IST AUSTRIA
Institute of Science and Technology

Annual Report 2016

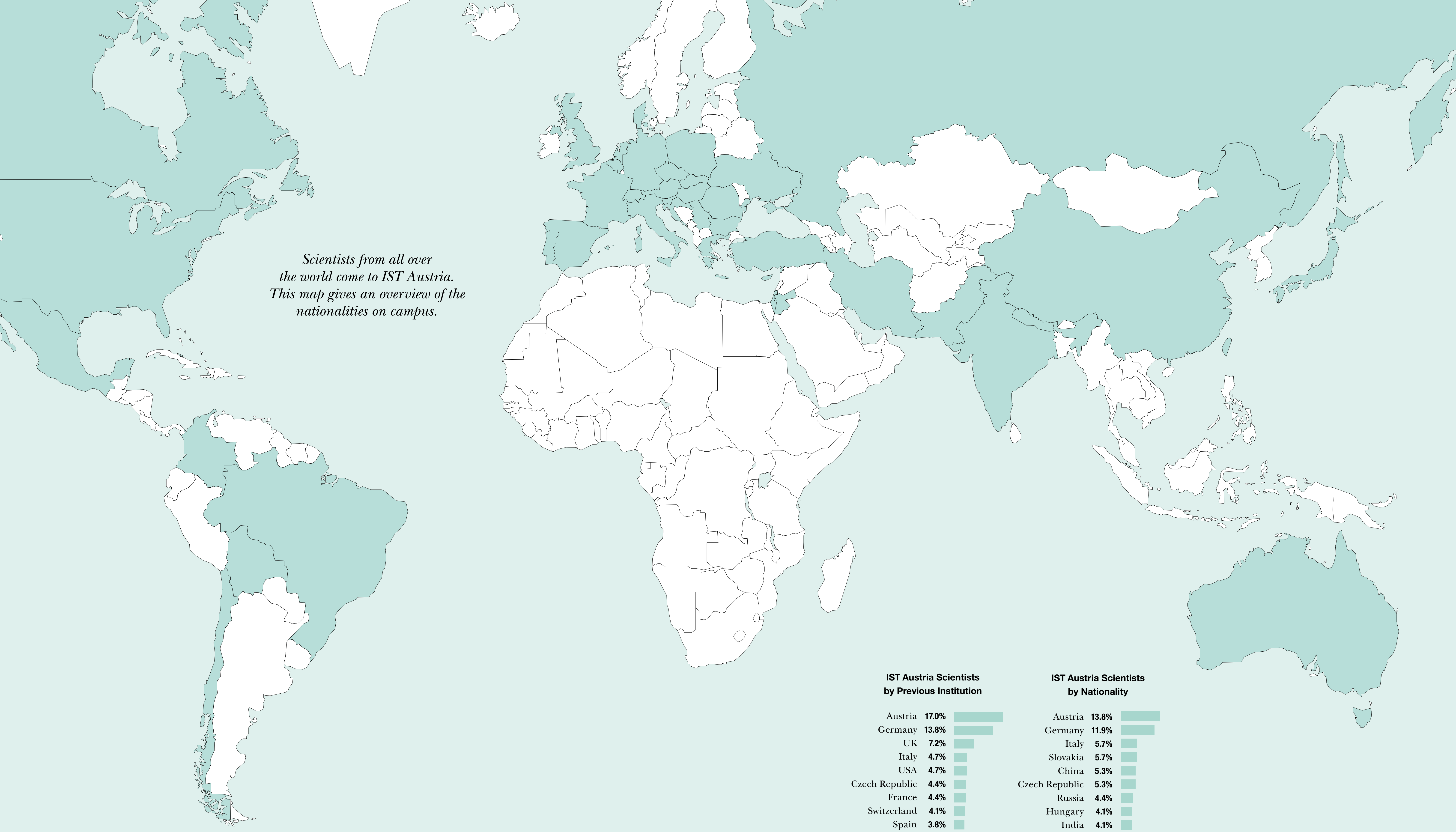
IST Austria Annual Report 2016

Content

An International Community

The Scientists of IST Austria

Scientists from all over the world come to IST Austria. This map gives an overview of the nationalities on campus.



IST Austria Scientists by Previous Institution

Austria	17.0%
Germany	13.8%
UK	7.2%
Italy	4.7%
USA	4.7%
Czech Republic	4.4%
France	4.4%
Switzerland	4.1%
Spain	3.8%
Russia	3.5%
China	3.1%
Hungary	2.5%
India	2.5%
Japan	2.5%
other	21.8%

IST Austria Scientists by Nationality

Austria	13.8%
Germany	11.9%
Italy	5.7%
Slovakia	5.7%
China	5.3%
Czech Republic	5.3%
Russia	4.4%
Hungary	4.1%
India	4.1%
Poland	3.5%
France	3.1%
Spain	3.1%
other	30.0%

Foreword

Thomas A. Henzinger
President, IST Austria

Ten years ago, Haim Harari, Olaf Kübler, and Hubert Markl submitted their report for the establishment of IST Austria to the Federation of Austrian Industries. The goal was to build a graduate institution in Austria that would rank among the top centers for basic research worldwide, and to this day, their vision continues to shape the Institute's development. With 45 professors under contract and almost 600 employees from more than 50 different countries on campus, we are now halfway to the target size of 90-100 research groups by 2026. As stated by the recent evaluation panel chaired by Stanford University's Roger Kornberg, the Institute has come a long way towards its goal in the remarkably short time of ten years, but hard work still lies ahead.

In the past year, IST Austria hired five new professors in the areas of mathematics, neuroscience, physics, chemistry, and computer science. Also in 2016, plant biologist Eva Benková and computer scientists Krzysztof Pietrzak and Chris Wojtan received tenure, and 13 doctoral degrees were awarded. The Institute's postdocs obtained group leader positions in academia and industry, in the United States, Spain, the Czech Republic, and Japan.

Growth in research activity naturally leads to growth in campus facilities. A nanofabrication facility for experimental physics will soon be completed, and planning is well under way for a new laboratory building, which will be equipped for research groups and experimental facilities in chemistry. Work on a technology park for research-driven enterprises will begin in 2017, and with the recently launched TWIST fellowship program, the Institute continues to actively support innovation and technology transfer.

At the founding of IST Austria in 2006, the federal government set aside EUR 95 million as a performance-dependent budget that could only be secured by acquiring the same amount in third-party funds by 2016. Few thought this target would be achieved, but as of the end of this year, the faculty of IST Austria has raised over EUR 83 million in external research funds, mostly from the European Union. This includes 10 new ERC grants awarded to IST Austria in 2016, increasing the total number of ERC-funded projects to 32, spread among 28 professors. Together with new donations of more than EUR 1 million, which bring the total amount of philanthropic giving to IST Austria to almost EUR 19 million, the Institute has surpassed the EUR 100 million mark in third-party funds and will be able to claim all of its conditional budget for the first ten years.

The success of the first decade of IST Austria would not have been possible without the strong support of both public and private partners. We would like to express our sincere gratitude to all donors, supporters, and friends of the Institute, especially the Federal Minister for Science, Research, and Economy, Vice-Chancellor Reinhold Mitterlehner, and the Governor of Lower Austria, Erwin Pröll. But, as the Kornberg panel pointed out, while we are moving in the right direction, our goals are lofty and our work is not yet finished. To continue on our way to the top, we count on the further support of our current partners and on engaging new partners who share our vision of seeing a premier-league institution for basic science in Austria.

Guest Commentary

by Alice Dautry

"IST Austria was created with a vision: to attract talented scientists, no matter what their research discipline is or where they come from, and to foster the conditions for them to work freely and interact with each other. These are wonderful conditions for creative ideas and unexpected discoveries."

Dautry, a French cell biologist and former managing director of the Pasteur Institute in Paris, France, has been a member of the Board of Trustees of IST Austria since 2006.

IST Austria was founded only a few years ago, but in this short time it has become a remarkable and beautiful institute. It was created with a vision: to bring together—in a creative, supportive, and encouraging environment—some of the best scientists in the world, no matter what their research discipline is or where they come from, whether they are young students or postdoctoral fellows or more established scientists. Only quality and talent count. IST Austria has had the rare chance to start a completely new institute, and the rules defined at its beginning have really been fully respected. It has benefited from the know-how of remarkable founders, who have put all their energy into bringing all the best practices of research institutions in the world to IST Austria. The campus is a forest of growing laboratory buildings, well-equipped for the most cutting-edge and multidisciplinary science.

In the years since its inauguration in 2009, word of mouth has spread in the scientific world about this unique research institution, and it has managed to attract remarkable and very successful scientists. For instance, IST Austria now has one of the highest success rates of scientists obtaining a prestigious European Research Council grant. Today, competition for attracting scientific talent is global and fierce. Scientists are internationally very mobile and join the institutions they feel have the environments that are best for their productivity and success. This involves the freedom to perform their research and a stimulating intellectual environment, meaning the presence of complementary scientists from other disciplines with whom they can collaborate and discuss, and where novel and unexpected ideas and discoveries can emerge at the frontiers of different fields of research. It also requires high-quality support staff and equipment, as well as respect between everyone involved in the Institute. Remarkably, in a very short time, IST Austria has managed to develop this reputation internationally, and more and more talented people apply to and join the Institute. When I ask them why, the above are the qualities they recognize in IST Austria, and the above are why those who work on campus are so enthusiastic.

It has been a privilege for me to be a board member, and to share all the steps in the young life of this Institute. Each year, I am amazed at what has been accomplished in the years before. IST Austria today is a young but solid institution and it has a very promising future. One important condition for its continued success is to adhere to the founding principles of this institution: attract the best people, without any kind of compromise, and support them as much as possible while respecting totally their freedom of research. If it continues on the basis of these principles, I am convinced that IST Austria has a bright future and that we will see unexpected and beautiful discoveries in the next decade.

"Since IST Austria was established in 2009, it has provided an international, state-of-the-art environment for science and attracted doctoral students and professors from all over the world to engage in world-class research in Klosterneuburg. More than 40 research groups are working on campus, and the remarkable number of rewards and donations acquired since the establishment of the Institute proves their scientific quality. Their work not only strengthens Austria's position as a key player in basic research, but also helps shape the international scientific dialogue."

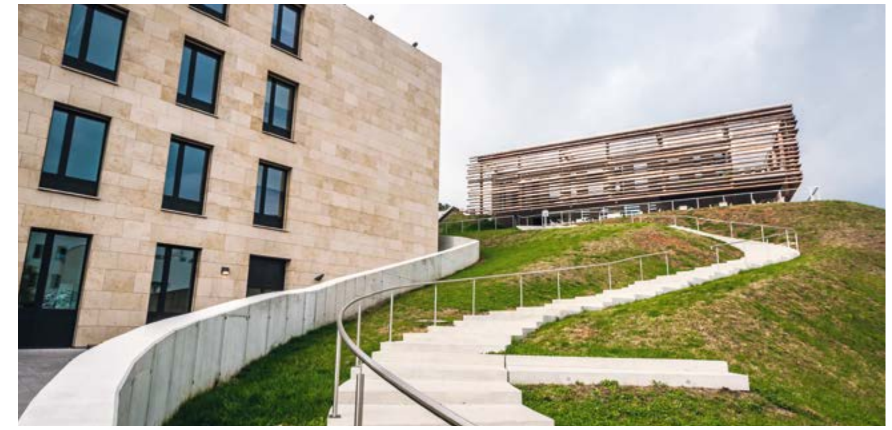
Reinhold Mitterlehner
Vice-Chancellor; Federal Minister of Science, Research, and Economy

"A former grey area on Austria's scientific landscape has blossomed into a flourishing science center! When Lower Austria won the competition to be the site of what was then called the "elite university", held among the provinces of Austria over ten years ago, there was a great deal of debate over the decision. It is no longer questioned today. On the contrary, we can take pride in the fact that IST Austria has established itself as an internationally recognized institution of scientific research, and with institutions like these, Lower Austria is ideally prepared for the future, both economically and socially. For me personally, establishing Lower Austria as a science hub is one of the accomplishments of my tenure as provincial governor that instills in me the greatest sense of pride. IST Austria is without a doubt the flagship of our fleet of scientific endeavors. I thank all those who have contributed to the implementation of this project so far, and look forward to observing its further development."

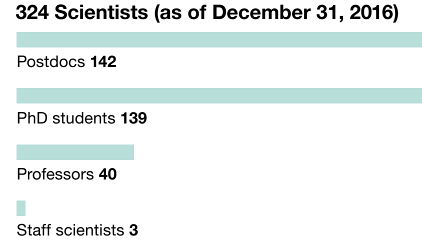
Erwin Pröll
Governor of Lower Austria

IST Austria at a Glance

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



324 Scientists (as of December 31, 2016)



Faculty recruiting in 2016

Applications for faculty positions	1'536
Faculty offers made	10
Faculty offers accepted	5

Student admissions in 2016

Applications for student positions	2'242
Student offers made	46
Student offers accepted	32

Total research grant funding acquired (rounded; as of December 31, 2016)

ERC European Research Council	47'393'000 €
FWF Austrian Science Fund	14'599'000 €
EU other	13'421'000 €
HFSP Human Frontier Science Program	1'916'000 €
DFG German Research Foundation	1'563'000 €
ÖAW Austrian Academy of Sciences	651'000 €
EMBO	501'000 €
WWFT Vienna Science and Technology Fund	404'000 €
NFB NÖ Forschung und Bildung	388'000 €
SNF Swiss National Fund	370'000 €
Simons Foundation	267'000 €
Microsoft Research	151'000 €
Others	1'480'000 €
Total	**83'104'000 €**

More information about IST Austria can be found at www.ist.ac.at, where you can also sign up for the Institute's quarterly newsletter.

IST Austria was established by the federal government of Austria and the government of Lower Austria and inaugurated in 2009. The development plans for IST Austria allow for the growth of up to 90-100 research groups in the period leading up to 2026. The Institute is located near the city of Klosterneuburg on the outskirts of Vienna.

COMMITMENT TO EXCELLENT SCIENCE

The scientists are organized into independent research groups, each headed by a professor or a tenure-track assistant professor. The Institute chooses which fields of science to enter based solely on the availability of outstanding individuals. It will pursue a direction of research only if it can compete with the best in the world. The Institute is evaluated regularly by leading international scientists and science administrators.

Research excellence and promise are the exclusive hiring criteria for all scientists at IST Austria—from doctoral students to professors. The Graduate School at IST Austria educates doctoral students from around the world to become researchers. The decision to promote an assistant professor to professor with a permanent contract is based entirely on an evaluation by international experts of the scientific achievements of the assistant professor.

IST Austria fosters an interdisciplinary scientific atmosphere: the Institute offers a single PhD program with courses for graduate students in all fields of the natural and formal sciences. Hierarchical and separating organizational structures such as departments are avoided.

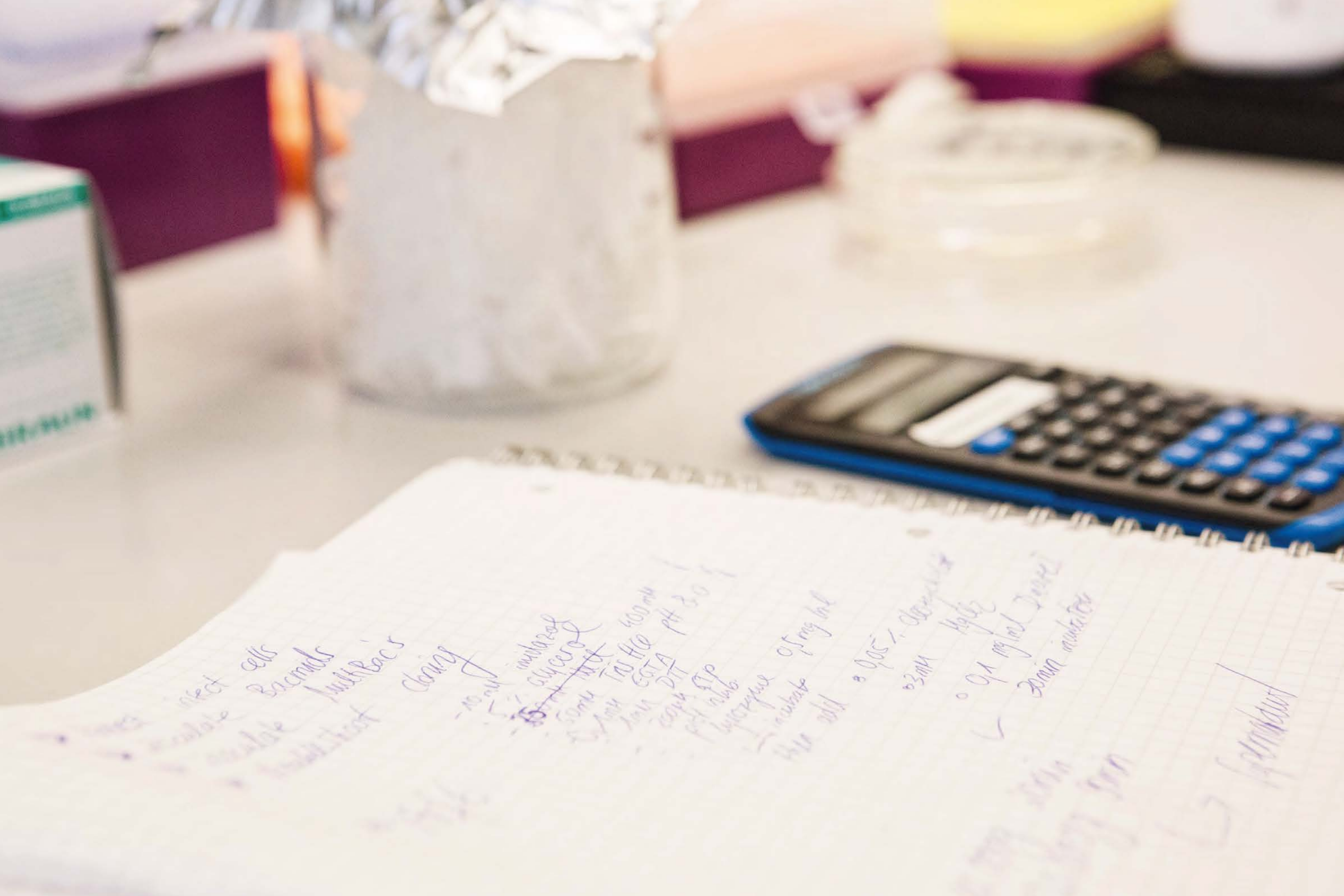
DIVERSE FUNDING

The long-term financial health of IST Austria relies on four different sources of funding: public funding, national and international research grants, technology licensing, and donations. For the period from 2007 to 2026, the federal government of Austria provides up to EUR 1'280 million in operational funds. Two thirds are guaranteed while the remaining third is dependent on performance-related criteria such as third-party sources. So far, income from outside sources has exceeded EUR 100 million, including EUR 83 million in research grants and EUR 18.7 million in donations. The state of Lower Austria covers the costs for construction and campus maintenance in the amount of EUR 510 million from 2007 to 2026.

INDEPENDENT LEADERSHIP

The governance and management structures of IST Austria guarantee the Institute's freedom from political and commercial influences. IST Austria is headed by the President, who is appointed by the Board of Trustees. More than half of the Board of Trustees is made up of international scientists, the remainder comprises members appointed by the federal government and the government of Lower Austria. The President is further advised by the Scientific Board.

The first and recently reappointed President of the Institute is Thomas A. Henzinger, a computer scientist and former professor of the University of California at Berkeley and the EPFL in Lausanne, Switzerland. He is supported by Vice President Michael Sixt, who oversees the operation of the scientific service units. The administration of IST Austria is led by Managing Director Georg Schneider.



insect cells
Bacmids
MultiBac
cloning
glycerol
Tris HCl pH 8.0
EGTA
DTT
lysozyme 0.5 mg/ml
MgCl2
0.1 mg/ml DNase I
30min incubation

Assessing Progress

Every four years, IST Austria is evaluated by an international panel of experts commissioned by the Board of Trustees. The latest evaluation attested to its success, progress, and bright future.

As stipulated by Austrian federal law, a comprehensive evaluation of IST Austria must be carried out every four years. Commissioned by the Board of Trustees, this evaluation shall meet best international practice standards and provide an objective assessment of the Institute's scientific performance and development. Two such evaluations have been carried out so far, one in 2011 and one in 2015. In 2016, the Kornberg Report—named after the panel chair—was submitted to the Austrian Federal Parliament via the Austrian Federal Government. The evaluation report is available for download from the Institute's website, *www.ist.ac.at/evaluations.*

THE 2015 EVALUATION PANEL:

Chair:
ROGER KORNBERG
Stanford University, Nobel Laureate 2006

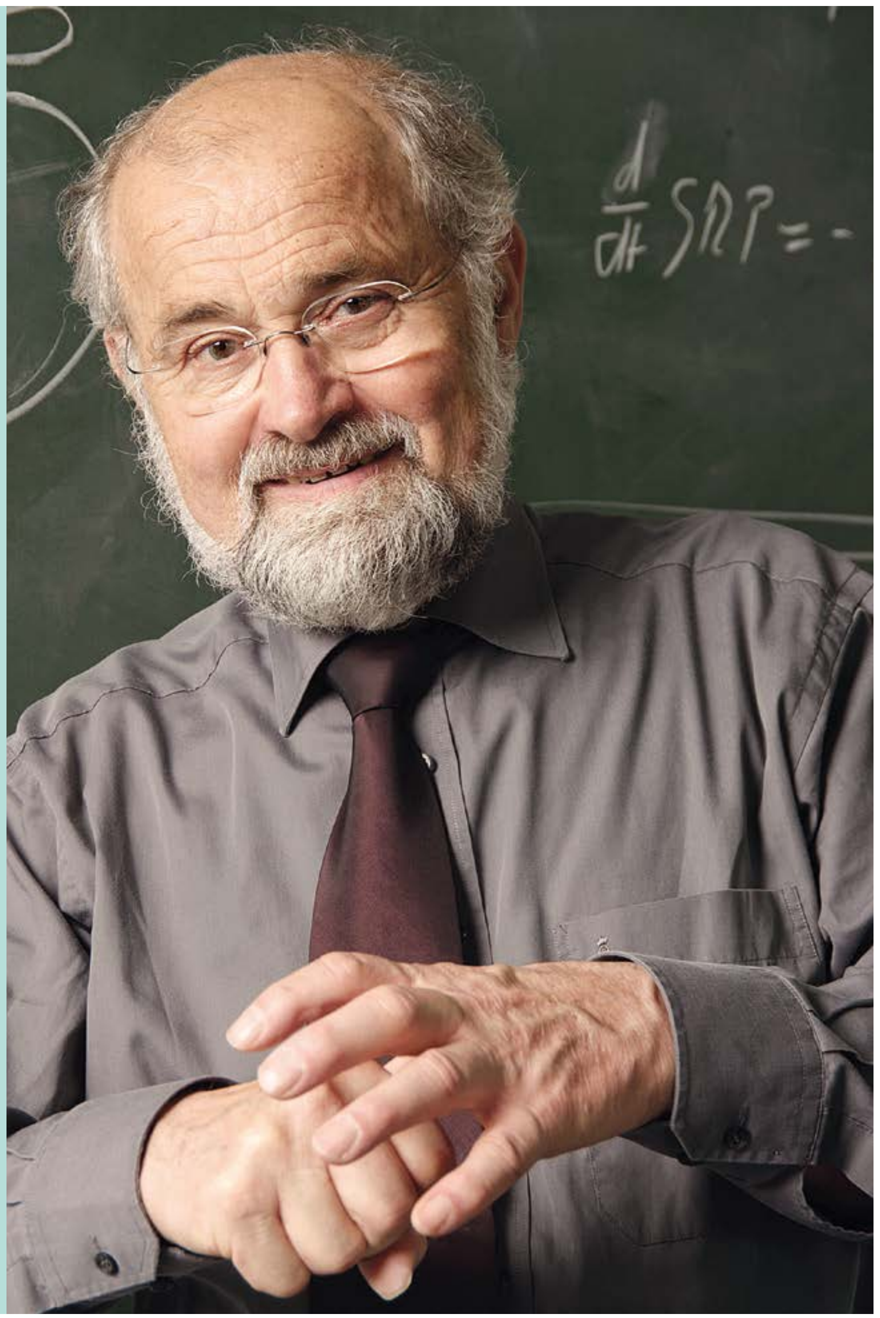
SIR JOHN BALL
University of Oxford

RALPH EICHLER
President Emeritus ETH Zurich

BARBARA LISKOV
Massachusetts Institute of Technology, Turing Award Winner 2008

ERWIN NEHER
Emeritus Director Max Planck Institute for Biophysical Chemistry, Nobel Laureate 1991

RANDY SCHEKMAN
University of California, Berkeley, Nobel Laureate 2013



Interview with Professor Erwin Neher, Emeritus Director of the Max Planck Institute for Biophysical Chemistry and Nobel Laureate

Professor Neher, could you briefly describe the methodology the panel used to evaluate the Institute?

EN: The Institute was evaluated according to the best international practices. We were commissioned by the Board of Trustees to provide an analysis of the Institute that focused on the overall development of research since 2011. How is the overall scientific output? How are faculty recruitment and the development of the Graduate School progressing? Is IST Austria on track to achieve its aspirations?

Our panel included experts in fields relevant to IST Austria as well as colleagues with profound experience in academic leadership. The final assessment was based on extensive documentation and meetings we had during a two-day site visit with management, researchers, PhD students, and personnel from the scientific service units and general administration.

What were the panel's major conclusions?

EN: Our main conclusion is that IST Austria is on the right path to reach the ambitious goal of being something very special, not just another good research institute, but one of the best worldwide. Of course, IST Austria is still very young, and the faculty in many research fields is quite young as well, but in some fields the Institute has neared this goal. For instance, the recruitment of Peter Jonas and Ryuichi Shigemoto really put the Institute on the map in terms of world-class neuroscience. Another important point is the Graduate School, which in 2011 required improvement. Our advice in the previous evaluation to focus on its development was taken seriously, and we had the impression that students are happy and well-trained, and that the curriculum has been set up to endorse the inter- and multi-disciplinary approach IST Austria stands for. The development of the campus is amazing. The speed of construction, the quality of the lab spaces and research facilities provided on campus are big accomplishments—unparalleled, at least to my knowledge. We also felt that the scientific service units, the core facilities, were very well set up and uniquely structured. Finally, we made a few recommendations, for instance to reconfirm support from the Austrian government for the period 2026-2036 before the year 2020. This long-term financial perspective is essential for attracting the best minds on a global scale.

You were the only member to serve on both the 2011 and 2015 evaluation panels. What are your observations concerning the overall development of the institute?

EN: In the early days, one of the principle guiding elements was the blueprint for the Institute provided by Hubert Markl, Haim Harari, and Olaf Kübler. This visionary document reads like a researcher's wish list, and I believe that many aspects of this wish list have been fulfilled. When I compare IST Austria to the Max Planck Institutes, which also strive to provide optimal conditions for scientists, there is one important difference: the Max Planck Society cannot confer academic degrees, IST Austria can. So, IST Austria has both excellent research conditions and a graduate school that has made immense progress.

You were invited as an expert to join the concluding discussion of the evaluation report in the Austrian parliament. What were your observations there?

EN: I had the pleasure to do this twice, and there was definitely a development. Four years ago, some of the questions were very critical, not to say antagonistic. This time, I had the impression that the whole committee, which comprised 28 members of parliament, was very much in favor of the Institute and genuinely interested in how IST Austria is doing. Members of all parties represented in parliament were happy to hear that the Institute is definitely on the right track.

What are your personal recommendations for the Institute?

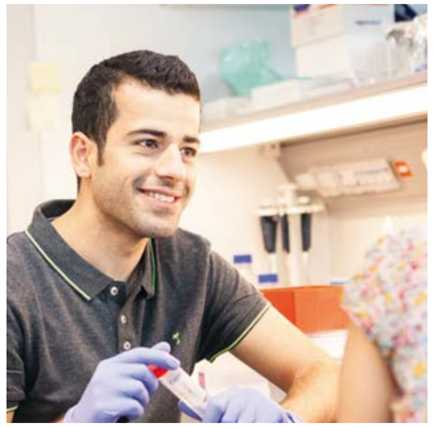
EN: I must say, I have a very strong opinion on that: given that the internal procedures of the Institute are running smoothly, all efforts should be put into recruiting the very best minds you can attract—this is the most crucial success factor I can think of. Any grand plans or top-down schemes regarding future collaborations will likely fail unless you really succeed in hiring the best people in a given field. When you achieve this, you more or less solve all the other problems, and all kinds of collaborations and high-quality research programs will develop by themselves.

Going back in time a bit, would you have considered joining IST Austria to do your research?

EN: A young, aspiring researcher mainly looks for two things: excellent research conditions for his or her specific scientific questions, and inspiring colleagues he or she wants to cooperate and compete with, colleagues who put you on a steep learning curve. In my field, neuroscience, IST Austria today would be able to provide all of that, at all career stages: graduate student, postdoc, or young principle investigator seeking a tenure-track position. Yes, IST Austria would have been on my wish list.

Doctoral Education at IST Austria

The Essentials for Future Success



One of IST Austria's core missions is to train the next generation of scientists. IST Austria's signature PhD program offers specializations in six different research areas while fostering the interdisciplinary spirit that is a cornerstone of the IST Austria experience.

Doctoral education is a fundamental part of IST Austria's mission as a research institute, and the PhD program at the Institute emphasizes both depth and breadth of education. Scientists who receive their degrees from IST Austria have a specialist's knowledge of their field, but are also able to think across disciplines and collaborate with scientists in other areas. Moreover, by encouraging the free exchange of knowledge between researchers in different fields, IST Austria aims to pave the way for new frontiers in doctoral education.

THE DOCTORAL TRAINING PROGRAM

IST Austria currently offers one PhD program, the ISTScholar program, with six research tracks that span the research areas represented at the Institute. Offering one program for all graduate students promotes a shared graduate experience and a sense of community across all research disciplines. Students with either a bachelor's or a master's degree may apply to the ISTScholar PhD program, and applicants come from all over the world. Successful candidates are selected through a centralized admissions process, and start the PhD program together as a class in September. During their first semester, all students take the signature ISTScholar core course that promotes the sharing of ideas and information between fields and fosters interdisciplinary research. The ISTScholar core course trains students to think critically and communicate effectively with scientists in other fields, and also encourages creativity and peer-to-peer interaction.

Students have a choice between one of six tracks of study: biology, computer science, mathematics, neuroscience, physics, or data science and scientific computing. To foster community within a track, students attend a track core course, and additionally have opportunities to take specialized elective courses. In keeping with the aim of a broad scientific education, and to give them the chance to experience several working environments, students also temporarily join different research groups for at least three rotation projects. After approximately nine months, students affiliate permanently with a research group and take a qualifying exam. In the subsequent three to four years, students pursue research projects towards a PhD thesis.

FUNDING THE ISTSCHOLAR PHD PROGRAM

The ISTScholar PhD program is co-funded by the European Union's Horizon 2020 research and innovation program through a Marie Skłodowska-Curie COFUND grant. The European Union co-funded the ISTScholar PhD program for incoming students during 2016, and will continue their support in the academic years 2017 and 2018. The EUR 4.4 million grant supplements the costs of each student's first two years in the PhD program.

The European Union, through its "Principles of Innovative Doctoral Training", encourages institutions to acknowledge the important contributions of doctoral research toward creating new knowledge. They also emphasize an exposure to industrial research and the importance of career development measures. IST Austria is dedicated to following these principles. During their PhD studies, students forge valuable connections with other researchers around the world, and all students are advised by at least one external academic committee member. Several students have also chosen to do internships in relevant industry sectors as part of their studies. The ISTScholar PhD program moreover offers a career development program that focuses on developing the broad set of skills necessary for successful careers inside and outside of academia.

IST AUSTRIA ALUMNI

IST Austria first began training PhD students in 2010, when seven students entered the program. This has increased to 32 students starting their graduate education at IST Austria at the beginning of the academic year 2016/2017. In 2016, 13 graduate students defended and filed their theses, making a total of 27 IST Austria graduates since the PhD program's inception. In order to remain in contact with and follow the progress of the growing number of alumni, the Office of Alumni Relations at the Institute has started the IST Alumni "Stay in Touch Initiative".

2016 PHD GRADUATES

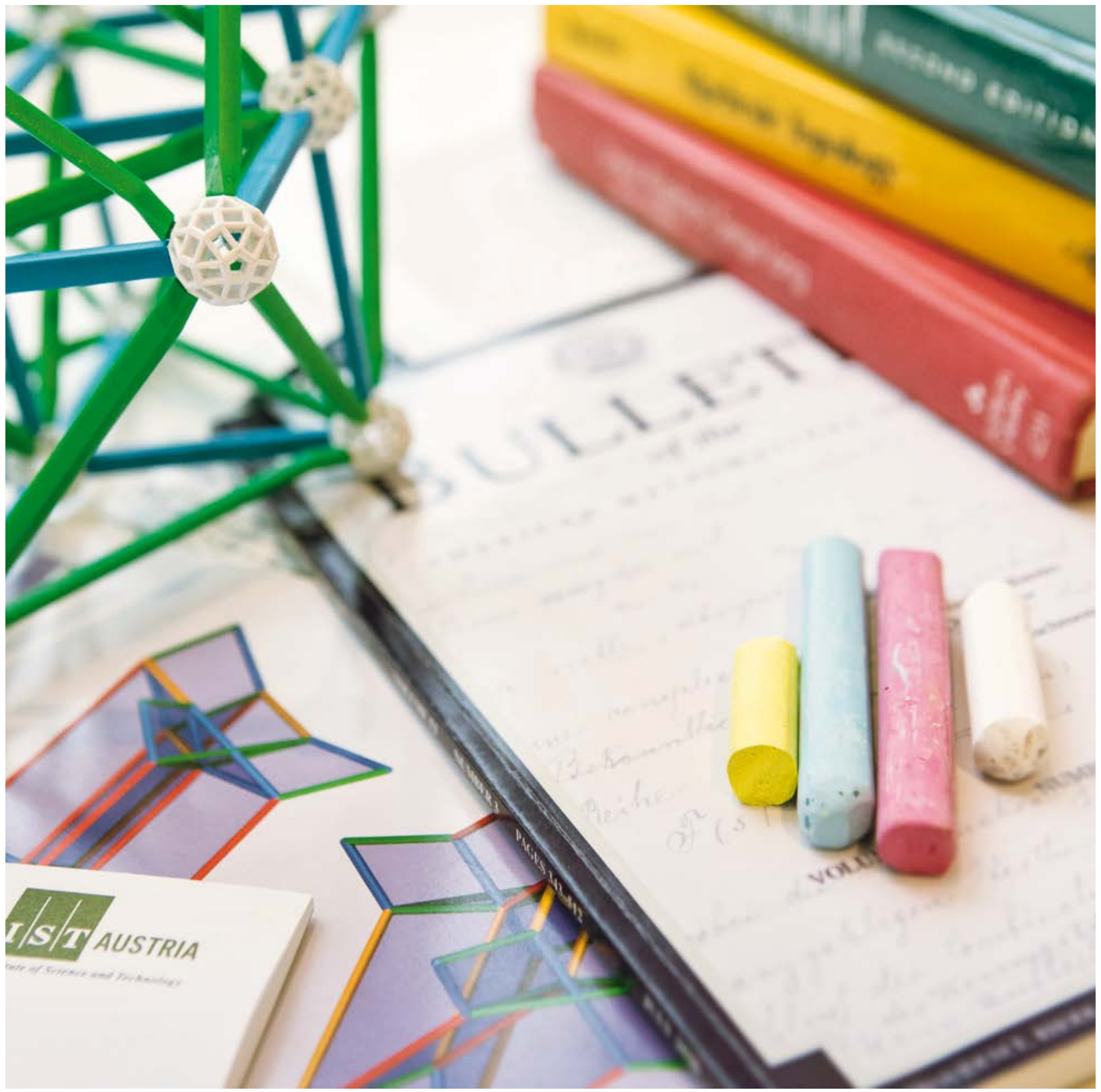
Hande Acar, Bollback group
Morten Bojsen-Hansen, Wojtan group
Martin Chmelik, Chatterjee group
Tom Ellis, Barton group
Isaac Mabillard, Wagner group
Rajiv Mishra, Jonas group
Maurizio Morri, Janovjak group
Sebastian Novak, Barton group
Anastasia Pentina, Lampert group
Georg Rieckh, Tkačik group
Jan Schwarz, Sixt group
Thorsten Tarrach, Henzinger group
Murat Tuğrul, Barton group

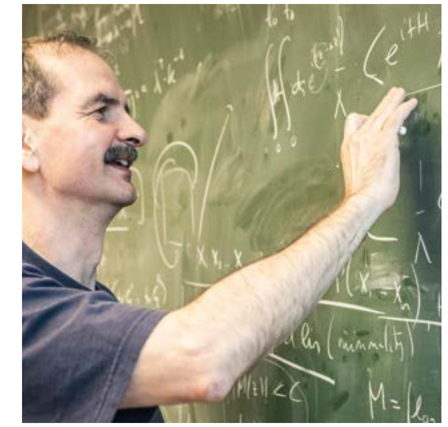
The ISTScholar PhD program has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 665385.

Research Highlight Mathematics

Open Minds

Exploration and Proof through Curiosity, Abstraction, and Precision





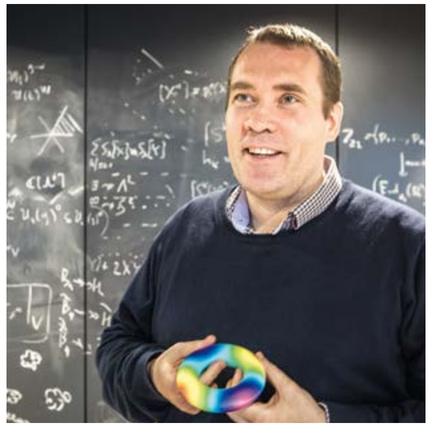
From one perspective, mathematics is the language to formalize quantitative aspects of natural sciences. It is also a tool for scientists to test certain hypotheses and discover new ones, a lens through which to view and understand a variety of phenomena. Even more than this, mathematics is the ability to distill ideas and observations, to abstract to their fundamentals, and precisely define concepts and objects and the connections between them. It has clear and unambiguous rules, and based on these rules, the correctness of a statement or theory can be decided. And in all of this, mathematics is an active field, constantly growing and developing, as new discoveries are made and new ideas are explored—for their utility, and simply for the sake of understanding.

Mathematicians at IST have interests in a variety of areas, from statistics to topology to combinatorics to mathematical physics and beyond. They explore a wide range of questions, such as: How can a particular continuous quantity be defined for discrete objects? How can we identify and study meaningful structures in different spaces? What parts of observed physical phenomena can be rigorously understood starting from a well-defined mathematical model? What is a meaningful higher-dimensional extension of a certain idea, and what related results can then be generalized? They pursue ideas rooted in purely mathematical notions, and also take inspiration from fields such as physics, biology, computer science, or chemistry. Mathematicians at IST are a diverse group—but one that is united in the creativity and curiosity of its members.

> "Whenever I ask a mathematical question, it is because I want to compute certain things. And whenever I want to compute certain things, I ask mathematical questions—it goes both ways."
>
> HERBERT EDELSBRUNNER

In order to understand and measure shapes at a particular level, it is necessary to have a precise definition of what that means. **HERBERT EDELSBRUNNER** has such a definition: it is one of many tools he uses to identify and study structure arising in different areas and on different scales. Imagine a set of points, and increase the radius of all points simultaneously. At some large enough radius, everything merges together, but prior to that, the different balls will start to intersect and form larger shapes and features in various dimensions. The group is especially interested in the cycle structure of these intermittent shapes: they study their homology as a function of the radius of the balls, that is, at different scales. One particularly important tool is persistent homology, which was introduced by Edelsbrunner and his collaborators in 2000. Essentially, it allows for the study of the "lifetime" of a cycle: at what radius is it born, and at what radius is it filled in? The lifetime (or persistence) of a cycle depends on the scale at which it is relevant, and this depends on the object or dataset being studied. Thus, persistent homology enables researchers to filter for features significant on the scale important in their research, and to disregard as noise characteristics appearing on smaller or larger scales. These methods of analyzing structure are used in numerous fields, and can be applied to both natural and abstract data. The cosmic web is one example of the former, and recently of interest to the group. Now, they are collaborating to search for homological features in the cosmic microwave background that could provide insight into the initial distribution of particles in the universe. Abstract data can, for instance, refer to medical records. Analysis of the (persistent) homology of these spaces could be used to understand the evolution or development of the system (e.g. of the patient's health).

Complex, chaotic systems have a tendency to develop interesting patterns in certain fundamental properties, and **LÁSZLÓ ERDŐS** uses random matrices to understand and prove conjectures about the universality of these patterns. This family of questions first arose in 1955, when Eugene Wigner observed from experimental data that the distribution of the energy gaps of atomic nuclei is always the same, no matter which nuclei he considered: this phenomenon is universal. Moreover, he conjectured that the same distribution arises from the eigenvalue gaps of large random matrices of mean field type, in particular, the latter is also universal. Erdős and his collaborators proved this conjecture of universality for mean field models—essentially, matrices for which each entry is chosen at random according to some probability distribution. While this result does not say anything about the nuclei themselves, it indicates that Wigner's universality phenomenon is ubiquitous. For the Erdős group, however, this accomplishment is only the beginning: Wigner's vision encompassed a great deal more. There exist a variety of other, more complicated classes of random matrices



for which universality has been observed, but not proved mathematically. One interesting class is the random Schrödinger operators. These operators can be used to describe, for instance, impurities in metal. Metals have a regular ionic lattice that allows electrons to flow easily from one part to another, i.e., they are good conductors. It has been shown experimentally that a metallic lattice will still conduct, though less well, if it is slightly irregular. When the lattice becomes sufficiently disordered, the metal becomes an insulator. Spectral statistics play an important role in distinguishing the two phases, and the random Schrödinger operator is considered an excellent model describing this phenomenon, but the gap statistics for them have not yet been established rigorously. Erdős and his team are working to develop the necessary mathematical techniques to demonstrate phenomena in these and additional models.

> "It is continually surprising to uncover connections between distant fields, and to see results describe predictions made in theoretical physics."
>
> TAMÁS HAUSEL

Given a collection of objects, it is sometimes possible to assign coordinates to each individual object in a meaningful way; the geometric space made up of these points is called a moduli space. **TAMÁS HAUSEL** studies particular classes of moduli spaces arising in supersymmetric quantum field theories, especially those of Yang-Mills instatons, magnetic monopoles, and Higgs bundles. As these are spatial objects, it is natural to ask questions about their geometric, topological, and arithmetic properties. One particular aspect Hausel and his group are working to understand is the structure of holes of these spaces in different dimensions. Not only does the team make use of existing techniques, such as Morse theory and global analysis, they are developing new representation theoretic and combinatorial methods in order to approach these questions. The results of the Hausel group's work find application in a variety of fields, not just in the quantum field and string theories that provided some of the initial motivation. For instance, their results have interpretations in number theory, in particular in relation to the geometric Langlands program. Moreover, there are connections to open conjectures concerning the combinatorics of hyperplane arrangements, and often the group's results are given in the language of algebraic and geometric combinatorics. Moreover, it is often the case that their results describe mathematically certain predictions made by theoretical physicists. Sometimes the reverse happens, and new predictions in theoretical physics are based on their results—results that were obtained by purely mathematical techniques. These deep, underlying relationships between seemingly distant fields are a source of particular inspiration to Hausel and his team. In the future, they hope to explicitly connect the various aspects of their research using the language of topological quantum field theory, and to understand how and where their work can be applied to knot theory.

The optimal transport problem—how can objects be moved as cheaply as possible?—is very old and very natural with many practical applications. Remarkably, this problem has played a crucial role in surprising mathematical developments connecting mathematical analysis, geometry, and probability theory. For instance, optimal transport can be used to give an elegant description of diffusion processes as trajectories of steepest ascent in an energy landscape determined by optimal transport and entropy. **JAN MAAS** and his collaborators showed that this description is valid for a much larger class of processes, including discrete systems, chemical reaction networks, and dissipative quantum systems. For a given Markov chain—which can be thought of as a random walk on a network—there is an initial probability density (i.e. the probability of being on a particular vertex at time zero), and this density evolves in time. The key to understanding the Markov chain is to describe this evolution, and it turns out that this can be done by interpreting it as motion in the space of probability densities: the path evolves in such a way that the entropy increases as quickly as possible. For a long time, it was unclear what the correct geometry is in which to measure this increase. Maas and his collaborators solved this problem using a new optimal transport problem: in a sense, the Markov chain aims to increase entropy as fast as possible while simultaneously minimizing the cost of transport. Building on these ideas, the Maas group gained new insights into the geometry of discrete networks using the notion of Ricci curvature, which captures crucial geometric information about the space involved, and can also be characterized in terms of optimal transport and entropy. The group now wants to extend these ideas to include dimension: the combination of Ricci curvature and dimension allows for still greater understanding of the complex network at hand.

ROBERT SEIRINGER develops mathematical tools and methods to rigorously explore quantum many-body systems. Nature behaves very differently on the microscopic level, and the theory of quantum mechanics is necessary to describe the basic interactions among particles. As a result of technological advances that enable scientist to cool gases to near absolute zero temperature, there has recently been substantial interest in ultra-cold gases, which are systems where quantum effects are amplified and can be explored experimentally. When trying to understand the fundamentals of such a complex system, however, approximations must be made both in the equations describing it and in finding solutions. The Seiringer group works to determine when such approximations are valid, and seeks to quantitatively evaluate their limitations. Mathematics is the perspective from which Seiringer and his team approach these questions; their work leads to new predictions and insights, which can in turn impact theoretical and experimental physics. In one recent project, Seiringer and members of his team considered the stability of a system of N fermions—a type of subatomic particle—interacting with an additional particle via point-like, i.e. zero-range, interactions. If N=1, this is an instance of the two-body problem, which was solved a long time ago. For N≥2, the stability of this system posed a challenging open problem that the Seiringer group successfully resolved, classifying the region of stability in terms of the mass of the extra particle. Among other pursuits, the group is now looking towards increasing the number of additional particles arbitrarily. This would lead to a solution of a prominent open question concerning the stability of fermionic gases of spin 1/2 particles, of significant interest because of the realizability of such models with cold atomic gases.

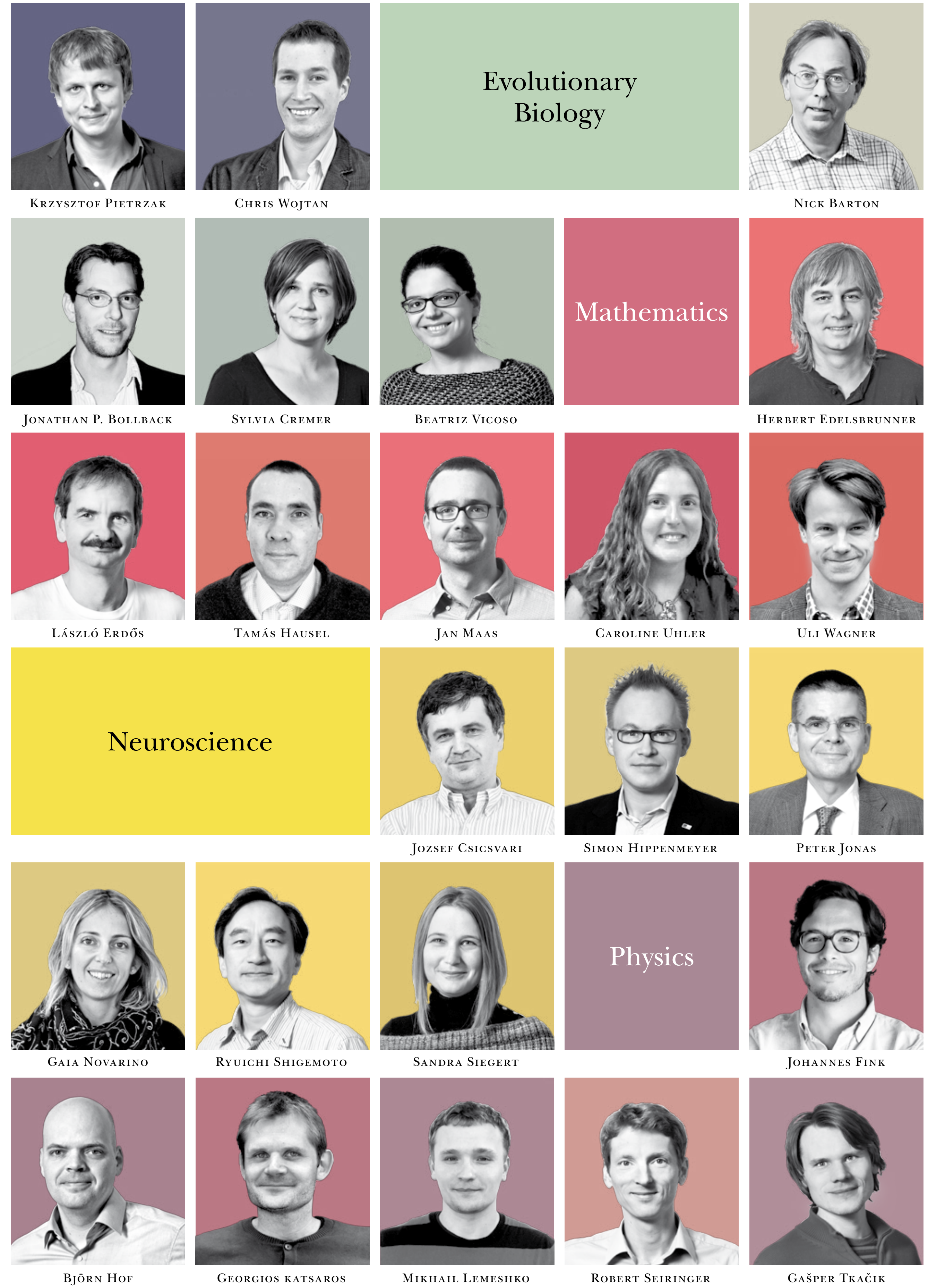
> "How can the same equations on a microscopic level lead to such drastically different effects on the macroscopic level?"
>
> ROBERT SEIRINGER

CAROLINE UHLER is a mathematical statistician who uses algebraic geometry and convex optimization to develop new methods in data analysis and computational biology. Of primary interest are graphical models—directed or undirected graphs that encode conditional independence relationships. Causal inference, i.e. determining these relationships in the case of directed acyclic graphs, is of central importance for scientists in many fields, but the language and methodology pertaining to it are not yet widely used; Uhler wants to change this. One active area of Uhler's research is in developing methods to infer gene regulatory networks—molecular regulators that determine gene expression—using causal graphs. Previously, this was done using an algorithm that relied on a particular assumption. Uhler and her collaborators showed that, in fact, this condition is not satisfied in a large number of cases, and moreover developed an alternative algorithm for a strictly larger class of problems. She now looks to develop further methods that are both reliable and scalable, in particular for applications in genomics. Once the relationships of a particular gene regulatory network have been determined, it remains to understand why they are structured as they are. One possibility is that differences result from variations in chromosome packings in cell nuclei. Uhler studies these packings in order to predict how gene regulatory networks change as cells differentiate in collaboration with cell biologists, which ensures that the models are informed by experimental observations. On the more theoretical side, independence relations of a graphical model give rise to a polytope (an n-dimensional analogue of a polygon). The polytopes for undirected graphical models are well-studied, and in a recent project, Uhler and her collaborators studied the combinatorics and geometry of the polytopes in the directed case. They were able to give an explicit construction for these objects, which led to a new algorithm for causal inference.

Topology is the study of properties of geometric shapes preserved under continuous deformation—stretching and twisting, but no tearing. Combinatorics is the study of discrete structures. **ULI WAGNER** takes techniques and ideas from both fields and uses them to provide insights and prove theorems about the other, an approach that has been very successful. For instance, the group's work extending a classical topological technique was essential in finding counterexamples to a decades-old question known as the topological Tverberg conjecture. The interplay of combinatorics and topology continues to be fruitful, and a variety of questions occupy the group's research program. One area of interest arises from the notion of embeddability in higher dimensions: when can a geometric shape (of two, three, or more dimensions) be placed in a larger-dimensional space without self-intersections? What conditions guarantee or prevent such an embedding? For instance, any two-dimensional simplicial complex (a geometric object made up of triangles, edges, and vertices fitted together in a "nice" way) can be embedded in five-dimensional space, but not necessarily into four dimensions. A natural question is thus: if a simplicial complex is embeddable in four dimensions, what conditions must be satisfied? One fascinating conjecture in this direction, open since the 1970s, gives a bound on the number of triangles in terms of the number of edges as one such necessary condition. More generally, the group is interested in how topological conditions (in this case, embeddability) restrict combinatorial properties (here, the number of triangles). The group also considers these and other questions from a computational perspective. In one recent paper, Wagner and his collaborators proved the decidability of (and gave an explicit algorithm for) the following problem: given a finite two-dimensional simplicial complex, can it be embedded in three dimensions? In doing so, they closed a significant gap in what was previously known about the embeddability problem.

Research at IST Austria

Currently, research at IST Austria focuses on basic research in the life, formal, and physical sciences. Interdisciplinary networks facilitate scientific collaborations between theoretical and experimental researchers.



Nick Barton

Mathematical Models of Evolution

Current Projects

Evolution of sex and recombination | Evolutionary computation | Evolution of polygenic traits | Understanding genealogies in space and at multiple loci | Limits to a species' range | Speciation and hybridization in *Antirrhinum*

Selected Publications

Paixao, T, Barton, NH. 2016. The effect of gene interactions on the long-term response to selection. PNAS (USA). 113, 4422-4427.

Polechova J, Barton NH. 2015. Limits to adaptation along environmental gradients. PNAS (USA). 112, 6401-6406.

Barton NH, Briggs DEG, Eisen JA, Goldstein DB, Patel NH. 2007. Evolution. Cold Spring Harbor Laboratory Press.

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. In collaboration with computer scientists, they apply population genetics to understand and improve evolutionary algorithms. Working with other groups at IST Austria, they study the evolution of gene regulation, using a thermodynamic model of transcription factor binding. They apply models for the spatial spread of introduced genes to optimize biocontrol programs that aim to suppress transmission of dengue fever. Finally, 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.

Career

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

Selected Distinctions

	ISI Highly Cited Researcher
2016	Schrödinger Lecture, Dublin
2013	Erwin Schrödinger Prize, Austrian Academy of Sciences
2013	Mendel Medal, German National Academy of Sciences Leopoldina
2009	Linnean Society Darwin-Wallace Medal
2009	ERC Advanced Grant
2006	Royal Society Darwin Medal
2001	President, Society for the Study of Evolution
1998	American Society of Naturalists President's Award
1994	Fellow, Royal Society of London
1994	David Starr Jordan Prize

Studies of hybridization between red- and yellow-flowered *Antirrhinum* in the Pyrenees tell us about the process of speciation.

Team

Stefanie Belohlavy (PhD student), Nurdan Erdem (academic visitor), Xavier Sebastien Stephane Erny (scientific intern), David Field (postdoc), Tamar Friedlander (postdoc), Maria Clara Melo Hurtado (postdoc), Sebastian Novak (PhD student), Tiago Paixao (postdoc), Pavel Payne (PhD student), Melinda Pickup (postdoc), Tadeas Priklopil (postdoc), Harald Ringbauer (PhD student), Himani Sachdeva (postdoc), Srdjan Sarikas (postdoc), Eniko Szep (PhD student), Barbora Trubenova (postdoc), Murat Tuğrul (PhD student)

Eva Benková

Plant Developmental Biology

Current Projects

Convergence of hormonal pathways on transport-dependent auxin distribution | Identification of hormonal cross-talk components by genetic approaches | Hormonal crosstalk driven nutrient-dependent root development

Selected Publications

Žádníková P, Wabnik K, Abuzeineh A, Gallemi M, Van Der Straeten D, Smith RS, Inzé D, Friml J, Prusinkiewicz P, Benková E. 2016. Model of Differential Growth-Guided Apical Hook Formation in Plants. Plant Cell. 28(10), 2464-2477.

Marhavý P, Montesinos JC, Abuzeineh A, Van Damme D, Vermeer JE, Duclercq J, Rakusová H, Nováková P, Friml J, Geldner N, Benková E. 2016. Targeted cell elimination reveals an auxin-guided biphasic mode of lateral root initiation. Genes and Development. 30(4), 471-83.

Šimášková M, O'Brien JA, Khan M, Van Noorden G, Ötvös K, Vieten A, De Clercq I, Van Haperen JM, Cuesta C, Hoyerová K, Vanneste S, Marhavý P, Wabnik K, Van Breusegem F, Nowack M, Murphy A, Friml J, Weijers D, Beeckman T, Benková E. 2015. Cytokinin response factors regulate PIN-FORMED auxin transporters. Nature Communications. 6, 8717.

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

Post-embryonic formation of new organs, a major determinant of the plant body architecture, is responsive to a myriad of environmental inputs such as light, temperature, and nutrition. Plant hormones represent the key endogenous mediators that allow plants to rapidly adjust their development to these external cues. Physiological and genetic studies have investigated the signaling components of the individual hormonal pathways. However, over the last years it became evident that hormones are interconnected by a complex network of interactions. How these hormonal networks are established, maintained, and modulated to control specific developmental outputs is the focus of the Benková group. Recently, the group has located several convergence points that integrate different hormonal inputs. Importantly, some of these identified components exceed their function in the hormonal cross-talk and they provide functional links with pathways mediating perception of environmental stimuli, such as abiotic stress, or nitrate availability. The group aims to integrate these unilateral pathways into complex molecular networks that connect plant development with varying external inputs.

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

Selected Distinctions

2014	FWF–ANR Bilateral Grant
2011	FWO Grants
2008	ERC Starting Grant
2003 – 2007	Margarete von Wrangell Habilitation Program

Plants in the plant growth chamber.

Team

Melinda Frances Anna Abas (senior laboratory technician), Rashed Abualia (PhD student), Nicola Cavallari (postdoc), Marcal Gallemi Rovira (postdoc), Karla Huljev (PhD student), Andrej Hurny (PhD student), Mamoona Khan-Djamei (postdoc), Juan Carlos Montesinos López (postdoc), Krisztina Ötvös (postdoc), Zlata Pavlovicova (scientific intern), Hana Semeradova (PhD student)

Bernd Bickel

Computer Graphics and Digital Fabrication

Current Projects

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

Selected Publications

Malomo L, Pietroni N, Bickel B, Cignoni P. 2016. Flexmolds: Automatic design of flexible shells for molding. 35. ACM Transactions on Graphics (Proceedings of SIGGRAPH Asia). Article 223.

Du T, Schluz A, Zhu B, Bickel B, Matusik W. 2016. Computational multicopter design. 35. ACM Transactions on Graphics (Proceedings of SIGGRAPH Asia). Article 227.

Miguel E, Lepoutre M, Bickel B. 2016. Computational design of stable planar-rod structures. 35. ACM Transactions on Graphics (Proceedings of SIGGRAPH). Article 86.

We are currently witnessing the emergence of novel, computer-controlled output devices that provide revolutionary possibilities for fabricating complex, functional, multi-material objects and meta-materials with stunning optical and mechanical properties. Leveraging the potential of advanced 3D printing technology is tightly coupled to efficient methods for content creation.

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

Career

since 2015 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

Selected Distinctions

2016 ERC Starting Grant
2015 Microsoft Visual Computing Award
2012 EUROGRAPHICS Best PhD Thesis
2011 ETH Medal for outstanding dissertation

Assemblage of microstructures that approximates the desired elastic behavior and requires only a single material for fabrication.

Team Thomas Auzinger (postdoc), Viktor Daropoulos (academic visitor), Ruslan Guseinov (PhD student), Emmanuel Iarussi (postdoc), Quentin Gaetan Raphael Lisack (scientific intern), Eder Miguel (postdoc), Kazutaka Nakashima (scientific intern), Jakob Zillner (scientific intern)

Jonathan P. Bollback

Microbial Experimental Evolution and Statistical Genomics

Current Projects

Selective barriers to horizontal gene transfer | Evolution of an adaptive heritable immune system in bacteria

Selected Publications

Lagator M, Igler C, Moreno A, Guet CC, Bollback JP. 2015. Epistatic interactions in the Arabinose cis regulatory element. Molecular Biology and Evolution. 33(3), 761–769.

Kupczok A, Bollback JP. 2013. Probabilistic models for CRISPR spacer content evolution. BMC Evolutionary Biology. 13(1), 54.

Bollback JP, Huelsenbeck JP. 2009. Parallel genetic evolution within and among bacteriophage species of varying degrees of divergence. Genetics. 181(1), 225-234.

Microbes can be found everywhere—in the soil, air, water, our food, and even inside of us. The Bollback group uses these ubiquitous organisms to study the process of evolution and to better understand what evolutionary forces have shaped the microbes themselves.

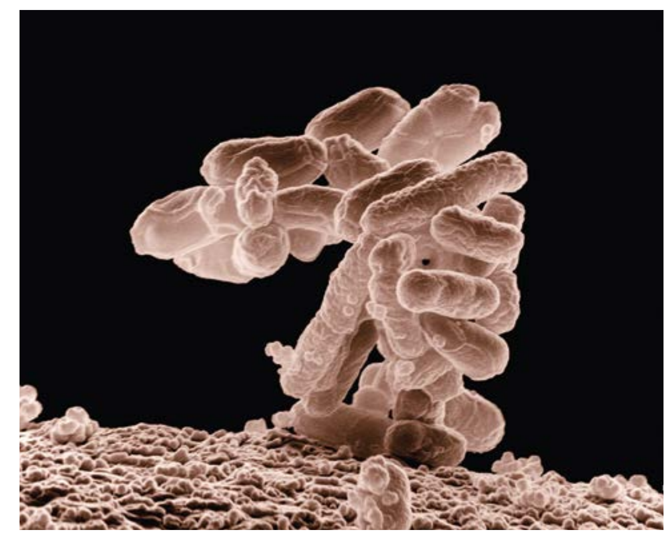
Microbes—viruses, bacteria, archaea, and protists—account for half of the world's biomass, the majority of the biological diversity on Earth, and are the culprits of many human diseases. Microbes are also an extraordinarily powerful model system for understanding how evolution works. By studying microbes, the Bollback group addresses a variety of fundamental evolutionary questions. First, how does adaptation differ between sexual and asexual populations? Microbes are mostly asexual, and asexuality slows down the rate of adaptation. Second, how do microbes defend themselves against parasites? Microbes, like other organisms, have their own parasites, and are thus a good model system for understanding the evolutionary dynamics of host-parasite interactions. Lastly, microbes can readily donate and receive genes from other individuals and species via a process called horizontal gene transfer. Yet it is unclear what evolutionary forces are acting to promote and restrict this process.

Career

since 2010 Assistant Professor, IST Austria
2008 – 2010 Postdoc, Interdisciplinary Centre for Human and Avian Influenza Research, University of Edinburgh, UK
2004 – 2008 Postdoc, University of Copenhagen, Denmark
2004 PhD, University of Rochester, USA

Selected Distinctions

2007 Forskningsradet for Natur og Univers (FNU) Grant
2007 Featured in Aktuel Naturvidenskab nr 3 (Current Science)
2006 Forskningsradet for Sundhed og Sygdom, FSS Grant
1995 – 1998 Predoctoral Fellow, Smithsonian Institution, USA



A cluster of *Escherichia coli*.

Team Hande Acar (PhD student), Claudia Igler (PhD student), Fabienne Jesse (PhD student), Mato Lagator (postdoc), Pavel Payne (PhD student), Katharina Maria Pöcher (scientific intern), Isabella Tomanek (PhD student), Xiaoyun Tu (postdoc)

Tobias Bollenbach

Biophysics and Systems Biology

Current Projects

Cellular responses to conflicting signals | Mechanisms of drug interactions | Physical descriptions of animal development

Selected Publications

Bollenbach T, Kishony R. 2011. Resolution of gene regulatory conflicts caused by combinations of antibiotics. Molecular Cell. 42(4), 413-425.

Bollenbach T, Quan S, Chait R, Kishony R. 2009. Nonoptimal microbial response to antibiotics underlies suppressive drug interactions. Cell. 139(4), 707-718.

Kicheva A, Pantazis P, Bollenbach T, Kalaidzidis Y, Bittig T, Jülicher F, González-Gaitán M. 2007. Kinetics of morphogen gradient formation. Science. 315(5811), 521-525.

Cells perceive a broad spectrum of signals. But how are these signals processed in the cell? And how are conflicts between different signals resolved? The group of Tobias Bollenbach uses a quantitative approach to understand cellular information processing.

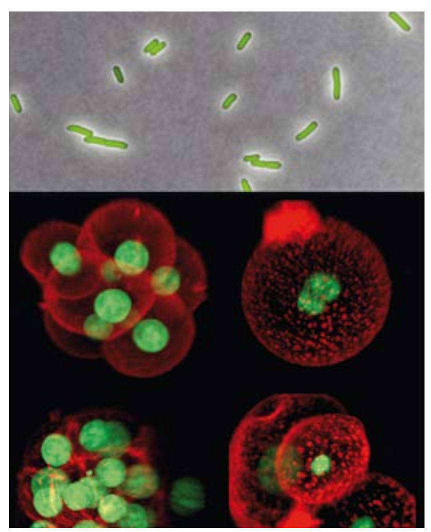
Cells need to respond to a variety of signals in their environment, such as nutrients, drugs, and signaling molecules. The Bollenbach group studies how cellular responses are computed and integrated, particularly in environments that contain multiple, potentially conflicting, signals. The experimental system the group currently focuses on is the bacterial response to combinations of antibiotics. While such drug combinations are crucially important for the treatment of infections, bacteria are getting more and more resistant to all available antibiotics. To use available antibiotics more efficiently, and identify any so far unexploited weaknesses, bacterial responses to different drugs and their combinations need to be understood in detail. The Bollenbach group combines quantitative experiments with statistical data analysis and theoretical modeling approaches to identify general design principles of cellular gene regulation responses. Using these quantitative approaches, the group aims to find new strategies of combining the currently available drugs in ways that maximize their efficiency while minimizing the evolution of drug resistance.

Career

since 2010	Assistant Professor, IST Austria
2006 – 2010	Postdoc, Harvard Medical School, Boston, USA
2005 – 2006	Postdoc, Max Planck Institute for the Physics of Complex Systems, Dresden, Germany
2005	Guest Scientist, University of Tokyo, Japan
2005	PhD, Max Planck Institute for the Physics of Complex Systems, Dresden, Germany

Selected Distinctions

since 2013	HFSP Program Grant
2011 – 2016	Member of the Young Academy at the German National Academy of Sciences Leopoldina and the Berlin-Brandenburg Academy of Sciences and Humanities
2007 – 2009	Feodor Lynen Fellowship, Alexander von Humboldt Foundation
2005	REES Fellowship, Japan International Science & Technology Exchange Center
2000 – 2005	Student and PhD Fellowships, German National Scholarship Foundation



Green fluorescent protein in bacteria (above) and mouse embryos (bottom, image courtesy N. Plachta).

Team Andreas Angermayr (postdoc), Bor Kavcic (PhD student), Martin Lukacisin (PhD student), Marta Lukacisinova (PhD student), Karin Mitosch (PhD student), Qin Qi (postdoc)

Krishnendu Chatterjee

Computer-aided Verification, Game Theory

Current Projects

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

Selected Publications

Ibsen-Jensen R, Chatterjee K, Nowak MA. 2015. Computational complexity of ecological and evolutionary spatial dynamics. PNAS (USA). 112, 15636-15641.

Chatterjee K, Henzinger M. 2014. Efficient and dynamic algorithms for alternating Büchi games and maximal end-component decomposition. J ACM. 61(3), 15.

Chatterjee K, Doyen L. 2012. Partial-observation stochastic games: How to win when belief fails. Proceedings of LICS. 175-184.

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.

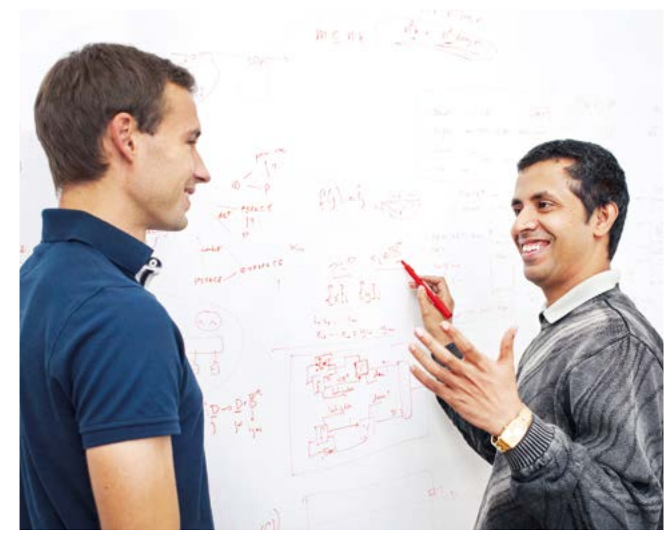
Game theory studies the interactive problems in decision making. It can be used to study problems in logic, automata theory, economics, cell population, evolutionary biology, and the design of the internet. The Chatterjee group is interested in the theoretical foundations of game theory, its application 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 broad framework allows for the effective analysis of many important questions in computer science and helps in the development of robust systems. The Chatterjee group also works on algorithmic aspects of evolutionary game theory on graphs, where the graph models a population structure. The goals of this research are the better understanding of games and the development of new algorithms.

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

Selected Distinctions

2011	Microsoft Research Faculty Fellowship
2011	ERC Starting Grant
2008	Ackerman Award, best thesis worldwide in Computer Science Logic
2007	David J. Sakrison Prize, best thesis in EECS, University of California, Berkeley, USA
2001	President of India Gold Medal, best IIT student of the year



Team Marek Chalupa (predoctoral visiting scientist), Martin Chmelik (PhD student), Ventsislav Krasimirov Chonev (postdoc), Hongfei Fu (postdoc), Shubham Goel (scientific intern), Amir Goharshady (PhD student), Christian Hilbe (postdoc), Rasmus Ibsen-Jensen (postdoc), Aviral Kumar (scientific intern), Petr Novotny (postdoc), Andreas Pavlogiannis (PhD student), Owen Rouille (academic visitor), Josef Tkadlec (PhD student), Stepan Simsa (scientific intern), Dorde Zikelic (academic visitor)

Sylvia Cremer

Disease Defense of the Superorganism

Current Projects

Collective sanitary care and pathogen avoidance in ant societies | Social interaction networks and epidemiology | Social immunization

Selected Publications

Milutinović B, Kurtz J. 2016. Immune memory in invertebrates. Seminars in Immunology. 28(4), 328-342.

Theis FJ, Ugelvig LV, Marr C, Cremer S. 2015. Opposing effects of allogrooming on disease transmission in ant societies. Philosophical Transactions of the Royal Society B: Biological Sciences. Theme issue: Sociality, Health and Fitness Nexus. 370, 20140108.

Novak S, Cremer S. 2015. Fungal disease dynamics in insect societies: Optimal killing rates and the ambivalent effect of high social interaction rates. Journal of Theoretical Biology. 372, 54-56.

Similar to an individual organism, social insect colonies are organized into germline (the reproductive queen) and soma (the sterile workforce), and hence are often referred to as a superorganism. The workers feed the queen, rear the brood, and perform all duties of an immune system, including nest hygiene and sanitary care.
The Cremer group studies this social immune system in ants to learn more about the parallel solutions of disease defense strategies across different levels of organization.

Social insect workers provide sophisticated sanitary care to their pathogen-exposed nestmates and the brood. They remove infectious particles by grooming and applying their formic-acid rich poison, which acts as a disinfectant. Such procedures drastically reduce the pathogen load and thus the risk of disease for the pathogen-exposed individuals. However, when infections are already so advanced that they cannot be cured anymore, the Cremer group found initial evidence that ants switch their strategy from individual care to colony-level protection. Ants can detect fatal infections of their brood by a "sickness smell", which acts as a stimulus similar to the "eat me" signal of infected cells within a vertebrate body. Like the immune cells of the body, the ant workers then target specifically the irrevocably sick and treat them to prevent pathogen multiplication. Similar selection pressures have thus led to similar solutions across organizational levels, the organism, and the superorganism.

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

Selected Distinctions

2015 Elisabeth Lutz Prize, Austria Academy of Sciences (ÖAW)
2013 Walther Arndt Prize of the German Zoological Society
2012 Research Award Lower Austria: Anerkennungspreis des Landes Niederösterreich
2011 Elected Member of the Young Curia of the Austrian Academy of Sciences, ÖAW
2009 ERC Starting Grant
2008 Member of the Young Academy at the German National Academy of Sciences Leopoldina and the Berlin-Brandenburg Academy of Sciences and Humanities; Alumna since 2013

Ants taking care of their cocoon-enclosed pupae.
Picture by Line V. Ugelvig and Barbara Leyrer

Team Marko Bracic (externally supervised MSc student), Matthew Coathup (ISTern student), Biplabendu Das (externally supervised BSc student), Leila El Masri (postdoc), Eva Flechl (laboratory technician), Matthias Fürst (postdoc), Anna Grasse (senior laboratory technician), Matthias Konrad (postdoc), Barbara Leyrer (laboratory technician), Sina Metzler (PhD student), Barbara Milutinovic (postdoc), Barbara Casillas Perez (PhD student), Christopher Pull (PhD student), Florian Wiesenhofer (laboratory technician)

Jozsef Csicsvari

Systems Neuroscience

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

Selected Publications

Schoenenberger P, O'Neill J, Csicsvari J. 2016. Activity-dependent plasticity of hippocampal place maps. Nature Communications. 7, 1824.

Dupret D, O'Neill J, Csicsvari J. 2013. Dynamic reconfiguration of hippocampal interneuron circuits during spatial learning. Neuron. 78, 166-180.

Dupret D, O'Neill J, Pleydell-Bouverie B, Csicsvari J. 2010. The reorganization and reactivation of hippocampal maps predict spatial memory performance. Nature Neuroscience. 13(8), 995-1002.

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

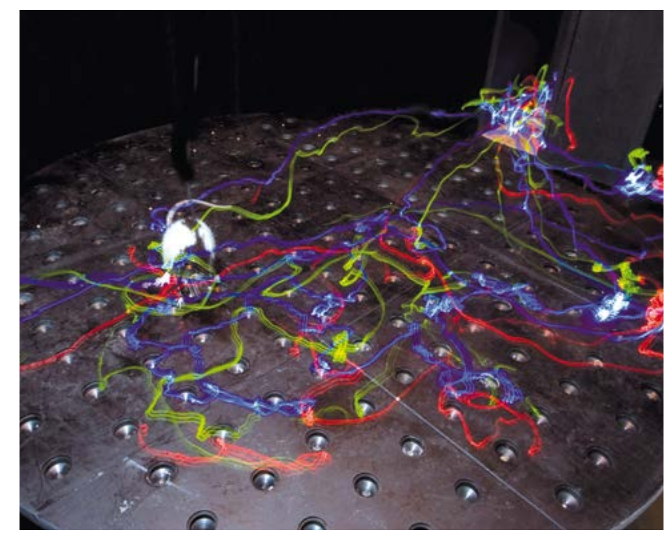
During learning, new memories are acquired and subsequently consolidated to ensure their successful later recall. The Csicsvari group focuses on understanding how learning leads to memory formation in neuronal circuits by investigating the neuronal system mechanisms of memory formation and stabilization.
The group focuses on spatial memory and investigates the mnemonic role of neuronal populations and their interactions in brain areas involved in spatial memory processing including the hippocampus, entorhinal cortex, and prefrontal cortex. 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. In addition, optogenetic methods are used to selectively manipulate neuronal activity in different brain areas.
The group also investigates the differential role of synchronous oscillations between related brain areas in encoding, storing, and ultimately recalling these spatial memories.

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
1993 – 1999 Graduate Assistant, Center for Behavioral and Molecular Neuroscience, Rutgers University, New Brunswick, USA
1999 PhD, Rutgers University, New Brunswick, USA

Selected Distinctions

2011 ERC Starting Grant
2010 Title of Ad Hominem Professor in Neuroscience at the University of Oxford



Ultra slow exposure image of a learning experiment on the "cheeseboard" maze.

Team Peter Baracskay (postdoc), Karel Blahna (postdoc), Charlotte Boccara (postdoc), Igor Gridchyn (PhD student), Agnes Hermann (scientific intern), Karola Käfer (PhD student), Krisztián Kovács (postdoc), Hugo Malagon Vina (predoctoral visiting scientist), Joseph O'Neill (postdoc), Dámaris Ketinó Rangel Guerrero (PhD student), Federico Stella (postdoc), Kira Vinogradova (academic visitor), Jago Wallenschus (laboratory technician), Haibing Xu (PhD student)

Herbert Edelsbrunner

Algorithms, Computational Geometry, and Topology

Current Projects

Discrete differential geometry and dynamics

Selected Publications

Edelsbrunner H, Harer JL. 2010. Computational Topology. An Introduction. American Mathematical Society, Providence, Rhode Island.

Edelsbrunner H. 2001. Geometry and topology for mesh generation. Cambridge University Press, Cambridge, England.

Edelsbrunner H. 1987. Algorithms in combinatorial geometry. Springer-Verlag, Heidelberg, Germany.

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

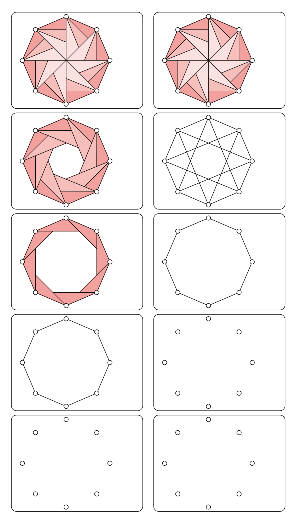
While geometry measures shapes, topology focuses its attention on how the shapes are connected. These shapes may be three-dimensional (an artistic sculpture or a cave in a mountain), it may be four-dimensional (a galloping horse or a flexing protein), or it may even have many more than four dimensions (the configuration space of a robot or the range of symptoms of a type of cancer). The Edelsbrunner group approaches the two related subjects of geometry and topology from a computational point of view. The computer aids in this study and it is used to make the insights useful in applications and workable for non-specialists. The group believes in a broad approach that does not sacrifice depth, including the development of new mathematics, the design of new algorithms and software, and the application in industry and other areas of science. Candidate areas for fruitful collaborations include 3D printing, structural molecular biology, and neuroscience.

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

Selected Distinctions

	ISI Highly Cited Researcher
2014	Fellow of the European Association for Theoretical Computer Science
2014	Member, Austrian Academy of Sciences (ÖAW)
2012	Corresponding Member of the Austrian Academy of Sciences
2008	Member, German Academy of Sciences Leopoldina
2006	Honorary Doctorate, Graz University of Technology
2005	Member, American Academy of Arts and Sciences
1991	Alan T. Waterman Award, National Science Foundation



The multi-scale image of connections in a sampled dynamical system.

Team Arseniy Akopyan (postdoc), Mabel Iglesias Ham (PhD student), Grzegorz Jablonski (postdoc), Mirko Daniel Klukas (postdoc), Zuzana Masarova (PhD student), Anton Nikitenko (PhD student), Katharina Ölsböck (PhD student), Georg Fritz Osang (PhD student), Peter Synak (PhD student), Ziga Virk (postdoc), Hubert Wagner (postdoc)

László Erdős

Mathematics of Disordered Quantum Systems and Matrices

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

Selected Publications

Bourgade P, Erdős L, Yau H-T. 2014. Edge universality of beta ensembles. Communications in Mathematical Physics. 332(1), 261-354.

Erdős L, Yau H-T. 2012. Universality of local spectral statistics of random matrices. Bulletin of the American Mathematical Society. 49(3), 377-414.

Erdős L, Yau H-T, Yin J. 2012. Rigidity of eigenvalues of generalized Wigner matrices. Advances in Mathematics. 229(3), 1435-1515.

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

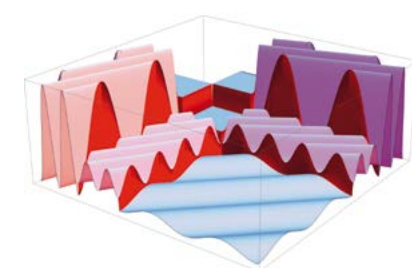
Large complex systems tend to develop universal patterns that often represent their essential characteristics. A pioneering vision of Eugene Wigner was that the distribution of the gaps between energy levels of complicated quantum systems depends only on the basic symmetry of the model and is otherwise independent of the physical details. This thesis has never been rigorously proved for any realistic physical system but experimental data and extensive numerics leave no doubt as to its correctness. Erdős' group took up this challenge to verify Wigner's vision with full mathematical rigor as well as to understand the underlying mechanism. Starting from the simplest model, a large random matrix with independent identically distributed entries, they are now able to deal with arbitrary distributions and even matrices with correlated entries. The next goal is to deal with physically more realistic models, especially those with a non-trivial spatial structure that models the three-dimensionality of the physical space. The mathematical ideas and tools developed along the way will extend the scope of random matrix theory and are likely to be used in its many applications beyond quantum physics such as wireless communications and statistics.

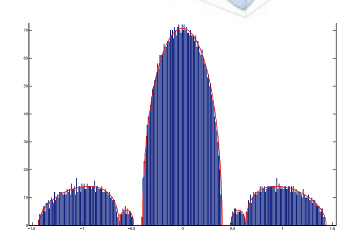
Career

since 2013	Professor, IST Austria
2003 – 2013	Chair of Applied Mathematics (C4/W3), Ludwig-Maximilians University, 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

Selected Distinctions

2016	Foreign member, Hungarian Academy of Sciences
2015	Corresponding member, Austrian Academy of Sciences (ÖAW)
2015	Member, Academia Europaea
2014	Invited Speaker, ICM
2013	ERC Advanced Grant
2007 – 2016	Participant of SFB TR12, Symmetries and Universality
1999 – 2005	NSF Grants
1993 – 1994	Alfred P. Sloan Foundation Dissertation Fellowship





Variance profile of an inhomogeneous random matrix H. (above) Eigenvalue distribution of H and its limiting density. (bottom)

Team Oskari Heikki Ajanki (postdoc), Johannes Alt (PhD student), Zhigang Bao (postdoc), Torben Heinrich Krüger (postdoc), Dangzheng Liu (postdoc), Peter Mühlbacher (student intern), Peter Nejjar (postdoc), Yuriy Nemish (postdoc), Christian Sadel (postdoc), Kevin Schnelli (postdoc), Dominik Julian Schröder (PhD student)

Johannes Fink

Quantum Integrated Devices

Current Projects

Hybrid optomechanical technologies | Quantum optics and quantum communication with compact superconducting qubits | Hardware protected qubits

Selected Publications

Fink JM, Kalaee M, Pitanti A, Norte R, Heinzle L, Davanço M, Srinivasan K, Painter O. 2016. Quantum electromechanics on silicon nitride nanomembranes. Nature Communications. 7, 12396.

Pitanti A, Fink JM, Safavi-Naeini AH, Lei CU, Hill JT, Tredicucci A, Painter O. 2015. Strong opto-electro-mechanical coupling in a silicon photonic crystal cavity. Optics Express. 23, 3196.

Fink JM, Göppl M, Baur M, Bianchetti R, Leek PJ, Blais A, Wallraff A. Climbing the Jaynes-Cummings ladder and observing its square root of n nonlinearity in a cavity QED system. Nature. 454, 315.

At the intersection of light and matter, the Fink group's research is positioned between quantum optics and mesoscopic condensed matter physics. The team studies quantum effects in electrical, mechanical, and optical chip-based devices to advance and integrate quantum technology for computation, communication, and sensing.

One of Fink's goals is to develop a microchip-based "router" that will be able to convert a microwave signal to an optical signal with ultra-high efficiency. With such devices, the Fink group seeks to perform quantum communication with artificial atoms and telecom wavelength photons. In one project, the group uses a superconducting 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.

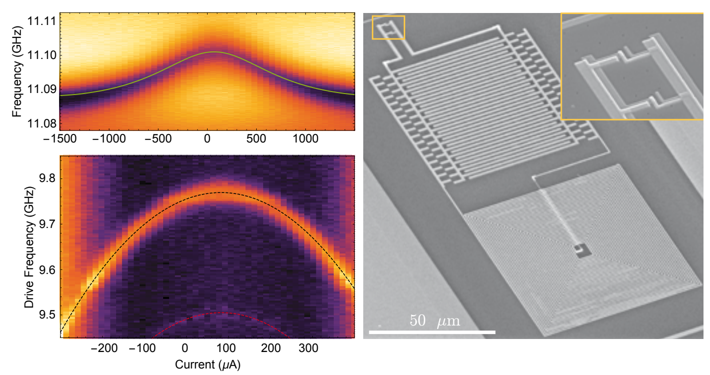
The Fink group will also use this technique to entangle microwave and optical photons—an important step toward realizing worldwide quantum networks. Another application is to develop more sensitive imaging techniques. Delicate systems may be destroyed if imaged with optical photons. Through so-called quantum ghost imaging, a low energy photon interacts with the object. Researchers then retrieve the image from an entangled high energy photon, which has itself never interacted with the imaged object.

Career

since 2016	Assistant Professor, IST Austria
2015 – 2016	Senior Staff Scientist, California Institute of Technology, Pasadena, USA
2012 – 2015	IQIM postdoctoral research scholar, California Institute of Technology, Pasadena, USA
2011 – 2012	Postdoctoral research fellow, ETH Zurich, Switzerland
2010	PhD, ETH Zurich, Switzerland

Selected Distinctions

2012	IQIM postdoctoral prize fellowship
2010	ETH Medal for outstanding dissertation
2009	CSF award at the QSIT conference on Quantum Engineering



Compact circuit quantum electrodynamics: Resonator frequency (top left) and transmon qubit spectroscopy of first and second excitation level (bottom left) vs. flux bias current, and compact transmon circuit QED sample fabricated on a 300 nm thick high resistivity SOI membrane with enlarged view of the Josephson junction SQUID (right).

Team Georg Arnold (scientific intern), Shabir Barzanjeh (postdoc), Tobias Bilgeri (scientific intern), Andreas Butler (academic visitor), Nikolaj Kuntner (laboratory technician), Pradyumna Paranjape (scientific intern), Matilda Peruzzo (PhD student), Alfredo Rueda Sanchez (predoctoral visiting scientist), Matthias Wulf (postdoc)

Jiří Friml

Developmental and Cell Biology of Plants

Current Projects

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

Selected Publications

Fendrych M, Leung J, Friml J. 2016. TIR1/AFB-Aux/IAA auxin perception mediates rapid cell wall acidification and growth of Arabidopsis hypocotyls. Elife. 5, e19048.

Rakusová H, Abbas M, Han H, Song S, Robert HS, Friml J. 2016. Termination of Shoot Gravitropic Responses by Auxin Feedback on PIN3 Polarity. Current Biology. 26(22), 3026-3032.

Viaene T, Landberg K, Thelander M, Medvecka E, Pederson E, Feraru E, Cooper ED, Karimi M, Delwiche CF, Ljung K, Geisler M, Sundberg E, Friml J. 2014. Directional auxin transport mechanisms in early diverging land plants. Current Biology. 24(23), 2786-2791.

When conditions get tough, animals typically fight or flee. Plants, however, are rooted in their environment. As a result, plants have become remarkably adaptable to different conditions. The Friml group investigates the mechanisms underlying plants' adaptability during embryonic and postembryonic development.

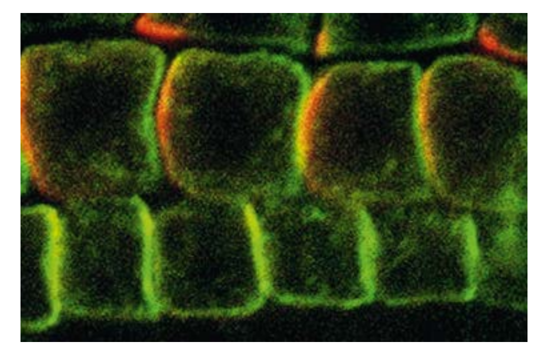
Plants and animals have different life strategies. Plants have acquired a highly adaptive development allowing them to modify development and physiology to environmental changes; they can easily regulate growth, initiate new organs or regenerate tissues. Many of these developmental events are mediated by the plant hormone auxin. The Friml group investigates the unique properties of auxin signaling, which stands out among plant signaling molecules as it can integrate both environmental and endogenous signals. Employing methods spanning molecular physiology, developmental and cell biology, genetics, biochemistry and mathematical modeling, the group focuses on auxin transport, cell polarity, endocytic recycling, as well as non-genomic mechanisms of signaling. In their work, the Friml group obtains fundamental insights into the mechanisms governing plant development. They show how signals from the environment are integrated into plant signaling and result in changes to plant growth and development. Many of their results are relevant for agriculture, providing a conceptual possibility for engineering plant development.

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

Selected Distinctions

2016	Charles Albert Shull Award, ASPB
2015	Selected to 2015 World's Most Influential Scientific Minds
2015	Erwin Schrödinger Prize, Austrian Academy of Science (ÖAW)
2014	Běhounek Prize, Czech Ministry of Education
2012	EMBO Gold Medal
2011	Elected fellow of American Association for the Advancement of Science (AAAS)
2010	Member, EMBO
2010	Körber European Science Award
2010	Olchemim Scientific Award
2005	Heinz Maier-Leibnitz Prize
2004	EMBO Young Investigator Award
2000	Max Planck Society Award: The Otto Hahn Medal



Polarity in *Arabidopsis* cells.

Team Mohamad Abbas (postdoc), Maciek Adamowski (PhD student), Matyas Fendrych (postdoc), Matous Glanc (predoctoral visiting scientist), Jakub Hajny (scientific intern), Rostislav Halouzka (academic visitor), Lukas Hörnmayer (scientific intern), Ivan Kulik (academic visitor), Gergely Molnar (postdoc), Madhumitha Narasimhan (PhD student), Tomas Prat (PhD student), Lesia Rodriguez Solovey (postoc), Yuliya Salanenka (postdoc), Sibu Simon (laboratory technician), Shutang Tan (postdoc), Petr Valosek (laboratory technician), Mina Vasileva (PhD student), Daniel von Wangenheim (postdoc), Saiko Yoshida (postdoc), Yuzhou Zhang (postdoc)

Călin Guet

Systems and Synthetic Biology of Genetic Networks

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

Selected Publications

Pleska M, Qian L, Okura R, Bergmiller T, Wakamoto Y, Kussell E, Guet CC. 2016. Bacterial autoimmunity due to a restriction-modification system. Current Biology. 26(3), 404-409.

Giacobbe M, Guet CC, Gupta A, Henzinger TA, Paixao T, Petrov T. 2015. Model checking gene regulatory networks. International Conference on Tools and Algorithms for the Construction and Analysis of Systems TACAS. LNCS. 9035, 469-483.

Guet CC, Gupta A, Henzinger TA, Mateescu M, Sezgin A. 2012. Delayed continuous-time Markov chains for genetic regulatory circuits. Computer Aided Verification (CAV) 2012. LNCS. 7358, 294-309.

Living systems are characterized by connections and interactions on many levels and across many environments—from genes, to organelles, to cells, to organs, to ecologies—as parts of networks. Which basic rules, if any, do these networks follow? Using systems and synthetic biology, the Guet group explores the biology of simple networks by analyzing both natural and synthetic networks.

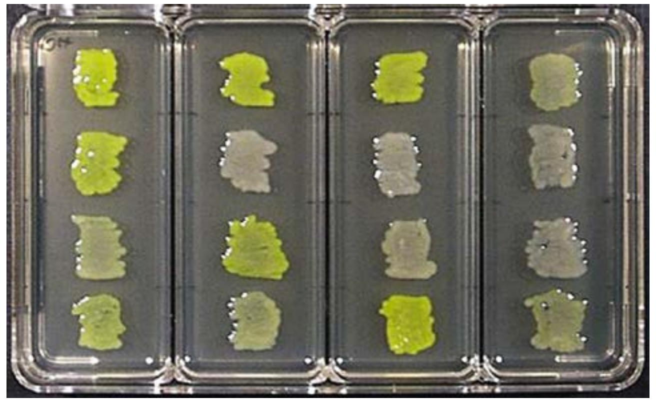
Genes and proteins constitute themselves into bio-molecular networks in cells. These genetic networks are engaged in a constant process of decision-making and computation over time scales of a few seconds to the time it takes the organism to replicate, and even beyond. By studying existing networks and constructing synthetic networks in living cells, the Guet group aims to uncover the existence of universal rules that govern bio-molecular networks. The group uses the bacterium *Escherichia coli* as a model system due to its relative simplicity and the powerful experimental genetic tools available. The group uses a variety of classical and modern experimental techniques that together enable them to construct any imaginable network in living bacteria and thus to study the network dynamics from the single-cell level all the way to the level of small ecologies, in which bacteria interact with bacteriophages.

Career

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

Selected Distinctions

2015	ETAPS EASST Best Paper Award
2011	HFSP Research Grant
2005	Yen Fellow, University of Chicago, USA
1997	Sigma XI Membership



Colonies of *Escherichia coli* performing Boolean logic computations with two chemical inputs and green fluorescent protein (GFP) as the output state.

Team Tobias Bergmiller (postdoc), Remy Chait (postdoc), Tamar Friedlander (postdoc), Rok Grah (PhD student), Claudia Igler (PhD student), Moritz Lang (postdoc), Anna Nagy-Staron (postdoc), Nela Nikolic (postdoc), Tatjana Petrov (postdoc), Maros Pleska (PhD student), Eva Sommer (scientific intern), Magdalena Steinrück (PhD student), Isabella Tomanek (PhD student), Kathrin Tomasek (PhD student)

Tamás Hausel

Geometry and Its Interfaces

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

Selected Publications

Hausel T, Letellier E, Rodriguez-Villegas F. 2013. Positivity for Kac polynomials and DT-invariants of quivers. Annals of Mathematics. 177(3), 1147-1168.

De Cataldo M, Hausel T, Migliorini L. 2012. Topology of Hitchin systems and hodge theory of character varieties. Annals of Mathematics. 175(3), 1329-1407.

Hausel T, Thaddeus M. 2003. Mirror symmetry, Langlands duality and Hitchin systems. Inventiones Mathematicae. 153(1), 197-229.

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

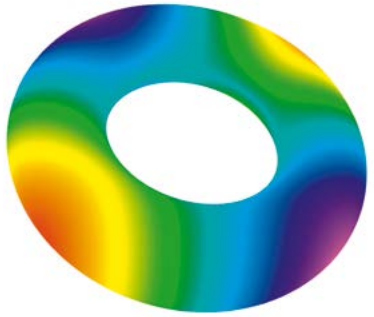
Start with a particle, and consider the different ways it can move between two points. Now, suppose there are many particles, and consider the space made up of all the ways each particle can move in between points. Then go beyond point-like particles to more complicated objects, such as vector fields, and play the same game. The resulting spaces are far too large to analyze, but it is possible to simplify them along symmetries in their structure, 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, which include the moduli spaces of Yang-Mills instantons in four dimensions, of magnetic monopoles in three dimensions, and of Higgs bundles in two dimensions. One particular question is the number of high-dimensional holes of the spaces. Making use of 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—connecting a wide variety of fields and ideas.

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
1995 – 1998	PhD, Trinity College, University of Cambridge, UK

Selected Distinctions

2013	ERC Advanced Grant
2009	EPSRC First Grant
2008	Whitehead Prize
2005	Sloan Research Fellow



Hitchin fibration on the real points of the toy model Higgs moduli space.

Team Ben Davidson (postdoc), Iordan Ganev (postdoc), Penghui Li (postdoc), Anton Mellit (postdoc), Dimitri Wyss (predoctoral visiting scientist)

Carl-Philipp Heisenberg

Morphogenesis in Development

Current Projects

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

Selected Publications

Ruprecht V, Wieser S, Callan-Jones A, Smutny M, Morita H, Sako K, Barone V, Ritsch-Marte M, Sixt M, Voituriez R, Heisenberg CP. 2015. Cortical contractility triggers a stochastic switch to fast amoeboid cell motility. Cell. 160(4), 673-85.

Behrndt M, Salbreux G, Campinho P, Hauschild R, Oswald F, Roensch J, Grill S, Heisenberg CP. 2012. Forces driving epithelial spreading in zebrafish gastrulation. Science. 338(6104), 257-260.

Maitre JL, Berthoumieux H, Krens SF, Salbreux G, Juelicher F, Paluch E, Heisenberg CP. 2012. Adhesion functions in cell sorting by mechanically coupling the cortices of adhering cells. Science. 338(6104), 253-256.

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

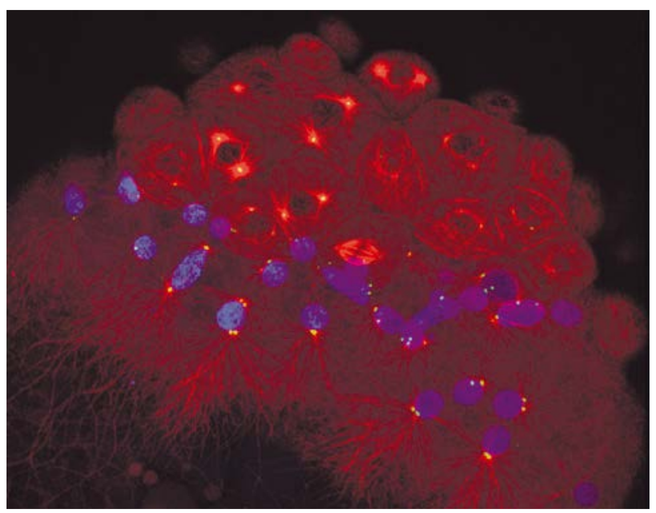
The Heisenberg group studies the molecular, cellular, and biophysical mechanisms by which vertebrate embryos take shape. To gain insights into critical processes in morphogenesis, the group focuses on gastrulation movements in zebrafish and ascidians. Gastrulation is a highly conserved process in which a seemingly unstructured blastula is transformed into a highly organized embryo. The group has chosen a transdisciplinary approach to analyzing gastrulation, employing a combination of genetic, cell biological, biochemical, and biophysical techniques. Using these tools, the group is deciphering key effector mechanisms involved in giving chordate embryos shape, such as cell adhesion, cell division, cell polarization, and cell migration. One central question they address is how adhesion between cells influences the specification and sorting of different populations of cells, which ultimately develop into different tissues and organs. 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.

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

Selected Distinctions

2015 Member, EMBO
2015 Member, German Academy of Sciences Leopoldina
2000 Emmy Noether Junior Professorship



Zebrafish embryo at the onset of gastrulation, stained for nuclei (blue), microtubules (red) and microtubule organizing centers (white).

Team Feyza Nur Arslan (PhD student), Vanessa Barone (PhD student), Silvia Caballero Mancebo (PhD student), Daniel Capek (PhD student), Benoit Gilbert Serge Godard (postdoc), Roland Kardos (postdoc), Hitoshi Morita (postdoc), Yuuta Moriyama (academic visitor), Nicoletta Petridou (postdoc), Kornelija Pranjic-Ferscha (laboratory technician), Keisuke Sako (postdoc), Cornelia Schwayer (PhD student), Mateusz Sikora (postdoc), Jana Slovakova (postdoc), Michael Smutny (postdoc), Zoltan Peter Spiro (postdoc), Peng Xia (postdoc)

Thomas A. Henzinger

Design and Analysis of Concurrent and Embedded Systems

Current Projects

Analysis and synthesis of concurrent software | Quantitative modeling and verification of reactive systems | Predictability and robustness for real-time and embedded systems | Model checking biochemical reaction networks

Selected Publications

Dragoi C, Henzinger TA, Zufferey D. 2016. PSync: a partially synchronous language for fault-tolerant distributed algorithms. Principles of Programming Languages (POPL) 2016. 51(1), 400-415.

Chatterjee K, Henzinger TA, Otop J. 2016. Quantitative automata under probabilistic semantics. Logic in Computer Science (LICS) 2016. 76-85.

Daca P, Henzinger TA, Kupriyanov A. 2016. Array folds logic. Computer Aided Verification (CAV) 2016. LNCS. 9780, 230-248.

Humans and computers are surprisingly 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.

Over 90% of today's worldwide computing power is found in unexpected places like cell phones, kitchen appliances, and pacemakers. Software has become one of the most complicated artifacts produced by man, making software bugs unavoidable. The Henzinger group addresses the challenge of reducing software bugs in concurrent and embedded systems. Concurrent systems consist of parallel processes that interact with one another, whether in a global network or on a tiny chip. Because of the large number of possible interactions between parallel processes, concurrent software is particularly error-prone, and sometimes bugs show up only after years of flawless operation. Embedded systems interact with the physical world; an additional challenge for this kind of safety-critical software is to react sufficiently quickly. The Henzinger group invents mathematical methods and develops computational tools for improving the reliability of software in concurrent and embedded systems.

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

Selected Distinctions

ISI Highly Cited Researcher
2015 Royal Society Milner Award
2015 EATCS Fellow
2015 Honorary Doctorate, Masaryk University, Brno, Czech Republic
2014 Most Influential 2004 POPL Paper Award
2013 AAAS Fellow
2012 Wittgenstein Award
2012 Honorary Doctorate, University Joseph Fourier, Grenoble, France
2012 Logic in Computer Science Test-of-Time Award
2011 Member, Austrian Academy of Sciences
2011 ACM SIGSOFT Impact Paper Award
2010 ERC Advanced Grant
2006 ACM Fellow
2006 IEEE Fellow
2006 Member, Academia Europaea
2005 Member, German Academy of Sciences Leopoldina
1995 ONR Young Investigator Award
1995 NSF Faculty Early Career Development Award

Team Guy Avni (postdoc), Sergiy Bogomolov (postdoc), Przemyslaw Daca (PhD student), Thomas Ferrere (postdoc), Mirco Giacobbe (PhD student), Hui Kong (postdoc), Bernhard Kragl (PhD student), Andrey Kupriyanov (postdoc), Aniket Murhekar (scientific intern), Tatjana Petrov (postdoc), Jakob Ruess (postdoc), Roopsha Samanta (postdoc), Thorsten Tarrach (PhD student), Kapil Eknath Vaidya (scientific intern), Chris Wendler (scientific intern)

Simon Hippenmeyer

Genetic Dissection of Cerebral Cortex Development

Current Projects

Determination of neuronal lineages by clonal analysis | Dissection of molecular mechanisms of cortical neuron migration | Probing of genomic imprinting in cortex development

Selected Publications

Gao P, Postiglione MP, Krieger TG, Hernandez L, Wang C, Han Z, Streicher C, Papusheva E, Insolera R, Chugh K, Kodish O, Huang K, Simons BD, Luo L, Hippenmeyer S, Shi SH. 2014. Deterministic progenitor behavior and unitary production of neurons in the neocortex. Cell. 159, 775-788.

Hippenmeyer S, Johnson RL, Luo L. 2013. Mosaic Analysis with Double Markers reveals cell type specific paternal dominance. Cell Reports. 3, 960-967.

Hippenmeyer S, Young YH, Moon HM, Miyamichi K, Zong H, Wynshaw BA, Luo L. 2010. Genetic mosaic dissection of Lis1 and Ndel1 in neuronal migration. Neuron. 68(4), 695-709.

The human brain is a sophisticated network of billions of interconnected neurons. The Hippenmeyer group exploits the genetic MADM technique to decipher the principles of neural development at single cell resolution in mice. The major goal of their research program is to determine the cellular, molecular, and epigenetic mechanisms of cerebral cortex development and neural circuit assembly.

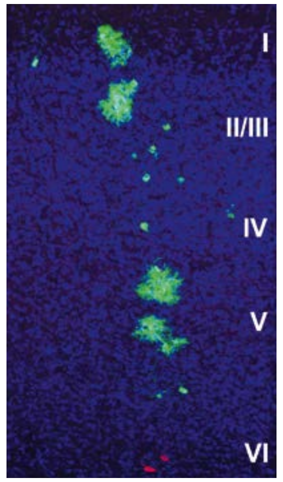
The human cerebral cortex, the seat of our cognitive abilities, is composed of an enormous number and diversity of neurons and glia cells. How the cortex arises from neural stem cells is an unsolved but fundamental question in neuroscience. In the pursuit to obtain mechanistic insights, we genetically dissect corticogenesis at unprecedented single cell resolution using the unique MADM (Mosaic Analyssis with Double Markers) technology. The Hippenmeyer group's current objectives are to 1) establish a definitive quantitative and mechanistic model of cortical neural stem cell lineage progression; 2) dissect the cellular and molecular mechanisms of cortical projection neuron migration and layer formation; 3) determine the role of genomic imprinting, an epigenetic phenomenon, in generating functional cell-type diversity in the cortex. 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.

Career

since 2012 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

Selected Distinctions

2016 ERC Consolidator Grant
2014 HFSP Program Grant
2013 Marie Curie Career Integration Grant
2009 – 2011 Fellowship for Advanced Researchers, Swiss National Science Foundation, Bern, Switzerland
2007 – 2009 HFSP Long-term Fellowship
2006 EMBO Long-term Fellowship
2005 Natural Sciences Faculty Prize for the best PhD thesis of the year 2004, University of Basel, Switzerland
2005 Edmond H. Fischer Prize



MADM-labeled clonally-related neurons and glia cells distributed across the six layers in the cerebral cortex.

Team Nicole Amberg (predoctoral visiting scientist), Robert Joseph Beattie (postdoc), Andi Harley Hansen (PhD student), Susanne Laukoter (PhD student), Florian Pauler (senior laboratory technician), Justine Renno (PhD student), Julio Rodarte (laboratory technician), Johanna Sonntag (laboratory technician), Carmen Streicher (laboratory technician)

Björn Hof

Nonlinear Dynamics and Turbulence

Current Projects

Transition from laminar to turbulent flow | Dynamics of complex fluids | Control of fully turbulent flows | Cytoplasmic streaming | Instabilities in cardiovascular flows

Selected Publications

Barkley D, Song B, Vasudevan M, Lemoult G, Avila M, Hof B. 2015. The rise of fully turbulent flow. Nature. 526, 550-553.

Lemoult G, Shi L, Avila K, Jalikop S, Avila M, Hof B. 2015. Directed percolation phase transition to sustained turbulence in Couette flow. Nature Physics. 12, 254–258.

Avila K, Moxey D, de Lozar A, Avila M, Barkley D, Hof B. 2011. The onset of turbulence in pipe flow. Science. 333, 192-196.

Most fluid flows of practical interest are turbulent, yet our understanding of this phenomenon is very 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. Turbulence governs friction losses and transport and mixing properties. Despite its ubiquity, insights into the nature of turbulence are very limited. To obtain a fundamental understanding of the origin and the principles underlying this phenomenon, 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. This enables the Hof group 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. Some of these insights can be directly applied to control turbulent flow, and the group actively develops such methods. In addition, the group investigates instabilities in fluids with more complex properties, such as dense suspensions of particles and polymer solutions.

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

Selected Distinctions

2012 ERC Consolidator Grant
2011 Dr. Meyer Struckmann Science Price
2005 RCUK Fellowship

Team Nishchal Agrawal (PhD student), Sebastian Altmeyer (postdoc), Nazmi Burak Budanur (postdoc), George Choueiri (postdoc), Jakob Kühnen (postdoc), Grégoire Marie Antoine Lemoult (postdoc), Jose Manuel Lopez Alonso (postdoc), Xingyu Ma (postdoc), Philipp Maier (technician), Chaitanya Paranjape (PhD student), Davide Scarselli (PhD student), Shayan Shamipour (PhD student), Mukund Vasudevan (postdoc)

Harald Janovjak

Synthetic Physiology

Current Projects

Synthetic control of receptors and signaling pathways | Remote restoration of cell and animal behavior

Selected Publications

Reichhart E, Ingles-Prieto Á, Tichy AM, McKenzie C, Janovjak H. 2016. A phytochrome sensory domain permits receptor activation by red light. Angewandte Chemie Int. Ed. 55, 6339-6342.

Ingles-Prieto Á, Reichhart E, Muellner MK, Nowak M, Nijman SM, Grusch M, Janovjak H. 2015. Light-assisted small molecule screening against protein kinases. Nature Chemical Biology. 11, 952-954.

Grusch M, Schelch K, Riedler R, Reichhart E, Differ C, Berger W, Ingles-Prieto Á, Janovjak H. 2014. Spatio temporally precise activation of engineered receptor tyrosine kinases by light. EMBO Journal. 33, 1713-1726.

When first faced with a new machine, an engineer's instinct is to disassemble it to understand its inner workings. The Janovjak group applies engineering principles to take apart the cell's signaling machinery and gain a better insight into how it orchestrates virtually all physiological functions.

The receptors on the surfaces of cells are the antennas that receive chemical signals and pass them on to the inside of the cell, causing specific and tightly controlled responses of multifaceted signaling pathways. The Janovjak group seeks to understand cellular signals and takes a unique synthetic biology approach to actively manipulate this process. Receptors are engineered to respond to new physical stimuli, such as light or ultrasound, rather than to their native chemical signals. The artificial stimuli are then used to study circuits and networks by activating or inactivating them at any given point, as well as to synthetically create or restore aberrant signaling in health and disease.

Career

since 2011 Assistant Professor, IST Austria
2010 – 2011 Postdoc, University of Munich, Germany
2006 – 2010 Postdoc, University of California, Berkeley, USA
2005 PhD, University of Dresden, Germany

Selected Distinctions

2011 HFSP Young Investigator Grant
2011 EU FP7 Career Integration Grant
2007 – 2009 EMBO Long-term Fellowship
2005 PhD with highest honors (summa cum laude)

Using optogenetics to manipulate the cell signaling machinery.

Team

Álvaro Ingles Prieto (postdoc), Stephanie Kainrath (PhD student), Kristian Kolev (laboratory technician), Christina Manner (scientific intern), Catherine Mckenzie (PhD student), Eva Reichhart (PhD student), Laura Rodriguez Hernandez (ISTFELLOW postdoc), Inmaculada Sanchez Romero (postdoc), Miroslava Spanova (laboratory technician), Alexandra-Madelaine Tichy (scientific intern)

Peter Jonas

Synaptic Communication in Hippocampal Microcircuits

Current Projects

Nanophysiology of fast-spiking, parvalbumin-expressing GABAergic interneurons | Analysis of synaptic mechanisms of information storage | Analysis of hippocampal synaptic transmission *in vivo*

Selected Publications

Gan J, Weng S-M, Pernía-Andrade AJ, Csicsvari J, Jonas P. 2016. Phase-locked inhibition, but not excitation, underlies hippocampal ripple oscillations in awake mice in vivo. Neuron. 93(2), 308-314.

Guzmán SJ, Schlögl A, Frotscher M, Jonas P. 2016. Synaptic mechanisms of pattern completion in the hippocampal CA3 network. Science. 353, 1117-1123.

Hu H, Jonas P. 2014. A supercritical density of Na^+ channels ensures fast signaling in GABAergic interneuron axons. Nature Neuroscience. 17, 686-693.

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 neuronal microcircuits is a major scientific challenge in the 21st century. The human brain is comprised of approximately 10 billion neurons, which communicate with each other at a huge number of communication sites, called synapses. Broadly, synapses fall into two categories: excitatory synapses releasing the transmitter glutamate, and inhibitory synapses releasing Gamma-Aminobutyric acid (GABA). The group studies the mechanisms of synaptic signaling quantitatively, using multiple-cell recording, subcellular patch-clamp, Ca^{2+} imaging, optogenetics, in vivo recording, and modeling. In one major project, the team tries to obtain a quantitative picture of subcellular signaling in fast-spiking, parvalbumin-expressing GABAergic interneurons. In a second project, the group examines the biophysical properties and the network function of the hippocampal mossy fiber synapse, a key synapse in hippocampal memory networks. This research has far-reaching implications for understanding neuronal coding, brain rhythms, and memory, and may lay the basis for the development of new therapeutic strategies.

Career

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

Selected Distinctions

2016 Wittgenstein Award
2016 ERC Advanced Grant
2015 Member, Academia Europaea
2011 ERC Advanced Grant
2009 Adolf-Fick-Award, Physicomedical Society, Würzburg, Germany
2008 Member, Academy of Sciences, Heidelberg, Germany
2007 Tsungming Tu Award, National Science Council Taiwan
2006 Szentagothai memorial lecture, University of California, Irvine, USA
2006 Gottfried Wilhelm Leibniz Award, German Research Foundation
2002 Member, German Academy of Sciences Leopoldina
1998 – 2001 Human Frontiers Science Program Organization Grant
1998 Max Planck Research Award
1997 Medinfar European Prize in Physiology, Portugal
1994 Heinz Maier Leibnitz Award, German Ministry for Education and Science
1992 Heisenberg Fellowship, German Research Foundation

Reconstruction of dendrites and axons of CA3 pyramidal neurons in hippocampus.

Team

Christina Altmutter (laboratory technician), Yoav Ben Simon (ISTFELLOW postdoc), Carolina Borges Merjane (ISTFELLOW postdoc), Chong Chen (PhD student), Claudia Espinoza Martinez (PhD student), Jian Gan (postdoc), Xiaoqi Geng (postdoc), José Guzmán (postdoc), Olena Kim (PhD student), Florian Marr (senior laboratory technician), Rajiv Mishra (postdoc), Alois Schlögl (software engineer), Benjamin Suter (Marie Curie Fellow postdoc), David Vandael (postdoc), Xiaomin Zhang (ISTFELLOW postdoc)

Georgios Katsaros

Nanoelectronics

Current Projects

Towards hole spin qubits and Majorana fermions in Germanium

Selected Publications

Watzinger H, Kloeffel C, Vukušić L, Rossell MD, Sessi V, Kukučka J, Kirchschlager R, Lausecker E, Truhlar A, Glaser M, Rastelli A, Fuhrer A, Loss D, Katsaros G. 2016. Heavy hole states in Germanium hut wires. Nano Letters. 16(11), 6879-6885.

Zhang JJ, Katsaros G, Montalenti F, Scopece D, Rezaev RO, Mickel C, Rellinghaus B, Miglio L, De Franceschi S, Rastelli A, Schmidt OG. 2012. Monolithic growth of ultra-thin Ge nanowires on Si(001). Physical Review Letters. 109, 085502.

Katsaros G, Spathis P, Stoffel M, Fournel F, Mongillo M, Bouchiat V, Lefloch F, Rastelli A, Schmidt OG, De Franceschi S. 2010. Hybrid superconductor-semiconductor devices made from self-assembled SiGe nanocrystals on silicon. Nature Nanotechnology. 5, 458-464.

Computers are becoming ever more powerful due to the continuous miniaturization of transistors. In his research, Georgios Katsaros uses semiconductor devices with a height of just 15-20 atoms. With these nano-scale semiconductor devices, the solid-state physicist investigates the fundamental physical concepts on which quantum computing could be based in the future.

Katsaros develops nano-devices based on germanium semiconductors and studies the quantum effects that appear when these nano-transistors are cooled down. One quantum mechanical property of a charge carrier is its spin. Katsaros investigates such quantum bits or qubits by manipulating them with microwaves. In classic computers, a bit can be in two states, ON or OFF. In quantum computers, a qubit can be both ON and OFF at the same time.

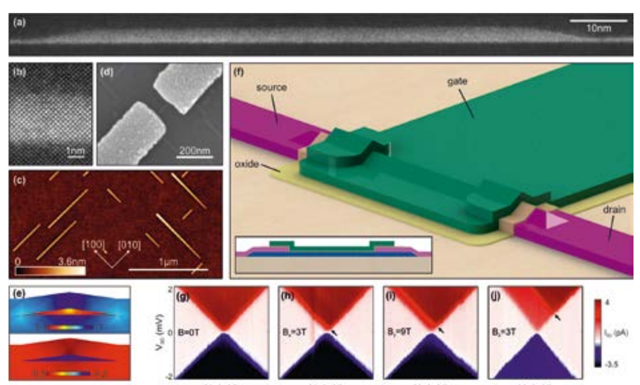
The Katsaros group is interested in spin qubits and Majorana fermions. The latter have been suggested as building blocks of a topological quantum computer, which would be protected from environments that could destroy the quantum information carried by electrons. Theory posits that an electron can be spilt into "two" parts, the Majorana fermions. In the topological quantum computer, both Majorana fermions have to be perturbed at the same time to destroy the quantum information. Currently there is strong experimental evidence that indeed Majorana fermions can be realized in solid-state devices, however, no studies exist so far addressing their real potential for topological quantum computing.

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
2001 – 2002 Research Assistant, National Center for Scientific Research "Demokritos", Athens, Greece

Selected Distinctions

2015 Elected member of the Young Academy of the Austrian Academy of Sciences
2013 ERC Starting Grant
2013 FWF START Award
2012 FWF Lise Meitner Fellowship
2011 Marie Curie Carrier Integration Grant



(a) Scanning transmission electron microscope image along a hut wire embedded in epitaxial silicon. (b) Wire cross section at higher resolution. (c) Atomic force microscopy image of uncapped Ge HWs. (d) Scanning electron micrograph of a HW contacted by Pd source and drain electrodes. (e) COMSOL simulations of the out-of-plane (up) and the inplane (down) strain distribution of a capped HW. (f) Schematic representation of a processed three-terminal device studied in this work. (g)-(j) Magnetotransport measurements around a charge degeneracy points taken for magnetic fields applied at different directions.

Team Sandesh Kalantre (academic visitor), Raimund Kirchschlager (predoctoral visiting scientist), Josip Kukucka (PhD student), Elisabeth Lausecker (postdoc), Alisha Truhlar (PhD student), Lada Vukusic (PhD student), Hannes Watzinger (PhD student)

Anna Kicheva

Tissue Growth and Developmental Pattern Formation

Current Projects

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

Selected Publications

Kicheva A, Briscoe J. 2015. Developmental Pattern Formation in Phases. Trends in Cell Biology. 25(10), 579-91.

Cohen M, Kicheva A, Ribeiro A, Blassberg R, Page K, Briscoe J. 2015. The roles of negative feedback and Gli regulation in the dynamics of Shh signaling. Nature Communications. 6, 6709.

Kicheva A, Bollenbach T, Ribeiro ACF, Pérez Valle H, Lovell-Badge RH, Episkopou V, Briscoe J. 2014. Coordination of progenitor specification and growth in mouse and chick spinal cord. Science. 345(6204), 1254927.

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.

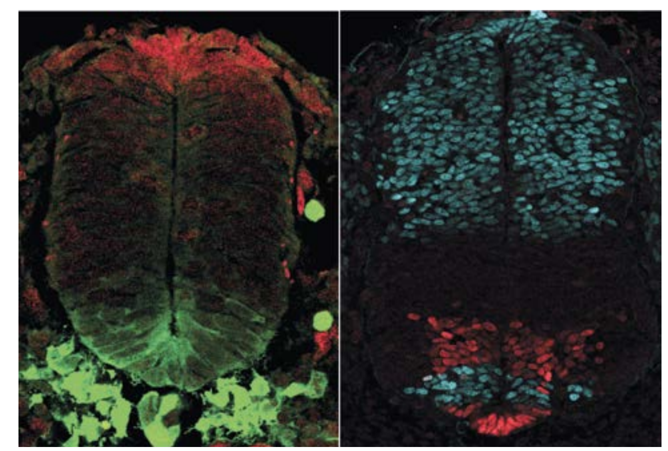
The development of the neural tube is controlled by secreted signaling molecules called morphogens. Morphogens control what type of neuron a neural progenitor cell will become. At the same time, they control the tissue growth by influencing the decisions of cells to divide or exit the cell cycle. The goal of the Kicheva group is to better understand how morphogen signaling levels are controlled and how cells interpret morphogen signaling to determine their cell fate and cell cycle progression. One of the current main projects in the lab focuses on investigating how a system of opposing morphogen gradients functions to inform cells about their dorsoventral position within the neural tube. The group uses diverse quantitative experimental approaches, including the collection of high-resolution spatio-temporal datasets of signaling and gene expression dynamics in the neural tube of mouse and chick embryos, ex vivo microfluidics assays, and others. They are developing methods for high-resolution imaging of the dynamics of morphogen signaling and growth in living tissues. They work in close collaboration with biophysicists to relate their experiments to theoretical frameworks.

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

Selected Distinctions

2015 ERC Starting Grant
2009 Marie-Curie Intra-European Fellowship
2008 FEBS Long-term Fellowship



The opposing Shh and BMP morphogen signaling gradients (left, green and red, resp.) and the striped pattern of target gene expression (right) in the mouse neural tube.

Team Martina Greunz (laboratory technician), Katarzyna Kuzmicz (PhD student), Dominik Ritzer (MSc student), Marcin Zagórski (postdoc)

Vladimir Kolmogorov

Computer Vision and Discrete Optimization Algorithms

Current Projects

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

Selected Publications

Kolmogorov V, Krokhin A, Rolínek M. 2015. The complexity of general-valued CSPs. In IEEE Symposium on Foundations of Computer Science (FOCS). 1246-1258.

Gridchyn I, Kolmogorov V. 2013. Potts model, parametric maxflow and k-submodular functions. In IEEE International Conference on Computer Vision (ICCV). 2320-2327.

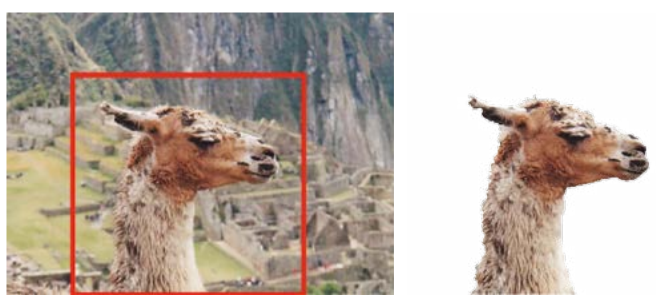
Kolmogorov V. 2009. Blossom V: A new implementation of a minimum cost perfect matching algorithm. Mathematical Programming Computation. 1(1), 43-67.

Stepping out onto 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. Such algorithms are the research focus of the Kolmogorov group.

The work of Vladimir Kolmogorov's group can be subdivided into three topics. The first one is development of efficient algorithms for inference in graphical models and combinatorial optimization problems. Some of the developed techniques are widely used in computer vision and other areas, for example the "Boykov-Kolmogorov" maximum flow algorithm and the "TRW-S" algorithm for MAP inference in pairwise graphical models. Kolmogorov's "Blossom V" algorithm is currently the fastest technique in practice for computing a minimum cost perfect matching in a graph. The second focus of the group is theoretical investigations of the complexity of discrete optimization, in particular using the framework of *Valued Constraint Satisfaction Problems* and their variants. Finally, the Kolmogorov group has worked on applications of discrete optimization in computer vision such as image segmentation and stereo reconstruction.

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



Example of the "Grabcut" interactive image segmentation algorithm based on graph cuts, which has been incorporated in Microsoft Office 2010.

Selected Distinctions

2013	ERC Consolidator Grant
2012	Koenderink Prize at the European Conference on Computer Vision for fundamental contributions to computer vision
2007	Honorable mention, outstanding student paper award (to M. Pawan Kumar) at Neural Information Processing Systems Conference
2006 – 2011	Royal Academy of Engineering/EPSRC Research Fellowship
2005	Best paper honorable mention award at IEEE Conference on Computer Vision and Pattern Recognition
2002	Best paper award at the European Conference on Computer Vision

Team Senanayak Karri (postdoc), Alexandr Kazda (postdoc), Michal Rolinek (PhD student), Paul Swoboda (postdoc)

Christoph Lampert

Computer Vision and Machine Learning

Current Projects

Life-long visual learning | Transfer learning | Image understanding with weak supervision | Structured prediction and learning

Selected Publications

Kolesnikov A, Lampert CH. 2016. Seed, expand and constrain: three principles for weakly-supervised image segmentation. European Conference on Computer Vision (ECCV). 695-711.

Lampert CH, Nickisch H, Harmeling S. 2014. Attribute-based classification for zero-shot visual object categorization. IEEE Transactions on Pattern Analysis and Machine Intelligence (TPAMI). 36(3), 453-465.

Pentina A, Lampert CH. 2014. A PAC-Bayesian bound for lifelong learning. In International Conference on Machine Learning (ICML). 991-999.

Today's computer programs are "idiots savant": software that is extremely good at a certain task, such as playing chess, is completely useless for most other tasks like searching a database, and vice versa. The Lampert group works on methods for computers to break out of this limitation by sharing information between different tasks.

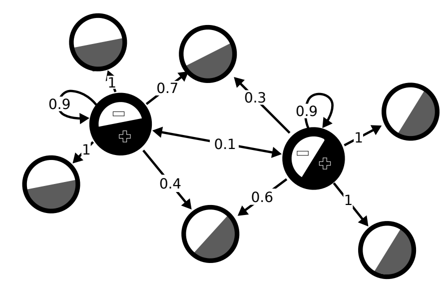
Modern computer software adapts to its users, e.g. voice recognition software learns to understand its speaker better over time, and email programs learn which of all incoming emails are spam and should therefore be suppressed. However, this learning process happens independently for each task that the computer is meant to solve. The Lampert group develops and analyzes algorithms that allow computers to learn new tasks while making use of the knowledge acquired from previous tasks. A particular application area is automatic image understanding, whereby the goal of the software is to analyze the contents of a natural image and automatically answer questions such as: What objects are visible in the image? Where are they located? How do they interact?

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

Selected Distinctions

2012	ERC Starting Grant
2008	Best Paper Award, IEEE Conference for Computer Vision and Pattern Recognition (CVPR)
2008	Best Student Paper Award, European Conference for Computer Vision (ECCV)
2008	Main Prize, German Society for Pattern Recognition (DAGM)



Schematic illustration of multi-task learning: information is transferred between different learning tasks through a suitably weighted sharing of annotated training examples. As a consequence, the number of necessary training examples per task is reduced and the prediction quality improved.

Team Alexander Kolesnikov (PhD student), Georg Martius (postdoc), Anastasia Pentina (postdoc), Amélie Royer (PhD student), Alexander Zimin (PhD student)

Mikhail Lemeshko

Theoretical Atomic, Molecular, and Optical Physics

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 ultracold quantum gases | Developing techniques to manipulate atoms, molecules, and interactions between them with electromagnetic fields

Selected Publications

Schmidt R, Lemeshko M. 2016. Deformation of a quantum many-particle system by a rotating impurity. Physical Review X. 6, 011012.

Schmidt R, Lemeshko M. 2015. Rotation of quantum impurities in the presence of a many-body environment. Physical Review Letters. 114, 203001.

Otterbach J, Lemeshko M. 2014. Dissipative Preparation of Spatial Order in Rydberg-Dressed Bose-Einstein Condensates. Physical Review Letters. 113, 070401.

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

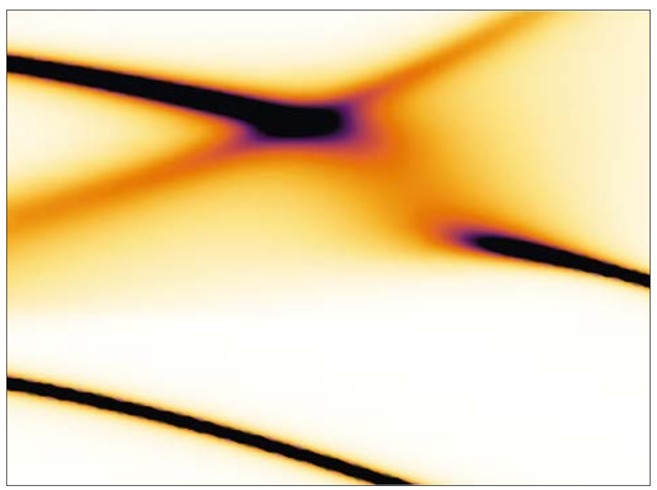
Most polyatomic systems we encounter in physics, chemistry, and biology are strongly correlated, in the sense that their complex behavior cannot be deduced from the properties of their individual constituents. Despite considerable effort, an understanding of strongly-correlated, many-body systems still presents a formidable challenge. For instance, looking at a single atom of a given kind, it is hard to predict whether the resulting bulk material will be solid, gaseous, or liquid, crystalline or amorphous, magnetic or non-magnetic, conductive or insulating. The Lemeshko group studies how the many-particle quantum phenomena emerge in ensembles of atoms and molecules. They seek to theoretically study and answer 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 theoretical efforts aim to explain the experiments on cold molecules and ultracold quantum gases, as well as to predict novel, previously unobserved phenomena.

Career

since 2014 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
2007 MSc, Southern Federal University Rostov, Russia

Selected Distinctions

2012 One of four finalists, worldwide Thesis Prize competition, AMO division of the American Physical Society
2011 ITAMP Postdoctoral Fellowship



Fine structure appearing in the rotational spectrum of a molecule due to the interaction with a quantum many-body environment (Schmidt&Lemeshko, Phys. Rev. Lett. 114, 203001. 2015).

Team Giacomo Bighin (postdoc), Xiang Li (PhD student), Bikashkali Midya (postdoc), Enderalp Yakaboylu (postdoc)

Martin Loose

Self-organization of the Cell

Current Projects

Identifying biochemical networks that determine intracellular organization | Studying the mechanism of polarity establishment and cell division

Selected Publications

Loose M, Mitchison TJ. 2014. The bacterial cell division proteins FtsA and FtsZ self-organize into dynamic cytoskeletal patterns. Nature Cell Biology. 16(1), 38-46.

Loose M, Fischer-Friedrich E, Herold C, Kruse K, Schwille P. 2011. Min protein patterns emerge from rapid rebinding and membrane interaction of MinE. Nature Structural and Molecular Biology. 18(5), 577-583.

Loose M, Fischer-Friedrich E, Ries J, Kruse K, Schwille P. 2008. Spatial regulators for bacterial cell division self-organize into surface waves in vitro. Science. 320(5877), 789-792.

How are nanometer-sized proteins able to perform complex functions on a cellular scale? The Loose group studies the molecular mechanisms of intracellular self-organization by using purified components and advanced fluorescence in a bottom-up in vitro approach.

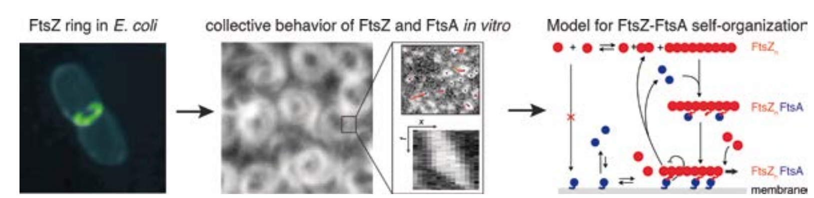
Although most individual players required for specific cellular processes have been identified, how they act together to accomplish their specific function is not yet understood. Instead of looking at complex phenomena in an intact cell, the Loose group aims to rebuild cellular functions from purified components. This bottom-up approach allows for much better control of the experimental conditions and a quantitative characterization of the underlying molecular processes. Ultimately, this helps to identify the mechanism and the general principles of intracellular protein self-organization. The interdisciplinary approach of the Loose group combines biochemical reconstitution experiments with advanced fluorescence microscopy down to the single molecule level, biomimetic membrane systems, and micropatterning techniques. Their current work focuses on the protein machinery responsible for bacterial cell division and the emergent properties of small GTPase networks involved in membrane identity formation and cell polarization.

Career

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

Selected Distinctions

2015 HFSP Young Investigator Grant
2015 ERC Starting Grant
2012 – 2014 HSFP Long-term fellowship
2011 – 2012 EMBO Long-term fellowship
2010 Dr.-Walter-Seipp-Award for best dissertation at TU Dresden
2001 – 2009 Student and PhD Fellowship of the German National Scholarship Foundation



In vitro reconstitution of minimal biochemical systems is a powerful approach to understand self-organized processes in the living cell. Left, in *Escherichia coli*, FtsZ assembles into a polymeric ring at the center of the cell. Middle, using supported membranes and TIRF imaging, they could analyze the self-organization of FtsA and FtsZ into dynamic, cytoskeletal rings or treadmilling filaments (see inset). Right, with the help of this well-controlled in vitro system, a mechanistic model of FtsZ-FtsA interaction on the cell membrane was developed.

Team Albert Auer (MSc student), Natalia Baranova (postdoc), Urban Bezeljak (PhD student), Paulo Renato Dos Santos Caldas (PhD student), Christian Frederic Düllberg (postdoc), Maria Del Mar Lopez Pelegrin (laboratory technician), Christine Mieck (postdoc)

Jan Maas

Stochastic Analysis

Current Projects

Structure-preserving discretization of gradient flow dynamics | Curvature-dimension criteria for Markov processes | Optimal transport metrics for dissipative quantum systems

Selected Publications

Fathi M, Maas J. 2016. Entropic Ricci curvature bounds for discrete interacting systems. Annals of Applied Probability. 26(3), 1774-1806.

Hairer M, Maas J, Weber H. 2014. Approximating rough stochastic PDEs. Communications on Pure and Applied Mathematics. 67(5), 776-870.

Maas J. 2011. Gradient flows of the entropy for finite Markov chains. Journal of Functional Analysis. 261(8), 2250-2292.

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

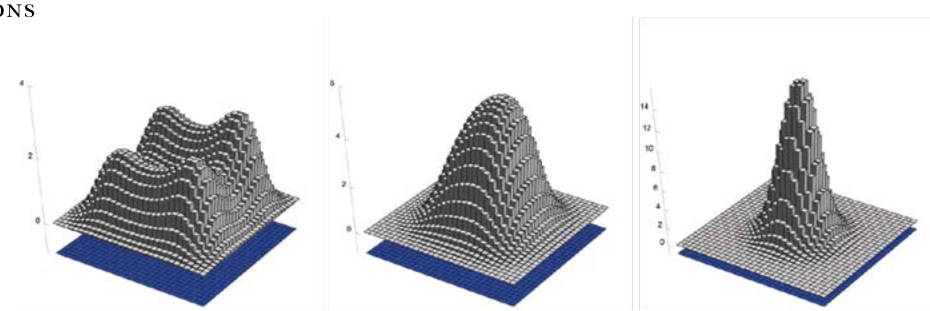
Random processes are often so irregular that existing mathematical methods are insufficient to describe them accurately. The Maas group combines ideas from probability theory, mathematical analysis, and geometry to gain new insights into the complex behavior of these processes. Recent work of the group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

Career

since 2014 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

Selected Distinctions

2016 ERC Starting Grant
2013 – 2014 Project Leader in Collaborative Research Centre "The mathematics of emergent effects"
2009 – 2011 NWO Rubicon Fellowship



Gradient flow discretization of a fourth-order diffusion equation.

Team Dominik Leopold Forkert (PhD student), Máté Gerencsér (postdoc), Peter Nejjar (postdoc), Giovanni Alessandro Zanco (postdoc)

Gaia Novarino

Genetic and Molecular Basis of Neurodevelopmental Disorders

Current Projects

Molecular mechanisms underlying autism spectrum disorders | SETD5 gene in intellectual disability | Modeling epileptic encephalopathies in human brain organoids | Role of the autism-associated gene CHD8 in cortical development

Selected Publications

Tărlungeanu DC, Deliu E, Dotter CP, Kara M, Janiesch PC, Scalise M, Galluccio M, Tesulov M, Morelli E, Sonmez FM, Bilguvar K, Ohgaki R, Kanai Y, Johansen A, Esharif S, Ben-Omran T, Topcu M, Schlessinger A, Indiveri C, Duncan KE, Caglayan AO, Gunel M, Gleeson JG, Novarino G. 2016. Impaired amino acid transport at the blood brain barrier is a cause of autism spectrum disorder. Cell. 167(6), 1481-1494.e18.

Kuechler A, Zink AM, Wieland T, Lüdecke HJ, Cremer K, Salviati L, Magini P, Najafi K, Zweier C, Czeschik JC, Aretz S, Endele A, Tamburrino F, Pinato C, Clementi M, Gundlach J, Maylahn C, Mazzanti L, Wohlleber E, Schwarzmayr T, Kariminejad R, Schlessinger A, Wieczorek D, Strom TM, Novarino G, Engels H. 2015. Loss-of-function mutations of SETD5 cause intellectual disability and core phenotype of microdeletion 3p25.3 syndrome. EJHG. 23(6), 753-760.

Novarino G, El-Fishawy P, Kayserili H, Meguid NA, Scott ES, Schroth J, Silhavy JL, Kara M, Khalil RO, Ben-Omran T, Ercan-Sencicek AG, Hashish AF, Sanders SJ, Gupta AR, Hashem HS, Matern D, Gabriel S, Sweetman L, Rahimi Y, Harris RA, State MW, Gleeson JG. 2012. Mutations in the BCKD-kinase lead to a potentially treatable form of autism with epilepsy. Science. 338(6105), 394-397.

Gaia Novarino's research aims to study 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 many different techniques, from molecular biology to behavior, to identify common pathophysiological mechanisms underlying this group of disorders.

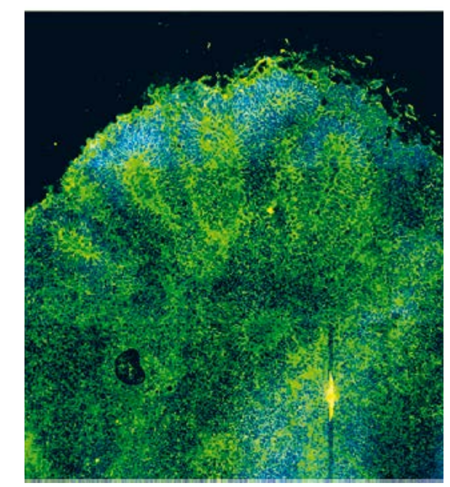
The causes of epilepsy, intellectual disability, and autism remain unknown for the majority of cases. A significant number have a genetic basis and many causative genes remain to be identified. With DNA sequencing being more accessible, the genomes of many patients can be analyzed and more disease-causing genes will be recognized. Though researchers predict that each identified gene may represent only a tiny fraction of the total genes involved in these disorders, studying the mechanisms underlying rare inherited forms of seizure and autism syndromes can be extremely helpful. In addition to searching for these novel genes, the Novarino group studies the function of epilepsy, intellectual disability and autism-causing genes at the system, cellular, and molecular levels with the goal of providing a framework for the development of effective pharmacological therapies and the background for the identification of new pathological genetic variants. Their work in understanding the underlying mechanisms will moreover advance the overall understanding of the human brain.

Career

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

Selected Distinctions

2016 Simons Foundation Autism Research Initiative (SFARI) Investigator
2016 ERC Starting Grant
2016 FENS-Kavli scholar
2015 Boehringer Ingelheim FENS Research Award 2016
2014 Citizens United for Research in Epilepsy (CURE): Taking Flight Award
2012 Citizens United for Research in Epilepsy (CURE): Young Investigator Travel Award
2011 German Research Foundation (DFG): 2-year fellowship



Embryonic stem cell-derived human cortical organoid stained for the radial glia marker Nestin (green) and nuclei (blue).

Team Marco Benevento (predoctoral visiting scientist), Alberto Coll Manzano (laboratory technician), Federica Rachele Danti (PhD student), Elena Deliu (postdoc), Christoph Dotter (PhD student), Jasmin Morandell (PhD student), Eva Maria Reinthaler (postdoc), Roberto Sacco (postdoc), Dora Tarlungeanu (PhD student)

Krzysztof Pietrzak

Cryptography

Current Projects

Leakage-resilient cryptography | Cryptosystems for light-weight devices | Computational entropy | Memory-hard functions | Crypto-currencies

Selected Publications

Dodis Y, Pietrzak K, Wichs D. 2014. Key derivation without entropy waste. EUROCRYPT. LNCS. 8441, 93-110.

Kiltz E, Pietrzak K, Cash D, Jain A, Venturi D. 2011. Efficient authentication from hard learning problems. EUROCRYPT. LNCS. 6632, 7-26.

Dziembowski S, Pietrzak K, Wichs D. 2010. Non-malleable codes. In ICS. 434-452.

Cryptography, the science of information security, is often relegated to the realm of spies and agents. However, we all rely on cryptography on a daily basis, for example when using internet banking or a wireless car key.

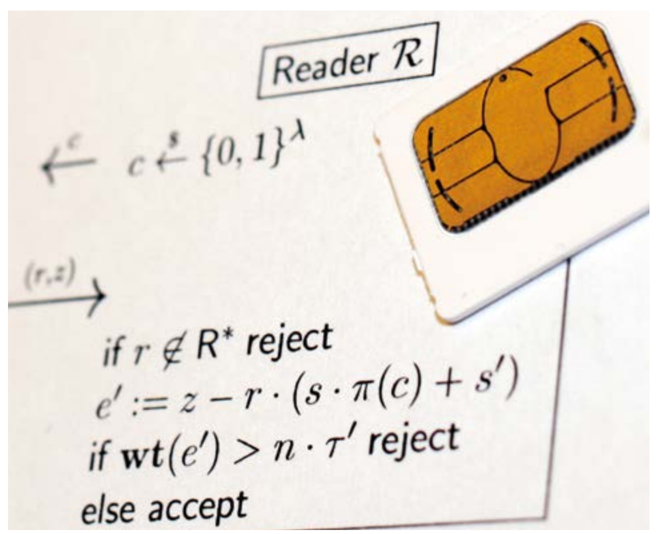
The cryptography group at IST Austria works on theoretical and practical aspects of cryptography. Current research topics of the group include:
Crypto for light-weight devices. The team works towards provably secure cryptographic schemes for light-weight devices such as RFID tags, which are too constrained to run existing cryptographic schemes.
Leakage-resilient cryptography. This project aims to construct schemes that are provably secure against "side-channel attacks". These are attacks in which an attacker exploits information leaked during computation from a cryptographic device like a smart card.
Sustainable Cryptocurrencies. Bitcoin is the first successful digital currency. Its popularity comes from the fact that it is decentralized, so no central authority controls it. To achieve security despite decentralization, a huge amount of computing power is constantly wasted towards generating "proofs of work". This is economically and ecologically problematic. The Pietrzak group works towards more sustainable cryptocurrencies.

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

Selected Distinctions

2015	ERC Consolidator Grant
2010	ERC Starting Grant



Light-weight devices require simple and efficient cryptographic schemes.

Team Hamza Abusalah (PhD student), Joel Francis Cyril Alwen (postdoc), Peter Gazi (postdoc), Chethan Kamath Hosdurg (PhD student), Danylo Khilko (academic visitor), Leonid Reyzin (visiting professor), Michal Rybar (PhD student), Maciej Skorski (predoctoral visiting scientist)

Leonid Sazanov

Structural Biology of Membrane Protein Complexes

Current Projects

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

Selected Publications

Fiedorczuk K, Letts JA, Degliesposti G, Kaszuba K, Skehel M, and Sazanov LA. 2016. Atomic structure of the entire mammalian mitochondrial complex I. Nature. 538, 406-410.

Letts JA, Fiedorczuk K, and Sazanov LA. 2016. The architecture of respiratory supercomplexes. Nature. 537, 644-648.

Baradaran R, Berrisford JM, Minhas GS, Sazanov LA. 2013. Crystal structure of the entire respiratory complex I. Nature. 494, 443-448.

Membrane proteins are responsible for many fundamental cellular processes including transport of ions and metabolites, energy conversion, and signal transduction. They are the target of about two thirds of modern drugs. However, membrane proteins, especially large complexes, are challenging for structural studies and so are underrepresented in structural databases.

The Sazanov Group has long been interested in the structural biology of membrane proteins. The main emphasis has been on complex I of the respiratory chain, a huge ~1 MDa enzyme central to cellular energy production and involved in many common human pathologies. So far, they have determined all the first atomic structures of complex I, from bacterial to the more elaborate mammalian version. The structure of the entire complex suggests a unique mechanism of proton translocation, involving long-range conformational changes. The Sazanov group is studying the mechanism using both X-ray crystallography and single particle cryo-electron microscopy. They are also investigating other related membrane protein complexes, such as hydrogenases and antiporters. Their studies will help derive general and specific features of molecular design of redox- and conformationally coupled proton pumps, representing some of the most intricate biological machines. Medical implications are multifaceted, especially for complex I-related diseases, and the Sazanov group is interested in developing potential drug candidates.

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

Selected Distinctions

2016	Academic Editor, Cell Stress
2013	Member of Faculty of 1000
2012	EMBO Grant
2004	Royal Society Grant
2002	Royal Society Grant
1992	Wellcome Trust Fellowship

Structure of the entire mitochondrial respiratory complex I (mammalian enzyme from *Ovis aries*, solved by cryo-EM). Each of 45 protein subunits is colored differently. Approximate location of the mitochondrial membrane is indicated in grey.

Team Alexej Charnagalov (laboratory technician), Karol Fiedorczuk (predoctoral visiting scientist), Javier Gutierrez-Fernandez (postdoc), Karol Kaszuba (postdoc), James Anthony Letts (postdoc), Kristina Lukic (intern), Julia Steiner (PhD student), Margherita Tambalo (predoctoral visiting scientist), Long Zhou (postdoc)

Robert Seiringer

Mathematical Physics

Current Projects

Stability of many-body systems with point interactions | The Heisenberg ferromagnet at low temperature and the spin-wave approximation | Excitation spectrum and superfluidity for weakly interacting Bose gases

Selected Publications

Giuliani A, Seiringer R. 2016. Periodic striped ground states in Ising models with competing interactions. Communications in Mathematical Physics. 347, 983-1007.

Seiringer R. 2014. Bose gases, Bose–Einstein condensation, and the Bogoliubov approximation. Journal of Mathematical Physics. 55, 075209.

Frank RL, Lewin M, Lieb EH, Seiringer R. 2013. A positive density analogue of the Lieb–Thirring inequality. Duke Mathematical Journal. 162, 435-495.

The Seiringer group develops new 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 has to resort to perturbation theory or other uncontrolled approximations, whose justification remains open. It therefore remains a challenge to derive non-perturbative results and to obtain precise conditions under which the various approximations can or cannot be justified.

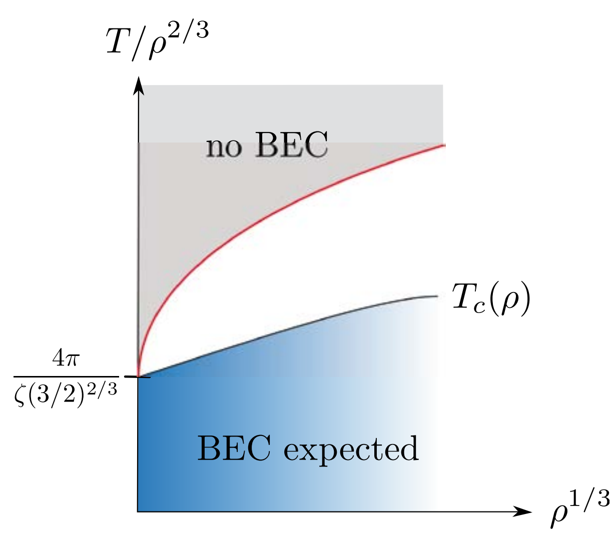
For this purpose it is necessary to develop new mathematical techniques and methods. These new methods lead to different points of view and thus increase their understanding of physical systems. Concrete problems under current investigation include the spin-wave approximation in magnetism, the validity of the Bogoliubov approximation for the excitation spectrum of dilute Bose gases, and pattern formation in Ising models with competing interactions.

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

Selected Distinctions

2016	ERC Advanced Grant
2012 – 2017	William Dawson Scholarship
2012 – 2014	NSERC E.W.R. Steacie Memorial Fellowship
2009 – 2010	U.S. National Science Foundation CAREER Grant
2009	Henri Poincaré Prize of the International Association of Mathematical Physics
2004 – 2006	Alfred P. Sloan Fellow
2001 – 2003	Erwin Schrödinger Fellow



Phase diagram of a dilute Bose gas.

Team Birger Brietzke (academic visitor), Andreas Deuchert (postdoc), Simon Mayer (PhD student), Thomas Moser (PhD student), Marcin Marek Napiórkowski (postdoc), Sõren Philipp Petrat (postdoc), Phan Thanh Nam (postdoc)

Ryuichi Shigemoto

Molecular Neuroscience

Current Projects

Ultrastructural localization and function of receptors and ion channels in the brain | Mechanisms of long-term memory formation | Left-right asymmetry of hippocampal circuitry

Selected Publications

Wang W, Nakadate K, Masugi-Tokita M, Shutoh F, Aziz W, Tarusawa E, Lorincz A, Molnár E, Kesaf S, Li YQ, Fukazawa Y, Nagao S, Shigemoto R. 2014. Distinct cerebellar engrams in short-term and long-term motor learning. PNAS (USA). 111, E188-193.

Fukazawa Y, Shigemoto R. 2012. Intra-synapse-type and intersynapse-type relationships between synaptic size and AMPAR expression. Current Opinion in Neurobiology. 22(3), 446-452.

Shinohara Y, Hirase H, Watanabe M, Itakura M, Takahashi M, Shigemoto R. 2008. Left-right asymmetry of the hippocampal synapses with differential subunit allocation of glutamate receptors. PNAS (USA). 105, 19498-19503.

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.

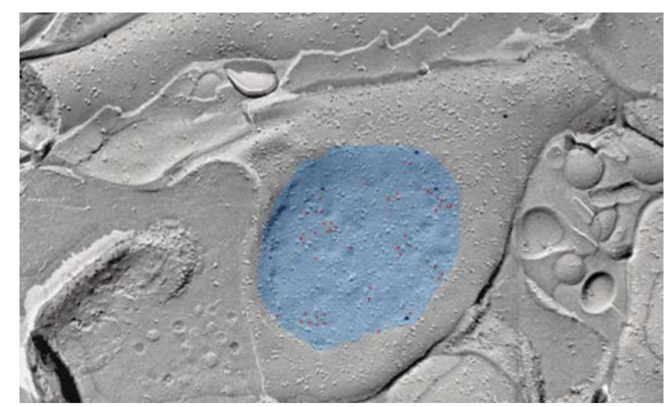
The release of neurotransmitters from a nerve cell into the synapse, where they act on receptors on the connecting nerve cell, is the primary method of information transmission and computation in the brain. The Shigemoto group studies the localization of single neurotransmitter receptors, ion channels, and other functional molecules to understand the molecular basis of neuronal computation. 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. The Shigemoto group studies the molecular mechanisms for long-term memory formation and stabilization, focusing on motor and spatial learning, and emotional memory formation, mediated by structural changes in brain regions. They are also working on the input side-dependent asymmetry of synaptic connections, receptor allocations and behaviors, to clarify both its physiological significance and the mechanism of asymmetry formation. The laterality of brain function is well known in humans, but the molecular determinants of this laterality are still largely elusive.

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, Kyoto, Japan
1994	PhD, Kyoto University, Japan
1985	MD, Kyoto University Faculty of Medicine, Japan

Selected Distinctions

	ISI Highly Cited Researcher
2000	ISI Citation Laureate Award



Clustering of P/Q-type voltage dependent calcium channels (red) in the presynaptic active zone (blue) of parallel fiber-Purkinje cell synapses in the rat cerebellum.

Team Catarina Alcarva (PhD student), Pradeep Bhandari (PhD student), Matthew Case (PhD student), Felipe Andrés Fredes Tolorza (postdoc), Tanja Fuchsberger (predoctoral visiting scientist), Harumi Harad (postdoc), Elena Hollergschwandtner (scientific intern), Marijo Jevtic (PhD student), David Kleindienst (PhD student), Elodie Le Monnier (laboratory technician), Takafumi Miki (academic visitor), Jacqueline-Claire Montanaro-Punzengruber (senior laboratory technician), Hũseyin Cihan Önal (scientific intern), Maria Alejandra Silva Sifuentes (scientific intern), Teresa Spano (academic visitor), Shigekazu Tabata (postdoc), Ming-Zhu Zhai (laboratory technician)

Sandra Siegert

Neuroimmunology in Health and Disease

Current Projects

A genetic atlas of microglial cells during development | Microglial dynamics in sequential removal and functional restoration of cell types | Molecular mechanism of healthy and diseased microglia in human retinal circuit formation

Selected Publications

Siegert S, Seo J, Kwon EJ, Rudenko A, Cho S, Wang W, Flood ZC, Martorell AJ, Ericsson M, Mungenast AE, Tsai L. 2015. The schizophrenia risk gene product miR-137 alters presynaptic plasticity. Nature Neuroscience. 18, 1008-1016.

Siegert S, Cabuy E, Scherf BG, Kohler H, Panda S, Le Y, Fehling HJ, Gaidatzis D, Stadler MBE, Roska BM. 2012. Transcriptional code and disease map for adult retinal cell types. Nature Neuroscience. 15(3), 487-495.

Siegert S, Scherf BG, Del Punta K, Didkovsky N, Heintz NM, Roska BM. 2009. Genetic address book for retinal cell types. Nature Neuroscience. 12(9), 1197-1204.

Microglia are commonly thought to only be involved in an active immune defense. However, recent studies have shown that microglia respond to their neuronal environment and influence synapse formation and maintenance. Moreover, genome-wide studies described several disease-associated genes, which have been related to microglial function. This raises the fascinating question of how microglia know when to alter neuronal circuit elements without inducing circuit malfunction.

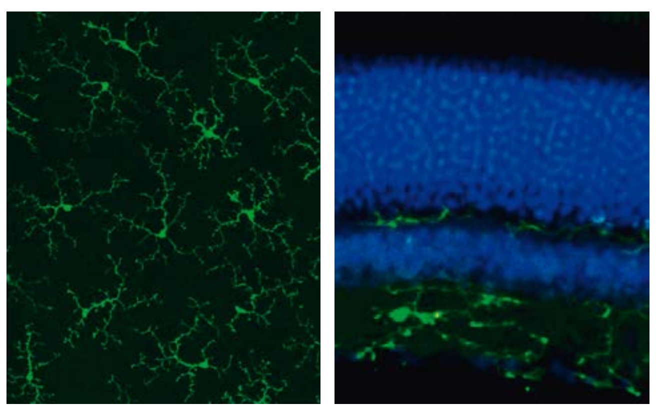
The main research focus of the Siegert group is to understand how neurons and microglia interact with each other, and how malfunctions within this relationship impact neuronal circuit formation and function in health and disease. They address this issue by taking advantage of the mammalian retina, which consists of morphologically well-defined cell types that are precisely mapped in their connection and functional properties. In the retina, microglial activation has been described in several inherited retinal degenerative diseases, however its role is unknown. In order to resolve these questions, they combine techniques from molecular biology, virology, genomics, (epi)genetics, and computational and multi-photon functional imaging. Additionally, they take advantage of reprogramming human-induced pluripotent stem cells into three-dimensional retinal structures to study human disease-relevant aspects.

Career

since 2015 Assistant Professor, IST Austria
2011 – 2015 Postdoctoral Associate, MIT, Cambridge, USA
2010 PhD, Friedrich Miescher Institute for Biomedical Research, Basel, Switzerland

Selected Distinctions

2016 ERC Starting Grant
2013 SWISS OphthAWARD
2012 HFSP Long-term Fellowship
2011 EMBO Long-term Fellowship
2011 Fellowship for prospective researchers, Swiss National Science Foundation (SNSF)



Left: Top view of microglial cells (green) in the mouse retina.
Right: Side view of the retina with the three nuclei layers labeled in blue.

Team Katarina Bartalska (laboratory technician), Gloria Colombo (PhD student), Tanja Himmel (intern), Marta Biarnes Martinez (scientific intern), Rajeshwari Meli (postdoc), Natasha Schmidt (academic visitor), Anna Schrempf (scientific intern), Rouven Schulz (PhD student), Alessandro Venturino (laboratory technician)

Daria Siekhaus

Invasive Migration

Current Projects

Communication between macrophages and the tissue barriers they move through | Regulation of adhesion during migration | Identifying the role of a novel transporter during invasive migration | Transcriptional control of invasive migration

Selected Publications

Ratheesh A, Belyaeva V, Siekhaus D. 2015. Drosophila immune cell migration and adhesion during embryonic development and larval immune responses. Current Opinion in Cell Biology. 36, 71-79.

Siekhaus D, Haesemeyer M, Moffitt O, Lehmann R. 2010. RhoL controls invasion and Rap1 localization during immune cell transmigration in Drosophila. Nature Cell Biology. 12(6), 605-610.

Siekhaus D, Drubin DG. 2003. Spontaneous receptor-independent heterotrimeric G protein signaling in an RGS mutant. Nature Cell Biology. 5(3), 231-235.

The ability of cells to migrate is crucial for their function in the immune system, the formation of the body, and the spread of cancer. The Siekhaus group investigates how cells move within the complex environment of an organism.

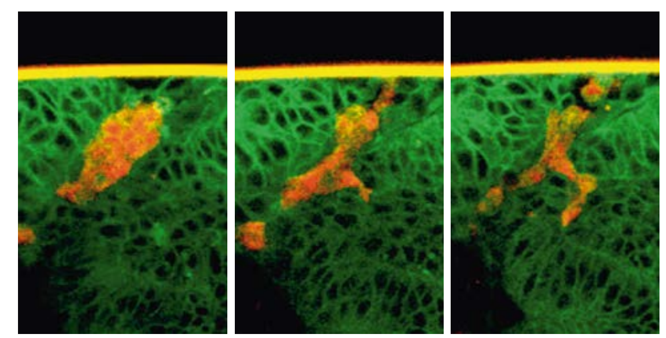
The group of Daria Siekhaus studies how immune cells penetrate tissue barriers, using the developmental movement of macrophages in the fruit fly *Drosophila melanogaster* as a model. Vertebrate immune cells use the vasculature as a highway to migrate through the body, and therefore also squeeze through blood vessel walls to reach infections in tissues. The Siekhaus group has shown that a cytokine needed for vertebrate immune cell vascular crossing is also required for tissue penetration in the Drosophila system. This similarity strengthens their confidence in the relevance of the fly model. The group's investigative focus is the functions of novel genes required in Drosophila macrophages for tissue penetration that are conserved in vertebrates, as well as three previously identified transcription factors. They use a combination of imaging, genetics, cell biology, and biophysics to identify the processes they affect and thus the strategies and principles that underlie invasive migration. The Siekhaus group is investigating the functions of the vertebrate orthologs of these novel genes in immune function and cancer metastasis.

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, USA

Selected Distinctions

2016 FWF Grant
2012 Marie Curie Career Integration Grant
2003 – 2005 NIH Fellowship



Immune cells (red) of the fruit fly *Drosophila melanogaster*.

Team Vera Belyaeva (PhD student), Julia Biebl (laboratory technician), Shamsi Emtenani (PhD student), Attila György (lab manager), Aparna Ratheesh (postdoc), Marko Roblek (postdoc), Katarina Valosková (PhD student), Stephanie Wachner (PhD student)

Michael Sixt

Morphodynamics of Immune Cells

Current Projects

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

Selected Publications

Kiermaier E, Moussion C, Veldkamp CT, Gerardy-Schahn R, de Vries I, Williams LG, Chaffee GR, Phillips AJ, Freiberger F, Imre R, Taleski D, Payne RJ, Braun A, Förster R, Mechtler K, Mühlenhoff M, Volkman BF, Sixt M. 2016. Polysialylation controls dendritic cell trafficking by regulating chemokine recognition. Science. 351(6269), 186-90.

Weber M, Hauschild R, Schwarz J, Moussion C, de Vries I, Legler DF, Luther SA, Bollenbach T, Sixt M. 2013. Interstitial dendritic cell guidance by haptotactic chemokine gradients. Science. 339(6117), 328-332.

Lämmermann T, Bader BL, Monkley SJ, Worbs T, Wedlich-Söldner R, Hirsch K, Keller M, Förster R, Critchley DR, Fässler R, Sixt M. 2008. Rapid leukocyte migration by integrin-independent flowing and squeezing. Nature. 453(7191), 51-55.

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 are able to migrate through tissues.

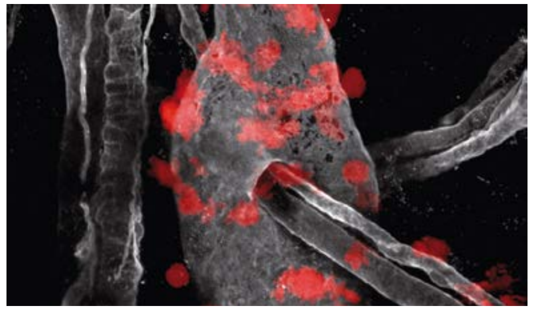
Most cells in our bodies are stationary, forming solid tissues and encapsulated organs. One exception is leukocytes, immune cells essential for both the innate and adaptive immune response to infections. Leukocytes migrate with extraordinary speed and are used by the Sixt group as a model to study cell migration. The group works at the interface of cell biology, immunology, and biophysics, and aims to identify mechanistic principles that might then be generalized to other migrating cells, such as metastasizing cancer cells or migratory cells during development or regeneration. A current focus of research is how the cell's internal skeleton, the actin cytoskeleton, generates the force to deform the cell body and how this force is transduced to the surrounding tissue in order to move the cell forward. The group also investigates other closely related aspects, such as cell polarization and guidance within tissues. To reach their goals, the members of the Sixt group combine genetics, pharmacology, micro-engineering, surface chemistry, and advanced imaging approaches. To test their findings in the context of living tissues, these reductionist approaches are complemented with in vivo imaging techniques.

Career

since 2013 Professor, IST Austria
2010 – 2013 Assistant Professor, IST Austria
2008 – 2010 Endowed Professor, Peter Hans Hofschneider Foundation for Experimental Biomedicine, Zurich, Switzerland
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 Full approbation in human medicine

Selected Distinctions

2014 EMBO Member
2013 European Biophysical Societies Association (EBSA) Young Investigator Medal
2013 Elected member of the Young Academy of the Austrian Academy of Sciences (ÖAW)
2012 Ignaz L. Lieben Award
2011 ERC Starting Grant
2011 FWF START Award
2008 Endowed Professor of the Peter Hans Hofschneider Foundation
2003 Novartis research price for the best medical dissertation at the University of Erlangen, Germany



Cells entering a lymph vessel.

Team Frank Assen (PhD student), Markus Brown (PhD student), Alessandra Maria Casano (postdoc), Ingrid de Vries (senior laboratory technician), Florian Reinfried Gärtner (postdoc), Miroslav Hons (postdoc), Eva Kiermaier (postdoc), Aglaja Kopf (PhD student), Alexander Leithner (PhD student), Jan Müller (PhD student), Maria Nemethova (senior laboratory technician), Jörg Renkawitz (postdoc), Anne Reversat (postdoc), Saren Tasciyan (PhD student)

Gašper Tkačik

Theoretical Biophysics and Neuroscience

Current Projects

Visual encoding in the retina | Genetic regulation during early embryogenesis | Collective dynamics | Evolution of gene regulation

Selected Publications

Friedlander T, Prizak R, Guet CG, Barton NH, Tkačik G. 2016. Intrinsic limits to gene regulation by global crosstalk. Nature Communications. 7, 12307.

Tkačik G, Bialek W. 2016. Information processing in biological systems. Annual Review of Condensed Matter Physics. 7, 89.

Cepeda-Humerez SA, Rieckh G, Tkačik G. 2015. Stochastic proofreading mechanism alleviates crosstalk in transcriptional regulation. Physical Review Letters. 115, 248101.

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 nevertheless perform their functions reliably. The Tkačik group uses biophysics and information theory to understand the principles and mechanisms behind this remarkable phenomenon.

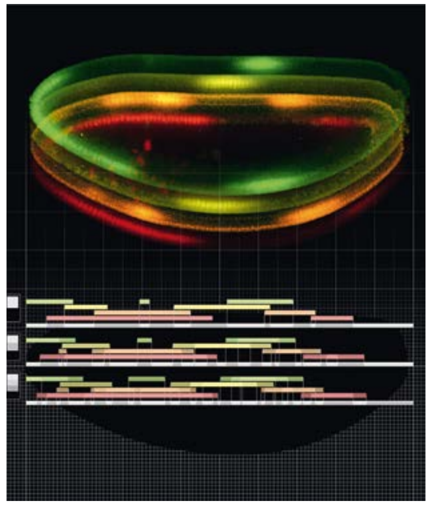
How can cells in a multicellular organism reproducibly decide what tissue they are going to become when this decision is based on noisy gene expression? How do neurons in the retina cooperate to best encode visual information about our world into neural spikes and send this information efficiently to the brain? How does the physics at the microscopic scale, which dictates how individual regulatory molecules interact with each other, constrain the kinds of regulatory networks that are observed in real organisms today? How do such networks arise through realistic evolutionary processes? These are some of the questions addressed by the Tkačik group. They use a combination of statistical physics and information theory to analyze, compare, and model examples of biological computation. About two thirds of their time is dedicated to data-driven projects that are done in close collaboration with experimental groups at IST Austria and elsewhere, with the remaining third spent on purely theoretical projects. Their goal is to develop theoretical ideas about biological network functions and connect them to high-precision or large-scale data.

Career

since 2016 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

Selected Distinctions

2012 HFSP Grant
2003 Burroughs-Wellcome Fellowship, Princeton University
2002 Golden sign of the University of Ljubljana



Analyzing positional information during fruit fly development.

Team Anna Andersson (postdoc), Katarina Bodova (postdoc), Vicente Botella-Soler (postdoc), Sarah Anhala Cepeda Humerez (PhD student), Matthew James Chalk (postdoc), Daniele De Martino (postdoc), Jan Humplik (PhD student), Anna Levina (postdoc), Roshan Prizak (PhD student), Georg Rieckh (PhD student), Cristina Savin (postdoc), Thomas Robert Sokolowski (postdoc)

Caroline Uhler

Algebraic Statistics and Mathematical Biology

Current Projects

Causal inference | Graphical models with hidden variables | Model selection in random graph models | Chromosome packing in cell nuclei | Privacy preserving data sharing for genomic data

Selected Publications

Uhler C, Raskutti G, Bühlmann P, Yu B. 2013. Geometry of faithfulness assumption in causal inference. Annals of Statistics. 41(2), 436-463.

Uhler C, Wright SJ. 2013. Packing ellipsoids with overlap. SIAM Review. 55(4), 671-706.

Uhler C. 2012. Geometry of maximum likelihood estimation in Gaussian graphical models. Annals of Statistics. 40(1), 238-261.

How are chromosomes packed into a cell's nucleus? How many observations are minimally needed for estimating interactions between genes? How can we estimate the dependence structure of weather variables in space and time? The Uhler group works on algebraic statistics and addresses questions in computational biology and weather forecasting.

Algebraic statistics exploits algebraic techniques to study statistical problems and to develop new paradigms and algorithms for data analysis and statistical inference. Algebraic methods have proven to be useful for statistical theory and applications alike. As such, the work of the Uhler group is at the interface of mathematical modeling, statistics and computational biology. On the theoretical side, the Uhler group works on gaining a better understanding of the mathematics and geometry of graphical models with hidden variables, particularly for causal inference. Another research direction is developing methods for model selection in random graph models. Projects motivated by biological problems include the understanding of the spatial organization of chromosomes inside the cell's nucleus. Gene expression is dependent on the proximity of different chromosomes and chromosomal regions. The Uhler group studies the organization of the mammalian genome under a probabilistic model, a fascinating problem at the interface of computational biology, statistics, optimization and computational geometry. Other questions addressed include the development of improved post-processing methods for weather prediction using discrete geometry.

Career

since 2011	Assistant Professor, IST Austria
2013	Research Fellow, Simons Institute, University of California, Berkeley, USA
2012	Postdoc, Seminar of Statistics, ETH Zurich, Switzerland
2011	Postdoc, Institute of Mathematics and its Applications, University of Minnesota, Minneapolis, USA
2011	PhD, University of California, Berkeley, USA

Selected Distinctions

2014	Elected Member of the International Statistical Institute (ISI)
2010 – 2011	Janggen-Poehn Fellowship
2007 – 2010	International Fulbright Science and Technology Award
2006	Best Student Award of the University of Zurich, Switzerland

Gaussian distributions on three nodes for which causal inference fails.

Team Anna Klimova (postdoc), Lenka Matejovicova (PhD student), Elisa Perrone (postdoc), Liam Solus (postdoc)

Beatriz Vicoso

Sex-chromosome Biology and Evolution

Current Projects

Sex chromosome turnover | Dosage compensation in female-heterogametic species | Ancient homomorphic sex chromosomes

Selected Publications

Pal A, Vicoso B. 2015. The X chromosome of hemipteran insects: conservation, dosage compensation and sex-biased expression. Genome Biology and Evolution. 7, 3259-3268.

Vicoso B, Bachtrog D. 2015. Numerous transitions of sex chromosomes in Diptera. PLoS Biology. 13(4), e1002078.

Vicoso B, Bachtrog D. 2013. Reversal of an ancient sex chromosome to an autosome in Drosophila. Nature. 499(7458), 332-335.

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.

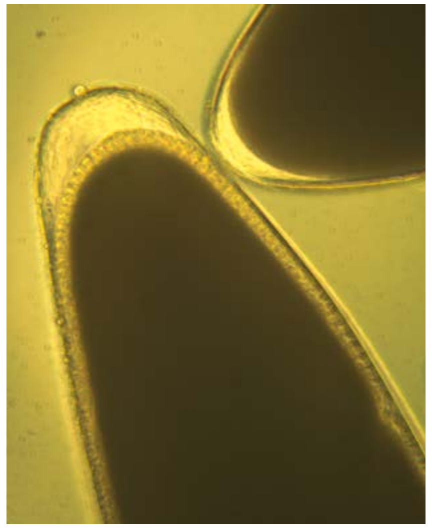
The Vicoso group is interested in understanding several aspects of the biology of sex chromosomes, and the evolutionary processes that shape their peculiar features. By combining the use of next-generation sequencing technologies with studies in several model and non-model organisms, they can address 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?

Career

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

Selected Distinctions

2016	ERC Starting Grant
2016	FWF Standalone Grant
2011	DeLill Nasser Travel Award from the Genetics Society of America



Sex is determined early in embryogenesis.

Team Claudia Engelmaier-Weber (laboratory technician), Claire Marie Fourcade (PhD student), Christelle Fraisse (postdoc), Ann Kathrin Huylmans (postdoc), Ariana Macon (laboratory technician), Marion Anne-Lise Picard (postdoc)

Uli Wagner

Combinatorics, Geometry, and Topology

Current Projects

Higher-dimensional embeddings (generalizations of graph planarity) | Topological Tverberg-type problems and multiple self-intersections of maps | Discrete isoperimetric inequalities and higher-dimensional expanders

Selected Publications

Mabillard I, Wagner U. 2014. Eliminating Tverberg points, I. An analogue of the Whitney trick. Proceedings of the 30th Annual Symposium on Computational Geometry. (SoCG). 171-180.

Matoušek J, Sedgwick E, Tancer M, Wagner U. 2014. Embeddability in the 3-sphere is decidable. Proceedings of the 30th Annual Symposium on Computational Geometry. (SoCG). 78-84.

Matoušek M, Tancer M, Wagner U. 2011. Hardness of embedding simplicial complexes in R^d. Journal of the European Mathematical Society. 13(2), 259-295.

How and when can a geometric shape be embedded in n-dimensional space without self-intersections? What restrictions does this place on the shape? These and other questions in combinatorial and computational geometry and topology are central to the Wagner group's research program.

A simplicial complex is a description of how to represent a geometric shape by gluing together points, edges, triangles, and their n-dimensional counterparts in a "nice" way. Simplicial complexes are a natural way to represent shapes for the purposes of computation and algorithm design, and the Wagner group explores both their topological properties, such as embeddability, as well as what can be proved about their combinatorics—e.g. bounds on the number of simplices—given a particular geometric or topological constraint. More generally, they take classically 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. Graphs can be thought of as one-dimensional simplicial complexes. However, there are numerous important concepts and results for graphs that so far have only partial or no higher-dimensional analogues, for instance related to graph planarity or crossing numbers, and the group works to develop such generalizations. They are moreover interested in the computational aspects of the above problems, in particular questions of decidability (does an algorithm exist?) and complexity (if so, what are the costs in terms of time or space?).

Career

since 2013	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
2003	PhD, ETH Zurich, Switzerland

Selected Distinctions

2014	Best Paper Award at the Symposium on Computational Geometry (SoCG)
2012	Research Assistant Professorship Grant of Swiss National Science Foundation (SNSF)
2012	Best Paper Award at Symposium of Discrete Algorithms (SODA)
2004	Richard Rado Prize

Team Sergey Avvakumov (PhD student), Marek Filakovský (postdoc), Peter Franek (FWF-supported postdoc), Radoslav Fulek, (ISTFELLOW postdoc), Kristóf Huszár (PhD student), Marek Krčál (postdoc), Isaac Mabillard (SNSF-supported PhD student), Zuzana Masárová (PhD student), Paval Paták (postdoc), Zuzana Patáková (FWF-supported postdoc), Stephan Zhechev (PhD student)

Chris Wojtan

Computer Graphics and Physics Simulation

Current Projects

Efficient simulation of fluid and fracture dynamics | Numerical and geometric algorithms for solving partial differential equations | Algorithms for re-using simulation data

Selected Publications

Hahn D, Wojtan C. 2015. High-resolution brittle fracture simulation with boundary elements. ACM Transactions on Graphics. 34(4) (Proceedings of SIGGRAPH 2015). Article 151.

Ando R, Thuerey N, Wojtan C. 2013. Highly adaptive liquid simulations on tetrahedral meshes. ACM Transactions on Graphics. 32(4) (Proceedings of SIGGRAPH 2013). Article 10.

Wojtan C, Thuerey N, Gross M, Turk G. 2009. Deforming meshes that split and merge. ACM Transactions on Graphics. 28(3) (Proceedings of SIGGRAPH 2009). Article 76.

Computer simulations of natural phenomena have become indispensable for scientific discoveries and industrial applications like virtual reality and special effects. However, fast and accurate simulations require intricate calculations and creative mathematical manipulations. The Wojtan group uses techniques from physics, geometry, and computer science to create efficient simulations and computer animations.

The Wojtan group focuses their research on the realistic simulation of complex processes in the physical world. In particular, physical phenomena like flowing fluids and shattering solids are both beautifully chaotic and overwhelmingly complex. This complexity makes such phenomena extremely difficult to compute without the aid of a supercomputer. The Wojtan group researches methods to overcome this complexity by combining rules of motion from physics, representations of deforming shapes from mathematics, and algorithmic optimizations from computer science to efficiently compute highly complicated natural phenomena with consumer-grade computing hardware. Recent research breakthroughs have led to the simulation of two-phase flows like splashing water, complex networks of soap foams, and intricate geometric features resulting from fracturing stone. In addition to developing new simulation methods, the Wojtan group also researches new workflows for leveraging and intuitively interacting with the overwhelming amount of data that results from physics simulations.

Career

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

Selected Distinctions

2016	ACM SIGGRAPH Significant New Researcher Award
2015	Eurographics Young Researcher Award
2015	Eurographics Gunter Enderle Best Paper Award
2014	ERC Starting Grant
2013	Microsoft Visual Computing Award
2011	Georgia Institute of Technology Sigma Chi Best PhD Thesis Award
2005	National Science Foundation Graduate Research Fellowship

Simulation of highly detailed surface tension phenomena such as the formation of water droplets using mesh-based surface tracking.

Team Morten Bojsen-Hansen (PhD student), Stefan Jeschke (postdoc), Ryoichi Ando (visiting scientist), David Hahn (PhD student), Ewa Gajda-Zagórska (postdoc), Hikaru Ibayashi (scientific intern), Julia Lyudchik (scientific intern), Camille Schreck (postdoc)

New Professors

Dan Alistarh

is a computer scientist studying the theory and applications of large-scale distributed systems. He obtained a double B.Sc. degree in computer science and mathematics from the Jacobs University Bremen, Germany, in 2007. For his PhD studies, Alistarh joined the École Polytechnique Fédérale de Lausanne (EPFL) in Switzerland and then moved to the Massachusetts Institute of Technology (MIT), Cambridge, USA, in 2012. In his thesis work, Alistarh focused on a better understanding of the power and limitations of computing in a concurrent, distributed setting. Since 2014, he has been a researcher at Microsoft Research Cambridge and a Morgan Fellow of Downing College at the University of Cambridge, both in the UK. Since his PhD, his work has been marked by a shift towards practical theory, yielding real-world algorithms and methodologies that have solid proofs and performance analyses. Alistarh will join IST Austria in September 2017.

Johann Danzl

is working in the field of biophotonics, developing new approaches for light microscopy with applications in biology and medicine. Danzl completed his medical studies (Dr. med. univ.) at the Medical University in Innsbruck, Austria, in 2005. Nearly simultaneously, he studied experimental physics at the Leopold Franzens University, also in Innsbruck, earning his diploma degree in 2007. Danzl remained at the Leopold Franzens University for his doctoral work in experimental physics, which he finished in 2010, and continued there as a postdoc until 2012. During this time, he worked on ultra-cold quantum gases and focused on ultra-cold ground-state molecules near quantum degeneracy with control over all internal and external molecular degrees of freedom at the level of single quantum states. From 2012 to 2016, Danzl was a postdoc in the Department of NanoBiophotonics at the Max Planck Institute for Biophysical Chemistry in Göttingen, Germany, working on nanoscale fluorescence imaging where innovative methods enable spatial resolution beyond the traditional bounds of light microscopy. Danzl will join IST Austria in March 2017.

Julian Fischer

is a mathematician working in the fields of applied analysis, partial differential equations, and numerical analysis. After his undergraduate studies in mathematics at the Friedrich Alexander University of Erlangen-Nürnberg in Germany, Fischer remained in Erlangen for his doctoral studies, where he worked on problems related to nonnegativity-preserving fourth-order parabolic equations. In 2013, he became a research assistant at the University of Zurich, Switzerland, and in 2014 he moved to the Max Planck Institute for Mathematics in the Sciences, Leipzig, Germany as a postdoc. Fischer's research centers on the rigorous theoretical and numerical analysis of partial differential equations motivated by problems in the applied sciences, with a current focus on stochastic homogenization and on modeling error estimates in fluid mechanics.
He will join IST Austria in January 2017.

Maximilian Jösch

is a neuroscientist in the field of systems neuroscience and neuroethology, seeking to understand the fundamental principles of how neuronal circuits create behavior. He studied biochemistry at the Eberhards Karls Universität in Tübingen, Germany, and from 2005 to 2009 performed his doctoral work at the Max Planck Institute of Neurobiology in Munich, Germany. As a graduate student, Jösch studied neuronal substrates of motion vision in the fruit fly *Drosophila melanogaster*. Jösch then worked as a postdoctoral fellow at Harvard University in Cambridge, USA, where he discovered a neuronal circuit for color vision in the rodent retina that relies on the interaction of rod and cone photoreceptors and developed a pipeline to quickly investigate targeted circuit motifs at ultraresolution. Jösch will move to IST Austria in January 2017.

Maksym Serbyn

is a theoretical condensed matter physicist. Serbyn studied physics at the Moscow Institute of Physics and Technology, Russia, from 2003 to 2009. Later, he moved to the Massachusetts Institute of Technology (MIT), Cambridge, USA for his graduate studies in physics. His PhD studies were dedicated to the study of quantum spin liquid, an antiferromagnetic state of matter that fails to order because of quantum fluctuations. Also at this time, Serbyn began working on non-equilibrium dynamics in isolated quantum many-body systems. Since 2014, Serbyn has been a Betty and Gordon Moor postdoctoral fellow at the University of California, Berkeley, USA, where he continued to work on many-body quantum dynamics and physics of strongly correlated condensed matter systems. Serbyn is perhaps best known for his work on many-body localization. Together with collaborators he introduced the description of many-body localized phase as a new type of integrability with an emergent extensive number of quasi-local conserved quantities. Serbyn will move to IST Austria in July 2017.

Grants Active or Acquired in 2016

BARTON GROUP

Speed of adaptation in population genetics and evolutionary computation, FP7 Cooperation ICT, €584'000, 1/2014-12/2016

Mating system and the evolutionary dynamics of hybrid zones, FP7 People MC-IIF, €179'000, 5/2014-4/2016

Rate of adaptation in changing environment, H2020 MSCA IF, €166'000, 1/2017-12/2018

BENKOVÁ GROUP

Hormone cross-talk drives nutrient dependent plant development, FWF International program, €349'000, 1/2015-12/2017

Plant gravitropism, FFG Femtech, €8'000, 7/2016-12/2016

Molecular mechanism of auxin-driven formative divisions delineating lateral root organogenesis in plants, EMBO LTF, €75'000, 7/2016-7/2018

BICKEL GROUP

Distributed 3D object design, H2020 MSCA ITN, €256'000, 1/2015-12/2018

Soft-bodied intelligence for manipulation, H2020 Cooperation ICT, €261'000, 5/2015-4/2019

MATERIALIZABLE: Intelligent fabrication-oriented computational design and modeling, H2020 ERC Starting Grant, €1'498'000, 3/2017-2/2022

BOLLBACK GROUP

Selective barriers to horizontal gene transfer, H2020 ERC Consolidator Grant, €1'821'000, 6/2015-5/2020

BOLLENBACH GROUP

Optimality principles in responses to antibiotics, FP7 People MC-CIG, €100'000, 2/2013-1/2017

Revealing the fundamental limits of cell growth, HFSP Program grant, €273'000, 9/2013-8/2016

Revealing the mechanisms underlying drug interactions, FWF Stand-alone, €349'000, 1/2015-12/2017

CHATTERJEE GROUP

Microsoft Research Faculty Fellowship, €143'000, 4/2011-3/2017

Quantitative graph games: theory and applications, FP7 ERC Starting Grant, €1'163'000, 12/2011-11/2016

Game theory, FWF NFN, €330'000, 3/2015-2/2019

Efficient algorithms for computer aided verification, WWTF Coop. project, €82'000, 3/2016-3/2020

CREMER GROUP

Individual function and social role of oxytocin-like neuropeptides in ants, WWTF Coop. project, €156'000, 1/2014-12/2017

Viral pathogens and social immunity in ants, FWF Meitner, €161'000, 7/2016-6/2018

CSICSVARI GROUP

Memory-related information processing in neuronal circuits of the hippocampus and entorhinal cortex, FP7 ERC Starting Grant, €1'441'000, 11/2011-10/2016

Inter- and intracellular signalling in schizophrenia, FP7 People MC-ITN, €240'000, 10/2013-9/2017

Interneuron plasticity during spatial learning, FWF International Program, €256'000, 1/2015-12/2017

EDELSBRUNNER GROUP

Persistent homology - images, data and maps, FP7 People MC-IEF, €248'000, 4/2014-3/2016

Persistent homology, FFG Femtech, €2'000, 8/2016-9/2016

Persistence and stability of geometric complexes, FWF International Program, €154'000, 9/2016-8/2020

ERDŐS GROUP

Random matrices, universality and disordered quantum systems, FP7 ERC Advanced Grant, €1'755'000, 3/2014-2/2019

Structured non-hermitian random matrices, FWF Meitner, €161'000, 1/2017-12/2018

FINK GROUP

Microwave-to-optical quantum link: quantum teleportation and quantum illumination with cavity optomechanics SUPEREOM, H2020 MSCA IF, €178'000, 4/2016-3/2018

Hybrid optomechanical technologies, H2020 Cooperation FET-Proactive, €548'000, 2/2017-1/2021

FRIML GROUP

Polarity and subcellular dynamics in plants, FP7 ERC Starting Grant, €1'269'000, 4/2013-1/2017

Effects of strigolactone analogues on subcellular distribution of dynamic PIN proteins in Arabidopsis, OEAD WTZ, €3'000, 1/2015-12/2016

Körber Prize, Körber Stiftung, €41'000, 4/2015-3/2017

Long Term Fellowship, EMBO LTF, €76'000, 2/2016-2/2018

Molecular basis of root growth inhibition by auxin, FWF Meitner, €121'000, 11/2016-4/2018

Cell surface receptor complexes for auxin signaling in plants, EMBO LTF, €75'000, 6/2017-5/2019

GUET GROUP

The systems biology of transcriptional read-through in bacteria: from synthetic networks to genomic studies, FP7 People MC-IEF, €187'000, 3/2014-2/2016

Effects of stochasticity on the function of restriction-modification systems at the single-cell level, OEAW DOC, €107'000, 1/2015-12/2017

Design principles underlying genetic switch architecture, OEAW DOC, €113'000, 1/2016-12/2018

Sigma switches, FFG Femtech, €8'000, 8/2016-1/2017

HAUSEL GROUP

Arithmetic and physics of Higgs moduli spaces, FP7 ERC Advanced Grant, €760'000, 9/2016-3/2018

Arithmetic quantization of character and quiver varieties, SNSF Professorships, €42'000, 9/2016-3/2017

HEISENBERG GROUP

Nano-analytics of cellular systems, FWF DK, €162'000, 3/2014-2/2018

Cell segregation in gastrulation: the role of cell fate specification, FWF International program, €304'000, 10/2014-9/2017

Role of chromatin organizer SATB2 in gastrulation in Danio rerio, OEAD WTZ, €6'000, 6/2015-5/2017

The generation and function of anisotropic tissue tension in zebrafish epiboly, EMBO LTF, €75'000, 7/2016-6/2018

HENZINGER GROUP

Automated tutoring system for automata theory, Microsoft Research Studio Award, €7'000, 1/2011-12/2017

Quantitative reactive modeling, FP7 ERC Advanced Grant, €2'326'000, 5/2011-4/2016

The Wittgenstein Prize, FWF, €1'500'000, 1/2014-12/2018

Modern concurrency paradigms, FWF NFN, €490'000, 3/2015-2/2019

HIPPENMEYER GROUP

Molecular mechanisms of cerebral cortex development, FP7 People MC-CIG, €100'000, 9/2013-8/2017

Quantitative structure-function analysis of cerebral cortex assembly at clonal level, HFSP Program grant, €270'000, 9/2014-8/2017

Mapping cell-type specificity of the genomic imprintome in the brain, NFB Life Science, €245'000, 3/2015-2/2018

Principles of neural stem cell lineage progression in cerebral cortex development, H2020 ERC Consolidator Grant, €1'996'000, 9/2017-8/2022

HOF GROUP

Decoding the complexity of turbulence at its origin, FP7 ERC Starting Grant, €1'396'000, 6/2013-12/2017

Experimental studies of the turbulence transition and transport processes in turbulent Taylor-Couette currents, DFG Forschergruppen, €273'000, 12/2013-11/2016

Eliminating turbulence in oil pipelines, H2020 ERC Proof of Concept Grant, €150'000, 7/2017-12/2018

JANOVJAK GROUP

Microbial ion channels for synthetic neurobiology, FP7 People MC-CIG, €100'000, 3/2012-2/2016

Molecular drug targets, FWF DK, €210'000, 3/2015-2/2019

JONAS GROUP

Nanophysiology of fast-spiking, parvalbumin-expressing GABAergic interneurons, FP7 ERC Advanced Grant, €2'500'000, 6/2011-5/2016

Zellkommunikation in Gesundheit und Krankheit, FWF DK, €143'000, 1/2016-6/2020

Presynaptic calcium channels distribution and impact on coupling at the hippocampal mossy fiber synapse, EMBO LTF, €76'000, 3/2016-3/2018

Is the hippocampal mossy fiber synapse a detonator in vivo?, H2020 MSCA IF, €166'000, 4/2016-3/2018

Presynaptic calcium channels distribution and impact on coupling at the hippocampal mossy fiber synapse, H2020 MSCA IF, €166'000, 1/2017-12/2018

Biophysics and circuit function of a giant cortical glumatergic synapse, H2020 ERC Advanced Grant, €2'678'000, 3/2017-2/2022

The Wittgenstein Prize, FWF, €1'500'000, 10/2017-9/2022

KATSAROS GROUP

Towards spin qubits and Majorana fermions in Germanium self-assembled hut-wires, FP7 ERC Starting Grant, €1'388'000, 2/2016-12/2018

Loch Spin-Qubits und Majorana-Fermionen in Germanium, FWF START, €200'000, 7/2016-4/2021

KICHEVA GROUP

Coordination of patterning and growth in the spinal cord, H2020 ERC Starting Grant, €1'499'000, 7/2016-6/2021

KOLMOGOROV GROUP

Discrete optimization in computer vision: theory and practice, FP7 ERC Consolidator Grant, €1'642'000, 6/2014-5/2019

LAMPERT GROUP

Lifelong learning of visual scene understanding, FP7 ERC Starting Grant, €1'465'000, 1/2013-12/2017

LEMESHKO GROUP

Quantum rotations in the presence of a many-body environment, FWF Stand-alone, €318'000, 2/2017-1/2020

LOOSE GROUP

Synthesis of bacterial cell wall, EMBO LTF, €87'000, 1/2016-12/2017

The biochemical basis of PAR polarization, FWF Firnberg, €227'000, 1/2016-12/2018

Self-organization of the bacterial cell, H2020 ERC Starting Grant, €1'497'000, 4/2016-3/2021

Reconstitution of bacterial cell wall synthesis, HFSP LTF, €157'000, 6/2016-5/2019

Reconstitution of cell polarity and axis determination in a cell-free system, HFSP Young Investigators' Grant, €300'000, 10/2016-9/2019

MAAS GROUP

Optimal transport and stochastic dynamics, H2020 ERC Starting Grant, €1'075'000, 2/2017-1/2022

Dissipation and dispersion in nonlinear partial differential equations, FWF DK, €143'000, 3/2017-2/2021

Taming complexity in partial differential systems, FWF SFB, €328'000, 6/2017-5/2021

NOVARINO GROUP

Transmembrane transporters in health and disease, FWF SFB, €348'000, 2/2015-1/2018

Molecular drug targets, FWF DK, €223'000, 3/2015-2/2019

Probing development and reversibility of autism spectrum disorders, Simons Foundation Pilot, €267'000, 9/2016-8/2019

Improving brain distribution of drugs targeted to the brain, NFB Life Science, €23'000, 12/2016-11/2019

Probing the reversibility of autism spectrum disorders by employing in vivo and in vitro models, H2020 ERC Starting Grant, €1'498'000, 9/2017-8/2022

PIETRZAK GROUP

Teaching old crypto new tricks, H2020 ERC Consolidator Grant, €1'882'000, 4/2016-3/2021

SAZANOV GROUP

The crystallization and co-crystal structure determination of bacterial mitochondrial complex I with proprietary inhibitors, BAYER, €150'000, 5/2015-10/2016

Atomic-resolution structures of mitochondrial respiratory chain supercomplexes, FEBS LTF, €77'000, 1/2016-12/2018

Atomic-resolution structures of mitochondrial respiratory chain supercomplexes, H2020 MSCA IF, €178'000, 9/2016-8/2018

SEIRINGER GROUP

Structure of the excitation spectrum for many-body quantum systems, FWF Stand-alone, €315'000, 4/2015-3/2018

Analysis of quantum many-body systems, H2020 ERC Advanced Grant, €1'498'000, 10/2016-9/2021

SHIGEMOTO GROUP

Localization of ion channels and receptors by two and three-dimensional immunoelectron microscopic approaches, FP7 Cooperation HBP, €234'000, 4/2014-3/2016

High resolution tagging for ion channels in neural membrane, FWF International program, €278'000, 7/2014-6/2016

Anatomical and functional properties of auditory nerve synapses, NIH, €17'000, 3/2015-2/2016

Mechanism of formation and maintenance of input side-dependent asymmetry in the hippocampus, OEAW DOC, €113'000, 1/2016-12/2018

Human Brain Project Specific Grant Agreement 1 (HBP SGA 1), H2020 Cooperation FET-Flagships, €274'000, 4/2016-3/2018

In situ analysis of single channel subunit composition in neurons: physiological implication in synaptic plasticity and behaviour, H2020 ERC Advanced Grant, €2'481'000, 7/2016-6/2021

SIEGERT GROUP

Microglia action towards neuronal circuit formation and function in health and disease, H2020 ERC Starting Grant, €1'500'000, 3/2017-2/2022

SIEKHAUS GROUP

Investigating the role of transporters in invasive migration through junctions, FP7 People MC-CIG, €100'000, 4/2013-3/2017

Examination of the role of a MFS transporter in the migration of Drosophila immune cells, OEAW DOC, €71'000, 7/2015-6/2017

Drosophila TNFα's Funktion in Immunzellen, FWF Stand-alone, €346'000, 11/2016-10/2019

Invasive migration, FFG Femtech, €6'000, 1/2017-4/2017

SIXT GROUP

Cytoskeletal force generation and force transduction of migrating leukocytes, FP7 ERC Starting Grant, €1'458'000, 4/2012-3/2017

Role of the WAVE-complex in the haematopoietic system, DFG Schwerpunktprogramm, €188'000, 11/2013-10/2016

Nano-analytics of cellular systems, FWF DK, €162'000, 3/2014-2/2018

Modeling of polarization and motility of leukocytes in three-dimensional environments, WWTF Coop. project, €196'000, 3/2014-2/2018

Molecular and system level view of immune cell migration, EMBO LTF, €97'000, 3/2015-2/2017

Mechanical adaptation of lamellipodial actin, FWF Stand-alone, €387'000, 3/2017-2/2020

Cellular navigation along spatial gradients, H2020 ERC Consolidator Grant, €1'985'000, 4/2017-3/2022

TKAČIK GROUP

Sensitivity to higher-order statistics in natural scenes, FWF Stand-alone, €351'000, 9/2013-8/2016

Biophysics of information processing in gene regulation, FWF Stand-alone, €341'000, 1/2016-12/2018

UHLER GROUP

Gaussian graphical models: theory and applications, FWF START, €985'000, 7/2015-6/2018

VICOSO GROUP

Sex chromosome evolution under male- and female-heterogamety, FWF Stand-alone, €224'000, 1/2016-12/2018

Prevalence and influence of sexual antagonism on genome evolution, H2020 ERC Starting Grant, €1'444'000, 9/2017-8/2022

WAGNER GROUP

Embeddings in higher dimensions: algorithms and combinatorics, SNSF Professorships, €174'000, 3/2013-6/2016

Robust invariants of nonlinear systems, FWF Meitner, €160'000, 2/2016-1/2018

WOJTAN GROUP

Efficient simulation of natural phenomena at extremely large scales, H2020 ERC Starting Grant, €1'500'000, 3/2015-2/2020

AWARDS AND PRIZES 2016

Bernd Bickel	ERC Starting Grant
László Erdős	External Member, Hungarian Academy of Sciences
Jiří Friml	Charles Albert Shull Award, American Society of Plant Biologists (ASPB)
Carl-Philipp Heisenberg	Member, European Molecular Biology Organization (EMBO)
Simon Hippenmeyer	ERC Consolidator Grant
Peter Jonas	ERC Advanced Grant Wittgenstein Prize 2016
Martin Loose	Young Investigator Grant, Human Frontier Science Program (HFSP)
Jan Maas	ERC Starting Grant
Gaia Novarino	ERC Starting Grant FENS-Kavli Scholar Simons Foundation Autism Research Initiative funds (SFARI) Award
Robert Seiringer	ERC Advanced Grant
Ryuichi Shigemoto	ERC Advanced Grant
Sandra Siegert	ERC Starting Grant
Michael Sixt	ERC Consolidator Grant
Beatriz Vicoso	ERC Starting Grant
Chris Wojtan	Significant New Researcher Award 2016 (ACM SIGGRAPH)

Communicating Scientific Results

Publications by IST Austria members published or accepted in 2016; joint publications involving several groups are listed multiple times.

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Scientific Events

Conferences, Symposia, and Workshops

In 2016, a variety of academic events were organized by the scientific community of IST Austria, some in collaboration with other universities and institutions; a representative selection is given here. In January, the Institute co-hosted a two-day meeting with Leica Microsystems and the Subcommittee of Structural and Analytical Biology of the Japanese Society of Microscopy. The meeting was an opportunity to discuss the future of electron microscopy, and also provided a platform for the active exchange of ideas on the latest trends and most advanced methods currently in use.

At the beginning of April, the FOR1182 Turbulence Spring School took place on campus. This two-day event served as the closing meeting for the joint project "Transport and Structure Formation in Turbulent Rayleigh-Bénard-, Taylor-Couette- and Pipe Flows near Solid Walls". Around thirty people from IST Austria and universities in Cottbus, Ilmenau, Marburg, and Erlangen had participated in the project and researched these three fundamental flows over the last six years.

CPS Week—the premier annual event on cyber-physical systems—attracted more than 800 global participants to the Hofburg in Vienna in mid-April. The event, which was organized by IST Austria, the Austrian Institute of Technology (AIT), and TU Vienna, combined four top conferences, as well as tutorials, workshops, a localization competition, and several exhibitions on various aspects of the research and development of cyber-physical systems. The particular themes of the week included embedded systems, hybrid systems, real-time systems, and sensor networks.

At the end of April, the postdocs and PhD students of IST Austria organized their fifth Young Scientist Symposium, with the theme "CONNECT! Do networks matter?". The one-day multidisciplinary event provided a broad overview of network properties and phenomena, and moreover gave participants the opportunity to meet and interact with experts from physics, biology, neuroscience, mathematics, and computer science.

In May, the cryptography group at IST Austria organized the 35th annual EUROCRYPT conference, one of the main events hosted by the International Association for Cryptologic Research. The five-day conference was held at the Aula der Wissenschaften in Vienna, and was dedicated to all practical and theoretical aspects of cryptography.

Also in May, the Information, Probability, and Inference in Systems Biology Conference (IPISB 2016) was held at IST Austria. The conference brought together experts in probability, information theory, stochastic systems, and experimental biology to develop a common understanding of the principles underlying cellular signaling and decision-making, and to develop quantitative analysis techniques to experimentally investigate these principles.

The workshop "Understanding Hybrid Zones" took place on campus in September. During this event, several groups met to discuss their research on hybrid zones—narrow regions where distinct populations meet—for a range of organisms, from snapdragons to sea squirts. One focus of the workshop was how these zones can be used to understand both gene flow between populations and speciation within a population. In addition to IST Austria, participants came from the Gregor Mendel Institute in Vienna, the University of Vienna, the Czech Academy of Sciences in Brno, and the University of Edinburgh.

IST Austria was also the host of a weeklong PhD course on social evolution in November, which aimed to foster communication between young scientists working in the field. Twelve PhD students and six invited scientists from around the world took part in the course, which comprised daily lectures, group work, poster presentations, and discussions. During the course, students had the chance to learn about the history of the field of social evolution, how it has grown, and—in the age of genomics—the molecular tools being used to understand sociality in animals.

Also in November, the joint Austrian-Japanese meeting "Understanding the Logic Behind Developmental Dynamics" was held on campus in collaboration with scientists from leading Japanese universities working in the field of 3D morphogenesis. The event provided a forum for discussions and information exchange, and laid the groundwork for possible future international collaborations.

THE INSTITUTE COLLOQUIUM

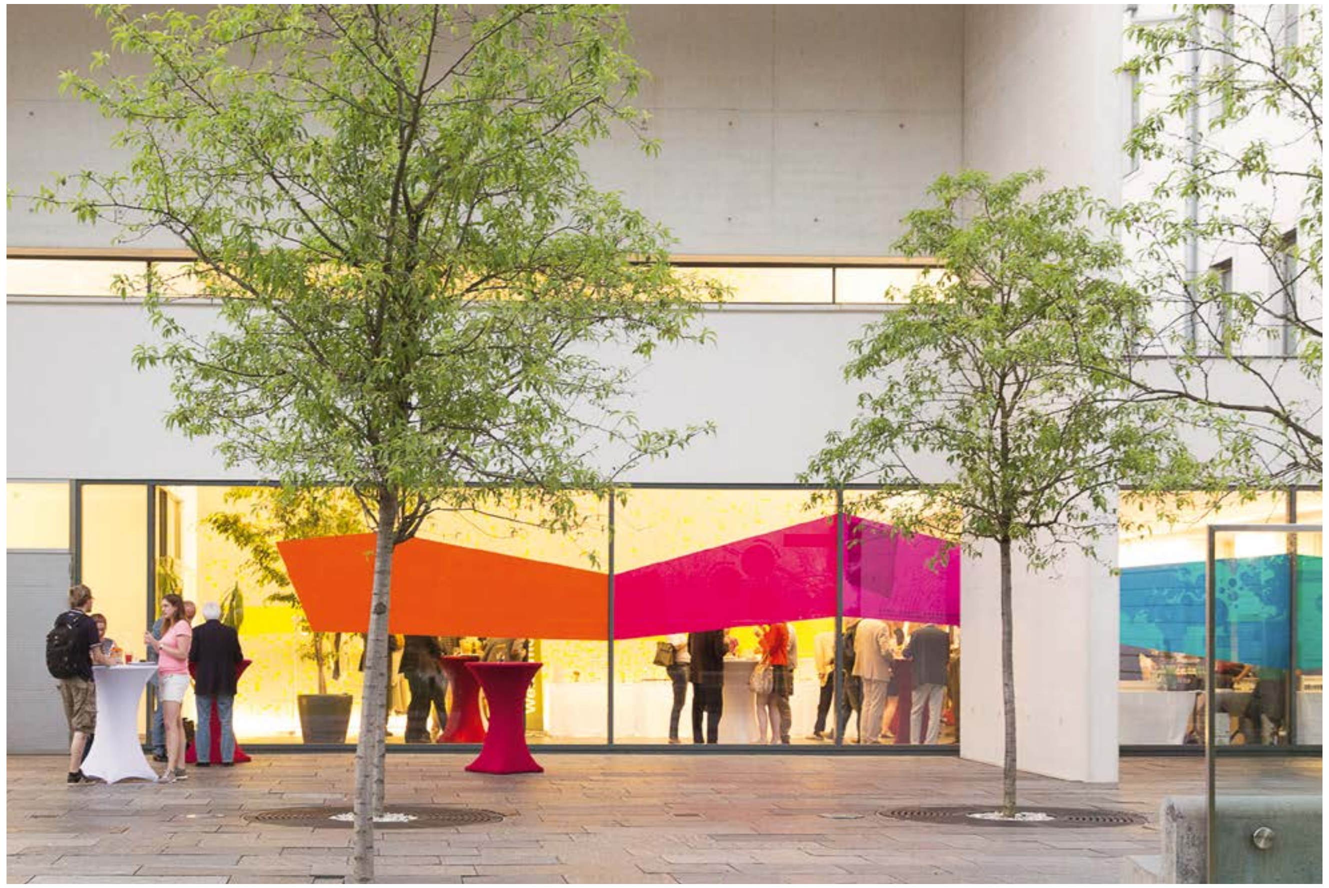
The Institute Colloquium is IST Austria's main weekly seminar, and not only are all scientists at IST Austria encouraged to attend, the talks are open to any interested member of the public. The colloquium talks address a broad range of topics in the fields represented at IST Austria—computer, life, mathematical, and physical sciences. Among the international experts who gave colloquium talks at IST Austria in 2016 were Frank Morgan from Williams College, James Briscoe from the Francis Crick Institute, and Kenneth Suslick from the University of Illinois at Urbana-Champaign.

More information about the Institute Colloquium can be found on the website, www.ist.ac.at.

Public Events

Communicating Science

IST Austria organizes numerous community events on campus and participates in many regional events to reach out to the general public. The goal is to raise public awareness of the importance of basic research and to foster an understanding of and appreciation for the sciences.



In April, IST Austria transformed into a meeting point for science and society. As the regional hub for the nationwide "Long Night of Research", the Institute hosted a total of 15 stations, representing ten research institutions from Lower Austria, including the International Institute for Applied Systems Analysis (IIASA), the Conrad Observatory, the Watercluster Lunz, and the Department for Cognitive Biology of the University of Vienna. IST Austria presented scientific findings at three stations, with a special focus on mathematics and computer science. The program also included two science slams and six talks by scientists. More than 500 science enthusiasts took the opportunity to find out more about the latest results in research.

Almost 2'000 guests of all ages explored the grounds of the Institute at "Open Campus" on a beautiful spring day in June. After President Tom Henzinger welcomed the visitors in the opening ceremony, moderator Oliver Lehmann interviewed the Vice Governor of Lower Austria, Johanna Mikl-Leitner, and the Mayor of Klosterneuburg, Stefan Schmuckenschlager, who particularly emphasized the importance of extracurricular activities such as Open Campus. Visitors enjoyed the awards ceremony of the school competition, the family lecture by IST Austria postdoc Matthias Fürst on "Ants as Role Models", and the bridge building competition. Campus tours and research islands provided fascinating insights into the labs and research at IST Austria.

The evening of June 6 was dedicated to the panel discussion "On the Way to the Top: What Makes a Research Institution Excellent?" Exactly ten years prior, on June 6, 2006, an international committee consisting of Haim Harari, Olaf Kübler, and Hubert Markl submitted a report to the Federation of Austrian Industries. This report outlined a concept for and recommended steps towards the establishment of IST Austria. Now, ten years later, the founding principles stated in the report continue to shape IST Austria's development, and bring the vision to reality. A select panel consisting of Patrick Aebischer (President of the École Polytechnique Fédérale de Lausanne (EPFL, 2000-2016)), Jonathan Dorfan (President of the Okinawa Institute of Science & Technology Graduate University (OIST, 2010-2016)), Peter Gruss (President of the Max Planck Society (2002-2014), Director Emeritus of the Max Planck Institute for Biophysical Chemistry, Chair of the Siemens Technology & Innovation Council), Haim Harari (Chair of the Executive Committee of the IST Austria Board of Trustees, President of the Weizmann Institute of Science (1988-2001)), Rolf-Dieter Heuer (Director General of CERN (2009-2015), President of the Deutsche Physikalische Gesellschaft), Olaf Kübler (President of ETH Zurich (1997-2005)), and Helga Nowotny (President of the European Research Council (ERC, 2010-2013), Chair of the ERA Council Forum Austria) discussed what it takes to achieve scientific excellence and become a first-class research center.

Summer saw further activities in the area of science education, amongst them a Czech-Polish-Slovakian training camp for participants of the Mathematics Olympiad, which took place in Hong Kong during July of 2016. Then, in August, IST Austria turned into a summer camp for elementary school children. 45 girls and boys aged 7-11 took their first steps into the world of science at the "Sommer Campus", a research discovery camp staffed by students of the University College of Teacher Education Lower Austria and IST Austria scientists. Research activities in physics, biology, and computer science were complemented by a campus-wide scavenger hunt and an excursion to the Zentralanstalt für Meteorologie und Geodynamik (Central Institute for Meteorology and Geodynamics). At the end of the week, the young scientists presented their work in an exhibition and proudly received their certificates at the graduation ceremony. Sommer Campus 2016 was supported by the Federal Ministry of Science, Research, and Economy, as well as the Government of Lower Austria.

The Sommer Campus was followed by the Science-Industry Talk on October 4. During the multi-panel event "New Science. New Business." international business leaders and technology transfer experts discussed the necessary ingredients for a successful translation of basic research into industry. IST Austria scientists and alumni moreover provided insights from the research perspective and their personal experiences. The event provided a forum to explore how best to support the development of spin-offs, cooperate with industry, and build an innovative ecosystem. The Science-Industry Talk series is organized in collaboration with the Federation of Austrian Industries to strengthen the relationship between industry and basic research.

IST LECTURES

IST Lectures are given by eminent scientists who are invited to present their research to the general public and the scientific community. On March 16, Nobel laureate Thomas C. Südhof spoke about "The Molecular Logic of Neural Circuits" at IST Austria. The Raiffeisen Lecture Hall was packed with people eager to hear the internationally recognized neuroscientist from the Stanford School of Medicine describe how neural circuits process information by transmitting and computing signals at synapses. In his IST Lecture, Professor Südhof provided a conceptual framework for understanding neural circuits in the human brain and how they are impaired in neuropsychiatric disorders.

"The Frontier of Fundamental Physics" was the inaugural talk of a new public lecture series, the ÖAW-IST Austria Lectures. The Austrian Academy of Sciences (ÖAW) and IST Austria initiated this joint lecture series with the goal of bringing to Austria speakers of the highest international standing who are active in fields of mutual interest to both institutions and the general public. Can there be a physical theory that explains all forces in the universe? "Yes", was the reply given by US physicist and Nobel laureate David Gross at the first ÖAW-IST Austria Lecture. On June 22 he presented a "theory of everything" in the ceremonial hall of the Austrian Academy of Sciences.

Nobel laureate Steven Chu gave an IST Lecture titled "Climate Change, Clean Energy and Nanotechnology for Energy" on November 30. The industrial and agricultural revolutions have profoundly transformed the world, but the unintended consequence of these revolutions is that these activities are also changing the climate of Earth. In his talk, Steven Chu, the William R. Kenan, Jr., Professor of Physics and Professor of Molecular and Cellular Physiology in the Medical School at Stanford University and the former US Secretary of Energy, described new satellite data monitoring climate change, how to make a low-cost transition to clean energy, and how nanotechnology can help meet the challenge.

On December 14, the Institute welcomed Professor Wolfgang Lutz for an IST Science and Society Lecture on campus. In his talk on "Human Capital as the Root Cause of Development and Policy Priority for the 21st Century", he presented state-of-the-art and multi-dimensional demographic analyses of changing global population sizes and structures.

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Pöttinger scholars,
Feyza Nur Arslan and Matilda Peruzzo

DONATIONS DEMONSTRATE CONFIDENCE IN IST AUSTRIA

In 2016, the Office of Stakeholder Relations, the department at IST Austria responsible for fundraising and liaison work, focused its activities on consolidating and extending IST Austria's network of supporters in Austria and abroad. The team hosted on average one campus visit per month by stakeholders from politics, industry, and philanthropy. In addition to connecting with potential donors, Stakeholder Relations hosted the second meeting of the recently-formed IST Austria Strategic Advisory Board in June 2016, which generated promising ideas for further fund-raising projects and prospects. The members of the Strategic Advisory Board are Willibald Cernko (Chief Risk Officer and Member of the Management Board at Erste Group Bank AG), Hermann Hauser (Founder of Amadeus Capital Partners Ltd), Steven Heinz (Director of Lansdowne Partners Austria Gmbh), Dr. Therese Niss, MBA (Federal Chair of the Junge Industrie), Dr. Rudolf Scholten (Former Director General of Österreichische Kontrollbank AG (OeKB)), Dr. Veit Sorger (Former President of the Federation of Austrian Industries), Dipl. Ing. Franz Viehböck (Chief Technology Officer of Berndorf AG), and Dr. Stefan Weber (Partner at Weber Rechtsanwälte GmbH).

New fundraising achievements in 2016 amounted to a total of EUR 1.02 million, generously donated by Allinvest Unter-nehmensbeteiligungs GmbH and one further donor. Fundraising has not only been an effort of the last year, however: during the ten-year period 2006-2016, IST Austria received EUR 18.7 million in private donations. Alongside the research- and education-based grants awarded to the Institute, these contributions brought the total given to the Institute by third parties to over EUR 100 million. The dona-tions, both new and old, demonstrate the confidence Austrian businesses and individu-als have in the quality of research at IST Austria, and in the Institute's importance for Austria's future.

Oliver Lehmann,
Head of Stakeholder Relations,
IST Austria

ENDOWING THE FUTURE OF RESEARCH

The Privatstiftung zur Förderung von Spitzen-forschung (Foundation for the Support of Research Excellence) transferred its assets to IST Austria in December 2016. The Foundation had administered the majority of the funds donated to IST Austria by Austrian companies since 2006. From 2017 on, these funds will be administered within a newly and specially established endowment in the tradition of US universities. The revenue generated by this endowment will be put towards the funding of professorships, research fellowships, and long-term research projects at IST Austria.

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Technology Transfer

Feeding the Entrepreneurial Bug

At the Science-Industry Talk 2016, IST scientists, business leaders, companies resident on campus, and IST graduates pursuing industry careers gathered and shared their experiences.

TECHNOLOGY TRANSFER OFFICE – TWIST

The Technology Transfer Office is the one-stop shop for all matters related to intellectual property, industry relations, and entrepreneurship at IST Austria. It is responsible for patent protection and licensing, and supports the creation of spin-off companies and cooperation with industry. A range of measures is offered to translate research results into product ideas that the Institute intends to commercialize through licensing and the support of start-ups.

ENTREPRENEURSHIP ACTIVITIES

For the first time this year, the Technology Transfer Office offered an entrepreneurship course that proved extremely popular and had high turn-out among students. As in previous years, the office invited speakers for the TWIST Talks from a variety of external organizations, including Haplogen, the Ethereum Foundation, Böhringer Ingelheim, and the Lead Discovery Center. To help develop promising inventions, the Technology Transfer Office introduced the TWIST Fellowship program in 2015. This fellowship program allows selected researchers to kickstart the development and translation of innovative technologies into commercially attractive assets. Fellows are supervised by Technology Transfer Office staff who guide them through the business maze.

INTELLECTUAL PROPERTY

As part of its ambition to develop technology transfer projects, IST Austria has continued to file patents on inventions with commercial potential. In total, IST Austria now has eight patent families on file in such diverse areas as optogenetic compounds, photo-patterning research tools, potential treatments for diabetes, and algorithms to generate flexible casting molds.

IST PARK

The project to build a science and technology park for research-intensive enterprises adjacent to the IST Austria campus is moving ahead. The joint development company between ecoplus—the business agency of Lower Austria—and IST Austria has secured sufficient commitments to start planning and construction of the first development phase. Until then, IST Austria is letting office space in the newly inaugurated Lab Building West to future residents of the Technology Park. Three companies, as well as an incubator for science-based start-ups, have so far been attracted to the Technology Park, which will officially open its first buildings at the end of 2018.

TWIST FELLOW NEWS

In September 2016, Andreas Anderluh started as a TWIST Fellow at IST Austria. Working in close collaboration with the group of Professor Janovjak, he seeks to establish market maturity for a novel, all-optical drug screening approach. To ensure a coordinated behavior in tissues, cells depend on cell surface receptors such as receptor tyrosine kinases (RTKs) that perceive extracellular signaling molecules. Due to their importance in shaping cellular behavior, RTKs are a major target for developing drugs against various diseases. Live cell systems are a crucial part of the automated screenings used for the identification of novel drugs. However, cell-based assays depend on the addition of reagents that activate and report cellular responses, often leading to complex operational design and high cost. The Janovjak group has used an optogenetic approach to develop light-controllable RTKs; these opto-RTKs offer a fast and easy approach for direct high-throughput identification of novel drugs such as RTK inhibitors. The method requires no additives for activation or readout, thus reducing the costs and improving specificity. Furthermore, since light is used as a stimulus, the method can be used to identify inhibitors of 'orphan' receptors (i.e. those for which the native activators are unknown). In addition to opto-RTKs, Andreas Anderluh also works to expand the all-optical drug screening to other disease-related protein families.

Scientific Service Units

Shared Scientific Resources and Services

"The Scientific Service Units (SSUs) at IST Austria give the researchers the support they need to perform at the technical state of the art. They provide them with know-how, infrastructure, technical support, routine services, and training. By centralizing infrastructure that is used by more than one research group, the facilities obey the principles of economy, adequacy, and cost effectiveness and guarantee the efficient use of well-maintained, cutting-edge equipment. The open user model also allows external scientists access to the facilities and fosters collaborations with other institutions. Since their establishment in 2009, the SSUs have continuously expanded their range of services to stay in line with the growth of IST Austria and its research scope. In 2016, a new SSU was established to meet the needs of our experimental physics groups: the Nanofabrication Facility provides all the tools and machines required for state-of-the-art micro- and nanofabrication processes."

Michael Sixt,
Vice President, IST Austria

The Scientific Service Units at IST Austria provide shared scientific support to researchers at the Institute. Set up in 2009, the Scientific Service Units have since grown to more than 76 employees in eight facilities. Their aim is to provide know-how and service for cutting-edge research at IST Austria through centralized acquisition, customized development, and training. The Scientific Service Units and their infrastructure may be used by any research group, providing up-to-date methodologies and facilitating interdisciplinary research at IST Austria. To promote the cost-effective and innovative use of equipment, the Scientific Service Units cooperate with similar facilities at other research institutes and universities in and around Vienna.

As of the end of 2016, eight Scientific Service Units have been established at IST Austria:

Bioimaging Facility: The Bioimaging Facility supports biologists with state-of-the-art microscopes and flow cytometry equipment.

Electron Microscopy Facility: The Electron Microscopy Facility provides electron microscopes, as well as sample preparation and image analysis facilities for the life sciences, physics, and—in the future—chemistry.

Nanofabrication Facility: The Nanofabrication Facility develops, optimizes, and maintains micro- and nanofabrication processes for experimental physics.

Library: The mainly electronic Library provides access to all types of scientific information, such as eJournals, eBooks, and databases, and supports open scientific communication.

Life Science Facility: The Life Science Facility supports experimental biologists by providing a laboratory infrastructure for the biological sciences, including refrigerators and centrifuges. In addition, the Life Science Facility supplies a wide range of experimental resources from liquid nitrogen to agar plates, and runs the fish and plant facilities.

Miba Machine Shop: The Miba Machine Shop produces non-conventional mechanical and electronic equipment for all experimental research groups.

Scientific Computing: Scientific Computing supports theoretical and experimental researchers for all scientific computing needs, primarily by providing a high-performance computing cluster.

Preclinical Facility: The Preclinical Facility provides the infrastructure for research groups whose investigations involve laboratory animals. One of its main duties is the breeding and documentation of wild-type and transgenic mouse and rat strains.

STAFF SCIENTISTS AT IST AUSTRIA

Staff scientists work closely together with various research groups on campus, organize trainings in preparation, imaging, and analysis techniques, and assist in the development of SSUs at the Institute. Typically associated with a specific SSU, staff scientists possess skills, expertise, and experience not usually present within the research groups, and their support and collaboration are critical to the success of a variety of projects at IST Austria. The Institute currently employs three staff scientists.

Robert Hauschild develops novel imaging solutions and applications as a staff scientist in the Bioimaging Facility. This includes design and realization of optical equipment for basic research, implementation of techniques that are not yet commercially available, modification and technological improvement of commercial equipment, automation, and image/data analysis.

Jack Merrin is a staff scientist in the Nanofabrication Facility, where he supports scientists, primarily from the life sciences, in incorporating microfluidics in their work.

Walter Kaufmann develops and optimizes sample preparation protocols and analysis procedures for electron microscopy techniques, and provides assistance for the application of advanced methods as a staff scientist in the Electron Microscopy Facility.

IST AUSTRIA'S NANOFABRICATION FACILITY

Dust grains seem small or even invisible to the human eye, and we are usually entirely unaware of the roughly 35 million particles that surround us in a typical cubic meter of air in our offices or homes. But compared to the transistors that comprise the microprocessors currently used in personal computers and mobile phones—millions of these transistors fit into a single microprocessor—dust grains are big, and their presence would be highly detrimental during the production of such devices.

Thus, in order to research and manufacture new microprocessor technologies, it is essential to work in an environment that has been cleaned of particles to the desired extent and is monitored continuously to ensure it remains so: a clean room, or, if it serves the production of nanoscale structures, a nanofabrication facility.

The Nanofabrication Facility (NFF) at IST Austria, which became partially operational in 2016 and will be fully operational in 2017, is equipped with all the state-of-the-art machines and devices required for the typical production of semiconductors and microprocessors. The overall space of 420 square meters encompasses rooms of category ISO 7 (class 10000) and ISO 6 (class 1000), as well as specific areas of ISO 5 (class 100), the last corresponding to levels of only about 100'000 particles larger than 0.1 micrometers per cubic meter. Nanofabrication procedures are essentially the same for all devices, and all the necessary steps can be performed at IST Austria. They are:

- Spin coating
- Light or electron beam lithography
- Metal deposition and/or etching
- Connecting contacts
- Electrical measurements

Spin coating: The top-down fabrication process, which resembles the art of sculpturing, starts with a material supported on a substrate. A thin layer of the material—usually a polymer—is distributed evenly by spinning it on top of the substrate.

Lithography: A pattern is then "written" onto the polymer layer by the means of light or electron beam lithography. The Raith EBPG 5150—the ultra-high performance electron beam lithography system—is the most important machine in the NFF. It is designed for high-resolution and high-accuracy patterning of devices on semiconductor wafers. The machine can load various sample sizes and quantities from parts of pieces to full wafer size. Highly-focused electron beams are used to draw nanometer-scale circuit patterns onto semiconductor wafers coated with resists, resulting in line widths down to less than 10 nm. A field emission scanning electron microscope (FE-SEM), the LoVac TENEO, can be used to verify the correct finalization of each step. The system allows for simultaneous loading of different samples and the possibility to work in low vacuum mode.

Deposition/Etching: After the pattern has been defined in the lithography process, material is added or removed by way of metal deposition or etching, respectively. The NFF of IST Austria has three systems for this important step in the manufacturing process: two for depositing metals of any kind in low, high, and ultra-high vacuum, the PLASSYS (HV) MEB 550S and the (UHV) MEB 550S2, and one for depositing insulating material. This latter system, the OXFORD instruments FlexAL-ALD (atomic layer deposition), allows material to be deposited atomic layer by atomic layer. For high quality and reproducible etching, the NFF of IST Austria has two identical pieces of equipment—the OXFORD PRO 100 COBRA ICP-RIE etcher—to avoid cross-contamination. One of the systems, which is based on fluoride, is used exclusively for deep silicon and germanium etching, the other, based on chloride, is for etching metals and insulators.

The processes of lithography, deposition (adding layers) and etching (removing unwanted parts of each layer) can be repeated an arbitrary number of times until the desired pattern is created. In this iterative procedure, lithography is the step that controls the outcome by regulating where material is added or removed by the other processes. The next two steps in nanofabrication, connecting the contacts and electrical testing, also require special equipment, but can be performed under normal air conditions.

Contact connection: A bonding machine connects the electric contacts of the microscopic device—typically a few micrometers across—with its socket. The latter is a macroscopic structure of centimeters across that allows easier handling of the final product. The NFF offers an F&S Bondtec 5330 Wire Bonder. This system has an aluminum wire with a diameter of 25 micrometers, and the operator can create different kinds of loops using the mechanical manipulator.

Electrical Measurements: In the last but very important step, electrical measurements are performed on the completed device to test its functionality.

At the moment, the NFF will primarily be used by groups investigating quantum transport physics. Specific projects include the study of spin qubits in Ge-based systems and the development of novel types of superconducting and photonic devices using advanced MEMS fabrication technologies.

The NFF is a multi-user and multi-disciplinary laboratory available to all research groups, which supports their research in and development of a broad range of micro- and nanotechnologies. The NFF is operated as an open-user facility; the reliability and quality of the NFF rely heavily on the actions and behavior of its users. Salvatore Bagiante, the manager of the Nanofabrication Facility, explains: "This model allows each student to develop his or her abilities and provides all scientific groups with access to a wide range of equipment, as well as the opportunity to test new methods in their device fabrication processes. The NFF is designed to be a flexible facility that can accommodate new professors who follow different research paths."

Administration

High-quality Support for World-class Research

"Over the past ten years, IST Austria was exceptionally successful in securing competitive funds from international and national funding agencies. Of the 45 professors currently under contract, 28 have received grants from the European Research Council. In 2016 alone, three Advanced Grants, two Consolidator Grants, and five Starting Grants were awarded to IST Austria scientists. These accomplishments, among many others, contributed to the more than EUR 83 million in external research funds acquired by the Institute, and, together with successful fundraising efforts, to the Institute's securing of the EUR 95 million conditional budget set aside by the Austrian Federal Government.

Additionally, the European Union awarded IST Austria two Marie Skłodowska-Curie COFUND grants, one worth EUR 4.4 million supporting its interdisciplinary PhD program and the other worth EUR 3.4 million for postdoctoral fellowships. The Austrian Science Fund supports IST Austria with around EUR 14.5 million, including three START and two Wittgenstein Awards.

The Grant Office provided valuable administrative support in securing grants worth EUR 25 million last year alone. The six-person team did an excellent job in advising the scientists on funding schemes and assisting them in drafting research applications. The grant management services they provided at IST Austria helped to exceed the target set by the government."

Georg Schneider,
Managing Director, IST Austria

Creating the best possible environment for world-class research is the central task of all administrative employees at IST Austria. Staffed with dedicated experts, five major divisions provide high-quality support in the following areas:

Academic Affairs: The division is responsible for administrating all academic matters. Its team coordinates the quality control of research at the Institute, organizes the recruitment process for professors and staff scientists, and coordinates meetings of the Scientific Board. Academic Affairs moreover supports postdocs and scientific visitors during their time at the Institute. The Graduate School Office within the division organizes the PhD program and academic courses, and manages the admissions and progress-monitoring processes for students.

Communications & Events: Its team provides services in media relations, scientific writing, web and social media management, alumni relations, event management, public outreach activities, and science education.

Construction & Maintenance: The division operates buildings and facilities on campus, including electricity, heating, ventilation and air-conditioning. Associated units include Environment, Health & Safety, and Campus Services, the latter of which takes care of the housing, food, transportation, and sports facilities.

Finance & Operations: Its team is in charge of accounting, controlling, and procurement. The Grant Office within the division advises scientists on funding schemes and assists in drafting research proposals and administrating approved grants.

Human Resources & Hospitality: Besides classic HR tasks, the division provides a variety of services, ranging from hospitality, gender and diversity, and dual career advice.

In addition to the divisions listed above, there are five administrative units that accomplish specialized tasks at IST Austria: Office of the President (including Stakeholder Relations), Executive Affairs (including Internal Audit, Legal Affairs, and Organization, Processes & Project Management), Technology Transfer, and Campus IT Services.

Grant Office

With awarded grants worth EUR 25 million, 2016 was the most successful year in the history of acquiring third-party funds at IST Austria. By the end of the year, the sum total of funds acquired so far exceeded EUR 100 million. As one third of the Institute's budget is conditional, the effective acquisition of third-party funds is essential for the growth of IST Austria. The Grant Office is designed to provide grant management services to all scientists at IST Austria. Pre-award operations include the development of a funding strategy, identification of grant opportunities, and support during proposal preparation. Special focus is put on assisting early-career scientists through specialized training and proposal coaching activities. Post-award tasks comprise account set-up, budget management, financial reporting, and close-outs. In order to understand and adhere to changing funding environments and grant management regulations, the Grant Office team undergoes continuous training. Networking with their colleagues from other institutions and universities plays an important role when it comes to exchanging knowledge and sharing best practices.

Boards of IST Austria

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The independent Board of Trustees oversees the development and strategic direction 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.

The Board of Trustees consists of 15 members. Eight of them are internationally well-known scientists, four are appointed by the federal government, and three are appointed by the government of Lower Austria.

EXECUTIVE COMMITTEE OF THE BOARD OF TRUSTEES

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Vice-Chair: *Reinhard Jahn*

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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

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The Scientific Board prepares recommendations for the scientific direction of the Institute. It provides guidance to ensure a continued high degree of scientific productivity, and among other duties, it commissions 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. Members of the Scientific Board are appointed by the Board of Trustees.

Location & Directions

1 Central Building
Science Offices, Guesthouse, Oberbank Ballroom, Mondi Seminar Center, Cafe/Pub
2 Raiffeisen Lecture Hall
3 voestalpine Building
4 Bertalanffy Foundation Building
5 Preclinical Facility
6 Lab Building East
9 Memorial
11 Facility Management
12 Heating Plant
13 Miba Machine Shop
16 Power Control
21 Lab and Office Building West
25 Cafeteria
27 Kindergarten
31-35 Apartments
41 Tennis Courts
42 Soccer Field
43 Pond

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