

Foreword



Five years ago, IST Austria admitted its first group of PhD students. This spring, Viktoriia Sharmanska and Johannes Reiter became the very first of these to defend their theses, both with flying colors. In keeping with our mission to educate outstanding scientists with the potential to become leaders, they are well on their way to success with positions at the University of Sussex and Harvard-MIT.

How do you create world-class scientists? While many factors contribute, two ingredients are unquestionably key factors: outstanding students and outstanding training. In our 6th call for applications this January, over 1300 students from 95 countries applied to the IST Austria Graduate School. The 3% selected to join us in the fall are among the top science graduates in their countries. Once on campus, our unique PhD program—characterized by close mentoring by world-class faculty, rigorous multidisciplinary education, and access to state-of-the-art facilities—provides training opportunities which we hope will create a new kind of scientist: one who can think across disciplinary boundaries and is fluent in both the analytical and experimental sciences.

I feel lucky to have arrived in time to witness the first IST Austria graduates take wing. As I sat in the packed seminar room watching Viktoriia and Johannes captivate their audiences with stories of computer vision and cancer evolution, I realized that we are right on track. And I am excited to be a part of it!

Hania Köver | Unit Head Graduate School Office, IST Austria



Henzinger named as EATCS Fellow

The European Association for Theoretical Computer Science (EATCS) has recognized five of its members for their outstanding contributions to theoretical computer science by naming them as recipients of an EATCS fellowship 2015. Among the laureates is IST Austria President Thomas A. Henzinger who was chosen for “fundamental contributions to formal verification and synthesis of computer and biological systems”.

Henzinger is among only 15 researchers having received this distinction, and the third Austrian. The Fellow status is conferred upon a person having a track record of intellectual and organizational leadership within the EATCS community.

EATCS is an international organization founded in 1972. Its aim is to facilitate the exchange of ideas and results among theoretical computer scientists as well as to stimulate cooperation between the theoretical and the practical community in computer science.



Bollback receives ERC Grant

Evolutionary biologist Jonathan P. Bollback has been awarded an ERC Consolidator Grant to study the “Selective Barriers to Horizontal Gene Transfer”. In spite of the importance of Horizontal gene transfer (HGT), little is understood about the evolutionary barriers to HGT. Bollback will outline a systematic experimental approach to elucidate factors that decide in favor or against horizontally transferred genes. His project will provide a systematic analysis of the roles of different factors in affecting the outcomes of horizontal gene transfer.

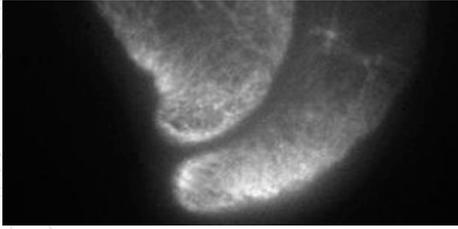
IST Austria President Thomas A. Henzinger: “The ERC grant for Jon highlights the outstanding quality of researchers at IST Austria. By applying statistical modeling to biological problems this project illustrates the multidisciplinary approach which is a hallmark of research at IST Austria.” Bollback joined IST Austria in 2010. The ERC Consolidator Grant is funded with € 1.8 million for five years and will start in the summer of 2015. Thus, 16 out of 34 Professors at IST Austria are ERC grantees.



Largest European grant so far

IST Austria has been awarded a Marie Skłodowska-Curie grant amounting to € 4.4 mio for IST Scholars attending the doctoral school of the institute. The program will start in the fall of 2016 and run until 2021, covering around 50 percent of the salaries and other costs for most PhD students in their first two years of study at IST Austria. During these two years, students take advanced courses, do rotation projects with multiple professors, pass a qualifying exam, and start their thesis research.

The grant is awarded by the European Commission (EC) to PhD-granting institutions in order to foster mobility of junior scientists within and into the European Union. The grant supports young researchers who have spent not more than 12 months in the past three years in their respective country of residence. The proposal by IST Austria was ranked first among 49 applications from European universities and research institutions; it is the first CO-FUND grant awarded to a doctoral program in Austria and Germany.



How cells move in a tight spot

In a recent edition of *Cell* the Heisenberg Group reported a novel type of 3D cell movement, termed stable-bleb migration, used by cells in confinement. They observed it in progenitor cells of the gastrulating zebrafish embryo under conditions of high spatial confinement. Progenitor cells quickly form a single balloon-like protrusion at their front, allowing them to move much faster and more persistent than any other cell within the embryo. These stable-bleb

cells may represent a novel cell migration mode that can be activated in various cell types under confinement.

The switch from a sessile or randomly migrating cell to a cell undergoing directed migration is guided by external and internal signals. Squeezing isolated progenitor cells between two surfaces is sufficient to induce stable bleb cell polarization and migration. Strikingly, stable bleb cells do not require an adhesive surface to do this; they are able to move because their internal cytoskeleton flows backwards, which when coupled through some un-specific friction to the outside environment, generates sufficient force to propel the cell forward.

The migration mode can be artificially induced and reversed, irrespective of the developmental stage or

primary fate of the progenitor cell. It is triggered by a purely mechanical process, with no need for either intracellular chemical signals or extracellular specific adhesion. The stable-bleb migration mode may represent a generic transformation of cells that become spatially confined. Hence, stable bleb cell transformation may represent a universal switch that allows cells to quickly respond with directional migration, especially when “stuck” in confined environments.

In early embryonic development, progenitor cells may use this mode of stable bleb migration to quickly get out of wound sites. It is possible that it is also triggered in metastatic cancer cells on the surface of a growing tumour, leading to fast dissemination of metastatic tumour cells into surrounding tissues.



Rigorous Systems Engineering continues to rise and shine

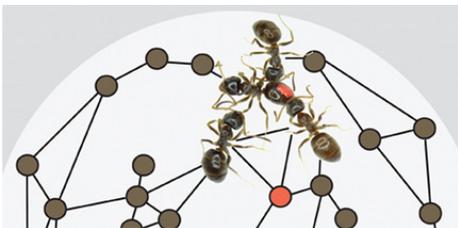
The internationally recognized research network RISE – short for Rigorous Systems Engineering – secured a second funding period of four years until 2019. The Austrian Science Fund FWF awarded a grant of 3.7 mio € for the follow-up project SHINE (Systematic Methods in Systems Engineering), con-

firming the group’s successful work in establishing an Austrian research network ranking among the best in their field globally.

RISE started in 2011 as a National Research Network (“Nationales Forschungsnetzwerk”, NFN) funded by FWF, and since then has put Austria on the map as a center of excellence in computer science, in particular in the emerging field of rigorous systems engineering, which intends to optimize the cooperation between different software applications. In the second funding period, SHINE aims to further expand the reliability and resilience of interacting software programs, which increasingly shape modern technology in basically all aspects of everyday life.

With the acceptance of follow-up funding, SHINE is now aiming to extend the understanding of system correctness to non-functional aspects such as automatically increasing concurrency as required by the Internet of Things (IoT) and Cloud Computing, and verifying that systems work correctly even if some pieces of hardware break down.

The principal investigators are renowned scientists from TU Graz, TU Wien, IST Austria, JKU Linz, and PLU Salzburg, namely Armin Biere, Roderick Bloem, Krishnendu Chatterjee, Thomas A. Henzinger, Helmut Veith, Uwe Egly, Christoph Kirsch, Ulrich Schmid, and Radu Grosu. They will be joined by several excellent young primary investigators for the second round of funding.



Infectious ants become antisocial

Looking after yourself, and trying not to infect others, is a good strategy to prevent disease from spreading – not only if you are a considerate co-worker, but also if you are an ant, as revealed by an epidemiological model developed by the groups of Professor Fabian Theis from the Helmholtz Center Munich and Professor Sylvia Cremer from IST Austria. In a Theme Issue of the *Philosophical Transac-*

tions of the Royal Society B on “The Society-Health-Fitness Nexus”, they combine observations of hygienic interaction networks within ant colonies with epidemiological modeling to conclude that this strategy is best to prevent disease spread in social animal groups.

In their study, they observed how garden ants (*Lasius neglectus*) react to being exposed to the fungal pathogen *Metarhizium* by cleaning themselves (self-grooming) or other ants (allogrooming), and how much allogrooming they receive from their healthy nestmates. The researchers then applied their theoretical model to determine whether the observed behavioral changes upon pathogen contact were adaptive in terms of reducing disease spread through the colony.

Cremer and colleagues observed that when exposed to the fungus, ants cleaned themselves more frequently, yet drastically diminished cleaning of their healthy group members. This leads to a social grooming asymmetry, where infectious ants received more sanitizing actions than they performed, yet this was not primarily due to increased received care, but by self-restriction of care performance. Epidemiological modeling predicts that increased self-grooming and decreased allogrooming by infectious ants helps to contain the pathogen’s spread in the ant colony. Taking care of oneself but restricting contact to others in a phase where one may be a risk to the health of others is thus a strategy benefiting the whole society under pathogen attack.

IST Lecture: Sir Roger Penrose

On May 21, 2015, Sir Roger Penrose will give an IST lecture titled "Before the Beginning and Beyond Eternity". Penrose has received numerous awards and honors including the 1988 Wolf Prize for physics, which he shared with Stephen Hawking for their contribution to our understanding of the Universe, as well as the knighthood in 1994 for his services to science. He is an internationally renowned author of many books on mathematical physics that contribute in particular to general relativity and cosmology.

In his lecture, Sir Roger Penrose will talk about the "conformal cyclic cosmology" (CCC). This recent cosmological theory proposes that what we regard as the entire history of our universe is merely one phase (an "aeon") of an infinite succession of similar aeons. The ultimate expansion of each aeon appears as the big bang of the next one. Collisions between supermassive black holes in the aeon prior to ours would leave an observable imprint on our cosmic microwave background. For information and registration for the IST Lecture visit the [IST Austria website](#).



Science-Industry Talk: Green Fields and Blue Sky

The Science-Industry Talk on June 2, 2015, will bring together experts at the interface between science and industry to discuss questions such as: What are the components of a successful innovative ecosystem? Which measures can be initiated proactively? Which areas need to grow at their own pace? How to combine the spirit of entrepreneurial green fields with the scientific vision of blue skies?

The panelists include Oliver Holle (CEO Speedinvest), Monika Kircher (Head of Committee for Research, Technology and Innovation, Federation of Austrian Industries), Tapio Siik (Head of ACE Aalto Center for Entrepreneurship), Nava Swersky Sofer (President and Board Member, International Commercialisation Alliance; Founder and Co-Chair, Nanolsrael), and Markus Wanko (Head of Technology Transfer, IST Austria).

For Information and registration visit the [IST Austria website](#).

COLLOQUIUM SPEAKERS

PAST SPEAKERS (March - April): Ming C. Lin, The University of North Carolina (March 2) | Aurélien Roux, University of Geneva (March 9) | Bill Freeman, Massachusetts Institute of Technology (March 16) | Sally Otto, The University of British Columbia (April 13) | Mark Krasnow, Stanford University (April 20) | Jan Born, University of Tübingen (April 27)

FUTURE SPEAKERS (May - June): Fred Hamprecht, University of Heidelberg (May 4) | Rebeca Rosengaus, Northeastern University (May 11) | Pierre Hohenberg, New York University (May 18) | Mark Estelle, University of California San Diego (June 2) | Stanislas Leibler, Rockefeller University (June 8) | Karl Sigmund, University of Vienna (June 15)

SELECTED RECENT PUBLICATIONS

Chatterjee, Krishnendu, Chmelik, Martin: POMDPs under probabilistic semantics. In: *Artificial Intelligence*. Elsevier, 2015, 46-72.

Pausinger, Florian, Steinerberger, Stefan: On the distribution of local extrema in Quantum Chaos. In: *Physics Letters, Section A: General, Atomic and Solid State Physics*. Elsevier, 6, 2015, 535-541.

Phan Thanh, Nam, Seiringer, Robert: Collective excitations of Bose gases in the mean-field regime. In: *Archive for Rational Mechanics and Analysis*. Springer, 2, 2015, 381-417.

Park, Youngyong, Do, Younghae, Altmeyer, Sebastian A, Lai, Yingcheng, Lee, Gyuwon: Early effect in time-dependent, high-dimensional nonlinear

dynamical systems with multiple resonances. In: *Physical Review E - Statistical, Nonlinear, and Soft Matter Physics*. American Physical Society, 2, 2015, Article number: 022906.

Rakusová, Hana, Fendrych, Matyas, Friml, Jiří: Intracellular trafficking and PIN-mediated cell polarity during tropic responses in plants. In: *Current Opinion in Plant Biology*. Elsevier Limited, 2015, 116-123.

Hühner, Jens, Ingles-Prieto, Álvaro, Neusüß, Christian, Lämmerhofer, Michael, Janovjak, Harald: Quantification of riboflavin, flavin mononucleotide, and flavin adenine dinucleotide in mammalian model cells by CE with LED-induced fluorescence detection. In: *Electrophoresis*. Wiley-Blackwell, 4, 2015, 518-525.

Ruess, Jakob, Lygeros, John: Moment-based methods for parameter inference and experiment design for

stochastic biochemical reaction networks. In: *ACM Transactions on Modeling and Computer Simulation*. ACM, 2, 2015, Article number: 8.

Keller-Schmidt, Stephanie, Tuğrul, Murat, Eguíluz, Víctor M, Hernandez-Garcia, Emilio, Klemm, Konstantin: Anomalous scaling in an age-dependent branching model. In: *Physical Review E - Statistical, Nonlinear, and Soft Matter Physics*. American Physical Society, 2, 2015, Article number: 022803.

Novak, Sebastian, Cremer, Sylvia: Fungal disease dynamics in insect societies: Optimal killing rates and the ambivalent effect of high social interaction rates. In: *Journal of Theoretical Biology*. Academic Press, 2015, 54-64.

A full list of publications from IST Austria can be found at publist.ist.ac.at.