NEWSLETTER 37th edition | Summer 2021

IST AUSTRIA
Institute of Science and Technology

Foreword

WoMen in Science: Change the World!

Throughout history, female scientists have made important and pioneering contributions to science, often in environments where the playing field was tilted against them. Like any human endeavor, science can ill afford to do without all available talent, and scientific talent is distributed equally across all national, ethnic, gender, and social boundaries. Today women are leaders in many fields of science and research, but a significant gap and much work remains before we can speak of gender equity. We need to attract more girls and women to science, and we need to do much better in keeping them in science. This requires action on all fronts from stopping outright harassment and calling out explicit as well as implicit bias, to changing institutional cultures and ensuring that women on all levels and of all backgrounds are recognized, included, and heard.

With this year's focus on "WoMen in Science: Change the World!" IST Austria wants to put the spotlight on the issues that academic researchers of all genders face, and on best practices to address these issues. In addition to several events and discussions centering on matters related to academic research careers, we have given the topic a face: "SHOW HOW TO EMPOWER" is a photo exhibition based on interviews without words, which can be visited in the Mondi hallway on campus and online. The artist Barbara Kapusta has created a poster for the main lecture hall, which will be on display soon. Our popular initiative, "Zoom a Scientist: Girls' Special", offers two sessions exclusively to connect girls of all ages with IST Austria scientists. To round off the year, a "WoMen in Science Day" will be organized in November.

Together we can raise awareness and show how to: Empower (men and) women! Tell our story! Act differently! Stand behind our choices! Be aware also of small things – communication matters!

Thomas A. Henzinger | President, IST Austria

A beacon of scientific success

In a highly competitive funding season with 42% more applications compared to the previous year, the European Research Council (ERC) awarded three prestigious grants to IST Austria.

Professors Leonid Sazanov, László Erdős, and Thomas Henzinger each received an advanced grant that rewards truly groundbreaking research. Professors Erdős and Henzinger will receive this prestigious grants for the second time. These three ERC awarded research projects, will secure over 6 million Euro funding for IST Austria:

- Theoretical physics, probability and mathematical analysis in synergy (László Erdős)
- Software supervising software (Thomas Henzinger)
- Seeing what nobody has seen before (Leonid Sazanov)

IST Austria is well ahead of other well-known European institutions when it comes to obtaining ERC grants.

Polluting Labs: Researchers for new solutions

To get correct results, researchers have to adhere to high standards of cleanliness. However, in doing so they sometimes produce a lot of waste: at the end of a working day in the lab, the dustbins overflow with disposable gloves, plastic pipettes, and petri dishes. The next generation of top researchers at IST Austria is seeking increased awareness and has therefore joined an Austria-wide initiative to make laboratories more environmentally friendly.

The Green Labs Austria initiative has calculated how big the problem really is. According to them, a single microbiology lab consumes about as much plastic as 13 Austrian households combined. That is about 1.3 tons of plastic waste per year. The goal of the initiative is to connect research groups so they can help each other find better solutions to avoid environmentally harmful practices. The Barton and Sixt groups have recently joined the network.

New management structure at IST Austria

IST Austria recently announced three new executives for its management. Professors Gaia Novarino and Bernd Bickel were appointed Vice Presidents for Science Education and for Technology Transfer, respectively. Professor Eva Benkova was appointed new Dean of the Graduate School. They will start their positions on September 1, 2021, with the new term of President Thomas Henzinger. The current Executive Vice President, Professor Michael Sixt, will continue to oversee the Scientific Services of IST Austria and serve as the President's deputy, while Georg Schneider continues to serve as Managing Director.

"I am very proud to present Gaia Novarino and Bernd Bickel for these two newly created positions, in addition to Eva Benkova, who will follow Nick Barton as new Dean of the Graduate School. Science Education and Technology Transfer are two of the most important ways in which IST Austria can contribute directly to society and industry," states Thomas Henzinger.

Research Highlights

Embryonic tissue undergoes phase transition

Scientists from the Heisenberg and Hannezo groups observed an abrupt and dramatic change in developing zebrafish embryos: Within just a few minutes, the solid-like embryonic tissue becomes fluid-like. In a study published in *Cell*, they found answers that could change how we look at key processes in development and disease, such as tumor metastasis.

Former postdoc in the Heisenberg group Nicoletta Petridou and her colleagues discovered a sudden change in the viscosity of the embryonic tissue in zebrafish embryos: "At this early stage, the tissues forming the embryo are very rigid, but suddenly, viscosity drops by ten times and the tissue flows very quickly – it fluidizes," the biologist explains. "What we found was that before this fluidization, an individual cell is connected to four to five of its neighboring cells. At the onset of fluidization, however, it has only three to four neighbor connections left," says Petridou. "This was when we turned to physics to provide us with a framework that could explain this effect."

"So, Nicoletta found this massive drop in tissue viscosity at the macroscopic level that is apparently not matching what is going on at the microscopic cell connectivity level. This is a key point of physics: to link what is going on at the microscopic level with the macroscopic level," says Bernat Corominas-Murtra, until recently part of the Hannezo group.

After finding that the fluidization of the tissue displays features of a phase transition the scientists challenged their theory by manipulating the cells' connectivity. No matter the manipulation, the critical point of connectivity was enough to explain the abrupt changes in tissue viscosity experimentally observed. The transition is essential for the further development of the fish embryo. It also seems to play a role in cancer growth. When a tumor metastasizes, recent studies have shown that the tissue also abruptly changes from solid to liquid, which could allow cancer cells to move around more easily.

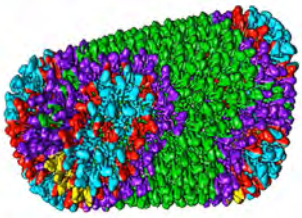
Smashing the Covid curve

A team of turbulence researchers at IST Austria led by Björn Hof reports that a small difference in epidemic mitigation levels can cause a discontinuous jump in infection numbers. In the article published in *Nature Communications* and co-authored by Marc Timme from the TU Dresden, the researchers show that limits in testing and contact tracing are responsible for this sudden change in the epidemic outcome. Testing followed up by contact tracing is extremely efficient in slowing down epidemics, however once their limit is exceeded the epidemic accelerates resulting in a faster than exponential spread.

"My group normally investigates turbulent flows in pipes and channels", he explains, "Over the last 10 years we have shown that the onset of turbulence is described by statistical models that are equally used to describe forest fires and epidemics." Given this experience, programming an epidemic model was a straightforward exercise for Burak Budanur, the group's theorist and computational expert.

Testing of known contacts (not testing per se) is one of the most powerful ways to slow down an epidemic. However, the number of cases that can be traced every day is limited and so is the number of tests that can be administered. The researchers found that exceeding these limits during the epidemic has far-reaching consequences. "If this happens", says Timme, "the disease begins to spread faster in the unchecked areas and this unavoidably causes a super-exponential increase in infections." As long as this acceleration can be avoided, epidemic curves collapse to a comparably low case level. While over the last year it has become apparent that an early and decisive response is essential when facing exponential growth, the team's study shows that test limits make timing even more crucial.

More recently the team has investigated optimal strategies, where lockdowns are used as a preventive tool rather than an emergency brake. A manuscript that outlines the optimal strategy, which minimizes both, the number of infected people and the required lockdown time, is currently in progress.



How retroviruses become infectious

Understanding every step in the life cycle of a virus is crucial for identifying potential targets for treatment. Now, scientists from the Schur group together with collaborators at Cornell University and the University of Missouri were able to show how a virus from the retrovirus family – the same family as HIV – protects its genetic information and becomes infectious. Furthermore, they show an unexpected flexibility of the virus. This study is published in the journal *Nature Communications*.

With deadly precision, viruses can cause diseases that cost millions of lives and keep the world on edge. One example for such a virus is HIV that causes the ongoing global AIDS-epidemic. Together with his colleagues, postdoc Martin Obr studies a virus belonging to the same family as HIV – the Rous sarcoma virus, a virus causing cancer in poultry. With its help, he gained new insights into the important role a small molecule plays in the assembly of these type of viruses. "It is a long way from an infected cell to the mature virus particle that can infect another cell," explains Obr. A new particle buds from the cell in an immature, non-infectious state. It then forms a protective shell, a so-called capsid, around its genetic information and becomes infectious. This protective shell consists of a protein, which is organized in hexamers and a few pentamers. The team discovered that a small molecule called IP6 plays a major role in stabilizing the protein shell within the Rous sarcoma virus.

"If the protective shell is not stable, the genetic information of the virus could be released prematurely and will be destroyed, but if it's too stable the genome can't exit at all and, therefore, becomes useless," says Assistant Professor Florian Schur. He and his colleagues were able to show IP6 importance in the assembly of HIV. Now, the team proved it to be as important in other retroviruses showing just how essential the small molecule is in the virus life cycle. "When building a car, you have all these big metal parts, like the hood, the roof and the doors – the screws are connecting everything. In our case, the big parts are the capsid proteins and the IP6 molecules are the screws," says Obr.

WoMen in Science

WoMen in Science: Change the World!

We are aware that science—especially in STEM fields—is a male-dominated field but it should not be accepted as the norm. IST Austria emphasizes the need to increase gender equity in science.

With the year's focus on WoMen in Science: Change the World!, the Institute showcases some of the available activities, sheds light on the issues that researchers confront regardless of their gender, and emphasizes best practice examples:

The STEM fatale Initiative, founded by Nicole Amberg and Melissa Stouffer, aims to raise awareness and dismantle stereotypes. Details on this network can be found on their website.

Additionally, the STEM fatale Talk Series presents successful women, their inspiring career paths, and research across STEM disciplines. They show how they overcame gender-related challenges in their professional lives and share experiences with young researchers.

For the younger generation, the "Zoom a Scientist Girls' Special" offers two sessions to connect girls with IST Austria scientists via online meetings. Participants can share how they experience working in science, share goals and ambitions, and discuss obstacles and prejudices. This format enables the furthering of scientific knowledge and also gives access to peers and established scientists.

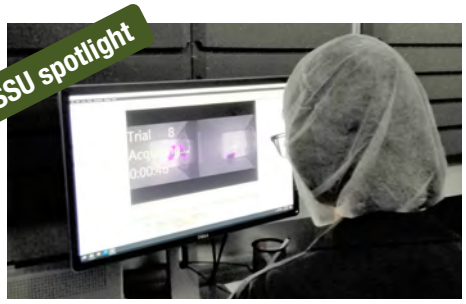
One of the highlights of the campaign is a photo exhibit: "SHOW HOW TO EMPOWER". Scientists were asked four questions each about their experiences of gender equity and balance, and their responses were visually captured by renowned photographer Peter Rigaud. The exhibition is available online as well as on camups.

Barbara Kapusta was invited to create a poster to provide a visual interpretation of WoMen in Science: Change the World! Her intervention is to be seen in the main lecture hall.

A "WoMen in Science Day", scheduled for November 10, will end the series of events.

More information about the campaign and the activities is available on WoMen in Science webpage.

SSU spotlight



Newbies at the Preclinical Facility

Mice (*Mus musculus*) have long served as the preferred mammalian model for both basic and preclinical research. Some advantages of mouse models include the high degree of conservation of the protein-coding region of the mouse and human genomes, availability of abundant research tools like Cre-recombinase, and the potential to examine modifications at the cellular level and across development *in vivo*. Behavior is the ultimate readout of many factors including neural function and is often affected in brain disorders and non-mental disorders. This is why rodent models with a changed behavior are of key importance for translational research to develop potential treatments.

The Preclinical Facility (PCF) is one of eight Scientific Service Units currently established at IST Austria. Its vast team of staff provides routine breeding, genetic monitoring, veterinary support, and maintenance of rodent colonies for IST scientists in accordance with Austrian and EU laws on animal welfare. Two staff scientists recently joined the PCF to provide expertise and support in generating transgenic lines and behavioral investigations in rodent models.

Genetic engineering and transgenics in rodents

The rodent genome engineering unit seeks to collaborate with research groups in providing state-of-the-art gene editing and transgenic technology. Steps include targeting design to the identification of so-called founder animals, germline transmission, and cryopreservation of new lines. Depending on the complexity of the project, embryos are manipulated either by microinjection or electroporation of reagents. Precise genome editing works are performed to generate knock-in and knock-out lines, from small gene modification to large gene deletions. To achieve this, we use molecular biology tools like Clustered Regularly Interspaced Short Palindromic Repeats (CRISPR) and its associated protein (CRISPR-Cas9), which are introduced into one-cell stage embryos. For instance, transcripts of the nuclear localizing signal containing fluorescent protein were introduced into zygotes by electroporation and cultured to a two-cell stage. A strong fluorescent signal from the nuclei of a two-cell mouse embryo was observed in less than 24 hours.

Investigation of behavioral functions in mouse models

The rodent behavior unit provides investigators with a wide variety of paradigms for studies in genetic, environmental, and pharmacological mouse models of human disease. Available testing regimes range from a general neurophysiological screen (SHIRPA protocol) of newly generated transgenic mouse models, to mazes and operant-based tasks for assessing cognitive and behavioral processes in rodents. The behavior test rooms at the unit are equipped with modular video-based tracking systems to facilitate the rapid acquisition of data. The unit also provides specialized equipment and a room dedicated for studies employing optogenetics, calcium imaging, and electrophysiological recordings in behaving animals.

We also work closely with members of research groups to provide all the necessary support to implement a behavioral study. This includes advice on experimental design and choice of task, training and instruction on conducting experiments, and interpretation of behavioral data. We are always looking to expand and upgrade the behavioral paradigms to accommodate specific needs of the research groups. In the coming weeks, the rodent behavior unit will house state-of-the-art automated operant platforms for investigating various cognitive functions in mice.

Save the Date: OPEN CAMPUS 2021

The Open Campus, the annual IST Austria science festival for families, will be held on September 19. This year's program will include a variety of science activities for children and adults. A hands-on exhibition will present research questions pursued by IST Austria scientists on campus and guided lab tours will provide interesting glimpses behind the scenes of the Institute's research culture.

More details on the Open Campus 2021 will soon be available on our website!

IST Austria Alumnus: Harald Ringbauer

Harald Ringbauer was a PhD student in the Nick Barton group. Now he is an archaeogenetics group leader at the Max Planck Institute for Evolutionary Anthropology in Leipzig. In January 2021, he visited the IST Austria campus to take a walk down memory lane where he answered some questions about his current work and career.

Watch Harald Ringbauer's interview here.

COLLOQUIUM SPEAKERS

PAST SPEAKERS: Asya Rolls, Technion - Israel Institute of Technology (Mar 1) | Nuno Maulide, University of Vienna (Mar 15) | Heike Riel, IBM (Mar 22) | Wade Regehr, Harvard Medical School (Apr 19) | Irene Miguel-Aliaga, Imperial College London (Apr 26) | Katia Bertoldi, Harvard University (May 10) | Cristina Marchetti, University of California Santa Barbara (May 17) | Verena Winiwarter, BOKU (Jun 2)

FUTURE SPEAKERS: Michele Devoret, Yale University (Jun 21) | Vidya Madhavan, University of Illinois Urbana-Champaign (Oct 11) | Lillian Pierce, Duke University (Oct 18) | Aviv Regev, Massachusetts Institute of Technology (Dec 6)

SELECTED RECENT PUBLICATIONS

Aichholzer, O., Akitaya, H. A., Cheung, K. C., Demaine, E. D., Demaine, M. L., Fekete, S. P.,https://doi.org/10.1016/j.comgeo.2020.101700__Schmidt, C. (2021). Folding polyominoes with holes into a cube. Computational Geometry: Theory and Applications. Elsevier.https://doi.org/10.1016/j.comgeo.2020.101700

Pitrik, J., &; Virosztek, D. (2021). A divergence center interpretation of general symmetric Kubo-Ando means, and related weighted multivariate operator means. Linear Algebra and Its Applications. Elsevier. https://doi.org/10.1016/j.laa.2020.09.007

Li, H., von Wangenheim, D., Zhang, X., Tan, S., Darwish-Miranda, N., Naramoto, S.,https://doi.org/10.1111/nph.16887__Friml, J. (2021). Cellular requirements for PIN polar cargo clustering in Arabidopsis thaliana. New Phytologist. Wiley.https://doi.org/10.1111/nph.16887

Ke, M., Ma, Z., Wang, D., Sun, Y., Wen, C., Huang, D.,https://doi.org/10.1111/nph.16915__Chen, X. (2021). Salicylic acid regulates PIN2 auxin transporter hyper-clustering and root gravitropic growth via Remorin-dependent lipid nanodomain organization in Arabidopsis thaliana. New Phytologist. Wiley.https://doi.org/10.1111/nph.16915

Browning, T. D., &; Heath-Brown, R. (2021). The geometric sieve for quadrics. Forum Mathematicum. De Gruyter.https://doi.org/10.1515/forum-2020-0074

Bozelos, P., &; Vogels, T. P. (2021). Talking science, online. Nature Reviews Neuroscience. Springer Nature.https://doi.org/10.1038/s41583-020-00408-6

Brown, A., &; Romanov, A. (2021). Contravariant forms on Whittaker modules. Proceedings of the American Mathematical Society. American Mathematical Society.https://doi.org/10.1090/proc/15205

Zeiner, M., Schmid, U., &; Chatterjee, K. (2021). Optimal strategies for selecting coordinators. Discrete Applied Mathematics. Elsevier.https://doi.org/10.1016/j.dam.2020.10.022

Runkel, I., &; Szegedy, L. (2021). Area-dependent quantum field theory. Communications in Mathematical Physics. Springer Nature.https://doi.org/10.1007/s00220-020-03902-1

Browning, T. D., &; Heath-Brown, R. (2021). The geometric sieve for quadrics. Forum Mathematicum. De Gruyter.https://doi.org/10.1515/forum-2020-0074

Bozelos, P., &; Vogels, T. P. (2021). Talking science, online. Nature Reviews Neuroscience. Springer Nature.https://doi.org/10.1038/s41583-020-00408-6

A full list of publications from IST Austria can be found in the IST Austria Research Explorer.

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