The Finnish Society of Sciences and Letters
LAUREATES
Annual Celebration on April 29, 2025

The Grand Prize of the Finnish Society of Sciences and Letters – Professor E.J. Nyström's Prize

Professor Leif B. Andersson, Uppsala University

It is a great pleasure for the Finnish Society of Sciences and Letters to present the Society's major prize – the Professor E.J. Nyström's Prize – to Professor Leif B. Andersson of Uppsala University.

Professor Andersson is awarded this prize for his outstanding contribution to the genome biology of domestic animals and natural animal populations. Leif Andersson is a pioneer in using animal models to investigate the relationship between genetic and phenotypic variations. His work has resulted in hundreds of publications describing how specific mutations cause disorders and phenotypic traits in domestic animals and how they have influenced the evolutionary history of domestic animals.

Leif Andersson's name is strongly associated with genome biology discoveries related to skeletal muscle carbohydrate metabolism and the growth of internal organs, which are crucial for the industrial production of pork. These findings have also proved to be of great theoretical importance, including understanding how the size of internal organs in placental mammals is regulated. The findings also have important medical applications, including the development of therapeutic strategies for type II diabetes in humans.

Leif Andersson is also responsible for the discovery of the gene that controls the gait of horses and the movement patterns of vertebrates. A mutation in this gene explains why Icelandic horses can do the ambling gait (or tölt) and flying pace and why trotting horses can trot at a high speed. This single mutation has, inter alia, determined how domesticated horses have historically been used for different purposes. This gene is expressed in specific interneurons in the spinal cord that come into direct contact with motoneurons and probably plays a crucial role in coordinating limb movements during locomotion in all vertebrates, including humans.

Leif Andersson was trained as a biologist and after 30 years of pioneering work in domestic animal genomics, he decided to shift his research focus to the study of natural populations when

next-generation sequencing made it possible to conduct genome studies on almost any organism.

Leif Andersson has studied Darwin's finches on the Galápagos Islands in collaboration with the legendary Princeton University researchers Peter and Rosemary Grant, who have studied the finches for over 40 years. The Grants visited the Society a few years ago and we had the great pleasure of listening to their talks. Leif Andersson's collaboration with them has resulted in several publications describing the evolutionary relationship between different species of Darwin's finches, including the discovery of new species and the identification of genes controlling their beak shape and size. A recent study carried out on Daphne Island sequenced the whole genomes of more than 4000 birds representing four species. The study identified six loci that explained about 50% of the variation in beak morphology and showed that a supergene comprising four genes is crucial for controlling body and beak size variation. The study shows how high-impact loci can contribute to the genetic basis of polygenic traits in natural populations.

Leif Andersson has also identified a supergene that controls male mating strategies, testosterone levels, body size and colour in the wading bird Calidris pugnax (ruff). The ruff performs a curious game in which males with beautiful ornamental feathers defend the territory where mating takes place. Previous studies have established that there are three different male morphs with strikingly different mating strategies. Independent males, known as sovereigns, have colourful plumage, high testosterone levels and defend their territory; satellite males have whitish plumage, low testosterone levels and do not defend their territory; a third group are female-mimicking males with no plumage, small with low testosterone levels, which do not defend their territory, either. Whole-genome sequencing revealed that satellites and intermediate males carry a 4.3 Mb supergene (inversion) comprising about 100 genes. The inversion is inherited recessively, otherwise it would be fatal because it disrupts an essential gene. This discovery has helped explain the low testosterone levels in satellites and female-mimickers and the other phenotypic features of this remarkable bird.

In his research on herrings, Leif Andersson has returned to his roots. His first scientific study in the late 1970s was a bachelor's degree project on the genetics of Atlantic and Baltic herring. In that study, he did not detect any genetic differentiation between them, even though Atlantic herring and Baltic herring are considered different subspecies. The explanation came 30 years later when Andersson decided to conduct a whole-genome sequencing of the samples he had collected as a student. It turned out that neutral sequence variants do not actually exhibit any genetic differentiation in this species. The reason is that the huge population size combined with some gene flow between subpopulations eliminates the effect of genetic drift. However, there is strong genetic differentiation at hundreds of loci, which controls the adaptation of these fish to climate, salinity, light conditions and spawning time. This work has established herring as an important model for genetic studies of ecological adaptation in natural populations. The detailed description of genetic differentiation between Atlantic and Baltic herring could also revolutionise the assessment of the state of one of the world's ten most important fisheries.

There is much more to say but by now the message is surely clear. Leif Andersson stands before us tonight as an example of how world-class biological research follows discoveries wherever they take, crossing the boundaries between basic and applied research and between disciplines. The Finnish Society of Sciences and Letters hopes that his example will continue to serve as an inspiration and model for new generations of researchers.

Professor Theodor Homén's Prize in Physics

Professor Päivi Törmä, Aalto University

Päivi Törmä was born in 1969. She received her PhD from the University of Helsinki in 1996 with a dissertation on quantum optics and quantum information. After taking her doctoral degree, she worked for a year at the University of Ulm in Germany and two years at the University of Innsbruck in Austria. After returning to Finland, Törmä worked for some time as an academy researcher at the Helsinki University of Technology until 2001, when she was appointed professor of nanoscience at the University of Jyväskylä, where she served as the director of the Nano Science Center from 2003 to 2005. In 2008, Törmä became Professor of Engineering Physics at what is currently Aalto University. From 2014 to 2017, she led the Computational Nanoscience Centre of Excellence (COMP) at Aalto University and was an Academy Professor from 2017 to 2021.

Päivi Törmä's research interests include theoretical and experimental quantum physics, nanophotonics and many-body quantum mechanics. In recent years, her research group has made significant advances in areas such as the transfer of large amounts of data by laser light and fundamental research into high-temperature superconductors. Päivi Törmä heads the large international SuperC research consortium coordinated by Aalto University, which aims to find room-temperature superconductors by 2033. In this work, one important tool is artificial intelligence, and new superconductors are expected to facilitate the alarmingly fast-growing demand for electrical energy by both large data centres and the ordinary electronic components required for artificial intelligence. SuperC is financed by several international donors, including the Magnus Ehrnrooth Foundation, which provides funding in response to a proposal made by the Finnish Society of Sciences and Letters.

Together with her research groups, Päivi Törmä has produced a wealth of first-class scientific publications. According to the ISI WoS database, she has more than 250 scientific articles that have been cited almost 10,000 times. Of these, her review article *Strong coupling between surface plasmon polaritons and emitters*, co-authored by William Barnes in 2015, has accumulated more than 1200 citations. Additionally, Törmä has supervised more than 25 doctoral theses and mentored over 20 post-doctoral researchers. A dozen or so of her former students are currently serving as professors all over the world.

Päivi Törmä has secured a total of about 10 million euros in domestic and European funding for her research, of which the most prestigious internationally are the Advanced Grant (2013-2017) and the Proof-of-Concept funding for the project *Low-cost coherent light sources from*

nanoparticle array surface plasmon polariton systems (2017-2019) awarded by the European Research Council. She is currently engaged in projects such as the Academy of Finland research project *Correlations in multi-energy quantum systems* and the EU Framework Programme project *Strong-coupling-enhanced nanoparticle array organic light-emitting diode.*

Päivi Törmä is a member of Academia Europaea (since 2021), the Finnish Society of Sciences and Letters (since 2017), the Academy of Engineering Sciences (since 2011) and the Finnish Academy of Sciences (since 2006). She has received numerous awards and honours, including the Finnish Academy of Sciences Väisälä Prize (2003); the European Young Investigator Award (2005); the Finnish Cultural Foundation Award (2008); and the Magnus Ehrnrooth Foundation Prize in Physics (2019).

Päivi Törmä's other achievements include membership in the State Research and Innovation Council and its predecessor Science and Technology Council 2007-2015 and the presidency of the International Millennium Prize Jury during 2017-2024.

The State Councillor Lorenz Lindelöf Prize

Professor Kaisa Matomäki, University of Turku

Kaisa Matomäki is undoubtedly one of the world's leading researchers in her field of analytic number theory.

In her research, Matomäki and her colleagues have introduced new approaches and developed powerful new proof techniques that have influenced the development of analytic number theory. For example, Matomäki has investigated the distribution of multiplicative functions in short intervals and their correlation. Other research problems that are of interest to Matomäki are related to the distribution of prime numbers.

Kaisa Matomäki's international breakthrough is her work co-authored with Maksym Radziwill in 2016, because of which they shared the SASTRA-Ramunajan Prize. In 2019, Matomäki received the New Horizons Prize in Mathematics, which is awarded to an early-career researcher who has already achieved significant results. Professor Matomäki's scientific output includes about 50 articles, nearly all of them published in leading journals. Matomäki was invited to deliver a speech at the European Congress of Mathematicians EMS-2016 in Berlin and at the International Congress of Mathematicians ICM-2018 in Rio de Janeiro in 2018.

Professor Matomäki was born in 1985 and received her PhD from Royal Holloway, University of London, in 2009. She has been honoured with numerous prizes, such as the Väisälä Prize in 2016 and the European Mathematical Society Prize in 2020. Furthermore, Matomäki was awarded the Ruth Lyttle Satter Prize in 2021 and the Cole Prize in Number Theory in 2023.

Matomäki joined the University of Turku in 2015 as an Assistant Professor and Academy Research Fellow. She was appointed Professor of Mathematics at the University of Turku in 2023. Kaisa Matomäki was admitted to the Finnish Academy of Sciences in 2019 and to the Finnish Society of Sciences and Letters in 2020. Additionally, she was elected to Academia Europaea in 2021.

The Prize of the PhD Mikael Björnberg Memorial Fund

PhD Joonas Hirvonen, University of Nottingham

Joonas Hirvonen is a Finnish theoretical particle physicist who received his PhD from the University of Helsinki in summer 2024 under the supervision of Professor Aleksi Vuorinen and is currently a postdoc researcher at the University of Nottingham. He specialises in high-temperature particle physics applications studying the conditions that prevailed in the early universe and in the interiors of neutron stars. The focus of Hirvonen's work has been to improve the description of phase transitions in these systems, and fittingly, the title of his PhD thesis was "Phase Transitions in Elementary-Particle Matter".

As a researcher, Hirvonen is highly versatile, creative and productive. Already in 2020, his master's thesis produced an important and widely acclaimed paper on the applications of effective field theory to bubble nucleation. Together with his co-doctoral supervisor Oliver Gould (then a postdoc in Helsinki), Hirvonen was able to solve several problems in phase transition processes, and his results have improved the accuracy of the description of phase transitions in a wide variety of physical systems, as evidenced by the high number of references made to his paper.

Another highlight of Hirvonen's career is his 2023 Nature Communications article, in which he investigated the constraints on the equation of state of matter in neutron stars, using insights from nuclear and particle physics as well as astrophysical observations. Largely thanks to Hirvonen, the paper was able to show that dense neutron star matter approaches conformal behaviour at densities below the average density of the most massive stars. This result was believed to offer strong evidence for the existence of a new form of matter – cold and dense quark matter – inside massive neutron stars. The significance of the findings is illustrated by the almost 100 citations made to the article in just over a year.

In Nottingham, Hirvonen focuses on research into the state of the early universe. Additional motivation is provided by the LISA (Laser Interferometer Space Antenna) satellite constellation, which will be launched in the 2030s and be able to detect gravitational waves from transitions just like this one. His work represents an exceptionally high standard of quality and is characterised by an extraordinary degree of independence, as evidenced by the two single-authored articles he has produced at such a young age. All in all, Hirvonen has so far written seven articles, which have been cited more than 300 times – an excellent performance for a researcher who took his PhD just a while ago.

The Magnus Ehrnrooth Prize in Physics

Professor Jukka Pekola, Aalto University

Professor Jukka Pekola is a researcher in experimental low-temperature physics and is among the absolute international leaders in his field. His research deals with the thermodynamics and heat transfer properties of nanostructures. Early in his career, he invented a temperature sensor based on superconducting junctions (Physical Review Letters 73, 2903 (1994)). In recent years, he has experimentally demonstrated that the so-called Maxwell demon can be used for information-based nanoscale cooling (Physical Review Letters 115, 260602 (2015)). A third example of a breakthrough finding is the photon-based single-mode thermal conduction experiment (Nature 444, 187 (2014)). In 2020, Pekola was awarded the prestigious international Simon Memorial Prize for his work on nanoscale electronic devices, particularly in the fields of quantum thermodynamics, metrology and cooling. Previous winners of the Simon Memorial Prize include several Nobel laureates in physics (https://en.wikipedia.org/wiki/Simon_Memorial_Prize).

Pekola served as an academy professor from 2000 to 2005 and 2014-2018. He holds a PhD from the Helsinki University of Technology's Low-Temperature Laboratory and was a professor of physics at the University of Jyväskylä in the 1990s. He also played a key role in establishing the Nanoscience Centre in Jyväskylä. In the early 2000s, he returned to Helsinki University of Technology. Currently Pekola heads Quantum Technology Finland, a national centre of excellence, and has also been involved in the launch of InstituteQ, which coordinates Finnish quantum technology research and education. Hence, his contribution to the advancement of Finnish quantum technology is substantial and pioneering, and Finland's current international position in quantum technology would not have been achieved without Pekola's persistent efforts.

Pekola has an impressive scientific track record and enjoys great respect within the international scientific community. Additionally, he has provided leadership and coordination in support of research and technological advancement in his field, demonstrating great altruism and achieving excellent results.

Magnus Ehrnrooth prize for the best doctoral dissertations in mathematics accepted at a Finnish university last year

PhD Susanna Heikkilä, University of Helsinki

Ehrnrooth Foundation awarded the prize for the best PhD thesis in mathematics accepted at a Finnish university in 2024 to Susanna Heikkilä, PhD (University of Helsinki).

Her dissertation is exceptional. Among other things, it gives an answer to one of the most important open questions in quasiregular mapping: the classification of closed, simply connected quasiregularly elliptic 4-manifolds.

In 1981, the Russian French mathematician Misha Gromov asked whether the existence of a quasiregular mapping is guaranteed if the target space is simply connected, meaning that its

fundamental group is trivial and does not constitute an obstruction. The question remained open until 2019 when Prywes provided a four-dimensional counterexample.

The main result of the doctoral thesis complements the answer to Gromov's question. Heuristically, the answer is as follows: for a closed manifold to be quasiregularly elliptic, the intersections of its submanifolds (in homological terms) must be realizable simultaneously in the exterior algebra of a Euclidean space. Formally speaking, this means that there must be algebra monomorphism from the de Rham cohomology of the closed n-manifold to the exterior algebra of the n-dimensional Euclidean space. The result was published in *Annals of Mathematics*, the world's leading mathematics journal.

In addition to the article on quasiregular mappings, Heikkilä's dissertation contains three articles on quasiregular curves, which in themselves constitute an excellent dissertation. Heuristically quasiregular curves are quasiregular mappings into higher dimensional codomain. In the theory of quasiregular mappings, an important topological property of the mapping - orientation preserving - is replaced in this theory by the choice of an additional geometric structure, so-called calibration. Calibration imparts these mappings in the concept of natural (geometric) orientation. The theory of quasiregular curves amplifies both the theory of quasiregular mappings and the theory of holomorphic curves.

Magnus Ehrnrooth prize for the best doctoral dissertations in physics accepted at a Finnish university last year

PhD Laura Vuorinen, University of Turku

Laura Vuorinen’s thesis “High speed jets downstream of the Earth’s bow shock” received the Magnus Ehrnrooth dissertation prize in the field of physics. In this work, she investigates fast plasma flows referred to as jets at the boundary region separating the solar wind and the Earth’s magnetosphere. These jets play a crucial role in the interactions between the solar wind and near-Earth space, acting as an important driver of space weather disturbances.

The thesis comprises five peer-reviewed papers, all published in the leading journals of the field with Vuorinen as the lead author in each. Her independent contribution is evident, and the publications are of exceptionally high international quality. Vuorinen has combined diverse data analysis and simulation techniques with remarkably careful uncertainty analysis of the obtained results, used a broad range of observations and developed novel empirical methods. As a key finding, she quantifies how the solar wind’s magnetic field and plasma conditions influence jet occurrence and demonstrates how jets can energize electrons and affect plasma and energy transfer from the solar wind into Earth's magnetosphere.

The defence opponent and pre-reviewers all consider this thesis to be of the highest standards and highlight its important new findings in the field.

Magnus Ehrnrooth prize for the best doctoral dissertations in chemistry accepted at a Finnish university last year

Doctor of Science (Technology) Daniel Langerreiter, Aalto University

Daniel Langereiter defended his PhD thesis *"Synthesis of cellulose based self-sterilizing materials via solid-state reactions"* at Aalto University in October 2024. His supervisor was Professor Mauri Kostiainen. The work involved the preparation of new photosensitive cellulose derivatives and the development of new synthesis methods for both the derivatisation of cellulose crystals and the preparation of photoactive compounds. The doctoral thesis is based on three high-quality publications. The first dealt with the antimicrobial activity of photoactive compounds in cellulose nanofiber matrices. The active compounds were either mixed into the matrix or covalently bound to it. In the second work, cellulose nanocrystals were derivatized using chemomechanical methods, which all but obviated the need for solvents. The chemical reactions on crystal surfaces occurred remarkably quickly. In the third study, the phthalocyanine derivative used in the first study was re-examined. As the previous synthesis of the compound was complex with poor yields, Langereiter's work helped develop an efficient solid-state synthesis. In this synthesis, the number of solvents could be reduced by a factor of 100. Langereiter's work made extensive use of various synthesis and structural analysis methodologies, resulting in several synthesis and material innovations.

The preliminary examiners of the dissertation and the opponent found it to be of an exceptionally high standard. The Aalto University School of Chemical Engineering granted the work the "Award for Excellence".

Teacher prizes

Lecturer Axel Holmberg, Hangö gymnasium

Axel Holmberg teaches biology and geography at the Hanko Upper Secondary School. He is a highly popular and inspiring teacher who emphasises theory and practice through field courses and other activities. His teaching in biology and geography in both secondary and upper secondary schools is of a high standard. Outdoor education combined with laboratory tasks (water samples) and observations (birds) are among his teaching methods. His focus is very much on the Baltic Sea and natural surroundings. There is a strong scientific element in his teaching; for example, he works closely with the Tvärminne Biological Research Station (operated by the University of Helsinki). This co-operation has been going on for over ten years, and five years ago the Hankoniemi Upper Secondary School joined the project. Together with his colleague from Hankoniemi School, Axel has created an in-depth project in marine biology in collaboration with Alf Norkko, Professor of Baltic Sea Research in Tvärminne. Students carry out scientific experiments for three days by taking samples and performing analyses, as well as writing scientific reports on their observations. The study module has been offered to other upper secondary schools in the region.

Axel Holmberg's inspiring, interdisciplinary and versatile teaching has motivated many students to pursue further education in the fields of biology and geography. He is described as a helpful and reliable colleague and teacher with great interpersonal skills, always ready to revise his teaching methods and expand his own knowledge.

Lecturer Lauri Hellsten, Espoon yhteislyseo

Lauri Hellsten teaches mathematics and physics at the Espoo Co-Educational Upper Secondary School. He has continuously developed his teaching methods in response to student feedback and has actively collaborated with LUMA Centre, a science education network of Finnish universities, and other parties. He has been involved in developing practices such as workshops and shared learning approaches to support students with different needs. Hellsten's workplace, the Espoo Co-Educational Upper Secondary School, is one of the schools in Espoo with the lowest average grades. Nevertheless, he has managed to inspire and motivate even students whose mother tongue is not Finnish or Swedish and who have faced challenges in terms of both language and knowledge when studying physics and advanced mathematics.

Lauri Hellsten is an active participant at international conferences related to educational technologies and mathematical subjects. He has also organised field trips to CERN (ITER Project). Additionally, Lauri Hellsten has played a key role in the school's Erasmus project and other international co-operation. A case in point is the STEAM Circus project in autumn 2024, funded by the National Agency for Education and designed to bring practical science knowledge to disadvantaged young people in Zimbabwe. Hellsten keeps organising inspiring events and offering new experiences, such as science circuses for kindergartens, where his students teach children physics and chemistry. In 2020, Hellsten founded an education channel called Opetus.tv on the Discord platform, which currently has around 1300 young users. He is also active in sharing his knowledge on the use of digital tools in education. Many of Hellsten 's students go on to pursue higher education, for example on engineering programmes.'

Lecturer Lea Kaijansinkko, Lappeenrannan lyseon lukio

Lea Kaijansinkko teaches music at the Lyceum Unit of the Lappeenranta Upper Secondary School. She has been involved in creating the musical theatre programme at the Lyceum since 2014. Lea has staged several musicals at the school, each project involving 45–70 young students, of whom some 20 were musicians and about 10 singing actors. Kaijansinkko has encouraged students to push their limits and discover new skills. Before these performances, some participants had never sung or played an instrument in front of a large audience. Kaijansinkko offers young people an opportunity to succeed, but she also ensures that no one ends up in a situation where they would be compelled to do something that is beyond their capabilities. This is real care and pedagogical skill. For some of the projects, Lea Kaijansinkko also wrote the music score herself and helped the young people compose their own songs, giving them an opportunity to showcase their talent.

Many of Kaijansinkko's students have become professional musicians, actors or music teachers. She leads school choirs and has especially encouraged boys to sing, for which she has been praised both within the school and by parents. In the classroom, she creates an atmosphere in

which students feel safe and free to test their skills. She has also been actively involved in creating interdisciplinary teaching methodology in accordance with the new national curricula. Cooperation with the Sibelius Academy also commenced with her initiative.