IST AUSTRIA
Institute of Science and Technology

Annual Report 2014

years

IST Austria Annual Report 2014

5 years of networking

As IST Austria celebrated its fifth anniversary in 2014, this annual report not just reviews the last year but also provides facts, figures, and numbers relevant to the first five years of IST Austria.
Scientists at IST Austria rely on professional networks to conduct excellent research. They work in teams and collaborate with research groups from numerous universities and institutes in Austria, Europe, and elsewhere. They meet colleagues at international events to exchange ideas and share their findings. As academic networking is crucial for scientists at IST Austria, “network” has been chosen as an ancillary theme for the 2014 annual report.

Number of chemical explosions since 2009: Almost none

Content

IST Austria Scientists

(December 31, 2014)

- 16.9% Germany
- 10.5% Austria
- 9.3% United States
- 7.7% United Kingdom
- 5.6% Belgium
- 4% Switzerland
- 3.6% France
- 3.2% Italy
- 3.2% Japan
- 2.8% Canada
- 2.8% Czech Republic
- 2.8% Spain
- 2.4% Hungary
- 2.4% Poland
- 2% Netherlands
- 2% Russian Federation

less than 2% each Australia, Bulgaria, Chile, China, Croatia, Cuba, Denmark, Finland, India, Iran, Israel, Kazahkhstan, Mexico, New Zealand, Norway, Portugal, Romania, Singapore, Slovakia, Slovenia, Sweden, Turkey, Ukraine

Scientists from all over the world come to IST Austria. The world map indicates the countries where their previous institutions are located. The graphics on the left-hand side give an overview of their nationalities as represented on campus.

The Vision Alive

The annual report is an opportunity to look back at what we have achieved. As we celebrated the fifth anniversary of IST Austria last year, I would like to invite you to take a brief journey with us through time, and learn about how we grew from 30 employees in 2009 to 430 in 2014.

Thomas A. Henzinger *President, IST Austria*

In June 2009, the IST Austria campus opened in Klosterneuburg, only 18 months after beginning the renovation and construction work at a former hospital site. I arrived from Switzerland to start work together with three other research groups and almost 20 administrative employees. In 2010, the first laboratory building for experimental science was completed and the Graduate School was in its first recruiting season. What had once been an idea of a new institute for basic research had become reality and duly featured on the cover of our first annual report titled “From Vision to Reality”. The main challenge was, and still remains, to attract excellent researchers while developing the nascent institute and its evolving campus step by step. Our continued success in meeting this challenge is perhaps best illustrated by the steadily increasing number of applications that IST Austria receives at all levels.

In 2014, six new professors, chosen from about 1’000 applicants, signed a contract with us. Three of them, together with 25 new doctoral students selected from about 1’500 applicants from almost 100 countries, started working on campus. This brings the total number of research groups to 31, among them are 16 experimental groups, bringing the current number of students to almost 100. There are now more than 250 scientists on campus, from more than 50 countries, supported by seven scientific service facilities. In 2012, we opened a second laboratory building and the third one will be finished in the upcoming year. In five short years, IST Austria has become an international top destination for science in biology, neuroscience, computer science, and mathematics, and has taken the first steps towards being put on the map in physics.

Ten students have already graduated from the Institute with a PhD degree, most of them pursuing postdoc positions in Europe and North America. Several of our postdocs have been hired as professors in 2014 in the Czech Republic, France, and the United States. Our scientists have already published more than 660 research articles, many of them in renowned journals such as Nature and Science. We have hosted close to 600 scientific talks and welcomed more than 220 scientific visitors. 15 of our current 31 faculty members have been awarded the coveted ERC Grants of the European Union. In 2014, in addition to the many ongoing collaborations, 13 new networking projects were selected by international peers for funding scientists at IST Austria together with researchers in Austria, the Czech Republic, France, Germany, Italy, Japan, Switzerland, the United Kingdom, and the United States. So far, three of our assistant professors have been promoted to tenured professors after undergoing extensive reviews.

The development of IST Austria had so many mothers and fathers that any list would be inherently incomplete. I would like to thank our donors and funders, our collaboration partners, advisers and friends all over the world, the federal and provincial governments, the members of our boards and committees, and especially the family of IST Austria for their passion and enthusiasm. You all have made IST Austria a successful and exciting hub for science. I am very much looking forward to continuing to shape IST Austria’s further growth and vision of excellence together with you.

Guest Commentary by **Arnold Schmidt**
Vice Chairman of the Scientific Board from 2007 to 2013

In 2006 an international committee released a concise report recommending the establishment of a high-class research institute for basic science in Austria. Authored by Haim Harari of the Weizmann Institute, Olaf Kübler of the ETH Zurich, and Hubert Markl of the Max Planck Society, the report prompted the Austrian parliament to pass a law that constituted the legal basis for the foundation of IST Austria. As the law was received with much acclaim at home and abroad – it also spurred some parochial skepticism – work could start right away. New buildings and facilities were erected, eventually changing the premises of an old hospital complex into a modern university campus.

Scientifically speaking, IST Austria has come to life in a remarkably short time. The research institute has been going to great lengths to attract highly motivated, ambitious, and gifted professors, postdocs, and graduate students from all over the world. More than anything else, my personal contacts with the researchers make me feel confident that IST Austria will prove to be a lasting success. Whenever I ask them why they have come to a research institute little known up to this day, I usually get the most fascinating answers. It is the spirit of the endeavor, the chance to engage with like-minded people, and the pleasure to work at a place whose primary aim is to conduct science for science’s sake. An American-style graduate school and the tenure-track career model are also considered major assets.

As a long-time observer of Austrian science policy, I think that the skepticism which IST Austria was facing in the beginning did not come as a big surprise. Neither the foundation of the Austrian Science Fund (FWF) in 1968 nor the establishment of the Institute of Molecular Pathology (IMP) some years later had been greeted with much enthusiasm. Within a few years, however, the FWF had a significant effect on science in Austria, raising the quality of science funding to a high and internationally respected standard. Additionaly the IMP played a decisive role in forming the Vienna Biocenter, a potent cluster of life sciences institutes. All this gives me the confidence that, within a decade, IST Austria will also be a widely recognized and highly respected research institute whose findings will have a major impact on the further development of science in Austria and beyond.

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.

Number of trees planted @ IST Austria since 2009: 218

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

Committed to pursue 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 maintain 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 research scientists. 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 one 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.

Faculty positions

	2014
Applications for faculty positions	1044
Faculty offers made	7
Faculty offers accepted	6

Student positions

	2014
Applications for student positions	1464
Student offers made	40
Student offers accepted	25
PhD graduates	4

Independent leadership

The long-term financial health of IST Austria will rely 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 1’280 million Euros in operational funds. Two thirds are guaranteed, while the remaining third is dependent on performance-related criteria such as raising third-party funds. The province of Lower Austria covers the costs for construction and campus maintenance, a total amount of 510 million Euros from 2007 to 2026.

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 and advised by the Scientific Board.

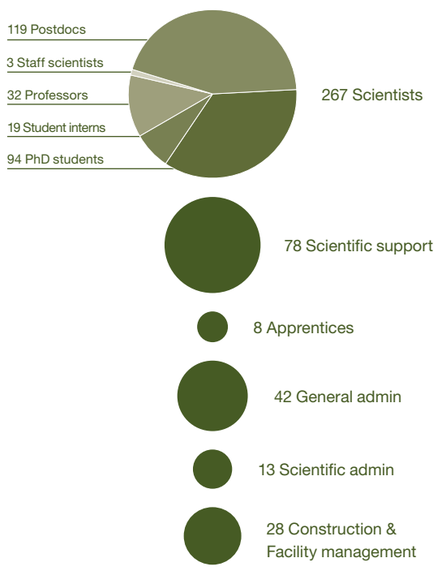
First President of the Institute is Thomas A. Henzinger, a computer scientist and former professor of the University of California at Berkeley and the EPFL in Lausanne, Switzerland. He is supported by Vice President Michael Sixt, who oversees the operation of the scientific service units. The administration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

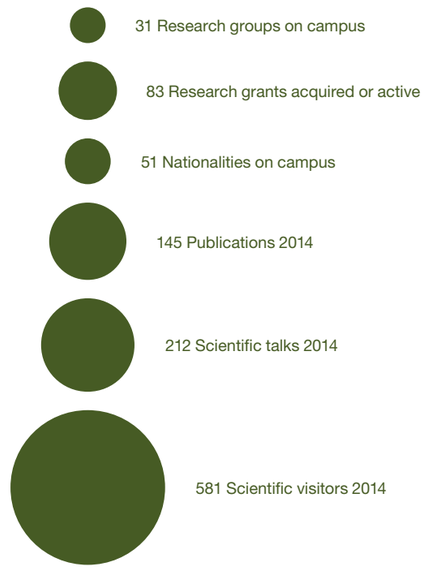
More information on IST Austria can be found at www.ist.ac.at, where you can also sign up for the Institute’s quarterly newsletter.

Number of extra-terrestrial scientists @ IST Austria: zero. (but 51 different nationalities)

Research grants (rounded amounts; acquired or active in 2014)

ERC European Research Council	22’260’000 €
FWF Austrian Science Fund	7’929’000 €
EU Framework Program 7 / Horizon 2020	7’097’000 €
HFSP Human Frontier Science Program	1’571’000 €
DFG Deutsche Forschungsgemeinschaft	771’000 €
ÖAW Austrian Academy of Sciences	426’000 €
WWTF Vienna Science and Technology Fund	352’000 €
NFB NÖ Forschung und Bildung	245’000 €
SNF Swiss National Science Foundation	174’000 €
Microsoft Research	119’000 €
EMBO Excellence in the Life Sciences	119’000 €
Others	207’000 €
Total	41’302’000 €





5 Years IST Austria

2014 saw the fifth anniversary of IST Austria. Opened in 2009, IST Austria has already grown into an internationally recognized research institute. With more and more scientists coming to the campus, it has developed into an interdisciplinary center for basic research and graduate education in the formal, physical, and life sciences. With several new lab buildings and scientific facilities put into operation, it has matured into a state-of-the-art environment where world-class research is conducted. The first five years of IST Austria, a high five for science and research!

In 2009 the first scientists took up their research on the IST Austria campus at Klosterneuburg. The remarkable number of rewards and donations acquired since prove that IST Austria has succeeded in meeting its extraordinarily high benchmarks in terms of excellence. By now there are 16 scientists working at IST Austria who have received an ERC grant. This interim result exemplifies what science can achieve if supported by politics in a sustainable manner and it's a proof of the international attractiveness of the location. I am confident that this cooperative approach will lay the groundwork for the translation of the research accomplishments into commercial applications.

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

The first half-decade of research at IST Austria and our general achievements in science and research enable us to draw a number of important conclusions:
1) Science and technology are the central drivers for a coherent and smooth conversion of a region into a technological front-runner and an innovation leader.
2) This conversion has a long-term impact on all aspects of societal activities in this region, especially on any form of education.
3) This conversion is without alternative. If we wish to preserve the essence of a society, we have to manage the change or else be managed by it. I congratulate IST Austria on its achievements so far and wish the institute a thriving future.

Erwin Pröll
Governor of Lower Austria

The first laboratory building was put into operation just one year after IST Austria had been opened and theoretical research had started. The opening of the **Bertalanffy Foundation Building** in 2010 marked the beginning of experimental research on campus.

Interview with Nick Barton

The 1st to Accept the Challenge

Ask Nick Barton what his research is about and he replies, "I do a lot of different things." And that is precisely what he likes about IST Austria: diversity. He is one of the leading population geneticists in the world and was the first professor to join the Institute. Nick Barton is reflecting on his first five years at IST Austria.

Nick, you were an established professor at the University of Edinburgh before you came to IST Austria. What motivated you to give up that position and start as the first professor at a brand-new institute?

NB: I was looking to move away from Edinburgh but couldn't see myself going to the US, and so was looking elsewhere in Europe. Vienna is one of the strongest places in Europe for evolutionary biology. So from the point of view of potential collaborators, Vienna was attractive for me.
When I saw the opportunity at IST Austria, with its strong emphasis on basic research, I was immediately attracted. It gave me the possibility of working with scientists from a wide range of fields, and that convinced me to set up my new office in Klosterneuburg. My research is centered on mathematical theories of evolution. In the UK, it is difficult to attract people with strong quantitative training into biology but the environment at IST Austria has helped me enormously to recruit the right people for the type of research that I do.

When you arrived as the first professor at IST Austria, the Institute was still a construction site with hardly anyone else around. What was that like for you?

NB: For me, an early move was possible because I had connections with groups in Vienna, and during the first year, I spent half the week there. However, IST Austria quickly became very active. Now, it is hard to find time for all the interesting seminars on campus, let alone getting to seminars in Vienna.

How did you experience the growth of the Institute and the development of your own research group over the last five years?

NB: The Institute has grown a lot and very quickly, which can sometimes make you rather dizzy. But it has been really interesting to be in a place where everyone does something very different, and to talk to people you wouldn't normally interact with—for example computer scientists. As a result, I now find myself with many more collaborations within the Institute rather than in Vienna.
We are now four evolutionary biology groups at IST Austria and my own group currently counts nine postdocs and five PhD students - two thirds of them with a background in mathematics or physics. We have shared projects with Gašper Tkačik in theoretical science and regularly interact with Krish Chatterjee and Tom Henzinger's computer science groups. Together, we address fundamental questions in both evolutionary biology and computation.

What were the challenges and opportunities associated with setting up a completely new institute?

NB: The main challenge has been to establish the best possible system, and we are fortunate to have almost complete freedom - and responsibility - for our choices. This applies not just to the administrative system, but also to setting up the best "culture" of open collaboration.
It has been especially important that everyone on the faculty takes an equal part in building the Institute and that we try to involve everyone - for example, inviting all at IST Austria to the annual retreat. This is becoming a logistical challenge as we are more and more people, but we hope to continue this in the future.
We have also created special seminars – "Think and Drink" and "The Big Think" – that allow students, postdocs, and faculty members to present their work and ideas to a very wide audience. This provides opportunities to develop skills and thoughts that would not be possible without the interdisciplinary environment.

What are the key developments and infrastructures that helped shape the Institute in the last five years?

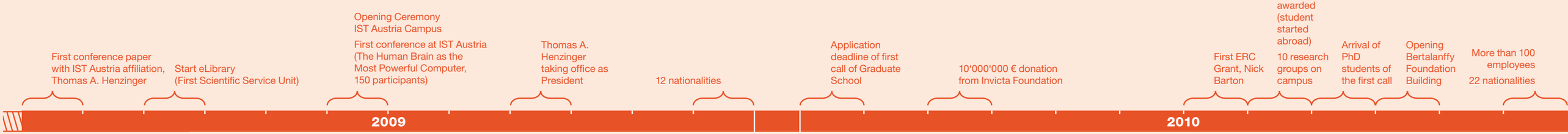
NB: To me, the most important component of IST Austria - and something almost unique in Europe - is the Graduate School. It's a single school that covers all the subject areas represented at IST Austria, which provides the students with a remarkably broad training. This is very much appreciated by them. The structure is modeled on the US system, with a central admission, coursework, and rotation projects. In the first year, we started with seven students, now we have 25 to 30 students per year.

Another important point is the culture of sharing – whether it is administration, space, equipment, or projects. When I first arrived, there were twelve administrators and one scientist. But even now, with many more scientists, the administration is wonderfully efficient – far beyond my experience anywhere else. This allows the scientists to really focus on science.
Sharing office and lab space, equipment, or lab meetings is similarly efficient. But equally important, it creates opportunities for interaction and exchange between people. So do the communal areas created in the different buildings – for example the blackboard on the bridge connecting the Central Building to the Bertalanffy Foundation Building.

Where do you see IST Austria in five years time?

NB: We have already grown from zero to more than 30 research groups and expect to nearly double in size over the next five years. There is currently a great atmosphere, with many collaborative lab meetings and interaction. I hope, and I expect, that we can maintain this unique environment as we grow towards maturity.

The former hospital building, still under construction when Nick Barton arrived in 2008, was transformed into the IST Austria **Central Building**. This is where most of the theoreticians are now accommodated.



Recognizing 5 years of excellence

Awards, prizes, research grants, and other honors are an important mark of recognition for scientists' work, and a metric for measuring research excellence. Over the past five years, scientists at IST Austria received such distinctions regularly at both the international and national level. Scientific results are shared with the community through publications in peer-reviewed journals and presentations at scientific conferences. From 2009 to 2014, IST Austria's scientists published more than 400 journal articles, presented over 230 refereed conference papers, and wrote several books.

International and national awards

2009: Mathematical biologist Nick Barton received the Darwin-Wallace Medal by the Linnean Society, one of the most prestigious awards in evolutionary biology.

2011: On the international level, computer scientist Krishnendu Chatterjee was awarded a Microsoft Research Faculty Fellowship. On the national level, the Austrian Academy of Sciences elected computer scientist Thomas A. Henzinger as member, and evolutionary biologist Sylvia Cremer as member of its Young Academy. Cell biologist Michael Sixt received a START Prize of the Austrian Science Fund (FWF).

2012: Thomas A. Henzinger was one of two recipients of the FWF Wittgenstein Award, which is the most important Austrian science prize. Michael Sixt received the Austrian Academy of Science's oldest award, the Ignaz L. Lieben Prize. Computer scientist Vladimir Kolmogorov was awarded the Koenderink Prize at the 2012 European Conference on Computer Vision.

2013: Nick Barton received the Mendel Medal by the German National Academy of Sciences Leopoldina and the Erwin Schrödinger Prize of the Austrian Academy of Sciences for his scientific achievements. Thomas A. Henzinger was named Fellow of the American Association for the Advancement of Science, for contributions to formal verification and hybrid systems. The Austrian Academy of Sciences elected Christoph Lampert and Michael Sixt as members of the Young Academy.
Sylvia Cremer received the 2013 Walther Arndt Award of the German Zoological Society for her research on ants' social immune system.

2014: The European Association for Theoretical Computer Science named ten of its members as Fellows for the first time in 2014, among them was Herbert Edelsbrunner, who was selected for his achievements in computational geometry. Edelsbrunner was also elected member of Austrian Academy of Sciences, and Jiří Friml as member of the Young Academy. Nick Barton and Michael Sixt were both elected members of the European Molecular Biology Organization, which recognizes the contributions of life scientists.

Grants

On the European level, the most prestigious grants for basic research are awarded by the European Research Council. The ERC is the first pan-European funding organization for the support of frontier research, and aims to stimulate scientific excellence in Europe by encouraging the very best scientists of any nationality to compete for funding. By the end of 2014, 15 of IST Austria's faculty members have been awarded such grants.

2009: ERC Advanced Grant for Nick Barton
2010: ERC Advanced Grants for Thomas A. Henzinger and Peter Jonas
2011: ERC Starting Grants for Krishnendu Chatterjee, Jozsef Csicsvari, and Michael Sixt
2012: ERC Starting Grant for Christoph Lampert
2013: ERC Consolidator Grant for Vladimir Kolmogorov, ERC Advanced Grant for László Erdős
2014: ERC Starting Grant for Chris Wojtan
Several faculty members received ERC Starting Grants before joining IST Austria: Eva Benková (2007), Sylvia Cremer (2009), Krzysztof Pietrzak (2010), Jiří Friml (2011), and Björn Hof (2012).

The Human Frontier Science Program (HFSP), a global funding agency, funds cutting-edge, risky projects pursued by international interdisciplinary teams. Six HFSP projects are pursued at IST Austria: Călin Guet and Michael Sixt (2011), Gašper Tkačik (2012), Harald Janovjak (2012), Tobias Bollenbach (2013), and Simon Hippenmeyer (2014).

Publications

Over the past five years, IST Austria's scientists have communicated their findings through more than 680 peer-reviewed articles. High-impact papers were published in all research areas studied at IST Austria. The publication list of 2014 can be found on pages 53 - 57.

Science is a Network

Scientists almost never do research in isolation, but usually in collaboration with others. IST Austria has research partners all over the world and influences the development of the national research landscape through an increasing number of local connections.

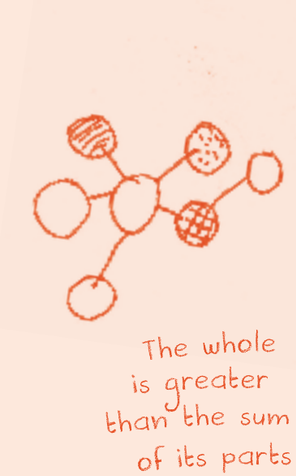
The buildings on campus may sparkle in the sunlight, and when you look out from inside the lab, the green surroundings make you feel far away from everything. But IST Austria is a networking institution, reaching out to over 200 universities and research institutes in 29 countries, and hosting and co-organizing events that draw many local and international visitors.

Participating in prestigious international projects

Science knows no national boundaries. In 2014, to add to the many ongoing collaborations, new projects were funded for IST Austria scientists working together with researchers in Austria, the Czech Republic, France, Germany, Italy, Japan, Switzerland, the UK, and the US.
Among them, IST Austria professor Simon Hippenmeyer together with three groups in the US and the UK studies how the brain region, which is controlling functions such as language and cognition, is assembled during development. This is done with support by a grant from the Human Frontier Science Program (HFSP).
Another example of a collaboration that began in 2014 is the EU project SAGE. It aims to develop a unified theory of the speed of adaptation in population genetics and evolutionary computation. In this project, IST Austria Professor Nick Barton's research group works together with universities in Jena and Sheffield.

Building national scientific excellence

IST Austria also strengthened its connections with the local research community and continues to help build scientific excellence in Austria. Three collaborative grants from the Austrian Science Fund (FWF) were renewed in 2014: a doctoral school (DK) on molecular drug targets with the Medical University of Vienna, the Vienna University of Technology, and the University of Vienna; a special research initiative (SFB) on transmembrane transport with the same three universities and the University of Linz; and a national research network (NFN) on rigorous systems engineering with the Technical Universities of Graz and Vienna and the universities of Linz and Salzburg.
A successful joint research infrastructure application with the University of Natural Resources and Life Sciences (BOKU) and the University of Veterinary Medicine ensures access to a new cutting-edge super-resolution microscope in Vienna.
Another example of teamwork that came to fruition in 2014: Harald Janovjak (IST Austria) and Michael Grusch (Medical University of Vienna) published work on engineered cell surface receptors that can be turned on and off by light with high precision. These are useful tools to study cell signaling in cancer and degenerative diseases.



PhD students and postdocs at IST Austria

Educating future researchers is one of the core missions of IST Austria. Young researchers are offered a world-class environment for the early stages of their scientific career.

By the end of 2014, 94 PhD students and 119 postdocs worked on campus.
The highly selective IST Austria Graduate School started its first academic year in September 2010. Seven PhD students from five countries, among them two Austrians, were the first year group to take up their studies in the natural sciences, computer science, mathematics, and interdisciplinary areas.

Once a year, the central admissions process is open to applicants from all over the world, who wish to begin their PhD studies at IST Austria in the subsequent September. Owing to the interdisciplinary research culture at IST Austria, all PhD students participate in a joint graduate program, which trains a new generation of researchers to approach scientific questions from different angles. In the first 12 to 24 months on campus, students attend courses from an interdisciplinary curriculum and work on projects with several research groups. This gives students both breadth and depth in their scientific education, and time to find a supervisor with whom they wish to pursue their doctoral research.

After successfully passing a qualifying exam, students focus on research towards a doctoral thesis. To allow PhD students to concentrate on their research, they are offered full-time employment contracts and a competitive salary. After a successful thesis defense, the student receives a PhD degree from IST Austria. By the end of 2014, eleven students have graduated from the IST Austria Graduate School. Young scientists who have already obtained a doctoral degree are supported at IST Austria throughout the early stage of their research careers as postdocs. To get exposed to different scientific approaches and research environments, it is strongly advisable for young researchers to switch institutions between the doctoral and the postdoctoral stages of their careers. Almost all postdocs at IST Austria have obtained their PhD degrees at institutions elsewhere. Postdocs perform largely independent scientific research under the supervision of a professor. Recent PhD graduates interested in working as a postdoc at IST Austria may apply directly to the research group leaders.

In 2013, IST Austria set up the highly selective ISTFELLOW program for postdocs, which emphasizes cross-disciplinary scientific approaches. ISTFELLOW is partially funded by the European Union through a Marie-Curie Action COFUND grant, and will - over a period of five years - support 40 international postdoctoral fellows for two years each. Applications for ISTFELLOW are handled centrally, and fellows are selected twice a year in October and April.

Meet some of our former students and postdocs ...

Among the first IST Austria Graduate School students to arrive on campus:
> Damien Zufferey joined IST Austria in August 2009. He graduated in September 2013 and now works as a postdoc at the Computer Science and Artificial Intelligence Laboratory of the MIT.

First student to arrive on campus:
> Simon Äschbacher started his PhD Program at the University of Edinburgh, UK, joined IST Austria in 2009, and now works as a postdoc at the Department of Evolution and Ecology of the University of California, Davis.

First graduate to go through the entire IST Graduate School process (application, selection, curriculum):
> To be found in next year's annual report

Among the first group of postdocs:
> Paul Bendich, joined IST Austria in 2009 and now works as Assistant Professor at the Mathematics Department of Duke University.

Others:
> Pedro Campinho, student alumnus of IST Austria; now postdoc at the Institute of Genetics and Molecular and Cellular Biology in Strasbourg, France
> Emilie Morvant, postdoc alumnus of the Lampert group; now Assistant Professor at the University of St. Etienne, France
> Guillaume Cheverau, postdoc alumnus of the Bollenbach group; now Lecturer at INSA Strasbourg, France
> Martin Tancer, postdoc alumnus of the Wagner group; now Lecturer at Charles University in Prague, Czech Republic
> Ulrich Bauer, postdoc alumnus of the Edelsbrunner group; now Assistant Professor at TU Munich, Germany
> Thomas Wies, postdoc alumnus of the Henzinger group; now Assistant Professor at New York University, USA

Number of students starting 2009–2014

2009	*no call for PhD students*
2010	7 PhD students started
2011	16 new PhD students
2012	18 new PhD students
2013	29 new PhD students
2014	25 new PhD students

In 2014, 94 PhD students from 32 countries work at IST Austria

Number of postdocs 2009–2014

2009	10 postdocs started
2010	15 new postdocs
2011	32 new postdocs
2012	26 new postdocs
2013	51 new postdocs
2014	44 new postdocs

In 2014, 119 postdocs from 38 countries work at IST Austria

2013: Start ISTernship Program; More than 300 employees; Full Professor Michael Sixt (First tenure evaluation); 51 nationalities

2014: Open Access Policy published; More than 400 employees; IST Park GmbH founded; 30 research groups on campus; 15th ERC grant awarded; 51 nationalities

Research Highlight Evolutionary Biology

Empire of Ants, Bacteria, and Numbers

Evolutionary biology at IST Austria is marked by a quantitative approach.

The work of all evolutionary biology groups at IST Austria combines mathematical modeling with empirical investigation in the lab and field. Both approaches support each other, in a fruitful cycle of theory and experiment: Mathematical models are used to make predictions, which are tested empirically. Experiments lead to results, used in turn to check and refine the mathematical models. This quantitative viewpoint spans the work of evolutionary biologists at IST Austria on topics ranging from the theory of evolutionary forces, evolutionary systems biology to the evolutionary ecology of epidemics. Through shared interests and common approaches, their research is strongly interconnected with the work of other scientists and disciplines within and outside IST Austria.

Nick Barton studies evolutionary genetics and focuses on how evolution leads to patterns we observe in nature. His group develops mathematical models of evolution to understand the evolutionary forces that act on populations distributed through space, and on populations in which many genes undergo selection. Nick Barton and his group explore the interconnections with other scientific fields. In one project, they use methods from physics to describe how evolution affects traits that are governed by several genes, such as body size. For another project, the Barton group collaborates closely with computer scientists at IST Austria and other European universities to study the speed of adaptation by combining approaches from evolutionary biology and computer science: population genetics and evolutionary computation. Biological evolution has produced an extraordinary diversity of organisms, even the simplest of which is highly adapted. Evolutionary computation mimics this process, creating an artificial evolution to produce innovative solutions to optimization and design problems. While population genetics has formalized biological evolution mathematically, evolutionary computation has developed tools of its own to understand how quickly evolutionary algorithms find solutions for adaptation. The Barton group seeks to unify the different methods and approaches used by population genetics and evolutionary computation to independently study the speed of adaptation, and to translate between the fields.

Jonathan Bollback seeks to understand in very fine detail how evolution works, using microbes as a powerful model system. His group uses synthetic biology to understand questions such as how evolution has shaped genetic switches. Genetic switches can turn genes on and off in response to a range of signals. Using methods from synthetic biology, the Bollback group constructs simple genetic switches. They disturb one, two or more components of the switch and then measure how well the genetic switch still works. By doing so, the group can test how robust genetic switches are in the face of disruptions and break down the interactions between their components. In another project carried out with Nick Barton, the group investigates the cost of bacterial immunity. Some bacteria have an adaptive immune system called Cas/CRISPR. This system protects them from viruses that attack bacteria, called bacteriophages, and plasmids, small pieces of DNA that can invade a bacterium. However, not all bacteria, and not even all bacteria in one population, possess this protective mechanism. The Bollback group therefore asks if bacteria have to pay the costs for having the Cas/CRISPR system, and if so, why and how. They also investigate CRISPR as a model to investigate the evolutionary mechanism of herd immunity.

Sylvia Cremer studies evolutionary ecology by investigating how ants react to disease by changing their individual and collective behaviors. In one project, her group looks at how ants interact with each other, and how this social network changes when a colony is infected with a pathogen. Combining their experimental work with the mathematical analysis of the network allows the group to study whether ants' behavioral changes are adaptive to prevent the spread of infections in the colony. By observing ants' contacts with each other during an infection, the researchers develop parameters for network models. Sylvia Cremer and her group use the social interaction networks of ants to apply and further develop epidemiological models of disease spread. This approach, carried out with collaborators at the Helmholtz Center in Munich, combines experiments with theory to gain insight into disease spread in societies. In a project undertaken with the Barton group, they also develop theoretical epidemiological models, describing unusual host-pathogen interactions. Aim of this work is to understand how disease is affected by host interactions, both in simple group living species and in the sophisticated societies of social insects expressing collective disease defences.

In 2015, evolutionary biologist **Beatriz Vicoso** will take up work at IST Austria. For her research into the comparative evolution of sex chromosomes, Beatriz Vicoso uses mathematical models of sequence variation and statistical analysis of DNA sequences in a variety of organisms.

The evolutionary biology groups at IST Austria have established strong connections with other evolutionary biology researchers through the evolVienna network. More than 50 research groups in and around Vienna study topics in evolutionary biology, making the Vienna region a hotspot of evolutionary research. The groups at several universities and research institutes connect and communicate through regular meetings in the evolVienna network.

Current Research at IST Austria

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

Mathematics


Caroline Uhler


Uli Wagner


Herbert Edelsbrunner


László Erdős


Jan Maas

Neuroscience


Peter Jonas


Jozsef Csicsvari


Simon Hippenmeyer


Gaia Novarino


Ryuichi Shigemoto

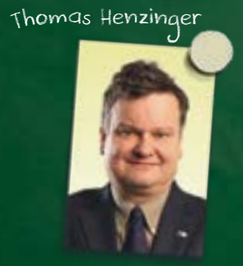
Computer Science


Chris Wojtan


Christoph Lampert


Bernd Bickel


Vladimir Kolmogorov


Thomas Henzinger


Krishnendu Chatterjee


Krzysztof Pietrzak

Physics


Mikhail Lemeshko


Johannes Fink


Robert Seiringer


Gašper Tkačik


Björn Hof


Georgios Katsaros

Evolutionary Biology


Beatriz Vicoso


Nick Barton


Jonathan Bollback


Sylvia Cremer

Cell Biology


Harald Janovjak


Călin Guet


Tobias Bollenbach


Michael Sixt


Eva Benková


Martin Loose


Carl-Philipp Heisenberg


Daria Siekhaus


Jiří Friml


Leonid Sazanov

Mathematical Models of Evolution

Nick Barton

How do new species emerge from a single population? Why do so many organisms reproduce sexually? How quickly can species adapt to changes in conditions? The Barton group develops mathematical models to probe fundamental issues in evolution.

Nick Barton and his group study diverse topics in evolutionary genetics. The main focus of their work is the evolution of populations that are distributed through space and that experience natural selection on many genes. Understanding how species adapt to their environment, and how they split into new species, requires understanding the effects caused by spatial subdivision. The distribution of genes through space can, in turn, tell us about evolutionary processes that are hard to measure directly. The interaction between large numbers of genes is important in the formation of new species as well as in their response to natural and artificial selection. The recent flood of genomic data makes analysis of the interactions amongst large numbers of genes essential, and the Barton group uses mathematical models to make sense of this mass of data and to find answers to fundamental questions 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 & hybridization in *Antirrhinum*

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

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

SELECTED PUBLICATIONS

> Weissman DB, Barton NH. 2012. Limits to the rate of adaptation in sexual populations. PLoS Genetics 8:e1002740.
> Barton NH, Turelli M. 2011. Spatial waves of advance with bistable dynamics: cytoplasmic and genetic analogs of the Allee effect. American Naturalist 178(3), E48-75.
> Barton NH, Briggs DEG, Eisen JA, Goldstein DB, Patel NH. 2007. Evolution. Cold Spring Harbor Laboratory Press.

TEAM

Tom Ellis (PhD student), David Field (Postdoc), Tamar Friedlander (joint ISTFELLOW Postdoc with Guet and Tkačik groups), Sebastian Novak (PhD student), Tiago Paixao (Postdoc), Pavel Payne (joint PhD student with Bollback group), Melinda Pickup (Postdoc), Jitka Polechova (Postdoc), Tadeas Priklopil (joint ISTFELLOW Postdoc with Chatterjee group), Harald Ringbauer (PhD student), Srdjan Sarikas (Postdoc), Murat Tugrul (joint PhD student with Tkačik group), Barbora Trubenova (Postdoc), Hildegard Uecker (Postdoc)

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

Plant Developmental Biology

Eva Benková

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.

Plant hormones regulate a multitude of processes, often overlapping and modulating their effects. The two hormones auxin and cytokinin show just how complicated these interactions can be: while they act together to promote cell division, they act antagonistically when regulating the lateral growth of roots. How these interactions are regulated on a molecular level is the main question pursued by the Benková group. To understand the components and mechanisms that balance the output of auxin and cytokinin signaling, they use the lateral outgrowth of roots in Arabidopsis as their model system. Recently, the group has shown that an important mode of interaction is the modulation of auxin transport through cytokinin. They now focus on how cytokinin can control the flow of auxin by controlling auxin efflux on the transcriptional and posttranscriptional level. To determine more components of this regulatory pathway, the Benková group applies profiling and genetic screens to investigate the interaction of cytokinin with the cellular endocytotic machinery. Novel cross-talk components will help the group reveal new mechanisms integrating auxin and cytokinin signaling.

Current projects

> Convergence of hormonal pathways on transport-dependent auxin distribution
> Identification of hormonal cross-talk components by genetic approaches
> Disclosing the molecular network mediating auxin-cytokinin interactions using a transcriptome profiling approach

CAREER

since 2013	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

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

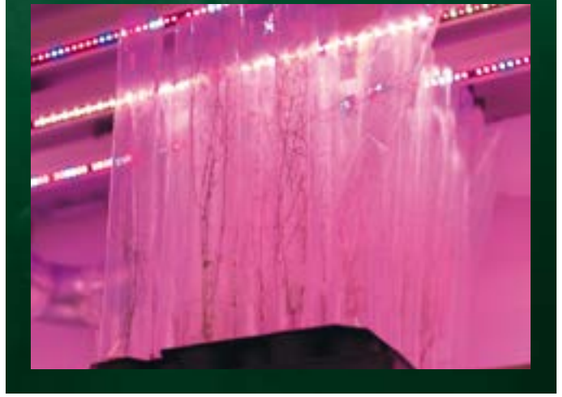
SELECTED PUBLICATIONS

> Marhavý P, Duclercq J, Weller B, Feraru E, Bielach A, Offringa R, Friml J, Schwechheimer C, Murphy A, Benková E. 2014. Cytokinin Controls Polarity of PIN1-Dependent Auxin Transport during Lateral Root Organogenesis. Curr Biol. 24(9):1031-1037.
> Marhavý P, Vanstraelen M, De Rybel B, Zhaojun D, Bennett MJ, Beeckman T, Benková E. 2013. Auxin reflux between the endodermis and pericycle promotes lateral root initiation. EMBO J. 32:149-158.
> Bielach A, Podlešáková K, Marhavý P, Duclercq J, Cuesta C, Müller B, Grunewald W, Tarkowski P, Benková E. 2012. Spatiotemporal regulation of lateral root organogenesis in Arabidopsis by cytokinin. Plant Cell. 24:3967-3981.

TEAM

Sonia Accossato (Student Intern), Andrej Hurny (PhD student), Mamoona Khan (ISTFELLOW Postdoc), Candela Cuesta Moliner (Postdoc), Peter Marhavy (Postdoc), Anna Müller (Technician), Krisztina Ötvös (Postdoc), Krzystof Wabnik (ISTFELLOW Postdoc), Qiang Zhu (Postdoc)

Plants in the plant growth chamber.



Microbial Experimental Evolution and Statistical Genomics

Jonathan P. Bollback

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. Firstly, how does adaptation differ between sexual and asexual populations? Microbes are mostly asexual, and asexuality slows down the rate of adaptation. Secondly, 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, via a process called horizontal gene transfer, from other individuals and species. Yet it is unclear what evolutionary forces are acting to promote and restrict this process.

Current projects

> The rate of adaptive evolution in sexual and asexual populations
> The evolution of an adaptive heritable immune system in bacteria

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

2007–2009	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

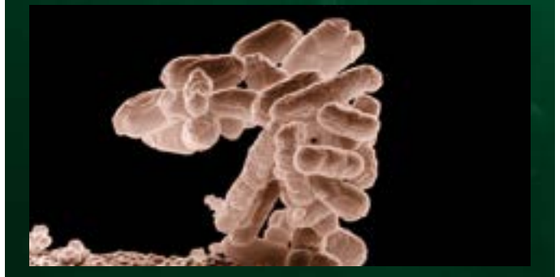
SELECTED PUBLICATIONS

> Redondo R, Kupczok A, Stift G, Bollback JP. 2013. Complete genome sequence of the novel phage MG-B1 infecting Bacillus weihenstephanensis. Genome Announcements. 1(3), e00216-13.
> Kupczok A, Bollback JP. 2013. Probabilistic models for CRISPR spacer content evolution. BMC Evolutionary Biology. 13:54.
> Bollback JP, Huelsenbeck JP. 2009. Parallel genetic evolution within and among bacteriophage species of varying degrees of divergence. Genetics. 181(1), 225-234.

TEAM

Hande Acar (PhD student), Claudia Igler (joint PhD student with Guet group), Fabienne Jesse, (PhD student), Mato Lagator (Postdoc), Pavel Payne (joint PhD student with Barton group), Isabella Tomanek (joint PhD student with Guet group)

A cluster of Escherichia coli.



Biophysics and Systems Biology

Tobias Bollenbach

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 Bollenbach group 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.

Current projects

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

CAREER

since 2010	Assistant Professor, IST Austria
2006–2010	Postdoc, Department of Systems Biology, 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
since 2011	Member of the Young Academy ("Junge Akademie") 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

SELECTED PUBLICATIONS

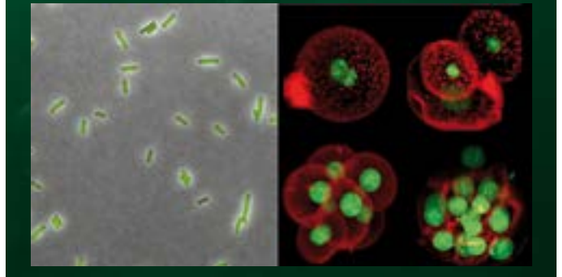
> Bollenbach T, Kishony R. 2011. Resolution of gene regulatory conflicts caused by combinations of antibiotics. Molecular Cell. 42(4), 413-425.
> Bollenbach T, Quan S, Chait R, Kishony R. 2009. Nonoptimal microbial response to antibiotics underlies suppressive drug interactions. Cell. 139(4), 707-718.
> 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.

**equal contribution*

TEAM

Veronika Bierbaum (Postdoc), Marta Dravecka (PhD student), Marjon de Vos (Postdoc), Martin Lukacisin (PhD student), Karin Mitosch (PhD student), Julia Tischler (Postdoc), Marcin Zagórski (Postdoc)

Green Fluorescent Protein in bacteria (left) and mouse embryos (right, image courtesy N. Plachta).



Computer-Aided Verification, Game Theory

Krishnendu Chatterjee

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, the study of interactive decision problems, can be used to study problems in logic and set theory, economics, cell, population and evolutionary biology, and the design of the internet. The Chatterjee group is interested in the theoretical foundations of game theory and formal verification. Game theory in the formal verification of software involves the algorithmic analysis of various forms of games played on graphs. This broad framework allows effective analysis of many important questions of computer science and helps in the development of software systems. The Chatterjee group works on theoretical aspects for the better understanding of games and develops new algorithms, presenting the theoretical foundations for the formal verification of systems.

Current projects

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

CAREER

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

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

SELECTED PUBLICATIONS

> Brazdil T, Chatterjee K, Forejt V, Kucera A. 2013. Trading Performance for Stability in Markov Decision Processes. Proc. of LICS. 2013, 331-340.
> Chatterjee K, Doyen L. 2012. Partial-Observation Stochastic Games: How to Win when Belief Fails. Proc. of LICS. 2012 175-184.
> Chatterjee K, Henzinger M. 2014. Efficient and Dynamic Algorithms for Alternating Büchi Games and Maximal End-Component Decomposition. J ACM. 61(3):15.

TEAM

Martin Chmelik (PhD student), Rasmus Ibsen-Jensen (Postdoc), Jan Kretinsky (ISTFELLOW Postdoc), Andreas Pavlogiannis (PhD student), Johannes Reiter (PhD student)

Fighting Disease as a Collective: Social Immunity in Ants

Sylvia Cremer

To counteract the high risk of disease spread in their dense and highly related colonies, social insects have evolved collective disease defenses to prevent epidemics. Sylvia Cremer's group investigates social behavior and evolutionary immunology in ants and its impact on disease management in insect societies.

Social insects like ants live together in densely populated colonies, facing a high risk of disease transmission among group members. Disease outbreaks are, however, kept in check as social insects have evolved collective anti-pathogen defenses – a so-called "social immune system" – that complement the individual immune systems of colony members. The Cremer group studies all aspects of social immune defenses in ants to learn more about disease management and epidemiology in societies.

Collective immune defences are based on three pilars: (1) joint or mutual expression of sanitary behaviours, (2) the use of antimicrobial compounds in e.g. nest hygiene, and (3) a social interaction network that minimises disease spread, particularly towards the most valuable and vulnerable colony members, like the queen and the brood. Such "organisational immunity" can arise due to an inherent network property of the colony, for example due to individuals performing particular tasks at a given age and interacting preferentially amongst each other, or due to modulation of interaction types and frequencies upon infection of group members. The Cremer group studies organisational immunity experimentally in ant societies and collaborates with theoreticians to determine its effect on epidemiology.

Current projects

> Social interaction networks & epidemiology
> Social vaccination
> Experience in hygienic tasks
> Pathogen detection abilities in ants
> Host-parasite coevolution

Fungus-infected garden ant; Electron microscopy: Birgit Lautenschläger, University of Regensburg.

CAREER

since 2010	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

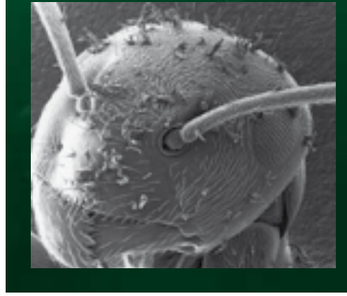
2013	Walther Arndt Prize of the German Zoological Society
2013	Co-PI WWTF Life Sciences Grant New Ventures Beyond Established Frontiers
2012	Research Award Lower Austria: Anerkennungspreis des Landes Niederösterreich
2011	Member of "Junge Kurie", Austrian Academy of Sciences
2009	ERC Starting Grant
2008–2013	Member, German Young Academy of Sciences Leopoldina and Berlin Brandenburg
2004–2006	Marie Curie Intra-European Fellowship & Reintegration Grant
2003–2004	Feodor Lynen Fellowship, Alexander von Humboldt Foundation

SELECTED PUBLICATIONS

> Stroeymeyt N, Casillas-Perez B, Cremer S. 2014. Organisational immunity in social insects. Current Opinions in Insect Science. 5: 1-15.
> Masri L & Cremer S. 2014 Individual and social immunisation in insects. Trends in Immunology. 35(10): 471-482.
> Konrad M, Grasse AV, Tragust S & Cremer S. 2014. Anti-pathogen protection versus survival costs mediated by an ectosymbiont in an ant host. Proceedings of the Royal Society B: Biological Sciences. 282: 20141976.

TEAM

Barbara Casillas-Perez (joint PhD student with Tkacik group), Thomas Eder (joint PhD student with T Rattei, University of Vienna), Matthias Fürst (Postdoc), Anna Grasse (Senior Technician), Matthias Konrad (Postdoc), Leila el Masri (Postdoc), Barbara Milutinović (Postdoc), Barbara Mitteregger (Technical Assistant), Christopher D. Pull (PhD student), Miriam Stock (Postdoc), Line V. Ugelvig (Postdoc), Florian Wiesenhofer (Technical Assistant)



Systems Neuroscience

Jozsef Csicsvari

Transforming novel information to memory is essential if we want to remember it again later. Memory formation is therefore crucial for learning new facts or skills. The Csicsvari group studies how learning is implemented in the brain.

During learning, memory traces are processed and encoded in neuronal circuits and consolidated for later recall. The Csicsvari group focuses on the hippocampus, a brain area known to be important for spatial memory formation, and aims to understand how learning leads to memory formation. The group seeks to understand how neuronal circuits process information and form spatial memory by recording the activity of many neurons in different brain circuits during learning tasks and sleep. In addition, optogenetic methods are used to selectively manipulate neuronal activity in the hippocampus. Different place learning tasks allow the researchers to investigate the role of oscillatory activity during encoding, consolidation and recall of spatial information. To store spatial memory, the hippocampus interacts with other cortical regions, and the Csicsvari group investigates whether and how synchronous oscillations between the hippocampus and the entorhinal cortex are required for storing spatial information.

Current projects

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

CAREER

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

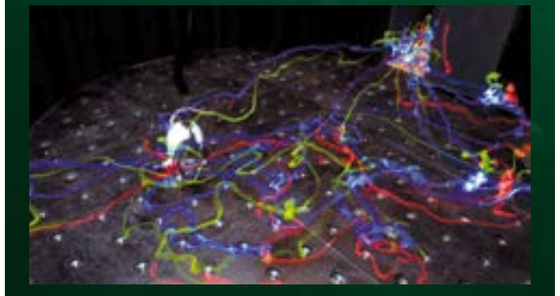
SELECTED PUBLICATIONS

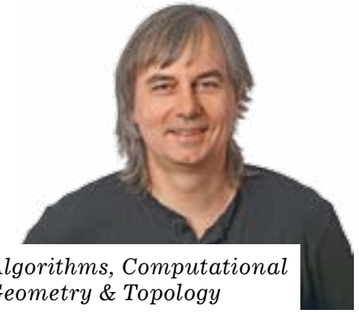
> Dupret D, O'Neill J, Csicsvari J. 2013. Dynamic reconfiguration of hippocampal interneuron circuits during spatial learning. Neuron. 78:166-180.
> Dupret D, O'Neill J, Pleydell-Bouverie B, Csicsvari J. 2010. The reorganization and reactivation of hippocampal maps predict spatial memory performance. Nature Neuroscience. 13(8), 995-1002.
> O'Neill J, Senior TJ, Allen K, Huxter JR, Csicsvari J. 2008. Reactivation of experience-dependent cell assembly patterns in the hippocampus. Nature Neuroscience. 11(2), 209-215.

TEAM

Peter Baracskay (Postdoc), Karel Blahna (Postdoc), Charlotte Boccara (Postdoc), Desiree Dickerson (Postdoc), Igor Gridchyn (PhD student), Krisztian Kovacs (Postdoc), Michael Lobianco (Technical Assistant), Alessia Manganaro (Student Intern), Joseph O'Neill (Postdoc), Philipp Schönenberger (Postdoc), Haibing Xu (PhD student)

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





Algorithms, Computational Geometry & Topology

Herbert Edelsbrunner

Uncovering fundamental shapes in a sea of occurrences is a central task in Computational Geometry and Topology. The Edelsbrunner group drives the frontiers in this constantly reshaping field of science.

Topology, the study of shapes and how they are connected and deform, can be used to address a number of questions in applications as diverse as dynamical systems, scientific visualization, structural molecular biology, systems biology, geometry processing, medical imaging and orthodontics. The common theme in these applications is the importance of recognizing connections and their dependence on scale. The question of scale and how reality changes as we zoom in and out is particularly fascinating. The Edelsbrunner group studies the two related subjects of topology and geometry from a computational point of view, in order to make mathematical insights useful in applications that are workable for nonspecialists. The group believes in a broad approach to problems, including the development of new mathematics, the translation into new computational methods, and the application to frontiers of science. Some candidate areas for fruitful collaborations are cell biology, neuroscience, medical imaging, and astronomy.

Current projects

> Applied computational algebraic topology
> Topological dynamical systems

CAREER

since 2009	Professor, IST Austria
2004–2012	Professor for 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 Member, Austrian Academy of Sciences
2012 Corresponding Member of the Austrian Academy of Sciences
2009 Member, Academia Europaea
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

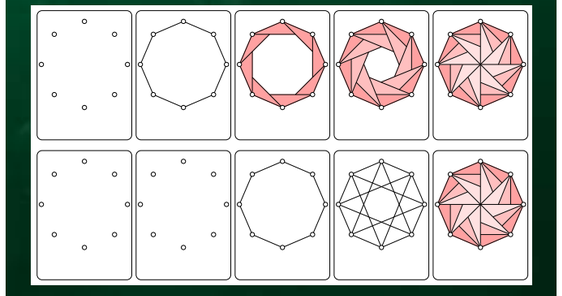
SELECTED PUBLICATIONS

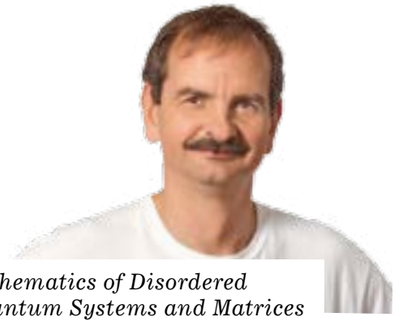
> Edelsbrunner H, Harer JL. 2010. Computational Topology. An Introduction. American Mathematical Society, Providence, Rhode Island.
> Edelsbrunner H. 2001. Geometry and topology for mesh generation. Cambridge University Press, Cambridge, England.
> Edelsbrunner H. 1987. Algorithms in combinatorial geometry. Springer-Verlag, Heidelberg, Germany.

TEAM

Arseniy Akopyan (Postdoc), Mabel Iglesias-Ham (Student), Anton Nikitenko (Student), Salman Parsa (Postdoc), Florian Pausinger (Student), Pawel Pilarczyk (Postdoc), Hubert Wagner (Postdoc)

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





Mathematics of Disordered Quantum Systems and Matrices

László Erdős

Wigner's vision that a simple random matrix can replace a multi-dimensional quantum model when calculating nuclear energy levels laid the groundwork for random matrix theory. Whether a random matrix underlies also other physical systems is the central question pursued by the Erdős group.

Surprisingly, a large matrix filled at random allowed for calculating energy levels of nuclei in heavy atoms. With this substitution, Eugene Wigner laid the basis for random matrix theory (RMT), which is now used to find patterns in huge amounts of data, even in stock market trends. Although experimental data leave no doubt that Wigner's substitution is correct, the reason for why it works is still not fully understood. In one part of their research, László Erdős and his group ask whether this reduction is also justified with mathematical rigor. Extending RMT to other physical systems and looking for universality in them, the group intends to move the simplified random matrix model back towards the original object of research from physics. At the same time, they ask whether the random matrix model is also underlying other physical models, and whether the "intermediate" approaches they develop may be used to mathematically solve other long-standing questions in physics. The mathematical ideas and tools developed as part of the Erdős group's work will extend RMT, and are likely to be used in its many applications, such as network analysis, information theory and other fields of physics.

Current projects

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

CAREER

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

SELECTED DISTINCTIONS

2014	Invited Speaker, ICM
2013	ERC Advanced Grant
2007-2016	Participant of SFB TR12, Symmetries and Universality
2002-2005	NSF Grant
1999-2002	NSF Grant
1993-1994	Alfred P. Sloan Foundation Dissertation Fellowship

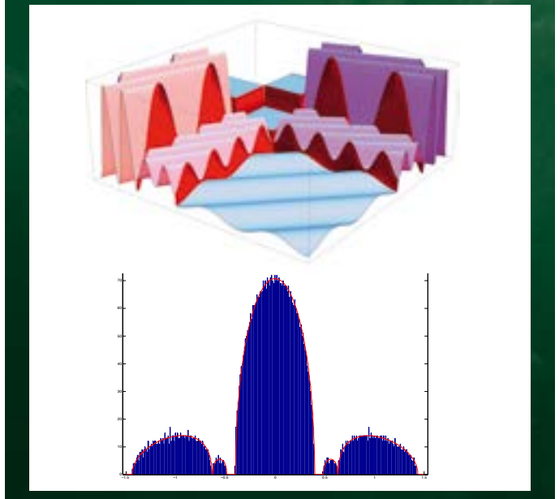
SELECTED PUBLICATIONS

> Bourgade P, Erdos L, Yau H-T. 2014. Edge universality of beta ensembles. Commun. Math. Phys. 332 no. 1, 261-354.
> Erdös L, Yau H-T. 2012. Universality of local spectral statistics of random matrices. Bull. Amer. Math. Soc. 49, no.3, 377-414.
> Erdös L, Yau H-T, Yin J. 2012. Rigidity of Eigenvalues of Generalized Wigner Matrices. Adv. Math. 229, no. 3, 1435-1515.

TEAM

Zhigang Bao (Postdoc), Heikki Oskari Ajanki (Postdoc), Torben Krüger (PhD student), Christian Sadel (ISTFELLOW Postdoc), Kevin Schnelli (Postdoc)

Variance profile of an inhomogeneous random matrix H.



Eigenvalue distribution of H and its limiting density.

Developmental and Cell Biology of Plants

Jiří Friml

While animals can move away if conditions turn harsh, plants are rooted in their environment. Plants have therefore become remarkably adaptable to different conditions. The Friml group investigates the mechanisms underlying their adaptability during plants' embryonic and postembryonic development.

Plants and animals live different lives. While animals can react to conditions by changing their behavior, plants have acquired a highly adaptive development that allows them to respond to changes. In development, plants can do much more than animals, such as growing new organs. Many of plants' unique developmental events are mediated by auxin, a plant hormone. The Friml group investigates the unique properties of auxin signaling, standing out among plant signaling molecules due to the integration of both environmental and endogenous signals in its gradients within plant tissues. Employing methods spanning physiology, developmental and cell biology, genetics, biochemistry and mathematical modeling, the group focuses on polar auxin transport, cell polarity, endocytosis and recycling, as well as non-transcriptional 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 altering developmental processes.

Current projects

> Polar auxin transport
> Cell polarity and polar targeting
> Endocytosis and recycling

CAREER

since 2013	Professor, IST Austria
2007–2012	Full Professor, University of Ghent, Belgium
2006	Full Professor, University of Göttingen, Germany
2002–2005	Groupleader, Habilitation in Genetics, University of Tübingen, Germany
2002	PhD, Biochemistry, Masaryk University, Brno, Czech Republic
2000	PhD, Biology, University of Cologne, Germany

SELECTED DISTINCTIONS

2012	EMBO Gold Medal
2011	AAAS Fellow
2010	EMBO Member
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

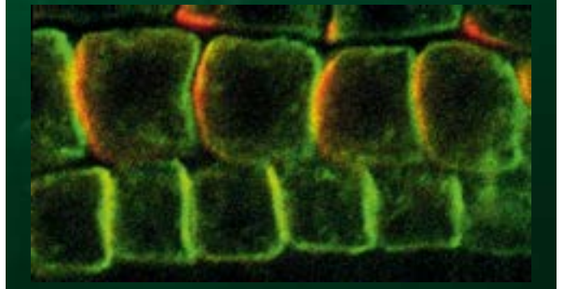
SELECTED PUBLICATIONS

> Chen X, Grandont L, Li H, Hauschild R, Paque S, Abuzeineh A, Rakusová H, Benkova E, Perrot-Rechenmann C, Friml J. 2014. Inhibition of cell expansion by rapid ABP1-mediated auxin effect on microtubules. Nature. 4;516(7529):90-93. Epub 2014 Nov 17.
> 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. Nov 24(23):2786-2791. Epub 2014 Nov 13.
> Naramoto S, Otegui MS, Kutsuna N, de Rycke R, Dainobu T, Karampelias M, Fujimoto M, Feraru E, Miki D, Fukuda H, Nakano A, Friml J. 2014. Insights into the Localization and Function of the Membrane Trafficking Regulator GNOM ARF-GEF at the Golgi Apparatus in Arabidopsis. Plant Cell. 26(7):3062-3076.

TEAM

Maciej Adamowski (PhD student), Xu Chen (Postdoc), Eduardo Cires Rodriguez (Postdoc), Matyas Fendrych (Postdoc), Urszula Kania (PhD student), Hongjiang Li (Postdoc), Petra Marhava (PhD student), Eva Medvecka (Postdoc), Gergely Molnar (Postdoc), Tomas Prat (PhD student), Hana Rakusova (PhD student), Yuliya Salanenka (Postdoc), Petr Valosek (Technician)

Polarity in Arabidopsis cells.



Systems and Synthetic Biology of Genetic Networks

Călin Guet

Networking is important on any level and in any environment – even bacteria, genes and proteins are networking. But which basic rules, if any, do these networks follow? Using systems and synthetic biology, the Guet group explores the biology of genetic 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. One aspect of the Guet group's work covers information processing at complex bacterial promoters, which integrate signals and regulate the expression of genes accordingly. The group uses a variety of classical and modern experimental techniques which together enable them to construct any imaginable network in living bacteria and thus to study the network dynamics at the single-cell level, which is the relevant scale of experimental interrogation.

Current projects

> Information processing and evolution of complex promoters
> Systems biology of the *mar* regulon
> Single-cell biology and evolutionary dynamics of restriction-modification systems

CAREER

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

SELECTED DISTINCTIONS

2011	HFSP Research Grant
2005	Yen Fellow, The University of Chicago, USA
1997	Sigma XI Membership

SELECTED PUBLICATIONS

> Guet CC, Gupta A, Henzinger TA, Mateescu M, Sezgin A. 2012. Delayed continuous-time Markov chains for genetic regulatory circuits. Lecture Notes in Computer Science CAV. 7358, 294-309.
> Yazdi NH, Guet CC, Johnson RC, Marko JF. 2012. Variation of the folding and dynamics of the Escherichia coli chromosome with growth conditions. Molecular Microbiology. 86, 1318-1333.
> Guet CC, Elowitz MB, Hsing WH, Leibler S. 2002. Combinatorial synthesis of genetic networks. Science. 296(5572), 1466-1470.

TEAM

Anna Andersson (joint Postdoc with Tkačik group), Tobias Bergmiller (Postdoc), Remy Chait (Postdoc), Tatjana Petrov (joint Postdoc with Guet group), Maros Pleska (PhD student), Anna Staron (Postdoc), Magdalena Steinrück (PhD student)

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

Morphogenesis in Development

Carl-Philipp Heisenberg

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 and cellular mechanisms by which vertebrate embryos take shape. To gain insights into critical processes in morphogenesis, the group focuses on gastrulation movements in zebrafish. Gastrulation is a highly conserved process in which a seemingly unstructured blastula is transformed into a highly organized embryo. The group has chosen a multidisciplinary 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 vertebrate embryos shape, such as cell adhesion and aggregation, 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.

Current projects

> Cell adhesion
> Actomyosin contractility and morphogenesis
> Cell polarization and migration

CAREER

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

SELECTED DISTINCTIONS

2000	Emmy Noether Junior Professorship
1998	Marie Curie Postdoctoral Fellowship
1997	EMBO Postdoctoral Fellowship

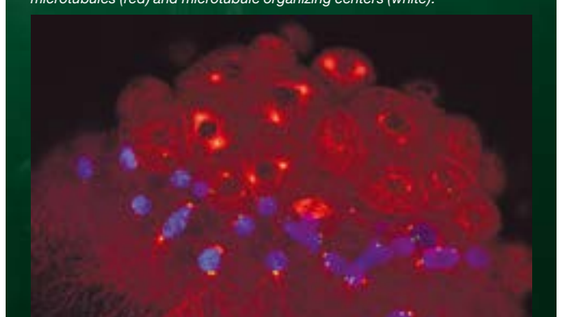
SELECTED PUBLICATIONS

> Campinho P, Behrndt M, Ranft J, Risler T, Minc N, Heisenberg CP. 2013. Nature Cell Biology. 15, 1405-1414.
> 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.

TEAM

Vanessa Barone (PhD student), Martin Behrndt (PhD student), Daniel Capek (PhD student), Julien Compagnon (Postdoc), Benoit Godard (Postdoc), Roland Kardos (Postdoc), Gabby Krens (Postdoc), Hitoshi Morita (Postdoc), Kornelija Pranjic-Ferscha (Technician), Verena Ruprecht (joint Postdoc with Sixt group), Keisuke Sako (Postdoc), Philipp Schmalhorst (Postdoc), Mateusz Sikora (Postdoc), Jana Slovakova (Postdoc), Michael Smutny (Postdoc)

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



Design and Analysis of Concurrent and Embedded Systems

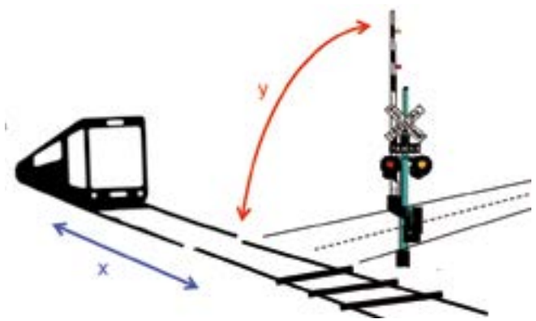
Thomas A. Henzinger

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 fast. The Henzinger group invents mathematical methods and develops computational tools for improving the reliability of software in 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



CAREER

since 2009	Professor, IST Austria
2004–2009	Professor, EPFL, Lausanne, Switzerland
1999–2000	Director, Max Planck Institute for Computer Science, Saarbruecken, 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
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

SELECTED PUBLICATIONS

> Boker U, Henzinger TA, Radhakrishna A. 2014. Battery transition systems.Proc. ACM Symp. Principles of Programming Languages (POPL). 595-606.
> Cerny P, Henzinger TA, Radhakrishna A, Ryzhyk L, Tarrach T. 2014. Regression-free synthesis for concurrency. Proc. Conf. Computer-Aided Verification (CAV), Springer Lecture Notes in Computer Science. 568-584.
> Henzinger TA, Otop J. 2014. Model measuring for hybrid systems, Proc. Conf. Hybrid Systems: Computation and Control (HSCC),Springer Lecture Notes in Computer Science. 212-222.

TEAM

Przemyslaw Daca (PhD student), Jessica Davies (Postdoc), Cezara Dragoi (Postdoc), Mirco Giacobbe (PhD student), Ashutosh Gupta (Postdoc), Jan Kretinsky (joint Postdoc with Chatterjee group), Jan Otop (Postdoc), Tatjana Petrov (joint postdoc with Guet group), Arjun Radhakrishna (PhD student), Jakob Ruess (joint postdoc with Tkačik group), Roopsha Samanta (Postdoc), Thorsten Tarrach (PhD student)

Genetic Dissection of Cerebral Cortex Development

Simon Hippenmeyer

The human brain is a sophisticated network of billions of interconnected neurons. Simon Hippenmeyer's group exploits genetic techniques in the mouse to better understand how the brain's precise connectivity emerges during development.

Our brains are composed of a vast number of neurons, and can function only because of the intricate connections formed between them. In order to better understand how the cerebral cortex accounts for behavior and cognitive activity, the Hippenmeyer group maps the assembly of the neuronal architecture during cortex development in the mouse. The group uses multidisciplinary approaches, including the genetic MADM (Mosaic Analysis with Double Markers) technique, to trace how individual neurons build up the cortex successively during development. Looking at the brain is similar to looking at a forest: While looking at a forest from afar, it is difficult to make out the trimming of a single branch of an individual tree. However, when a tree stands alone in a field, it is easy to observe the snip of even the finest branch. The MADM technique allows the Hippenmeyer group to visualize small groups of neurons, and even individual neurons, at the single cell level and manipulate them at the same time. This unparalleled method allows researchers to navigate through the dense network of neurons in the brain to exactly follow individual neurons and their fine branches. Simon Hippenmeyer's group determines the molecular mechanisms regulating neurogenesis, lineage and neuronal migration; and analyzes the cellular pathology associated with genes that when mutated in human cause neurodevelopmental disorders. In a second line of research the Hippenmeyer group analyzes the role of genomic imprinting (an epigenetic phenomenon) in neuronal circuit assembly.

Current projects

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

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 and Friedrich Miescher Institute for Biomedical Research, Basel, Switzerland

SELECTED DISTINCTIONS

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	Faculty Prize 2005 for the best PhD thesis of the year 2004 (Faculty of Natural Sciences, University of Basel, Switzerland)
2005	Edmond H. Fischer Prize 2005 (Friedrich Miescher Institute for Biomedical Research, Basel, Switzerland)

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.

TEAM

Gloria Arque (Postdoc), Elaine Fisher (Student Intern), Martin Frank (Student Intern), Priscila Hirschfeld (ISTern), Tajamul Hussain (Student Intern), Susanne Laukoter (PhD student), Maria-Pia Postiglione (Postdoc), Justine Renno (PhD student), Johanna Sonntag (Technician), Carmen Streicher (Technician)

Nonlinear Dynamics and Turbulence

Björn Hof

Turbulent fluid motion is the most prominently encountered form of disorder in nature. The Hof group seeks insights into the fundamental nature of turbulence and the dynamics of complex fluids.

Weather systems, galaxy and planet formation, airflow and networks are governed by complex chaotic dynamics. Fluid turbulence – seen in fluids such as water or air – is the most common form of disorder in nature. Despite its ubiquity, insights into the nature of turbulence are very limited. To gain a fundamental understanding of turbulence, 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 the Hof group's insights can be directly applied to control turbulent flow, and the group actively develops such methods.

Current projects

> Transition from laminar to turbulent flow
> Dynamics of complex fluids
> Control of fully turbulent flows
> Locomotion of plankton larvae

CAREER

since 2013	Professor, IST Austria
2007–2013	Max Planck 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 Starting Grant

2011 Dr. Meyer Struckmann Science Price

2005 RCUK Fellowship

SELECTED PUBLICATIONS

> Hof B, de Lozar A, Avila M, Tu X, Schneider TM. 2010. Eliminating turbulence in spatially intermittent flows. Science. 327, 1491-1494.
> 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.
> Hof B, Westerweel J, Schneider TM, Eckhardt B. 2006. Finite lifetime of turbulence in pipe flow. Nature. 443, 05089, 59-62.

TEAM

Sebastian Altmeyer (Postdoc), Jose Manuel Gallardo Ruiz (Postdoc), Shreyas Vaman Jalikop (Postdoc), Jakob Kühnen (Postdoc), Gregoire Lemoult (Postdoc), Philipp Maier (Technician), Liang Shi (PhD student), Baofang Song (PhD student), Mukund Vasudevan (Postdoc)

Synthetic Physiology

Harald Janovjak

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

Receptors on the surface 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, 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 and to synthetically create or restore aberrant signaling in health and disease.

Current projects

> Artificial control of receptors and signaling pathways
> Synthetic restoration of cell and animal behavior

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

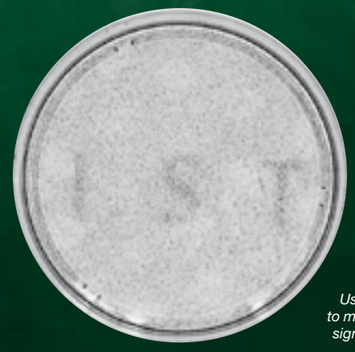
2011	HFSP Young Investigator Grant
2011	EU FP7 Career Integration Grant
2007–2009	EMBO Long-term Fellowship
2005	PhD with highest honors (summa cum laude)

SELECTED PUBLICATIONS

> Grusch M, Schelch K, Riedler R, Reichhart E, Differ C, Berger W, Inglés-Prieto A, Janovjak H. 2014. Spatio temporally precise activation of engineered receptor tyrosine kinases by light. EMBO Journal. 33:1713-1726.
> Janovjak H, Sandoz G, Isacoff EY. 2011. A modern ionotropic glutamate receptor with a potassium-selectivity signature sequence. Nature Communications. 2, 232.
> Janovjak H, Szobota S, Wyart C, Trauner D, Isacoff EY. 2010. A light-gated, potassium-selective glutamate receptor for the optical inhibition of neuronal firing. Nature Neuroscience. 13(8), 1027-1032.

TEAM

Cathrin Heidsiek (Student Intern), Martin Jendryka (Student Intern), Kris Kolev (Technician), Carina Kraupa (Student Intern), Catherine McKenzie (PhD student), Maurizio Morri (PhD student), Alvaro Ingles Prieto (Postdoc), Eva Reichhart (PhD student), Laura Rodriguez (Postdoc), Inmaculada Sanchez Romero (Postdoc), Miroslava Spanova (Technician)



Using optogenetics to manipulate the cell signaling machinery.

Synaptic Communication in Hippocampal Microcircuits

Peter Jonas

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 one of the major challenges of life science in the 21st century. The human brain is comprised of approximately 10 billion neurons, which communicate with each other at a huge number of synapses, specialized sites of contact between neurons. Broadly, synapses in the brain fall into two categories: excitatory synapses releasing the transmitter glutamate and inhibitory synapses releasing Gamma-Aminobutyric acid (GABA). The Jonas group seeks to quantitatively address the mechanisms of synaptic signaling, using multiple-cell recording, subcellular patch-clamp techniques, Ca^{2+} imaging, and modeling. Amongst other projects, the group examines subcellular elements of the fast-spiking, parvalbumin–expressing GABAergic interneurons in the hippocampus, which are thought to contribute to storage and retrieval of memories. These interneurons play a key role in cortical neuronal networks, and the Jonas group aims to obtain a quantitative nanophysiological picture of signaling in this type of interneuron. This research has far reaching implications for understanding the contribution of GABAergic interneurons to neuronal coding and brain energetics, and may lay the basis for the development of new therapeutic strategies against diseases of the nervous system.

Current projects

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

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

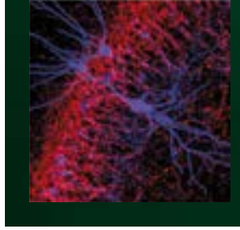
2011	ERC Advanced Grant
2009	Adolf-Fick-Award, Physicomedical Society, Würzburg, Germany
2008	Member, Academy of Sciences, Heidelberg, Germany
2007	Tsungming Tu Award, National Science Council Taiwan
2006	Szentagothai memorial lecture, University of California, Irvine, USA
2006	Gottfried Wilhelm Leibniz 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

SELECTED PUBLICATIONS

> Hu H, Jonas P. 2014. A supercritical density of Na^+ channels ensures fast signaling in GABAergic interneuron axons. Nature Neuroscience. 17, 686-693.
> Vyleta NP, Jonas P. 2014. Loose coupling between Ca^{2+} channels and release sensors at a plastic hippocampal synapse. Science. 343, 665-670.
> Pernía-Andrade A, Jonas P. 2013. Theta-gamma modulated synaptic currents in hippocampal granule cells in vivo define a mechanism for network oscillations. Neuron. 81, 140-152.

TEAM

Itaru Arai (Postdoc), Michelle Duggan (Technical Assistant), Claudia Espinoza (PhD student), Jian Gan (Postdoc), Sarit Goswami (PhD student), José Guzmán (Postdoc), Hua Hu (Postdoc), Sooyun Kim (Postdoc), Eva Kramberger (Administrative Assistant, on maternity leave), Florian Marr (Technician), Rajiv Mishra (PhD student), Alejandro Pernía-Andrade (Postdoc), Giovanni Russo (Postdoc), Alois Schlögl (Software Engineer), Amália Solymosi (interim Administrative Assistant), David Vandael (Postdoc) Nicholas Vyleta (Postdoc), Shih-Ming Weng (Postdoc)



Presynaptic hippocampal basket cell (lower right) and postsynaptic granule neurons (upper left).

Computer Vision and Discrete Optimization Algorithms

Vladimir Kolmogorov

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 computation. The Kolmogorov group's work on algorithms gives computers "stereo vision".

Research of Vladimir Kolmogorov's group focuses on the development of efficient algorithms for inference in graphical models, which have applications in many different fields such as computer vision, computer graphics, data mining, machine learning and bioinformatics. Two classical examples from computer vision are binary image segmentation and stereo vision problems. Binary image segmentation gives automatic systems the ability to divide an image into foreground and background, while stereo vision allows them to infer the depth of objects. Kolmogorov has developed algorithms widely used in computer vision, such as the "Boykov-Kolmogorov" maximum flow algorithm and the "TRW-S" algorithm for inference in graphical models. His "Blossom V" algorithm is currently the fastest technique for computing a minimum cost perfect matching in a graph. Vladimir Kolmogorov has also done theoretical work on the analysis of discrete optimization problems.

Current projects

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

CAREER

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

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	The 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

SELECTED PUBLICATIONS

> Kolmogorov V. 2013. The power of linear programming for valued CSPs: a constructive characterization. 40th International Colloquium on Automata, Languages and Programming (ICALP). 2013.
> Gridchyn I, Kolmogorov V. 2013. "Potts model, parametric maxflow and k-submodular functions". In IEEE International Conference on Computer Vision (ICCV), Sydney, Australia.
> Kolmogorov V. 2009. Blossom V: A new implementation of a minimum cost perfect matching algorithm. Mathematical Programming Computation. 1(1), 43-67.

TEAM

Michal Rolinek (PhD student), Rustem Takhanov (Postdoc)

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

Computer Vision and Machine Learning

Christoph Lampert

Every kid knows how to play "I spy with my little eye", but to a computer the task of analyzing images and recognizing objects in them is tremendously difficult. The Lampert group helps computers "see" with the tools of Computer Vision and Machine Learning.

Recognizing objects in an image is child's play to humans, but presents an exceedingly difficult challenge to computers. The Lampert group develops algorithms and methods that allow computers to analyze high-dimensional data and make decisions based on it. In machine learning, computers arrive at knowing general rules by making abstractions based on examples provided. Object recognition is one aspect of machine learning essential for applications requiring computer vision.

In their research, the Lampert group members develop algorithms that enable automatic image understanding systems to analyze digital images regarding their contents. In the long run, the Lampert group is interested in building automatic systems that understand images on the same semantic level as humans do, enabling them to answer questions like: What objects are visible in an image? Where are they located? How do they interact?

Current projects

> Life-long learning for visual scene understanding
> Object recognition and localization
> Structured prediction and learning
> Attribute representations

CAREER

since 2010	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 Price, German Society for Pattern Recognition (DAGM)

SELECTED PUBLICATIONS

> 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.
> Lampert CH, Blaschko MB, Hofmann T.2009. Efficient subwindow search: A branch and bound framework for object localization. IEEE Transactions on Pattern Analysis and Machine Intelligence (TPAMI). 31(12), 2129-2142.

TEAM

Csaba Domokos (Postdoc), Tomas Kazmar (PhD student, joint with IMP Vienna) , Alexander Kolesnikov (PhD student), Anastasia Pentina (PhD student), Neel Shah (PhD student), Viktoriia Sharmanska (PhD student), Alexander Zimin (PhD student)

Object recognition in natural images: learning-based computer vision techniques aim at detecting objects and describing them semantically.

Theoretical Atomic, Molecular, and Optical Physics

Mikhail Lemeshko

The whole is greater than the sum of its parts. Aristotle's saying also holds true in most systems studied by physics, chemistry, and biology. Mikhail Lemeshko investigates how phenomena arise when more and more parts are added to make the whole.

Many physical, chemical, and biological systems show the property called emergence: from the social behavior of insects, to the dynamics of internet traffic, to the stock market trends – all of these phenomena can hardly be explained by just looking at the individual parts that they are made up of. The same applies to the physical systems: 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.
Mikhail Lemeshko studies the emergent behavior in quantum systems composed of atoms and molecules. Usually, these questions are approached "top-down": by cutting a system into ever smaller parts and studying those. Lemeshko, however, follows a "bottom-up" approach: In some quantum systems, such as quantum gases or ultracold atoms, researchers can fully control individual atoms and molecules. By manipulating these parts, researchers can study how phenomena emerge with an increasing number of particles. Mikhail Lemeshko focuses on atomic, molecular and optical physics. He seeks to theoretically study and answer questions such as: How many particles are sufficient for a given property to emerge? How does dissipation act on quantum systems? How can the novel phenomena be observed in modern experiments? And what are the practical applications of controllable quantum systems, such as artificial atoms?

Main research directions

> 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

CAREER

since 2014	Assistant Professor, IST Austria
2011–2014	ITAMP postdoctoral fellow, Harvard University, Cambridge, USA
2011	PhD in AMO physics, Fritz Haber Institute of Max Planck Society, Berlin
2007	MSc in Condensed Matter Physics, Southern Federal University Rostov, Russia

SELECTED DISTINCTIONS

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

SELECTED PUBLICATIONS

> Otterbach J, Lemeshko M. 2014. Dissipative Preparation of Long-Range Spatial Order in Rydberg-Dressed Bose-Einstein Condensates, Phys. Rev. Lett. 113, 070401.
> Lemeshko M, Weimer H. 2013. Dissipative binding of atoms by non-conservative forces, Nature Communications. 4, 2230.
> Lemeshko M, Krems RV, Weimer H. 2012. Non-adiabatic preparation of spin crystals with ultracold polar molecules, Phys. Rev. Lett. 109, 035301.

TEAM

Clemens Jochum (Student Intern), Jan Kaczmarczyk (ISTFELLOW Postdoc), Bikashkali Midya (ISTFELLOW Postdoc), Laleh Safari (ISTFELLOW Postdoc)

Fine structure appearing in the rotational spectrum of a molecule due to the interaction with a quantum many-body environment (Schmidt&Lemeshko, arXiv:1502.03447).

Stochastic Analysis

Jan Maas

Exchange rate fluctuations, bacteria colony growth, and burning fronts are highly irregular systems subject to randomness or uncertainty. Mathematician Jan Maas develops new techniques for the mathematical study of such random phenomena in science and engineering.

A modern mathematical approach to study random systems is inspired by optimal transport, an economics and engineering subject that deals with the optimal allocation of resources. Recently, optimal transport has been used to establish deep and fascinating connections between seemingly unrelated problems in geometry, mathematical analysis and probability. Jan Maas aims to extend ideas from optimal transport theory to study stochastic processes. He now applies these techniques to diverse problems involving complex networks, chemical reaction systems and quantum mechanics.
Another focus of Maas' work is on stochastic partial differential equations. These are commonly used to model high-dimensional random systems in science and engineering. Solutions to such equations are often so irregular that mathematicians cannot use existing models to find them. Often, even finding an appropriate concept of a solution can be very challenging. Jan Maas wants to develop robust mathematical techniques to study these equations, which will also lead to new insights into the underlying models.

Current projects

> Gradient flow structures in chemical reaction networks
> Curvature bounds for discrete interacting systems
> Transport inequalities for quantum Markov processes

CAREER

since 2014	Assistant Professor, IST Austria
2009–2014	Postdoc, University of Bonn, Germany
2009	Postdoc, University of Warwick, UK
2005–2009	PhD in Applied Mathematics, Delft University of Technology, The Netherlands

SELECTED DISTINCTIONS

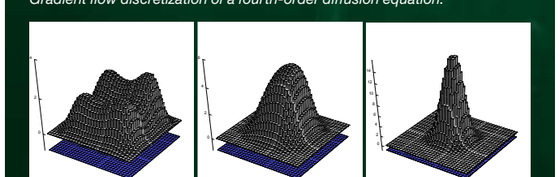
2013–2014	Project leader in Collaborative Research Centre "The mathematics of emergent effects"
2009–2011	NWO Rubicon Fellowship

SELECTED PUBLICATIONS

> Hairer M, Maas J, Weber H. 2014. Approximating rough stochastic PDEs. Comm. Pure Appl. Math. 67 (5), 776-870.
> Carlen E, Maas J. 2014. An analog of the 2-Wasserstein metric in non-commutative probability under which the fermionic Fokker-Planck equation is gradient flow for the entropy. Comm. Math. Phys. 331 (3) 887-926.
> Maas J. 2011. Gradient flows of the entropy for finite Markov chains. J. Funct. Anal. 261 (8), 2250-2292.

TEAM

Dominik Forkert (Student Intern)



Gradient flow discretization of a fourth-order diffusion equation.

Genetic and Molecular Basis of Epilepsy and Cognitive Disorders

Gaia Novarino

Epilepsy affects millions of people, many of them children. Often, epilepsy patients also suffer from autism or intellectual disability. Gaia Novarino asks whether all these disorders share common molecular mechanisms. She seeks to identify and study disease-causing mechanisms by analyzing both the genomes of patients and studying mouse models of the disease.

Epilepsy, autism and intellectual disability often occur together in patients, comprising the neurodevelopmental disorder (NDD) spectrum. Gaia Novarino seeks to identify the genes responsible for these disorders by studying genetic forms of NDDs. Each gene identified probably only represents a fraction of all genes that cause this spectrum of disorders. Nevertheless, studying rare forms of epilepsy, autism and intellectual disability can be extremely helpful as similarities among the functions of disease-causing genes may point to a small number of molecular mechanisms responsible for seizure syndromes. Information from rare inherited diseases could hence contribute to the development of treatments that also target more common forms of epilepsy.

In 2014, publications by Gaia Novarino doubled the number of known causes of a neurodegenerative disorder associated with epilepsy, called hereditary spastic paraplegia, and identified mutations in the gene SETD5 as a relatively frequent cause of intellectual disability.

Current projects

> Molecular mechanisms underlying autism spectrum disorders
> The SETD5 gene in intellectual disability
> Modeling Epileptic Encephalopathies in Human Brain Organoids

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 in Cell Biology, University "La Sapienza", Rome, Italy

SELECTED DISTINCTIONS

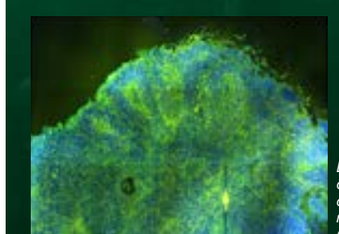
2014	Citizens United for Research in Epilepsy (CURE): Taking Flight Award
2012	Citizens United for Research in Epilepsy (CURE): Young Investigator Travel Award
2011	German Research Foundation (DFG): 2-year fellowship

SELECTED PUBLICATIONS

> 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. (*Corresponding authors)
> Novarino G, Fenstermaker AG, Zaki MS, Hofree M, Silhavy JL, Heiberg AD, Abdellateef M, Rosti B, Scott E, Mansour L, Masri A, Kayserili H, Al-Aama JY, Abdel-Salam GM, Karminejad A, Kara M, Kara B, Bozorgmehri B, Ben-Omran T, Mojahedi F, Mahmoud IG, Bouslam N, Bouhouche A, Benomar A, Hanein S, Raymond L, Forlani S, Mascaro M, Selim L, Shehata N, Al-Allawi N, Bindu PS, Azam M, Gunel M, Caglayan A, Bilguvar K, Tolun A, Issa MY, Schroth J, Spencer EG, Rosti RO, Akizu N, Vaux KK, Johansen A, Koh AA, Megahed H, Durr A, Brice A, Stevanin G, Gabriel SB, Ideker T, Gleeson JG*. 2014. Exome sequencing links corticospinal motor neuron disease to common neurodegenerative disorders. Science . (6170):506-511.
> 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#. 2014. Loss-of-function mutations of SETD5 cause intellectual disability and core phenotype of microdeletion 3p25.3 syndrome. EJHG #Contributed equally as senior authors.

TEAM

Ximena Contrera (PhD student), Emanuela Morelli (Postdoc), Mike Liu (Technician), Roberto Sacco (Postdoc), Dora Tarlungeanu (PhD student)



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

Cryptography

Krzysztof Pietrzak

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. One focus of their work is the construction of provably secure cryptographic schemes for light-weight devices such as RFID tags, which are used in many security-relevant applications like electronic passports or for access control. RFID tags are typically too constrained to run existing cryptographic schemes, and thus one must design schemes that are provably secure, but at the same time extremely simple and efficient.

Another line of work is concerned with so called “side-channel attacks”. These are attacks on cryptographic devices, for example smart-cards, in which one measures information leaked during computation, and then exploits it to break the security of the scheme. This information can for example be the power consumption or emitted radiation. The group works on “leakage-resilient” cryptography, which aims at constructing schemes which remain provably secure even in the context of side-channel attacks.

Current projects

> Leakage-resilient cryptography
> Cryptosystems for light-weight devices
> Computational Entropy

CAREER

since 2011	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

2010 ERC Starting Grant

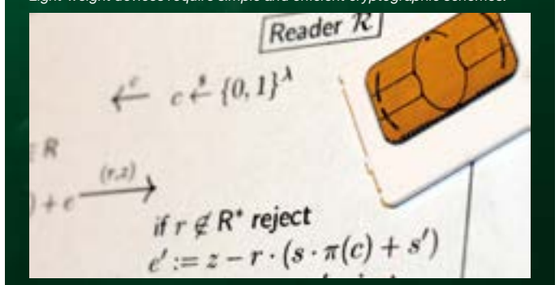
SELECTED PUBLICATIONS

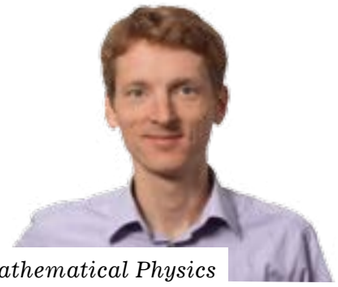
> Kiltz E, Pietrzak K, Szegedy M. 2013. Digital Signatures with Minimal Overhead from Indifferentiable Random Invertible Functions. CRYPTO. (1) 2013: 571-588.
> Kiltz E, Pietrzak K, Cash D, Jain A, Venturi D. 2011. Efficient authentication from hard learning problems. EUROCRYPT. 7-26.
> Dziembowski S, Pietrzak K. 2008. Leakage-resilient cryptography. IEEE Symposium on Foundations of Computer Science. 293-302.

TEAM

Hamza Abusalah (PhD student), Joel Alwen (Postdoc), Georg Fuchsbauer (Postdoc), Peter Gazi (Postdoc), Michal Rybar (PhD student)

Light-weight devices require simple and efficient cryptographic schemes.





Mathematical Physics

Robert Seiringer

Many-body systems in quantum mechanics display a rich variety of complex phenomena. The Seiringer group develops new mathematical tools in the quest to seek a thorough understanding of their basic underlying principles.

Ice and water may look different, but are in fact described by the same equations of quantum mechanics. How the same equations can lead to two such very different macroscopic manifestations is one of the questions that inspire the Seiringer group in their effort to precisely understand physical systems. The Seiringer group focuses on many-body systems in quantum mechanics, in particular on problems in quantum statistical mechanics and condensed matter physics. They investigate how atoms and molecules, the building blocks of matter, interact and how this interplay of fundamental parts affects the entire system, and mathematically analyze the behavior of condensed matter at very low temperatures. The Seiringer group applies modern mathematical techniques and even develops new mathematical tools for the rigorous analysis of physical systems, of which they seek to gain a thorough theoretical understanding.

Current projects

> The Heisenberg ferromagnet at low temperature and the spin-wave approximation
> Structure and dynamics of polarons at strong coupling
> Excitation spectrum and superfluidity for weakly interacting Bose gases

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

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

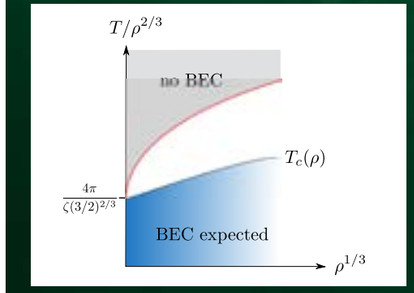
SELECTED PUBLICATIONS

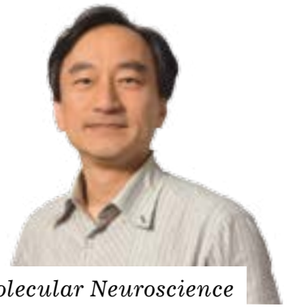
> R. Seiringer. 2014. Bose gases, Bose–Einstein condensation, and the Bogoliubov approximation. J. Math. Phys. 55, 075209.
> R.L. Frank, M. Lewin, E.H. Lieb, R. Seiringer. 2013. A positive density analogue of the Lieb–Thirring inequality, Duke Math. J. 162, 435-495.
> P. Grech, R. Seiringer. 2013. The Excitation Spectrum for Weakly Interacting Bosons in a Trap, Commun. Math. Phys. 322, 559-591.

TEAM

Phan Thanh Nam (Postdoc), Marcin Napiorkowski (Postdoc), Soeren Petrat (Postdoc)

Phase diagram of a dilute Bose gas.





Molecular Neuroscience

Ryuichi Shigemoto

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 way 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 left-right 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.

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

CAREER

since 2013	Professor, IST Austria
since 1998	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

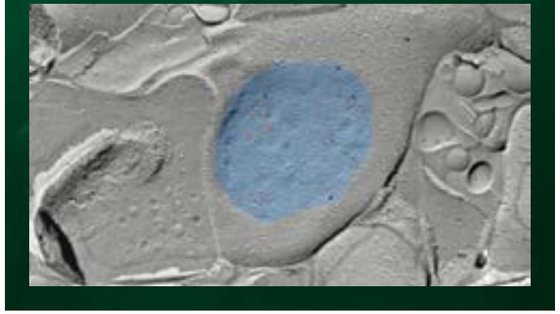
SELECTED PUBLICATIONS

> 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. Proceedings of National Academy of Science, USA. 105:19498-19503.
> Fukazawa Y, Shigemoto R. 2012. Intra-synapse-type and inter-synapse-type relationships between synaptic size and AMPAR expression. Current Opinion in Neurobiology. 22 (3), 446-452.
> 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. Proceedings of National Academy of Science, USA. 111:E188-193.

TEAM

Pradeep Bhandari (PhD student), Matthew Julian Case (PhD student), Felipe Fredes (Postdoc), Harumi Harada (Postdoc), Yukihiro Nakamura (Postdoc)

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.



Invasive Migration

Daria Siekhaus

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

Cells, the building blocks of life, mostly remain stationary to form stable organs and tissues. However, some of our cells need to migrate through our body, as they fight infecting pathogens. The group of Daria Siekhaus studies how these immune cells move during the development of the fruit fly *Drosophila melanogaster* from the place they are born to their final locations in the embryo. The Siekhaus group has shown that one particular developmental path taken by the immune cells requires them to squeeze through a tissue barrier. This behavior displays similarities with that of vertebrate immune cells that use the vasculature as a highway for easy migration through the body, and therefore need to squeeze through the wall of the blood vessels to enter and leave the vasculature. The Siekhaus group has identified many genes required for cells to overcome such barriers, and has shown that some of them allow cells to change how "sticky" cells are. Using a powerful combination of imaging, genetics, cell biology and biophysics, the Siekhaus group seeks to understand the functions of these genes, the pathways they act in, and the strategies and principles that underlie invasive migration. Similar barrier penetration is involved in the metastatic spread of cancer cells, and the results of the Siekhaus group's Drosophila studies may be translated to autoimmunity and metastasis.

Current projects

> Communication between hemocytes and the barriers they move through
> Regulation of adhesion during migration
> Identifying the role of a novel transporter during invasive migration

CAREER

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

SELECTED DISTINCTIONS

2012	Marie Curie Career Integration Grant
2003–2005	NIH Fellowship
2000–2003	NSRA Fellowship

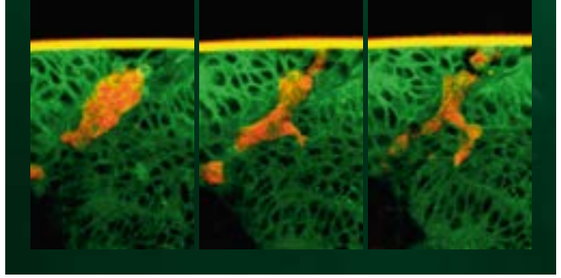
SELECTED PUBLICATIONS

> DeGennaro M, Hurd T, Siekhaus D, Biteau B, Jasper H, Lehmann R. 2011. Peroxiredoxin stabilization of E-cadherin promotes primordial germ cell adhesion. Developmental Cell. 20(2), 233-243.
> 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.

TEAM

Vera Belyaeva (PhD student), Julia Biebl (Technician), Attila György (Technician), Katarina Valoskova (PhD student, DOC Award), Jana Strouhalová (Technician), Aparna Ratheesh (Postdoc)

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



Morphodynamics of Immune Cells

Michael Sixt

Immune cells zip through our body at high speed 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 are 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 then might 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 challenge their findings in the context of living tissues, the Sixt group has developed tissue explants and whole-animal imaging techniques that complement studies in reductionist *in vitro* systems.

Current projects

> Environmental control of leukocyte migration
> Cellular force generation & transduction
> Invasion of tissue barriers

CAREER

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

SELECTED PUBLICATIONS

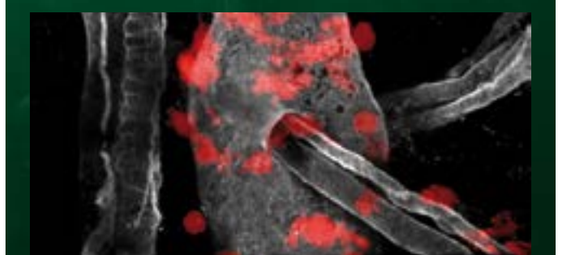
> Weber M, Hauschild R, Schwarz J, Moussion C, de Vries I, Legler DF, Luther SA, Bollenbach T, Sixt M. 2013. Interstitial dendritic cell guidance by haptotactic chemokine gradients. Science. 339(6117):328-332.

> Schumann K, Lämmermann T, Bruckner M, Legler DF, Polleux J, Spatz JP, Schuler G, Förster R, Lutz MB, Sorokin L, Sixt M. 2010. Immobilized chemokine fields and soluble chemokine gradients shape migration patterns of dendritic cells. Immunity. 32(5), 703-713.

> 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.

TEAM

Frank Assen (PhD student), Miroslav Hons (Postdoc), Eva Kiermaier (Postdoc), Aglaja Kopf (Student Intern), Alexander Leithner (PhD student), Christine Moussion (Postdoc), Jan Muller (PhD student), Anne Reversat (Postdoc), Verena Ruprecht (joint Postdoc with Heisenberg group), Jan Schwarz (PhD student), Kari Vaahtomeri (Postdoc), Ingrid de Vries (Technician)



Cells entering a lymph vessel.

Theoretical Biophysics and Neuroscience

Gašper Tkačik

Networks that process and transmit information are everywhere in biology. Neurons, signaling molecules, genes, and organisms are part of extensive networks that have evolved to detect, represent, and compute responses to changes in the environment or the organism's internal state. The Tkačik group uses theoretical biophysics to study information processing in such biological networks.

The Tkačik group focuses on information flow in biological networks, using tools from statistical physics of disordered systems and information theory to analyze, compare and model examples of biological computation. This biological computation takes place across a large range of time scales and is implemented using very different substrates, for instance electrical signals, transcription factor concentrations, covalent modification states of signaling molecules, or visual and auditory signals. The group looks for design principles that would predict how biological networks are wired to perform their functions well under biophysical noise and resource constraints. Their work spans the range from biophysics, signal transduction and genetic regulation over computational neuroscience and neural coding to the collective motion of groups of organisms. For example, the Tkačik group studies how the visual systems of various organisms have adapted to their environments to efficiently extract information from natural stimuli and send it to the central nervous system.

Current projects

> Visual encoding in the retina
> Genetic regulation during early embryogenesis
> Collective dynamics in groups of organisms

CAREER

since 2011	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
2006	Charlotte E Procter Honorific Fellowship, Princeton University
2003	Burroughs-Wellcome Fellowship, Princeton University
2002	Golden sign of the University of Ljubljana

SELECTED PUBLICATIONS

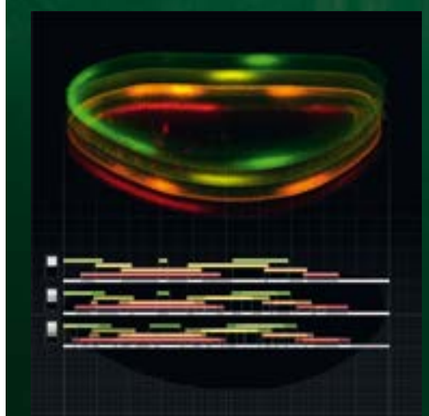
> Tkačik G, Marre O, Amodei D, Schneidman E, Bialek W, Berry MJ. 2014. Searching for collective behavior in a large network of sensory neurons. 2nd PLOS Comp Biol. 10: e1003408.

> Dubuis JO, Tkačik G, Wieschaus EF, Gregor T, Bialek W. 2013. Positional information in bits. PNAS. 110(41): 16301-16308.

> Tkačik G, Granot-Atedgi E, Segev R, Schneidman E. 2013. Retinal metric: a stimulus distance measure derived from population neural responses. Physical Review Letters. 110(5):058104.

TEAM

Anna Andersson (joint Postdoc with Guet group), Katarina Bodova (joint Postdoc with Barton group), Vicente Botella Soler (Postdoc), Sarah Cepeda (PhD student), Tamar Friedlander (joint ISTFELLOW Postdoc with Barton and Guet groups), Jan Humplik (PhD student), Gabriel Mitchell (Postdoc), Roshan Prizak (joint PhD student with Barton and Guet groups) , Georg Rieckh (PhD student), Cristina Savin (ISTFELLOW Postdoc), Thomas Sokolowski (Postdoc)



Analyzing positional information during fruit fly development.

Algebraic Statistics and Mathematical Biology

Caroline Uhler

How are chromosomes packed into the cell's nucleus? How many observations are minimally needed for estimating interactions between genes? How can privacy be ensured when releasing genomic data? The Uhler group works on algebraic statistics and addresses questions in computational biology.

Algebraic statistics exploits the use of 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 consists of 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, amongst others, 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 methods to release data from genomewide association studies without compromising an individual's privacy.

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

CAREER

since 2011	Assistant Professor, IST Austria
2013	Research Fellow, Theoretical Foundations of Big Data Analysis, 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

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.

TEAM

Abraham Martin del Campo (Postdoc), Mabel Iglesias-Ham (PhD student, joint with Edelsbrunner group), Anna Klimova (Postdoc), Lenka Matejovicova (PhD student), Fatemeh Mohammadi (ISTFELLOW Postdoc), Patrik Noren (ISTFELLOW Postdoc)

Gaussian distributions on three nodes for which causal inference fails.

Combinatorics, Geometry, and Topology

Uli Wagner

How are molecules connected through chemical bonds? How do people know each other? How is a city's road network laid out? All these are questions on connections – of objects, places or people. Asking questions about connections mathematically, the Wagner group's focus lies on combinatorial and computational geometry and topology.

Graphs consist of vertices – points such as houses – and edges which connect vertices – for example connecting roads. Classical graph theory then asks questions on these graphs: is a graph planar, so can all points be connected without the connections crossing each other? What does the fact that a graph is planar tell us about the connections, e.g. about a city's road map? Such graphs are one-dimensional shapes. The Wagner group studies questions analogous to these classical questions of graph theory for geometric shapes and structures of higher dimensions. They ask whether a shape can be fitted in higher dimensional space, and what information this conveys about the shape's structure and complexity. Their research combines geometry and topology with combinatorics, as they study questions in geometry and topology from a combinatorial viewpoint, while also applying methods from topology to problems in combinatorics, discrete geometry and theoretical computer science. The group also asks to what extent classical questions in topology and geometry can be answered in a mechanical way, i.e. by a computer program.

Current projects

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

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
2004–2004	Postdoc, Department for Applied Mathematics, Univerzita Karlova, Prague, Czech Republic
2003–2003	Postdoc, Mathematical Sciences Research Institute, Berkeley, USA
2000–2004	PhD in Mathematics, ETH Zurich, Switzerland

SELECTED DISTINCTIONS

2012	Research Assistant Professorship Grant of Swiss National Science Foundation (SNSF)
2012	Co-winner of Best Paper Award at Symposium of Discrete Algorithms (SODA)
2004	Richard Rado Prize

SELECTED PUBLICATIONS

> Mabillard I, Wagner U. 2014. Eliminating Tverberg Points, I. An analogue of the Whitney trick. Proc. 30th Ann. Symp. on Comput. Geom. (SoCG). 171-180.
> Matoušek J, Sedgwick E, Tancer M, Wagner U. 2014. Embeddability in the 3-sphere is decidable. Proc. 30th Ann. Symp. on Comput. Geom. (SoCG). 78-84.
> Matoušek M, Tancer M, Wagner U. 2011. Hardness of embedding simplicial complexes in Rd . J. Eur. Math. Soc. 13(2), 2011, 259-295.

TEAM

Kristóf Huszár (PhD student), Marek Krcal (Postdoc), Isaac Mabillard (PhD student), Arnau de Mesmay (Postdoc)

Computer Graphics

Chris Wojtan

Deceptively realistic virtual worlds, animated movies and computer games are highly popular. Complex calculations and models operate in the background to achieve these accurate simulations. The Wojtan group uses numerical techniques to provide the basis for complex animations and graphics.

The realistic simulation of complex processes in the physical world is the focus of research in the Wojtan group. Using numerical techniques, they create computer simulations of physical phenomena such as fluids, deformable bodies or cloth. Such accurate representations are required not only for computer animation, but also for medical simulations, computational physics and digital modeling. In their work, the Wojtan group combines mathematical methods from computational physics with geometric techniques from computer graphics. A key contribution of the Wojtan group is the efficient treatment of topological changes with deforming meshes that split and merge, in order to simulate highly detailed surface tension phenomena, such as the formation of water droplets and splashes. This method is used for the realistic animation of flowing and splashing water. The latest research of the group couples high-resolution embedded surface geometry to low-resolution simulations, to simulate detailed animations of elastic, plastic, and fluid phenomena.

Current projects

> Simulating fractured materials to create highly detailed surfaces
> Generating temporally coherent deforming surfaces with changing topology from space-time data
> Efficient simulation of fluid dynamics

CAREER

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

SELECTED DISTINCTIONS

2014	ERC Starting Grant
2013	Microsoft Visual Computing Award
2011	Georgia Institute of Technology Sigma Chi Best PhD Thesis Award
2010	Outstanding Graduate Research Assistant Award (Georgia Institute of Technology)
2005	National Science Foundation Graduate Research Fellowship
2004	Presidential Fellowship
2003	James Scholarship

SELECTED PUBLICATIONS

> Ando R, Thürey N, Wojtan C. 2013. Highly adaptive liquid simulations on tetrahedral meshes. ACM Transactions on Graphics. 32(4) (Proceedings of SIGGRAPH 2013). Article 10.
> Bernstein G, Wojtan C. 2013. Putting holes in holey geometry: topology change for arbitrary surfaces. ACM Transactions on Graphics. 32(4) (Proceedings of SIGGRAPH 2013). Article 34.
> Bojsen-Hansen M, Li H, Wojtan C. 2012. Tracking Surfaces with Evolving Topology. ACM Transactions on Graphics. 31(4) (Proceedings of SIGGRAPH 2012). Article 53.

TEAM

Ryoichi Ando (Postdoc), Morten Bojsen-Hansen (PhD Student), David Hahn (PhD student), Stefan Jeschke (Postdoc), Álvaro Fernández Sánchez (Visiting Scientist)

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

Starting in 2015 and 2016

New Professors

increase of brain capacity @ IST Austria since 2009: 1860 percent

Beatriz Vicoso

is an evolutionary biologist interested in the evolution of sex chromosomes. She studied Genetics at the Federal University of Rio de Janeiro in Brazil and received her PhD in Evolutionary Genomics in 2009 at the University of Edinburgh, UK. Her predoctoral studies were performed in the group of Brian Charlesworth. Since 2009, she has been a postdoctoral fellow in the laboratory of Doris Bachtrog at the University of California, Berkeley. Her postdoctoral work focused on using next-generation sequencing to study the sex chromosomes of various non-model species, including trematodes, birds, snakes and insects. She uncovered several novel patterns, such as the first known case of a differentiated X-Chromosome reverting back to an autosome, a lack of dosage compensation in snakes, and the persistence of homomorphic sex chromosomes through sex-biased gene expression in emus. Beatriz Vicoso will start at IST Austria as assistant professor in 2015.

Georgios Katsaros

is a condensed matter physicist who is interested in self-assembled semiconductor nanostructures and their electronic transport properties at low temperatures. He studied Physics at the University of Patras and then moved to the National Center For Scientific Research – Demokritos in Athens. For his PhD, he joined the group of Klaus Kern at the MPI for Solid State Research in Stuttgart in 2002 where he worked in the field of surface science. His PhD thesis was focused on the structural properties of SiGe Stranski-Krastanov islands. For his postdoctoral research at CEA Grenoble, he changed the field to perform low temperature electronic transport measurements through SiGe semiconductors nanostructures. In 2012, Katsaros joined the Johann-Kepler-University in Linz, Austria, as group leader, working on low temperature electronic transport through semiconductor nanostructures. Katsaros will move to IST Austria as assistant professor in early 2016.

Martin Loose

is a systems biologist who aims to understand the mechanisms and evolution of biochemical self-organization and how proteins are able to organize intracellular space. He studied Chemistry at the University of Heidelberg and performed his predoctoral studies in the group of Petra Schwille at the Biotechnology Center of the University of Dresden and the Max-Planck-Institute for Molecular Cell Biology and Genetics in Dresden. After receiving his PhD in 2010, he spent a further year as a postdoctoral fellow in Schwille's lab. In 2011, he joined the Department of Systems Biology at Harvard Medical School, Boston, USA, as an independent Departmental Fellow to work in the lab of Timothy Mitchison. As a graduate student, he demonstrated for the first time that complex protein patterns could be reconstituted in vitro in a simple, mathematically easily accessible setting. In his postdoctoral studies, he developed a novel model for the initial steps of bacterial cell division. Martin Loose will join at IST Austria as assistant professor in 2015.

Starting in 2015 and 2016

New Professors

Leonid Sazanov

is a structural biologist who studied biophysics (B.Sc. and M.Sc.) at the Belarusian State University in Minsk and performed his doctoral studies at the Department of Biophysics at the Moscow State University where he remained as a research fellow in the group of Sergei V. Zaitsev till 1992. After continuing his research at the University of Birmingham and at Imperial College in London, he joined as a research associate in the group of Nobel Laureate John E. Walker at the MRC Laboratory of Molecular Biology in Cambridge. Since 2000, he is at the MRC Mitochondrial Biology Unit in Cambridge, UK, where he has been a Tenured Program Leader since 2006. Sazanov's research aims to understand the structure and function of membrane proteins and focuses on the determination of the structure of the very large protein assembly respiratory complex I. Sazanov will start at IST Austria as professor in April 2015.

Johannes Fink

is a physicist whose main field of research is the interaction of matter and light which he studies using superconducting circuit quantum electrodynamics (QED) and integrated opto- and electro-mechanical devices. After his undergraduate studies at the University of Vienna from 2002 to 2007 he joined the lab of Prof. Andreas Wallraff at ETH Zurich for his master's thesis and his graduate studies. He managed to observe the geometric phase in an electrical circuit for the first time and continued to work on circuit QED experiments. In his doctoral work he studied a number of important aspects of the resonant interaction between microwave photons and superconducting qubits. Since 2012, Johannes has been a postdoc with Prof. Oskar Painter at the Institute for Quantum Information and Matter at the California Institute of Technology in Pasadena. Fink will set up his lab at IST Austria as assistant professor in early 2016.

Bernd Bickel

is interested in computer graphics and its applications in animation, biomechanics, material science and computational design for digital fabrication. Bickel studied Computer Science at ETH Zurich, where he also received his PhD in 2010, having performed research in the Computer Graphics Laboratory under the supervision of Markus Gross. Following his PhD, Bickel joined Disney Research Zurich as a postdoc, and was appointed as visiting professor at TU Berlin from 2011 to 2012. Since 2012, Bickel is a researcher and research group leader at Disney Research Zurich. Bickel's recent work includes next generation 3D surface scanner devices, performance capture, measuring and modeling the deformation behavior of soft tissue, animation tools, and computational synthesis for 3D printing. Bernd Bickel will join IST Austria as assistant professor in 2015.

Grants & Prizes

The scientists of IST Austria received prestigious awards, grants, prizes, and other honors in 2014. International and national distinctions are an important mark of recognition for researchers and a reliable metric for measuring scientific excellence. Please find some examples below.

The most prestigious grants for basic research in Europe are awarded by the European Research Council (ERC). In 2014, an ERC Starting Grant was awarded to the computer scientist **Chris Wojtan**, bringing the total number of ERC grantees among the IST Austria faculty to 15. In his ERC-funded project "Big Splash: Efficient Simulation of Natural Phenomena at Extremely Large Scales", Wojtan will apply two main approaches to the problem of efficiently simulating large-scale liquid and solid dynamics. His first avenue of research will combine numerics and shape by investigating a careful de-coupling of dynamics from geometry, allowing essential shape details to be preserved and retrieved without wasting computation. The second main research direction will be the manipulation of large-scale simulation data: Given the redundant and parallel nature of physics computation, Wojtan intends to drastically speed up computation with novel dimension reduction and data compression approaches, thus minimizing unnecessary computation by re-using existing simulation data. The novel approaches resulting from this work are intended to improve simulations and contribute to the understanding of complicated natural and biological processes that are presently unfeasible to compute.

The Human Frontier Science Program (HFSP) is a global funding agency that competitively selects cutting-edge, risky projects pursued by international, interdisciplinary teams. In 2014, an HFSP grant was awarded to neurobiologist **Simon Hippenmeyer** and research groups in the US and the UK. In their project "Quantitative Structure-Function Analysis of Cerebral Cortex Assembly at Clonal Level", the researchers will seek to understand how the cortex, the brain region that controls all higher order brain functions such as perception, emotion, language and cognition, is constructed. Assuming that cortex assembly is fundamentally influenced by the order in which neurons are born, called the neuronal lineage, they will examine how individual neuronal lineages develop both structurally and functionally. Hippenmeyer and his collaborators will take an interdisciplinary approach to visualize neuronal lineages in vivo with unprecedented resolution. Their objective is to develop mathematical models of how a neuronal lineage is built, identify molecular signatures defining lineages and so uncover principles of circuits' spatial and functional organization. So far, six scientists at IST Austria have succeeded to acquire prestigious HFSP grants.

In 2014, evolutionary biologist **Nick Barton** and cell biologist **Michael Sixt** were elected to EMBO membership. The European Molecular Biology Organization (EMBO) is an organization of leading researchers in the life sciences. Each year, new members and associate members are elected to life-long membership to ensure that EMBO remains at the cutting edge of life science.

For the first time, the European Association for Theoretical Computer Science (EATCS) named ten of its members as EATCS fellows. Among them was computer scientist **Herbert Edelsbrunner**, who was selected for his outstanding contributions to computational geometry. EATCS is an international organization whose aim is to facilitate the exchange of ideas and results among theoretical computer scientists as well as to stimulate cooperation between the theoretical and the practical community in computer science.

Peer-reviewed research grants acquired or active in 2014

Barton group
> Limits to selection in biology and in evolutionary computation, FP7-ERC Advanced Grant, €1'976'000, 7/2010-6/2015
> LOREAL Fellowship, OeAW L'OREAL, €20'000, 10/2013-3/2014
> Mating system and the evolutionary dynamics of hybrid zones, FP7-PEOPLE MC-IIF, €179'000, 5/2014-4/2016
> Speed of Adaptation in Population Genetics and Evolutionary Computation, FP7-Cooperation ICT-2013.9.3, €584'000, 1/2014-12/2017

Benková group
> Hormonal cross-talk in plant organogenesis, FP7-ERC Starting Grant, €87'000, 4/2013-3/2014
> Hormone cross-talk drives nutrient dependent plant development, FWF Int. Koop. (ANR), €349'000, 1/2015-12/2017
> FONDECYT, €43'000, 12/2014-12/2015

Bickel group
> DISTRO: Distributed 3D Object Design, Horizon 2020-MSCA ITN, €256'000, 1/2015-12/2018
> Soft-bodied intelligence for Manipulation, Horizon 2020-ICT, €261'000, 5/2015-4/2019

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, €256'000, 9/2013-8/2016
> Revealing the mechanisms underlying drug interactions, FWF Stand Alone, €349'000, 1/2015-12/2017
> Austrian Programme for Advanced Research and Technology, OeAW APART, €225'000, 5/2012-4/2015

Chatterjee group
> Quantitative Graph Games: Theory and Applications, FP7-ERC Starting Grant, €1'163'000, 12/2011-11/2016
> Rigorous Systems Engineering, FWF NFN, €464'000, 3/2011-2/2015
> Modern Graph Algorithmic Techniques in Formal Verification , FWF Stand Alone, €107'000, 9/2011-8/2014
> Microsoft Research Faculty Fellowship, Microsoft Research Faculty Fellowship, €143'000, 7/2011-3/2015
> Spiel Theorie, FWF NFN, €330'000, 3/2015-2/2019

Cremer group
> Individual function and social role of oxytocin-like neuropeptides in ants, WWTF LS 2013 Step 2, €162'000, 1/2014-12/2017
> Social Vaccines - Social Vaccination in Ant Colonies: from Individual Mechanisms to Society Effects, FP7-ERC Starting Grant, €1'278'000, 11/2010-3/2015
> Collective disease defence and pathogen detection abilities in ant societies: a chemo-neuro-immunological approach, FP7-PEOPLE MC-IEF, €180'000, 4/2012-3/2014
> Junior Fellowship, Wissenschaftskolleg zu Berlin/WIKO, €17'000, 9/2014-12/2014

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, €234'000, 10/2013-9/2017
> Interneuron plasticity during spatial learning, DFG FOR, €256'000, 1/2015-12/2017

Edelsbrunner group
> Topological Complex Systems, FP7-COOPERATION ICT-2011-8, €498'000, 10/2012-9/2015
> Persistent Homology - Images, Data and Maps, FP7-PEOPLE MC-IEF, €248'000, 4/2014-3/2016

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

Friml group
> Polarity and subcellular dynamics in plants, FP7-ERC Starting Grant, €1'269'000, 4/2013-1/2017
> Kooperation IFA-Tulln/IST im Bereich Pflanzenhormone, NÖ Technologieförderung , €62'000, 1/2014-12/2014
> Effects of strigolactone analogues on subcellular distribution of dynamic PIN proteins in Arabidopsis, OeAW WTZ, €3'000, 4/2013-1/2017
> Chinese Scholarship Council, €14'000, 10/2014-10/2015

Guet group
> Multi-Level Conflicts in Evolutionary Dynamics of Restriction-Modification Systems, HFSP Young Investigators' Grant, €263'000, 11/2011-10/2015
> 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-Modication Systems at the Single-Cell Level, OeAW DOC fellowship, €107'000, 1/2015-12/2017
> SNF Fellowship, €54'000, 10/2013-4/2015

Heisenberg group
> Cell Cortex and Germ Layer Formation in Zebrafish Gastrulation, FWF DACH DFG, €282'000, 10/2011-9/2014
> Control of Epithelial Cell Layer Spreading in Zebrafish, FWF DACH DFG, €345'000, 5/2012-4/2015
> Cell Cortex and Germ Layer Formation in Zebrafish Gastrulation, FWF DACH DFG, €304'000, 10/2014-9/2017
> Modulation of adhesion function in cell-cell contact formation by cortical tension, EMBO LTF, €70'000, 7/2013-6/2015
> Cell- and Tissue Mechanics in Zebrafish Germ Layer Formation, FWF Hertha Firnberg, €214'000, 2/2012-1/2015
> Nano-Analytics of Cellular Systems, FWF DoktoratsKollegs (DK), €162'000, 3/2014-2/2018
> Japan Society for the Promotion of Science (JSPS), €103'000, 10/2012-10/2014
> DFG Forschungsstipendium, €36'000, 12/2013-12/2014

Henzinger group
> Quantitative Reactive Modeling, FP7-ERC Advanced Grant, €2'326'000, 5/2011-4/2016
> Rigorous Systems Engineering, FWF NFN, €465'000, 3/2011-2/2015
> Automated Tutoring System for Automata Theory, Microsoft Research Education Studio Award, €7'000, 1/2011-12/2016
> The Wittgenstein Prize, FWF Wittgenstein Prize, €1'500'000, 1/2014-12/2018
> Modern Concurrency Paradigms, FWF NFN, €490'000, 4/2015-3/2018

Hippenmeyer group
> Molecular Mechanisms of Celebral Cortex Development, FP7-PEOPLE MC-CIG, €100'000, 9/2013-8/2017
> Mapping Cell-Type Specificity of the Genomic Imprintome in the Brain, NFB Life Science call 2013, €245'000, 3/2015-2/2018
> Quantitative Structure-Function Analysis of Cerebral Cortex Assembly at Clonal Level, HFSP RGP, €270'000, 9/2014-8/2017

Hof group
> Decoding the complexity of turbulence at its origin, FP7-ERC Starting Grant, €1'396'000, 6/2013-12/2017
> Wandnahe Transport- und Strukturbildungsprozesse in turbulenten Rayleigh-Bénard-, Taylor-Couette- und Rohrströmungen, DFG FOR, €273'000, 12/2013-12/2016
> SFB 963 Astrophysikalische Strömungsinstabilität und Turbulenz, DFG SFB, €52'000, 6/2013-4/2014
> Promotionsstipendium der Max-Planck-Gesellschaft, €12'000, 9/2013-6/2014
> Max Planck Institut, €34'000, 2/2013-6/2014

Janovjak group
> Microbial Ion Channels for Synthetic Neurobiology, FP7-PEOPLE MC-CIG, €100'000, 3/2012-2/2016
> In situ real-time imaging of neurotransmitter signaling using designer optical sensors, HFSP Young Investigators' Grant, €264'000, 8/2012-7/2015
> Molecular Drug Targets, FWF DoktoratsKollegs (DK), €196'000, 3/2014-2/2018
> Optical drug targets, FFG FEMTech, €8'000, 8/2014-2/2015
> Optical NT sensor, FFG FEMTech, €8'000, 9/2014-2/2015
> Dan David Scholarship, €11'000, 5/2014-10/2014
> Ramon Areces Foundation, €26'000, 10/2014-10/2015

Jonas group
> Nanophysiology of fast-spiking, parvalbumin-expressing GABAergic interneurons, FP7-ERC Advanced Grant, €2'500'000, 6/2011-5/2016
> Mechanisms of transmitter release at GABAergic synapses, FWF Stand Alone, €494'000, 10/2012-9/2015

Kolmogorov group
> DOiCV : Discrete Optimization in Computer Vision: Theory and Practice, FP7-ERC CoG, €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

Novarino group
> Molecular Drug Targets, FWF DoktoratsKollegs (DK), €196'000, 3/2015-2/2019
> Transmembrane Transporters in Health and Disease, FWF SFB, €348'000, 2/2014-1/2017
> Modeling Epileptic Encephalopathies in Human Brain Organoids, CureEpilepsy, €80'000, 1/2015-12/2015

Pietrzak group
> Provable Security for Physical Cryptography, FP7-ERC Starting Grant, €1'005'000, 9/2011-10/2015

Shigemoto group
> High resolution tagging for ion channels in neural membrane, FWF Int. Koop. (JSPS), €278'000, 7/2014-6/2016
> Localization of ion channels and receptors by two and three-dimensional immunoelectron microscopic approaches, Horizon 2020- FET-FLAG Human Brain Project, €234'000, 4/2014-3/2016
> Anatomical and Functional Properties of Auditory Nerve Synapses, NIH, €14'000, 3/2014-2/2015

Siekhaus group
> Investigating the role of transporters in invasive migration through junctions, FP7-PEOPLE MC-CIG, €100'000, 4/2013-3/2017
> Breaking barriers: Investigating the junctional and mechano-biological changes underlying the ability of Drosophila immune cells to invade an epithelium, FP7-PEOPLE MC-IIF, €179'000, 3/2013-2/2015
> Examination of the role of a MFS transporter in the migration of Drosophila immune cells, OeAW Doc fellowship, €71'000, 6/2015-5/2017

Sixt group
> LeukocyteForces: 'Cytoskeletal force generation and force transduction of migrating leukocytes', FP7-ERC Starting Grant, €1'458'000, 4/2012-3/2017
> Stromal Cell-immune Cell Interactions in Health and Disease, FP7-PEOPLE MC-ITN, €248'000, 1/2012-12/2015
> Cytoskeletal force generation and force transduction of migrating leukocytes, FWF START, €200'000, 8/2011-7/2017
> Cell migration in complex environments: from in vivo experiments to theoretical models, HFSP Program Grant, €254'000, 11/2011-10/2014
> DFG SBH, €190'000, 10/2013-9/2016
> Modeling of Polarization and Motility of Leukocytes in Three-Dimensional Environments, WWTF LS 2013 Step 2, €196'000, 3/2014-2/2018
> Long Term Fellowship, EMBO , €48'000, 3/2015-2/2016
> Böhringer Ingelheim, €46'000, 10/2012-10/2014
> Juselius Foundation, €60'000, 11/2013-11/2014
> Nano-Analytics of Cellular Systems, FWF DoktoratsKollegs (DK), €162'000, 3/2014-2/2018

Tkačik group
> Sensitivity to higher-order statistics in natural scenes, FWF Stand Alone, €352'000, 9/2013-8/2016
> Information processing and computation in fish groups, HFSP Program Grant, €264'000, 10/2012-9/2016

Wagner group
> Embeddings in Higher Dimensions: Algorithms and Combinatorics, SNF Förderprofessur, €174'000, 3/2013-6/2016

Wojtan group
> Big Splash: Efficient Simulation of Natural Phenomena at Extremely Large Scales, Horizon 2020-ERC Starting Grant, €1'500'000, 3/2015-2/2020
> Deep Pictures: Creating Visual and Haptic Vector Images, FWF Stand Alone, €342'000, 8/2012-7/2015
> Japan Society for the Promotion of Science (JSPS), €79'000, 4/2014-4/2016

Publications 2014

Communicating Scientific Results

Publications by IST Austria members published or accepted in 2014; joint publications involving several groups are listed multiple times.

Barton group
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Bollback group
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Chatterjee group
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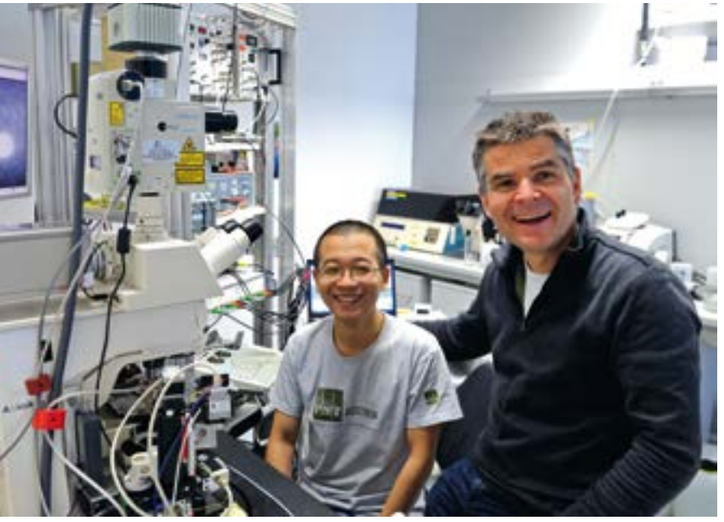

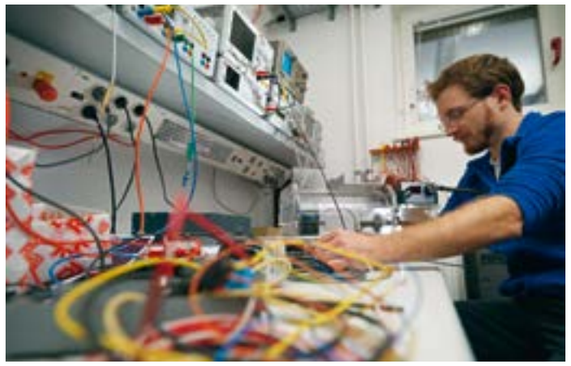

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Number of breathtaking computer-generated graphics since 2009: uncountable

Scientific Events - Platforms for Exchange

Conferences, Symposia, and Workshops

IST Austria is linked to the scientific community through a range of scientific events, from annual conferences to weekly seminars, including many interdisciplinary events.

Number of Think & Drink-Meetings since 2009: 60!

In May 2014, IST Austria hosted several scientific events on campus. First, the Institute organized an interdisciplinary **conference on Stochastic Biology**. The objective of the meeting was to bring together researchers with diverse backgrounds, in particular in physics, biology, mathematics, and computer science, to help address challenging questions arising from stochasticity in biology. This exciting new field relies strongly on interdisciplinary approaches. The event brought established leaders in the field together with early career researchers in order to help promote a better common understanding of the fundamental issues. It also contributed to shaping an emerging discipline that is currently still underrepresented in Europe.

The postdocs and PhD students of IST Austria organized their third **Young Scientist Symposium** in May, titled Synchronize! Clocks, Rhythms and Communication Across the Sciences. The study of synchronization and its applications has been undertaken in a variety of fields ranging from the neuroscience of brain oscillations or quorum sensing in bacterial populations to the complexity of distributed computing in computer science and the mathematics of coupled oscillators. The one-day multidisciplinary event encompassed six general talks and a panel discussion on these diverse topics, including neuroscience, biology, physics, and computer science.

Finally, IST Austria organized the **38th Annual Workshop of the Austrian Association for Pattern Recognition (ÖAGM)** at the end of May. This provided a platform for researchers and industry to discuss traditional and new areas of computer vision. This year's main topic was Pattern Recognition: Interdisciplinary Challenges and Opportunities. Additional general topics of interest included all aspects of computer vision and pattern recognition including object detection, recognition and categorization, 3D vision, motion and tracking, video analysis and event recognition, face and gesture analysis, cognitive vision and robot perception.

In the summer of 2014, Vienna hosted the largest event in the history of logic. The **Vienna Summer of Logic**, organized by the Technical University Vienna with support from IST Austria, consisted of twelve large conferences and numerous workshops, attracting over 2000 researchers from all over the world, gathering to present important findings, emerging trends, and new challenges in computer science, artificial intelligence, and mathematical logic.

In fall, the second annual **project meeting of the Topological Complex Systems project** funded by the FP7 framework of the European Union was held at IST Austria. Combining category theory, statistics, and dynamical systems with computational topology as the joint platform, the project aims at new approaches to the mathematically rigorous description of the dynamics of a system, from a local to a global scale.

The Institute Colloquium

The IST Colloquium is IST Austria's main weekly seminar, which is aimed at engaging a broad range of scientists in the fields of computer, mathematical, physical, and life sciences. Gershon Kurizki from the Weizmann Institute of Science, Przmyslaw Prusinkiewicz from the University of Calgary, and Ralf Schneggenburger from EPFL Lausanne are among the many international experts who were invited to speak in 2014 and present their latest research. The IST Colloquium is open not only to the scientists at IST Austria, but also to scientists in the Vienna region. More information on the IST Colloquium can be found on the website (www.ist.ac.at) as well as in the Institute's quarterly newsletter.

If you wish to be added to the mailing list that announces IST Colloquia and other events, please subscribe on our website or mail to office@ist.ac.at.

Conferences & Symposia in 2014

May 5-7	Stochastic Biology: from Cells to Populations
May 16	Young Scientist Symposium: Synchronize!
May 22-23	The 38th Annual Workshop of the Austrian Association for Pattern Recognition (ÖAGM)
Sept 8-10	Topology for Dynamical Systems

Speakers at IST Austria in 2014

Abedon Stephen (Columbus, USA) **Akopian Nika** (Delft; Eindhoven, The Netherlands) **Allan Milan** (Zurich, Switzerland) **Angermayr Andreas** (Amsterdam, The Netherlands) **Barth Alison L.** (Pittsburgh, USA) **Basu Mahashweta** (Bidhannagar, India) **Bogani Lapo** (Stuttgart, Germany) **Bohr Tomas** (Lyngby, Denmark) **Bonanomi Dario** (La Jolla, USA) **Bonifazi Davide** (Namur, Belgium) **Bui Hung** (Bristol, UK) **Calo Victor** (Thuwal, Saudi Arabia) **Caron Sophie** (New York, USA) **Carvalho Lara** (Lisbon, Portugal) **Chen I-Wen** (Zurich, Switzerland) **Chen Peter** (Zurich, Switzerland) **Christie Jason** (Jupiter, USA) **Clark Andrew** (Paris, France) **Colgin Laura** (Austin, USA) **Collins Terrance** (Pittsburgh, USA) **Couzin Iain** (Princeton, USA) **Dalibard Jean** (Paris, France) **Damgård Ivan Bjerre** (Aarhus, Denmark) **De Renzis Stefano** (Heidelberg, Germany) **Dogic Zvonimir** (Waltham, USA) **Dorfan Jonathan** (Okinawa, Japan) **Dutzler Raimund** (Zurich, Switzerland) **Eder Miguel** (Madrid, Spain) **Ehrenfreund Pascale** (Vienna, Austria) **Eisele Dörthe M.** (Cambridge, USA) **Eisenhauer Kirstin** (Bochum, Germany) **Elsayad Kareem** (Vienna, Austria) **Engl Tobias** (Jena, Germany) **Engstroem Alex** (Helsinki, Finland) **Essex Edwards** (Vancouver, Canada) **Fery Andreas** (Bayreuth, Germany) **Fink Johannes** (Pasadena, USA) **Fries Pascal** (Frankfurt am Main, Germany) **Fujita Yasuyuki** (Sapporo, Japan) **Fussenegger Martin** (Zurich, Switzerland) **Gavin Anne-Claude** (Heidelberg, Germany) **Geldner Niko** (Lausanne, Switzerland) **Gerlich Daniel** (Vienna, Austria) **Gordon Deborah** (Stanford, USA) **Gröblacher Simon** (Pasadena, USA) **Guyot-Sionnest Philippe** (Chicago, USA) **Halasyamani Shiv** (Houston, USA) **Hallermann Stefan** (Leipzig, Germany) **Heckmann Manfred** (Würzburg, Germany) **Heinemann Matthias** (Groningen, The Netherlands) **Heinze Jürgen** (Regensburg, Germany) **Hermsen Rutger** (Utrecht, The Netherlands) **Hiraoka Yasu** (Fukuoka, Japan) **Hotta Kohji** (Tokyo, Japan) **Hyman Tony** (Dresden, Germany) **Jacinto Antonio** (Lisbon, Portugal) **Jahn Reinhard** (Göttingen, Germany) **Jenko Frank** (Ulm, Germany) **Kalinka Alex** (Vienna, Austria) **Kanade Varun** (Berkeley, USA) **Kardos Roland** (Pécs, Hungary) **Kato Fusao** (Tokyo, Japan) **Keplinger Christoph** (Cambridge, USA) **Khammash Mustafa** (Zurich, Switzerland) **Kuehn Christian** (Vienna, Austria) **Kurizki Gershon** (Rehovot, Israel) **Lässig Michael** (Cologne, Germany) **Lee Kwonmee** (Cambridge, USA) **Lee Suk-Ho** (Seoul, South Korea) **Lengyel Máté** (Cambridge, UK) **Lieb Elliot** (Princeton, USA) **Linial Nathan** (Jerusalem, Israel) **Loose Martin** (Cambridge, USA) **Losonczy Attila** (New York, USA) **Lucas Robert** (Manchester, UK) **Maas Jan** (Bonn, Germany) **Machta Ben** (Princeton, USA) **Maerkl Sebastian J.** (Lausanne, Switzerland) **Maizel Alexis** (Heidelberg, Germany) **Malnasi-Csizmadia Andras** (Budapest, Hungary) **Manson Josiah** (College Station, USA) **Marques Francisco** (Barcelona, Spain) **Massignan Pietro** (Barcelona, Spain) **Matsushima Ayano** (Sapporo, Japan) **Mellibovsky Fernando** (Barcelona, Spain) **Menéndez de la Prida Liset** (Madrid, Spain) **Metzler Ralf** (Potsdam, Germany; Tampere, Finland) **Meyer Tobias** (Stanford, USA) **Mieck Christine** (Vienna, Austria) **Milatz Malte** (Aachen, Germany) **Misgeld Thomas** (Munich, Germany) **Mitra Niloy J.** (London, UK) **Morandi Bill** (Pasadena, USA) **Muir Tom** (Princeton, USA) **Muller Eilif** (Lausanne, Switzerland) **Müller Holger** (Berkeley, USA) **Nakamura Yukihiro** (Paris, France) **Naor Moni** (Rehovot, Israel) **Neukomm Lukas** (Worcester, USA) **Nguyen Laurent** (Liege, Belgium) **Nordborg Magnus** (Vienna, Austria) **Nori Franco** (Saitama, Japan; Ann Arbor, USA) **Nowack Moritz** (Ghent, Belgium) **Nusser Zoltan** (Budapest, Hungary) **Oberhofer Martina** (Greensboro, USA) **Pachter Lior** (Berkeley, USA) **Panova Greta** (Los Angeles, USA) **Pauli Andrea** (Cambridge, USA) **Paulsen Ole** (Cambridge, UK) **Payne Joshua L.** (Zurich, Switzerland) **Piel Matthieu** (Paris, France) **Polack Pierre-Olivier** (Los Angeles, USA) **Prusinkiewicz Przmyslaw** (Calgary, Canada) **Qin Qi** (Oxford, UK) **Quadrio Maurizio** (Milano, Italy) **Radlwimmer Bernhard** (Heidelberg, Germany) **Raikhel Natasha** (Riverside, USA) **Rangan Prashanth** (Albany, USA) **Rein ten Wolde Pieter** (Amsterdam, The Netherlands) **Richards Donald** (State College, USA) **Rivera-Fuentes Pablo** (Cambridge, USA) **Rosenblum Michael** (Potsdam, Germany) **Sacco Robert** (Vienna, Austria) **Sakmann Bert** (Martinsried, Germany) **Savageau Michael** (Davis, USA) **Sazanov Leonid** (Cambridge, UK) **Schanz Martin** (Graz, Austria) **Schmeisser Michael** (Ulm, Germany) **Schmiedel Jörn** (Berlin, Germany) **Schneebeli Severin T.** (Evanston, USA) **Schneggenburger Ralf** (Lausanne, Switzerland) **Schramek Daniel** (New York, USA) **Semyanov Alexey** (Nizhny Novgorod, Russia) **Smith Breannan** (New York, USA) **Soen Yoav** (Rehovot, Israel) **Søgaard-Andersen Lotte** (Marburg, Germany) **Solovej Jan Philip** (Copenhagen, Denmark) **Spatz Joachim** (Stuttgart, Germany) **Speck James S.** (Santa Barbara, USA) **Springer Michael** (Cambridge, USA) **Stagljar Igor** (Toronto, Canada) **Steiger Sandra** (Ulm, Germany) **Stemmer Susanne** (Santa Barbara, USA) **Stökl Johannes** (Regensburg, Germany) **Swain Peter** (Edinburgh, UK) **Tapken Daniel** (Bochum, Germany) **Tarabykin Victor** (Berlin, Germany) **Tole Shuba** (Mumbai, India) **Trauner Dirk** (Munich, Germany) **Tsimring Lev** (San Diego, USA) **Valachova Ivana** (Bratislava, Slovak Republic) **Vicoso Beatriz** (Berkeley, USA) **Vitek Jan** (West Lafayette, USA) **Weidinger Juan Flórez-Daniel** (Goettingen, Germany) **Welzl Emo** (Zurich, Switzerland) **White Richard Mark** (New York, USA) **Will Sebastian** (Cambridge, USA) **Willis Ashley** (Sheffield, UK) **Wolff Steffen** (Basel, Switzerland) **Wonka Peter** (Thuwal, Saudi Arabia) **Yuzaki Michisuke** (Tokyo, Japan) **Zeng Kai** (Sheffield, UK) **Zou Yimin** (San Diego, USA) **Zsolnai Károly** (Vienna, Austria) **Zweig George** (Cambridge, USA)

Public Events

Communicating Science

IST Austria aims to raise the public awareness of basic research and foster an understanding for the natural sciences. This is why the Institute actively seeks to reach out to the general public, organizing numerous community events on campus and participating in many local and regional events.

Burning bright: the candles of enthusiasm!

Birthday celebrations

In 2014, IST Austria celebrated its fifth anniversary with a series of events addressing the general public. The first event to commemorate the opening of the research institute in June 2009 was held on May 25, when more than 1'400 guests from Lower Austria and Vienna visited the Open Campus Day to enjoy a colorful program with many attractions and highlights. After President Thomas A. Henzinger welcomed the visitors in the Raiffeisen Lecture Hall, the Governor of Lower Austria, Erwin Pröll, congratulated IST Austria on its development and awarded the students for their contributions to this year's creative competition on "Forms of Nature". The family lecture by IST Austria Professor Björn Hof and a science comedy show presented science in an informative and entertaining manner. The campus tours and research islands gave the visitors the opportunity to see the labs from the inside.

The Open Campus Day was followed by the Science-Industry Talk on June 3. Jointly organized by IST Austria and the Federation of Austrian Industries (IV) with the intention to strengthen the relationship between industry and basic research, the Science-Industry Talk focused on how to identify and foster talent. The event commenced with opening words by the Federal Science Minister Reinhold Mitterlehner and IV President Georg Kapsch. The panelists included international business and science experts such as Imperial College's former Pro-rector Enterprise Edward Astle, Stanford Professor Friedrich Prinz, Ashoka regional director Marie Ringler, pharmaceutical entrepreneur Helga Rübsamen-Schaeff, and venture capitalist Falk Strascheg.

IST Lectures

IST Lectures aim to introduce eminent researchers presenting their work to a scientific audience and the general public and are given in English. "From Democratic Consensus to Cannibalistic Hordes: The Principles of Collective Behavior", Iain Couzin's IST Lecture on June 5, concluded the event series to celebrate the fifth anniversary of IST Austria. Couzin, professor at the Department of Ecology and Evolutionary Biology at Princeton University, spoke about mobile animal groups and their complex and coordinated collective behaviors.

A real crowd-puller was Cédric Villani's IST Lecture on November 6. When the famous French mathematician Villani (see picture next page) stepped into the Raiffeisen Lecture Hall, he found more than 220 people eagerly awaiting his talk entitled "Of Triangles, Gases, Prices and Men". Professor at the University of Lyon and Director of the Institut Henri Poincaré in Paris, he talked about the discovery of unexpected links between Boltzmann's famous notion of entropy, the Monge-Kantorovich theory of transporting at least cost, and the curvature in non-Euclidean geometry. His instructive, yet entertaining lecture was followed by a book and poster signing session. Surrounded by people, Villani took the time to make little drawings into each and every book.

Nightshift

The campus buzzed with excitement until midnight when IST Austria hosted the "Long Night of Research" on April 4. More than 500 people attended the public event to learn about science in Lower Austria. Eight research institutes presented their scientific findings at 15 stations. In addition, scientists gave half-hour talks about their fields of research and films on scientific topics were shown in the Raiffeisen Lecture Hall.

More than science

On November 25, the Raiffeisen Lecture Hall was again tightly packed with people when Herwig Czech from the Dokumentationsarchiv des oesterreichischen Widerstands gave the first IST Commemoration Lecture on "Nazi Medical Crimes at the Psychiatric Hospital Gugging: Historical Context, Facts, and Legacy." This new series of lectures aims to introduce the members of the Institute and the public to the past of the IST Austria campus. After some introductory remarks by Haim Harari, historian Czech presented the findings of his study on the Nazi's euthanasia program in Gugging.

IST Austria also initiated a new IST Lecture series on December 3, when Terrence Collins talked about "Building the Chemical Dimension of a Sustainable World". The "Science and Society" lecture series presents eminent personalities from different domains to showcase the relevance of science to society. Teresa Heinz Professor of Green Chemistry and Director of the Institute for Green Science at Carnegie Mellon University, Collins focused on today's challenging relationship between sustainability and leadership. Since universities train most leaders of western civilization, he emphasized the responsibility of researchers and scientists in finding sustainable solutions for the future.

For kids only

The IST Austria campus turned into a summer camp for elementary school children when the first "Sommer Campus" was held in August. Twenty-two students from Vienna, Klosterneuburg, and surrounding areas participated in a research week for kids on campus. With the support of IST Austria scientists and students of the University College of Teacher Education (PH) Lower Austria, the girls and boys aged 7 to 11 took their first steps into physics, biology, and computer science. Their research activities were complemented by a scavenger hunt on campus, an excursion to a water plant, a mini conference, and a graduation ceremony.

Babies born since 2009: 18

Tech Transfer & Tech Park

Bridging Science and Industry

Under the umbrella of TWIST, IST Austria has launched a series of initiatives to support IST researchers interested in developing their ideas towards commercialization. We facilitate the exchange with industry, support young entrepreneurs, and help students and postdocs make informed career decisions. While we recognize the long-term nature of technology transfer activities, now is the time to implement appropriate policies and foster an innovative culture on campus.

IST Austria's IP policies are clear: all intellectual property from inventions of our scientists rests with IST Austria and is actively developed in a cooperative way between the inventors and the Institute, for the benefit of both.

We support the exchange with industry; companies we brought to campus in 2014 include Amazon, Airbus, Bosch, and TTTech.

In order to provide the resources to develop promising ideas for commercialization, IST Austria has introduced the TWIST Fellowship program, which allows its scientists to dedicate time to translational research.

IST Austria supports the development of IST Park, a science and technology park for research-intensive enterprises, adjacent to campus, through a joint venture with Ecoplus, the business development agency of Lower Austria.

Markus Wanko, an MIT alumnus who joined IST Austria after 15 years of experience in management consulting and venture capital investing, develops our initiatives in technology transfer and in establishing IST Park.

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- Petra Schwille, Director, Max Planck Institute for Biochemistry, Martinsried, Germany
- **Non-voting Member:** Claus J. Raidl, President, Oesterreichische Nationalbank, Vienna, Austria

Administration

"Excellent service for excellent science. To follow this overarching principle, we developed a Mission Statement for the administration and scientific services in 2014 that is broken down into seven detailed aspects: to promote an international and open culture, to be innovative and focus on high-quality services, to learn and develop continuously, to be compliant and create lean processes, to use public and private funds effectively, to encourage participation and cooperation, and for everyone in a management position to be a responsible leader. We will strive to preserve and further develop IST Austria's culture in the years to come! I thank all administrative employees for their excellent work and dedication in 2014."

Georg Schneider
Managing Director, IST Austria

In 2014, the management of various events was brought together by establishing **the events team**. They support the research groups in organizing academic events. To promote science and foster interaction and networking, they plan and implement public and business events. Find more information on last year's events on pages 58-63.

The **cafeteria** has been remodeled to fit in the growing number of employees at IST Austria and to create a space inviting people not only to have lunch, but also to relax, meet and potentially create new ideas.

Number of coffee-beans needed increase from 1'980'000 (2010) to 14'400'000 (2014)

Barbara Abraham
Grant Office

Wolfgang Erdhart
Campus Services

Stefan Hipfinger
Construction & Maintenance

Peter Jakubitz
Organization, Processes & Project Management

Claudia Kernstock
Human Resources & Hospitality

Laurenz Niel
Academic Affairs

Manuela Raith
Finance & Operations

Markus Wanko
Technology Transfer Office

Susanne Wertheimer-Wiegel
Environment, Health & Safety

Beate Zöchmeister
Communications & Events

Family matters – to support the balance between work and family life, IST Austria participates in the **"workandfamily"** audit, a sustainable quality management instrument under the supervision of the Austrian Federal Ministry of Families and Youth. A first set of family-friendly measures has been developed in 2014. The on-campus kindergarten "Froschkönig" with English and German speaking nursery teachers offers day-care for children starting from the age of one.

Today seeking and managing third-party funds is part of every scientist's life. Our **Grant Office** supports this process by providing advice on funding strategies and potential funding sources, assisting with the development and writing of proposals, and taking care of the financial management of grants.

"IQ" was officially launched by the proud project team – the unique software platform maps the whole student lifecycle from the time of admission to graduation. It provides quick and easy access to up-to-date information for students, professors, and the administration.

Scientific Service Units

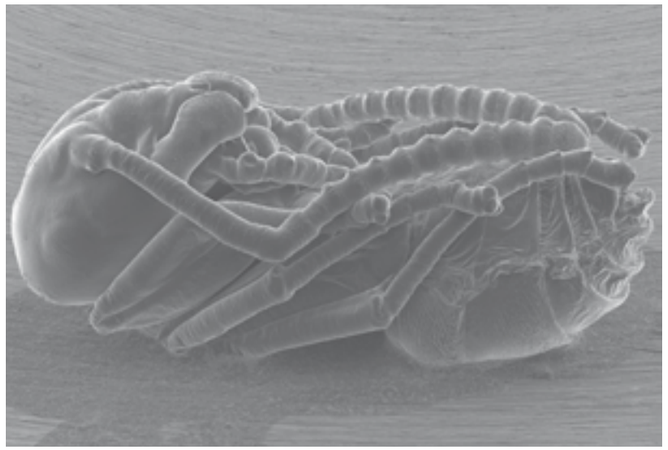
Number of all electrons used in EMF: 3.05573 E+13 (2014)

"The mission of the Scientific Service Units (SSUs) is to provide research groups with shared scientific resources through central acquisition, customized development, and training. Such services, which are only possible due to the absolute dedication of our SSU managers and staff scientists, allow excellent infrastructure to be developed and to be used by any experimental research group independent of its previous experience and group size, thus facilitating methodological novelty of high quality as well as inter-disciplinary research at IST Austria."

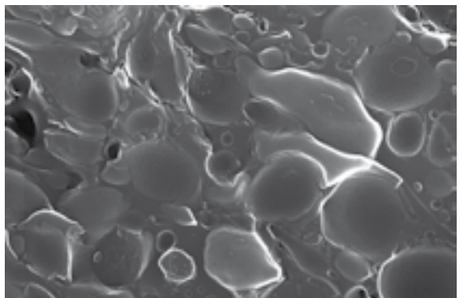
Michael Sixt *Vice President, IST Austria*

At the suggestion of the president, the board of trustees appointed Michael Sixt Vice President of IST Austria as of June 1, 2014. The cell biologist joined IST Austria in 2010 and is now responsible for the scientific service units and space management on campus.

The **Plant Facility**, which is part of IST Austria's Life Sciences Facility, supports the plant biologists at IST Austria with maintaining specific breeds (cultivating seedlings, growing plants, and harvesting seeds) in defined conditions. Fully operational since 2014, the Plant Facility is where mostly Arabidopsis and Tobacco species are handled for current research projects.



The **scanning electron microscope (SEM)**, acquired in 2014, is able to perform 3D sample reconstruction using an array tomography approach, a method that is based on a physical serial sectioning of a sample. Thousands of ultrathin sections with a thickness ranging from 30 – 200 nanometers are collected by using automated ultramicrotome, and are subsequently processed by SEM. The resulting two-dimensional image tiles can be reconstructed computationally into three-dimensional volume images for visualization and quantitative analysis.



e-Infrastructures Austria is a national project for the coordinated establishment and development of open-access repository infrastructures for digital resources (articles and data) in research and science throughout Austria. IST Austria collaborates with all national universities in this three-year project. e-Infrastructures Austria promotes the exchange of experiences on all topical levels between libraries, IT services, and scientists.

Astrit Arslani is the first to successfully complete an **apprenticeship** in a technical profession within IST Austria's apprentice initiative. He is now employed at the Miba Machine Shop on campus where he works in machine and prototype production supporting experimental scientists, e.g. by building a demonstrator for the Hof group.

As of the end of 2014, seven Scientific Service Units were established at IST Austria:

- Bioimaging Facility
- Electron Microscopy Facility
- Library
- Life Sciences Facility
- Miba Machine Shop
- Preclinical Facility
- Scientific Computing

Roland Gansch
Head of Scientific Services

Todor Asenov
Machine Shop

Patrick Danowski
Library

Ludek Lovicar
Electron Microscopy Facility

Matthias Nowak
Life Sciences Facility

Ekaterina Papusheva
Bioimaging Facility

Franz Schäfer
Scientific Computing & Core Infrastructure

Michael Schunn
Pre-Clinical Facility

Three staff scientists support the research groups as well as the scientific service units: Robert Hauschild works on optical developments, Walter Kaufmann on sample preparation methods, and Jack Merrin in microfluidics.

Robert Hauschild
Bioimaging Facility

Walter Kaufmann
Electron Microscopy Facility

Jack Merrin
Life Sciences Facility

Donors

IST Austria is proud that individuals and companies have generously contributed to the research at the Institute. We show our gratefulness for their support of basic research by establishing scholarships, e.g. the OMV scholars and Heinz scholars, or by naming buildings and rooms after donors. Lectures and events take place in the Mondi Seminar Rooms, the Raiffeisen Lecture Hall, or the Oberbank Ballroom; experimental research is conducted in the Bertalanffy Foundation Building. The scientists are supported by the administration accommodated in the voestalpine Building.


Bertalanffy Foundation Building

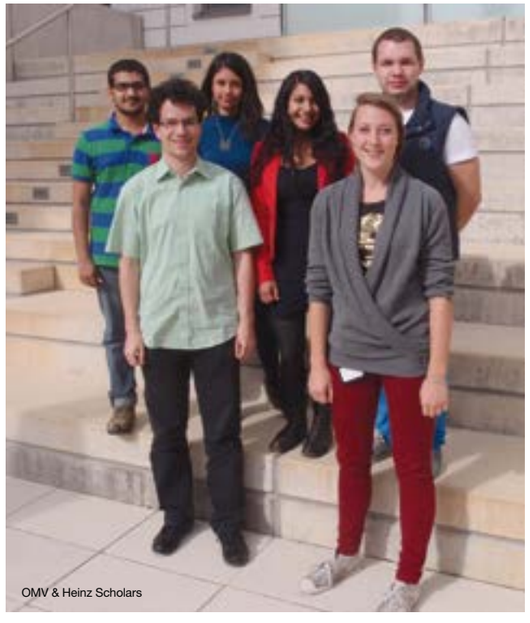

voestalpine Building


Raiffeisen Lecture Hall


Mondi Seminar Rooms

MIBA Machine Shop


Oberbank Ballroom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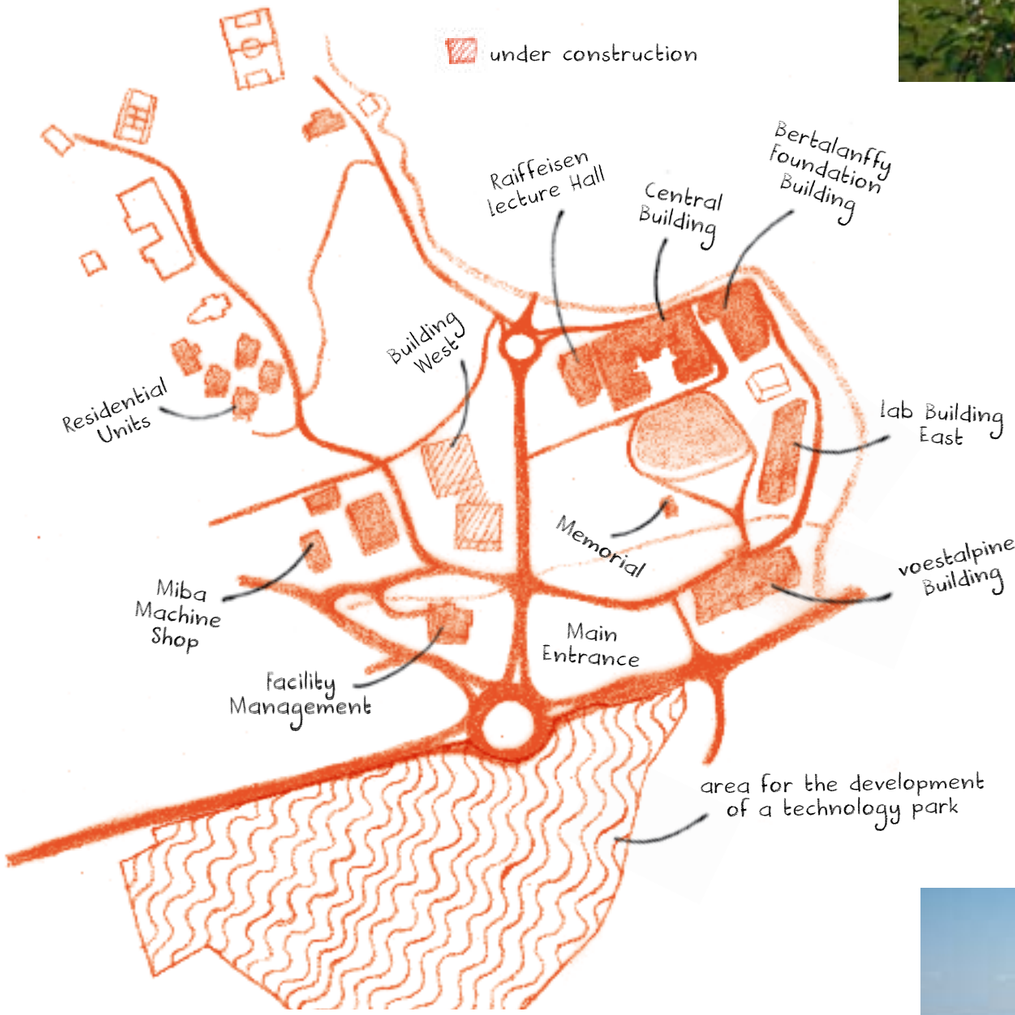

IST Austria is located in the city of Klosterneuburg, a suburb of Vienna known for its high standard of living. The location of IST Austria's campus amidst the hills of the Vienna woods provides a tranquil and stimulating environment for scientific research. The city of Klosterneuburg offers educational, medical, cultural, and recreational facilities of the highest standard.

The historical center of Klosterneuburg is dominated by its medieval monastery, redesigned in the Baroque style as a residence for the Austrian emperor in the early 18th century. The Essl Museum, world-famous for its collection of contemporary art, is located close to the city center. Our immediate neighbor on campus is the internationally renowned Art Brut Center Gugging.

IST Austria can be reached easily by public and individual transportation, including the IST Austria shuttle bus 242 from the subway station Heiligenstadt in Vienna.

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