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The Finnish Centre of Excellence (CoE) in Analysis and Dynamics Research belongs to the national programme for Centres of Excellence in Research for the years 2008-2013. The CoE brings together leading Finnish mathematicians working in analysis and its applications, and with a common interest in various aspects of dynamics.

Analysis and Dynamics

The modern field of dynamics emerged in the 60's and 70's when computer simulations started to reveal the extraordinary rich phenomena present in simple dynamical models. One of the earliest examples of such "chaotic" behaviour emerged from models of population dynamics--one of the central fields of mathematical biology. A theoretical landmark was the application of ideas from mathematical physics dealing with renormalization and universality to iterations of maps of one or few variables. Subsequently powerful methods from complex analysis were used to understand the structure of complex iterations and the Julia and Mandelbrot sets that had caught great attention. The field of geometric measure theory was invigorated by the study of such fractals that were attractors of the dynamics, describing its observable long time properties.

The dynamical origin of pattern formation in natural systems became the object of study of extended dynamics which employed as mathematical tools nonlinear partial differential equations and systems of coupled maps. These are systems where global order (spatial pattern) arises from local chaos. One of the most interesting phenomena of global chaos in extended systems is fully developed turbulence. Significant progress in its theoretical understanding was achieved in the turn of the millenium when ideas from quantum field theory led to the explanation of the phenomenon of intermittency in certain stochastic models of turbulent advection.

The past few years have seen a remarkable coming together of mathematical physics and complex analysis in the study of two dimensional random fractals. The stochastic Loewner evolution of O. Schramm, abbreviated as SLE, combines ideas from stochastic and complex analysis to the study of random curves and sets that describe phase boundaries in physical models of magnetization and percolation.

Goals of the Centre of Excellence

Our main goal is to develop a new culture in Finnish mathematics that encourages collaboration between different fields in pure mathematics and connects the highest level of pure mathematics with applications. As has been seen in numerous cases, this will also have an invigorating effect on pure mathematics. Indeed, the whole modern theory of dynamical systems is a prime example of such fruitful interaction between pure theory and real world applications. The CoE is well positioned to achieve this goal. The group is truly interdisciplinary and provides a framework for pure mathematicians to contribute to problems of mathematical physics and biology as well as to more practical problems.

We also aim to renew researcher training in our fields. A broad cultural background is becoming more and more essential even in pure mathematics. However, Finnish PhD students in mathematics tend to specialize very early in their career and often lack the capacity to enter new fields or acquire unfamiliar tools even when this would be useful. We want to change this by offering them a broad education, and by encouraging them to move between fields in their post-doc phase.

The proposed CoE provides an environment that facilitates such education. The presence of applied fields in the CoE will also improve the job opportunities of pure mathematics students.

We want to create a research and researcher training centre in Finland of top international level that can compete for the best PhD students and post-docs in our fields on the market. The participating groups are of highest level in their fields, and by bringing them together we aim to reach the critical mass to attract students from within Finland as well as from abroad.

The members have strong international collaboration networks with top researchers in the world in their respective fields. This will facilitate student and post-doc mobility to and from Finland.

