XVII BALTIC CONFERENCE ON INTELLECTUAL COOPERATION

MATHEMATICS FOR SOCIETY

28–29 June 2021

Estonian Academy of Sciences

Tallinn

ORGANISERS OF THE CONFERENCE:

AKADEMIE DER
WISSENSCHAFTEN
IN HAMBURG

ORGANISERS OF THE PRE-SEMINAR ON ENERGETICS:

TAL TECH

TUHH
Hamburg University of Technology

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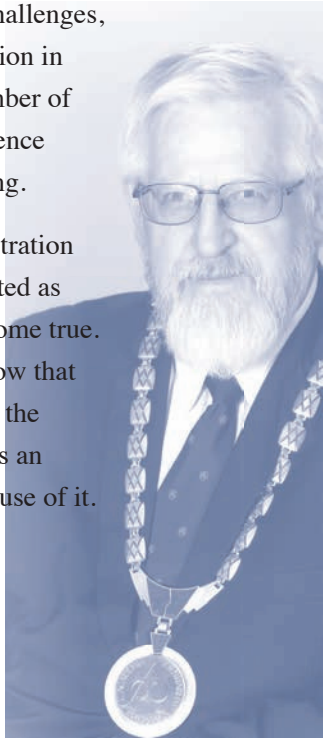
Photos by Reti Kokk

FOREWORD

"Never alone again," said the people who restored the independence of the Baltic States three decades ago. This message was coined into various agreements in many ways, starting from the Baltic Assembly almost 30 years ago, restoring diplomatic relationships with many countries soon thereafter, entering the European Union a dozen years later, and reaching the world-wide scene by serving as members of the United Nations Security Council.

Science and scientists are, by definition, never alone even though their labs and universities are physically separated. The voice of scientists, however, becomes much stronger when their efforts are concerted. The academic communities of the Baltic States realised this aspect many decades ago. They are gathering for the 17th time to rejoice and strengthen that idea, now together with sister academies in Finland and Hamburg.

The importance of the voice of science is rapidly growing as the competitiveness of countries, regions and even continents greatly depends on the ability of society to extract competence from the academic landscape for the benefit of all people. The more complicated are contemporary challenges, the larger is the role of science, scientists and scientific cooperation in supporting the needs of society. Helmut Schwarz, a foreign member of the Estonian Academy of Sciences, has stressed that without science we are unlikely to be able to construct a future that is worth living.



An unexpected corollary of the COVID pandemic is the demonstration of how important the research fields are that are usually interpreted as abstract ones, with minimum contribution to make the dreams come true. Today we see how far-reaching Galileo Galilei was. It is clear now that mathematics is not only "the language in which God has written the universe" but also a handy and powerful tool that directly creates an enormous benefit for the societies that are wise enough to make use of it.

Welcome to the 17th Conference of Intellectual Cooperation of the Baltic Academies of Sciences.

Tarmo Soomere
President, Estonian Academy of Sciences

DAY 1: 28 JUNE 2021

SCIENTIFIC SEMINAR ON ENERGETICS, TALTECH

(online seminar, will be broadcast at the Estonian Academy of Sciences Hall)

Chair	Professor Jakob Kübarsepp, Tallinnv University of Technology, Department of Mechanical and Industrial Engineering Member of the Estonian Academy of Sciences
10:00–10:05	Opening words Jakob Kübarsepp
10:05–10:25	*Photovoltaic and Wind Generation Systems within the Global Energy System – on the Way towards an All-Electric-World?* Professor Martin Kaltschmitt, Hamburg University of Technology Member of the Academy of Sciences and Humanities in Hamburg
10:30–10:50	*Power System Stability Related Challenges and Possibilities in Future Power Systems with a Significant Share of Renewables* Professor Jako Kilter, Tallinn University of Technology, School of Engineering, Department of Electrical Power Engineering and Mechatronics
10:55–11:15	*Development of Hydrogen Based Energy Systems in Estonia* Professor Enn Lust, University of Tartu, Institute of Chemistry Member of the Estonian Academy of Sciences
11:15–11:30	*Trends Influencing the Development of Estonia's Distribution Network* Dr Mihkel Härm, Elektilevi OÜ
11:30–11:45	Discussion

11:45–12:00	Summing up and conclusions Martin Kaltschmitt, Jako Kilter, Enn Lust, Jakob Kübarsepp
12:00–13:00	LUNCH at the Estonian Academy of Sciences

XVII BALTIC CONFERENCE ON INTELLECTUAL COOPERATION

MATHEMATICS FOR SOCIETY

Chair	Professor Krista Fischer, University of Tartu, Institute of Genomics Member of the Estonian Academy of Sciences
13:00–13:30	Opening speeches
13:30–15:00	**Session 1: Mathematics for Policy**
13:30–13:50	*Producing and Using Model-Assisted Policy Advice* Professor Ahti Salo, Aalto University School of Science, Systems Analysis Laboratory Member of the Finnish Academy of Science and Letters
13:50–14:10	*Advanced Maths for the Policy Decisions: The Case of the Shadow Economy Research* Professor Arnis Sauka, Centre for Sustainable Business at the Stockholm School of Economics in Riga Corresponding Member of the Latvian Academy of Sciences
14:10–14:30	*Social Physics: Data-Driven Analysis and Computational Modelling of Human Social Connectome* Professor Kimmo Kaski, Aalto University School of Science, Department of Computer Science Vice President of the Finnish Academy of Science and Letters
14:30–14:50	*The Influence of COVID-19 on Mobility: An Analysis of Mobile Positioning Data from Estonia* Professor Anto Aasa, University of Tartu, Department of Geography, Associate Professor
14:50–15:10	Coffee break

15:10–17:00	**Session 2: Mathematics and COVID-19**
Chair	Professor Tarmo Soomere, Tallinn University of Technology, School of Science, Department of Cybernetics, President of the Estonian Academy of Sciences
15:10–15:30	*Data Analytic Approaches to Support the Management of COVID-19 in Estonia* Krista Fischer
15:30–15:50	*Dynamic Modelling of the Evolution of SARS-CoV-2 Epidemic in Lithuania* Professor Olga Štikonienė, Vilnius University, Institute of Applied Mathematics
15:50–16:10	*The Increase of Scientific Activity in Artificial Intelligence during the Pandemic* Professor Guntis Bārzdiņš, University of Latvia, Artificial Intelligence Laboratory Corresponding Member of the Latvian Academy of Sciences
16:10–16:30	*Functional Pathways Analysis for COVID-19 Modelling: The Case of Lithuania* Professor Audronė Jakaitienė, Vilnius University, Faculty of Medicine
16:30–16:50	*What Can/Should We Learn from the COVID-19 Pandemic?* Professor Reiner Lauterbach, University of Hamburg, Department of Mathematics Member of the Academy of Sciences and Humanities in Hamburg
16:50–17:00	Summary of the day
17:00–18:00	Refreshments and Tour of the Academy Building by the Vice-President of the Academy, Prof. Mart Kalm
18:00–20:00	Conference Dinner hosted by the President of the Estonian Academy of Sciences (by invitations only)

DAY 2: 29 JUNE 2021

09:30–10:00	Morning coffee
10:00–12:00	**Session 3: Mathematical Applications**
Chair	Professor Emeritus Jüri Engelbrecht, Tallinn University of Technology, School of Engineering Member of the Estonian Academy of Sciences
10:00–10:20	*Universality: When Can Complex Be Simple?* Assistant Professor Juhan Aru, École Polytechnique Fédérale de Lausanne (EPFL, Federal Polytechnic Institute of Lausanne) Member of the Estonian Young Academy of Sciences
10:20–10:40	*Mathematics of Quantum Computing* Professor Andris Ambainis, University of Latvia, Faculty of Computing Full Member of the Latvian Academy of Sciences
10:40–11:00	*Computational Modelling and Analysis of 3D Structures of Proteins and Protein Complexes* Dr Česlovas Venclovas, Vilnius University, Institute of Biotechnology Member of the Lithuanian Academy of Sciences
11:00–11:20	*Digging Genomes to Understand Our Past – Modern Tools for Old Puzzles* Professor Mait Metspalu, University of Tartu, Institute of Genomics
11:20–11:40	*How Will Water Resources of the Baltic Region Change in the Future?* Dr Jūratė Kriaučiūnienė, Lithuanian Energy Institute Member of the Lithuanian Academy of Sciences
11:40–12:00	*On the Development of Navigation Tables in Early Modern England* Professor Thomas Sonar, Technical University of Braunschweig, Institute for Partial Differential Equations Corresponding Member of the Academy of Sciences and Humanities in Hamburg
12:00–12:15	Final remarks and conclusions
12:15–13:00	LUNCH at the Estonian Academy of Sciences
13:00–16:00	Meeting of the Presidents of Academies

PRE-SEMINAR

SCIENTIFIC SEMINAR ON ENERGETICS

CHAIRED BY PROFESSOR JAKOB KÜBARSEPP

Everyone recognises that climate change is happening and there is a transition to renewable resources. Studies of experts demonstrate that much higher levels of renewable energy can be reliably achieved while significantly reducing carbon emissions. It is a global challenge to all nations, in particular for Germany reducing the consumption of coal and for Estonia reducing the use of oil shale for electrical energy generation. Challenges and possibilities related to reliable future power systems are discussed at the scientific seminar on energetics.

PROF. MARTIN KALTSCHMITT

Hamburg University of Technology, Germany

Member of the Academy of Sciences and Humanities in Hamburg

Martin Kaltschmitt graduated in petroleum engineering and received his Doctor of Engineering in the field of renewable energies. After that he headed a research group in this field of research at the University of Stuttgart where he did his habilitation. Following a research stay at King's College in London and at the University of California, Berkeley, Prof. Kaltschmitt became Managing Director of the Leipzig Institute for Energy. In 2006 he was promoted to Full Professor at Hamburg University of Technology where he is heading the Institute of Environmental Technology and Energy Economics (IUE).

Photovoltaic and Wind Generation Systems within the Global Energy System – on the Way towards an All-Electric-World?

Electricity provision from windmills and photovoltaic systems can help save GHG emissions. First, an update is presented on the current global provision of electricity from wind and solar energy. Then, an outlook on the expected future developments is provided related to a possible global market expansion and further price development. The findings show that most likely the relative share of "green" electricity within the global energy system will clearly increase. Thus, there is an obvious development towards an all-electric-world, but still on a low level.

Tallinn University of Technology, School of Engineering, Department of Electrical Power Engineering and Mechatronics, Estonia

Jako Kilter received his BSc, MSc and PhD (2009) in electrical power engineering from Tallinn University of Technology. Currently, he is Professor of Power Systems and Head of the Power Systems Research Group in the School of Engineering at Tallinn University of Technology; Chairman of the Estonian National High Voltage Committee at the Estonian Centre for Standardisation and Accreditation; and Co-Chair of the CIGRE (Conférence Internationale des Grands Réseaux Électriques, International Council on Large Electric System) Estonian National Committee. Prof. Kilter's research and consultancy work over the years has been divided between the areas of power system dynamics, wide-area control and applications, and power quality.

Power System Stability Related Challenges and Possibilities in Future Power Systems with a Significant Share of Renewables

The increased level of the integration of renewable energy sources (RES) into power systems means additional challenges and possibilities to power system engineers and researchers. The main aspects to consider are related to system stability, monitoring, protection, and quality. Power systems in use today were built decades ago considering the availability of synchronous machines and their physical principles. This, however, is not the case any longer as RES is predominantly connected to the system through power converters. Therefore, new solutions are needed for system planning, control and security enhancement. This presentation discusses these challenging aspects from the viewpoint of transmission systems and clarifies the importance of system dynamic balancing in future power systems.

PROF. ENN LUST

University of Tartu,
Institute of Chemistry, Estonia

Member of the Estonian
Academy of Sciences

Enn Lust is Professor of Physical Chemistry, Director of the Institute of Chemistry at the University of Tartu, Member of the Estonian Academy of Sciences and Member of the EASAC (European Academies Science Advisory Council) Energy Steering Panel. His fields of research cover development of materials for fuel cells, Na-ion batteries, supercapacitors and hybrid supercapacitors, synchrotron radiation-based X-ray absorption methods (XANES, EXAFS), neutron beam-based methods for electrochemical systems, FIB-SEM-EDX, FIB-TOF-SIMS and high-temperature electrochemical XRD methods, as well as investigation of the electric double layer and adsorption. Enn Lust has been awarded the Order of the White Star, Class III (2020), and Theodor von Grotthuss Medal (2018).

Development of Hydrogen Based Energy Systems in Estonia

The European Union's transition to a decarbonized sustainable energy community is underway during the following years. In recent years, some progress has taken place in Estonia. The first complex energy generation/storage, hydrogen electrolysis and pressurized storage, regeneration of electricity and heat have been completed at the Institute of Chemistry, University of Tartu. The self-driving car IseAuto has been turned into a hydrogen-powered fuel cell car and next-generation vehicles are under development. The Estonian hydrogen technology development roadmap completed by Civitta et al. is under final acceptance stage. For some regions like Keila, Tartu, Ida–Virumaa, Rakvere, and Tallinn, local hydrogen roadmaps/application plans and even complex hydrogen technology platforms have been completed or discussed. The city of Tartu has presented a wide-scale hydrogen application project for the Hydrogen Regions programme.

Elektrilevi OÜ

Mihkel Härm is the CEO of Elektrilevi OÜ, Estonia's largest network operator, since January 2021. He was Partner Relations Manager in Eesti Energia AS from 2017 until 2020 and Secretary General of the Estonian National Committee of the World Energy Council in 2010–2018. Mihkel Härm has a PhD from Tallinn University of Technology in energy and geology studies and an MA in international business administration from the Estonian Business School.

Trends Influencing the Development of Estonia's Distribution Network

There is a change in the role of distribution networks with the increase in renewable energy and development of microgeneration. A network is not only the carrier of electricity, but also an enabler of green transition, thanks to two-way movement of power. Extensive use of electric cars and heat pumps brings along the rise in peak power. One can slow down the growth rate with network service price models, which also helps to decrease the pressure for investments and the increase of network fee. Expectations for quality are growing. Electricity always, 24/7. Large-scale investments to the security of supply – in Elektrilevi's case primarily to the medium voltage network – are necessary for that purpose, helping to eliminate defects faster via modern work processes.

XVII BALTIC CONFERENCE ON INTELLECTUAL COOPERATION

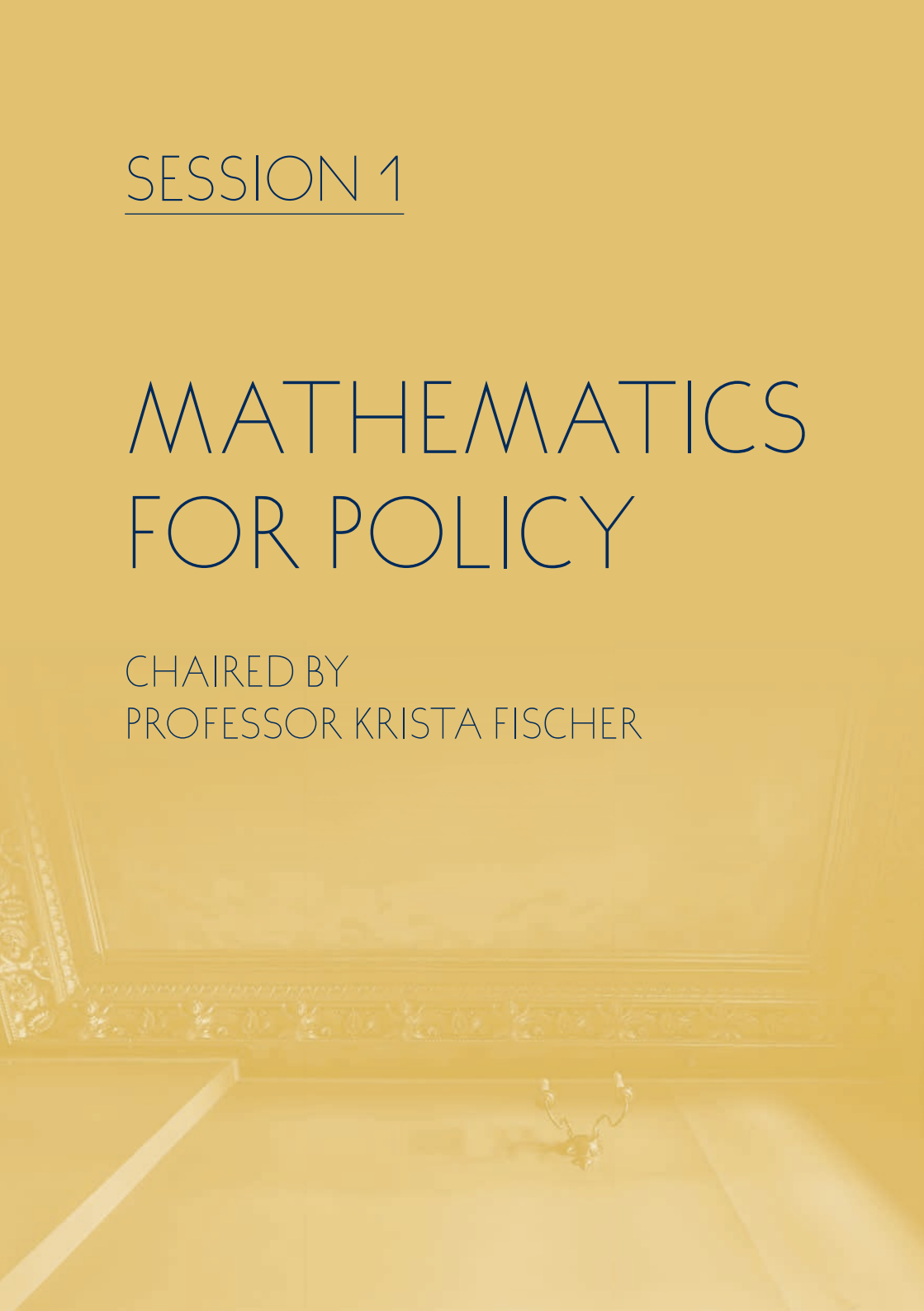
MATHEMATICS FOR SOCIETY

The theme of the conference “Mathematics for Society” is motivated by massive contribution of many scientists to the analysis of processes during the COVID-19 pandemic and the design of the exit strategy of this pandemic. While the efforts of medical experts and life scientists have been widely recognised, the related developments in exact sciences, informatics, and engineering are still to be acknowledged and appreciated. The conference has a wider focus, covering the applications of mathematics in several fields, from policy to genetics.

SESSION 1

MATHEMATICS FOR POLICY

CHAIRED BY
PROFESSOR KRISTA FISCHER



Aalto University School of Science, Systems Analysis Laboratory, Finland

Member of the Finnish Academy of Science and Letters

PROF. AHTI SALO

Professor Ahti Salo has worked extensively on the development of decision analytic methods and their uses in resource allocation, efficiency analysis, innovation management, risk management, foresight and forecasting. He has published over 180 scientific papers and received major awards from the Decision Analysis Society of the Institute for Operations Research and the Management Sciences, and from the International Society for Multiple Criteria Decision Making. In 2020, Prof. Salo was Member of the Science Panel, appointed by the Prime Minister's Office of Finland to provide scientific support in the COVID-19 pandemic. In 2020–2023, he is Member of the Government Foresight Group, also appointed by the Prime Minister's Office.

Producing and Using Model-Assisted Policy Advice

In the rapidly changing decisions contexts characterised by fast changes, high stakes and a paucity of scientific evidence, the production and use of mathematical models for policy advice involves major challenges. This presentation highlights these challenges in view of the COVID-19 pandemic and argues that in such contexts it can be beneficial to adopt a collaborative approach, in which the results from formal modelling approaches are complemented by bringing in expertise from a broad range of stakeholders. Initiatives for providing evidence-based support to Finnish policy makers in the COVID-19 crisis are also discussed and further examples from collaborative risk management and participatory foresight are presented.

PROF. ARNIS SAUKA

Centre for Sustainable Business at the Stockholm School of Economics in Riga, Latvia

Corresponding Member Member of the Latvian Academy of Sciences

Dr Arnis Sauka is Professor and Director of the Centre for Sustainable Business at the Stockholm School of Economics in Riga, and Founding Member of the IfM (Institut für Mittelstandsforschung) Research Fellow Network (Germany). He holds a PhD from the University of Siegen (Germany) and has been Visiting Scholar at the Jönköping International Business School (JIBS, Sweden) and the School of Slavonic and East European Studies, University College London (UCL/SSEES, UK). His research findings, which deal with the shadow economy, productivity and competitiveness, have been published in *Strategic Entrepreneurship Journal, Journal of Business Ethics, International Small Business Journal* and *Journal of Comparative Economics*. Prof. Sauka is extensively involved in applied research, he Board Member of the Foreign Investment Council in Latvia.

Advanced Maths for the Policy Decisions: The Case of the Shadow Economy Research

This presentation introduces the methodology behind the Shadow Economy Index and the application of the index for policy making purposes. The index draws on the surveys of company managers, aiming to measure the size and explore the determinants of the shadow economy. The index measures the size of the shadow economy as a percentage of GDP and is based on the income approach, which calculates GDP as the sum of gross remuneration of employees and gross operating income of firms. It has been estimated annually since 2010 for the three Baltic States, and recently applied also to other countries. The findings of this study have been widely used for policy making purposes as well as communicated to industrial sectors and wider audiences.

Aalto University School of Science, Department of Computer Science, Finland

Vice President of the Finnish Academy of Science and Letters

PROF. KIMMO KASKI

Kimmo Kaski is Professor of Computational Science at Helsinki University of Technology, now Aalto University School of Science, he has been Academy Professor and Director of the Centre of Excellence in Computational Complex Systems Research. Prof. Kaski is Supernumerary Fellow of Wolfson College, Oxford University; External Faculty Member of the Complexity Science Hub Vienna; Visiting Fellow of The Alan Turing Institute, UK; Fellow of the APS and the IOP; and Member of Academia Europaea, and Academia Mexicana de Ciencias. His research interests are in computational science, complexity science, complex systems and network, social physics, AI, and medical image analytics with deep learning.

Social Physics: Data-Driven Analysis and Computational Modelling of Human Social Connectome

In recent years, modern social physics has focused on studying large-scale socially relevant datasets using data analysis and computational modelling, which has yielded unprecedented insights into human social network structures and processes therein. This is well-demonstrated by our analysis of a large mobile phone dataset, finding the social networks that have a modular structure of communities with strong internal ties and weaker external ties. As this data includes the phone users' demographics, i.e. gender and age, we have investigated the nature of human social interactions from the egocentric viewpoint and gained a deeper insight into the gender and age-related social behaviour patterns and dynamics of human relationships, across their lifespan.

PROF. ANTO AASA

University of Tartu, Department of Geography, Estonia

Anto Aasa is Associate Professor in Human Geography at the Mobility Lab of the University of Tartu. He defended his doctoral dissertation in 2005 and has been working in the University of Tartu since then. Prof. Aasa has participated in various research projects focusing on different aspects of population distribution and spatio-temporal mobility (population geography, tourism, transportation, commuting, migration, etc.). The Mobility Lab is one of the world's leading innovators in the development of new methods for analysing human mobility. Anto Aasa has paid special attention to the development and application of mobile data collection methods, in which data is gathered via mobile positioning and/or GPS, and has been actively involved in analysing and visualising such data. Prof. Aasa is a co-author of many thematic scientific publications.

The Influence of COVID-19 on Mobility: An Analysis of Mobile Positioning Data from Estonia

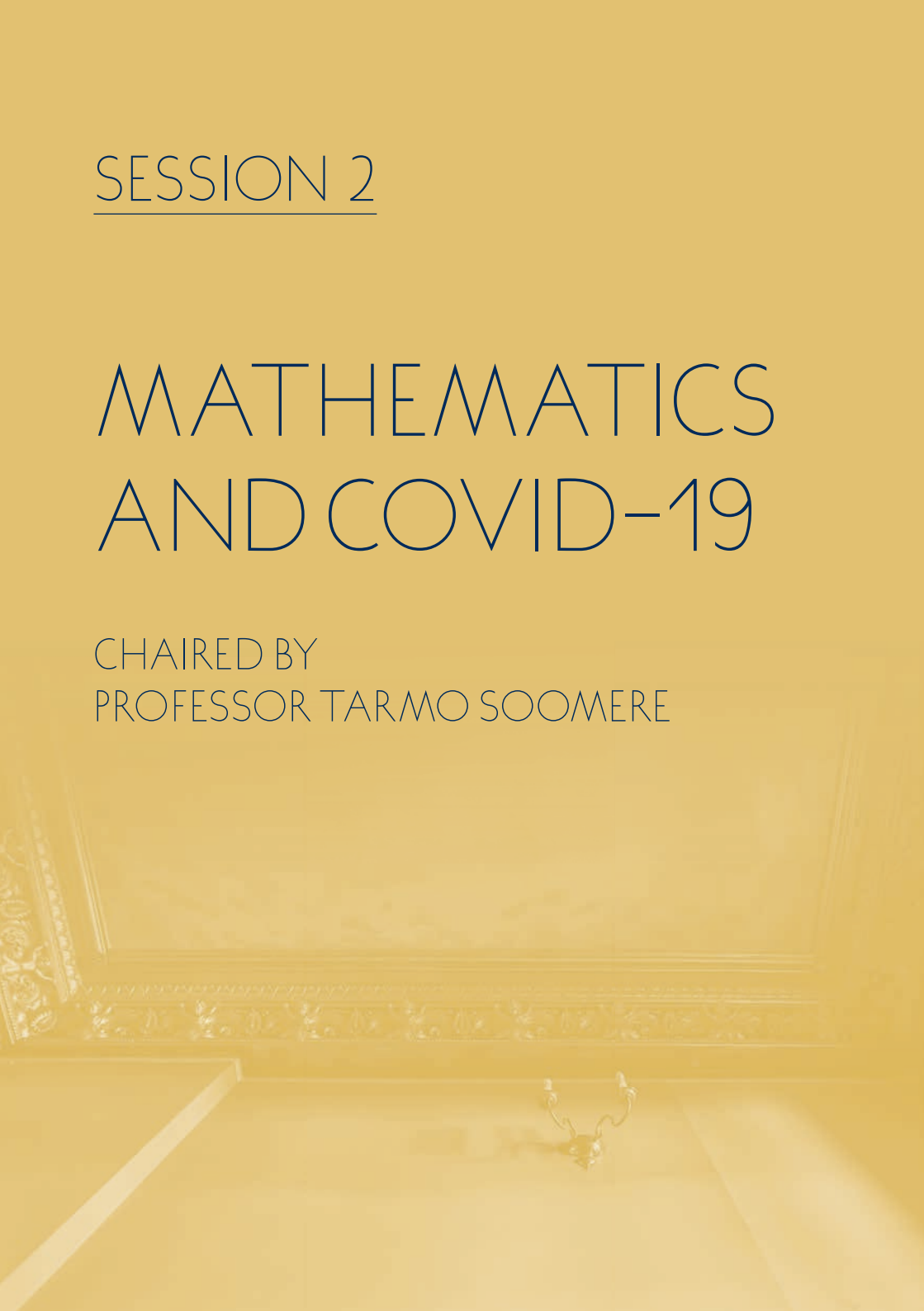
This presentation introduces how mobile positioning can be applied to study the mobility patterns in case of emergency, using two main datasets: passive mobile positioning and GPS-data. Passive mobile positioning data is very helpful to characterise the general mobility patterns in the whole society. GPS-data, on the other hand, can enlighten the nature of mobility changes on a large scale and at individual level.

The latest (ending) pandemic has proved that it is vital for decision makers to get instant information about the mobility patterns in the society. It has also shown, however, that the implementation of mobile positioning data is difficult due to the very long value chain. Therefore, it is urgent to devise how mobile positioning could be used not only during emergency situations but also in normal conditions for official statistics and scientific research.

SESSION 2

MATHEMATICS AND COVID-19

CHAIRED BY
PROFESSOR TARMO SOOMERE



PROF. KRISTA FISCHER

University of Tartu,
Institute of Genomics, Estonia

Member of the Estonian Academy of Sciences

Krista Fischer is an Estonian biostatistician (PhD in mathematical statistics, University of Tartu, Estonia, 1999). Between 1999 and 2010 she worked at University of Ghent, Belgium, University of Tartu, Medical Research Council, Cambridge, UK. Since 2010 she has been working as Senior Researcher/ Associate professor at the Institute of Genomics and since 2018 as the Professor of mathematical statistics at the Institute of Mathematics and Statistics, University of Tartu. Since 2015 she is a member of the Executive Board of the International Biometric Society. Since March 2020 she belongs to the Estonian Covid-19 Scientific Advisory Board.

Data Analytic Approaches to Support the Management of COVID-19 in Estonia

When COVID-19 reached Estonia in March 2020, the Estonian research community immediately took the initiative to provide scientific support for the management of the spread of the disease. Also statisticians and data scientists were involved and immediately started to gather and systematize available data-based evidence from the worldwide community and developing prediction models and other analytic tools for the Estonian data. This presentation provides an overview of some tools that were developed for monitoring the course of epidemics in Estonia. First, some data visualization tools are demonstrated. Next, a model-based approach for assessing the transmission probabilities of the disease is introduced. Finally, a brief overview of the prediction models for hospital (and critical care) bed demand is presented.

Vilnius University, Institute of Applied Mathematics, Lithuania

Olga Štikonienė is Professor of Differential Equations at the Institute of Applied Mathematics of Vilnius University. She obtained a master's degree from Lomonosov Moscow State University and holds a PhD in mathematics from the Institute of Mathematics and Informatics in Vilnius. Her research interests include numerical methods for nonlinear partial differential equations, nonlocal differential problems, mathematical modelling in physics and medicine. Prof. Štikonienė is a principal investigator of the research project "COVID-19 Infection in Lithuania: Modelling and Analysis of Socio-Economic Consequences", which was funded by the Research Council of Lithuania under 'Projects for decisions on the consequences of COVID-19'.

Dynamic Modelling of the Evolution of SARS-CoV-2 Epidemic in Lithuania

Epidemiological modelling of SARS-CoV-2 has been a crucial tool in trying to predict and control the spread of the disease. It has the potential to be one of the government's tools for managing crisis situations caused by epidemics, especially in their early stage. In the initial phase of the virus' spread, when the data were very limited, it was necessary to rely on the experience of other countries and adapt the used epidemiological models to Lithuania. Later it became possible to construct more accurate and flexible models due to a wide range of data. As with many mathematical-statistical models, the accuracy of prediction relies heavily on the quality of the available data and the level of model abstraction.

PROF. GUNTIS BĀRZDIŅŠ

University of Latvia, Artificial Intelligence Laboratory, Latvia

Corresponding Member of the Latvian Academy of Sciences

Prof. Guntis Bārzdiņš is Senior Researcher at the Artificial Intelligence Laboratory, University of Latvia, and Head of the Innovations Lab at the LETA News Agency. He is Chairman of the Doctoral Council on the Computer Science and Informatics and teaches deep learning and computer networking courses (MA) at the University of Latvia. After post-doctoral studies (1991–1992) at the New Mexico State University (USA), Guntis Bārzdiņš established the first Internet connection in Latvia in 1992 and later worked on satellite communications at Airbus. Prof. Bārzdiņš is presently engaged in computational linguistics and has coordinated numerous projects, including two Horizon 2020 BigData projects.

The Increase of Scientific Activity in Artificial Intelligence during the Pandemic

Artificial Intelligence research and applications have accelerated during the pandemic of the past year. It could be a coincidence, but more likely the global lockdown has pushed the cutting-edge research and collaboration online from the previously elite off-line conferences. GPT-3, DALL-E and Wav2Vec are examples of the recent major deep learning breakthroughs immediately shared online.

Also in Latvia, the pandemic energized AI research and spawned into existence a new AI platform PiniTree.com – a “cloud in the box” answer to the global AI service providers like AWS, Azure and Google Cloud. Such localized AI toolboxes reduce reliance on the global supply chains also in the AI industry and enable the emergence of the local AI ecosystems.

Vilnius University,
Faculty of Medicine,
Lithuania

Audronė Jakaitienė is Professor and Chief Researcher at Vilnius University. Prior to this, she held the position of Senior Economist at the Bank of Lithuania, having also worked as Senior Expert (Economist) for the European Central Bank. Dr Jakaitienė is Board Member of the Lithuanian Statistical Society and Lithuania's representative at the International Biometric Society. Since 2019 she is Member of the European Statistical Advisory Committee (ESAC). Dr Jakaitienė conducts research in econometrics, biostatistics and statistics of education.

Functional Pathways Analysis for COVID-19 Modelling: The Case of Lithuania

One can find many studies analysing the genome of the SARS-CoV-2 virus. However, the studies on the analysis of genetic features of a host organism as well as interactions between the virus and human organism are just starting to emerge. We analyse two main genetic functional pathways of the viral infection: the virus entering the host organism and replication by using host resources; and the host organism's reaction to the viral infection – immunity and inflammatory response. The identified genomic factors might help predict the susceptibility and potential outcome of the COVID-19 disease in the Lithuanian population. The findings might contribute to genome-driven disease treatment or prevention measures in the future.

PROF. REINER LAUTERBACH

University of Hamburg, Department of Mathematics, Germany

Member of the Academy of Sciences and Humanities in Hamburg

Reiner Lauterbach graduated with an MA in mathematics from State University of New York (SUNY) at Albany (1978) and received a Diploma (1980) and a PhD (1982) from the University of Würzburg. After that he worked as Scientific Assistant at the Universities of Augsburg and Würzburg. In 1984–1985 Prof. Lauterbach had a German Research Foundation (DFG) research grant at the Institute for Mathematics and its Applications (IMA), University of Minnesota, and did his habilitation in mathematics at the University of Augsburg in 1988. From 1992 to 1998 he was Deputy Head of the Research Group "Dynamical Systems and Control" at the Weierstrass Institute (WIAS), Berlin, and worked as Privatdozent at the Free University of Berlin starting from 1993. Reiner Lauterbach became Professor for Applied Mathematics at the University of Hamburg in 1998 and retired in 2020.

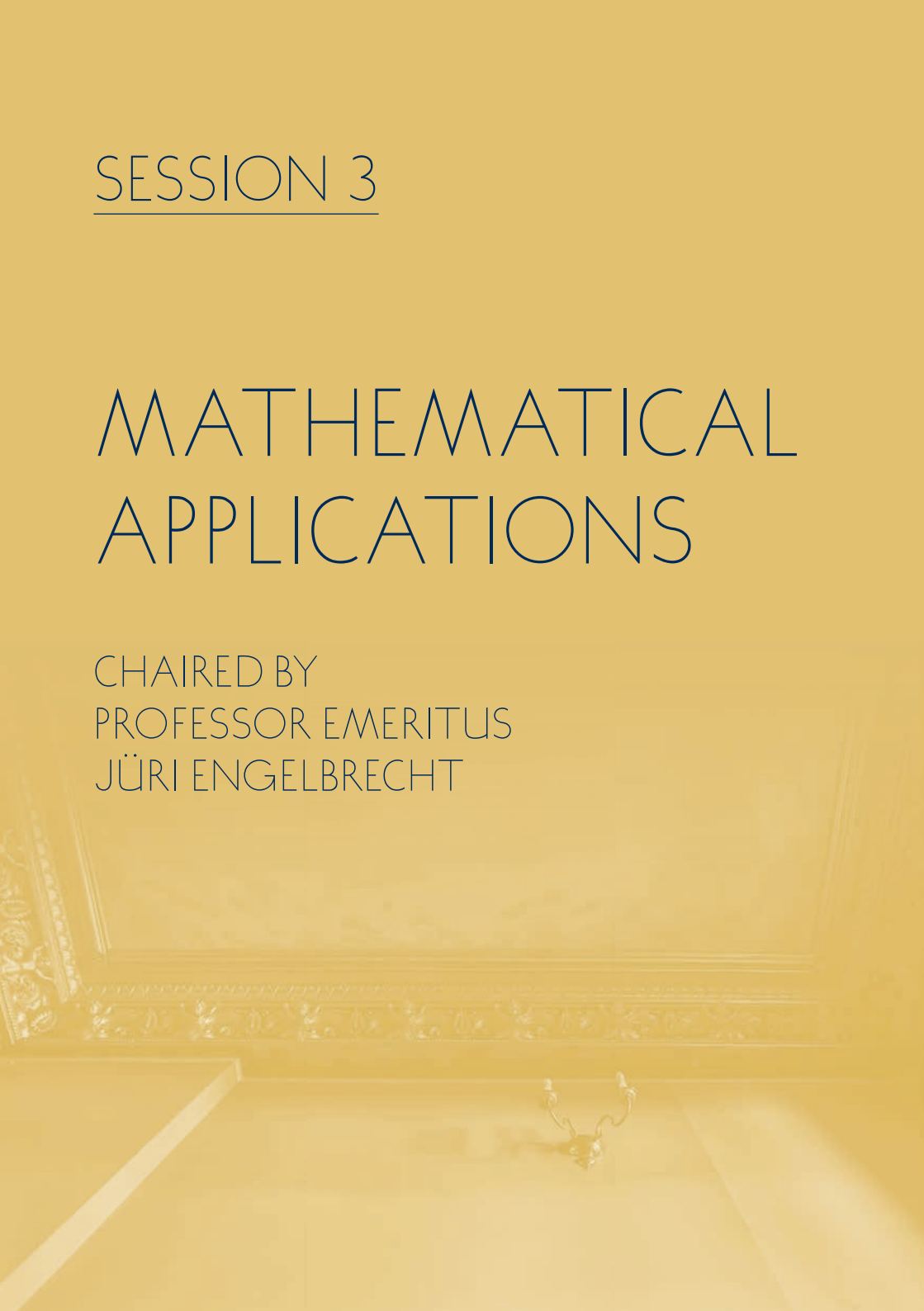
What Can/Should We Learn from the COVID-19 Pandemic?

From a mathematical or dynamical system's point of view, a pandemic is a rather simple growing process. Near the beginning one observes nearly exponential increase of cases, on the long run a certain limit is approached, and the details depend on a few parameters like the probability of contracting the disease when an infected and a non-infected individual meet, on lethality and maybe on some other factors. Of course, the dynamics becomes much more complicated if various measures are put in place: we have seen varied forms of lockdown, different approaches to school openings and many more measures. It is important to evaluate these different approaches in order to provide sound scientific advice concerning possible and likely future pandemics. We propose an approach for such an evaluation.

SESSION 3

MATHEMATICAL APPLICATIONS

CHAIRED BY
PROFESSOR EMERITUS
JÜRI ENGELBRECHT



PROF. JUHAN ARU

École Polytechnique Fédérale de Lausanne (EPFL Lausanne)

Member of the Estonian Young Academy of Sciences

Juhan Aru obtained his PhD in mathematics from the ENS (École normale supérieure) Lyon. After spending three years as a postdoc with W. Werner at the ETH (Swiss Federal Institute of Technology) Zürich, he joined the EPFL as Tenure-Track Assistant Professor in Mathematics in 2019, heading the Chair of Random Geometry..

Universality: When Can Complex Be Simple?

In this presentation, a few mathematical examples of the phenomenon called ‘universality’ are discussed and it can be seen how the behaviour of complex-looking systems might sometimes still be simple to describe. The presentation also speculates about the potential usefulness of such phenomena, when trying to understand the real world.

University of Latvia,
Faculty of Computing, Latvia

Full Member of the Latvian Academy of Sciences

Andris Ambainis is Professor of Computer Science at the University of Latvia. His research is centered around developing new algorithms for quantum computers. Prof. Ambainis has developed quantum walks (quantum counterparts of random walks) into a major method for constructing quantum algorithms and invented the quantum adversary method for proving the optimality of quantum algorithms. He has co-authored more than 160 research papers, including 25 papers in the two leading theoretical computer science conferences in the world (STOC and FOCS) and papers in *Nature Communications* and *Physical Review Letters*. His work has been recognized by an European Research Council (ERC) Advanced Grant (2012) and the Grand Medal of the Latvian Academy of Sciences (2013).

Mathematics of Quantum Computing

Quantum computing combines quantum physics with computer science to build quantum computers that can be exponentially faster than conventional computers. Mathematics provides the interface between quantum physics and computer science, through mathematical models of quantum mechanics. These models enable computer scientists to build quantum algorithms that will be implementable on quantum computers based on a variety of different physical systems.

Mathematics also provides tools for both constructing quantum algorithms and understanding the limits of quantum computers. Mathematical proofs of correctness have a very important role in those cases, and methods from both algebra and probability theory are very useful.

DR ČESLOVAS VENCLOVAS

Vilnius University, Institute of Biotechnology, Lithuania

Member of the Lithuanian Academy of Sciences

Dr Česlovas Venclovas is Head of the Bioinformatics Lab at the Life Sciences Center of Vilnius University. He obtained his PhD in computational modelling of three-dimensional structures of biological macromolecules in 1994. Currently, Dr Venclovas' research lies in the field of protein structural bioinformatics. His major scientific interests include computational prediction of the three-dimensional structure of proteins and protein complexes, detection of distant evolutionary relationships between proteins, computational studies of DNA replication machineries and CRISPR-Cas systems.

Computational Modelling and Analysis of 3D Structures of Proteins and Protein Complexes

Proteins are biological macromolecules that typically fold into a specific three-dimensional (3D) structure, the knowledge of which is the key to understanding the protein function. In this presentation, a complex nature of protein 3D structure is discussed, along with the long-standing efforts to predict it using computational methods. It is introduced how a mathematical construct, known as the Voronoi diagram, has enabled the Bioinformatics Lab to develop effective methods for the analysis and prediction of protein structure. The focus is also on recent breakthroughs in protein structure prediction and remaining problems, as well as on the involvement of the lab in community-wide initiatives of computational modelling of SARS-CoV-2 protein structures.

University of Tartu,
Institute of Genomics, Estonia

Mait Metspalu has studied geography as well as molecular biology and evolution at the University of Tartu where he also defended his PhD on phylogeography of human mtDNA in South Asia in 2006. In 2012–2013 Dr Metspalu was Visiting Research Fellow at the UC Berkeley. He became Vice-Director (2010) and subsequently Director (2014) of the Estonian Biocentre. After merger in 2018 Dr Metspalu became Director of the new Institute of Genomics at the University of Tartu. His research concentrates on using and developing population genetics approaches to understand the genesis of the genetic diversity patterns of humans through reconstructions of past population movements, he has launched a dedicated ancient DNA program aiming mostly at reconstructing population changes in the East European Plain since the Paleolithic.

Digging Genomes to Understand Our Past – Modern Tools for Old Puzzles

Human genetic diversity is shaped by three main factors. Firstly, demographic history, which combines a complex web of population splits, migrations, mergers, declines and expansions. Secondly, natural selection. Human populations have populated practically the whole globe, adapting to the extremely different environmental conditions, which among other things influence our diet. Thirdly, culture. Social structure translates into the genetic structure of the populations. All of the above means that understanding human genetic diversity helps us to unearth aspects of our past in terms of history, natural selection and culture.

In this presentation, snapshots are given of population genetics approaches that address these three intermixed areas of research.

DR JŪRATĖ KRIAUČIŪNIENĖ

Lithuanian Energy Institute, Lithuania

Member of the Lithuanian Academy of Sciences

Dr Jūratė Kriaučiūnienė, Doctor Habilitus, is Head of the Laboratory of Hydrology at the Lithuanian Energy Institute. Her main research areas are related to the analysis of the impact of climate change on water bodies; modelling of hydrological and hydrodynamic processes, sediment transport and water quality; and assessment of the environmental impact of anthropogenic activities on water bodies. Dr Kriaučiūnienė has conducted and participated in more than 80 local and international projects and been involved in more than 110 scientific publications. She is a member of editorial boards of three scientific journals, the Scientific Council of the Lithuanian Energy Institute, and the board of a joint graduate school.

How Will Water Resources of the Baltic Region Change in the Future?

Climate change can have a significant impact on water abundance and hydrological extremes of the rivers in the Baltic region. What are the projected changes? Should we anticipate floods and droughts of increased frequency and intensity? How can the selection of climate scenarios affect the magnitude and change of river runoff projections? What are the main sources of uncertainty in predicting future changes in river runoff?

Technical University of Braunschweig, Institute for Partial Differential Equations, Germany

Corresponding Member of the Academy of Sciences and Humanities in Hamburg

Thomas Sonar received a Diploma in mechanical engineering (1980), and a Diploma with distinction in mathematics and computer science from the University of Hannover (1987). He obtained a PhD with distinction in mathematics from the University of Stuttgart in 1991 and did his habilitation in mathematics at the Technical University of Darmstadt in 1995. Thomas Sonar was Professor of Applied Mathematics at the University of Hamburg in 1996 and has been Professor of Technomathematics at the Technical University of Braunschweig since 1999.

On the Development of Navigation Tables in Early Modern England

The navigation tables to determine latitude at sea were first stolen by the English from the Spanish ships where Cortes' navigation manuals were found.

As navigation was fairly complicated by these tables, English mathematicians quickly understood and developed a theory to simplify the process for ordinary mariners. William Bourne introduced only one table while three were needed by Cortes. The climax of early modern navigation techniques was reached in the publications of Edward Wright starting in 1599.

BALTIC CONFERENCES ON INTELLECTUAL COOPERATION

The tradition of the Baltic Conferences on Intellectual Cooperation (BCIC) extends back to the pre-World War II period. In 1935–1940 six such conferences were held, with the Nordic countries involved. The first conference took place in 1935 in Kaunas and supported the idea of the establishment of the Academies of Sciences in the Baltic countries.

In Estonia, the Academy of Sciences was established in 1938. In Latvia and Lithuania, public institutions – the History Institute of Latvia (1936) and the Antanas Smetona Institute of Lithuanian Studies (1938) – were founded, which later developed into national academies of sciences. They were instrumental in organising research on a national scale.

After the first conference, annual conferences followed before World War II: in 1936 in Tartu, Estonia; in 1937 in Helsinki, Finland; in 1938 in Riga, Latvia; and in 1939 again in Kaunas, Lithuania. The last pre-war conference was scheduled in Tallinn on 15–17 June 1940, in conjunction with the "Baltic Week", but the conference was interrupted by the USSR aggression against the Baltic States.

The tradition was renewed after the Baltic countries started to regain their independence in 1990. Since 1999 conferences with a focus on various fields of research and development have been organised in one of the three Baltic countries or Finland biannually.

Since the restart of the Baltic Conferences on Intellectual Cooperation, the conference themes have sought to address the following issues:

7th BCIC (Riga, 1999) – The history of and future prospects of mutual cooperation of Baltic States with particular focus on the protection of intellectual values and science;

8th BCIC (Tallinn, 2001) – The historical experience of the Baltic States, research strategies in small countries, and the humanities during the past decade;

9th BCIC (Vilnius, 2003) – Globalization, Europe, and National Identity, with considerable attention paid to science and culture of small countries;

10th BCIC (Helsinki, 2005) – The Baltic: Past, Present and Future. History and politics, the Baltic Sea as a body of water and scientific collaboration around the Baltic Sea;

11th BCIC (Riga, 2007) – National Development Strategies of the Baltic States;

12th BCIC (Vilnius, 2010) – Science and Society;

13th BCIC (Tallinn, 2013) – European Research Area and Small Countries;

14th BCIC (Riga, 2015) – Academies of Sciences for Research and Innovation: Past and Future;

15th BCIC (Helsinki, 2017) – Research-based teacher training in the Baltic region;

16th BCIC (Vilnius, 2019) – Genes, from the Past to the Future.

MEDAL OF THE BALTIC ACADEMIES OF SCIENCES

Medal of the Baltic Academies of Sciences is awarded for contribution to promoting cooperation between the Baltic States and for achievements in science.

Laureates 1999–2019:

1999 – Juras Požela (Lithuania), Jānis Stradiņš (Latvia), Evald Ojaveer (Estonia)
2000 – Jüri Engelbrecht (Estonia), Jarmo Visakorpi (Finland), Jurgis Vilemas (Lithuania), Juris Ekmanis (Latvia)
2001 – Tālis Millers (Latvia), Carl-Olof Jacobson (Sweden), Benediktas Juodka (Lithuania), Mihkel Veiderma (Estonia)
2003 – Jonas Kubilius (Lithuania), Jānis Kristapsons (Latvia), Peeter Tulviste (Estonia)
2007 – Olof G. Tandberg (Sweden), Andrejs Siliņš (Latvia), Zenonas Rokus Rudzikas (Lithuania), Raimo Pullat (Estonia), Matti Saarnisto (Finland)
2010 – Pietro Umberto Dini (Italy), Ain-Elmar Kaasik (Estonia), Ervīns Lukševičs (Latvia), Zigmas Zinkevičius (Lithuania)
2013 – Tarmo Soomere (Estonia), Andris Šternbergs (Latvia), Eugenius Butkus (Lithuania)
2015 – Benedikts Kalnačs (Latvia), Zenonas Norkus (Lithuania), Peeter Järvelaid (Estonia)
2019 – Isaak Rashal (Latvia), Maris Laan (Estonia), Vaidutis Kučinskas (Lithuania)

THE HOST

The Estonian Academy of Sciences was founded in 1938 as an association of top-level scientists and scholars with commitment and responsibility to advance scientific research and represent Estonian science both nationally and internationally. The primary mission of the Academy is to assist in building a knowledge-based Estonia, fostering the adaptation of new knowledge for economic growth and for the improvement of the quality of life in Estonia, enhancing public appreciation of science and scientific methods of thought.

Relying on the intellectual power of its members, the Academy organises various activities to achieve its objectives. The Academy provides independent and highly professional scientific expertise and science-policy advice, promotes excellence in research, communicates and disseminates knowledge, enhances public awareness of science and scientists, encourages research cooperation at national and international levels.

Two institutions work under the umbrella of the Academy:

- **Under and Tuglas Literature Centre**

The overall purpose of the Under and Tuglas Literature Centre of the Estonian Academy of Sciences is the study and theoretical modelling of the written culture of the Estonian language in its entirety and the multilingual Baltic-German culture from earlier eras, making it visible and interesting in the international scientific landscape.

Estonian Academy of Sciences
Under and Tuglas
Literature Centre

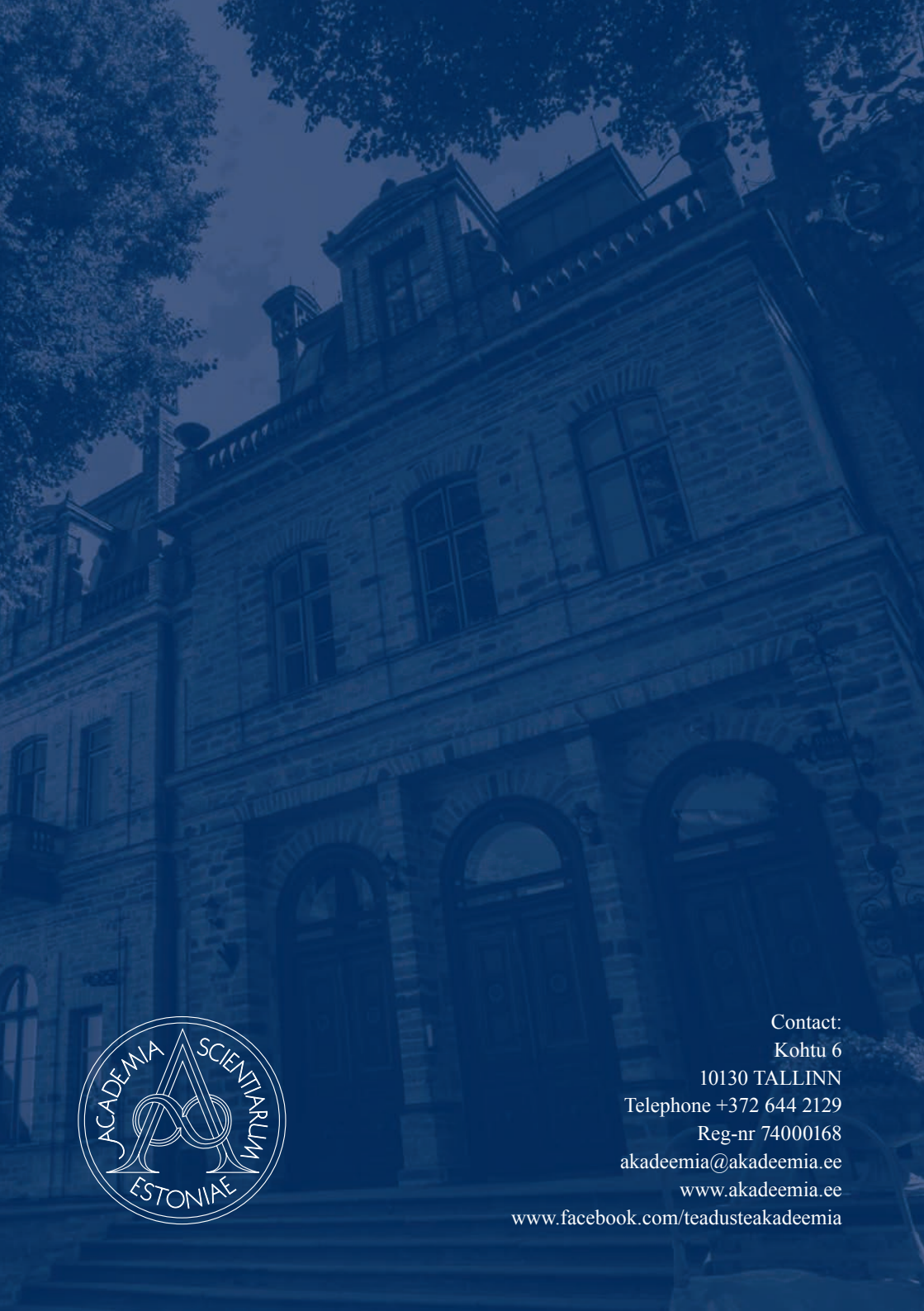
• **Estonian Academy Publishers**

The Estonian Academy Publishers issues seven open access scientific journals, which are peer-reviewed, indexed and abstracted in international review publications and databases. Each journal has an international editorial board. In the Estonian Research Information System, all the seven journals are classified under category 1.1. The Estonian Academy Publishers welcomes research authors from around the world. More information about the journals and instructions to authors for submitting an article is available at www.eap.ee/journals-issues.

ESTONIAN ACADEMY PUBLISHERS

THE CONFERENCE VENUE

The residence of the Estonian Academy of Sciences, on the slope of Toompea, is the former city residence of the prominent Ungern-Sternberg noble family and a conspicuous building in Tallinn architecture. The palace on Toompea was commissioned by Count Ewald Alexander Andreas von Ungern-Sternberg, descendent of a highly influential Baltic-German noble family. The architect of the building is the renowned Berlin architect Martin Philipp Gropius.



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