IST AUSTRIA

# Annual Report **2012**



## Lab Building East

... shown on the cover was opened in November 2012. This second lab building provides space for up to 120 researchers – another step in the growth of IST Austria.

## WHERE DO THE SCIENTISTS OF IST AUSTRIA COME FROM? Take a look inside to find out,

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IST AUSTRIA SCIENTISTS (December 31, 2012)

#### PROFESSORS (last appointment before IST Austria)

- Nick Barton University of Edinburgh, Edinburgh, UK
- 2 Eva Benková Ghent University, Ghent, Belgium
- 3 Jonathan Bollback University of Edinburgh, Edinburgh, UK
- 4 Tobias Bollenbach Harvard Medical School, Boston, USA
- 5 Krishnendu Chatterjee University of California, Santa Cruz, USA
- 6 Sylvia Cremer University of Regensburg, Regensburg, Germany
- Jozsef Csicsvari University of Oxford, Oxford, UK
- 8 Herbert Edelsbrunner Duke University, Durham, USA
- 9 Laszlo Erdös Ludwig Maximilians University of Munich, Munich, Germany

39 40 58 78 87 88 89 113 141

- 10 Jiři Friml Ghent University, Ghent, Belgium
- 11 Călin Guet Harvard University, Cambridge, USA
- 12 Carl-Philipp Heisenberg Max Planck Institute of Molecular Cell Biology and Genetics, Dresden, Germany
- 13 Thomas A. Henzinger EPFL, Lausanne, Switzerland
- 14 Simon Hippenmeyer Stanford University, Palo Alto, USA
- 15 Björn Hof Max Planck Institute for Dynamics and Self-Organization,
- Göttingen, Germany
- 16 Harald Janovjak Ludwig Maximilians University of Munich, Munich, Germany
- 17 Peter Jonas University of Freiburg, Freiburg, Germany
- 18 Vladimir Kolmogorov University College London, London, UK
- 19 Christoph Lampert Max Planck Institute for Biological Cybernetics, Tübingen, . German
- 20 Krzysztof Pietrzak Centrum Wiskunde & Informatica,
- Amsterdam, Netherlands 21 Robert Seiringer McGill University, Montreal, Canada
- 22 Ryuichi Shigemoto National Institute for Physiological Sciences (NIPS), Okazaki, Japan
- 23 Daria Siekhaus NYU Medical Center, New York, USA
- 24 Michael Sixt Max Planck Institute of Biochemistry, Martinsried, Germany
- 25 Gašper Tkačik University of Pennsylvania, Philadelphia, USA
- 26 Caroline Uhler University of Minnesota, Minneapolis, USA
- 27 Uli Wagner EPFL, Lausanne, Switzerland
- 28 Chris Wojtan Georgia Institute of Technology, Atlanta, USA

#### **POSTDOCS** (institution of PhD degree)

29 Anna Andersson University of Copenhagen, Copenhagen, Denmark

70

27 34 55 77 140

30 41 42 45 61 72 142

- 30 Alice Alvernhe University of Provence, Marseille, France
- 31 Itaru Arai University of Tokyo, Tokyo, Japan
- 32 Gloria Arque University of Barcelona, Barcelona, Spain
- 33 Ulrich Bauer University of Göttingen, Göttingen, Germany
- 34 Tobias Bergmiller ETH Zurich, Zurich, Switzerland
- 35 Karel Blahna Charles University in Prague, Prague, Czech Republic
- 36 Charlotte Boccara Norwegian University of Science and Technology,
- Trondheim, Norway 37 Udi Boker Tel Aviv University, Tel Aviv, Israel
- 38 Vicente Botella-Soler University of Valencia, Valencia, Spain
- 39 Pavol Cerny University of Pennsylvania, Philadelphia, USA
- 40 Remy Chait Harvard University, Cambridge, USA
- 41 Guillaume Chevereau ENS de Lyon, Lyon, France
- Julien Compagnon University of Paris VII: Denis Diderot, Paris, France
- 43 Marjon de Vos FOM Institute AMOLF, Amsterdam, Netherlands
- 44 Desiree Dickerson University of Otago, Dunedin, New Zealand
- 45 Cezara Dragoi University of Paris VII: Denis Diderot, Paris, France
- 46 Leila El Masri Kiel University, Kiel, Germany
- 47 David Field University of Wollongong, Wollongong, Australia
- 48 Jian Gan University of Glasgow, Glasgow, UK
- 49 Ashutosh Gupta Technical University of Munich, Munich, Germany
- 50 Hua Hu University of Oslo, Oslo, Norway
- 51 Stefan Jeschke University of Rostock, Rostock, Germany
- 52 Eva Kiermaier University of Vienna, Vienna, Austria
- 53 Klaus Koren Graz University of Technology, Graz, Austria



- 89 Daniel Benjamin Weissman Stanford University, Palo Alto, USA
- 90 Stefan Wieser Johannes Kepler University Linz, Linz, Austria

- 141 Sooyun Kim USA
- 142 Jean-Leon Maitre France

# BASIGRESEARCE Curiosity Driven INTERNATIONAL INTERDISCIPLINARY No Boundaries PHD FRANCE Graduate School SUPPORTING CAREERS Tenure Track IRSEF H Public and Private Intellectual Property EXPLOITING RESULTS



## Positioned for success Thomas A. Henzinger » President, IST Austria

Another important year for IST Austria has come to a close. The young Institute reached several milestones in 2012: the future of IST Austria's public financing was secured until 2026; IST Austria expanded its scientific scope into important new research fields; the second laboratory building opened its doors on campus; and the scientists continued to collect an impressive number of research awards and competitive grants at both the national and international levels.

IST Austria succeeded in recruiting several new professors in 2012, broadening its research activities to include plant biology, mathematical physics, fluid dynamics, and discrete mathematics. The Institute's 28 professors come from 14 different countries and altogether, at the end of 2012, scientists of 35 different nationalities work on campus. They wrote more than 100 publications in 2012 and are funded by a variety of different sources, such as the European Research Council, which currently supports 12 of our professors. In 2012, IST Austria started ISTFELLOW, a fellowship program for especially talented postdoctoral researchers, also funded primarily by the European Union. Our third class of PhD students consists of 18 new students from 12 countries, who were chosen from several hundred applicants and follow a cross-disciplinary doctoral program.

As the research activities of the Institute continue to grow, there is also an increasing need for both laboratory and office space. In 2012, Lab Building East added 7'000 square metres of new laboratory space to the campus, where neuroscientists have already begun to carry out their experiments, and physicists will follow in 2013.

Perhaps most importantly, in 2012 the Federal Republic of Austria and the state of Lower Austria provided a long-term planning horizon for IST Austria, in the form of a financing promise until 2026. Following a recommendation by the international evaluation panel in 2011, the new financing agreement will let the Institute grow over the next decade and a half to 90–100 professors, and about 1'000 scientists in total. The pledged funds are not a blank check, however, as a significant part is tied to the scientific performance of the Institute, especially to the amount of third-party support of its research activities. This secure longterm perspective will enable IST Austria to continue attracting outstanding scientists and to establish itself permanently as an internationally recognized institution for basic research.

I would like to use this opportunity to thank all friends and supporters of IST Austria, be they in science, in government, in industry, in the local community, or in the wider public. Your support on all levels is critical to our success. I particularly thank the Federal Minister for Science and Research, Karlheinz Töchterle, and the Governor of Lower Austria, Erwin Pröll, for securing the future of the Institute. I also thank all employees and board members of IST Austria, whose hard and dedicated work has put us into a position to succeed and will, I am sure, let us reach our full potential.

#### **Thomas A. Henzinger**



# Building an orchestra

Olaf Kübler » Chair, Professorial Committee of IST Austria

The strategy to create a top research institution sounds deceptively simple: search, appoint, and retain world leaders in research; all else will follow. The highest-ranking global research universities and research establishments keep producing powerful empirical evidence for the soundness of this strategy. They devote remarkable efforts and attention to recruitment and retention, take great pride in their outstanding scholars, and make sure to attract and integrate junior researchers and students of compelling talent and dedication.

IST Austria spares no effort in implementing this strategy. The president has assumed personal responsibility for the recruitment and retention of faculty, devoting himself totally to the task. In a collegial manner, he involves the entire faculty and – together with all Professors and Assistant Professors – constantly expands an international network of scientific consultants and advisors. Checks and balances have been instituted by installing – particular to IST Austria – a Professorial Committee responsible for uncompromising standards in faculty appointments, endowed with the power to halt an unsatisfactory recruitment.

Serving on the Professorial Committee of IST Austria means forming a fair judgment on candidates for tenured and assistant professorships, mainly on the basis of extensive documentation. The president presents every case to the plenum of the Professorial Committee which, by secret vote, approves – or blocks – the further process. Understanding fundamental research as cultural achievement suggests a compelling analogy: it is like building a world-class symphony orchestra where only the idea and ambition existed before. The founding conductor, chosen for his vision and international accomplishments, has to find and attract brilliant musicians – often beyond his own specialization. At the same time, he has to make sure the infrastructure for practicing and performing becomes available at the appropriate time, and he has to secure the funding. The Professorial Committee, then, is in the role of the auditioning panel, an elating experience. Having a chance to witness top performers and becoming aware of exciting new perspectives has been as joyful and rewarding as watching the ensemble grow and develop its characteristic theme and tone.

All interested parties will form their own opinions about IST Austria's level of achievement and position in international science. As with the development of an orchestra, the most revealing and joyful appraisal will come from dedicated listening and the sensations it inspires. I am confident that we will not only hear wonderful symphonies but also experience operas commensurate with the incomparable musical heritage of Austria.

#### Olaf Kübler

Olaf Kübler is chair of the Professorial Committee of IST Austria. The physicist served two terms as President of ETH Zurich, from 1997 to 2005. In 2006, he was a co-author of the main strategy paper for the establishment of IST Austria; from 2007 to 2009 he was chair of the Institute's Scientific Board. In its three and a half years of operation, IST Austria has in **EXEMPLARY FASHION** managed to acquire private funds. Also, Austria's **LONG-TERM COMMITMENT** to the Institute as well as the new laboratory building will allow the **EXCELLENT DEVELOPMENT OF IST AUSTRIA** to continue. It sets an internationally visible signal that will benefit all science and research in Austria.





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IST Austria lies at the heart of the structural change happening in Lower Austria, but it is by no means our only investment in the future of the people of this state. We will **STEADFASTLY CONTINUE ON THIS PATH TOWARDS STRENGTHENING SCIENCE** 

Dr. Erwin Pröll » Governor of Lower Austria

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# **ISTAUSTRIA** at a Glance

The Institute of Science and Technology Austria (IST Austria) is a multidisciplinary research institution dedicated to basic research in the biological, physical, and mathematical sciences. The Institute is located in the city of Klosterneuburg, 18 km from the center of Vienna. As a PhD granting institution, the graduate school of IST Austria educates doctoral students from around the world. IST Austria was established jointly by the federal government of Austria and the provincial government of Lower Austria and inaugurated in 2009. In the fall of 2010, the first laboratory building was opened and the first experimental research groups started their work at the Institute. The second laboratory building, Lab Building East, was completed at the end of 2012, when 21 professors and a total of 257 employees from 39 different countries worked on campus. The development plans of IST Austria allow for a growth to 90–100 research groups by 2026. At that time, around 1'000 scientists will conduct research in an international, state-of-the-art environment.

To foster a creative and interdisciplinary scientific atmosphere, all hierarchical and separating organizational structures, such as departments, are avoided at IST Austria. The scientists are organized into independent research groups, each headed by a Professor or a tenure-track Assistant Professor. The decision to promote an Assistant Professor to Professor with a permanent contract is based entirely on an evaluation of the scientific achievements of the Assistant Professor by international experts. Research excellence and promise are the exclusive hiring criteria for all scientists at IST Austria -

from doctoral students to professors. The Institute's choice of scientific topics is based solely on the availability of outstanding individuals: a direction of research is pursued only if IST Austria can compete with the best in the world.



#### Funding sources

The long-term financial viability of IST Austria relies on four different sources of funding: public funding, national and international research grants, technology licensing, and donations. For the period from 2007 until 2026, the federal government of Austria provides up to 1'280 million Euro in operational funds. Two thirds of this budget are guaranteed, while the remaining third is conditioned on performance-related criteria such as the raising of third-party funds. The state of Lower Austria contributes the budget for construction and campus maintenance, in a total amount of 510 million Euro from 2007 until 2026. By the end of 2012, IST Austria has obtained commitments for more than 27 million Euro in research grants, the vast majority of which originates from sources outside of Austria. The Institute holds the rights to all research results and discoveries of its scientists and is committed to promote their use through technology licensing. IST Austria is also active in fundraising and, by the end of 2012, has received more than 17 million Euro in donations.

#### <3% each: Australia, Brazil, Austria 19% China, Cuba, Denmark, Finland, Greece, Hungary, Iran, Israel, Italy, Japan, Kazakhstan, Mexico, Netherlands, New Zealand, Poland, Portugal, Romania, Russia, Slovenia, Spain, Sweden, Turkey, Germany 15% Ukraine, Venezuela **USA 6%** Czech Republic 3% Switzerland 3,5% Great Britain 5% Slovakia 4% India 4,5%

#### Nationalities of Scientists at IST Austria

France 4,5%





#### Independent leadership

The governance and management structures of IST Austria guarantee the Institute's freedom from political and commercial influences. The Institute and its scientific fields are evaluated regularly by leading international scientists and science administrators. IST Austria is headed by the President, who is appointed by the Board of Trustees and advised by the Scientific Board. The 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. In 2012, based on the achievements reached in the past years and the vision for the future, the Board of Trustees appointed Henzinger for a second four-year term, from September 2013 until August 2017.

The administration of IST Austria is led by the Managing Director, Georg Schneider, who took over from Gerald Murauer on December 1, 2012. Georg Schneider joins IST Austria coming from A\*Star, Singapore's strategic umbrella organization for science, technology, and research, where he served as deputy director and CIO of A\*Star's Bioinformatics Institute since 2008.

Latest information on IST Austria can be found at ist.ac.at, where it is possible to sign-up for the Institute's quarterly newsletter.



## **RESEARCH GRANTS** (rounded amounts)

ERC European Research Council	14'640'000 €
EU Framework Program 7	5'000'000 €
FWF Austrian Science Fund	4'615'000 €
HFSP Human Frontier Science Program	1'055'000 €
DFG Deutsche Forschungsgemeinschaft	710'000 €
ESF European Science Foundation	320'000 €
ÖAW Austrian Academy of Sciences	220'000 €
Microsoft Research	150'000 €
NSF National Science Foundation	115'000 €
Others	360'000 €
TOTAL	27'185'000 €

#### **PROFESSORIAL RECRUITMENT**

	2012	lotal since 2007
Applications and nominations	1270	4276
Evaluated by international experts	268	667
Invited to campus	30	206
Offers made	8	44
Offers accepted	6	28

#### **IST AUSTRIA EMPLOYEES 2012**

(December 31, 2012)

	HEAD COUNT
Scientists	141
Professors	22
Postdocs	61
PhD students	49
Student interns	8
Staff scientists	1
Scientific support	50
Administration	67
TOTAL	258

# FINANCING A Long-Term Plan

In 2012 the future of IST Austria was secured beyond 2016. On February 22, the Federal Ministers Maria Fekter (finance) and Karlheinz Töchterle (science and research), together with the Governor of Lower Austria, Erwin Pröll, announced an agreement on the future financing of IST Austria for the ten-year period 2017-2026. According to the financing plan, which was subsequently passed by the parliaments of the Federal Republic of Austria and the state of Lower Austria, the Federal Republic of Austria will invest an average of up to 99 million Euro per year between 2017 and 2026. In addition, the state of Lower Austria will provide 368 million Euro from 2012 until 2026, for infrastructure, construction, and maintenance on the IST Austria campus. A third of the federal funds are conditioned on the performance of the Institute, including the acquisition of third-party funds such as research grants and private donations, as well as scientific achievements measured by quality criteria. With the

government's pledge, IST Austria is not given a blank check but will receive the amount held out in prospect only if it performs as desired.

The financing beyond 2016 will allow IST Austria to continue attracting world-class scientists and to grow into a successful, internationally visible institution for basic research. With the secured funding, it will be possible for IST Austria to firmly establish physics, chemistry, and mathematics on campus, in addition to biology and computer science. This broadening of research activities, which follows a recommendation of the international evaluation panel that analyzed IST Austria in 2011, will significantly enhance the Institute's scientific impact. With the planned expansion in research fields, additional scientists and graduate students will join IST Austria. By 2026, the Institute expects to grow to 90–100 research groups with around 1'000 scientists, more than half of them PhD students.

Governor Erwin Pröll, Federal Ministers Maria Fekter and Karlheinz Töchterle, and IST Austria President Thomas Henzinger present the agreement on the future financing of IST Austria.







"I am extremely pleased that the Austrian government has provided long-term financing for IST Austria, allowing it to grow to 90–100 research groups by 2026. This is important for IST Austria and for Austrian science as a whole. As the Baltimore

committee pointed out, IST Austria has evolved into one of the premier research institutes not only in Europe but in the world. The level of excellence that it has established is superb and all of us who have seen this growth of scientific strength in Austria are proud of IST Austria's accomplishments. The government should be congratulated for its far-sighted vision. Science of this quality not only produces new insights into life's processes but is also an important component of the engine that drives the economy." **Eric Kandel » Member, IST Austria Board of Trustees; Nobel laureate** 





"It is – even in an international context – extraordinarily remarkable that the Austrian Federal Government and Lower Austria have agreed on a long-term growth perspective for the further development of IST Austria until 2026, supporting basic research. Austria thereby sets an example that many other European countries should follow."

Alice Dautry » Member, IST Austria Board of Trustees; President Institute Pasteur Paris



# THE LAB AS A CRYSTAL Opening Lab Building East

In 2012, Lab Building East, the second laboratory building of IST Austria, opened its doors, increasing the space available for the growing number of research groups working on campus. Lab Building East was inaugurated on November 28 in the presence of the Federal Minister for Science and Research, Karlheinz Töchterle, and the Governor of Lower Austria, Erwin Pröll. Designed by the Viennese architects' office Frank and Partner, Lab Building East was completed just over two years after the groundbreaking ceremony in October 2010. Located in the eastern part of the campus, Lab Building East together with the Central Building, the Bertalanffy Foundation Building, and the voestalpine Building, surrounds the pond and the green areas at the campus center. With Lab Building East, 7'000 sqm become available for the activities of up to twelve research groups. The building with its six floors is designed for experimental research in the life sciences and, a first for IST Austria, the physical sciences. Three research groups have already taken up their work in the new building after a short trial period. Once fully occupied, up to 120 researchers will work in Lab Building East.

#### Form follows energy

Lab Building East is designed according to passive house standards for sustainable energy use. The geometry of Lab Building East is based on the design principle of "form follows energy". Reminding the viewer of a crystal, the building's body is designed to be as compact as possible. Through its energy-efficient shape, especially the southern facade with an overhanging cliff, only little direct sunlight reaches the inside, reducing the need for cooling during the summer months. Conversely, the low position of the sun during the winter months allows for a deep penetration of sunlight into the building. Through these and additional measures, including the use of eco-concrete, concrete core cooling, and photovoltaic elements, Lab Building East achieves a reduction in carbon dioxide emissions compared to similar buildings of around 2'160 tons over the next 20 years. With Lab Building East, IST Austria has become a partner of the European GreenBuilding Program.

Lab Building East is accessed through a glass-domed atrium and open staircase, which is flooded with sunlight through the roof and forms the entrance area for employees and visitors. A seminar room and communally used scientific service facilities, including a light microscopy facility and a media kitchen, are located on the ground floor, while electron microscopy is accommodated in the basement. The upper floors are divided into a lab zone, a service area, and office space. All corridors are



In Lab Building East, glass galleries facilitate interaction, while several measures including solar panels ensure a sustainable use of energy.

lit by daylight. The corridors become wider at both ends of the building, creating areas for informal meetings. The spaces surrounding the atrium are partly designed as galleries to facilitate interaction between different floors.

#### Further construction projects

The end of the opening ceremony of Lab Building East was marked by the filling of a foundation tube by Minister Töchterle, Governor Pröll, and the Chair of the Executive Committee, Haim Harari, for Lab and Office Building West. This building, which will offer 11'500 sqm floor area distributed over two building blocks with six floors each, will provide space for up to 300 researchers in the fields of physics, mathematics and chemistry. It is expected to be completed in 2015.

#### Lab Building East – Facts & Figures

7'000 sqm floor space Capacity of up to 12 research groups (120 scientists) Built according to passive house standards Recognized by the European GreenBuilding Program

# **THE IST AUSTRIA GRADUATE SCHOOL** Educating Future Scientists

The international IST Austria Graduate School offers its PhD students a first step into scientific careers in biology, neuroscience, computer science, mathematics, and physics, as well as interdisciplinary areas. Entry to the Graduate School is open to applicants from all over the world, and prospective students are selected in an institute-wide admissions procedure. Highly qualified students seeking to start a scientific career in a truly multidisciplinary, international research environment are encouraged to apply to the IST Austria Graduate School.

#### PhD students from 20 nations

The IST Austria Graduate School is now in its third year. In 2012, more than 400 students from 56 countries applied for admission. 54 applicants were invited to IST Austria for interviews, 29 of whom received an admission offer. 18 new

#### Admission to the IST Austria Graduate School

- Annual call for applications
- Online application opens November 15 (www.ist.ac.at)
- Open day for prospective applicants in November
- Application deadline January 15
- Visit day for shortlisted candidates in March
- > PhD program starts September 15

#### Application

- BS or MS or equivalent degree required
- Academic CV and Statement of Purpos
- Official university transcripts
- Contact addresses for three reference letters
- GRE and TOEFL scores optional

PhD students started their graduate studies at IST Austria in September 2012. This newest class of PhD students comes from 12 different countries. In total, 49 PhD students from 20 countries are currently working at IST Austria.

#### A multidisciplinary PhD program

Owing to the interdisciplinary spirit of IST Austria, a single joint graduate program is offered for all students who are interested in the different research fields present at IST Austria. The Institute trains a new generation of researchers who are able to approach scientific questions from different angles and are fluent in the languages of both the life sciences and analytical sciences.

The doctoral program is divided into two phases, one before and one after the qualifying exam. During the first phase of the program, which can last up to two years, students take advanced courses in all scientific fields represented at IST Austria and carry out projects with three different research groups. This phase offers the student an opportunity to work closely with several professors, while the interdisciplinary curriculum gives students both breadth and depth in their scientific background. Upon successfully passing a qualifying exam, students enter the second phase of the doctoral program, during which they focus on research towards a doctoral thesis. After a successful thesis defense, the student receives the PhD degree from IST Austria.

#### Annual call for PhD students

All students interested in joining the IST Austria PhD program in September must apply by January 15. The entire IST Austria faculty evaluates the applicants, as prospective students need not identify a potential supervisor when applying. All admitted PhD students are offered employment contracts with an internationally competitive salary.



# **ISTFELLOW** Opportunities for Postdocs

To attract outstanding postdoctoral researchers to IST Austria, the Institute has set up the ISTFELLOW program. This program for exceptional young scientists that have obtained a PhD degree elsewhere is partially funded by the European Union. ISTFELLOW places an emphasis on multidisciplinary scientific approaches and is open to qualified applicants from all over the world.

#### Selecting fellows

The main selection criterion for ISTFELLOW is the scientific excellence and promise of prospective fellows. These are assessed using several indicators, including the past publication record and reference letters. Initially, the fellowship scheme is primarily intended for postdocs in the research fields that are currently represented at IST Austria, however, as IST Austria will branch out into new scientific areas, so will ISTFELLOW.

#### Internationally funded

ISTFELLOW is partially funded through Marie-Curie Actions -

COFUND, a part of the EU Framework Programme 7. Over a period of five years, ISTFELLOW will support 40 international postdoctoral fellows for two years each, and a prolongation for another two years is possible through the support of an IST Austria professor. ISTFELLOW is also open to a small number of postdocs from other institutions in Austria. As they do not fulfill the transnational mobility criterion required by the European Commission, IST Austria will support these fellows through other funds.

#### Applications

Applications for ISTFELLOW are accepted continuously but the selection of fellows takes place twice a year, in October and April. To guarantee that IST Austria can adequately host the applicant's research project, applicants have to obtain a letter of support from at least one IST Austria professor prior to the selection process. All postdoctoral fellows appointed to ISTFELLOW are offered full-time employment contracts at internationally competitive salaries.

# **BRANCHING OUT** A round-up of cell biology at IST Austria

All life is made of cells, which come in all shapes and sizes. As single cells can compose whole organisms, they contain everything essential and necessary for survival. Cell biology, the endeavor to understand all aspects of how cells function, is a highly dynamic research field. Cell biologists at IST Austria not only use many different model organisms to study aspects of cell biology in the most appropriate environment, but also take unconventional approaches. Making the most of the interdisciplinary nature of IST Austria to understand phenomena from new, innovative angles, cell biologists work together with physicists, mathematicians and computer scientists at the Institute.

Rather than being passive building blocks, cells actively respond to their environment. Some cells actually need to move in order to function: immune cells which fight pathogens in our bodies move rapidly to the site of infection to fend off invading germs. During development, when a bunch of cells develops into distinctive body shapes, many cells have to migrate from the places they are born to different locations in the body, where they build organs and tissues. Gaining insights into how cells manage to move in their environment is essential in order to understand these processes.

#### **Cell migration**

Working at the interface of cell biology, immunology and biophysics, **Michael Sixt** seeks to uncover how the cell's inner skeleton generates the force that is required for immune cells to zip through the body at extraordinary speed, and how this force is efficiently directed to the surrounding environment to propel the cell forward. In the course of such migration, cells en-



counter obstacles that hinder their progress. Daria Siekhaus uses immune cells in the developing fruit fly to investigate how cells squeeze through such barriers. Combining imaging, genetics, and cell biology, Siekhaus has shown that several genes alter the stickiness of the cell's outside, allowing it to attach to and overcome barriers. She now seeks to understand the strategies that underlie invasive migration (1). In a 2012 Science publication, Carl-Philipp Heisenberg explored the forces involved when epithelial cells spread over the zebrafish embryo during gastrulation, a collective cell movement that provides protection to the developing embryo (2). Cell migration is also essential for proper development of the brain. Neuroscientist Simon Hippenmeyer studies genes that regulate the migration of newly born neurons to their intended target location, and how proper neuron positioning contributes to the assembly of neuronal circuits in the cerebral cortex of the mouse brain (3).

#### **Cell segregation**

Like neurons in the brain, other cells also need to find their intended place. In a variety of biological processes, mixed populations of cells with different properties need to segregate into distinct groups. Carl-Philipp Heisenberg studies the forces and cellular properties driving cell segregation in early stages of zebrafish development, when cells sort into domains from which different tissues and organs are formed. In another study published this year in *Science*, the Heisenberg group demonstrated the role played by tension in cell sorting during gastrulation, uncovering a new mechanism that drives cell segregation (4). To compare different experimental conditions and quantify results, Heisenberg collaborates with mathematician **Herbert Edelsbrunner**, also at IST Austria. Together, the

researchers developed a refined measurement that characterizes the sorting process topologically (5). This so-called *Medusa* model is a space-time representation of cell sorting, freezing it solid in four dimensions. The researchers measure how the *Medusa* is connected topologically using persistent homology, providing detailed information on how the cells are sorted. This framework – motivated by a specific cell biological problem – also applies to other phenomena occurring at arbitrary locations and times such as





1 Migrating immune cells in the fruit fly. 2 Spread of epithelial cells during gastrulation in the zebrafish. 3 Migrating neurons. 4 Contacting cells within a gastrulating zebrafish embryo, with nuclei in red and cell-cell contacts in blue. 5 Topology changes in the cell segregation process. 6 Blood vessels (red). lymphatic vessels (green) and chemokine CCL21.



a flock of birds arranging in formation, galaxies moving under the influence of gravity or microbes forming microfilms.

#### Signaling and transcriptional regulation

Cells, for the most part, do not exist in isolation. For cells to function correctly, they need to respond to the environment they are in by perceiving signals from their surroundings and modifying their behavior to respond accordingly. The signals cells perceive have long been thought to exist in gradients in the surrounding environment, with cells moving along gradients through so called haptotaxis. In a collaborative effort that involved the groups of **Michael Sixt** and **Tobias Bollenbach** as well as the Bioimaging Facility, researchers at IST Austria this year provided experimental confirmation of haptotactic cell guidance in tissues. Visualizing the gradient of chemokine CCL21 in tissue, they showed that the gradient is able to guide immune cells towards lymphatic vessels (6).

Cells perceive such cues through specialized receptors, which biophysicist **Harald Janovjak** studies by taking a multidisciplinary optogenetic approach. With this method, Harald Janovjak manipulates receptors, ultimately using light as a remote control to switch signaling cascades on and off. This allows him to decode in space and time how signals lead to a cell's physiological response. The fundamental insights gained in these experiments will also provide a basis to shed light on cell migration and differentiation in collaboration with Carl-Philipp Heisenberg and Michael Sixt. Signals impinging on receptors are relayed and translated into an appropriate response by interacting genes and proteins, which constitute themselves in genetic networks. These molecu-



lar networks are constantly involved in decisionmaking and computation, and **Călin Guet** uses the bacterium *Escherichia coli* to study how existing molecular networks make decisions. One system under study is the regulation of membrane pumps in *Escherichia coli*. Călin Guet collaborates with physicist **Gašper Tkačik** to develop a theoretical model of this regulatory system. Călin Guet's group also constructs novel networks in living cells using synthetic biology approaches to



uncover universal rules governing such networks. In collaboration with computer scientist **Thomas A. Henzinger**, they developed a new algorithm for modeling genetic networks more realistically, which takes the time element of responses into account in a highly efficient manner.

The cell biologists at IST Austria thus study all types of cell biological problems, from migration to signal processing. Tackling cell biological problems from a unique, interdisciplinary viewpoint, they take advantage of the diverse research fields and collaborative spirit of IST Austria to bring forward a highly relevant, dynamic research discipline.

#### References

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- Maître, J., Berthoumieux, H., Krens, S.F.G., Salbreux, G., Julicher, F., Paluch, E. & Heisenberg,
   C. 2012. Adhesion functions in cell sorting by mechanically coupling the cortices of adhering cells. Science 338(6104), 253–256.
- Weber, M., Hauschild, R., Schwarz, J., Moussion, C. , de Vries, I., Legler, D.F., Luther, S.A., Bollenbach, T., & Sixt, M. 2013. Interstitial dendritic cell guidance by haptotactic chemokine gradients. Science 339(6117). 328–332.
- Guet, C., Gupta, A., Henzinger, T.A., Mateescu, M. & Sezgin, A. 2012. Delayed continuous time Markov chains for genetic regulatory circuits. In: LNCS: CAV: Computer Aided Verification 7358, 294–309.
- > Edelsbrunner, H., Heisenberg, C., Kerber, M., & Krens, G. 2012. The Medusa of spatial sorting: topological construction. arXiv:1207.6474
- 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.
   Hippenmeyer, S., Yong, H.Y., Moon, H.M., Miyamichi, K., Zong, H., Wynshaw-Boris, A. & Luo, L. 2010. Genetic mosaic dissection of Lis1 and Ndel1 in neuronal migration. Neuron 68(4), 695–709

**Raiffeisen Lecture Hall** 



# **CURRENT RESEARCH** at IST Austria

Currently, research at IST Austria focuses on cell biology, physics, mathematics, computer science, evolutionary biology and neuroscience. There are strong synergies between these fields, and to foster an interdisciplinary spirit, the Institute is not organized into departments. The Central Building, in which theoretical research groups are located, is linked by a bridge with the Bertalanffy Foundation Building, which houses experimental research groups. The bridge contains communal areas, encouraging interaction. In 2012, neuroscientists took up their work in the newly opened Lab Building East, with physics groups following in 2013.





## NICK BARTON Mathematical models of evolution

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

## CV

#### CAREER

2008– Professor, IST Austria
1990– 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

- 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

## P

#### 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.



#### Tom Ellis (PhD Student), David Field (Postdoc), Sebastian Novak (PhD Student), Tiago Paixao (Postdoc), Pavel Payne (joint PhD Student with Bollback group), Melinda Pickup (Postdoc), Jitka Polechova (Postdoc), Murat Tugrul (PhD Student), Harold P. de Vladar (Postdoc), Daniel Weissman (Postdoc)

## **JONATHAN P. BOLLBAC** MICRORIAI FXPFRIMENTAI EVOLUTION AN STATISTICAL GENOMICS



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, Achaea, 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**

- Microbial population genetics
- Evolutionary host-parasite interactions
- > Evolution of microbial immune systems
- , Experimental evolution

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

1. Bollback JP, Huelsenbeck JP. 2009. Parallel genetic evolution within and among bacteriophage species of varying degrees of divergence. Genetics 181(1), 225-234. 2. Bollback JP, Huelsenbeck JP. 2007. Clonal interference is alleviated

by high mutation rates in large populations. Molecular Biology and Evolution 24(6), 1397-1406.

3. Bollback JP. 2002. Bayesian model adequacy and choice in phylogenetics. Molecular Biology and Evolution 19(7), 1171-1180.

#### TEAM

Hande Acar (PhD Student), Fabienne Jesse (PhD Student) Anne Kupczok (Postdoc), Pavel Payne (Joint PhD Student with Barton group) Rodrigo A. F. Redondo (Postdoc)

A cluster of Escherichia coli



## TOBIAS BOLLENBACH BIOPHYSICS AND SYSTEMS BIOLOGY

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.



## PV

#### CAREER

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

- 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 Feedor Lynen Fellowship, Alexander von Humboldt Foundation2005 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.

#### TEAM

Guillaume Chevereau (Postdoc), Marta Dravecka (PhD Student), Marjon de Vos (Postdoc), Karin Mitosch (PhD Student), Julia Tischler (Postdoc) 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



## **KRISHNENDU CHATTERJEE** COMPUTER-AIDED VERIFICATION, GAME THEORY

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



## 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

2009- 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

## P

#### SELECTED PUBLICATIONS

1. Chatterjee K, Doyen L. 2012. Partial-Observation Stochastic Games: How to Win when Belief Fails. Proc. of LICS. 2012, 175–184.

 ${\bf 2.}$  Chatterjee K, Henzinger M. 2012. An O(n²) Time Algorithm for Alternating Büchi Games. Proc. of SODA. 2012, 1386–1399.

**3.** Chatterjee K, de Alfaro L, Henzinger T.A. 2011. Qualitative Concurrent Parity Games. ACM Transactions on Computational Logics 12(4), 28.

#### TEAM

Martin Chmelik (PhD Student), Andreas Pavlogiannis (PhD Student), Johannes Reiter (PhD Student), Sasha Rubin (Postdoc)





## **SYLVIA CREMER** COLLECTIVE DISEASE DEFENSE IN ANT SOCIETIES

Like crowded cities, ant colonies face a high risk of disease outbreaks. Despite this risk, epidemics occur extremely rarely in social insect colonies. Sylvia Cremer's group investigates behavioral ecology and evolutionary immunology in ants and its impact on disease management in social insect societies.



#### CAREER

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

- 2012 Research Award Lower Austria: Anerkennungspreis des Landes Niederösterreich
- 2011 Member of "Junge Kurie" of the ÖAW (Austrian Academy of Sciences)
- 2009 ERC Starting Grant
- 2008 Member, German Young Academy of Sciences Leopoldina and Berlin Brandenburg

2004–2006 Marie Curie Intra-European Fellowship & Reintegration Grant2003–2004 Feodor Lynen Fellowship, Alexander von Humboldt Foundation

#### SELECTED PUBLICATIONS

 Konrad M, Vyleta ML, Theis FJ, Stock M, Tragust S, Klatt M, Drescher V, Marr C, Ugelvig LV, Cremer S. 2012 Social transfer of pathogenic fungus promotes active immunisation in ant colonies. PLoS Biology 10(4), e1001300.
 Ugelvig LV, Cremer, S. 2012. Effects of social immunity and unicoloniality

on host-parasite interactions in invasive insect societies. Functional Ecology 26 (Special Issue "Invasion and Infection"), 1300–1312.

**3.** Tragust S, Mitteregger B, Barone V, Konrad M, Ugelvig LV, Cremer, S. 2012. Ants disinfect fungus-exposed brood by oral uptake and spread of their poison. Current Biology 23(1), doi: 10.1016/j.cub.2012.11.034.

#### TEAM

Barbara Casillas-Perez (Joint PhD Student with Tkačik Group), Anna Grasse (Technical Assistant), Matthias Konrad (PhD Student), Leila el Masri (Postdoc), Barbara Mitteregger (Technical Assistant), Christopher D. Pull (PhD Student), Katharina Seif (Student Helper), Miriam Stock (PhD Student), Line V. Ugelvig (Postdoc), Meghan L. Vyleta (Postdoc), Claudia Westhus (PhD Student cosupervised with Dr. Claudie Doums, University Pierre et Marie Curie, Paris) 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.

One important way of how ant colonies are protected against disease is "social vaccination", a process in which taking care of sick ants promotes disease protection in caring colony members. Ants do not avoid sick colony members, but on the contrary lick them to remove the pathogen from the exposed ant's body. This social grooming behavior drastically increases the survival chances of exposed individuals, but bears the risk that helper ants contract the disease. The researchers showed that social interaction indeed causes infectious fungal spores to spread throughout the colony. However, spore transfer occurred at very low levels, causing only sub-lethal micro-infections in the previously healthy helper ants. These low-level infections induce the expression of a set of immune genes and increase the ants' capacity to fight the fungal pathogen. In 2012, Sylvia Cremer and her group so unraveled the underlying mechanism of social immunization against fungal infections in ant societies.

#### **Current Projects**

- Social vaccination
- Social interaction networks & epidemiology
- Pathogen detection abilities in ants
- Host-parasite coevolution



## **JOZSEF CSICSVAR** SYSTEMS NEUROSCIENCE

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 Osicsvari 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

#### SELECTED PUBLICATIONS

1. 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.

2. Huxter JR, Senior TJ, Allen K, Csicsvari J. 2008. Theta phase-specific codes for two-dimensional position, trajectory and heading in the hippocampus. Nature Neuroscience 11(5), 587-594.

3. 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

Alice Alvernhe (Postdoc), Karel Blahna (Postdoc), Charlotte Boccara (Postdoc), Desiree Dickerson (Postdoc), Michael Lobianco (Technical Assistant), Alessia Manganaro (Student Intern), Joseph O'Neill (Postdoc), Philipp Schönenberger (Postdoc), Haibing Xu (PhD Student)

SELECTED DISTINCTIONS

- **2011** ERC Starting Grant (consolidator)
- 2010 Title of Ad Hominem Professor in Neuroscience at the University of Oxford







#### CAREER 2011- Professor, IST Austria





## HERBERT EDELSBRUNNER ALGORITHMS. COMPUTATIONAL GEOMETRY & TOPOLOGY

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 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 material science.



The projection of the torus to the plane. The distance function defined by the marked value in the plane is illustrated by showing one of its sublevel sets.

#### **Current Projects**

- Discrete and computational geometry
- Applied computational algebraic topology
- , Reconstruction and description of root traits

2009- Professor, IST Austria 2004–2012 Professor for Mathematics, Duke University, Durham, USA **1999–2012** Professor for Computer Science, Duke University, Durham, USA

CAREER

- 1996- 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

- 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

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

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

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



#### TEAM

Ulrich Bauer (Postdoc), Daria Malkova (Student Intern), Salman Parsa (Student Intern), Florian Pausinger (PhD Student), Jan Reininghaus (Postdoc), Olga Symonova (Postdoc), Hubert Wagner (Student Intern)

## CĂLIN GUET Systems and synthetic biology of genetic networks

Networking is important on any level and in any environment – even in 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 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

## GV

#### CAREER

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 Grant2005 Yen Fellow, The University of Chicago, USA1997 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.
 Kinkhabwala A, Guet CC. 2008. Uncovering cis regulatory codes using synthetic promoter shuffling. PLoS One 3(4), e2030.
 Guet CC, Elowitz MB, Hsing WH, Leibler S. 2002. Combinatorial synthesis of genetic networks. Science 296(5572), 1466–1470.

#### TEAM

Tobias Bergmiller (Postdoc), Remy Chait (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



## **CARL-PHILIPP HEISENBERG** MORPHOGENESIS IN DEVELOPMENT

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

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

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
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 Neether, Junier Drefesserabin

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

#### SELECTED PUBLICATIONS

**1.** 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.

**2.** 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.

**3.** Krieg M, Arboleda-Estudillo Y, Puech PH, Kafer J, Graner F, Muller DJ, Heisenberg CP. 2008. Tensile forces govern germ-layer organization in zebrafish. Nature Cell Biology 10(4), 429–436.

#### TEAM

Vanessa Barone (PhD Student), Martin Behrndt (PhD Student), Pedro Campinho (PhD Student), Daniel Capek (PhD Student), Julien Compagnon (Postdoc), Klaus Koren (Joint Postdoc with Janovjak Group), Gabby Krens (Postdoc), Hitoshi Morita (Postdoc), Kornelija Pranjic (Technician), Verena Ruprecht (Joint Postdoc with Sixt Group), Keisuke Sako (Postdoc), Philipp Schmalhorst (Postdoc), Mateusz Sikora (Postdoc), Michael Smutny (Postdoc), Stefan Wieser (Joint Postdoc with Sixt Group)

## THOMAS A. HENZINGER DESIGN AND ANALYSIS OF CONCURRENT AND EMBEDDED SYSTEMS

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.



#### CV

#### CAREER

2009-	Professor, IST Austria
2004–2009	Professor, EPFL, Lausanne, Switzerland
1999–2000	Director, Max Planck Institute for Computer Science,
	Saarbrücken, Germany
1998–2005	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

- **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

1. Cerny P, Henzinger TA, Radhakrishna A. 2012. Simulation distances. Theoretical Computer Science 413(1), 21–35.

**2.** Chatterjee K, Henzinger TA. 2012. A survey of stochastic omega-regular games. Journal of Computer and System Sciences 78(2), 394–413.

**3.** 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.

#### TEAM

Udi Boker (Postdoc), Pavol Cerny (Postdoc), Cezara Dragoi (Postdoc), Ashutosh Gupta (Postdoc), Jan Otop (Postdoc), Arjun Radhakrishna (PhD Student), Ali Sezgin (Postdoc), Damien Zufferey (PhD Student) 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**

- Quantitative modeling and analysis of reactive systems
- Interfaces and contracts for componentbased hardware and software design
- Predictability and robustness for real-time and embedded systems
- Modern concurrency paradigms such as software transactional memory and cloud computing
- Model checking biochemical reaction networks





## **SIMON HIPPENMEYER** GENETIC DISSECTION OF CEREBRAL CORTEX DEVELOPMENT

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



#### CAREER

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 Institu	
	for Biomedical Research, Switzerland	
2004	PhD, University of Basel and Friedrich Miescher Institute for Biomedical	
	Research, Switzerland	
	SELECTED DISTINCTIONS	
2010	Poster Presentation Award (Gordon Research Conference 'Neural	
	Development', Newport, RI, USA)	
2009–2011	Fellowship for Advanced Researchers (Swiss National Science Foundation	
	Bern, Switzerland)	

- 2006 EMBO Long-Term Fellowship (FMBO; Heidelberg, Germany)
  - **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

**1.** Tasic B\*, Miyamichi K\*, Hippenmeyer S\*, Dani VS, Zeng H, Joo W, Zong H, Chen-Tsai Y, Luo L. 2012. Extensions of MADM (Mosaic Analysis with Double Markers) in mice. (\*equal contribution). PLoS ONE 7(3), e33332.

**2.** Liu C, Sage JC\*, Miller MR\*, Verhaak RCW\*, Hippenmeyer S, Vogel H, Foreman O, Bronson RT, Nishiyama A, Luo L, Zong H. 2011. Mosaic Analysis with Double Markers Reveals Tumor Cell of Origin in Glioma. (\*equal contribution). Cell 146(2), 209–21.

Hippenmeyer S\*, Young YH, Moon HM, Miyamichi K, Zong H, Wynshaw-Boris A, Luo L\*.
 2010. Genetic Mosaic Dissection of Lis1 and Ndel1 in Neuronal Migration.
 (\*co-corresponding authors). Neuron 68 (4), 695–709.

#### TEAM

Gloria Arque (Postdoc), Susanne Laukoter (Technician), Katharina Leopold (Student Intern), Maria-Pia Postiglione (Postdoc)

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 cellular, molecular and epigenetic mechanisms regulating neurogenesis and the migration of neurons in the cortex.

#### **Current Projects**

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

Cortical neurons labelled using the MADM technique



## HARALD JANOVJA MOLECULAR AND CELLULAR BIOPHYSICS

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 cell surface are the antennas that receive signals and pass them on to the inside of the cell, causing specific and tightly controlled responses. The Janovjak group seeks to understand this process and takes a unique biophysical approach to actively manipulate signaling pathways. In multiple experimental systems, receptors are engineered to respond to a light stimulus rather than to the native signal. Light is then used as a "remote control" to activate or inactivate the receptor, allowing the researchers to switch it on or off. This optogenetic approach is used to study circuits and networks by activating or inactivating them at any given point, and allows researchers to analyze information processing in the brain and during signaling processes in general.

#### **Current Projects**

- Optogenetic identification of active signaling pathways
- Manipulation of sensory domains to study receptor dimerization
- Theoretical models of receptor activation

#### CAREER

2011- Assistant Professor, IST Austria 2006–2010 Postdoc, University of California, Berkeley, USA 2005–2006 Postdoc, University of Dresden, Germany **2005** PhD, Max Planck Institute of Molecular Cell Biology and Genetics, Dresden, Germany

#### SELECTED DISTINCTIONS

Long-term fellow of the European Molecular Biology Organization **2005** PhD thesis honored with highest honors (summa cum laude)

SELECTED PUBLICATIONS

1. Janovjak H, Sandoz G, Isacoff EY. 2011. A modern ionotropic glutamate receptor with a potassium-selectivity signature sequence. Nature Communications 2, 232. 2. 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. 3. Syzmcyak P, Janovjak H. 2009. Periodic forces trigger a complex mechanical response

in ubiquitin. Journal of Molecular Biology 390(3), 443-456.

#### TEAM

Christopher Differ (Student Intern), Alexander Kitzmann (Technician), Klaus Koren (Joint Postdoc with Heisenberg group), Catherine McKenzie (PhD Student), Maurizio Morri (PhD Student), Robert Riedler (Student Intern), Miroslava Spanova (Technician)

Using optogenetics to manipulate the cell signaling machinery



## **PETER JONAS** Synaptic communication in hippocampal microcircuits

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 patchclamp techniques, Ca<sup>2+</sup> imaging, and modeling. Amongst other projects, the group examines subcellular elements of the fast-spiking, parvalbumin-expressing GABAergic interneurons in the hippocampus, which is 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 farreaching implications for understanding the contribution of GABAeraic 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

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



#### CAREER

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

#### P

#### SELECTED PUBLICATIONS

**1.** Kim S, Guzman SJ, Hu H, Jonas P. 2012. Active dendrites support efficient initiation of dendritic spikes in hippocampal CA3 pyramidal neurons. Nature Neuroscience 15(4), 600–606.

Eggermann E, Jonas P. 2012. How the 'slow' Ca<sup>2+</sup> buffer parvalbumin affects transmitter release in nanodomain-coupling regimes. Nature Neuroscience 15(1), 20–22.
 Hu H, Martina M, Jonas P. 2010. Dendritic mechanisms underlying rapid synaptic activation of fast-spiking hippocampal interneurons. Science 327(5961), 52–58.

#### TEAM

Itaru Arai (Postdoc), Michelle Duggan (Technical Assistant), Jian Gan (Postdoc), Sarit Goswami (PhD Student), José Guzmán (Postdoc), Hua Hu (Postdoc), Sooyun Kim (Postdoc), Janina Kowalski (Postdoc), Eva Kramberger (Administrative Assistant), Florian Marr (Technician), Rajiv Mishra (PhD Student), Alejandro Pernía-Andrade (Postdoc), Alois Schlögl (Software Engineer), Nicholas Vyleta (Postdoc)

## **VLADIMIR KOLMOGOROV** COMPUTER VISION AND DISCRETE OPTIMIZATION ALGORITHMS

Stepping out on 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



CV	2011– 2005–2011 2003–2005 2003	<b>CAREER</b> Assistant Professor, IST Austria Lecturer, University College London, UK Assistant Researcher, Microsoft Research, Cambridge, UK PhD, Cornell University, USA
		SELECTED DISTINCTIONS
	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
	0000 0011	Systems Conference
	2000-2011	
	2005	Best paper honorable mention award at IEEE Conference
	2000	on Computer Vision and Pattern Recognition
	2002	Best paper award at the European Conference on
		Computer Vision
P	SELECTED P	UBLICATIONS
	I. Kolmogoro	v v. 2012. The power of linear programming for

**1.** Kolmogorov V. 2012. The power of linear programming for valued CSPs: a constructive characterization. Technical report arXiv:1207.7213, July 2012.

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

**3.** Kolmogorov V. 2006. Convergent tree-reweighted message passing for energy minimization. IEEE Transactions on Pattern Analysis and Machine Intelligence 28(10), 1568–1583.

Rustem Takhanov (Postdoc)



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



## **CHRISTOPH LAMPERT** Computer Vision and Machine Learning

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

	048558
	CAREER
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
	2010– 2007–2010 2004–2007 2003 2012 2012 2008

- 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

**1.** Lampert CH, Nickisch H, Harmeling S. 2009. Learning to detect unseen object classes by between-class attribute transfer. IEEE Conference on Computer Vision and Pattern Recognition (CVPR), 951–958.

**2.** Lampert CH, Blaschko MB, Hofmann T. 2008. Beyond sliding windows: Object localization by efficient subwindow search. IEEE Conference on Computer Vision and Pattern Recognition (CVPR), 1–8.

**3.** Blaschko MB, Lampert CH. 2008. Learning to localize objects with structured output regression. European Conference on Computer Vision (ECCV), 2–15.

#### TEAM

Viktoriia Sharmanska (PhD Student)



## KRZYSZTOF PIETRZAK CRYPTOGRAPHY

Cryptography is often relegated to the realm of spies and agents. However, we all rely on cryptography every time we withdraw money from an ATM. The Pietrzak group works on cryptographic theory and practice to improve the security of light-weight devices.



Reader R € c € {0,1}× (r,z)if  $r \notin \mathbb{R}^*$  reject  $e' := z - r \cdot (s \cdot \pi(c) + s')$ if  $wt(e') > n \cdot \tau'$  reject las accont

Light-weight devices require simple and efficient cryptographic schemes.

The Pietrzak group is interested in the theoretical and practical aspects of cryptography, the science of information security. Their work focuses on constructing secure cryptographic schemes for lightweight devices such as smartcards and RFID tags which are used, for example, in security-relevant applications like electronic passports, wireless car keys, or bankcards. These frequently used devices are susceptible to side-channel attacks, in which information automatically leaked from the device, such as power consumption or radiation, is measured and used to break security completely. Pietrzak's group works on developing cryptosystems for lightweight devices that are provably secure against all sidechannel attack. Smartcards and RFID tags are also often computationally highly restricted, and the group is establishing simple cryptographic schemes that are provably secure, but at the same time simple and efficient enough so that they can be implemented on such devices.

#### **Current Projects**

- Leakage-resilient cryptosystems
- Cryptosystems for computationally restricted devices

1	CAREER
2011-	Assistant Professor,
	IST Austria
005–2011	Scientific staff member,
	Centrum Wiskunde & Informatica
	Amsterdam, Netherlands
2006	Postdoc, École Normale
	Supérieure, Paris, France
2005	PhD, ETH Zurich, Switzerland

#### SELECTED DISTINCTIONS

2010 ERC Starting Grant

SELECTED PUBLICATIONS

P

 Kiltz E, Pietrzak K, Cash D, Jain A, Venturi D. 2011. Efficient authentication from hard learning problems. EUROCRYPT, 7–26.
 Dziembowski S, Pietrzak K, Wichs D. 2010. Non-malleable codes. International Conference on Supercomputing, 434–452.

**3.** Dziembowski S, Pietrzak K. 2008. Leakage-resilient cryptography. IEEE Symposium on Foundations of Computer Science, 293–302.



TEAM

Stephan Krenn (Postdoc)



## DARIA SIEKHAUS INVASIVE MIGRATION

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**

- Understanding the communication between hemocytes and the barriers that they move through
- Understanding the regulation of adhesion that occurs during hemocyte migration



#### CAREER

 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

2012Marie Curie Career Integration Grant2003–2005NIH Fellowship2000–2003NSRA 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.
- 2. 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.

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



TEAM

Aparna Ratheesh (Postdoc), Cornelia Schwayer (Technician)

Immune cells (green) of the fruit fly Drosophila melanogaster

## MICHAEL SIXT MORPHODYNAMICS OF IMMUNE CELLS

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 body 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

# 2010 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 Hol, University of Erlangen, Germany 2002 Full approbation in human medicine

- 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

#### SELECTED PUBLICATIONS

 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.
 Renkawitz J, Schumann K, Weber M, Lämmermann T, Pflicke H, Polleux J, Spatz JP, Sixt M. 2009. Adaptive force transmission in amoeboid cell migration. Nature Cell Biology 11(12), 1438–1443.

**3.** 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

Alexander Eichner (PhD Student), Maria Frank (Technician), Eva Kiermaier (Postdoc), Aglaja Kopf (Student Intern), Christine Moussion (Postdoc), Anne Reversat (Postdoc), Verena Ruprecht (Joint Postdoc with Heisenberg Group), Jan Schwarz (PhD Student), Kari Vaahtomeri (Postdoc), Ingrid de Vries (Technician), Stefan Wieser (Joint Postdoc with Heisenberg Group)





## GAŠPER TKAČIK Theoretical biophysics and neuroscience

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

V

#### CAREER

2011- Assistant Professor, IST Austria

- 2008-2010 Postdoc, University of Pennsylvania, 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, Prentice JS, Victor JD, Balasubramanian V. 2010. Local statistics in natural scenes predict the saliency of synthetic textures.
 Proceedings of the National Academy of Sciences USA 107(42), 18149–18154.
 Tkačik G, Prentice JS, Balasubramanian V, Schneidman E. 2010.
 Optimal population coding by noisy spiking neurons. Proceedings of the National Academy of Sciences USA 107(32), 14419–14424.
 Tkačik G, Callan CG, Bialek W. 2008. Information flow and optimization in transcriptional regulation. Proceedings of the National Academy of Sciences USA 105(34), 12265–12270.

#### TEAM

Anna Andersson (Postdoc), Vicente Botella Soler (Postdoc), Barbara Casillas-Perez (Joint PhD Student with Cremer Group), Georg Rieckh (PhD Student) system autput biological input in

Processing of information input by biological networks

## **CAROLINE UHLER** ALGEBRAIC STATISTICS AND COMPUTATIONAL BIOLOGY

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

SELECTED PUBLICATIONS

Statistics 40(1), 238-261.

62(4), 603-638.

20(1), 238-266.

TEAM

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

1. Uhler C. 2012. Geometry of maximum likelihood

estimation in Gaussian graphical models. Annals of

2. Sturmfels B, Uhler C. 2010. Multivariate Gaussians,

3. Evans SN, Sturmfels B, Uhler C. 2010. Commuting birth-

semidefinite matrix completion and convex algebraic geometry. Annals of the Institute of Statistical Mathematics

and-death processes. Annals of Applied Probability

Abraham Martin del Campo (Postdoc)



#### CAREER

2011- Assistant Professor, IST Austria

- 2012 Postdoc, Seminar of Statistics, ETH Zurich, Switzerland
- 2011 Postdoc, Institute of Mathematics and its Applications, University of Minnesota, USA
- 2011 PhD, University of California, Berkeley, USA

#### SELECTED DISTINCTIONS

2010–2011 Janggen-Poehn Fellowship

2007–2010 International Fulbright Science and Technology Award2006 Best Student Award of the University of Zurich



Gaussian distributions on three nodes for which causal inference fails

#### Annual Report 2012 37



## CHRIS WOJTAN Computer graphics

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 mesh surfaces
- Generating temporally coherent deforming surfaces with changing topology from space-time data
- Efficient simulation of fluid dynamics



#### CAREER

2011– Assistant Professor, IST Austria2010 PhD, Georgia Institute of Technology, USA

#### SELECTED DISTINCTIONS

- 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

#### TEAM

Ryoichi Ando (Visiting Scientist), Morten Bojsen-Hansen (PhD Student), Jakob Egger (PhD Student), Stefan Jeschke (Postdoc), Karthik Raveendran (PhD Student, co-advised with Prof. Greg Turk at Georgia Institute of Technology), Bo Wu (PhD Student)

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



#### SELECTED PUBLICATIONS

**1.** Bojsen-Hansen C, Li H, Wojtan C. 2012. Tracking Surfaces with Evolving Topology. ACM Transactions on Graphics 31(4) (Proceedings of SIGGRAPH 2012), Article 53.

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

**3.** Wojtan C, Turk G. 2008. Fast viscoelastic behavior with thin features. ACM Transactions on Graphics 27(3) (Proceedings of SIGGRAPH 2008), Article 47.









# IST AUSTRIA PROFESSORS Starting in 2013

In 2012, IST Austria succeeded in recruiting several new professors who will join the Institute in 2013. The new professors will strengthen the scientific activities at IST Austria and also open up new fields of research. Laszlo Erdös and Robert Seiringer will establish mathematical physics at IST Austria, while Björn Hof will be the first experimental physicist on campus. Eva Benková and Jiři Friml will broaden the scope of biological research at IST Austria to include plant science, and Uli Wagner will strengthen the Institute's activities in discrete mathematics, at the boundary to computer science. The establishment of new research directions in the physical, plant, and mathematical sciences will significantly enhance the overall research portfolio and scientific impact of IST Austria. Also joining the Institute in 2013 will be Ryuichi Shigemoto, a neuroscientist who was hired in 2011.



#### Eva Benková

focuses on plant hormone research. After studying Molecular Biology and Genetics at Masaryk University in Brno, Czech Republic, Benková moved to the Institute of Biophysics

of the Academy of Science of the Czech Republic, where she earned her PhD in 1998. After three years as Postdoctoral fellow at the Max Planck Institute for Plant Breeding in Cologne, Germany, Benková joined the Centre for Plant Molecular Biology in Tübingen. Since 2007, Benková holds a group leader position at the Plant Systems Biology Department, Flanders Institute for Biotechnology (VIB) in Ghent, Belgium. Eva Benková uses *Arabidopsis* root development as a model system to unravel the molecular and cellular mechanisms underlying signaling networks in plants. In 2007, Benková was awarded an ERC Starting Grant for her work on plant hormonal crosstalk. Eva Benková will join IST Austria as Assistant Professor in April 2013.



#### Laszlo Erdös

works on mathematical analysis and probability theory, focusing on problems arising from physics. Erdös studied mathematics at the Loránd Eötvös University in Budapest, before pursuing

his doctoral studies with Elliot H. Lieb at Princeton University, where he received his PhD in 1994. After holding junior positions at ETH Zurich and the Courant Institute (NYU), Erdös worked at the Georgia Institute of Technology for five years, where he moved through the academic ranks from Assistant to Full Professor. Since 2003, Laszlo Erdös is Professor at the Ludwig Maximilians University Munich. Erdös' scientific interest is in questions on disordered systems. Recently, together with collaborators he solved two long-standing problems related to the Wigner-Dyson-Mehta conjecture in the theory of random matrices. Laszlo Erdös will join IST Austria as Professor in April 2013.



#### Jiři Friml

studies signal integration during plant development. Friml studied Biochemistry at Masaryk University in Brno, Czech Republic. He then performed his doctoral studies at

the Max Planck Institute for Plant Breeding in Cologne, Germany, obtaining his PhD in 2000. Friml received a second PhD in Biochemistry from Masaryk University in 2002. In 2002, Friml became group leader at the Centre for Plant Molecular Biology at the University of Tübingen. In 2006, Friml was conferred a full Professorship at the Plant Cell Biology Department at the University of Göttingen. Jiři Friml joined the Flanders Institute for Biotechnology as full professor in 2007. In 2011, Friml received an ERC Starting Grant supporting his research in polarity and subcellular dynamics in plants. Friml was elected EMBO member in 2010 and AAAS fellow in 2011, and awarded the Körber European Science Award in 2010 and the EMBO Gold Medal in 2012. Jiři Friml will join IST Austria as Professor in April 2013.



#### Björn Hof

investigates turbulence and self-organization in fluid dynamics. After his undergraduate studies in Marburg, Germany, Björn Hof moved to the University of Manchester, UK, where he

acquired his PhD in 2001. After postdoc positions in Manchester and at the Delft University of Technology, Netherlands, he returned to the University of Manchester as a lecturer in 2005. In 2007, Björn Hof became leader of the independent research group "Complex Dynamics and Turbulence" at the Max Planck Institute for Dynamics and Self Organization in Göttingen, Germany. Hof is best known for his investigation of the transition from ordered (laminar) to disordered (turbulent) flow. Hof recently received an ERC Starting Grant. Björn Hof will join IST Austria as Professor in May 2013.



#### Robert Seiringer

focuses on quantum many-body theory. Seiringer studied Theoretical Physics at the University of Vienna and earned his PhD in 2000, under the supervision of Jakob Yngvason. In

2001, he moved to Princeton University, becoming Assistant Professor in 2003. Since 2010, Seiringer is Associate Professor with tenure at McGill University in Montreal, Canada. His habilitation was accepted by the University of Vienna in 2005. In 2009, Seiringer received the Henri Poincaré Prize of the International Association of Mathematical Physics, considered to be the most prestigious award in that field. Robert Seiringer focuses on many-body systems in quantum mechanics, in particular in problems in quantum statistical mechanics and condensed matter physics. Robert Seiringer will join IST Austria as Professor in May 2013.



#### Ryuichi Shigemoto

works on the mechanisms of signaling and plasticity in the brain. He received his MD from the University of Kyoto in 1985 and his PhD in 1994, having performed research in

the groups of Noboru Mizuno and Shigetada Nakanishi. Shigemoto was appointed as an Assistant Professor at the Kyoto University Faculty of Medicine Department of Anatomy in 1989 and at the Department of Morphological Brain Science in 1990. Since 1998, Ryuichi Shigemoto has been a Professor at the National Institute for Physiological Sciences in Okazaki. Shigemoto is interested primarily in the subcellular localization of neurotransmitter receptors and voltage gated Calcium channels, as well as in the mechanisms of long-term stabilization of memory in the mouse. He has pioneered the cutting-edge SDS-FRL method for detecting single membrane proteins at unprecedented sensitivity and received an ISI Citation Laureate Award in 2000. Shigemoto will join IST Austria as Professor in March 2013.



works on problems in mathematics and computation. Uli Wagner studied mathematics at Freie Universität Berlin, Germany. He completed his PhD at ETH Zurich in 2003, followed

by postdoc positions at MSRI Berkeley, Charles University in Prague, the Hebrew University of Jerusalem, and ETH Zurich. From 2008 to 2012, he was Senior Researcher at ETH Zurich. Since June 2012, Wagner is Assistant Professor at EPF Lausanne. Uli Wagner works in discrete and computational geometry and topology, an area at the junction between mathematics and theoretical computer science. His main focus is on algorithmic and combinatorial questions regarding embeddings and homotopy theory, and on topological methods in discrete mathematics. Uli Wagner will join IST Austria as Assistant Professor in March 2013.

# **RESEARCH GRANTS** Supporting Excellence

Research grants, awards, and other honors are an important metric for measuring research excellence. IST Austria's scientists receive such recognitions regularly on the national and international levels.

#### **European grants**

The most prestigious grants for basic science in Europe are awarded by the European Research Council (ERC). Set up in 2007 by the European Union, the ERC is the first pan-European funding organization for frontier research. By encouraging competition for funding between the very best individual researchers of any nationality and age, the ERC aims to stimulate scientific excellence in Europe. In 2012, computer scientist Christoph Lampert received an ERC Starting Independent Researcher Grant, bringing the total number of ERC Grantees among the IST Austria faculty to twelve. Lampert obtained the grant for his project on "Life-Long Learning for Visual Scene Understanding", which develops and analyzes algorithms that use machine learning from images and videos to interpret visual scenes on a level comparable to intuitive human understanding.

The European Commission also awarded an EU Cooperation Grant to Herbert Edelsbrunner for his project on "Topological Complex Systems". Cooperation Grants support collaborative research on strategic topics. The partners in this project are the Jožef Stefan Institute in Ljubljana, the Royal Institute of Technology in Stockholm, the Jagiellonian University in Krakow, and the Technion in Haifa. Edelsbrunner is also supported through the

#### **RESEARCH GRANTS AND AWARDS (SELECTION)**

- > ERC Advanced Grantees: Nick Barton, Thomas Henzinger, Peter Jonas
- > ERC Starting Grantees: Eva Benková, Krishnendu Chatterjee, Sylvia Cremer, Jozsef Csicsvari, Jiři Friml, Björn Hof, Christoph Lampert, Krzysztof Pietrzak, Michael Sixt
- > Mega Grant by the Russian Government: Herbert Edelsbrunner
- > HFSP Grants: Călin Guet, Harald Janovjak, Michael Sixt, Gašper Tkačik
- Microsoft Research Faculty Fellowship: Krishnendu Chatterjee
- Wittgenstein Award: Thomas Henzinger
- > START Award: Michael Sixt
- , Ignaz L. Lieben Prize: Michael Sixt

Mega-Grant program of the Russian government. He heads a Mega project on "Discrete and Computational Geometry" coordinated by the Yaroslavl State University. A global funding agency, the Human Frontier Science Program (HFSP), puts its emphasis on competitively selecting cutting-edge, risky projects that are pursued by international, interdisciplinary teams. In 2012, such prestigious HFSP grants were awarded to international teams that include the IST Austria professors Harald Janovjak and Gašper Tkačik.

#### National awards

The professors of IST Austria were also honored through national awards. IST Austria President Thomas Henzinger is one of two Wittgenstein Laureates of 2012, receiving the most important Austrian science prize together with the chemist Niyazi Serdar Sarizifti of the University of Linz. The Wittgenstein award supports researchers who have accomplished outstanding scientific achievements and earned a high reputation in the international scientific community of their discipline. Awarded by the Austrian Science Fund (FWF) and based on the decision of an international jury, the Wittgenstein award promotes the pursuit of long-term scientific research that expands the horizon of our current knowledge. Also in 2012, the Austrian Academy of Sciences bestowed its oldest prize, the Ignaz L. Lieben Prize, to cell biologist Michael Sixt, for his extraordinary achievements in the study of immune-cell morphodynamics. Sylvia Cremer was one of the 2012 recipients of the Science Award of the province of Lower Austria.

#### Long-term impact

Computer scientists Vladimir Kolmogorov and Thomas Henzinger were both honored for past contributions in their research fields. Kolmogorov was awarded the Kænderink Prize at the 2012 European Conference on Computer Vision (ECCV) for his paper "What Energy Functions can be Minimized via Graph Cuts", published at ECCV 10 years ago, and the fundamental contribution this publication made to the field of computer vision. Henzinger received, jointly with his co-authors, the Logic in Computer Science Test-of-Time Award for the paper "Symbolic Model Checking for Real-Time Systems", which was published 20 years earlier at the International Symposium for Logic in Computer Science. These prizes honor the significance of findings in basic research, which can be gauged only with a long-term perspective.



## **RESEARCH GRANTS** 2012

#### Peer-reviewed research grants acquired or active in 2012

#### **IST AUSTRIA**

International IST Postdoc Fellowship Programme, FP7 COFUND-2011, € 3'408'000, 7/2012–6/2017

#### **BARTON GROUP**

- Limits to selection in biology and in evolutionary computation, ERC Advanced Grant, € 1'975'000, 7/2010–6/2015
- Mating systems and the evolutionary dynamics of hybrid zones, FWF Lise Meitner, € 133'000, 11/2012–10/2014
- Mating system and the evolutionary dynamics of hybrid zones, MC-IIF International Incoming Fellowship, € 180'000

#### **BOLLENBACH GROUP**

- Optimality principles in responses to antibiotics, MC-CIG Career Integration Grant,  $\in$  100'000, 6/2012–5/2016
- → OEAW APART, € 220'000, 5/2012-4/2015

#### **CHATTERJEE GROUP**

- Quantitative Graph Games: Theory and Applications, ERC Starting Grant, € 1'163'000, 12/2011–11/2016
- Rigorous Systems Engineering, FWF NFN, € 455'000, 3/2011–2/2015
- Microsoft Research Faculty Fellowship, Microsoft Research, \$ 200'000, 7/2011–12/2013

#### **CREMER GROUP**

- Host-Parasite Coevolution, DFG, € 130'000, 2/2010–1/2013
- Social Vaccines Social Vaccination in Ant Colonies: from Individual Mechanisms to Society Effects, ERC Starting Grant, € 1'278'000, 4/2010–3/2015
- Collective disease defence and pathogen detection abilities in ant societies: a chemo-neuro-immunological approach, MC – IEF Intra-European Fellowship, € 180'000, 4/2012–3/2014
- Antnet Project, Junge Akademie Leopoldina & Berlin-Brandenburg Akademie der Wissenschaften, € 12'500, 7/2008–6/2013

#### **CSICSVARI GROUP**

- Memory-related information processing in neuronal circuits of the hippocampus and entorhinal cortex, ERC Starting Grant, € 1'441'000, 12/2011–11/2016
- Mechanisms of information transfer from the hippocampus to the entorhinal cortex and its role in memory consolidation, SNF PD Fellowship, € 51'000, 7/2011–12/2012
- → Fondation Fyssen, € 25'000, 09/2011–10/2012

#### **EDELSBRUNNER GROUP**

→ Applied and Computational Algebraic Topology, ESF Research Network, € 320'000

- Topological Complex Systems, FP7 Cooperation, € 498'000, 10/2012–9/2015
- Genome-wide Analysis of Root Traits, NSF Genome-Enabled Plant Research, € 114'000, 9/2010–8/2012
- → Discrete and Computational Geometry, Mega grant from the Russian government, € 3'700'000, 10/2011–12/2013

#### GUET GROUP

 Multi-Level Conflicts in Evolutionary Dynamics of Restriction-Modification Systems, HFSP Young Investigators' Grant, € 264'000, 11/2011–8/2012

Internship, FFG FEMtech, € 10'600, 1/2013–6/2013

#### **HEISENBERG GROUP**

 Analysis of the Formation and Function of Different Cell Protusion Types During Cell Migration in Vivo, DFG, € 51'000, 11/2010–3/2012

 The Interplay of FGF Signalling and Integrins in Mesoderm Formation during Zebrafish Gastrulation, DFG PD Auslandsstipendium, € 73'000, 12/2011–11/2013

 Cell Cortex and Germ Layer Formation in Zebrafish Gastrulation, FWF DACH DFG, € 280'000, 11/2011–10/2014

Control of Epithelial Cell Layer Spreading in Zebrafish, FWF DACH DFG, € 344'000, 12/2011–11/2013

Cell- and Tissue Mechanics in Zebrafish Germ Layer
 Formation, FWF Herta Firnberg, € 206'000, 2/2012–1/2015

- Japan PostDoc Stipendium, JSPS Postdoctoral Fellowships for Research Abroad, € 103'000, 10/2012–9/2014
- → Uehara Memorial Foundation, €30'000, 10/2011–09/2012

#### **HENZINGER GROUP**

- Quantitative Reactive Modeling, ERC Advanced Grant, € 2'326'000, 5/2011-4/2016
- The Wittgenstein Award, FWF, € 1'500'000
- Rigorous Systems Engineering, FWF NFN, € 455'000, 3/2011–2/2015

#### **JANOVJAK GROUP**

- Microbial Ion Channels for Synthetic Neurobiology, MC-CIG Career Integration Grant, € 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
- Internship, FFG FEMtech, € 8'900, 1/2013–6/2013

#### JONAS GROUP

 Nanophysiology of fast-spiking, parvalbumin-expressing GABAergic interneurons, ERC Advanced Grant, € 2'500'000, 6/2011–5/2016  Mechanisms of transmitter release at GABAergic synapses, FWF, € 491'000, 10/2012–9/2015

#### **LAMPERT GROUP**

Lifelong Learning of Visual Scene Understanding, ERC Starting Grant, € 1'465'000, 1/2013–12/2017

#### PIETRZAK GROUP

Provable Security for Physical Cryptography, ERC Starting Grant, € 1'005'000, 9/2011–10/2015

#### **SIEKHAUS GROUP**

- Breaking barriers: Investigating the junctional and mechanobiological changes underlying the ability of Drosophila immune cells to invade an epithelium, MC-IIF International Incoming Fellowship, € 180'000, 3/2013–2/2015
- Investigating the role of transporters in invasive migration through junctions. IRTIM, MC-CIG Career Integration Grant, € 100'000, 3/2013–2/2017

#### SIXT GROUP

- > Zytoskelettdynamik und Kraftgenerierung wandernder Leukozyten, DFG, € 114'000, 11/2010–3/2012
- Einfluss der Chemokinpräsentation auf das Reaktionsmuster von Leukozyten, DFG, € 200'000, 1/2011–1/2013
- Role of the WAVE-complex in the haematopoietic system, DFG, € 140'000, 11/2010–10/2014
- → LeukocyteForces: 'Cytoskeletal force generation and force transduction of migrating leukocytes', ERC Starting Grant, € 1'485'000, 2/2012–3/2017
- Stromal Cell-immune Cell Interactions in Health and Disease, MC-ITN Initial Training Networks, € 248'000, 1/2012–12/2015
- Oytoskeletal force generation and force transduction of migrating leukocytes, FWF START, € 200'000, 8/2011–7/2019
- Cell migration in complex environments: from in vivo experiments to theoretical models, HFSP Program Grant, € 257'000, 11/2011–10/2014
- > Böhringer Ingelheim Fonds Fellowship, € 45'000, 10/2012– 09/2014
- Juselius Foundation Fellowship, € 60'000, 11/2012– 10/2013

#### TKAČIK GROUP

Information processing and computation in fish groups, HFSP Program Grant, € 264'000, 10/2012–9/2015

#### **WOJTAN GROUP**

- → Deep Pictures: Creating Visual and Haptic Vector Images, FWF, € 340'000, 8/2012–7/2015
- Chinese Scholarship Council Student Grant, €12'000, 09/2012–08/2013

## **PUBLICATIONS** 2012

#### Publications by IST Austria members published or accepted in 2012 (joint publications involving several groups are listed multiple times)

#### **BARTON GROUP**

- Aeschbacher, S., Beaumont, M.A. & Futschik, A. 2012. A novel approach for choosing summary statistics in approximate Bayesian computation. *Genetics* 192(3), 1027–1047.
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- Lohse, K., Barton, N.H., Melika, G. & Stone, G.N. 2012. A likelihood based comparison of population histories in a parasitoid guild. *Molecular Ecology* 21(18), 4605–4617.
- Vladar, H.P. & Chela-Flores, J. 2012. Can the evolution of multicellularity be anticipated in the exploration of the solar system?. In: Cellular Origin, Life in Extreme Habitats and Astrobiology. Genesis: Origin of Life on Earth and Planets. Springer, in press.
- Vladar, H.P. 2012. Amino acid fermentation at the origin of the genetic code. *Biology Direct* 7:6.
- Weissman, D.B. & Barton, N.H. 2012. Limits to the rate of adaptive substitution in sexual populations. *PLoS Genetics* 8(6), e1002740.

#### **BOLLBACK GROUP**

- Pereira, A.C.T.C., Leite, F.G.G., Brasil, B.S.A.F., Soares-Martins, J.A.P., Torres, A.A., Pimenta, P.F.P., Souto-Padrón, T., Tranktman, P., Ferreira, P.C.P., Kroon, E.G. & Bonjardim, C.A. 2012. A vaccinia virus-driven interplay between the MKK47/-7JNK1/2 pathway and cytoskeleton reorganization. *Journal of Virology* 86(1), 172–184.
- Vilaça, S.T., Redondo, R.A.F., Lins, L.V. & Santos, F.R. 2012. Remaining genetic diversity in Brazilian Merganser Mergus octosetaceus. Conservation Genetics 13(1), 293–298.

#### **BOLLENBACH GROUP**

- Kicheva, A., Bollenbach, T., Wartlick, O., Julicher, F. & Gonzalez-Gaitan, M. 2012. Investigating the principles of morphogen gradient formation from tissues to cells. *Current Opinion in Genetics and Development* 22(6), 527–532.
- Pantazis, P. & Bollenbach, T. 2012. Transcription factor kinetics and the emerging asymmetry in the early mammalian embryo. *Cell Cycle* 11(11), 2055–2058.

#### **CHATTERJEE GROUP**

- Brázdii, B., Chatterjee, K., Kucera, A., & Novotný, P. 2012. Efficient controller synthesis for consumption games with multiple resource types. In: LNCS. CAV: Computer Aided Verification 7358, 23–38.
- Cerný, P., Chmelik, M., Henzinger, T.A. & Radhakrishna, A. 2012. Interface Simulation Distances. GandALF: Symposium on Games, Automata, Logics and Formal Verification 29–42.
- Chatterjee, K. & Doyen, L. 2012. Energy parity games. Theoretical Computer Science 458(2), 49–60.
- Chatterjee, K. & Doyen, L. 2012. Games and Markov decision processes with mean payoff parity and energy parity objectives. In: LNCS. MEMICS: Mathematical and Engineering Methods in Computer Science 7119, 37–46.
- Chatterjee, K. & Doyen, L. 2012. Partial observation stochastic games: How to win when belief fails. In: *LICS. Logic in Computer Science* 175–184.
- Chatterjee, K. & Henzinger, M. 2012. An O(n<sup>2</sup>) time algorithm for alternating Büchi games. In SODA: Symposium on Discrete Algorithms 1386–1399.

 Chatterjee, K. & Henzinger, T.A. 2012. A survey of stochastic ω regular games. *Journal of Computer and System Sciences* 78(2), 394–413.

- Chatterjee, K. & Majumdar, R. 2012. Discounting and averaging in games across time scales. *International Journal* of Foundations of Computer Science 23(3), 609–625.
- Chatterjee, K. & Raman, V. 2012. Synthesizing protocols for digital contract signing. In: LNCS. VMCAI: Verification, Model Checking, and Abstract Interpretation 7148, 152–168.
- Chatterjee, K. & Tracol, M. 2012. Decidable problems for probabilistic automata on infinite words. In: LICS: Logic in Computer Science 185–194.
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- Chatterjee, K., Doyen, L. & Henzinger, T.A. 2012. A survey of partial observation stochastic parity games. *Formal Methods in System Design* 1, 1–17.
- Chatterjee, K., Henzinger, T.A. & Prabhu, V.S. 2012. Finite automata with time delay blocks. In: *EMSOFT: Embedded* Software. ACM, 43–52.

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#### **CREMER GROUP**

- Cremer, S., Suefuji, M., Schrempf, A. & Heinze, J. 2012. The dynamics of male-male competition in *Cardiocondyla* obscurior ants. *BMC Ecology* 12, Article No. 7.
- Konrad, M., Pamminger, T. & Foitzik, S. 2012. Two pathways ensuring social harmony. *Naturwissenschaften* 99(8), 627–636.
- Konrad, M., Vyleta, M.L., Theis, F.J., Stock, M., Tragust, S., Klatt, M., Drescher, V., Marr, C., Ugelvig, L.V. & Cremer, S. 2012. Social transfer of pathogenic fungus promotes active immunisation in ant colonies. *PLoS Biology* 10(4), e1001300-.
- Tragust, S., Mitteregger, B., Barone, V., Konrad, M., Ugelvig, L.V. & Cremer, S. 2012. Ants disinfect fungus-exposed brood by oral uptake and spread of their poison. *Current Biology* 23(1), doi: 10.1016/j.cub.2012.11.034.

- Ugelvig, L.V. & Cremer, S. 2012. Effects of social immunity and unicoloniality on host parasite interactions in invasive insect societies. *Functional Ecology* 26(6), 1300–1312.
- Ugelvig, L.V., Andersen, A., Boomsma, J. J & Nash, D.R. 2012. Dispersal and gene flow in the rare parasitic Large Blue butterfly *Maculinea arion*. *Molecular Ecology* 21(13), 3224–3236.
- Vyleta, M.L., Wong, J. & Magun, B.E. 2012. Suppression of ribosomal function triggers innate immune signaling through activation of the NLRP3 inflammasome. *PLoS One* 7(5), e36044-.

#### **CSICSVARI GROUP**

 Allen, K., Rawlins, J.N.P., Bannerman, D.M. & Csicsvari, J. 2012. Hippocampal place cells can encode multiple trialdependent features through rate remapping. *Journal of Neuroscience* 32(42), 14752–14766.

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#### **EDELSBRUNNER GROUP**

- Bendich, P., Cabello, S. & Edelsbrunner, H. 2012. A point calculus for interlevel set homology. *Pattern Recognition Letters* 33(11), 1436–1444.
- Berberich, E., Halperin, D., Kerber, M. & Pogalnikova, R. 2012. Deconstructing Approximate Offsets. *Discrete and Computational Geometry* 48, 964–989.



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- Chen, C. & Kerber, M. 2012. An output sensitive algorithm for persistent homology. In: SoCG'11 Proceedings of the 27<sup>th</sup> annual ACM symposium on computational geometry 207–216.
- Dolbilin, N.P., Edelsbrunner, H. & Musin, O.R. 2012. On the optimality of functionals over triangulations of Delaunay sets. *Russian Mathematical Surveys* 67(4), 781–783.
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#### **GUET GROUP**

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- Guet, C., Gupta, A., Henzinger, T.A., Mateescu, M. & Sezgin, A. 2012. Delayed continuous time Markov chains for genetic regulatory circuits. In: *LNCS: CAV: Computer Aided Ventication* 7358, 294–309.
- Hadizadeh Yazdi, N., Guet, C.C., Johnson, R.C. & Marko, J.F. 2012. Variation of the folding and dynamics of the Escherichia coli chromosome with growth conditions. *Molecular Microbiology* 86(6), 1318–1333.

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- Barone, V. & Heisenberg, C. 2012. Cell adhesion in embryo morphogenesis. Current Opinion in Cell Biology 24(1), 148–153.
- Behrndt, M. & Heisenberg, C. 2012. Spurred by resistance mechanosensation in collective migration. *Developmental Cell* 22(1), 3–4.
- Behrndt, M., Salbreux, G., Campinho, P., Hauschild, R., Oswald, F., Roensch, J., Grill, S.W. & Heisenberg, C. 2012. Forces driving epithelial spreading in zebrafish gastrulation. *Science* 338(6104), 257–260.
- Castanon, I., Abrami, L., Holtzer, L., Heisenberg, C., Van Der Goot, F.G. & González-Gaitán, M.A.F. Anthrax toxin receptor 2a controls mitotic spindle positioning. *Nature Cell Biology* 15(1), 28–39.
- Engel, J., Schmalhorst, P. S., & Routier, F. H. 2012.
   Biosynthesis of the fungal cell wall polysaccharide galactomannan requires intraluminal GDP-mannose. *Journal* of Biological Chemistry 287(53), 44418–44424.
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#### **HENZINGER GROUP**

- Alur, R., Cerný, P. & Weinstein, S.A. 2012. Algorithmic analysis of array accessing programs. ACM Transactions on Computational Logic (TOCL) 13(3), Article 27.
- Asarin, E.A., Donze, A., Maler, O. & Ničković, D. 2012. Parametric identification of temporal properties. In: LNCS. RV: Runtime Verification 7186, 147–160.
- Beyer, D., Henzinger, T.A., Erkan Keremoglu M. & Wendler, P. 2012. Conditional model checking: A technique to pass information between verifiers. *FSE: Foundations of Software Engineering,ACM Press*, article 57
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# SCIENTIFIC EVENTS Discussing Ideas



At the IST Austria Young Scientist Symposium, plenary talks and a panel discussion – organized and chaired by young scientists of IST Austria – attracted an interdisciplinary audience.

Conferences, symposia, and seminars are platforms for researchers to share and discuss ideas, an integral part of scientific progress. IST Austria is linked to the scientific community, both globally and locally, specialist and interdisciplinary, through a range of scientific events – from annual conferences to weekly seminars.

#### **Conferences and symposia**

In 2012, IST Austria was the venue of a number of international scientific conferences and workshops. These events, organized by IST Austria professors together with faculty of other institutions, brought scientists from various research fields to the campus. Examples of the conferences include a week-long Computational Geometry and Topology workshop, the IST Austria Fluid Simulation workshop and a conference on Cell and Tissue Biomechanics (a list of the major scientific events at IST Austria in 2012 can be found on the right). The NEURON course 2012 at IST Austria was the first such intensive, five-day course to be held in Europe. The course, which brought researchers from 12 different countries to IST Austria, offered the opportunity to learn about computational strategies and modeling methods based on the NEURON simulation environment. The Sensory Coding and Natural Environment (SCNE) conference at IST Austria was a follow-up of a successful Gordon Research Conference series, which started in 2002. Held from September 9-12, the interdisciplinary conference drew together scientists at the interface of neuroscience, physics, engineering, psychology, and machine learning. The goal of SCNE 2012 was to ask how understanding natural signals can help to understand sensory processing and perception. A workshop on Algebraic Statistics on September 28-30 brought together 30 participants to learn about ongoing work in algebraic statistics and start new collaborations across Europe. The symposium Crossing Boundaries between Physics, Chemistry and Biology explored the interface of the different disciplines of the natural sciences.

#### **IST Austria Young Scientist Symposium**

2012 saw the introduction of a new event format at IST Austria. The IST Austria Young Scientist Symposium is a one-day symposium organized entirely by the postdocs and PhD students of IST Austria. It is aimed at young scientists from all over the world, with a focus on Central European universities and research institutions. At the one-day meeting, which in 2012 focused on Human Evolution, the international speakers attracted a broad and interdisciplinary audience of more than 100 scientists from the Vienna region and led to lively discussions in a relaxed atmosphere. Six lectures were given by the international experts Morten Rasmussen, Bence Viola, Eörs Szathmáry, Daniel Nettle, Bill Sellers, and Philipp Mitteröcker on diverse topics in human evolution, such as genetics or locomotion. The lectures were followed by an exciting panel discussion on the future of human evolution.

#### The Institute Colloquium and research seminars

An integral part of research activities are regular seminars on the latest developments in the scientific topics represented at the Institute. In a typical week, around five external speakers from Austria and abroad present their work at IST Austria. The Institute Colloquium is the principal seminar series at IST Austria, to which leading international scientists from all disciplines of the natural and mathematical sciences are invited to present their latest findings. This year, 25 speakers gave an Institute Colloquium at IST Austria.

As Institute Colloquia are aimed at the entire research community of IST Austria as well as that of Vienna and its vicinity, they have a strong interdisciplinary outlook. Institute Colloquia take place regularly on Monday afternoons in the Raiffeisen Lecture Hall of IST Austria; they are open to any interested person. A preview of upcoming speakers can be found on the IST Austria website (www.ist.ac.at) as well as in IST Austria's quarterly newsletter.





#### SCIENTIFIC EVENTS IN 2012 (selection)

February 27–March 2	DFG Workshop on Host-Parasite Coevolution
March 5–9	Computational Geometry and Topology Workshop
April 26–27	Austrian Association for Research in IT Meeting
May 7	IST Austria Young Scientist Symposium
May 21–23	IST Austria Fluid Simulation Workshop
June 15	Crossing Boundaries between Physics, Chemistry, and Biology Symposium
August 20–24	NEURON Course
September 9–12	Sensory Coding and Natural Environment Conference
September 28–30	Algebraic Statistics in Europe Workshop
October 15	Third IST Austria Workshop on Computer Vision
November 15–16	Cell and Tissue Biomechanics
November 30	ÖGAI Symposium
December 14	Symposium: IST Austria Math Extravaganza
	February 27–March 2 March 5–9 April 26–27 May 7 May 21–23 June 15 August 20–24 September 9–12 September 28–30 October 15 November 15–16 November 30 December 14

SPEAKERS AT IST AUSTRIA IN 2012 Acar, Umut (Saarbrücken, Germany) I Affolter, Markus (Basel, Switzerland) I Alon, Ronen (Rehovot, Israel) I Ando, Ryoichi (Fukuoka, Japan) I Andriluka, Micha (Saarbrücken, Germany) | Angelaki, Dora (St. Louis, USA) | Armitage, Sophie (Münster, Germany) | Attardo, Alessio (Stanford, USA) | Bähler, Jürg (London, UK) | Balasubramanian, Vijay (Philadelphia, USA) I Bannerman, David (Oxford, UK) I Batty, Christopher (New York, USA) I Baum, Buzz (London, UK) I Beilhack, Andreas (Würzburg, Germany) I Bellaiche, Yohanns (Paris, France) I Benton, Richard (Lausanne, Switzerland) | Berothaler, Andreas (Vienna, Austria) | Bialek, William (Princeton, USA) | Black, Michael (Stuttoart, Germany) | Bobenko, Alexander (Berlin, Germany) | Bodová, Katarína (Bratislava, Slovakia) I Boomsma, Jacobus J. (Copenhagen, Denmark) I Borst, Axel (Martinsried, Germany) I Botella-Soler, Vicente (Valencia, Spain) I Brainard, David (Philadelphia, USA) I Brockhurst, Michael (Liverpool, UK) I Bui, Xuan Thanh (Copenhagen, Denmark) I Campo, Abraham Martin del (College Station, USA) I Carnevale, Ted (New Haven, USA) I Chan, Frank (Plön, Germany) I Charlesworth, Brian (Edinburgh, UK) I Chodera, John (Berkeley, USA) I Coons, Michael (Waterloo, Canada) I Coros, Stelian (Zurich, Switzerland) I Couzin, Iain (Princeton, USA) I Coyne, Jerry (Chicago, USA) I Cremers, Daniel (Munich, Germany) | Dawson, Jonathan E. (Dresden, Germany) | Deinhardt, Katrin (New York, USA) | Delogu, Alessio (London, UK) | Dotsenko, Vladimir (Luxembourg, Luxembourg, I Emek, Yuval (Zurich, Switzerland) I Emiliani, Valentina (Paris, France) I Eriksson, Nicholas (Mountain View, USA) I Faistrup, Lisbeth (Aalborg, Denmark) I Fitch, W Tecumseh (Vienna, Austria) I Fratzl, Peter (Potsdam, Germany) I Garstecki, Piotr (Warsaw, Poland) I Giomi, Luca Cambridge, USA) I Gottschling, Daniel E. (Seattle, USA) I Goyal, Sidhartha (Santa Barbara, USA) I Grill, Leonhard (Berlin, Germany) I Gruenstaeudl, Michael (Austin, USA) I Gurvits, Leonid (Los Alamos, USA) I Hallatschek, Oskar (Göttingen, Germany) I Hamelryck, Thomas (Copenhagen, Denmark/Leeds, UK) I Hassan, Bassem (Leuven, Belgium) I Heaton, Luke (Oxford, UK) I Hiess, Joe (Nottingham, UK) I Hines, Michael (New Haven, USA) I Hof, Björn (Göttingen, Germany) I Hommelhoff, Peter (Garching, Germany) I Hurst, Laurence (Bath, UK) I Hwa, Terence (La Jolla, USA) I Janke, Carsten (Orsay, France) I Jeschke, Stefan (Vienna, Austria) I Jiggins, Francis (Cambridge, UK) I Jones, Felicity (Stanford, USA) I Kaiser, Christian (Berkeley, USA) I Kantsler, Vasily (Cambridge, UK) I Kaser, Arthur (Cambridge, UK) I Keren, Kinneret (Haifa, Israel) I Keutsch, Frank N. (Madison, USA) I Kevasan, Gokul (Dresden, Germany) I Kleinfeld, David (La Jolla, USA) I Klimova, Anna (Seattle, USA) I Knoblich, Jürgen (Vienna, Austria) I Koehl, Patrice (Davis, USA) I Kölliker, Mathias (Basel, Switzerland) I Kondev, Jane (Waltham, USA) I Krüger, Matthias (Cambridge, USA) I Kruse, Karsten (Saarbrücken, Germany) I Kryazhimskiy, Sergey (Cambridge, USA) I Kündig, Thomas (Zurich, Switzerland) | Kussell, Edo (New York, USA) | Labernadie, Anna (Toulouse, France) | Lagarias, Jeffrey (Ann Arbor, USA) | Laurent, Gilles (Frankfurt, Germany) | Lecuit, Thomas (Marseille, France) | Lee, Daniel (Philadelphia, USA) | Legler, Daniel F. (Konstanz, Germany) | Lehmann, Laurent (Lausanne, Switzerland) | Lenne, Pierre-Francois (Marseille, France) | Leptin, Maria (Heidelberg, Germany) I Lewicki, Michael (Cleveland, USA) I Libchaber, Albert (New York, USA) I Lien, Cheng-Chang (Taipei, Taiwan) I Liesegang, Heiko (Göttingen, Germany) I Logothetis, Nikos K. (Tübingen, Germany) I Lovász, László (Budapest, Hungary) I Maier, John P. (Basel, Switzerland) I Margoliah, Daniel (Chicago, USA) I Maulide, Nuno (Mülheim an der Ruhr, Germany) I Mayer, Barbara (Martinsried, Germany) I McAuley, Julian (Stanford, USA) I Melkebeek, Dieter van (Madison, USA) I Mensink, Thomas (Grenoble, France) I Merrin, Jack (New York, USA) I Mitteröcker, Philipp (Vienna, Austria) I Müller, Patrick (Cambridge, USA) I Munoz Descalzo, Silvia (Cambridge, UK) I Nemenman, Ilya (Atlanta, USA) I Nettle, Daniel (Newcastle, UK) I Nijman, Sebastian (Vienna, Austria) I Nikolic, Nela (Zurich, Switzerland/Dübendorf, Switzerland) I Novarino, Gaia (San Diego, USA) I Oliveira, Ana (Durham, USA) I Olshausen, Bruno (Berkeley, USA) I Paluch, Ewa (Dresden, Germany) I Parent, Carole A. (Bethesda, USA) | Peters, Jan (Darmstadt, Germany) | Peters, Jonas (Zurich, Switzerland) | Pfaff, Tobias (Zurich, Switzerland) | Piel, Matthieu (Paris, France) | Rancz, Ede (London, UK) I Ranft, Jonas (Paris, France) I Rasmussen, Morten (Copenhagen, Denmark) I Raveendran, Karthik (Atlanta, USA) I Raymond, Ben (London, UK) I Raz, Erez (Münster, Germany) I Read, Andrew (University Park, USA) I Ringrose, Leonie (Vienna, Austria) I Rivin, Igor (Philadelphia, USA) I Rodewald, Hans-Reimer (Heidelberg, Germany) I Rot, Antal (Birmingham, UK) I Rottner, Klemens (Bonn, Germany) | Rumpel, Simon (Vienna, Austria) | Saidu, Nathaniel Edward Bennett (Saarbrücken, Germany) | Sanchez Romero, Inmaculada (Granada, Spain) | Sanguinetti, Gonzalo (Bologna, Italy) | Saucan, Emil (Haifa, Israel) I Sauvage, Magdalena (Bochum, Germany) I Segev, Idan (Jerusalem, Israel) I Sellers, Bill (Manchester, UK) I Sergeev, Alexey (Berkeley, USA) I Shykoff, Jacqui (Paris, France) I Silhavy, Thomas J. (Princeton, USA) I Smet, Jurgen (Stuttgart, Germany) I Soltesz, Ivan (Irvine, USA) I Sommer, Ralf (Tübingen, Germany) I Song, Yun S. (Berkeley, USA) I Spanova, Miroslava (Poitiers, France) I Stampfer, Christoph (Aachen, Germany) I Sundström, Liselotte (Helsinki, Finland) I Szathmáry, Eörs (Budapest, Hungary) I Szegedy, Mario (New Brunswick, USA) I Tamás, Gábor (Szeged, Hungary) | Tashiro, Ayumu (Trondheim, Norway) | Theis, Fabian (Munich, Germany) | Thuerey, Nils (Vancouver, Canada) | Trepat, Xavier (Barcelona, Spain) | Typas, Athanasios (Heidelberg, Germany) | Ulanovsky, Nachum (Rehovot, Israel) | Vertesi, Vera (Cambridge, USA) | Victor, Jonathan (New York, USA) | Viola, Bence (Leipzig, Germany) | Vos, Marion de (Amsterdam, Netherlands) | Vuilleumier, Séverine (Lausanne, Switzerland) I Wagner, Uli (Zurich, Switzerland) I Ward, Melissa J. (Edinburgh, UK) I Wehner, Stephanie (Singapore) I Weijer, Kees (Dundee, UK) I Weninger, Wolfgang (Camperdown, Australia) I Widrich, Virgil (Vienna, Austria) I Wood, Will (Bath, UK) I Yu, Jihun (New York, USA) I Zenklusen, Rico (Cambridge, USA)



# **COMMUNICATING SCIENCE** Open Doors



Communicating science is a central mission of IST Austria. To communicate the research performed at IST Austria to a wide public, the Institute has developed a variety of formats for different target audiences. These range from public lectures to hands-on science experiences at the Open Campus.

#### **IST Lectures**

In the IST Lecture series, eminent scientists are invited to IST Austria to present their work to the scientifically interested public. Talks are followed by a discussion with the audience and a social gettogether, offering further possibilities for conversations with the speaker. In 2012, four distinguished scientists gave public lectures at IST Austria. Hannah Monyer, Head of the Department of Clinical Neurobiology and the Interdisciplinary Center of Neurosciences of the University of Heidelberg, gave the first IST Lecture of 2012. In her lecture on "Studying interneurons at the cellular and network level", Monyer presented her work on short- and long-term spatial learning and memory. She illustrated how she studies the connectivity of neurons using optogenetics, a revolutionary method that uses light to switch neurons "on" or "off". For the second IST Lecture, IST Austria welcomed Stefan Hell, Director of the Max Planck Institute for Biophysical Chemistry in Göttingen. Hell lectured on "Nanoscopy with focused light", showing how modern high-resolution microscopy transcends what used to be thought of as physical limits set by the wave length of light. Arnold J. Levine, Professor at the Institute for Advanced Study in Princeton, visited IST Austria to speak on "How does the influenza virus escape the immune system?". Levine presented his research on why the influenza virus caused such a devastating pandemic in 1918. The final IST Lecture of 2012 was given by Christos H. Papadimitriou, C. Lester Hogan Professor of Computer Science at UC Berkeley. His talk on "Computational insights and the theory of evolution" showed how covertly computational ideas reveal surprising connections between evolution, game theory, and learning. The IST Lecture series promises another exciting line-up of speakers in 2013.

#### Science-Industry Talk

The Science-Industry Talk event series is a joint initiative of IST Austria and the Federation of Austrian Industries (IV), fostering the interaction and partnership between the business world and basic research. This year's Science-Industry Talk, which took place on June 5, featured a panel discussion on the topic "Basic Research, Economic Value, and Entrepreneurship". The panel members Tillman Gerngross, Barbara Mayer, David Mirelman, and Gerald Murauer discussed best practices of international spin-off and technology parks, and what it takes to start a



- 1 The family lecture at the Open Campus presents research to the curious of all ages.
- 2 Representatives of governmental organizations meet with young scientists of IST Austria.
- **3** IST Lectures offer opportunities for conversations with distinguished speakers.
- 4 Hands-on science stations let visitors of the Open Campus experience research.
- 5 Hannah Monyer at the first IST Lecture of 2012.



successful park close to an institute for basic research. Looking at international examples, the experts debated how their experiences might be applicable in the context of IST Austria.

#### **Open Campus and school competition**

The biggest public event at IST Austria is the Open Campus. The open day for friends and neighbors of IST Austria is celebrated each year on a weekend in early June. On June 3, 2012, 1'500 visitors spent the day on the IST Austria campus. The varied program included a lecture by IST Austria professor Harald Janovjak introducing children and adults to the world of sensory stimuli. Tours of the campus, including the Bertalanffy Foundation Building and the Miba machine shop, gave visitors a glimpse into the day-to-day life of a research institute. Visitors could also experience research for themselves at hands-on science stations such as microscopy workshops and tricky math games. The Open Campus was rounded off with the award ceremony for the 2012 School Science Competition run by IST Austria, this year on the topic of "Our five senses – how we perceive the world".

#### Outreach

IST Austria actively seeks to reach out into the community. In addition to the Open Campus, the Institute hosts many visits by

different groups and constituencies. In 2012, IST Austria was visited by entrepreneurs, industrialists, political delegations, schools, and students from Austria and abroad, as well as by the management and administration of Austrian and foreign universities and research institutions. For example, the Institute welcomed students for a Girls' Day on campus, presenting the many employment options at a research institute. To introduce IST Austria and its research to children, IST Austria regularly publishes a kids' brochure, which showcases the research of two of its scientists and a day in the life of a scientist. An important aim of the Institute is to broaden the public's awareness of IST Austria; therefore it participates in many local and regional events.

#### **PUBLIC EVENTS 2012**

April 12	IST Lecture Hannah Monyer
June 3	Open Campus 2012
June 5	Science Industry Talk
June 28	IST Lecture Stefan Hell
September 12	IST Lecture Arnold J. Levine
December 17	IST Lecture Christos H. Papadimitriou

# **DIVERSE FUNDS** Pillars of Support

Diverse funding sources support IST Austria. In addition to public funding, peer-reviewed research grants and, in future, technology transfer, the success of IST Austria is aided by the generous support given by donors.

Already in the few years since its founding, several donors have made significant contributions to the Institute. The extraordinary donation of 10 million Euro by the Invicta Foundation of Peter Ber-



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talanffy was the largest single gift given to an institution for basic research in Austria for at least a century. Many donations to IST Austria have come from major Austrian businesses such as the Raiffeisen Group, voestalpine AG, Mondi AG, and OMV AG. So far, more than 17 million Euro have been donated to IST Austria. IST Austria would like to take this opportunity to express its profound gratitude to all its donors for their support.

As in other matters, IST Austria follows international best practices also in fundraising. Adhering to the basic principles of hiring scientists at all levels solely through competitive selection processes, determining research directions solely based on the curiosity of the scientists, and exploiting discoveries competitively through a technology transfer office, donors cannot influence research personnel, topics, or strategy at the Institute, nor can they profit from its scientific results. Following international role models, IST Austria honors donors' contributions by naming buildings, rooms, professorships, or fellowships after the donor. For example, the first laboratory building on campus was named "Bertalanffy Foundation Building" to recognize the generous gift by Peter Bertalanffy's Invicta Foundation.

In the future, IST Austria is planning to use income from intellectual property rights as a fourth pillar of financing. The Institute is committed to promote the use of all scientific discoveries through licensing and technology transfer. To this end, IST Austria established a Technology Transfer Office in 2012, headed by Egenhart Link, formerly Senior Patent and Licensing Manager at Max Planck Innovation GmbH.



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 Claus J. Raidl I President, Oesterreichische Nationalbank, Vienna (1)

<sup>\* (</sup>as of December 31, 2012)



# ADMINISTRATION & SCIENTIFIC SERVICE UNITS

In the busy year 2012, the administration and scientific service units provided support to the researchers at IST Austria, helping to create a prospering scientific environment. The services offered by the administration team include grant support and a dual-career support.

All major scientific resources, services, and equipment of IST Austria are pooled within Scientific Service Units (SSUs),

which provide the researchers with both the professional services and the state-of-the-art equipment necessary to perform cutting-edge research. I thank all employees of the administration and SSUs of IST Austria for their dedication and excellent work in 2012. It is a pleasure to be part of IST Austria as the new Managing Director.

**Georg Schneider, Managing Director** 





#### NEW MANAGEMENT PERSONNEL IN THE ADMINISTRATION IN 2012

- Georg Schneider I Managing Director (1)
- Egenhard Link I Deputy Managing Director, Head of Technology Transfer (2)
- Beate Zöchmeister I Head of the Executive Office (3)
   Susanne Wertheimer-Wiegl I Head of Environment, Health. and Safety (4)



- The Academic Affairs team supports faculty recruitment, the Graduate School and postdocs.
- **b** + e The life sciences facilities provide the infrastructure for cell biologists and neuroscientists.
- c IT and scientific computing are taken care of by the IT team
- I IST Austria's library is predominantly electronic, supplemented by books for scientists of all disciplines.

# LOCATION and Directions



IST Austria is located in the city of Klosterneuburg, a leafy suburb of Vienna noted for its high standard of living. The setting of IST Austria's campus, close to the river Danube and amidst the Vienna Woods, creates an environment both tranquil and stimulating for research and recreation. Klosterneuburg offers educational, medical, social and cultural facilities of the highest standard.

The historical center of Klosterneuburg is dominated by the medieval monastery, redesigned in the Baroque style as a re-

sidence 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. IST Austria's immediate neighbor on campus is the internationally renowned Art Brut Center Gugging.

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









