelbrechtsmüller-Strauß
Claus J. Raidl
Alexander Hartig

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.

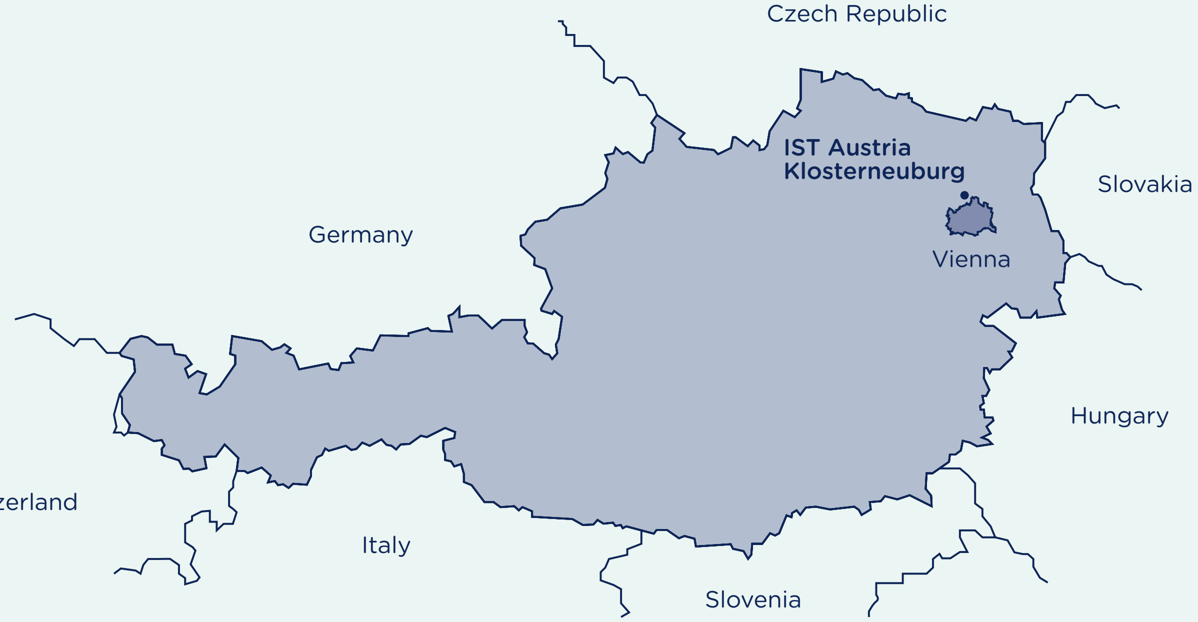
Scientific Board

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
Conny Aerts, from 2022, Professor, Institute of Astronomy, KU Leuven, Belgium
Ben Feringa, Professor, Stratingh Institute for Chemistry, University of Groningen, The Netherlands
Véronique Garcon, from 2022, Senior Scientist, Laboratory of Space Geophysical and Oceanographic Studies, CNRS Toulouse, France
Tony F. Heinz, Professor, Department of Applied Physics, Stanford University, Palo Alto, USA
Kathryn Hess Bellwald, from 2022, Professor and associate vice-president for student affairs and outreach, EPFL, Lausanne, Switzerland
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
Helen Saibil, from 2022, Professor, Department of Biological Sciences, Birkbeck College, London, United Kingdom
Non-voting Member: **Claus J. Raidl**, Former President, Österreichische 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.

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 Visitor Center (planned)
09 Bridge (under construction)
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 Sunstone Building
Graduate School
24 Lab Building 6
(under construction)
27 Kindergarten
CO3 Multipurpose Research Facility

31–45 Apartments
60 Tennis courts
61 Sports Facility

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

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Nicole Amberg, postdoc in the Hippenmeyer group, is an expert for stem cells in the cerebral cortex and founder of "The STEM fatale Initiative" (turquoise, outside).
Laura Schmid, postdoc in the Chatterjee group, finished her PhD in 2021. In her thesis she explored the evolution of cooperation via (in)direct reciprocity (yellow).
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Unsettling as our present at times might be, one lesson we have learned over the past couple of years is how deeply our modern world depends on the ability of fast adapting to all challenges thrown at us. Hence, we rely on the ideas of bright, curious, unbiased, and innovative minds and on institutions like IST Austria that provide a home for them. I hold a high appreciation for our researchers' outstanding commitment to science and their at times surprising discoveries that evolve from it. Therefore I am glad that IST Austria's financial future and its further growth until 2036 could be secured. Bearing in mind the challenges we are currently facing, I could not think of a better investment.

Martin Polaschek
Federal Minister of Education, Science and Research

Those who listen to science will continue to be successful in the future, paving the way for innovations, creating jobs and improving people's quality of life. IST Austria is the best example of this. With the extension of its funding until 2036, IST Austria faces a dynamic future that will continue to make it a magnet for scientists from all over the world. The annual report impressively underlines that the Institute is a research lighthouse of international radiance. Thanks to President Thomas Henzinger, on behalf of all those working at the Institute, and continued success.

Johanna Mikl-Leitner
Governor of Lower Austria

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