

Foreword



Building a campus from scratch—without major restrictions and the freedom to think big—is a chance only few people get in their life time. I got this chance in late 2007 when the premises of IST Austria were characterized by the ruined buildings of the former neurological hospital and by caterpillars paving the ground. Since then, much has happened. In a fruitful cooperation with Lower Austria, more than 27'000m² have been built for laboratories, offices, seminar rooms, a guesthouse, and a restaurant. Today, more than 450 people are working—and some of them even living—on campus. The campus has turned into a prospering garden with flowers, artworks and places to work. And the development still continues.

Currently, three projects are under construction: the Preclinical Facility will be finalized in summer, Lab Building West with offices for theoretical research and labs for physical research will follow in fall, and the new campus restaurant is scheduled to open next summer. Furthermore, a new administration building and a housing project, providing additional 90 apartments, are in the planning phase. To meet the new challenges in chemistry and to support the education of first-year students, a joint project is currently put out to tender. The long-term goal for 2026 is to have more than 1'000 people working on campus. Although there still is a lot of work to be done, I have no doubt that we will achieve our high aims. For me, it was the chance of a life time and I am proud to be a part in this great endeavor.

Stefan Hipfinger | Division Head Construction and Maintenance, IST Austria



Uhler receives START Award

IST Professor Caroline Uhler is one of this year's START Award recipients. Around € 1 Mio are allocated for the duration of six years. Uhler receives the award for her project "Gaussian graphical models: Theory and Applications", which is at the interface of mathematical statistics, convex optimization and applied algebraic geometry. Her aim in the coming years is to expand knowledge and insight about graphical models and to deepen the connections between mathematical statistics, convex optimization and applied algebraic geometry.

Caroline Uhler is a mathematician whose research focus lies on mathematical statistics and its applications in algorithmic biology. In particular, she is interested in the area of algebraic statistics. In her research, she uses methods from algebraic geometry, algorithmic algebra and combinatorics to study problems of statistical theory. Uhler, who has been with IST Austria since 2011, is the second of 35 professors working on campus to receive a START Award.



Graduation Ceremony at IST Austria

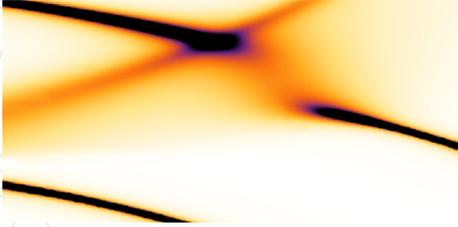
On June 1, IST Austria celebrated the fourth graduation ceremony. After President Thomas Henzinger's address and Scientific Board Member Hannah Monyer's speech, the graduates received their PhD diplomas and green sashes. Miriam Stock (Cremer Group) studied the evolution of a fungal pathogen towards individual versus social immunity in ants. Arjun Radharkrishna (Henzinger Group) worked on quantitative specifications for verifications and synthesis and now holds a postdoc position at the University of Pennsylvania. Martin Behrndt (Heisenberg Group) did his PhD on the forces driving epithelial spreading in zebrafish epiboly. Petra Marhava (Friml Group) examined molecular mechanisms of patterning and subcellular trafficking in *Arabidopsis thaliana* before she moved to a postdoc position at the University of Lausanne. Viktoriia Sharmanska (Group Lampert) did her PhD on learning with attributes for object recognition. Johannes Reiter (Chatterjee Group) finished his thesis on the subclonal evolution of cancer and then went on to the Dana-Farber Cancer Center of Harvard University.



Henzinger honored with Milner Award

The Royal Society announced that IST Austria President Thomas Henzinger is to receive the Milner Award 2015 in recognition of his fundamental advances in the theory and practice of formal verification and synthesis of reactive, real-time, and hybrid computer systems. The award, supported by Microsoft Research, is given annually for outstanding achievement in computer science by a European researcher. The winner of the award receives a medal, a personal prize of £5'000, and is invited to deliver a public lecture on their research at the Society. The recipient is chosen by the Council of the Royal Society on the recommendation of the Milner Award Committee.

Henzinger states: "I am extremely honored and humbled to receive the Royal Society Milner Award, as Robin Milner is one of my scientific heroes and role models. For my entire scientific life I have tried to follow his example of designing formalisms that, by their very purity, bring a specific aspect of computation into clear view."



Quantum rotors in a quantum bath

Rotation and angular momentum are ubiquitous concepts in physics, and play a role in such diverse areas as the reactivity of biological molecules, accuracy of atomic clocks or spectra of stars. In a [Physical Review Letters paper](#), Mikhail Lemeshko, Professor at IST Austria, and Richard Schmidt, Postdoc at Harvard University, develop the first general theory describing the effect of a quantum

many-body environment on the rotation of quantum particles.

During the last 70 years, the quantum theory of angular momentum evolved into a powerful machinery, commonly used to describe isolated quantum systems. In realistic experiments, however, quantum systems are seldom isolated. Instead, they are disturbed by the surrounding environment, the quantum bath—be it a gas, a solution, or fluctuations of the electromagnetic field. Such an environment may profoundly change the physics of the system and can hardly be controlled experimentally. In particular, the properties related to rotation become tremendously complex even when only a few particles interact.

In their paper, Richard Schmidt and Mikhail Lemeshko introduce a new quasiparticle, the “angulon”, as an efficient description of rotation in the context of many-particle systems. A “quasiparticle” is a mathematical concept that allows physicists to explain the collective behavior of strongly-interacting particles as an almost free motion of non-interacting quasiparticles. The newly presented “angulon” consists of a quantum rotor dressed by a quantum many-body field, and is characterized by the total angular momentum of the many-particle system. Studying the angulon’s properties paves the way to understanding the redistribution of angular momentum between impurities and a crystal lattice in solid state physics, as well as between molecules and a solution in chemically relevant processes.



Hitting the borders of expansion

Why does a species not adapt to an ever-wider range of conditions, gradually expanding its geographical range? In their [PNAS paper](#), Jitka Polechová and Nick Barton seek to answer this question, which lies at the interface between ecology and evolution. Their theory suggests that any natural population is liable to form sharp margins. J.B.S. Haldane, one of the founders of population

genetics, studied this question in the 1950s. He suggested that in a habitat in which the environment subtly differs, the migration of individuals would bring alleles that are advantageous in the habitat’s center to the margin. These replace alleles that would be more advantageous at the margin, and so prevent the species from adapting to the marginal environment. When the species is no longer able to inhabit the slightly differing neighboring area, a sharp margin to the species’ range emerges.

Jitka Polechová and Nick Barton investigated the problem for populations in which genetic variance can evolve. Combining mathematical analysis with simulations, Polechová and Barton explain how in finite natural populations, sharp range limits arise

even when the environment varies smoothly. The researchers show that random fluctuations in gene frequencies (which arise in any finite population) can generate sharp margins by reducing genetic variance below the level that would be needed for the species to adapt to spatially variable conditions.

Two parameters describe the threshold at which adaptation fails. The first key parameter describes how conditions change across space, measuring the loss of fitness due to dispersal across environments. The second key parameter describes how effective selection is relative to random fluctuations. Even when the environment doesn’t change abruptly, the theory predicts that a sharp range margin may form.



New evolutionary game theory model

The competition for resources among cells, individuals or species is a fundamental characteristic of evolution. In a [Proceedings of the Royal Society B paper](#), Johannes Reiter and co-authors from IST Austria and Martin A. Nowak from Harvard University add a new model to the framework of evolutionary game theory.

So-called biological all-pay auctions have previously been used to model situations where multiple individuals compete for a single resource. In this kind of auction the cost of the individual corresponds to their bid irrespective of who wins the reward. However, in many situations multiple resources with various values exist and single reward auctions are not applicable.

In their paper, Johannes Reiter and his colleagues generalize the existing model to include a competition for multiple rewards and study the evolution of strategies in this new model. The decreasingly ordered rewards are distributed according to the decreasingly ordered bids of the participating individuals. The inferred evolutionary stable strategies for the multiple reward case are qualitatively very

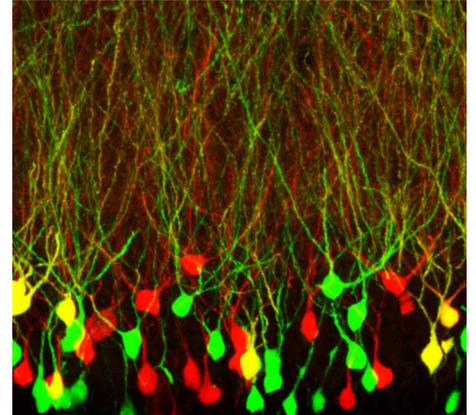
different from the single reward case. In a situation where only few individuals compete for few resources high bids are observed. However, the competition among many individuals for few resources leads to a form of specialization where only a small part of the population competes for the rewards. The majority prefers either bidding low or not at all and avoids costly competitions.

Johannes Reiter adds “In our new model we show that a shortage of resources can lead to a separation into subpopulations of competitive and unambitious individuals, and can thus contribute to speciation.” Johannes Reiter graduated in March 2015 at IST Austria, and is now working as a postdoc at the Dana-Farber Cancer Institute and at Harvard University in Boston.

AXON 2015

IST Austria will be the host of the first European Conference on Axon Guidance, Circuit Development and Regeneration (AXON2015) from September 20-23. The major goal of the AXON2015 meeting is to provide a forum for the exchange of results and ideas in the rapidly advancing fields of nerve cell polarization, axon guidance, synapse formation, circuit assembly, and neuronal regeneration. There is increasing overlap among these disciplines and some of the most outstanding recent advances have been achieved by research at the intersection of these different areas. In particular, it is now apparent that diverse neurological diseases can trace their origins to defects in early mechanisms of neuronal wiring. By bringing together scientists working in these diverse areas, including the clinically relevant field of regeneration, we hope to inspire new insights, collaborations and new research directions.

For further information visit the [AXON 2015 website](#).



SOMMER CAMPUS



Sommercampus 2015

IST Austria is organizing a one-week research camp for school children from August 17-21. The Sommercampus will give 32 talented kids the opportunity to discover science at first hand. Guided by IST Austria scientists and students of the Pädagogische Hochschule Niederösterreich (Lower Austrian College of Education), the youngsters at the age of six to ten will join one of three research groups – “Plants, animals and humans”, “Games, computers and robots” or “Observe, measure, experiment” - to find out more about basic concepts in life sciences, computer science, or physics. After studying, exploring and researching for four days, the young scientists will present the results of their experiments and discoveries at a mini conference on the fifth day. A graduation ceremony for the kids will mark the end of a research week full of fun and thrills.

For further information visit the [Sommercampus website](#).

COLLOQUIUM SPEAKERS

PAST 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)

FUTURE SPEAKERS (September - November): Daniel Geschwind, University of California Los Angeles (Sep 7) | Steve Marschner, Cornell University (Sept 28) | Yves Barde, Cardiff University (Oct 5) | Judith Mank, University College London (Oct 12) | Julie Theriot, Stanford University (Oct 19) | Harry Swinne, University of Texas at Austin (Nov 2) | Andrew Goldberg, Amazon.com (Nov 9) | Erik van Nimwegen, University of Basel (Nov 23) | Daniel Choquet, University of Bordeaux (Dec 14)

SELECTED RECENT PUBLICATIONS

Bollenbach, Tobias: Antimicrobial interactions: Mechanisms and implications for drug discovery and resistance evolution. In: *Current Opinion in Microbiology*. Elsevier, 2015, 1-9.

Klimova, Anna, Uhler, Caroline, Rudas, Tamás: Faithfulness and learning hypergraphs from discrete distributions. In: *Computational Statistics & Data Analysis*. Elsevier, 2015, 57-72.

Boccaro, Charlotte N, Kjøningsen, Lisa J, Hammer, Ingvild M, Bjaalie, Jan Gunnar, Leergaard, Trygve B, Witter, Menno P: A three-plane architectonic atlas of the rat hippocampal region. In: *Hippocampus*. John Wiley and Sons Inc., 7, 2015, 838-857.

Pentina, Anastasia, Sharmanska, Viktoriia, Lampert,

Christoph H: Curriculum learning of multiple tasks. In: *CVPR: Computer Vision and Pattern Recognition*. IEEE, 2015.

Symonova, Olga, Topp, Christopher N, Edelsbrunner, Herbert: DynamicRoots: A software platform for the reconstruction and analysis of growing plant roots. In: *PLoS ONE*. Public Library of Science, 6, 2015, Article number: e0127657.

Chatterjee, Krishnendu, Chmelik, Martin, Gupta, Raghav, Kanodia, Ayush: Optimal cost almost-sure reachability in POMDPs. In: *AAAI: Association for the Advancement of Artificial Intelligence*. AAAI Press, 2015.

Trubenová, Barbora, Novak, Sebastian, Hager, Reinmar: Indirect genetic effects and the dynamics of social interactions. In: *PLoS One*. Public Library of

Science, 5, 2015, Article number: e0126907.

Norén, Patrik: The three-state toric homogeneous Markov chain model has Markov degree two. In: *Journal of Symbolic Computation*. Academic Press, P2, 2015, 285-296.

Safari, Laleh, Santos, J P, Amaro, Pedro, Jänkälä, Kari, Fratini, Filippo: Analytical evaluation of atomic form factors: Application to Rayleigh scattering. In: *Journal of Mathematical Physics*. American Institute of Physics, 5, 2015, Article number: 052105.

Ando, Ryoichi, Thürey, Nils, Wojtan, Chris: A dimension-reduced pressure solver for liquid simulations. In: *Computer Graphics Forum*. Wiley-Blackwell, 2, 2015, 473-480.

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