NEWSLETTER 36th edition | Spring 2021

IST AUSTRIA
Institute of Science and Technology

Foreword

Recruiting season is here!

5,000 is roughly the number of applications the institute received in this year's recruiting season. It includes applications for professorships (around 1,800), the Graduate School (more than 2,500) and our ISTERNship program (close to "only" 600 due to this year's restrictions).

Unsurprisingly, this is therefore one of the busiest times of the year for many people on campus. Our postdocs pre-screen thousands of student applications. Faculty checks tons of CVs and meets numerous candidates from a broad range of scientific areas. Last, but definitely not least, the teams of Faculty Recruiting and the Graduate School Office plan and coordinate the whole process, answer candidates' questions (often the night before the deadline), screen applications and are busy scheduling and organizing meetings. Following the spontaneous and necessary switch from on-site interviews to remote recruiting in the middle of the 2020 recruiting season, this year the whole season was planned to be held remotely right from the beginning. A solution born out of necessity, which may help us to scale these processes with ever-growing application numbers in the future.

We also plan to boost our postdoc recruiting efforts and are very happy to announce that IST Austria was successful in receiving 4.6 million EUR from the European Commission under Horizon 2020 for its new postdoctoral program IST-BRIDGE. This program will be carried out in cooperation with the BRIDGE network and will allow us to hire 60 excellent postdoctoral fellows from all over the world over a period of 5 years. Prior to this, we will also have the second call for the interdisciplinary NOMIS fellowship in June. Just so you know, recruiting season is never over…!

Barbara Abraham | Head of Academic Affairs

Thomas Henzinger reappointed as President of IST Austria

Last year on November 30, the Board of Trustees of IST Austria reappointed Thomas Henzinger for a fourth term as President of the Institute. His new term of office will start on September 1, 2021.

Professor Henzinger, accepting to lead the Institute for another term, said: "The reappointment is a great honor for me. I am grateful and humbled by the confidence vested in me by the Board of Trustees. I am committed to continue doing my best also over the next few years, helping IST Austria to grow further and establish itself firmly in the international league of premier science institutions. As I also wish to return to full-time science myself, I have indicated to the Board that I do not plan to serve a full fourth term."

Dr. Claus J. Raidl, chairman of the Board of Trustees thanked President Thomas Henzinger for his excellent work during the past twelve years and for achieving such a unique and strong position for the Institute.

IST Austria's independence and development secured beyond 2026

The Federal Ministry of Education, Science, and Research and the state of Lower Austria recently declared their commitment to secure the further growth of IST Austria by signing a "Memorandum of Understanding" (MoU).

The MoU reaffirms the founding principles of the Institute and serves as a basis for a new long-term financial agreement to be concluded this year that will allow the Institute to reach a critical size and permanently establish itself as one of the leading institutions of basic research internationally. It is an important step that will allow IST Austria to remain attractive for the best faculty and student applicants from all over the world.

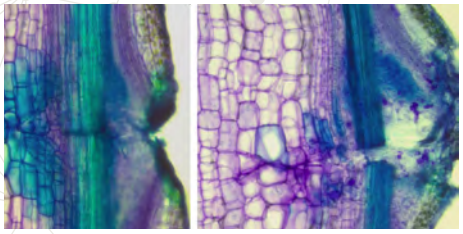
Both Minister Faßmann and Lower Austrian Governor Johanna Mikl-Leitner lauded the Institute's outstanding achievements in basic research and graduate education during the press conference accompanying the signing of the MoU at IST Austria.

More than 40 million euros fresh capital for life science and tech spin-offs

IST cube is a venture fund initiated by IST Austria for life science and tech start-ups from an academic environment. At the end of 2020, the IST cube team, with its long experience in technology transfer, business development, patent law and financing, successfully closed a large international financing round: more than 40 million euros are now available to develop pioneering scientific research projects into commercially successful companies.

IST cube acts as an investor as well as a partner for the start-ups. So far, eight start-ups from the fields of medicine, biotechnology, IT and display technology from various Austrian universities such as MedUni Vienna and TU Graz as well as IST Austria belong to the IST cube portfolio. The spectrum is as broad as science itself: from biologists working on programming the elements of life to computer scientists exploring the possibilities of machine learning in healthcare and business.

Research Highlights

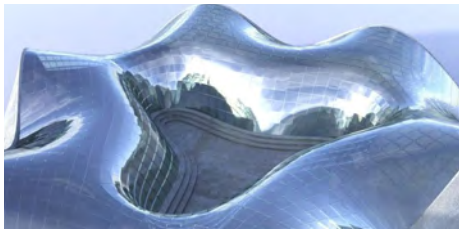


Molecular compass for cell orientation

The human body uses veins and blood to transport nutrients and oxygen throughout the body. Plants use a similar approach, the vascular systems. These veins transport nutrients for survival, define the size, structure, and position of new leaves, and allow long-range communication between distant organs. Scientists from the group of Professor Jiří Friml discovered how the plant hormone auxin dictates the newly formed veins' positions and published their findings in the journal *Science*. This phenomenon also applies to wound healing and might lead to the development of mechanically more resistant plants and further agricultural applications.

"Auxin decides which cells will differentiate into vascular tissue and orchestrates them to form intricate vein patterns," explains PhD student Jakub Hajný, who led the study. When cells have no ability to sense auxin signal, plants form disorganized veins with disconnections that limit nutrients distribution. In case of mechanical damage, it also decreases regeneration after wounding.

Already decades ago, scientists suspected that auxin is the vein-inducing signal organizing tissue into conserved vein patterns. Until now, scientists could not understand how the cells decrypt this chemical signal into a cellular response. The Friml group managed to identify the responsible proteins, called *CAMEL* and *CANAR*, which serve as auxin sensors. The *CAMEL/CANAR* complex most likely perceives the auxin concentration in its neighborhood and allows cells to synchronize their orientations to create continuous veins. "It is basically a molecular compass for cell orientation, only instead of a magnetic field, it detects auxin concentration," explains Jakub Hajný.



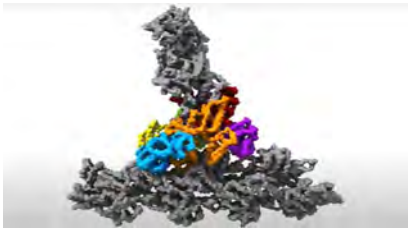
Bend, don't break: new tool enables economic glass

Computer scientists developed a new design tool that allows the use of a cost-efficient technology for implementing curved glass panels. The tool is based on a deep neural network and enables free-form design of beautiful glass façades.

Curved glass façades can be stunningly beautiful, but traditional construction methods are extremely expensive. Panes are usually made with "hot bending", where glass is heated and formed using a mold or specialized machines – an energy-intensive process that generates excess waste in the form of individual molds. Cold-bent glass is a cheaper alternative in which flat panes of glass are bent and fixed to frames at the construction site. However, given the fragility of the material, coming up with a form that is both aesthetically pleasing and producible is extremely challenging. Now, an interactive, data-driven design tool allows architects to do just that.

Created by a team of scientists from IST Austria including the Bickel group, TU Wien, UJRC, and KAUST, the software allows users to interactively manipulate a façade design and receive immediate feedback on the viability and aesthetics of the panelization – a very convenient way for navigating various realizations of the designer's intentions. The deep neural network uses special physical simulations to predict glass panel shapes and viability. In addition to allowing users to interactively adapt an intended design, it can automatically optimize a given design, and can be easily integrated into an architect's usual workflow. The software and research results were presented at SIGGRAPH Asia 2020 and study was published in the journal *ACM Transactions on Graphics.*

To test the accuracy of the simulations, the team manufactured frames and glass panels, including panels under extremely high stress. In the worst case, they observed miniscule deviation from the predicted shapes of less than a panel's thickness, and all panels were viable as expected. The team further verified that the data-driven model faithfully and efficiently reproduces the output of the simulations.



Cutting-edge technology reveals structures within cells

Temperatures of minus 196 degrees Celsius enable high-resolution imaging of a cell's interior. Researchers at IST Austria are able to show for the first time how the active form of the Arp2/3 protein complex plays a critical role in cell mobility and also what other important biological functions look like. This study was published in the journal *Nature* Communications.

Until now, scientists had to decide between two options when they wanted to analyze the structure of the Arp2/3 protein complex: One option was to study it in isolation, where the protein complex is in an inactive stage and hence does not show how a network of such proteins is formed. To become fully activated, however, the Arp2/3 complex needs to be bound to actin filaments. This requires using a method called electron tomography, which comes at the cost of considerably lower resolution. "Previous electron tomography data of Arp2/3 complexes bound to actin filaments in a test-tube environment was too imprecise, making it impossible to unambiguously tell where the individual elements of the complex must be located," explains Florian Fäßler, a postdoc in the Schur group.

With a new technology, the researchers could now freeze the samples within milliseconds – too quickly to allow ice crystals to form that would have destroyed the cell's fine structures. They then used one of the most powerful cryo-electron microscopes available – and the only one of its kind in Austria – to image cells from different angles using cryo-electron tomography. Doing so, the team collected enough data for the 3D reconstruction of over 10,000 Arp2/3 complexes in their active state. Combined with advanced image processing, they then generated a 3D model of the Arp2/3 complex at a resolution of less than one nanometer. For comparison: human hair is about 50,000 nanometers thick. "We are now able to describe relatively precisely the structure of the protein complex and its subunits and how they form the actin filament network inside the lamellipodium of previously living cells," says Florian Fäßler. "Five years ago, probably no one would have thought that this could be done," adds Schur.

ISTernship

ISTernship – a unique summer research experience at IST Austria

Every year, IST Austria welcomes around 30 outstanding undergraduate and graduate students for a summer internship called ISTernship, which is composed of "IST" as in IST Austria and the word "(int)ernship". This year, bachelor and master students from around Europe can gather new scientific and practical experience in biology, neuroscience, computer science, data science, physics, mathematics, and chemistry.

All interns join a research group and gain valuable hands-on experience working on cutting-edge research projects under the guidance of the group leader. Besides the full-time research experience, interns develop skills in project management, communication, and interpersonal skills. The program culminates with a research symposium, where ISTerns present their work to peers, faculty, and lab mentors. 34 research groups participated in the ISTernship call which closed on February 15, 2021.

"The ISTernship is a great opportunity for students to gain insight into the everyday life at a world-class research institute," explains Maria Trofimova, Head of the IST Austria Graduate School Office. "Also, ISTerns receive an introduction to the Graduate School—in the end, one or the other may wish to come back as a PhD student in the future."

The ISTernship takes place between May and September and can last up to 3 months. Students obtain enhanced exposure to the outstanding research setting and further benefits, such as monthly compensation, health insurance, travel assistance, contribution to travel expenses, housing support, campus housing options, and a free shuttle bus between Vienna and the IST Austria campus in Klosterneuburg.

The call for the 2022 program will open in December 2021.

The ISTernship program is run in partnership with the OeAD, the Austrian Agency for Education and Internationalisation.

More information on the ISTernship can be found on the Graduate School website!

SSU spotlight

The (new) frog facility on campus

Amphibians are frequently used animal models in developmental and cell biology, regeneration, genetics, and neuroscience for their conserved molecular and cellular organization and their ability to produce abundant numbers of large oocytes that allow extensive manipulation. Xenopus laevis, the South-African Clawed Frog, became very popular in the second half of the 20th century and many fundamental mechanisms in developmental biology were discovered in Xenopus laevis embryos.

Lora Sweeney is a neuroscientist who uses Xenopus laevis to answer the largely unexplored question of how motor circuits develop and remodel during metamorphosis.. Her arrival on campus in 2020 required the construction of a new Xenopus laevis research facility at IST Austria. The new frog facility was established under the roof of the existing zebrafish facility and to pay tribute to our new arrivals both fish and frogs are now formally grouped in the renamed aquatics facility.

The new frog facility consists of three independent functional units:

(1) The main facility established in the Multipurpose Research Facility. It is equipped with 45 tanks with 27 liter water volume that can house about 500 adult animals and 240 tanks with 3.5 liter water volume for approximately 10,000 tadpoles of various developmental stages.

(2) A raising facility equipped with 120 3.5 liter tanks exclusively for raising tadpoles. This facility is located in Lab East to allow the researchers easy access to the animals.

(3) A special flow-through tank system that allows treatment of individual tanks or groups of animals with experimental reagents like chemicals or viruses. To enable work with viruses, the system is connected to a wastewater autoclave that sterilizes all water coming from the system. It is located in a Bio Safety Level 2 room in Lab East and has space for 30 3.5 liter tanks.

The facility was constructed over summer and fall, and the installation of the aquaria systems was finished in October 2020. In November 2020 we received the first batch of 87 adult animals, a second batch of 37 animals arrived in December. The facility is now fully operational.

During normal operations the aquatics team will take care of the wellbeing of the animals and the overall functionality of the technical equipment. In addition, they will support the scientists with animal deliveries from the multipurpose research facility to Lab East, handling and marking of animals, documentation, and legal compliance issues.

Science Education Day 2021

The Institute's Science Education Day is an annual event for teachers, scientists and all those interested in communicating science. The current edition focuses on the changes and challenges that the past months brought to teaching STEM.

The Science Education Day 2021 on March 24 combines open discussions, keynotes, and hands-on workshops! The event is held in German and is regarded as a teacher-training course in cooperation with the University College of Teacher Education Vienna.

Further information and details about the registration can be found on the event page.

Celebrating Haim Harari on his 80th Birthday

Last year in November, IST Austria (virtually) celebrated the 80th birthday of Professor Haim Harari, one of the founding fathers of IST Austria.

In a 60-minute online session, several speakers, among them Claus Raidl, Ken Peach, and Thomas Henzinger honored Haim Harari's efforts and vision to turn IST Austria into one of the top places for research not just in Europe, but worldwide. At the end, Haim was presented a book that compiled personal stories and anecdotes written by more than 50 people who were part of his decades-long journey as Chair of the Executive Committee of the Board of Trustees at IST Austria.

COLLOQUIUM SPEAKERS

PAST SPEAKERS: Maria Chudnovsky, Princeton University (Dec 7) | Elchanan Mossel, Massachusetts Institute of Technology (Dec 14) | Tom Mrsic-Flogel, University College London (Jan 11) | Rong Li, National University of Singapore (Jan 18)

FUTURE 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) | Aviv Regev, Massachusetts Institute of Technology (May 31) | Michele Devoret, Yale University (Jun 21)

SELECTED RECENT PUBLICATIONS

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

Düllberg, C. F., Auer, A., Canigova, N., Loibl, K., &; Loose, M. (2021). In vitro reconstitution reveals phosphoinositides as cargo-release factors and activators of the AR GAP ADA. PNAS. National Academy of Sciences.https://doi.org/10.1073/pnas.2010054118

Tan, S., Luschnig, C., &; Friml, J. (2021). Pho-view of auxin: Reversible protein phosphorylation in auxin biosynthesis, transport and signaling. Molecular Plant. Elsevier.https://doi.org/10.1016/j.molp.2020.11.004

Avila, K., &; Hof, B. (2021). Second-order phase transition in counter-rotating taylor-couette flow experiment. Entropy. MDPI.https://doi.org/10.3390/e23010058

Grosser, J. A., Maes, M. E., &; Nickells, R. W. (2021). Characteristics of intracellular propagation of mitochondrial BAX recruitment during apoptosis. Apoptosis. Springer Nature.https://doi.org/10.1007/s10495-020-01654-w

Gulden, T., &; Kamenev, A. (2021). Dynamics of ion channels via non-hermitian quantum mechanics. Entropy. MDPI.https://doi.org/10.3390/e23010125

Virosztek, D. (2021). The metric property of the quantum Jensen-Shannon divergence. Advances in Mathematics. Elsevier.https://doi.org/10.1016/j.aim.2021.107595

De Nicola, S., Michailidis, A., &; Serbyn, M. (2021). Entanglement view of dynamical quantum phase transitions. Physical Review Letters. American Physical Society.https://doi.org/10.1103/physrevlett.126.040602

Römhild, R., &; Andersson, D. I. (2021). Mechanisms and therapeutic potential of collateral sensitivity to antibiotics. PLoS Pathogens. Public Library of Science.https://doi.org/10.1371/journal.ppat.1009172

Mondelli, M., Hashemi, S. A., Cioffi, J. M., &; Goldsmith, A. (2021). Sublinear latency for simplified successive cancellation decoding of polar codes. IEEE Transactions on Wireless Communications. IEEE. https://doi.org/10.1109/TWC.2020.3022922

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

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

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