

Report of the state of mathematics in Finland 2009

1. There are 12 universities with teaching and research in mathematics

1. University of Helsinki (abbreviated below UH)
2. University of Turku (UT)
3. University of Jyväskylä (UJ)
4. University of Oulu (UO)
5. University of Tampere (UTa)
6. University of Joensuu (UJo)
7. University of Kuopio (UK)
8. University of Vaasa (UV)
9. Åbo akademi (in Turku, ÅA))
10. Technical University of Helsinki (UTH)
11. Technical University of Tampere (UTT)
12. Technical University of Lappeenranta (UTL)

2. The estimated number of mathematics professors in Finland: 77

3. The estimated number of research mathematicians in Finland: 400

4. There is one mathematical society, the Finnish Mathematical Society with 303 members

5. A list of some best known mathematicians in Finland with their research areas and institutions

- analysis, UH: Kari Astala, Olli Martio, Pertti Mattila, Seppo Rickman, Eero Saksman, Pekka Tukia, Jussi Väisälä
- analysis, UT: Matti Vuorinen
- analysis, UJ: Tero Kilpeläinen, Pekka Koskela, Jani Onninen, Xiao Zhong
- analysis UJo: Ilpo Laine
- analysis, UTH: Juha Kinnunen
- topology, UH: Sören Illman
- mathematical logic, UH: Jouko Väänänen
- number theory, UT: Matti Jutila
- combinatorics, UT: Tero Harju, Iiro Honkala, Juhani Karhumäki, Jouko Kari, Arto Salomaa
- applied analysis, UH: Matti Lassas, Lassi Päivärinta
- applied analysis, UTH: Gustaf Gripenberg, Stig-Olof, Londen, Olavi Nevanlinna, Juhani Pitkäranta, Rolf Stenberg
- applied analysis, UJ: Pekka Neittaanmäki
- applied analysis, ÅA: Olaf Staffans
- applied analysis, UTL: Heikki Haario
- mathematical physics, UH: Antti Kupiainen, Jouko Mickelsson
- biomathematics, UH: Mats Gyllenberg
- stochasticity, UH: Esa Nummelin
- stochasticity, UTH, Esko Valkeila
- stochasticity, UJ: Stefan Geiss
- stochasticity, ÅA: Göran Högnäs, Paavo Salminen
- stochasticity, UV: Tommi Sottinen
- statistics (mathematical), UH: Elja Arjas, Pentti Saikkonen

- statistics (mathematical), UTa: Hannu Oja
- statistics (mathematical), UJ: Antti Penttinen
- statistics (mathematical), ÅA: Jukka Corander
- statistics (mathematical), UO: Lasse Holmström

6. There is one international mathematical research journal published in Finland: *Annales Academiae Scientiarum Fennicae*

The Finnish Mathematical Society is publishing jointly with the four other Nordic Mathematical Societies *Mathematica Scandinavica*. Since its foundation in 1882 at least one member of the Editorial Board of *Acta Mathematica* has been from Finland.

There are popular journals in Finnish and Swedish, for example, *Arkhimedes* of the Finnish Mathematical and Physics Societies, and *Solmu*, directed to high school students.

7. A brief overview of educational activities

There are several regular events in mathematics in general. The Finnish Mathematical Society organizes every second year 'Mathematics Days', a two-day national meeting. The Nordic Mathematical conferences have long traditions; they started in 1909. They have alternated in all five nordic countries in roughly four-year intervals. Since 2000 the three last ones have been organized jointly with some other nations; 2000 with AMS, 2005 with France, 2009 with the British. Recently there have been regular Estonian-Finnish conferences. There are every year some international high level mathematical conferences in special topics in Finland. One of the most prominent was Lars Ahlfos centennial conference in Helsinki in 2007. In analysis there are regular Nevanlinna colloquia which started in 1964. They have been organized in 2-4-year intervals, mostly in Finland or Switzerland, but also in USA and Japan. In these there has always been wide Finnish representation in participants, invited speakers and organizing committees.

The Instruction Subcomission (ICMI) is a subcommittee of the National Committee of Mathematics of Finland. After the great success of Finland in the PISA-survey, the ministry of education and politicians have been convinced of the excellency of the mathematics teaching in Finland. The instruction subcomission has made serious efforts to communicate the fact that the mathematical skills of the incoming higher education students have been declining. In 2007 the subcomission made an unsuccessful proposal for Finland to participate in the TIMSS-survey. Apparently, politicians were afraid of weaker success in TIMSS than in PISA. Eventually, Finland is now participating in the TIMSS-survey. Relating to the PISA-success, the subcomission organized with SMF in 2005 in Paris a colloquium titled "L'enseignement des mathématiques à partir de l'enquête PISA". The subcomission has been actively participating in the work directed by the Finnish National Board of Education towards strategies for improving Mathematics and Science education. The subcomission is and has been promoting the idea of math clubs. In 2008, three members of the subcomission participated in ICME-11 in Mexico. The subcomission typically meets two times per year and the members represent the entire field of players in mathematics teaching: from elementary school mathematics didactics to accomplished research mathematics.

8. Overview of mathematics in Finland

The main research area in mathematics of Finland is analysis. It has long traditions going back to E. Lindelöf, F. and R. Nevanlinna, L. Ahlfors and their fundamental contributions in classical complex analysis in the first half of the 20th century. In the 1950's a more modern part of complex analysis, the theory of quasiconformal mappings, became central in Finnish mathematics through the work of O. Lehto and his co-workers. In the 1960's and 70's O. Martio, S. Rickman P. Tukia and J. Väisälä developed systematically quasiconformal and quasiregular mappings in n -dimensional Euclidean spaces. Roots of large parts of the present day Finnish mathematics lie in these foundations. Quasiconformal mappings of one complex variable are still actively studied. Prime examples of this can be found in K. Astala's work: in the 90's he solved the fundamental problem on the area distortion of quasiconformal mappings receiving a Salem prize for it. In a paper of 2006 together with L. Päivärinta he solved an old problem of Calderon applying quasiconformal mappings to an inverse problem in partial differential equations. Quasiconformal mappings in higher dimensions also remain an active research area, with some highlights in the work of P. Koskela and his co-workers. Perhaps more importantly for the present day Finnish mathematics, interesting work has been done in several closely related areas, for example in non-linear partial differential equations and potential theory and mappings of finite distortion with relations to elasticity. These theories have also been developed in metric space settings with Heisenberg and more general Lie groups as primary specific cases.

Lindelöf had students going into several directions, including applied mathematics. Hj. Mellin, name known in Mellin transformation, was not a student of Lindelöf, but e.g. E.J. Nyström was. Nyström's active years were on 1930's and in numerical analysis certain numerical approximation methods carry his name. From these origins a strong school of numerical analysis at UTH has developed, today represented among others by O. Nevanlinna in applications of operator theory to numerical analysis, and J. Pitkäranta and R. Stenberg in finite element methods. A more recent strong group in applied analysis is that in inverse problems (M. Lassas and L. Päivärinta among others). It has spread to five Finnish universities with a wide scientific spectrum from pure mathematics (e.g. the above mentioned Calderon's problem with connections to quasiconformal mappings) to concrete applications in, for example, astronomy and medicine (via tomography). From others in applied analysis one should mention at least O. Staffans in control theory at ÅA.

Another internationally active research area in Finland is discrete mathematics. This started as research in number theory (M. Jutila as one of the present researchers). Since 1970's A. Salomaa became a prominent figure among Finnish mathematicians. His achievements and views, complemented by pioneering research of A. Tietäväinen, made Finland a highly recognized research center in several areas of discrete mathematics motivated by computer science and information transmission. Over the last 20 years a number of classical problems have been solved by Finnish researchers. For instance, Erdős problem on unavoidable sequences was solved by V. Keränen, the equivalence problem for multitape automata was solved by T. Harju and J. Karhumäki. Also, J. Kari made two fundamental contributions to the theory of tilings and cellular automata. The coding theory traditions have been successfully

developed by I. Honkala. In addition, the above mentioned researchers have had a prominent influence in solving several well-known and central problems, like the Ehrenfeucht compactness conjecture for free semigroups, Conway's conjecture on commutation of languages and the road coloring problem.

In addition to these three main general areas, there are several good smaller groups and individuals. A strong name in stochastics was K. Karhunen, whose work on late 1940's lead to Karhunen-Loeve expansion. Presently there are good groups in stochastics in UH (E. Nummelin), in ÅA (G. Högnäs and P. Salminen) and in UTH (E. Valkeila), and in statistics in UH (E. Arjas) and UTa (H. Oja). In UH there is an internationally well-known group in mathematical logic lead by J. Väänänen.

One indication of the strength of Finnish mathematics (in particular appropriate in connection of IMU) are the many invited speakers at ICM. Since 1990 they are A. Kupiainen (1990 and 2010), P. Tukia (1994), K. Astala and P. Mattila (1998), T. Kilpeläinen (2002), O. Staffans (2006) and P. Koskela (2010).

An important feature in Finnish mathematics has been the central role of Finland in the European Mathematical Society. Several Finnish mathematicians and other employees have been active in its operation and the central office of EMS has been in Finland since it was founded in 1990.

Nevanlinna prize has been granted at the ICM's since 1982 for outstanding contributions in mathematical aspects of information sciences. It is sponsored by the University of Helsinki.